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Project: Surface Water Drainage Strategy (SWDS)

Prepared for: Fluent Ads

Reference: SWDS 3110

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Site Location: London School of Theology, Green Lane, Northwood, Middlesex, HA6 2UW

Proposed Development: It is understood that the development is for the removal of two existing 2 storey buildings and the construction of a new 2.5 storey apartment block with basement. The development will provide 12 residential units.

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Contents

1. Summary

SITE DETAILS			
Site Name	London School of Theology, Green lane, Northwood, HA6 2UW		
Total Site Area	0.28 ha		
Site Area which is positively drained	0.28 ha		
Developed Area	0.15 ha		
Predevelopment Use	Site already developed for residential purposes.		
Site Constraints	Residential Site		
	Groundwater Source Protection Zone: YES. Outer zone (Zone 2).		
	Groundwater Vulnerability Zone: Minor Aquifer High		
	- Poor Infiltration Soils		
	- Unknown Groundwater Table		
IMPERMEABLE AREAS			
	Existing	Proposed	Difference (Proposed - Existing)
Impermeable Area (Ha)	0.13 ha	0.16 ha	0.03 ha
Drainage Method (Infiltration/Sewer/Watercourse)	Sewer	Sewer	N/A
PROPOSED TO DISCHARGE SURFACE WATER VIA			
	YES	NO	Evidence
Infiltration		X	Soils with Poor Infiltration Media.
To Watercourse		X	Discharge to watercourse is not viable.
To Surface water sewer	X		
Combination of above		X	
PEAK DISCHARGE RATES			
	Greenfield Rates (l/s)	Proposed Pre-development Rates (l/s)	Proposed Discharge Rates (l/s)
Greenfield Q_{BAR}	**1.28 l/s**	N/A	N/A
1 in 1	1.09 l/s	18.80 l/s	3.80
1 in 20	N/A	22.80 l/s	-
1 in 30	3.15 l/s	22.80 l/s	3.80
1 in 100	4.08 l/s	22.90 l/s	3.80
1 in 100 plus climate change	N/A	N/A	3.80

SITE STORAGE VOLUME		
Source Control Provided	Yes	
Interception Volume Storage (Daily Storms)	$7m^3$	
Attenuation Volume Storage (1 in 100 year + CC storm, critical duration)	$95m^3$	
Approach used for Long Term storage (LTS) Either Use Long Term Storage or Discharge at very low rate	Discharge at very Low Rate, thus LTS is not taken into account.	
LTS (1 in 100 years, 6 hours event)	$0.00\ m^3$	
Total Site Storage	$102m^3$	

INFILTRATION FEASIBILITY ANALYSIS		
Geology	Pre-quaternary Marine/Estuarine Sand and Silt Clay to Silt	
Infiltration Rates	Less than $3x10^{-8}$ m/s	This value must be confirmed through trial pit infiltration tests on site prior to the final detailed drainage design stage being carried out.
Infiltration Rates Suitability	Unsuitable	
Ground Water Level	Unknown	It is recommended that a groundwater level check be undertaken at the later detailed design stage in order to accurately identify the depth of the water table at the site.
Is the site within a known Source Protection Zones (SPZ)?	Yes	Outer Zone (Zone 2)
Site's Contamination	Site already developed, thus there is a potential contamination due to petrochemical pollutants of the cars.	
Infiltration Feasibility	NO	
If Infiltration is not feasible, how is the Storage Requirements Approach?	Simple Approach. Discharge Long Term Storage and Attenuation Volume at very low discharge rate.	

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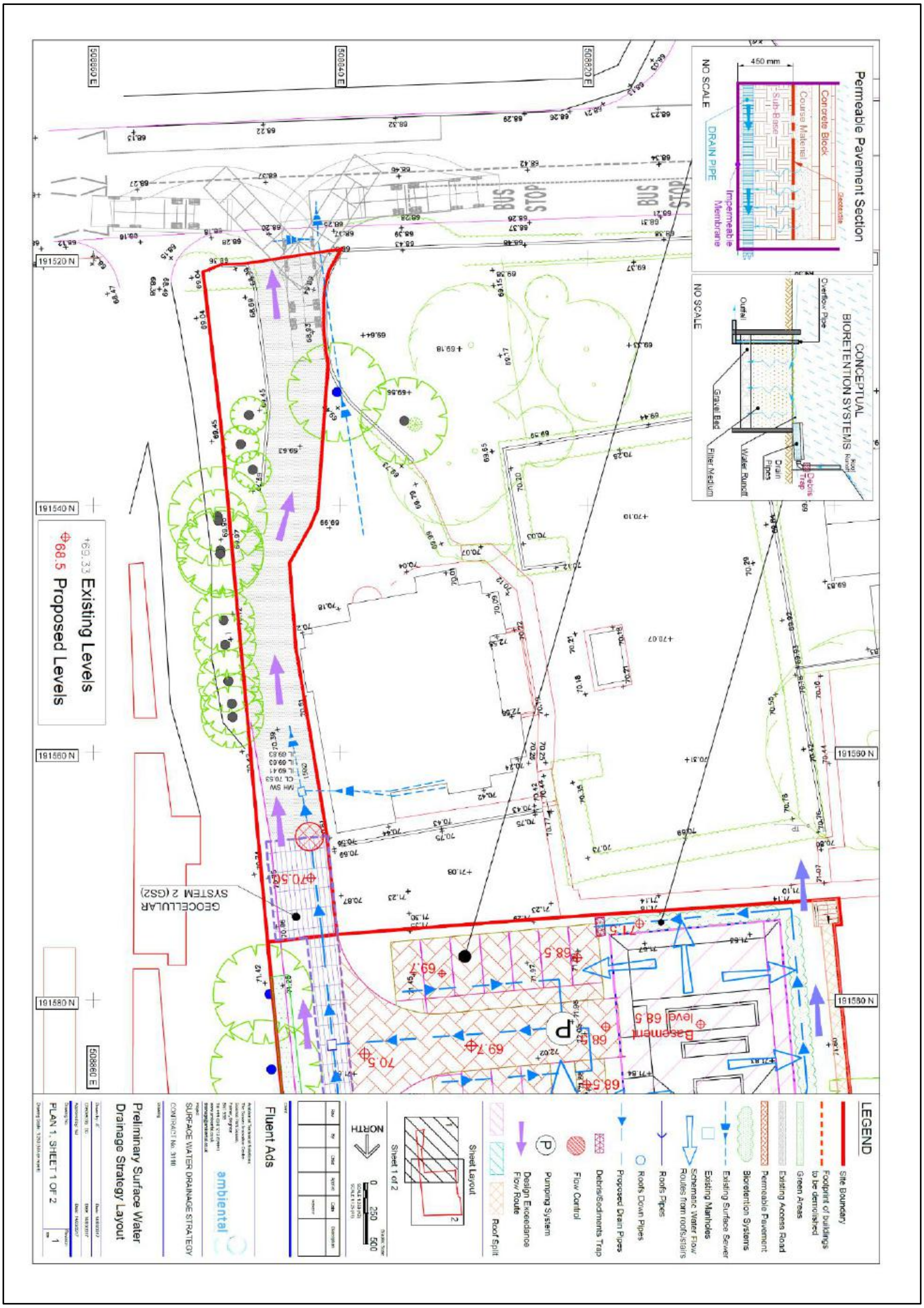
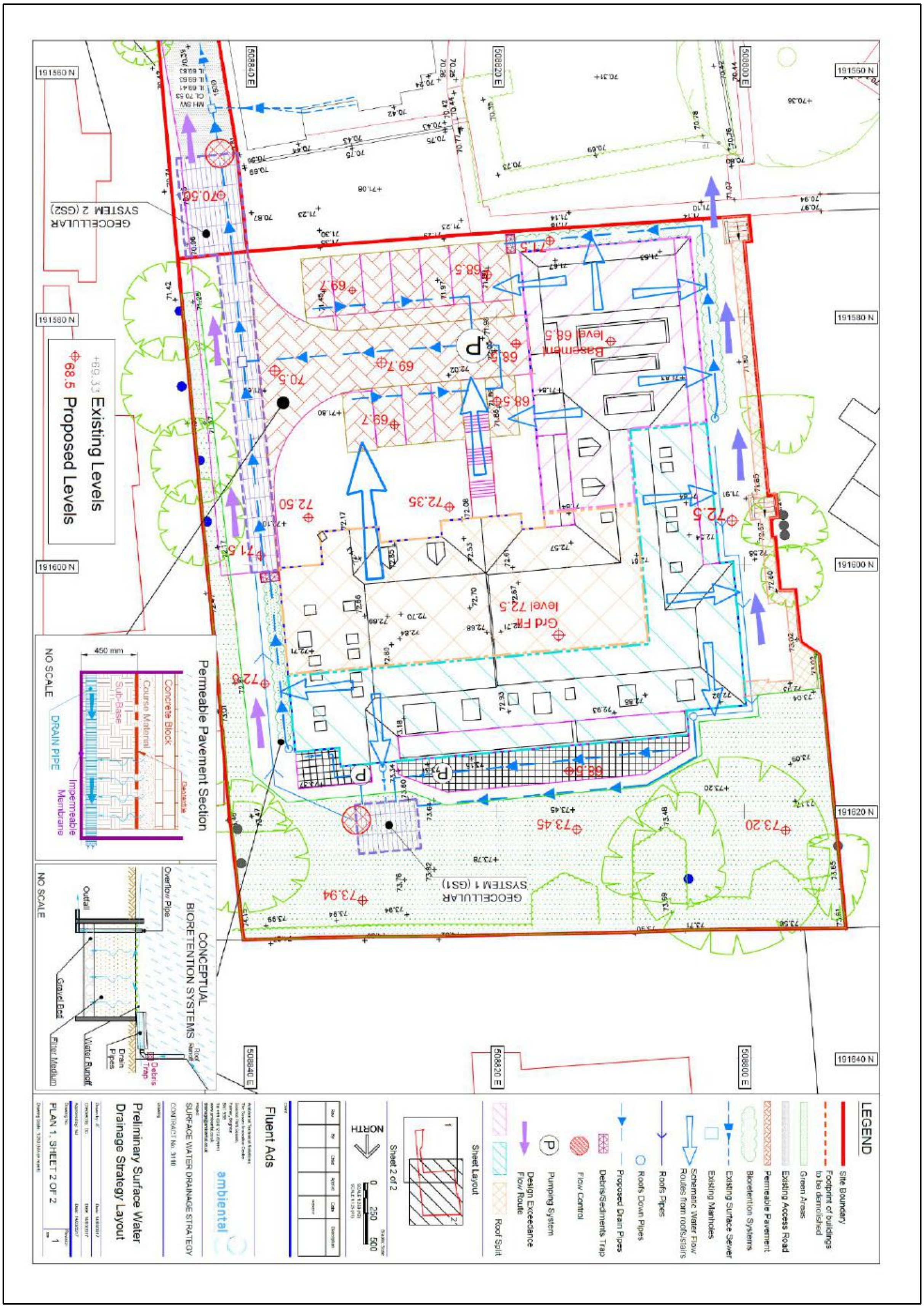
PROPOSED DRAINAGE COMPONENTS	
Permeable Pavement	Pervious surfaces provide a surface suitable for pedestrian and/or vehicular traffic, while allowing rainwater to infiltrate through the surface and into underlying layers.
Bioretention Systems	Bioretention areas are shallow landscaped depressions which are typically under drained and rely on engineered soils, enhanced vegetation and filtration to remove pollution and reduce runoff downstream. They are aimed at managing and treating runoff from day-to-day rainfall events.
Geocellular System	Geocellular systems can be used to control and manage rainwater surface water runoff as a storage tank. The modular/honeycomb nature of geocellular systems means that they can be tailored to suit the specific requirements of any site.
Rills/Channels	Canals and rills are open surface water channels with hard edges. They are simply channels that water flows along whereby they can have a variety of cross sections to suit the urban landscape, including the use of planting to provide both enhanced visual appeal and water treatment.
Flow Control	A self-activating device that provides improved hydraulic performance over conventional flow controls such as orifice plates and throttle pipes and reduced maintenance requirements.

DESIGN CHECKS		
Drainage Systems Measures	Permeable Pavement, Geocellular System, Bioretention Systems, Flow Control (Hydrobrake or Vortex Control), Pumping System	
How are rates being restricted	Hydrobrake	
Key Drainage component	Geocellular Systems and Pumping Systems	
Drainage Systems Maintenance	Supplier must provide appropriate guidance for maintenance	
All SuDS storage located outside Q100 floodplain	Yes	
Provision for blockage / Design Exceedance	Yes	Exceedance routes are provided
Time taken for 50% of storage to drain down	2.34 hours	

Proposed Surface Water Drainage Strategy Layout




LEGEND
Site Boundary
Footprint of buildings to be demolished
Green Areas
Existing Access Road
Permeable Pavement
Bioretention Systems
Existing Surface Sewer
Existing Manholes
Schematic Water Flow Routes from roofs/stairs
Roofs Pipes
Roofs Down Pipes
Proposed Drain Pipes
Debris/Sediments Trap
Flow Control
Pumping System
Design Exceedance Flow Route
Roof Split
Sheet Layout
Sheet 2 of 2
NORTH
Fluent Ads
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SURFACE WATER DRAINAGE STRATEGY
Preliminary Surface Water Drainage Strategy Layout
PLAN 1, SHEET 2 OF 2
Permeable Pavement Section
450 mm
Concrete Block
Course Material
Sub-Base
DRAIN PIPE
Impermeable Membrane
NO SCALE
CONCEPTUAL BIORETENTION SYSTEMS
Overflow Pipe
Outfall
Gravel Bed
Filter Medium
Water Runoff
Drain Pipes
Debris Trap
+69.33 Existing Levels
68.5 Proposed Levels
GEOCELLULAR SYSTEM 2 (GS2)
GEOCELLULAR SYSTEM 1 (GS1)
Basement level 68.5
Grd Flr level 72.5

2. Introduction

2.1 This Surface Water Drainage Strategy has been prepared by Ambiental Technical Solutions, in respect of a planning application for the redevelopment of two existing storey buildings at the London School of Theology, Green Lane, Northwood, Middlesex, HA6 2UW (X:508808; Y:191602). See Appendix 1, Plan 1 – Site Location, Plan 2 – Plan Location and an extract of the Plan 1 on the Figure 1 below.

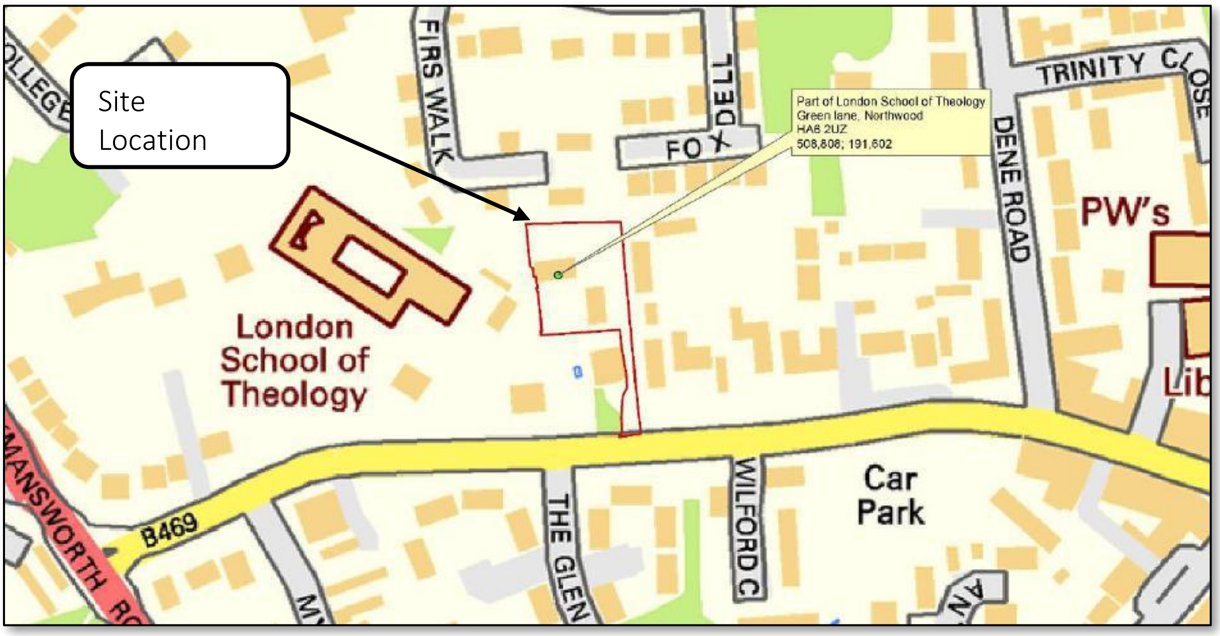

Figure 1 - Extract of Appendix 1, Plan 1 - Site Location (Source: OS-Street View). Site boundary shown in red.

Development Proposal

2.2 It is understood that the development is for the removal of two existing 2 storey buildings to build a new 2.5 storey apartment block with basement, providing 12 residential units.

2.3 This study is based on the plans in Appendix 1 (refer to Plans 1 to 12. Plans 1 and 4 were made in-house, while the remaining plans were provided by the client).

Need for Study

2.4 The purpose of this assessment is to demonstrate that the development proposal outlined above can be satisfactorily accommodated without worsening flood risk for the area and without placing the development itself at risk of flooding, as per National guidance provided within the National Planning Policy Framework (NPPF).

3. Development Description and Site Area

3.1 The site forms part of the London School of Theology which is located within Northwood to the north of the London Borough of Hillingdon. Specifically, it is bounded by Green Lane to the south, several dwellings to the north and the east, while the main building of the London School of Theology is to the west. The site is currently formed of two 2-storey buildings, a square grass area as well as access from Green Lane. Refer to Appendix 1, Plan 1 – Site Location, Plan 2 – Plan Location, Plan 3 – Topographical Survey of the Site as well as the Figures 1 (above) and 2 (below).

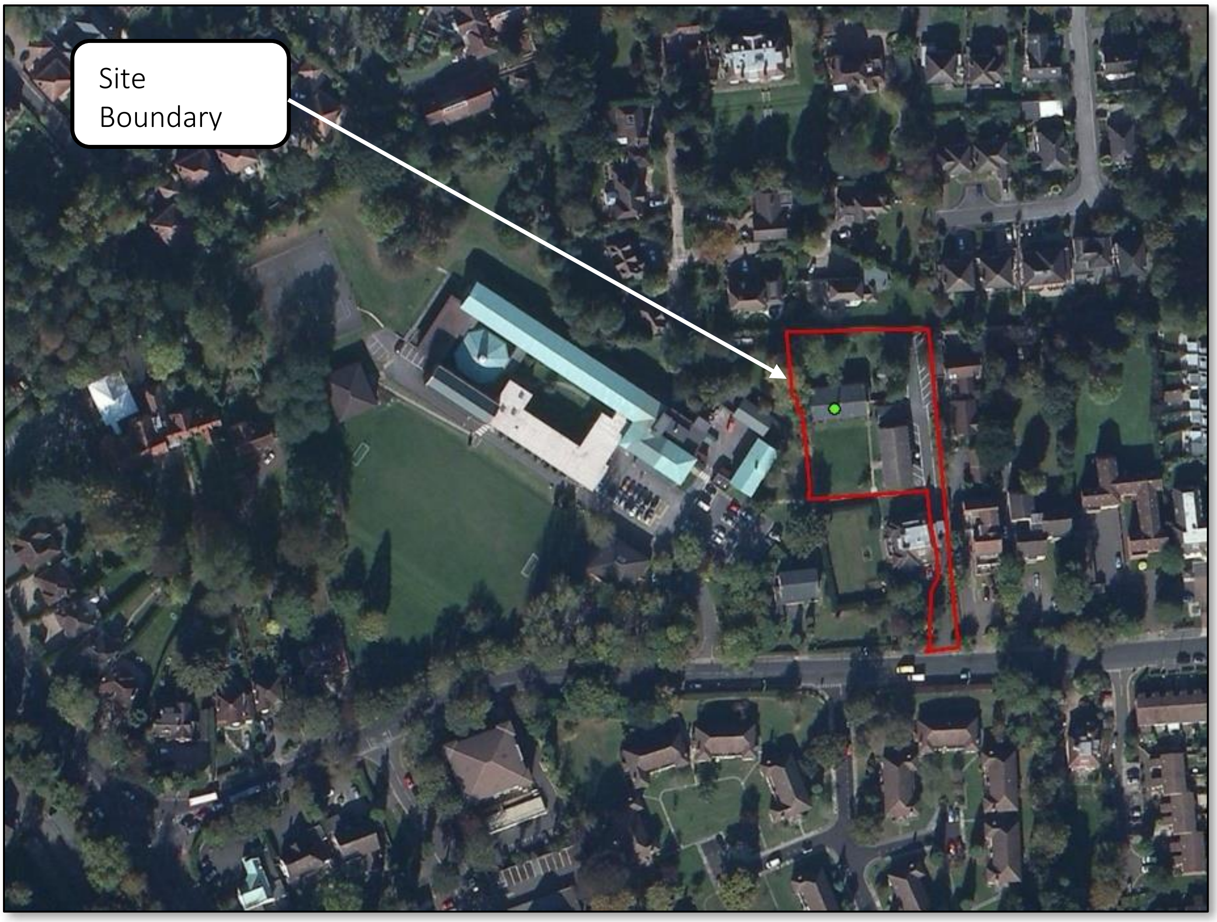

Figure 2 - Aerial View of Development Site (Source: ESRI). Site boundary shown in red.

3.2 It is understood that the development is for the removal of two existing 2 storey buildings to build a new 2.5 storey apartment block with basement, providing 12 residential units. See Appendix 1, Plan 5 – Proposed Site Layout and Figure 3 overleaf.

Figure 3 - Extract of Appendix 1, Plan 5 – Proposed Site Layout.

3.3 As the existing site is already developed, it is considered **brownfield**.

3.4 The total area of the site is approximately 3030.2m^2 (0.3 Ha), based on plans the provided by the client. However road access is subtracted as it is not to be modified. Hence, the area on the Site to be taken into account is approximately 2766.6m^2 (approximately 0.28Ha).

3.5 Having said that, the existing site to be modified is considered partly pervious (1492.75m^2, approx. 0.15Ha), due to the existing green areas, thus there is an existing impervious area of 1273.86m^2 (approximately 0.13 Ha). Following development, the pervious areas on site will be reduced to approximately 1166m^2 (approximately 0.12 Ha), while the impervious areas will be increased to approximately 1601m^2 (0.16 Ha).

3.6 According to the topographical survey provided by the client, the topography of the site ranges from 68.33mAOD[1] to 74.26mAOD. Hence the site can be considered to slope to the south with likelihood of rapid runoff within the property boundary. Refer to Appendix 1, Plan 3 – Topographical Survey of the Site, Plan 4 – Existing Surface Water Flow Pathways and an extract of the Plan 4 on the Figure 4 below.

Figure 4 – Extract of Appendix 1, Plan 4 – Existing Surface Water Flow Pathways.

[1] mAOD: meters Above Ordnance Datum.

Existing Drainage Infrastructure

3.7 The existing site is currently developed, thus it is considered that there is a drainage infrastructure associated to it. This is confirmed by the topographical survey provided by the client. Refer to Appendix 1, Plan 3 – Topographical Survey of the Site and an extract of it on the Figure 5 below. Based on this plan, the surface water of the Site is drained by a 100mm of diameter pipe. See Figure 5 below:

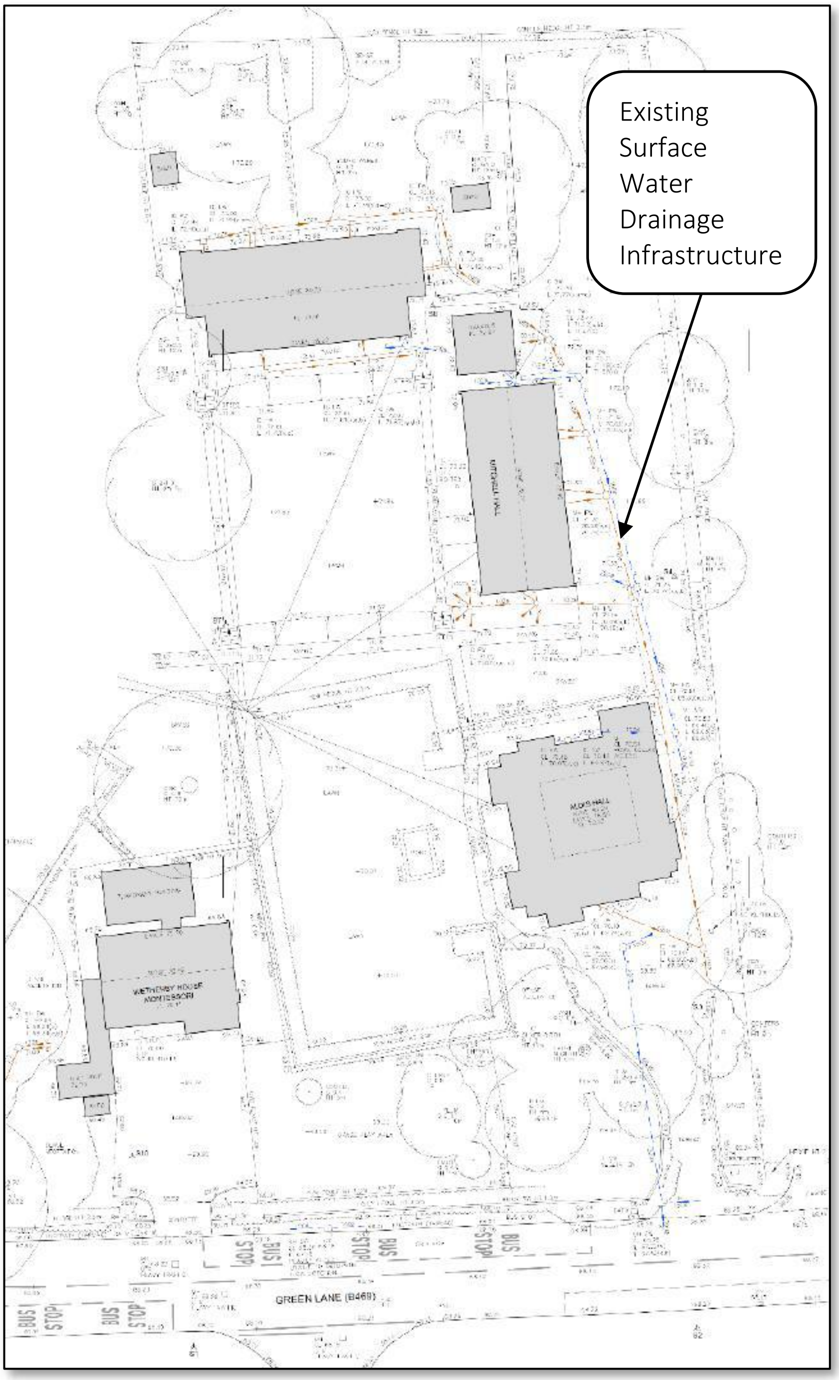

Figure 5 – Extract of Appendix 1, Plan 3 – Topographical Survey of the Site.

3.8 Although public sewer records were not provided by the client, **there is a potential opportunity of utilising the public sewer network for surface water discharging purposes.**

Existing Ground Conditions

3.9 The British Geological Survey (BGS) Map indicates that the bedrock underlying the site is the *London Clay Formation – Clay, Silt and Sand* and the *Lambeth Group – Clay, Silt and Sand*. (See an extract from the BGS Geology map in Appendix 2, Figure 1.A – Bedrock Geology, London Clay Formation and Figure 1.B – Bedrock Geology, Lambeth Group).

3.10 The *London Clay Formation* is a sedimentary bedrock formed approximately 34 to 56 million years ago in the Palaeogene Period. The local environment of the origin of these rocks was previously dominated by deep seas, being formed from infrequent slurries of shallow water sediments which were then redeposited as graded beds. The Lambeth Group, however is a sedimentary bedrock formed approximately 56 to 66 million years ago in the Palaeogene Period as well. The local environment was previously dominated by swamps, estuaries and deltas, thus these rocks were formed in marginal coastal plains with lakes and swamps.

3.11 There are no records in relation to the Superficial Deposits in the BGS database. (See the extract from BGS Geology Map in Appendix 2, Figure 2 – Superficial Deposits).

3.12 The Soil Parental Material in the area taken from the UK Soil Observatory (UKSO) website is classified as *Pre-quaternary Marine/Estuarine Sand and Silt* while the Soil Texture is *Clay to Silt* to the north of the site and *Loam to Silty Loam* to the south. See Appendix 2, Figure 3 – Soil Parental Material as well as the Appendix 2, Figure 4.A – Soil Texture-North, Clay to Silt and the Figure 4.B – Soil Texture, South, Loam to Silty Loam.

3.13 Standard values from the specialized literature *CIRIA 753 'The SUDS Manual'* suggest the infiltration coefficient of these types of soils is less than 1.08×10^{-4} m/h (3×10^{-8} m/s) for clayey soils, the range for loam soils is between 0.00036 m/h (1×10^{-7} m/s) and 0.018 m/h (5×10^{-6} m/s), while the range for silty loam soils is between 0.00036 m/h (1×10^{-7} m/s) and 0.036 m/h (1×10^{-5} m/s). See Table 1 – Typical Infiltration Coefficients based on Soil Texture below. It is recommended that these values are checked through trial pit infiltration tests on site prior to the final detailed drainage design being carried out.

SOIL TYPE	Typical infiltration Coefficients (m/h)
Poor Infiltration media	
Loam	0.00036 - 0.018
Silt Loam	0.00036 - 0.036
Very Poor Infiltration media	
Clay	$< 1.08 \times 10^{-6}$

Table 1 – Typical Infiltration Coefficients based on Soil Texture

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3.14 There are three boreholes from the BGS database, very close to the site to the east. The borehole's reference are TQ09SE50, TQ09SE103 and TQ09SE104 located at approximately 120, 90 and 80 metres respectively. See Appendix 2, Figure 5 – Boreholes Map and an extract of it on the Figure 6 below as well as the boreholes data on the Appendix 2, Figures 5.2.1, 5.2.2, 5.3.1 and 5.4.1. Based on the description of the Boreholes TQ09SE103 and TQ09SE104, the site is underlain by clayey layers.

Figure 6 - Extract of Appendix 2, Figure 5.1 – Boreholes Location Map

3.15 It is recommended that a groundwater level check be undertaken later at the detailed design stage, in order to accurately identify the depth of the water table at the site.

3.16 Additionally, it is important to note for the infiltration devices they should follow the guidance of the specialized literature the *CIRIA 753 – 'The SuDS Manual'*, section 25.2.2:

> *"Groundwater levels should be investigated to ensure that the base of a proposed infiltration component is at least 1 m above the maximum anticipated groundwater level (taking account of seasonal variations in levels and any underlying trends)"*.

3.17 Thus, in compliance with the *CIRIA 753 – 'The SuDS Manual'*, if an infiltration device was proposed, the groundwater table must be always at least 1m below of the bottom of the device. This measure could be loose to fix the groundwater table just below the bottom of the device, under the consent of the corresponding environmental regulator or drainage approval body.

3.18 The site lies in within aquifers with significant intergranular flow and considered as a *Low Productive Aquifer* according to the BGS hydrogeological database (see Appendix 2, Figure 6 – Hydrogeology).

3.19 The EA's[2] *Groundwater Source Protection Zone Map* confirms that the site lies within a Source Protection Zone considered as *Outer Zone (Zone 2)*, as well as within a Groundwater Vulnerability Zone classified as *Minor Aquifer High*. See Appendix 2, Figure 7 - Groundwater Source Protection Zones and Figure 8 – Groundwater Vulnerability Zones.

Nearby Watercourses and Drainage

3.20 In general terms, the runoff from the existing site flows to south of the site where the lowest point is located, according to the topographical survey data provided by the client.

3.21 A watercourse, considered as a main river by the Environmental Agency is located approximately 630m to north-east of the red line application boundary. See Figure 7 below.

3.22 **Thus, it is considered that there is no watercourse close enough to the site for discharging purposes.**

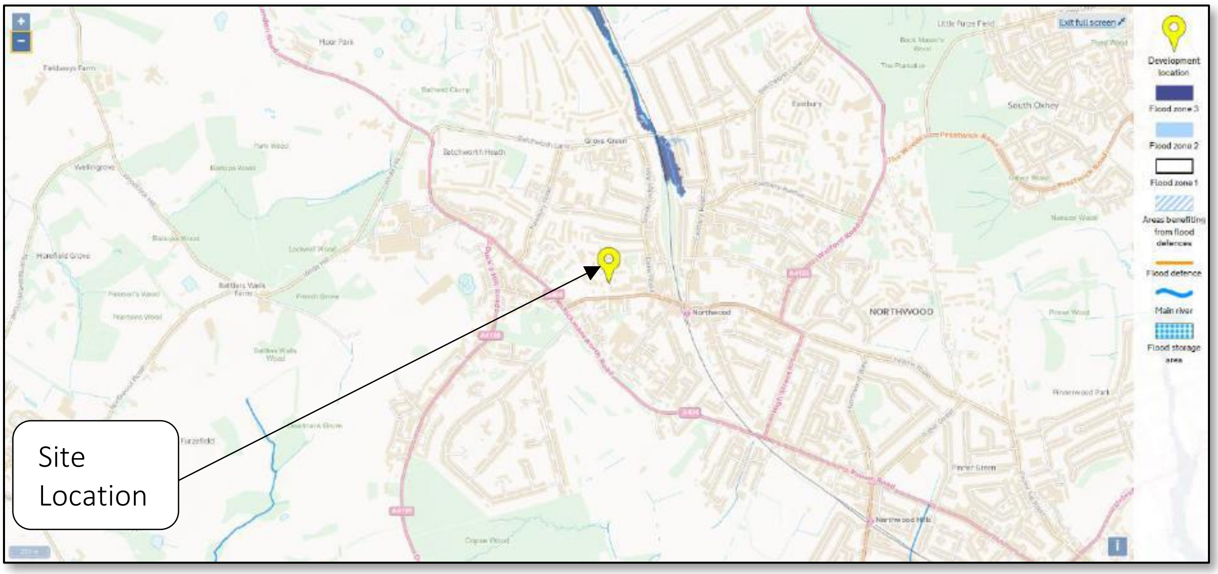


Figure 7 – Extract of EA Flood Map for Planning (Source: EA).

[2] EA: Environmental Agency

4. Surface Water Drainage

4.1 In order to mitigate flood risk posed by the proposed development, adequate control measures are required to be considered. This will ensure that surface water runoff is dealt with at source and the flood risk off site is not increased.

4.2 The existing site is already developed, being considered brownfield, and it is comprised of impervious surfaces areas; thus there is an existing drainage infrastructure which is confirmed by the Topographical Survey provided by the client. In accordance with the proposed development plans, the proposed development will increase the impermeable surface cover to the site by approximately 327m^2.

4.3 Based on the Policy 5.13 of the London Plan 2016:

"Development should utilise sustainable urban drainage systems (SUDS[3]) unless there are practical reasons for not doing so, and should aim to achieve greenfield run-off rates and ensure that surface water run-off is managed as close to its source as possible in line with the following drainage hierarchy:

1. *Store rainwater for later use;*
2. *Use infiltration techniques, such as porous surfaces in non-clay areas;*
3. *Attenuate rainwater in ponds or open water features for gradual release;*
4. *Attenuate rainwater by storing in tanks or sealed water features for gradual release;*
5. *Discharge rainwater direct to a watercourse;*
6. *Discharge rainwater to a surface water sewer/drain;*
7. *Discharge rainwater to the combined sewer.*

Drainage should be designed and implemented in ways that deliver other policy objectives of this Plan, including water use efficiency and quality, biodiversity, amenity and recreation".

4.4 Therefore, the runoff arising from the redevelopment will need to be managed in accordance with sustainable drainage principles.

Infiltration Potential

4.5 The BGS database and the UK Soil Observatory records indicate the site is predominantly underlain by clayey soils which are unlikely to be suitable for infiltration drainage. Furthermore, the local Surface Water Management Plan, London Borough of Hillingdon, indicates that the area is unsuitable for infiltration drainage. See Appendix 2, Figure 9 – Infiltration SUDS Suitability Map.

4.6 Therefore it is proposed that surface water will be discharged post development via attenuation SuDS.

[3] SuDS: Sustainable Drainage Systems which are able to manage surface water that take account of water quantity (flooding), water quality (pollution) biodiversity (wildlife and plants) and amenity.

Runoff rates

4.7 The specialised literature *CIRIA 753 'The SUDS Manual'* provides two approaches guidance for the rates of discharge in relation to the Long-Tem Storage:

- Approach A

"Where there is extra volume generated by the development that has to be discharged (because there are no opportunities for it to be infiltrated and/or used on site), this volume should be released at a very low rate (eg < 2 l/s/ha or as agreed with the local drainage approving body and/or environmental regulator) and the 1:100 year greenfield allowable runoff rate reduced to take account of this extra discharge." (Kellagher, 2002).

- Approach B

"An alternative approach to managing the extra runoff volumes from extreme events separately from the main drainage system is to release all runoff (above the 1 year event) from the site at a maximum rate of 2 l/s/ha or QBAR, whichever is the higher value (or as agreed with the drainage approving body and/or environmental regulator). This avoids the need to undertake more detailed calculations and modelling."

4.8 As Infiltration techniques are not viable, it is proposed to discharge all runoff due to any storm events above than 1 in 1 year event at a low rate such as Q_{BAR} or as agreed with the drainage approving body in compliance with the **Approach B** above.

4.9 Greenfield runoff rates have been calculated using the *Institute of Hydrology Report 124 (*Marshall and Bayliss, 1994*)*, as recommended in the *CIRIA 753 'The SUDS Manual'* (See calculations in Appendix 3, Table 1 – Greenfield Runoff Rates Calculation Summary).

4.10 The Greenfield runoff rates for several storm durations for various return periods have been calculated based on the following equation:

$$QBAR_{rural} = 0.00108 * AREA^{0.89} * SAAR^{1.179} * SOIL^{2.17}$$

Where,

$Q_{BAR,rural}$: Mean Annual Flood (m^3/s).

AREA: Catchment Area (km^2).

SAAR: Standard Average Annual Rainfall for the 1941 to 1970 (mm).

SOIL: Soil Index of the catchment from Wallingford Procedure Volume 3.

Equation 1 – IH 124 Mean Annual flood flow Rate Equation.

4.11 Preliminary calculations based on Equation 1 show that the *Greenfield Runoff Rate* ($Q_{BAR,rural}$) from 50Ha is 231.34l/s. According to the size area positively drained (0.28ha), **the *Greenfield Runoff Rate* from the area of the site is 1.28l/s (4.63l/s/ha)**. Other results properly factored for each return period and area of the site are shown in Appendix 3, Table 1 – Greenfield Runoff Rates Calculation Summary.

4.12 The CIRIA 753 'The SUDS Manual', Section 24.5, specifies that the runoff rate and runoff volume estimation to previously developed sites can be carried out as per the paragraph below:

"(…)

Runoff characteristics for a previously developed site can be estimated in a number of ways:

1 Any land that has been previously developed is likely to have had a system in place to drain surface water runoff from the site. This drainage system may or may not have included storage and flow control systems. Where any drainage system is still operational, peak flow rates at the outfall for the relevant return periods (usually 1:1 year, 1:30 year and 1:100 year) can be demonstrated by producing a simulation model that includes an accurate representation of the drainage system and site area contributions – thus allowing derivation of an appropriate head-discharge relationship at the outfall.

It is recognised that existing drainage systems will probably be overwhelmed for the 1:30 and 1:100 year events and therefore the actual rate of discharge from the site in such scenarios is likely to be increased by overland flow contributions or surcharging. However, these effects should not be accounted for, and the discharge limit should be based solely on the flow rate from the piped system (thus providing a conservative estimate).

(…)".

4.13 Therefore in view of the above, a minimum flow based on the 1 in 20 year pre development runoff rate will be utilised as the limiting discharge rate from the site. In order to look into the existing runoff rates of the existing site, a storm sewer design simulation has been carried out using the industry standard software, Microdrainage v2016.1. The results from a variety of rainfall events are shown on the Appendix 3 – Calculations, Existing Runoff Rates and a summary of them on the Table 2.

4.14 Additionally, and following the guidance of the Sustainable Design and Construction SPG, Mayor of London:

"(…)

3.4.8 Most developments referred to the Mayor have been able to achieve at least 50% attenuation of the site's (prior to re-development) surface water runoff at peak times. This is the minimum expectation from development proposals.

3.4.9 There may be situations where it is not appropriate to discharge at greenfield runoff rates. These include, for example, sites where the calculated greenfield runoff rate is extremely low and the final outfall of a piped system required to achieve this would be prone to blockage. An appropriate minimum discharge rate would be ***5 litres*** *per second per outfall.*

3.4.10 All developments on greenfield sites must maintain greenfield runoff rates. ***On previously developed sites, runoff rates should not be more than three times the calculated greenfield rate****. The only exceptions to this, where greater discharge rates may be acceptable, are where a pumped discharge would be required to meet the standards or where surface water drainage is to tidal waters and therefore would be able to discharge at unrestricted rates provided unacceptable scour would not result.*

(…)".

4.15 It should be noted that although a rate of 5l/s has been historically considered as a limiting discharge when Q_{BAR} was lower than that (this is due to the fact that most of devices would require an outlet orifice size smaller than 50mm which would increase the susceptibility of blockage and failure); currently there are flow control devices that can be designed up to a limiting discharge rate of 1.0l/s.

4.16 Therefore, taking into consideration the discharge restrictions exposed above, and according to the guidance of the Sustainable Design and Construction SPG, Mayor of London, if the Greenfield Runoff Rate is 1.28l/s, a limiting discharge of 3 times greenfield runoff rate could be proposed, 3.84l/s. Additionally, the proposed rate is lower than the 50% of the existing 1 in 100 year pre-development runoff rate as required by the Sustainable Design and Construction SPG of the Mayor of London.

4.17 **Hence, a limiting discharge of 3.8l/s will be utilised as the design runoff rate**. See Table 2 – Surface Water Discharge Rates Summary below:

SURFACE WATER DISCHARGE RATES SUMMARY						
	Impermeable Area (m²)	Discharge Rates (l/s)				
		Q_{BAR}	1 year	20 years	30 years	100 years
Greenfield Site	0	**1.28**	1.09	-	3.15	1.08
Existing Site (Using Microdrainage)	1274	-	18.8	22.8	22.8	22.9
Reduction of 50% for the Existing Site	1274	-	9.4	11.4	11.4	11.45
Limiting Discharge for Proposed Site	1600	-	3.8	-	3.8	3.8
Designed Discharge for Proposed Site (from calculations in Appendix 3)	**1761 (Urban Creep Factor applied)**	**-**	**3.6**	**-**	**3.8**	**3.8**

Table 2 – Surface Water Discharge Rates Summary

4.18 It can be seen from the Table 2 that the proposed limiting discharge rates are lower than the existing runoff rates for the 1 in 1, 1 in 30 and 1 in 100 years rainfall events. Proposed limiting discharge rates will reduce the outflow capacity of the existing drainage infrastructure network within the site and improving the existing discharge conditions.

Interception Storage

4.19 Preliminary calculations have been carried out for a typical rainfall depth of $5mm/m^2$ to store the volume owing to these very frequent storms.

4.20 Urban Creep Factor (UCF) is defined as any increase in the impervious area that is drained to an existing drainage system without planning permission being required, such as the construction of patios, conservatories, small extensions, etc. Hence, an increase in paved surface area of 10% is often suggested by the *CIRIA 753 'The SUDS Manual'*. Also, a typical Runoff Percentage of 80% has been taken into account.

4.21 **Based on the size of the whole area of the site, the UCF and the Runoff Percentage, the Interception Storage is 7.04m^3.**

Long Term Storage

4.22 **Long-Term Storage is not taken into account, as defined by *Approach B* in Paragraph 4.7.**

Attenuation Storage

4.23 Attenuation storage is needed to temporarily store water during periods when the runoff rates from the development site exceed the allowable discharge rates from the site.

4.24 Rainfall depths for the 1 in 100 years Return Period plus 40% of climate change were produced using the *Microdrainage* software in order to estimate the largest volume, *critical storm*, for typical storm durations up to and including 48 hours for the proposed site limiting the discharge rate up to **3.8 l/s**. In addition to this, the Urban Creep Factor, 10%, is applied for the impervious surface. See summary calculations in Appendix 3, Calculations, Summary of Results for Proposed SuDS.

4.25 Thus, it meets with the minimum standards required by the DEFRA - Non-statutory technical standards for sustainable drainage systems (March 2015), to avoid the flood risk within the development in a 1 in 100 year rainfall event.

4.26 In terms of storage, for a 100 years storm event with an allowance for climate change **therefore the Attenuation Storage Volume required is 95m^3**. See summary calculations in Appendix 3, Calculations, Summary of Results for Proposed SuDS.

Storage Volumes

4.27 Preliminary calculations indicate that 95m^3 of storage will be required to attenuate all runoff above the 1:1 year storm events up to a 1 in 100 years return period storm event - with a 40% climate change allowance and including a 10% of Urban Creep Factor. Approximately 7m^3 of storage are required for the day-to-day rainfall as Interception Volume. Long-Term Storage Volume (6 hours, 100 year Return Period event) is not taken into account.

4.28 **Thus a Total Storage of 102m^3 is required to be managed through SuDS techniques.**

5. SuDS Assessment

5.1 In accordance with a SuDS management train approach, the use of various SuDS measures to reduce and control surface water flows have been considered in details for the development. Based on the hierarchy line of discharge provided by the Policy 5.13 of the London Plan 2016:

Drainage Hierarchy			
		Suitability	Comment
1.	Store rainwater for later use.	✓	The use of rainwater for a potential non-potable use such as gardening might be suitable.
2.	Use infiltration techniques, such as porous surfaces in non-clay areas.	×	Due to the geology at the site, infiltration is considered unsuitable.
3.	Attenuate rainwater in ponds or open water features for gradual release.	×	There is no ponds or open water features within the site. Besides that, space and topographical constraints would make too complicate to incorporate this type of storage water to the development.
4.	Attenuate rainwater by storing in tanks or sealed water features for gradual release.	✓	Due to the proposed layout, sealed water features for gradual release is considered suitable.
5.	Discharge rainwater direct to a watercourse.	×	There is no watercourses close enough to the site.
6.	Discharge rainwater to a surface water sewer/drain.	✓	There is an existing surface water drainage infrastructure within the site, thus it is taking into consideration.
7.	Discharge rainwater to the combined sewer.	-	Not taken into account.

Table 3 – Drainage Hierarchy

5.2 At this stage the practicality and viability of certain SuDS options have been ruled out on the basis of ground conditions and constraints presented by the site layout:

Suitability of SuDS Components		
SuDS Component	Description	Suitability
Infiltrating SuDS	Infiltration can contribute to reducing runoff rates and volumes while supporting baseflow and groundwater recharge processes. The suitability and infiltration rate depends on the permeability of the surrounding soils	×
Permeable Pavement	Pervious surfaces can be used in combination with aggregate sub-base and/or geocellular/modular storage to attenuate and/or infiltrate runoff from surrounding surfaces and roofs. Liners can be used where ground conditions are not suitable for infiltration	✓
Green Roofs	Green Roofs provide areas of visual benefit, ecological value, enhanced building performance and the reduction of surface water runoff. They are generally more costly to install and maintain than conventional roofs but can provide many long-term benefits and reduce the on-site storage volumes	×
Rainwater Harvesting	Rainwater Harvesting is the collection of rainwater runoff for use. It can be collected form roofs or other impermeable area, stored, treated (where required) and then used as a supply of water for domestic, commercial and industrial properties. Rainwater butts are likely to be installed in accordance with best practice and harvesting could be utilised on this development but would be subject to detailed design. Thus, water butts are considered **suitable**.	✓
Swales	Swales are designed to convey, treat and attenuate surface water runoff and provide aesthetic and biodiversity benefits. They can replace conventional pipework as a means of conveying runoff, however space constraints of some sites can make it difficult incorporating them into the design.	×
Rills and Channels	This SuDS technique is an excellent choice as part of the SuDS train management to convey the runoff water into further SuDS features due to its appealing visual features in urban landscapes, amenity value and effectiveness to treat pollution in water, acting as pre-treatment to remove silt. As such they are considered **suitable**.	✓
Bioretention Systems	Bioretention systems can reduce runoff rates and volumes and treat pollution through the use of engineer soils and vegetation. They are particularly effective in delivering interception, but can also be an attractive landscape feature whilst providing habitat and biodiversity.	✓
Retention Ponds and Wetlands	Ponds and Wetlands are features with a permanent pool of water that provide both attenuation and treatment of surface water runoff. They enhance treatment processes and have great amenity and biodiversity benefits. Often a flow control system at the outfall controls the rates of discharge for a range of water levels during storm events. Nevertheless, they are dismissed as they are recommended to manage high volumes runoff due to large developments such as a neighbourhood.	×
Detention Basins	Detention Basins are landscaped depressions that are usually dry except during and immediately following storm events, and can be used as a recreational or other amenity facility. They generally appropriate to manage high volumes of surface water from larger sites such as a neighbourhood.	×
Geocellular Systems	Attenuation storage tanks are used to create a below-ground void space for the temporary storage of surface water before infiltration, controlled release or use. The inherent flexibility in size and shape means they can be tailored to suit the specific characteristics and requirements of any site.	✓
Proprietary Treatment Systems	Proprietary treatment systems are manufactured products that remove specific pollutants from surface water runoff. They are especially useful where site constraints preclude the use of other methods and can be useful in reducing the maintenance requirements of downstream SuDS.	×
Filter Drains and Filter Strips	Filter drains are shallow trenches filled with stone, gravel that cerate temporary subsurface storage for the attenuation, conveyance and filtration of surface water runoff. Filter strips are uniformly graded and gently sloping strips of grass or dense vegetation, designed to treat runoff from adjacent impermeable areas by promoting sedimentation, filtration and infiltration	×

Table 4 – Suitability of SuDS Components.

5.3 As such, several SuDS components are deemed appropriate. It is suggested to use a SuDS train management composed by **Bioretention Systems, lined Permeable Pavements** with No Infiltration (Type C) and **Geocellular Systems**. Rills/Channels could be used to convey water runoff from the hardstanding areas as long as the gradient and slope is adequate. A **throttle device** such as a hydrobrake must be set up to control the flow rates up to a maximum of 3.8l/s. And, finally, **pumping systems** would be required to convey water runoff from low points and proposed basements. See Appendix 4, Plan 1 – Preliminary Drainage Strategy Layout, Sheets 1 & 2.

5.4 The combined action of the proposed SuDS train will be able to manage the arising runoff volume from hardstanding areas and roofs due to the day-to-day storms, Interception Volume, as well as the Attenuation Volume, being progressively stored and gradually discharged while also providing enough water quality treatment.

5.5 The Bioretention Systems, which are formed by shallow depressions with vegetation within them, will provide ecological benefits such as biodiversity and cool the local microclimate due to the evapotranspiration. They are very flexible and can be integrated into a wide variety of developments, thus these are proposed to the sides of the building pedestrian accesses. Refer to Appendix 4, Plan 1 – Preliminary Drainage Strategy Layout, Sheets 1 & 2.

5.6 The Bioretention System must be lined and incorporate a layer of gravel as bed, and filled with engineered soil. The Bioretention Systems should be finalised at the later detailed design by a specialist. Guidance about proper use and maintenance must also be provided. See conceptual design of this SuDS technique on Figure 8 below.

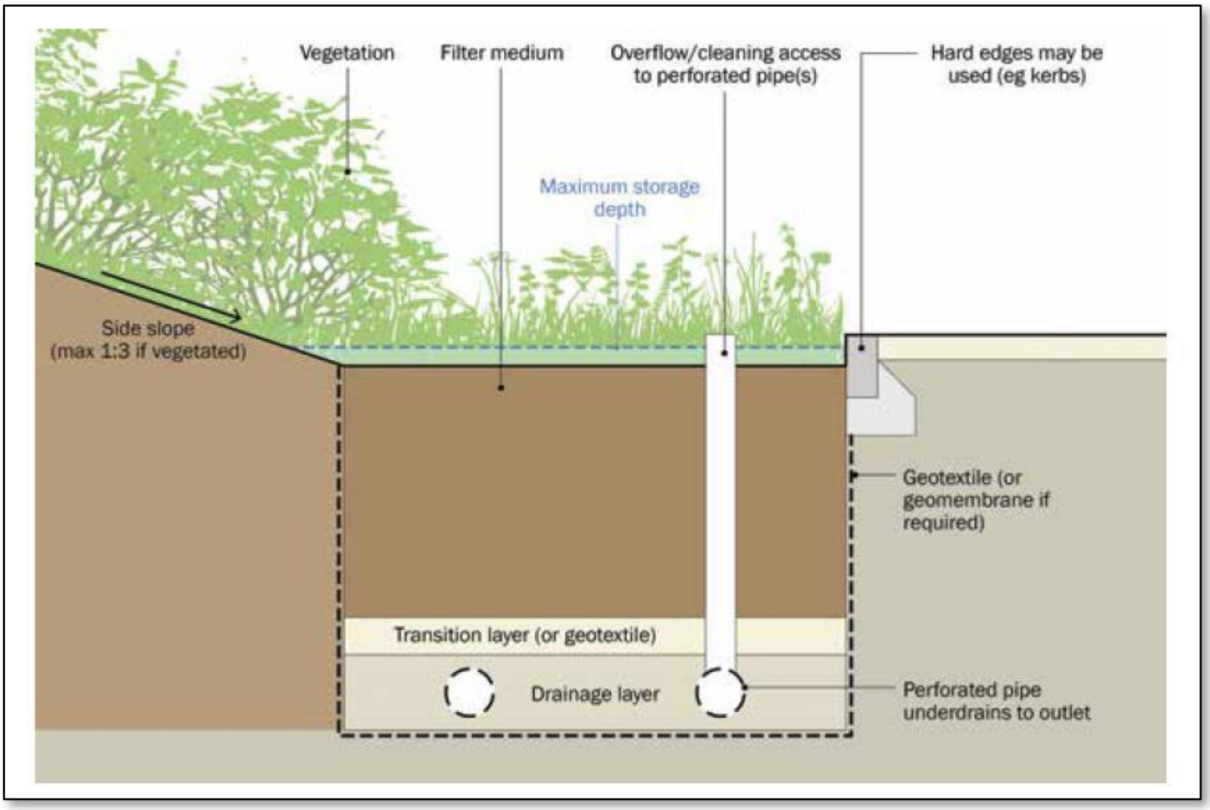


Figure 8 – Conceptual Design of the Components of a Bioretention System.

5.7 The Permeable Paving will be Type C (NO infiltration), with Geotextile to retain pollutants. It would be formed by 3 layers:

- Permeable Concrete blocks.
- Laying Course Material.
- Geotextile filter.
- Sub-Base: Clean Stone (Depth: 450 mm).
- Impermeable membrane.

Refer to Appendix 4, Plan 1 – Preliminary Surface Water Drainage Strategy Layout, Sheets 1 & 2.

5.8 It is proposed to utilise two Geocellular Systems with a depth of 1m to manage water runoff due to extreme storm events up to a 1 in 100 years storm event with a 40% climate change allowance.

5.9 For a reference, the geocellular system located to the north of the site is named 'Geocellular System 1' (GS1), while the Geocellular System located to the east of the site (under the car access) is named 'Geocellular System 2' (GS2). Refer to Appendix 4, Plan 1 – Preliminary Surface Water Drainage Strategy Layout, Sheets 1 & 2. The areas of the Geocellular System 1 and 2 would be 20m^2 and 105m^2 respectively. While the capacity of them with a typical porosity of 0.95 would be 19m^3 and 99.75m^3.

5.10 Throttle devices such as a Crown Vortex Valves and/or Hydrobrakes must be set up to control the flow rates among the SuDS devices. Besides that, a flow control should limit the discharge to the existing drainage infrastructure within the site, up to a maximum rate of 3.8 l/s. See Appendix 4, Plan 1 – Preliminary Surface Water Drainage Strategy Layout, Sheets 1 & 2.

5.11 Finally, pumping systems would likely be required to drain water runoff from low points and basements. Guidance about proper use, installation and maintenance of any proprietary system should be provided by the supplier and incorporated into the site proposals at detailed design stage.

5.12 Sediment Traps should be installed on the storm drainage pipework at incoming connections to SuDS features to reduce the incidence of blockage or silting up.

5.13 Guidance about proper use, installation and maintenance of any proprietary system must be provided by the supplier and incorporated into the site proposals at detailed design stage.

6. Drainage Strategy

6.1 Following the hierarchy line provided by the Policy 5.13 of the London Plan 2016, it is proposed to store rainwater for later use where this is feasible, while the excess of water runoff should be stored to be gradually discharged to the existing surface water sewer within the site.

6.2 The proposed storm water management regime for the site is to store runoff in Permeable Paving - located under parking bays and the car access to the basement, as well as in two Geocellular Systems strategically located to store and adequately release the water runoff to the existing sewer network within the site.

Interception Volume

6.3 It is proposed to contain rainwater from the roof due to the day-to-day storms (Interception Volume) through the proposed Bioretention Systems and the Permeable Pavement. The exceedance of runoff from the Bioretention Systems would be conveyed to the sub-base of the Permeable Paving and to the Geocellular Systems to be properly stored and gradually discharged.

6.4 Debris traps must be installed in the connection to the sub-base of the Permeable Paving to avoid any blockage. For a better understanding, the roof has been split into 3 zones to show how the runoff would be discharged. Refer to Appendix 4, Plan 1 – Preliminary Surface Water Drainage Strategy Layout, Sheets 1 & 2.

6.5 It is proposed to utilise the water stored in the Geocellular System 1 for non-potable purposes such as gardening as the water runoff to be stored in it would derive from roofs and other free petrochemical pollutants hardstanding surfaces such as pedestrian accesses, thus the water quality treatment would be very low.

6.6 It is important to point out that there are two basements located to the north of the site. Refer to Appendix 4, Plan 1 – Preliminary Surface Water Drainage Strategy Layout, Sheet 2. Water runoff from there would be raised through the proposed Pumping Systems to the Geocellular System 1.

6.7 Water runoff from hardstanding surfaces for pedestrian facilities purposes such as stairs, accesses, etc. would be conveyed to the proposed Bioretention Systems and to the Permeable Paving through appropriate landscaping and/or Rills/Channels.

Attenuation Volume

6.8 Surface water runoff due to storm events above 1 in 1 year return period and up to a 1 in 100 years event with a 40% climate change allowance would be stored in the Sub-base of the Permeable Paving, the Geocellular System 1 and the Geocellular System 2, to be gradually released.

6.9 It should be noted that as the Permeable Paving is sloped, the water runoff should be drained through the proposed Pumping System to the Geocellular System 2 up to a rate of 25l/s.

6.10 The outflow from Geocellular System 1 would be controlled up to a rate of 5l/s, while the limiting discharge rate from Geocellular System 2 would be 3.8l/s as it is connected to the existing surface water sewer within the site.

6.11 In order to connect and coordinate all the proposed SuDS, a model in cascade has been carried out using the industry standard software, Microdrainage v2016. See Figure 9 below. The results for a variety of rainfall events are shown on the Appendix 3 – Calculations, Summary of Results.

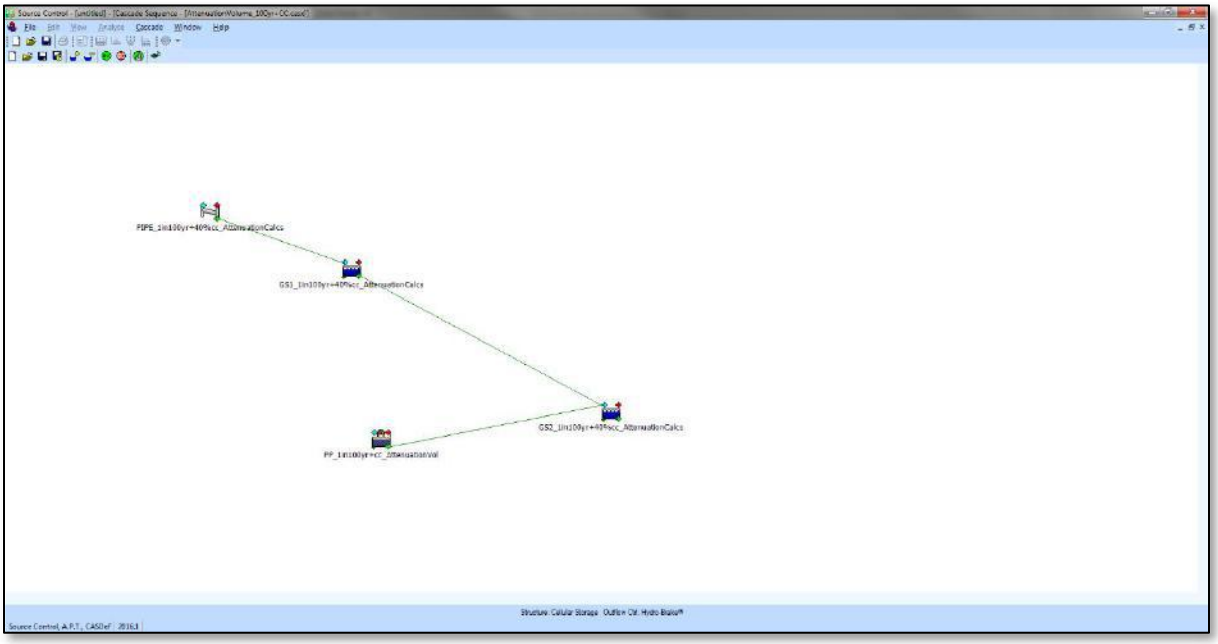


Figure 9 – Model in Cascade using Microdrainage.

6.12 Table 5 summarizes the attenuation volumes and the SuDS devices to be used to manage them:

	ATTENUATION VOLUMES SUMMARY Attenuation Volumes for each of the sub-catchments	
SuDS Device	Limiting Discharge Rate (l/s)	Required total 1:100 year Attenuation storage volume (m³)
Pumping System for Basement ('PIPE' on Figure 9).	2l/s	0.5m³
Pervious Pavement ('PP' on Figure 9).	25l/s	0.3m³
Geocellular System 1 ('GS1' on Figure 9).	5l/s	14.6m³
Geocellular System 2 ('GS2' on Figure 9).	3.8l/s	79.6m³
TOTAL	**-**	**95m³**

Table 5 – Attenuation Volume Summary.

6.13 Preliminary calculations show that the storage capacity of the Geocellular Systems (with typical features such as porosity, n=0.95, and depth, d=1000mm) is approximately 118.75m^3. Hence, the storage capacity of this SuDS train (under a conservative point of view Permeable Paving is not taken into account) is higher than the total required volume, 102m^3.

6.14 A throttle device such as a Hydrobrake at the Geocellular System 1 will control the flow rates up to a maximum of 5 l/s before the runoff is conveyed and discharged to the Geocellular System 2. A Pumping System would raise the water runoff from the Permeable Pavement to the Geocellular System 2 up to a maximum Rates of 25l/s, while another flow control (Hydrobrake or Vortex Control) would limit the discharge rate from the Geocellular System 2 to the sewer network through drain pipes up to 3.8l/s. Refer to Appendix 4, Plan 1 – Preliminary Drainage Strategy Layout, Sheets 1 & 2.

6.15 In the case of a rainfall event that exceeds the storage capacity of these SuDS techniques, overland conveyance routes should be established that direct water away from property to landscaped areas or off site. Design of external ground levels will need to be undertaken at detailed design stage to finalise these routes, but some indicative flow paths have been indicated on the outline strategy drawings. See Appendix 4, Plan 1 – Preliminary Surface Water Drainage Strategy, Sheets 1 & 2.

6.16 It may be necessary to update or alter the drainage strategy at detailed design stage following confirmation of site constraints or alterations to the overall layout. Calculations for, and the design of the SuDS devices, should be reviewed at detailed design stage to ensure a robust drainage strategy is maintained.

Water Quality

6.17 Adequate treatment must be delivered to the water runoff to remove pollutants through SuDS devices which are able to provide pollution mitigation. Pollution Hazards and the SuDS Mitigation have been indexed in the specialized literature *CIRIA 753 'The SUDS Manual'*. This is determined by the following restriction:

POLLUTION HAZARD INDICES FOR DIFFERENT LAND USE CLASSIFICATIONS				
LAND USE	Pollution Hazard Level	Total suspended Solids (TSS)	Metals	Hydrocarbons
Residential Roofs	Very Low	0.2	0.2	0.05
Individual property driveways, residential car parks, low traffic roads (eg cul de sacs, homezones and general access roads) and non-residential car parking with infrequent change (eg schools, offices) ie < 300 traffic movements/day	Low	0.5	0.4	0.4

Table 6 – Summary of Pollution Hazard Indices for different Land Use.

6.18 The Mitigation Indices of the proposed SuDS techniques are summarized in the Table 7 - Indicative SuDS Mitigation Indices, below:

INDICATIVE SuDS MITIGATION INDICES FOR DISCHARGES TO SURFACE WATER			
SuDS Component	Total suspended Solids (TSS)	Metals	Hydrocarbons
Bioretention Systems	0.8	0.8	0.8
Permeable Pavement	0.7	0.6	0.7

Table 7 – Indicative SuDS Mitigation Indices

6.19 Table 8 – Pollution Treatment below, summarizes the water treatment for each zone:

POLLUTION HAZARD TREATMENT					
LAND USE	Treatment	Pollution Hazard Level	Total suspended Solids (TSS)	Metals	Hydrocarbons
Roofs	Permeable Pavement	Very Low	0.2<0.7	0.2<0.6	0.05<0.7
Roofs	Bioretention Systems	Very Low	0.2<0.8	0.2<0.8	0.05<0.8
Car Facilities / Pedestrian Accesses	Permeable Pavement	Low	0.5<0.7	0.4<0.6	0.4<0.7
Pedestrian Accesses	Bioretention Systems	Low	0.5<0.8	0.4<0.8	0.4<0.8

Table 8 – Pollution Treatment

6.20 **Thus, the water treatment provided by this SuDS train is enough to remove the pollutants.**

Design Exceedance

6.21 In the event of drainage system failure under extreme rainfall events or blockage, flooding may occur within the site. In the event of the drainage system failure, the runoff flow will be dictated by topography on site. This will not impact on the site or nearby dwellings.

6.22 It is advised that the finished floor level of the proposed building should be 300mm above surrounding finished ground levels to mitigate against any potential surface water flows. External ground levels should be designed to direct water away from thresholds where feasible. See plans on Appendix 4, Plan 1 - Preliminary Surface Water Drainage Strategy Layout, Sheets 1 & 2.

Adoption and Maintenance

6.23 All onsite SuDS and drainage systems will be privately maintained. A long term maintenance regime should be agreed with the site owners before adoption. In addition to a long term maintenance regime it is recommended that all drainage elements implemented on site should be inspected following the first rainfall event post construction and monthly for the first quarter following construction.

Proposed Schedule of Maintenance for Below Ground Drainage				
Item	Visual Inspection	Cleanse / De-sludge	CCTV Survey	Comments
Surface Water Drainage System (pipework, chambers etc.)	5 years	10 years	10 years	Cleansing to be carried as necessary
Gullies/Channels	1 year	1 year	N/A	Cleansing to be carried as necessary
Permeable Block Paving	1 year	'Swept' clean of debris every 2 years.	N/A	Lift blocks and remove sand bedding and replace and re-bed paving – refer to individual manufacturers recommendations.
Catchpits	1 year	-	N/A	Cleansing to be carried as necessary.

Table 9 – Proposed Schedule of Maintenance for Below Ground Drainage.

7. Conclusions

7.1 The existing site is already developed, runoff from the proposed development is to be managed in accordance with the sustainable drainage principles.

7.2 The drainage strategy for this site is to discharge to the existing surface water sewer within the Site utilising Bioretention Systems, Permeable Pavement and Geocellular Systems with managed offsite flows controlled by hydrobrake, or similar flow control, as necessary.

7.3 Initial calculations indicate a storage requirement of approximately $102m^3$, being properly managed by the proposed SuDS train. This can be accommodated in the Geocellular Systems proposed on site.

7.4 The Treatment train of Bioretention Systems and Permeable Paving is suitable to offer acceptable contamination treatment to runoff from parking bays and trafficked areas prior to being discharged to local sewer network.

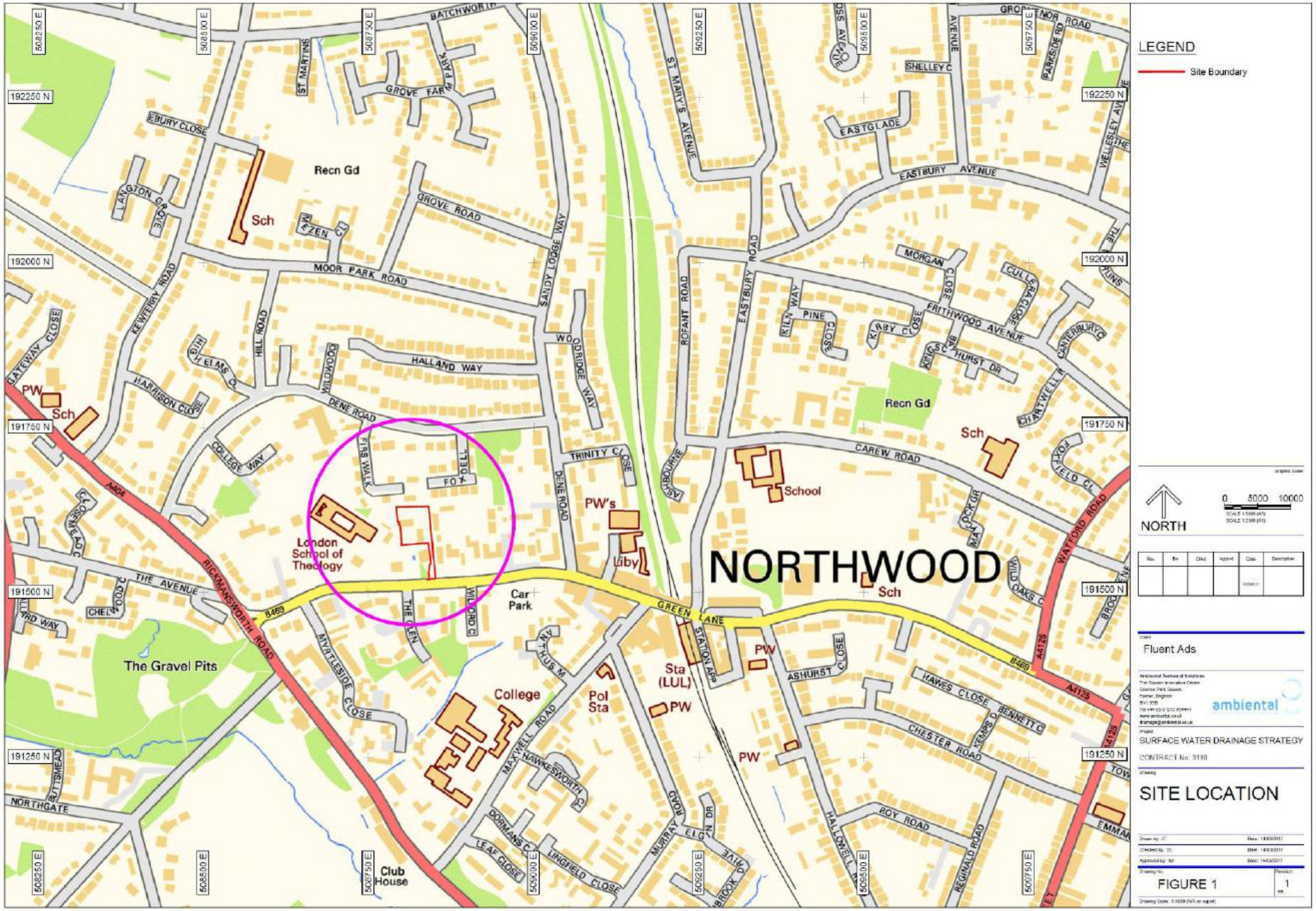
7.5 It is advised that the finished floor level of the proposed building should be 300mm above surrounding finished ground levels to mitigate against any potential surface water flows. Ground levels should be designed to convey water away from the proposed development where feasible.

The findings and recommendations of this report are for the use of the client who commissioned the assessment, and no responsibility or liability can be accepted for the use of the report or its findings by any other person or for any other purpose.

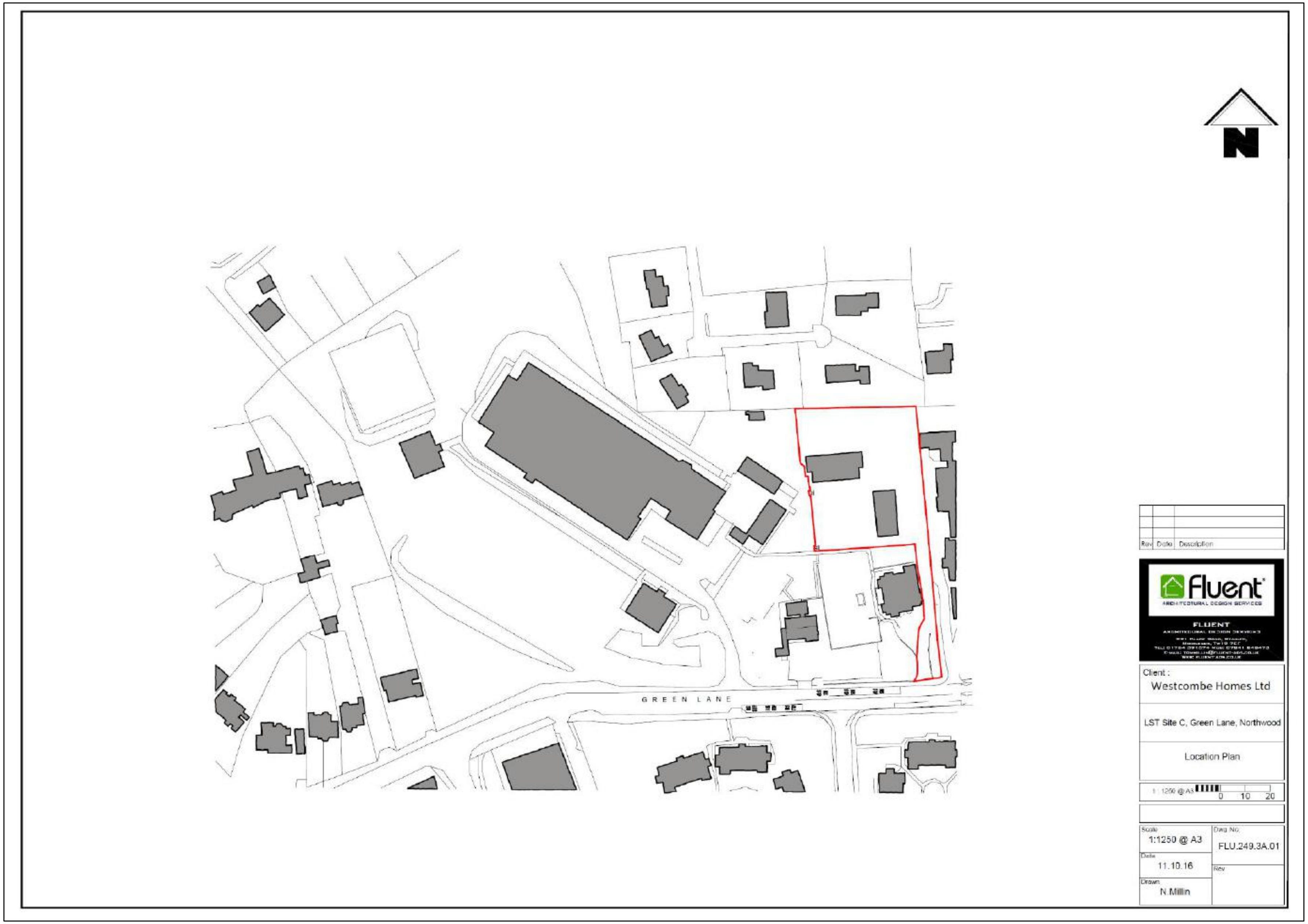
Dr. J. B. Butler
B.Sc., M.Phil., PhD.
Ambiental Technical Solutions Ltd. May 2017

Appendix 1 – Plans

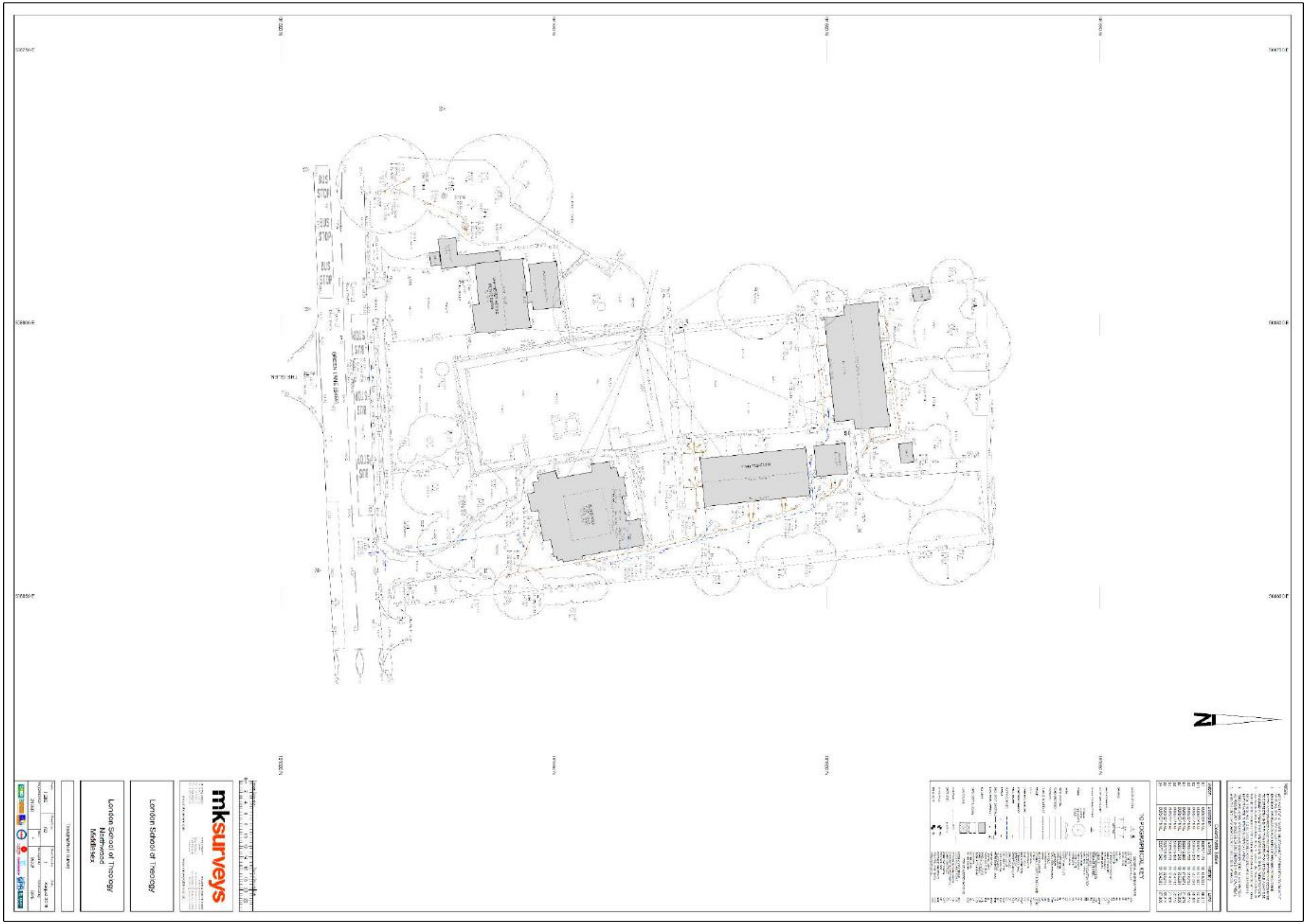
- *Plan 1 – Site Location*
- *Plan 2 – Plan Location*
- *Plan 3 – Topographical Survey of the Site*
- *Plan 4 – Existing Surface Water Flow Pathways*
- *Plan 5 – Proposed Site Layout*
- *Plan 6 – Basement Floor Plan*
- *Plan 7 – Ground Floor Plan*
- *Plan 8 – First Floor Plan*
- *Plan 9 – Second Floor Plan*
- *Plan 10 – Front & Side Elevations*
- *Plan 11 – Rear & Side Elevations*
- *Plan 12 – BRE 25^{o} Test*



Appendix 1, Plan 1 – Site Location

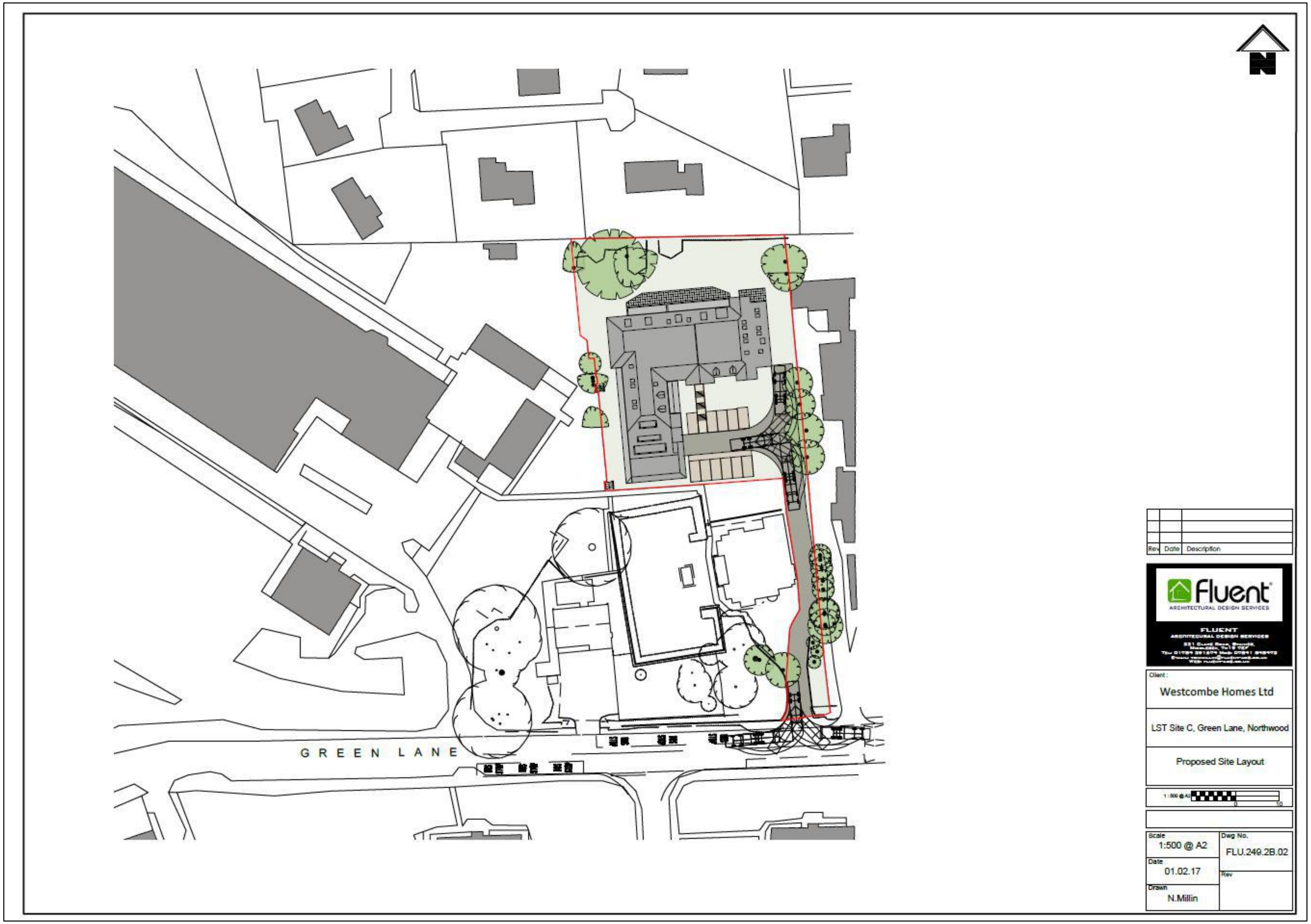


Appendix 1, Plan 2 – Plan Location

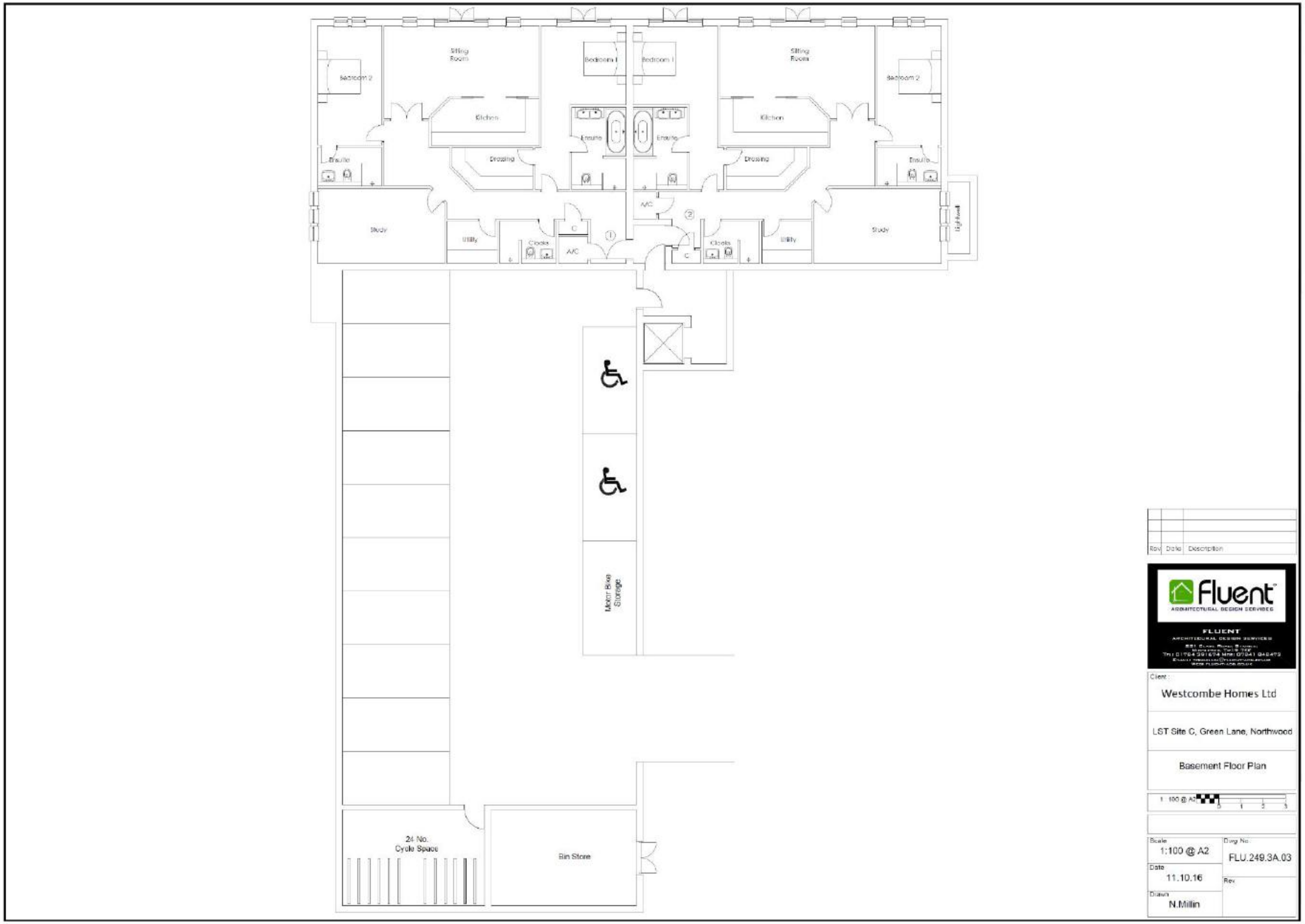


Appendix 1, Plan 3 – Topographical Survey of the Site

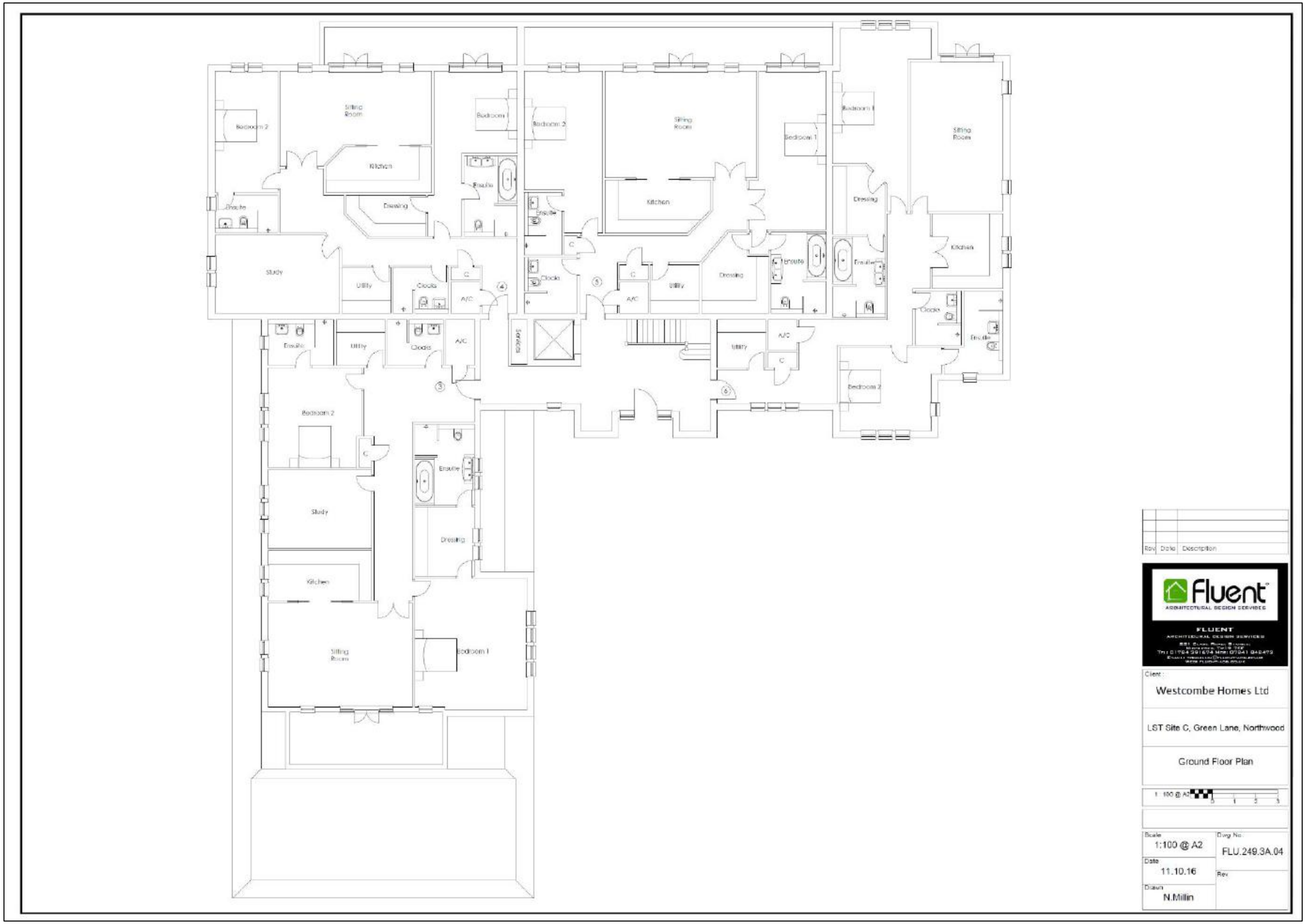
Appendix 1, Plan 4 – Existing Surface Water Flow Pathways



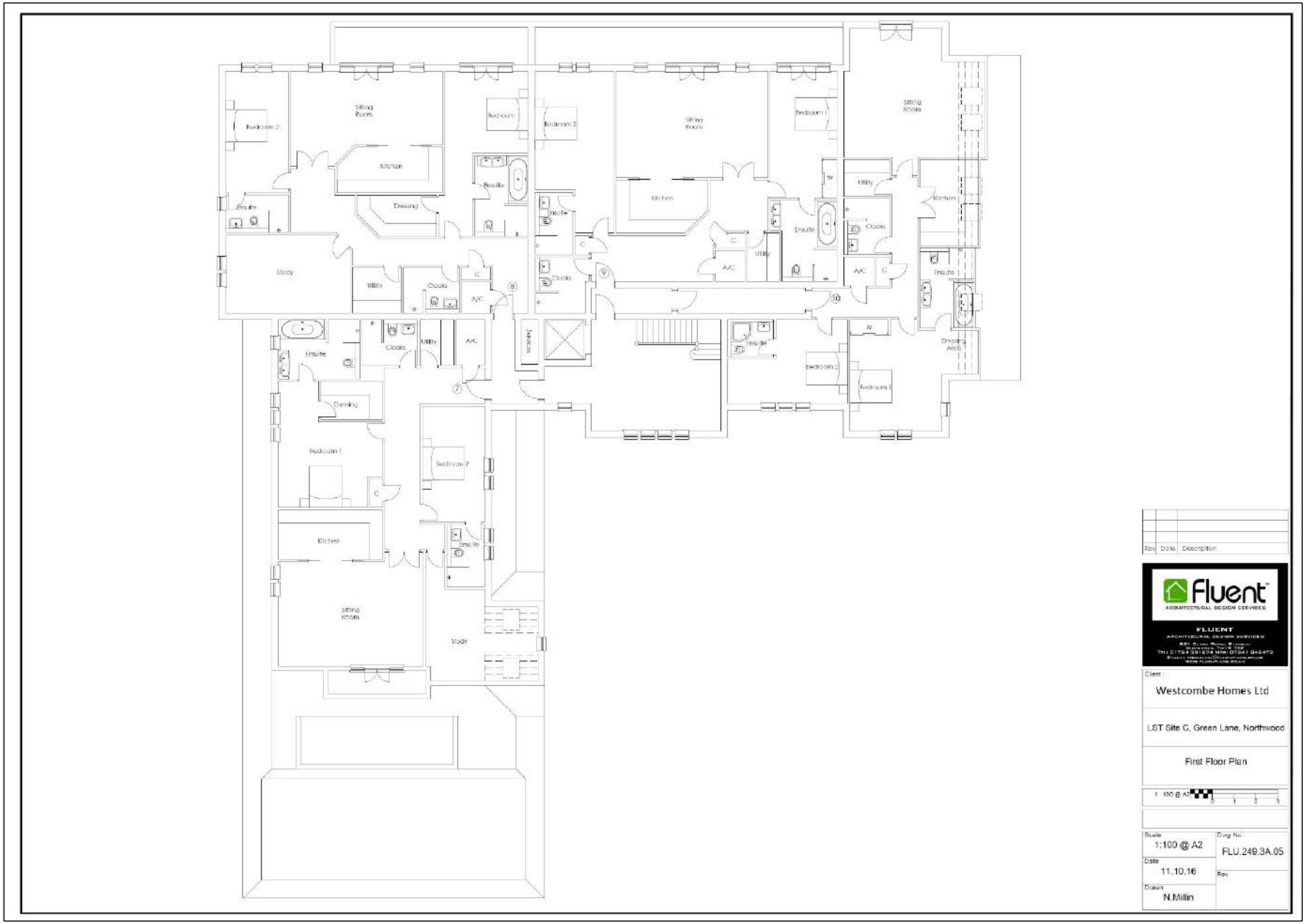
Appendix 1, Plan 5 – Proposed Site Layout



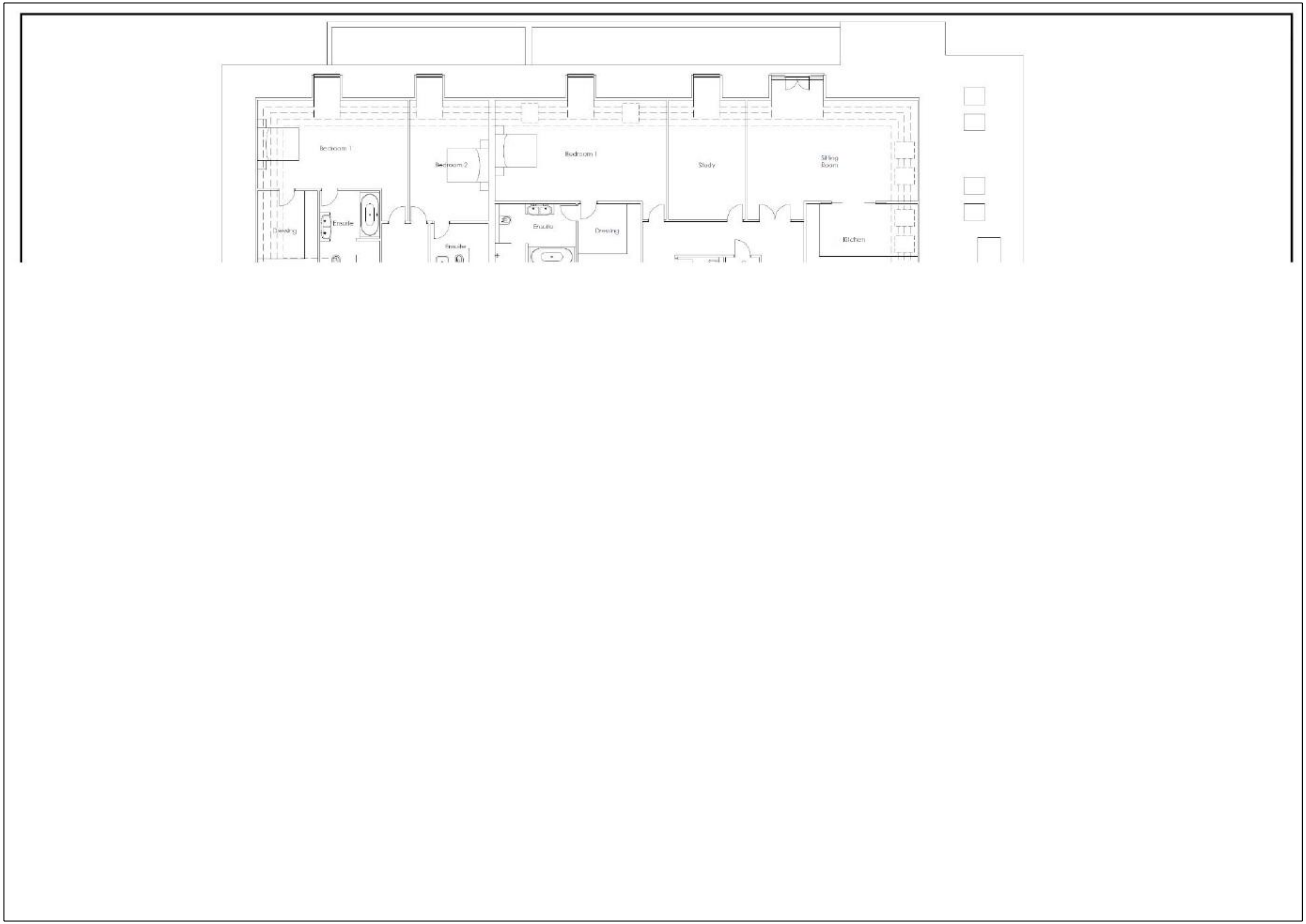
Appendix 1, Plan 6 – Basement Floor Plan



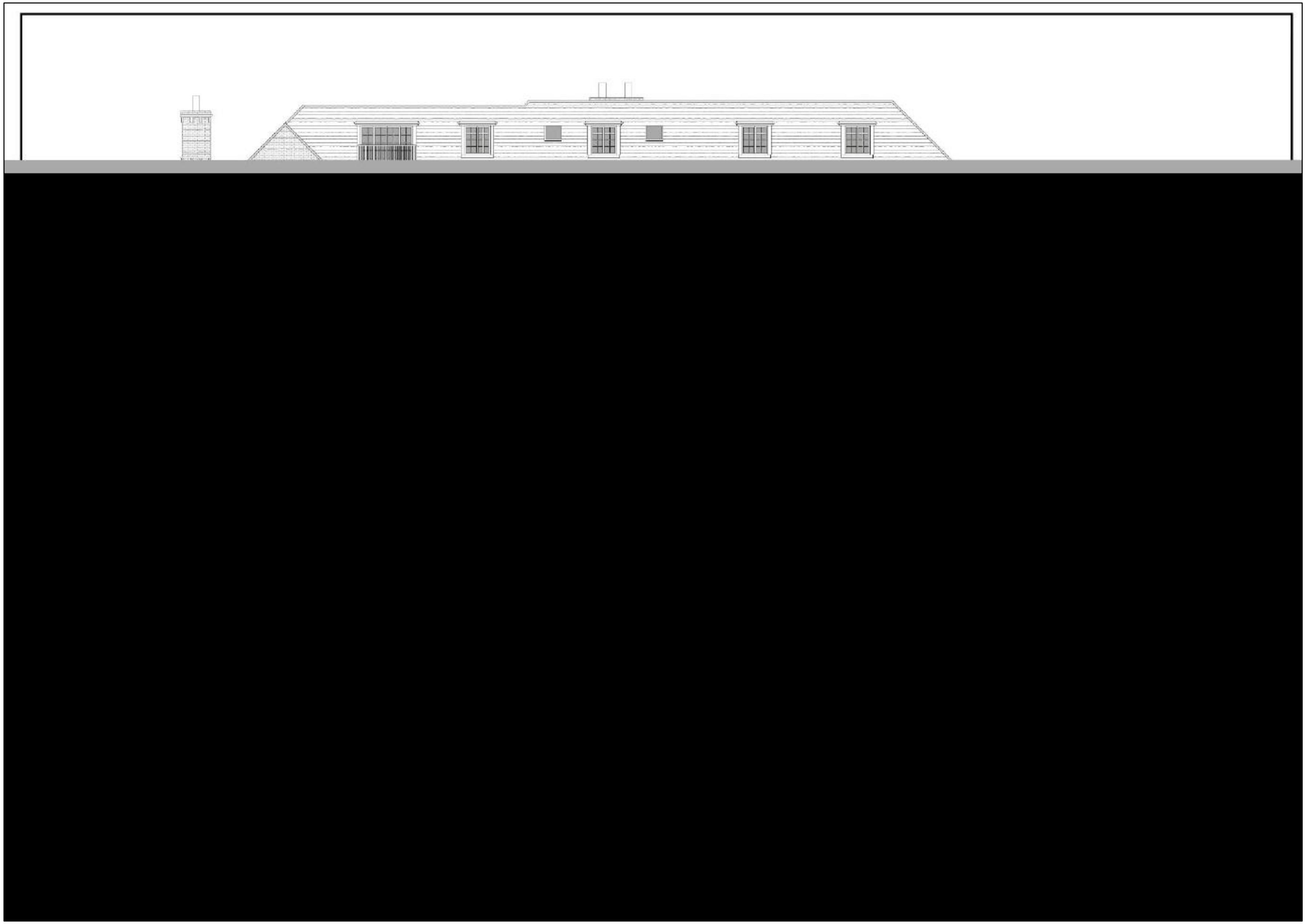
Appendix 1, Plan 7 – Ground Floor Plan,



Appendix 1, Plan 8 – First Floor Plan



Appendix 1, Plan 9 – Second Floor Plan



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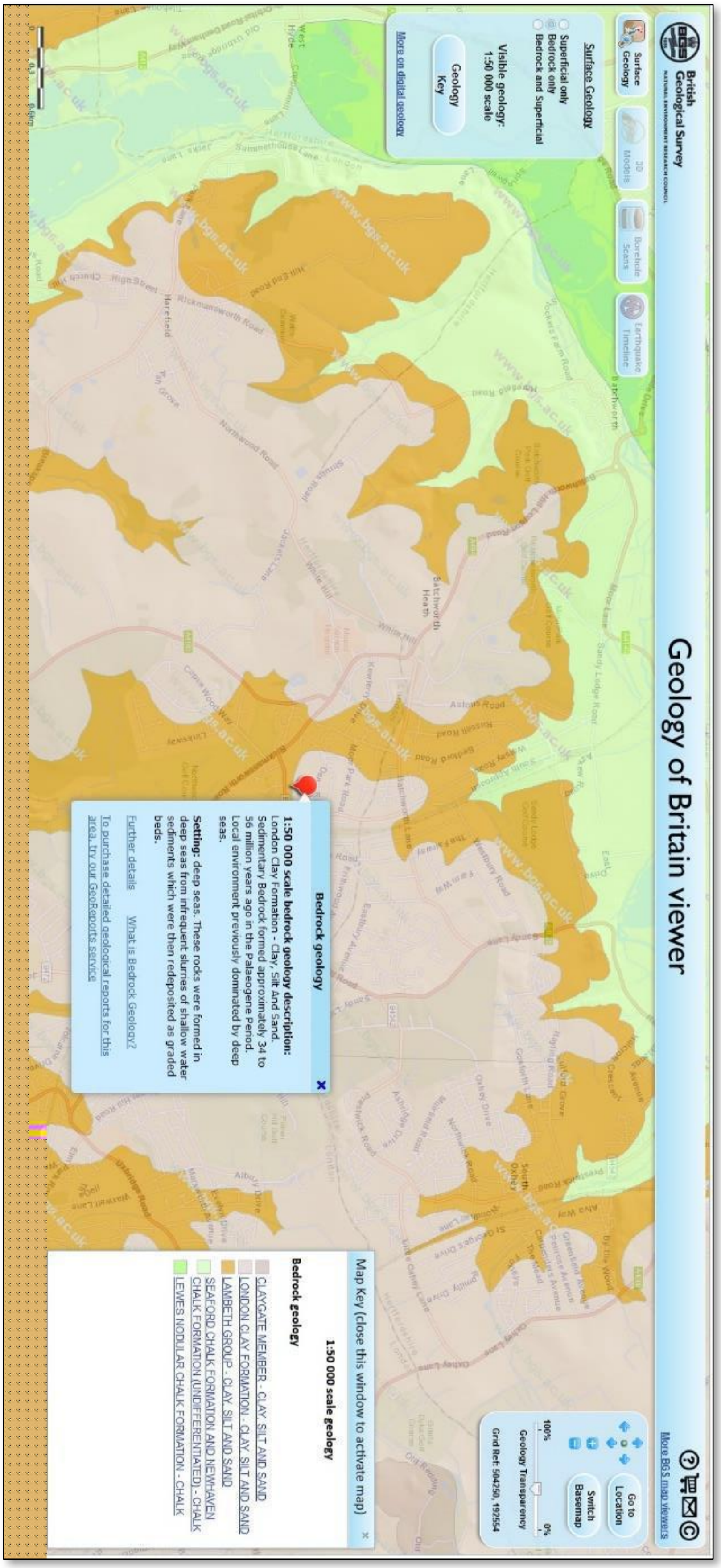
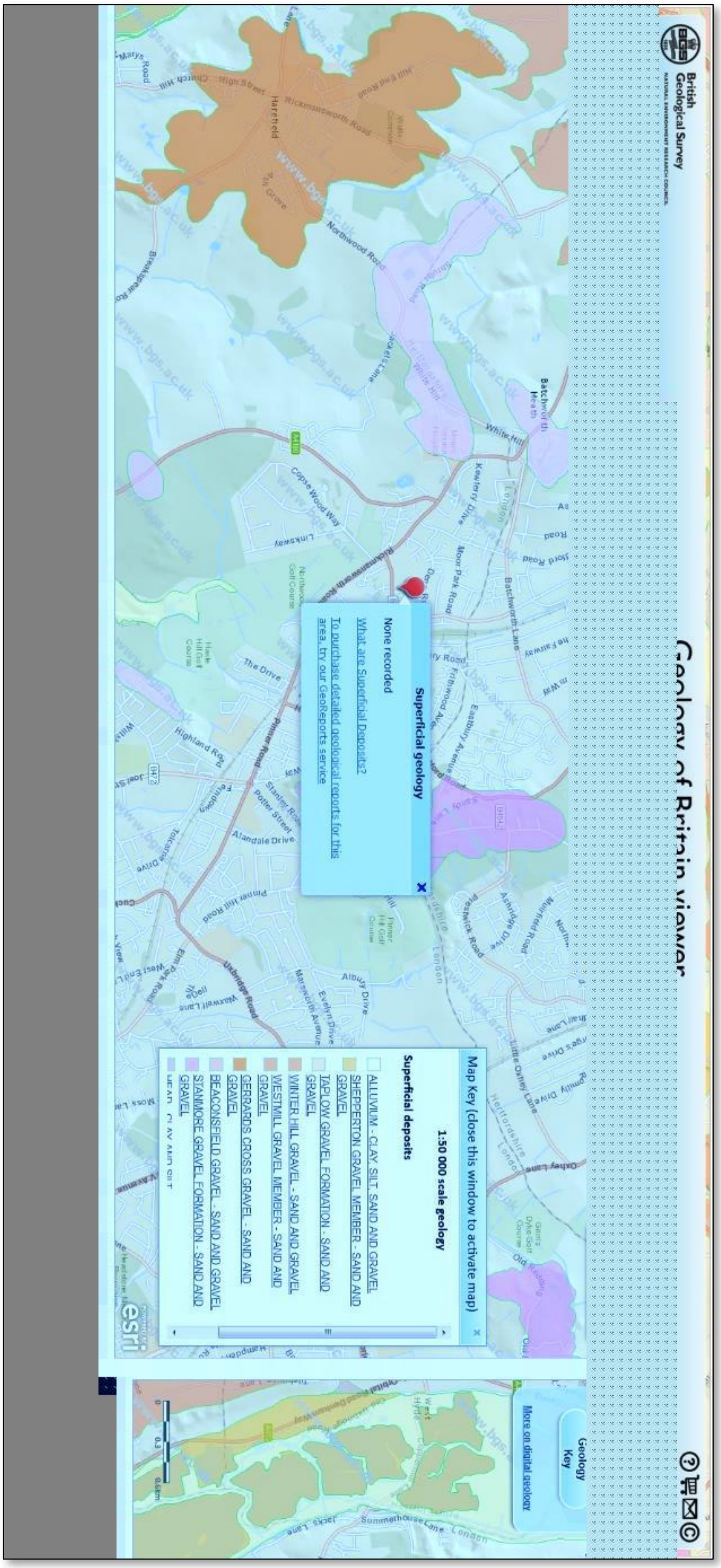
Appendix 1, Plan 11 – Rear & Side Elevations

Appendix 2 – Site Geology Maps

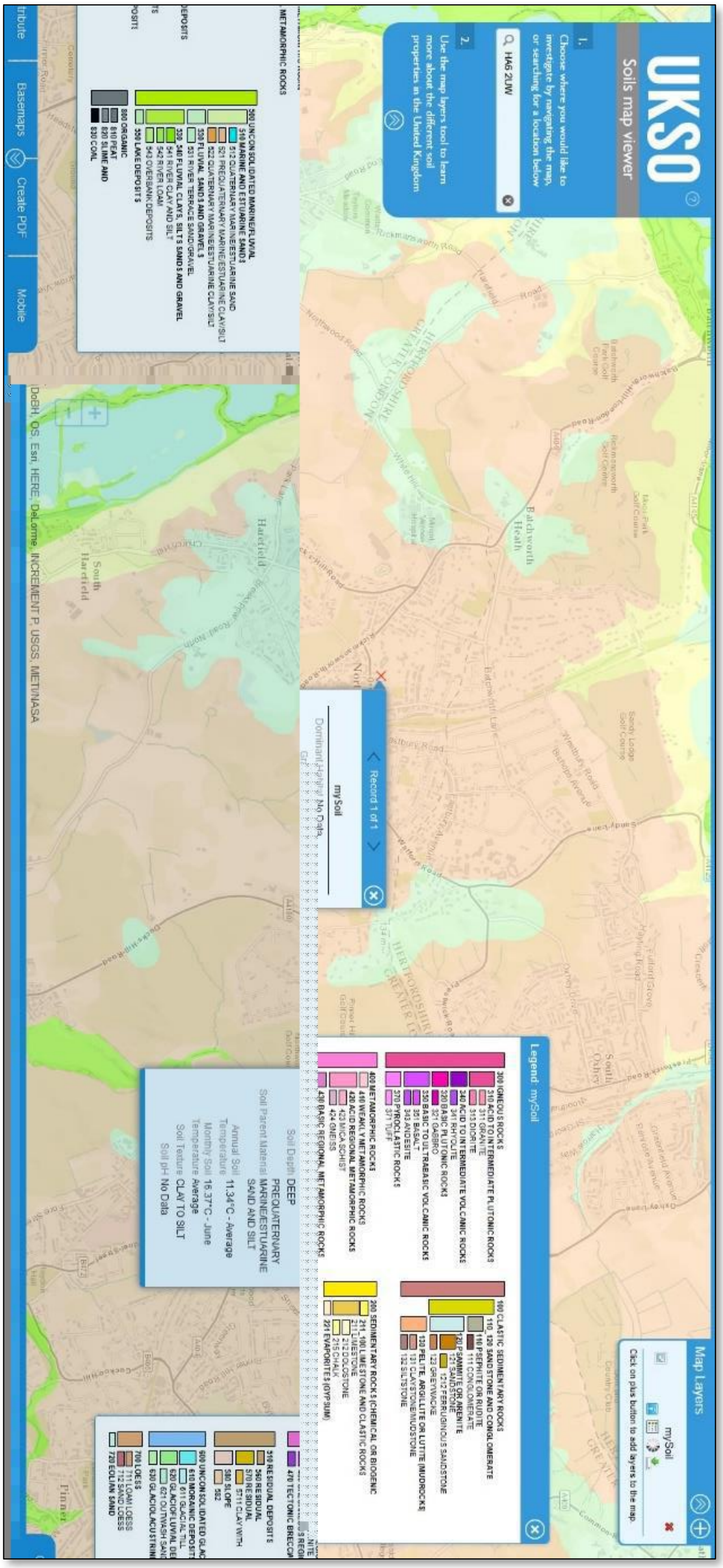
- *Figure 1.A – Bedrock Geology, London Clay Formation*
- *Figure 1.B – Bedrock Geology, Lambeth Group*
- *Figure 2 – Superficial Deposits*
- *Figure 3 – Soil Parental Material*
- *Figure 4.A – Soil Texture-North, Clay to Silt*
- *Figure 4.B – Soil Texture, South, Loam to Silty Loam*
- *Figure 5.1 – Boreholes Location Map*
- *Figure 5.2.1 – Borehole TQ09SE50, Sheet 1*
- *Figure 5.2.2 – Borehole TQ09SE50, Sheet 2*
- *Figure 5.3.1 – Borehole TQ09SE103, Sheet 1*
- *Figure 5.4.1 – TQ09SE104, Sheet 1*
- *Figure 6 – Hydrogeology*
- *Figure 7 – Groundwater Source Protection Zones*
- *Figure 8 – Groundwater Vulnerability Zones*
- *Figure 9 – Infiltration SUDS Suitability Map*



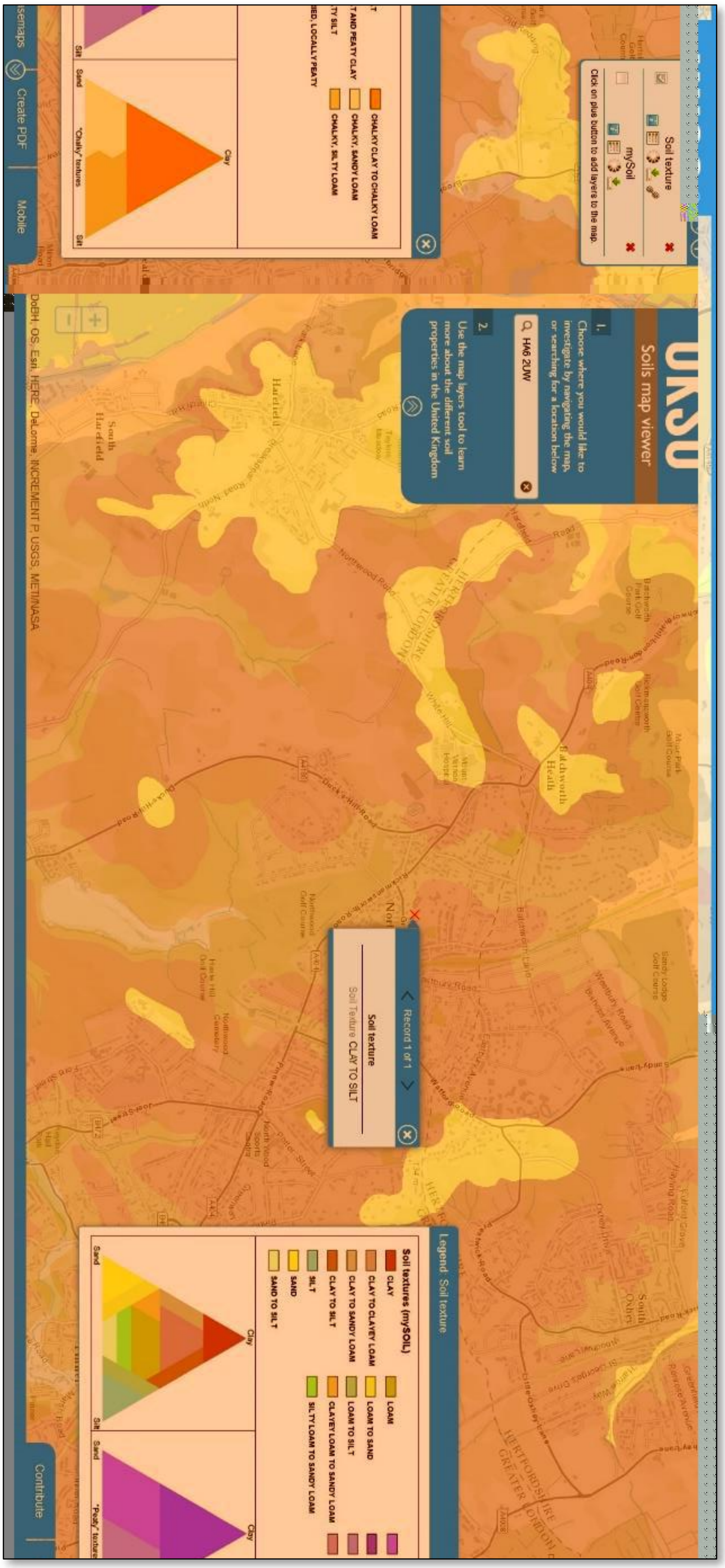
Appendix 2, Figure 1.A – Bedrock Geology, London Clay Formation



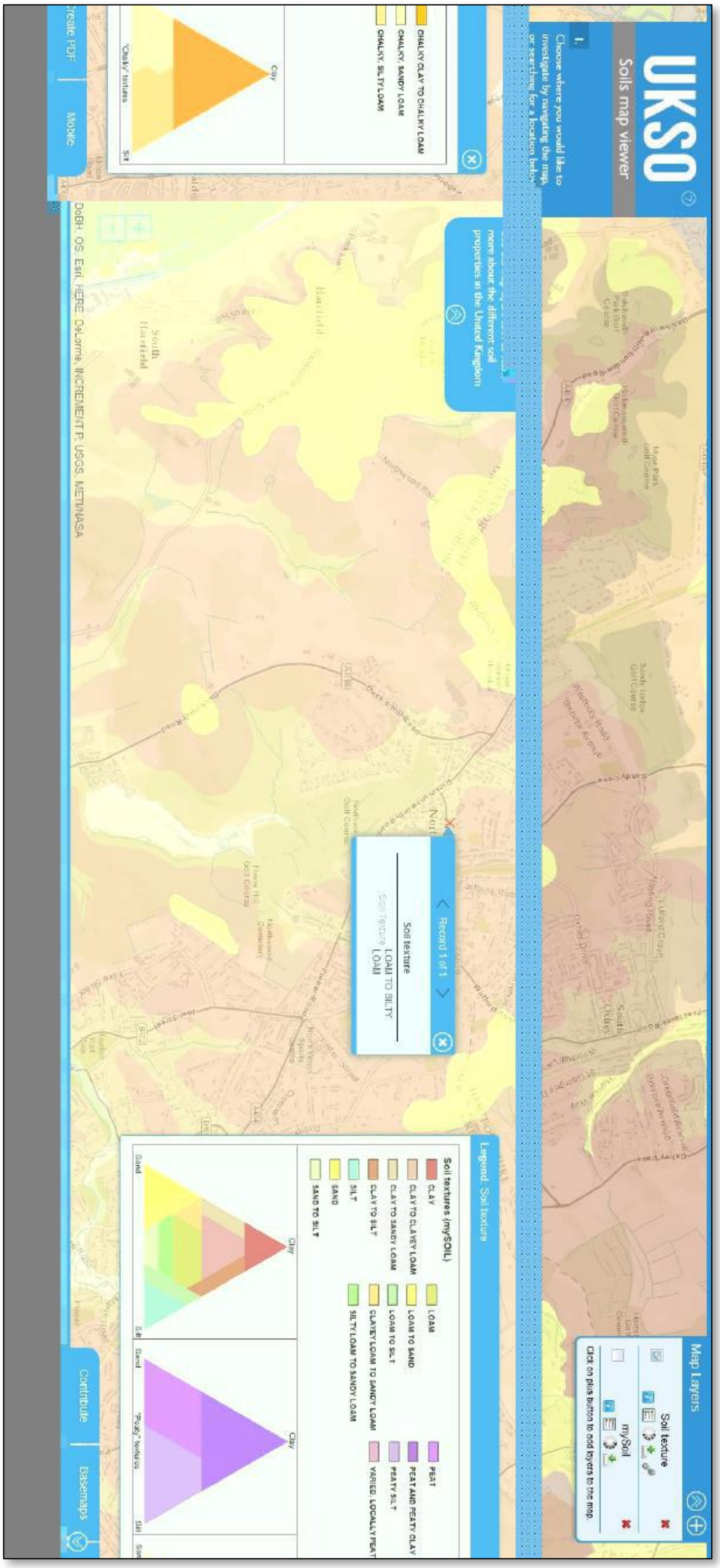
Appendix 2, Figure 2 – Superficial Deposits



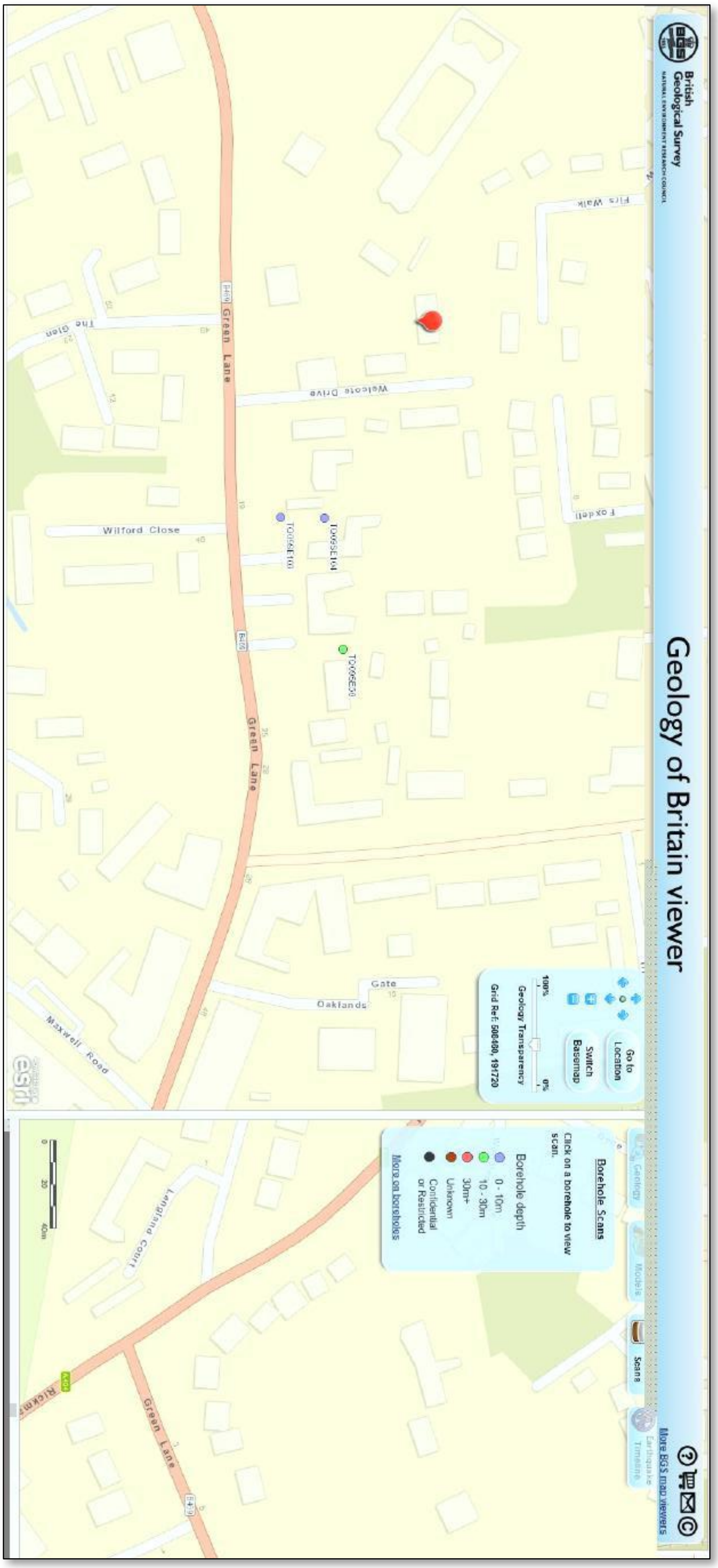
Appendix 2, Figure 3 – Soil Parental Material



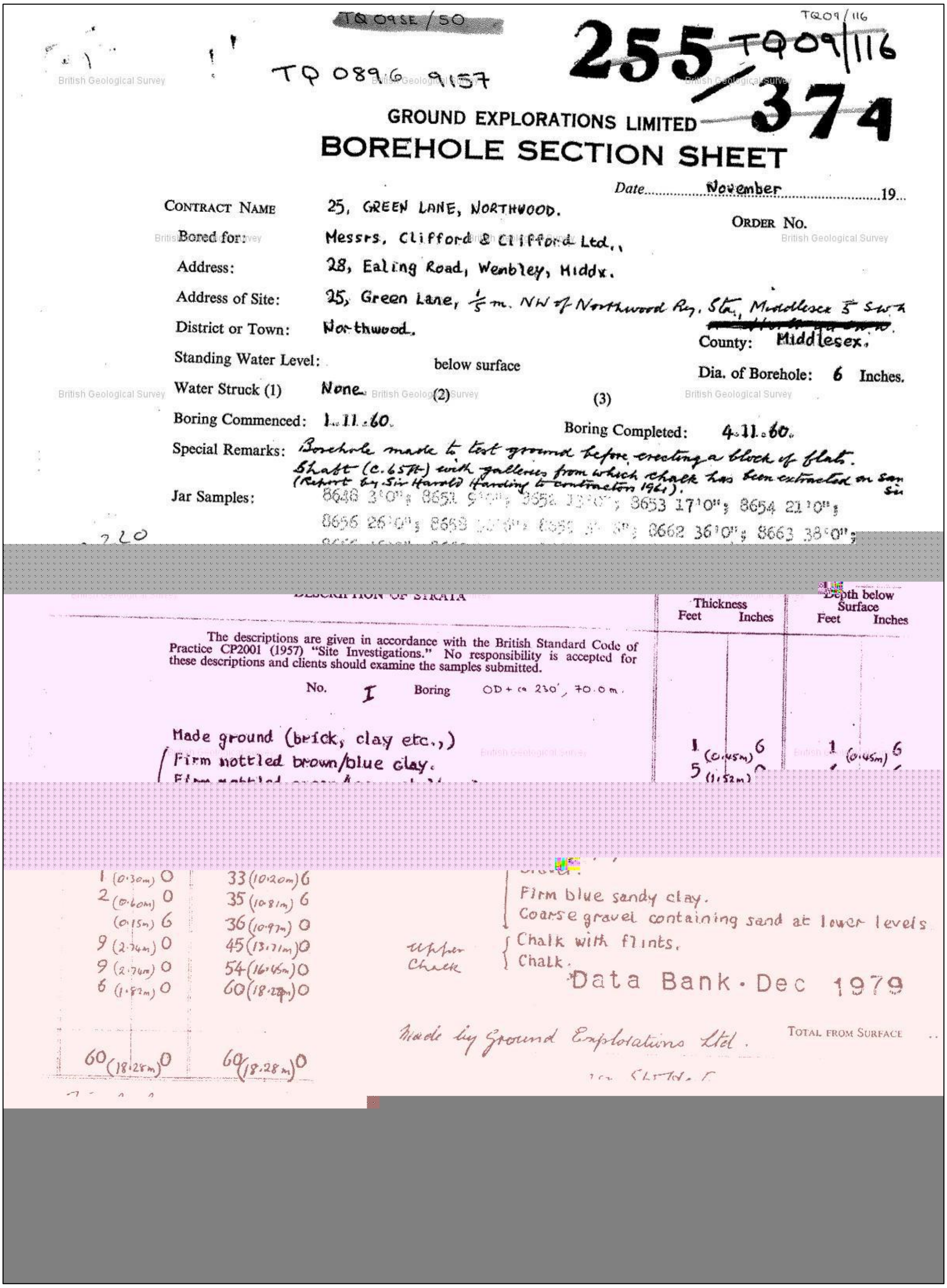
Appendix 2, Figure 4.A – Soil Texture-North, Clay to Silt



Appendix 2, Figure 4.B – Soil Texture, South, Loam to Silty Loam



Appendix 2, Figure 5.1 – Boreholes Location Map



TQ 09SE / 50

TQ09/116

255 TQ09/116
374

TQ 0896 9157

GROUND EXPLORATIONS LIMITED

BOREHOLE SECTION SHEET

Date November 19..

CONTRACT NAME 25, GREEN LANE, NORTHWOOD.

ORDER NO.

Bored for: Messrs. Clifford & Clifford Ltd.,

Address: 28, Ealing Road, Wembley, Middx.

Address of Site: 25, Green Lane, 1/5 m. NW of Northwood Ry. Stn., Middlesex

District or Town: Northwood.

County: Middlesex.

Standing Water Level: below surface

Dia. of Borehole: 6 Inches.

Water Struck (1) None. (2) (3)

Boring Commenced: 1.11.60.

Boring Completed: 4.11.60.

Special Remarks: Borehole made to test ground before erecting a block of flats. Shaft (c.65ft) with galleries from which chalk has been extracted on site (Report by Sir Harold Harding to contractor 1961).

Jar Samples: 8648 3'0"; 8651 9'0"; 8652 13'0"; 8653 17'0"; 8654 21'0"; 8656 26'0"; 8658 ...; 8662 36'0"; 8663 38'0";

DESCRIPTION OF STRATA

Thickness Feet Inches — Depth below Surface Feet Inches

The descriptions are given in accordance with the British Standard Code of Practice CP2001 (1957) "Site Investigations." No responsibility is accepted for these descriptions and clients should examine the samples submitted.

No. I Boring OD + ca 230', 70.0 m.

Made ground (brick, clay etc.,) — 1 (0.45m) 6 — 1 (0.45m) 6

Firm mottled brown/blue clay. — 5 (1.52m) 0

Thickness	Depth
1 (0.30m) 0	33 (10.20m) 6
2 (0.60m) 0	35 (10.81m) 6
(0.15m) 6	36 (10.97m) 0
9 (2.74m) 0	45 (13.71m) 0
9 (2.74m) 0	54 (16.46m) 0
6 (1.82m) 0	60 (18.28m) 0

Firm blue sandy clay.

Coarse gravel containing sand at lower levels.

Upper Chalk: Chalk with flints. Chalk.

Data Bank · Dec 1979

Made by Ground Explorations Ltd.

TOTAL FROM SURFACE 60 (18.28m) 0 — 60 (18.28m) 0

Appendix 2, Figure 5.2.1 – Borehole TQ09SE50, Sheet 1

TQ 0892 9157

255/374 TQ09/116

GROUND EXPLORATIONS LIMITED

BOREHOLE SECTION SHEET

Date November 19 60

CONTRACT NAME 25, GREEN LANE, NORTHWOOD. ORDER NO.

Bored for: Messrs. Clifford & Clifford Ltd.,

Address: 28, Ealing Road, Wembley, Middx.

Address of Site: 25, Green Lane, 1/5 m. NW of Northwood Ry. Sta. Middlesex 5 SW.W

District or Town: Northwood. County: Middlesex.

Standing Water Level: below surface Dia. of Borehole: 6 Inches.

Water Struck (1) None. (2) (3)

Boring Commenced: 1.11.60. Boring Completed: 4.11.60.

Special Remarks: Borehole made to test ground before erecting a block of flats. Shaft (c.65ft) with galleries from which chalk has been extracted on same site. (Report by Sir Harold Harding to contractors 1961).

Jar Samples: 8648 2'0"; 8651 9'0"; 8652 11'0"; 8653 17'0"; 8654 21'0"; 8656 26'0"; 8658 30'0"; 8659 32'6"; 8662 36'0"; 8663 38'0"; 8666 46'0"; 8667 50'0"; 8668 55'0"; 8669 60'0"

c 220

Core Samples: 8649 3'6"-5'0"; 8650 6'0"-7'0"

Large Disturbed Samples: 8655 24'0"; 8657 28'0"; 8660 33'6"; 8661 34'0"; 8664 40'0"; 8665 44'0"

The descriptions are given in accordance with the British Standard Code of Practice CP2001 (1957) "Site Investigations." No responsibility is accepted for these descriptions and clients should examine the samples submitted.

No. I Boring

	DESCRIPTION OF STRATA	Thickness Feet	Thickness Inches	Depth below Surface Feet	Depth below Surface Inches
	Made ground (brick, clay etc.,)	1 (0.45m)	6	1 (0.46m)	6
Woolwich + Reading Beds	Firm mottled brown/blue clay.	5 (1.52m)	0	6 (1.97m)	6
	Firm mottled green/brown chalky clay.	1 (0.30m)	0	7 (2.28m)	6
	Stiff mottled red/green/brown chalky clay.	5 (1.67m)	6	13 (3.96)	0
	Brown sand with pockets of grey clayey sand.	10 (3.04m)	0	23 (7.01m)	0
	Brown sand.	7 (2.13m)	0	30 (9.14m)	0
(Reading Type) 45ft +	Light brown sand.	2 (0.60m)	0	32 (9.75m)	0
	Firm brown silty clay with thin layers of sand.	(0.15m)	6	32 (9.90m)	6
	Grey clayey sand.	1 (0.30m)	0	33 (10.20m)	6
	Gravel.	2 (0.60m)	0	35 (10.81m)	6
	Firm blue sandy clay.	(0.15m)	6	36 (10.97m)	0
	Coarse gravel containing sand at lower levels.	9 (2.74m)	0	45 (13.71m)	0
Upper Chalk	Chalk with flints.	9 (2.74m)	0	54 (16.46m)	0
	Chalk.	6 (1.82m)	0	60 (18.28m)	0
Made by Ground Explorations Ltd.	TOTAL FROM SURFACE ..	60 (18.28m)	0	60 (18.28m)	0

Data Bank · Dec 1979

per S W Hester

Trial for foundations.
Site visited.

Signed Date

PR10359 Data Bank · Dec 1979

OD to 230 ft AOD

Received March 1975.

31.10.77 RMcJ/MA.

Appendix 2, Figure 5.2.2 – Borehole TQ09SE50, Sheet 2

Contract Name GREEN LANE, NORTHWOOD

Borehole No. HA1
Sheet 1 **of** 1

Method of boring Hand auger
Diameter 100 mm nominal
Ground level about 70.0 m O.D
Start 10.9.76 0890
Finish 10.9.76 9154

Daily progress	Water levels	In-situ tests	Samples	Depth (m)	Reduced level (m O.D.)	Thickness (m)	Description of Strata
				0.15	69.85	0.15	Topsoil
				0.70	69.30	0.55	Soft mottled reddish brown silty clay with traces of organic material, root fibres and some fine sand partings
			U* U* U*	2.00	68.00	1.30	Stiff to very stiff mottled reddish brown silty clay with traces of organic material, root fibres and some fine sand partings
10/9			U*	2.43	67.57	0.43	Very stiff mottled greyish brown silty sandy clay with some traces of fine gravel
							Bottom of Borehole

Notes

Terresearch Limited **Report No.** S.26/875 **Appendix 1 Sheet** 3

Appendix 2, Figure 5.3.1 – Borehole TQ09SE103, Sheet 1

Contract Name GREEN LANE, NORTHWOOD

Borehole No. HA2
Sheet 1 **of** 1

Method of boring Hand auger
Diameter 100 mm nominal

Ground level 71.0 m O.D. 0890
Start 10.9.76 9186
Finish 10.9.76

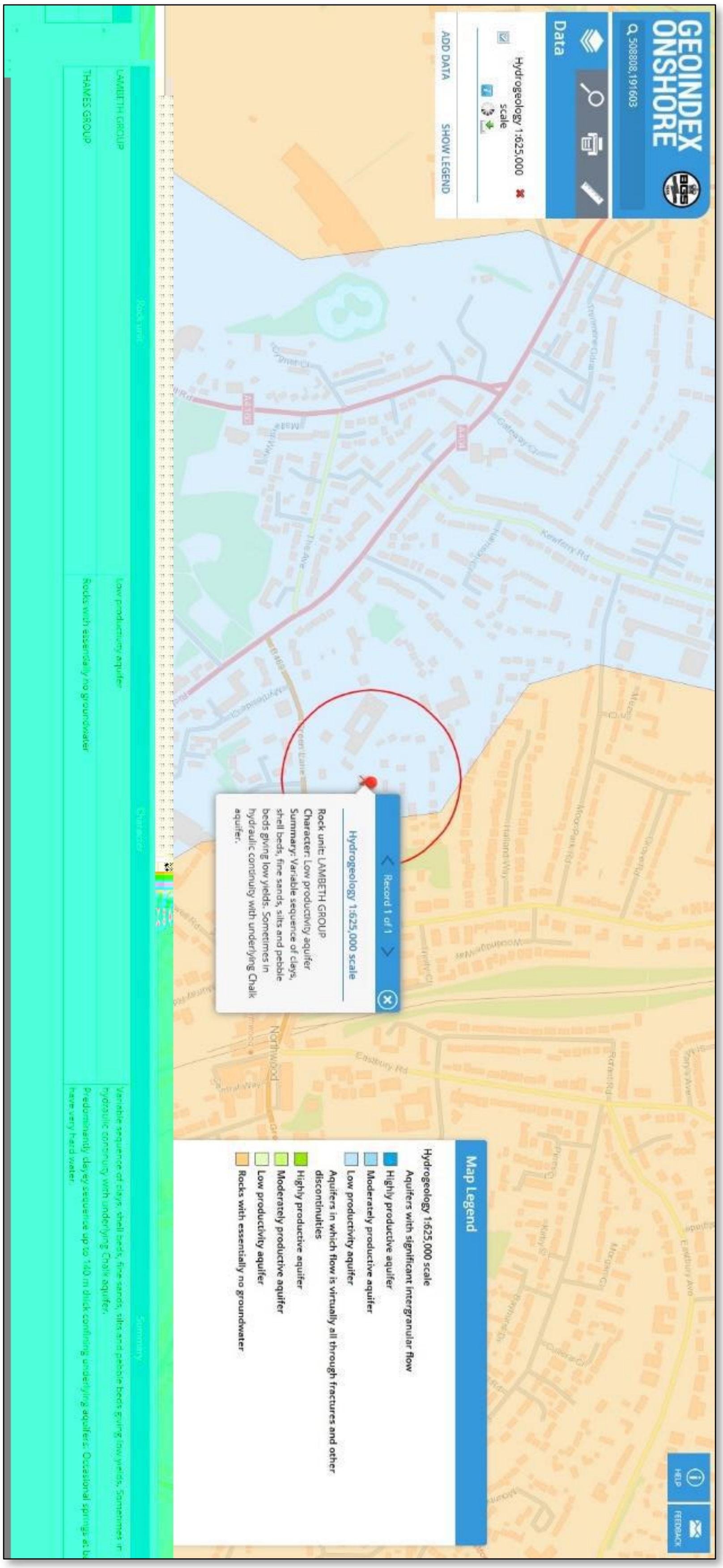
Daily progress	Water levels	In-situ tests	Samples	Depth (m)	Reduced level (m O.D.)	Thickness (m)	Description of Strata
				0.15	70.95	0.15	Topsoil
			U* U*	1.00	70.10	0.85	Soft mottled light brown grey silty clay with numerous traces of organic material and some root fibres
			U* U* U* U*	2.73	68.37	1.73	Firm to very stiff light brown grey silty clay with traces of organic material
10/9							Bottom of Borehole

Notes

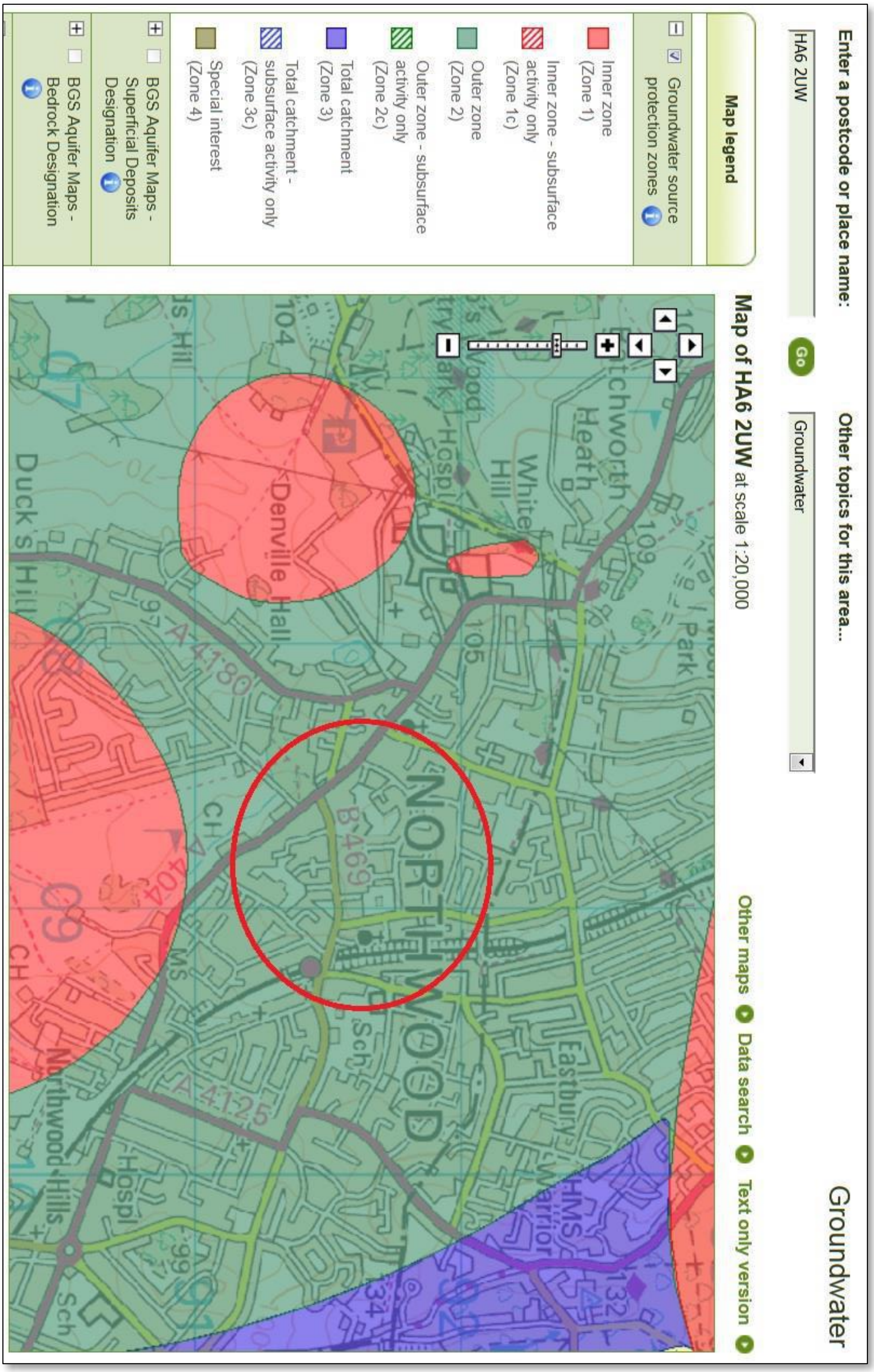
d **Report No.** S.26/875 **Appendix 1 Sheet** 4

Terresearch Limite

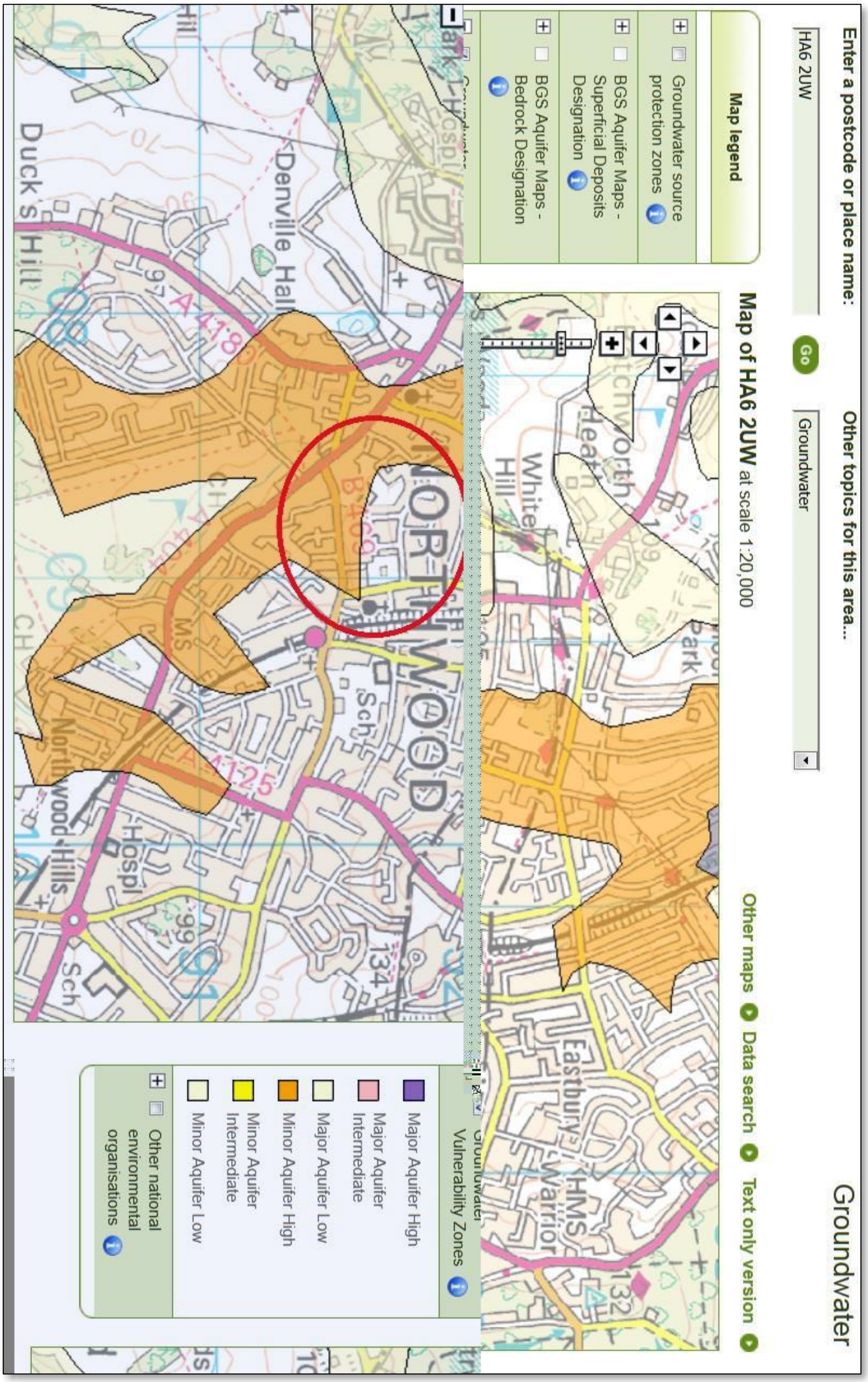
Appendix 2, Figure 5.4.1 – TQ09SE104, Sheet 1



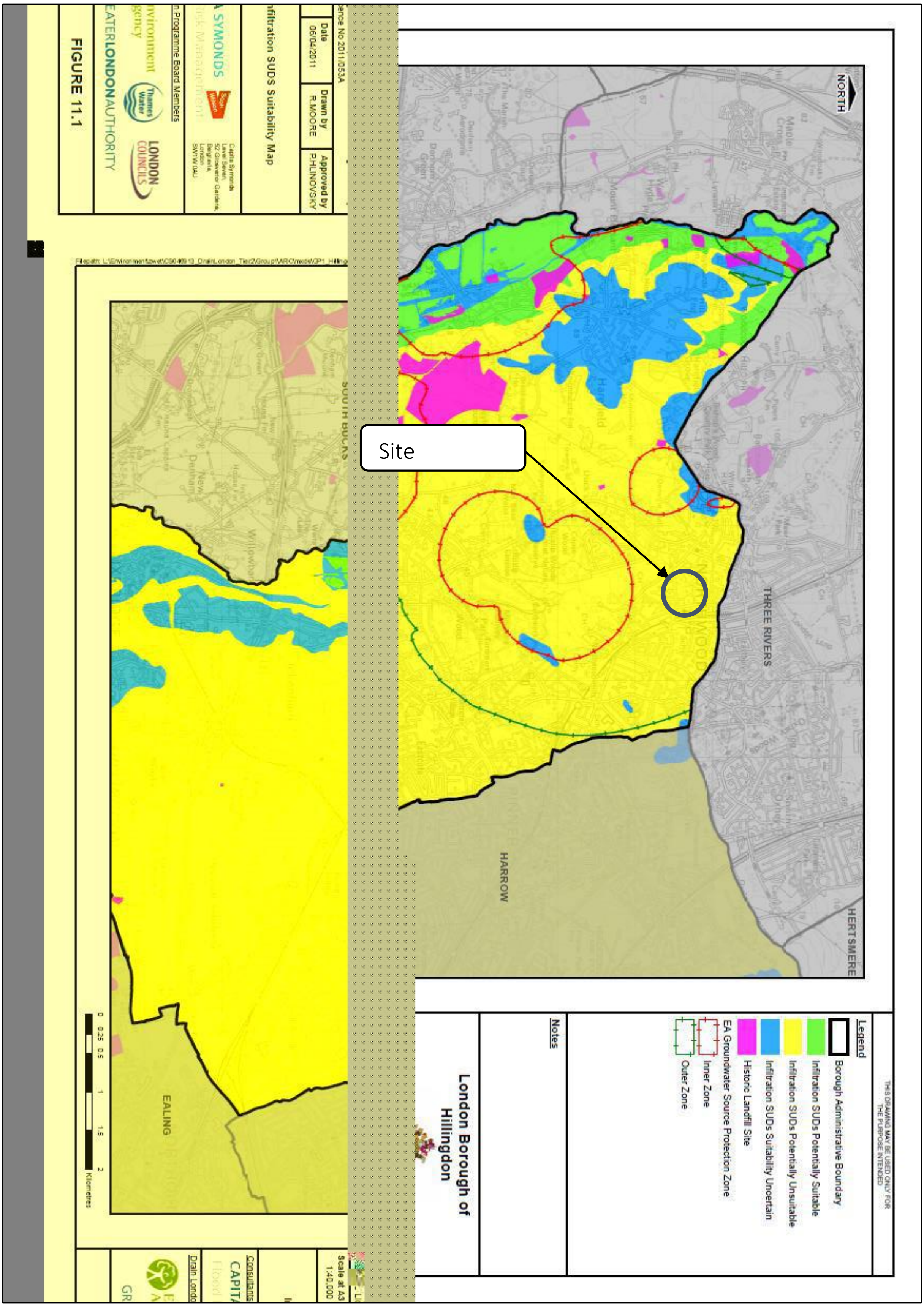
Appendix 2, Figure 6 – Hydrogeology



Appendix 2, Figure 7 - Groundwater Source Protection Zones



Appendix 2, Figure 8 - Groundwater Vulnerability Zones



Appendix 2, Figure 9 – Infiltration SUDS Suitability Map

Appendix 3 – Calculations

- *Greenfield Runoff Rates Calculation Summary*
- *Existing Runoff Rates*
- *Summary of Results for Proposed SuDS – Basement Pump*
- *Summary of Results for Proposed SuDS – Geocellular System No 1*
- *Summary of Results for Proposed SuDS – Permeable Pavement*
- *Summary of Results for Proposed SuDS – Geocellular System No 2*

Greenfield Runoff Rates Calculation Summary

GREENFIELD RUNOFF RATES CALCULATION SUMMARY		
PARAMETERS		
Catchment Area	2766.61 m^2	0.28 ha
Open Public Space	0.00 m^2	0.00 ha
Area Positively Drained	2766.61 m^2	0.28 ha
SAAR (mm)	675 mm	
SOIL	4	
SPR	0.47	
$Q_{BAR,rural}$ (l/s) for 50 Ha	**231.34 l/s**	
Hydrological Region	6	
Growth Curve Factor 1 year	0.85	
Growth Curve Factor 30 year	2.46	
Growth Curve Factor 100 year	3.19	
Return Period	**Greenfield Runoff per Hectare (l/s/ha)**	
QBAR	4.63	
1	3.93	
30	11.38	
100	14.76	
Return Period	**Greenfield Runoff (l/s)**	
QBAR	1.28	
1	1.09	
30	3.15	
100	**4.08**	

Appendix 3, Table 1 - Greenfield Runoff Rates Calculation Summary

Existing Runoff Rates

Ambiental		Page 1
Science Park Square Brighton BN1 9SB	Existing Storm Sewer Design London School of Theology Contract No 3110	
Date 14/03/2017 12:50 File Existing Runoff Rates#3...	Designed by Jose Tenedor Checked by Mark Naumann	
XP Solutions	Network 2016.1	

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	Add Flow / Climate Change (%)	0
M5-60 (mm)	20.100	Minimum Backdrop Height (m)	0.200
Ratio R	0.412	Maximum Backdrop Height (m)	1.500
Maximum Rainfall (mm/hr)	50	Min Design Depth for Optimisation (m)	1.200
Maximum Time of Concentration (mins)	30	Min Vel for Auto Design only (m/s)	1.00
Foul Sewage (l/s/ha)	0.000	Min Slope for Optimisation (1:X)	500
Volumetric Runoff Coeff.	0.750		

Designed with Level Soffits

Time Area Diagram for Storm

Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.105	4-8	0.022

Total Area Contributing (ha) = 0.127

Total Pipe Volume (m³) = 0.837

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	20.000	3.040	6.6	0.127	4.00	0.0	0.600	o	100	Pipe/Conduit	
S1.001	38.465	0.481	80.0	0.000	0.00	0.0	0.600	o	150	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	4.11	71.000	0.127	0.0	0.0	0.0	3.03	23.8	17.2
S1.001	50.00	4.68	67.910	0.127	0.0	0.0	0.0	1.13	19.9	17.2

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S1.001	S	70.000	67.429	0.000	0	0

Ambiental		Page 2
Science Park Square Brighton BN1 9SB	Existing Storm Sewer Design London School of Theology Contract No 3110	Micro Drainage
Date 14/03/2017 12:50 File Existing Runoff Rates#3...	Designed by Jose Tenedor Checked by Mark Naumann	
XP Solutions	Network 2016.1	

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

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Ambiental		Page 3
Science Park Square Brighton BN1 9SB	Existing Storm Sewer Design London School of Theology Contract No 3110	
Date 14/03/2017 12:50 File Existing Runoff Rates#3...	Designed by Jose Tenedor Checked by Mark Naumann	
XP Solutions	Network 2016.1	

1 year Return Period Summary of Critical Results by Maximum Outflow (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 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 0.412
Region England and Wales Cv (Summer) 0.750
M5-60 (mm) 20.100 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years) 1, 20, 30, 100
Climate Change (%) 0, 0, 0, 0

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
S1.000	S1	15 Winter	1	+0%	20/15 Summer	20/15 Summer			71.070
S1.001	S2	15 Winter	1	+0%	20/15 Summer				68.029

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S1.000	S1	-0.030	0.000	0.82		18.8	FLOOD RISK	14
S1.001	S2	-0.031	0.000	0.97		18.6	OK	

Ambiental		Page 4
Science Park Square	Existing Storm Sewer Design	
Brighton	London School of Theology	
BN1 9SB	Contract No 3110	
Date 14/03/2017 12:50	Designed by Jose Tenedor	
File Existing Runoff Rates#3...	Checked by Mark Naumann	
XP Solutions	Network 2016.1	

20 year Return Period Summary of Critical Results by Maximum Outflow (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 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 0.412
Region England and Wales Cv (Summer) 0.750
M5-60 (mm) 20.100 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years) 1, 20, 30, 100
Climate Change (%) 0, 0, 0, 0

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
S1.000	S1	15 Summer	20	+0%	20/15 Summer	20/15 Summer			71.232
S1.001	S2	15 Winter	20	+0%	20/15 Summer				68.244

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S1.000	S1	0.132	1.620	0.99		22.8	FLOOD	14
S1.001	S2	0.184	0.000	1.18		22.8	SURCHARGED	

Ambiental		Page 5
Science Park Square Brighton BN1 9SB	Existing Storm Sewer Design London School of Theology Contract No 3110	
Date 14/03/2017 12:50	Designed by Jose Tenedor	

Ambiental		Page 6
Science Park Square Brighton BN1 9SB	Existing Storm Sewer Design London School of Theology Contract No 3110	Micro Drainage
Date 14/03/2017 12:50 File Existing Runoff Rates#3...	Designed by Jose Tenedor Checked by Mark Naumann	
XP Solutions	Network 2016.1	

100 year Return Period Summary of Critical Results by Maximum Outflow (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 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 0.412
Region England and Wales Cv (Summer) 0.750
M5-60 (mm) 20.100 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years) 1, 20, 30, 100
Climate Change (%) 0, 0, 0, 0

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
S1.000	S1	15 Summer	100	+0%	20/15 Summer	20/15 Summer			71.236
S1.001	S2	15 Winter	100	+0%	20/15 Summer				68.245

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S1.000	S1	0.136	6.328	1.00		22.9	FLOOD	14
S1.001	S2	0.185	0.000	1.18		22.8	SURCHARGED	

Summary of Results for Proposed SuDS - Basement Pump

Ambiental		Page 1
Science Park Square Brighton BN1 9SB	Proposed SuDS - Pump London School of Theology Contract No 3110	Micro Drainage
Date 14/03/2017 18:44 File VolumeCalcs_1yr+CC.casx	Designed by Jose Tenedor Checked by Mark Naumann	
XP Solutions	Source Control 2016.1	

Cascade Summary of Results for PIPE_1in1yr+40%cc_VolumeCalcs.srcx

Upstream Structures	Outflow To	Overflow To
(None)	(None)	GS1_1in1yr+40%cc_VolumeCalcs.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	68.000	0.000	0.9	0.0	O K
30 min Summer	68.000	0.000	0.9	0.0	O K
60 min Summer	68.000	0.000	0.8	0.0	O K
120 min Summer	68.000	0.000	0.6	0.0	O K
180 min Summer	68.000	0.000	0.5	0.0	O K
240 min Summer	68.000	0.000	0.4	0.0	O K
360 min Summer	68.000	0.000	0.3	0.0	O K
480 min Summer	68.000	0.000	0.3	0.0	O K
600 min Summer	68.000	0.000	0.2	0.0	O K
720 min Summer	68.000	0.000	0.2	0.0	O K
960 min Summer	68.000	0.000	0.2	0.0	O K
1440 min Summer	68.000	0.000	0.1	0.0	O K
2160 min Summer	68.000	0.000	0.1	0.0	O K
2880 min Summer	68.000	0.000	0.1	0.0	O K
4320 min Summer	68.000	0.000	0.1	0.0	O K
5760 min Summer	68.000	0.000	0.0	0.0	O K
7200 min Summer	68.000	0.000	0.0	0.0	O K
8640 min Summer	68.000	0.000	0.0	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	44.043	0.0	0.7	0
30 min Summer	28.612	0.0	0.9	0
60 min Summer	18.021	0.0	1.1	0
120 min Summer	11.117	0.0	1.3	0
180 min Summer	8.339	0.0	1.5	0
240 min Summer	6.792	0.0	1.6	0
360 min Summer	5.057	0.0	1.8	0
480 min Summer	4.090	0.0	2.0	0
600 min Summer	3.468	0.0	2.1	0
720 min Summer	3.031	0.0	2.2	0
960 min Summer	2.451	0.0	2.4	0
1440 min Summer	1.817	0.0	2.6	0
2160 min Summer	1.348	0.0	2.9	0
2880 min Summer	1.090	0.0	3.1	0
4320 min Summer	0.808	0.0	3.5	0
5760 min Summer	0.653	0.0	3.8	0
7200 min Summer	0.554	0.0	4.0	0
8640 min Summer	0.485	0.0	4.2	0

Ambiental		Page 2
Science Park Square Brighton BN1 9SB	Proposed SuDS - Pump London School of Theology Contract No 3110	
Date 14/03/2017 18:44 File VolumeCalcs_1yr+CC.casx	Designed by Jose Tenedor Checked by Mark Naumann	
XP Solutions	Source Control 2016.1	

Cascade Summary of Results for PIPE_1in1yr+40%cc_VolumeCalcs.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
10080 min Summer	68.000	0.000	0.0	0.0	O K
15 min Winter	68.000	0.000	1.0	0.0	O K
30 min Winter	68.000	0.000	1.0	0.0	O K
60 min Winter	68.000	0.000	0.8	0.0	O K
120 min Winter	68.000	0.000	0.5	0.0	O K
180 min Winter	68.000	0.000	0.4	0.0	O K
240 min Winter	68.000	0.000	0.3	0.0	O K
360 min Winter	68.000	0.000	0.2	0.0	O K
480 min Winter	68.000	0.000	0.2	0.0	O K
600 min Winter	68.000	0.000	0.2	0.0	O K
720 min Winter	68.000	0.000	0.1	0.0	O K
960 min Winter	68.000	0.000	0.1	0.0	O K
1440 min Winter	68.000	0.000	0.1	0.0	O K
2160 min Winter	68.000	0.000	0.1	0.0	O K
2880 min Winter	68.000	0.000	0.1	0.0	O K
4320 min Winter	68.000	0.000	0.0	0.0	O K
5760 min Winter	68.000	0.000	0.0	0.0	O K
7200 min Winter	68.000	0.000	0.0	0.0	O K
8640 min Winter	68.000	0.000	0.0	0.0	O K
10080 min Winter	68.000	0.000	0.0	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
10080 min Summer	0.433	0.0	4.4	0
15 min Winter	44.043	0.0	0.7	0
30 min Winter	28.612	0.0	1.0	0
60 min Winter	18.021	0.0	1.2	0
120 min Winter	11.117	0.0	1.5	0
180 min Winter	8.339	0.0	1.7	0
240 min Winter	6.792	0.0	1.8	0
360 min Winter	5.057	0.0	2.0	0
480 min Winter	4.090	0.0	2.2	0
600 min Winter	3.468	0.0	2.3	0
720 min Winter	3.031	0.0	2.4	0
960 min Winter	2.451	0.0	2.6	0
1440 min Winter	1.817	0.0	2.9	0
2160 min Winter	1.348	0.0	3.3	0
2880 min Winter	1.090	0.0	3.5	0
4320 min Winter	0.808	0.0	3.9	0
5760 min Winter	0.653	0.0	4.2	0
7200 min Winter	0.554	0.0	4.5	0
8640 min Winter	0.485	0.0	4.7	0
10080 min Winter	0.433	0.0	4.9	0

Ambiental		Page 3
Science Park Square Brighton BN1 9SB	Proposed SuDS - Pump London School of Theology Contract No 3110	Micro Drainage
Date 14/03/2017 18:44 File VolumeCalcs_1yr+CC.casx	Designed by Jose Tenedor Checked by Mark Naumann	
XP Solutions	Source Control 2016.1	

Cascade Rainfall Details for PIPE_1in1yr+40%cc_VolumeCalcs.srcx

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	1	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.100	Shortest Storm (mins)	15
Ratio R	0.412	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.008

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.003	4	8	0.003	8	12	0.003

Ambiental		Page 4
Science Park Square Brighton BN1 9SB	Proposed SuDS - Pump London School of Theology Contract No 3110	Micro Drainage
Date 14/03/2017 18:44 File VolumeCalcs_1yr+CC.casx	Designed by Jose Tenedor Checked by Mark Naumann	
XP Solutions	Source Control 2016.1	

Cascade Model Details for PIPE_1in1yr+40%cc_VolumeCalcs.srcx

Storage is Online Cover Level (m) 68.500

Pipe Structure

Diameter (m) Conduit Section Length (m) 27.000
Slope (1:X) 1000.000 Invert Level (m) 68.000

Section Number 41 Minor Dimn (mm) 300 4 * Hyd Radius (mm) 0.299
Conduit Type oo Side Slope (Deg) XSect Area (m²) 0.141
Major Dimn (mm) 600 Corner Splay (mm)

Pump Outflow Control

Invert Level (m) 67.500

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	2.0000	0.900	2.0000	1.700	2.0000	2.500	2.0000
0.200	2.0000	1.000	2.0000	1.800	2.0000	2.600	2.0000
0.300	2.0000	1.100	2.0000	1.900	2.0000	2.700	2.0000
0.400	2.0000	1.200	2.0000	2.000	2.0000	2.800	2.0000
0.500	2.0000	1.300	2.0000	2.100	2.0000	2.900	2.0000
0.600	2.0000	1.400	2.0000	2.200	2.0000	3.000	2.0000
0.700	2.0000	1.500	2.0000	2.300	2.0000		
0.800	2.0000	1.600	2.0000	2.400	2.0000		

Ambiental		Page 1
Science Park Square Brighton BN1 9SB	Proposed SuDS - Pump London School of Theology Contract No 3110	
Date 14/03/2017 18:39 File VolumeCalcs_30yr+CC.casx	Designed by Jose Tenedor Checked by Mark Naumann	
XP Solutions	Source Control 2016.1	

Cascade Summary of Results for PIPE_1in30yr+40%cc_VolumeCalcs.srcx

Upstream Structures	Outflow To	Overflow To
(None)	(None)	GS1_1in30yr+40%cc_VolumeCalcs.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	68.013	0.013	2.0	0.0	O K
30 min Summer	68.021	0.021	2.0	0.0	O K
60 min Summer	68.000	0.000	1.9	0.0	O K
120 min Summer	68.000	0.000	1.4	0.0	O K
180 min Summer	68.000	0.000	1.1	0.0	O K

Ambiental		Page 2
Science Park Square	Proposed SuDS - Pump	
Brighton	London School of Theology	
BN1 9SB	Contract No 3110	
Date 14/03/2017 18:39	Designed by Jose Tenedor	
File VolumeCalcs_30yr+CC.casx	Checked by Mark Naumann	
XP Solutions	Source Control 2016.1	

Cascade Summary of Results for PIPE_1in30yr+40%cc_VolumeCalcs.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
10080 min Summer	68.000	0.000	0.1	0.0	O K
15 min Winter	68.038	0.038	2.0	0.1	O K
30 min Winter	68.036	0.036	2.0	0.1	O K
60 min Winter	68.000	0.000	1.8	0.0	O K
120 min Winter	68.000	0.000	1.2	0.0	O K
180 min Winter	68.000	0.000	0.9	0.0	O K
240 min Winter	68.000	0.000	0.7	0.0	O K
360 min Winter	68.000	0.000	0.5	0.0	O K
480 min Winter	68.000	0.000	0.4	0.0	O K
600 min Winter	68.000	0.000	0.4	0.0	O K
720 min Winter	68.000	0.000	0.3	0.0	O K
960 min Winter	68.000	0.000	0.2	0.0	O K
1440 min Winter	68.000	0.000	0.2	0.0	O K
2160 min Winter	68.000	0.000	0.1	0.0	O K
2880 min Winter	68.000	0.000	0.1	0.0	O K
4320 min Winter	68.000	0.000	0.1	0.0	O K
5760 min Winter	68.000	0.000	0.1	0.0	O K
7200 min Winter	68.000	0.000	0.0	0.0	O K
8640 min Winter	68.000	0.000	0.0	0.0	O K
10080 min Winter	68.000	0.000	0.0	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
10080 min Summer	0.792	0.0	8.0	0
15 min Winter	108.085	0.0	1.8	17
30 min Winter	70.019	0.0	2.3	25
60 min Winter	43.355	0.0	2.9	0
120 min Winter	26.057	0.0	3.5	0
180 min Winter	19.144	0.0	3.9	0
240 min Winter	15.318	0.0	4.1	0
360 min Winter	11.161	0.0	4.5	0
480 min Winter	8.912	0.0	4.8	0
600 min Winter	7.480	0.0	5.0	0
720 min Winter	6.481	0.0	5.2	0
960 min Winter	5.166	0.0	5.6	0
1440 min Winter	3.748	0.0	6.0	0
2160 min Winter	2.716	0.0	6.6	0
2880 min Winter	2.160	0.0	7.0	0
4320 min Winter	1.563	0.0	7.6	0
5760 min Winter	1.242	0.0	8.0	0
7200 min Winter	1.038	0.0	8.4	0
8640 min Winter	0.897	0.0	8.7	0
10080 min Winter	0.792	0.0	8.9	0

Ambiental		Page 3
Science Park Square Brighton BN1 9SB	Proposed SuDS - Pump London School of Theology Contract No 3110	Micro Drainage
Date 14/03/2017 18:39 File VolumeCalcs_30yr+CC.casx	Designed by Jose Tenedor Checked by Mark Naumann	
XP Solutions	Source Control 2016.1	

Cascade Rainfall Details for PIPE_1in30yr+40%cc_VolumeCalcs.srcx

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	30	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.100	Shortest Storm (mins)	15
Ratio R	0.412	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.008

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.003	4	8	0.003	8	12	0.003

Ambiental		Page 4
Science Park Square Brighton BN1 9SB	Proposed SuDS - Pump London School of Theology Contract No 3110	Micro Drainage
Date 14/03/2017 18:39 File VolumeCalcs_30yr+CC.casx	Designed by Jose Tenedor Checked by Mark Naumann	
XP Solutions	Source Control 2016.1	

Cascade Model Details for PIPE_1in30yr+40%cc_VolumeCalcs.srcx

Storage is Online Cover Level (m) 68.500

Pipe Structure

Diameter (m) Conduit Section Length (m) 27.000
Slope (1:X) 1000.000 Invert Level (m) 68.000

Section Number 41 Minor Dimn (mm) 300 4 * Hyd Radius (mm) 0.299
Conduit Type oo Side Slope (Deg) XSect Area (m²) 0.141
Major Dimn (mm) 600 Corner Splay (mm)

Pump Outflow Control

Invert Level (m) 67.500

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	2.0000	0.900	2.0000	1.700	2.0000	2.500	2.0000
0.200	2.0000	1.000	2.0000	1.800	2.0000	2.600	2.0000
0.300	2.0000	1.100	2.0000	1.900	2.0000	2.700	2.0000
0.400	2.0000	1.200	2.0000	2.000	2.0000	2.800	2.0000
0.500	2.0000	1.300	2.0000	2.100	2.0000	2.900	2.0000
0.600	2.0000	1.400	2.0000	2.200	2.0000	3.000	2.0000
0.700	2.0000	1.500	2.0000	2.300	2.0000		
0.800	2.0000	1.600	2.0000	2.400	2.0000		

Ambiental		Page 1
Science Park Square Brighton BN1 9SB	Proposed SuDS - Pump London School of Theology Contract No 3110	
Date 14/03/2017 18:16 File AttenuationVolume_100yr...	Designed by Jose Tenedor Checked by Mark Naumann	
XP Solutions	Source Control 2016.1	

Cascade Summary of Results for PIPE_1in100yr+40%cc_AttenuationCalcs.srcx

Upstream Structures	Outflow To	Overflow To
(None)	GS1_1in100yr+40%cc_AttenuationCalcs.srcx	(None)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	68.062	0.062	2.0	0.3	O K
30 min Summer	68.068	0.068	2.0	0.4	O K
60 min Summer	68.050	0.050	2.0	0.2	O K
120 min Summer	68.000	0.000	1.9	0.0	O K
180 min Summer	68.000	0.000	1.5	0.0	O K
240 min Summer	68.000	0.000	1.2	0.0	O K
360 min Summer	68.000	0.000	0.9	0.0	O K
480 min Summer	68.000	0.000	0.7	0.0	O K
600 min Summer	68.000	0.000	0.6	0.0	O K
720 min Summer	68.000	0.000	0.5	0.0	O K
960 min Summer	68.000	0.000	0.4	0.0	O K
1440 min Summer	68.000	0.000	0.3	0.0	O K
2160 min Summer	68.000	0.000	0.2	0.0	O K
2880 min Summer	68.000	0.000	0.2	0.0	O K
4320 min Summer	68.000	0.000	0.1	0.0	O K
5760 min Summer	68.000	0.000	0.1	0.0	O K
7200 min Summer	68.000	0.000	0.1	0.0	O K
8640 min Summer	68.000	0.000	0.1	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	140.352	0.0	2.1	19
30 min Summer	91.674	0.0	2.8	26
60 min Summer	57.005	0.0	3.4	40
120 min Summer	34.241	0.0	4.1	0
180 min Summer	25.078	0.0	4.5	0
240 min Summer	19.989	0.0	4.8	0
360 min Summer	14.479	0.0	5.2	0
480 min Summer	11.517	0.0	5.5	0
600 min Summer	9.637	0.0	5.8	0
720 min Summer	8.327	0.0	6.0	0
960 min Summer	6.608	0.0	6.3	0
1440 min Summer	4.764	0.0	6.9	0
2160 min Summer	3.429	0.0	7.4	0
2880 min Summer	2.712	0.0	7.8	0
4320 min Summer	1.947	0.0	8.4	0
5760 min Summer	1.538	0.0	8.9	0
7200 min Summer	1.280	0.0	9.2	0
8640 min Summer	1.101	0.0	9.5	0

Ambiental		Page 2
Science Park Square Brighton BN1 9SB	Proposed SuDS - Pump London School of Theology Contract No 3110	
Date 14/03/2017 18:16	Designed by Jose Tenedor	

Ambiental		Page 3
Science Park Square Brighton BN1 9SB	Proposed SuDS - Pump London School of Theology Contract No 3110	

Ambiental		Page 5
Science Park Square Brighton BN1 9SB	Proposed SuDS-Geocellular S.#1 London School of Theology Contract No 3110	
Date 14/03/2017 18:44 File VolumeCalcs_1yr+CC.casx	Designed by Jose Tenedor Checked by Mark Naumann	
XP Solutions	Source Control 2016.1	

Hydro-Brake Optimum® Outflow Control

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.6	1.200	5.4	3.000	8.4	7.000	12.5
0.200	4.8	1.400	5.8	3.500	9.0	7.500	12.9
0.300	5.0	1.600	6.2	4.000	9.6	8.000	13.3
0.400	4.9	1.800	6.6	4.500	10.1	8.500	13.7
0.500	4.7	2.000	6.9	5.000	10.6	9.000	14.1
0.600	4.3	2.200	7.2	5.500	11.1	9.500	14.5
0.800	4.5	2.400	7.5	6.000	11.6		
1.000	5.0	2.600	7.8	6.500	12.1		

Ambiental		Page 1
Science Park Square Brighton BN1 9SB	Proposed SuDS-Geocellular S.#1 London School of Theology Contract No 3110	Micro Drainage
Date 14/03/2017 18:40 File VolumeCalcs_30yr+CC.casx	Designed by Jose Tenedor Checked by Mark Naumann	
XP Solutions	Source Control 2016.1	

Cascade Summary of Results for GS1_1in30yr+40%cc_VolumeCalcs.srcx

Upstream Structures	Outflow To	Overflow To
PIPE_1in30yr+40%cc_VolumeCalcs.srcx	GS2_1in30yr+40%cc_VolumeCalcs.srcx	(None)

Half Drain Time : 14 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	72.555	0.305	0.0	5.0	5.0	5.8	O K
30 min Summer	72.607	0.357	0.0	5.0	5.0	6.8	O K
60 min Summer	72.589	0.339	0.0	5.0	5.0	6.4	O K
120 min Summer	72.511	0.261	0.0	5.0	5.0	5.0	O K
180 min Summer	72.445	0.195	0.0	4.8	4.8	3.7	O K
240 min Summer	72.399	0.149	0.0	4.6	4.6	2.8	O K
360 min Summer	72.360	0.110	0.0	3.9	3.9	2.1	O K
480 min Summer	72.343	0.093	0.0	3.3	3.3	1.8	O K
600 min Summer	72.332	0.082	0.0	2.8	2.8	1.6	O K
720 min Summer	72.325	0.075	0.0	2.5	2.5	1.4	O K
960 min Summer	72.316	0.066	0.0	2.0	2.0	1.2	O K
1440 min Summer	72.305	0.055	0.0	1.5	1.5	1.0	O K
2160 min Summer	72.296	0.046	0.0	1.1	1.1	0.9	O K
2880 min Summer	72.290	0.040	0.0	0.8	0.8	0.8	O K
4320 min Summer	72.284	0.034	0.0	0.6	0.6	0.6	O K
5760 min Summer	72.280	0.030	0.0	0.5	0.5	0.6	O K
7200 min Summer	72.277	0.027	0.0	0.4	0.4	0.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	108.085	0.0	9.7	20
30 min Summer	70.019	0.0	12.6	29
60 min Summer	43.355	0.0	15.6	46
120 min Summer	26.057	0.0	18.8	76
180 min Summer	19.144	0.0	20.7	106
240 min Summer	15.318	0.0	22.0	134
360 min Summer	11.161	0.0	24.1	192
480 min Summer	8.912	0.0	25.7	252
600 min Summer	7.480	0.0	26.9	312
720 min Summer	6.481	0.0	28.0	372
960 min Summer	5.166	0.0	29.7	492
1440 min Summer	3.748	0.0	32.4	730
2160 min Summer	2.716	0.0	35.2	1096
2880 min Summer	2.160	0.0	37.3	1464
4320 min Summer	1.563	0.0	40.5	2200
5760 min Summer	1.242	0.0	42.9	2912
7200 min Summer	1.038	0.0	44.8	3576

Ambiental		Page 2
Science Park Square Brighton BN1 9SB	Proposed SuDS-Geocellular S.#1 London School of Theology Contract No 3110	
Date 14/03/2017 18:40 File VolumeCalcs_30yr+CC.casx	Designed by Jose Tenedor Checked by Mark Naumann	
XP Solutions	Source Control 2016.1	

Cascade Summary of Results for GS1_1in30yr+40%cc_VolumeCalcs.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
8640 min Summer	72.275	0.025	0.0	0.4	0.4	0.5	O K
10080 min Summer	72.274	0.024	0.0	0.3	0.3	0.4	O K
15 min Winter	72.603	0.353	0.0	5.0	5.0	6.7	O K
30 min Winter	72.661	0.411	0.0	5.0	5.0	7.8	O K
60 min Winter	72.623	0.373	0.0	5.0	5.0	7.1	O K
120 min Winter	72.492	0.242	0.0	4.9	4.9	4.6	O K
180 min Winter	72.403	0.153	0.0	4.6	4.6	2.9	O K
240 min Winter	72.365	0.115	0.0	4.1	4.1	2.2	O K
360 min Winter	72.338	0.088	0.0	3.1	3.1	1.7	O K
480 min Winter	72.326	0.076	0.0	2.5	2.5	1.4	O K
600 min Winter	72.318	0.068	0.0	2.1	2.1	1.3	O K
720 min Winter	72.312	0.062	0.0	1.8	1.8	1.2	O K
960 min Winter	72.305	0.055	0.0	1.5	1.5	1.0	O K
1440 min Winter	72.296	0.046	0.0	1.1	1.1	0.9	O K
2160 min Winter	72.288	0.038	0.0	0.8	0.8	0.7	O K
2880 min Winter	72.284	0.034	0.0	0.6	0.6	0.6	O K
4320 min Winter	72.279	0.029	0.0	0.5	0.5	0.5	O K
5760 min Winter	72.275	0.025	0.0	0.4	0.4	0.5	O K
7200 min Winter	72.273	0.023	0.0	0.3	0.3	0.4	O K
8640 min Winter	72.271	0.021	0.0	0.3	0.3	0.4	O K
10080 min Winter	72.270	0.020	0.0	0.2	0.2	0.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
8640 min Summer	0.897	0.0	46.5	4384
10080 min Summer	0.792	0.0	47.9	5072
15 min Winter	108.085	0.0	10.9	21
30 min Winter	70.019	0.0	14.1	30
60 min Winter	43.355	0.0	17.5	48
120 min Winter	26.057	0.0	21.0	80
180 min Winter	19.144	0.0	23.1	108
240 min Winter	15.318	0.0	24.7	134
360 min Winter	11.161	0.0	27.0	192
480 min Winter	8.912	0.0	28.7	252
600 min Winter	7.480	0.0	30.2	314
720 min Winter	6.481	0.0	31.3	370
960 min Winter	5.166	0.0	33.3	488
1440 min Winter	3.748	0.0	36.3	734
2160 min Winter	2.716	0.0	39.4	1088
2880 min Winter	2.160	0.0	41.8	1440
4320 min Winter	1.563	0.0	45.4	2204
5760 min Winter	1.242	0.0	48.1	2920
7200 min Winter	1.038	0.0	50.2	3624
8640 min Winter	0.897	0.0	52.1	4272
10080 min Winter	0.792	0.0	53.7	5072

Ambiental		Page 3
Science Park Square Brighton BN1 9SB	Proposed SuDS-Geocellular S.#1 London School of Theology Contract No 3110	Micro Drainage
Date 14/03/2017 18:40 File VolumeCalcs_30yr+CC.casx	Designed by Jose Tenedor Checked by Mark Naumann	
XP Solutions	Source Control 2016.1	

Cascade Rainfall Details for GS1_1in30yr+40%cc_VolumeCalcs.srcx

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	30	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.100	Shortest Storm (mins)	15
Ratio R	0.412	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.048

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.016	4	8	0.016	8	12	0.016

Ambiental		Page 4
Science Park Square Brighton BN1 9SB	Proposed SuDS-Geocellular S.#1 London School of Theology Contract No 3110	Micro Drainage
Date 14/03/2017 18:40 File VolumeCalcs_30yr+CC.casx	Designed by Jose Tenedor Checked by Mark Naumann	
XP Solutions	Source Control 2016.1	

Cascade Model Details for GS1_1in30yr+40%cc_VolumeCalcs.srcx

Storage is Online Cover Level (m) 73.450

Cellular Storage Structure

Invert Level (m) 72.250 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	20.0	0.0	1.300	0.0	0.0
0.100	20.0	0.0	1.400	0.0	0.0
0.200	20.0	0.0	1.500	0.0	0.0
0.300	20.0	0.0	1.600	0.0	0.0
0.400	20.0	0.0	1.700	0.0	0.0
0.500	20.0	0.0	1.800	0.0	0.0
0.600	20.0	0.0	1.900	0.0	0.0
0.700	20.0	0.0	2.000	0.0	0.0
0.800	20.0	0.0	2.100	0.0	0.0
0.900	20.0	0.0	2.200	0.0	0.0
1.000	20.0	0.0	2.300	0.0	0.0
1.001	0.0	0.0	2.400	0.0	0.0
1.200	0.0	0.0	2.500	0.0	0.0

Hydro-Brake Optimum® Outflow Control

Unit Reference	MD-SHE-0105-5000-1000-5000
Design Head (m)	1.000
Design Flow (l/s)	5.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	105
Invert Level (m)	72.250
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	5.0
Flush-Flo™	0.296	5.0
Kick-Flo®	0.637	4.1
Mean Flow over Head Range	-	4.3

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake Optimum® as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Ambiental		Page 5
Science Park Square Brighton BN1 9SB	Proposed SuDS-Geocellular S.#1 London School of Theology Contract No 3110	Micro Drainage
Date 14/03/2017 18:40 File VolumeCalcs_30yr+CC.casx	Designed by Jose Tenedor Checked by Mark Naumann	
XP Solutions	Source Control 2016.1	

Hydro-Brake Optimum® Outflow Control

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.6	1.200	5.4	3.000	8.4	7.000	12.5
0.200	4.8	1.400	5.8	3.500	9.0	7.500	12.9
0.300	5.0	1.600	6.2	4.000	9.6	8.000	13.3
0.400	4.9	1.800	6.6	4.500	10.1	8.500	13.7
0.500	4.7	2.000	6.9	5.000	10.6	9.000	14.1
0.600	4.3	2.200	7.2	5.500	11.1	9.500	14.5
0.800	4.5	2.400	7.5	6.000	11.6		
1.000	5.0	2.600	7.8	6.500	12.1		

Ambiental		Page 1
Science Park Square Brighton BN1 9SB	Proposed SuDS-Geocellular S.#1 London School of Theology Contract No 3110	Micro Drainage
Date 14/03/2017 18:14 File AttenuationVolume_100yr...	Designed by Jose Tenedor Checked by Mark Naumann	
XP Solutions	Source Control 2016.1	

Cascade Summary of Results for GS1_1in100yr+40%cc_AttenuationCalcs.srcx

Upstream Structures	Outflow To	Overflow To
PIPE_1in100yr+40%cc_AttenuationCalcs.srcx	GS2_1in100yr+40%cc_AttenuationCalcs.srcx	(None)

Half Drain Time : 27 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	72.780	0.530	0.0	5.0	5.0	10.1	O K
30 min Summer	72.911	0.661	0.0	5.0	5.0	12.6	O K
60 min Summer	72.920	0.670	0.0	5.0	5.0	12.7	O K
120 min Summer	72.813	0.563	0.0	5.0	5.0	10.7	O K
180 min Summer	72.697	0.447	0.0	5.0	5.0	8.5	O K
240 min Summer	72.597	0.347	0.0	5.0	5.0	6.6	O K
360 min Summer	72.463	0.213	0.0	4.9	4.9	4.0	O K
480 min Summer	72.395	0.145	0.0	4.6	4.6	2.8	O K
600 min Summer	72.367	0.117	0.0	4.2	4.2	2.2	O K
720 min Summer	72.352	0.102	0.0	3.7	3.7	1.9	O K
960 min Summer	72.336	0.086	0.0	3.0	3.0	1.6	O K
1440 min Summer	72.319	0.069	0.0	2.2	2.2	1.3	O K
2160 min Summer	72.307	0.057	0.0	1.6	1.6	1.1	O K
2880 min Summer	72.300	0.050	0.0	1.2	1.2	0.9	O K
4320 min Summer	72.291	0.041	0.0	0.9	0.9	0.8	O K
5760 min Summer	72.287	0.037	0.0	0.7	0.7	0.7	O K
7200 min Summer	72.283	0.033	0.0	0.6	0.6	0.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	140.352	0.0	14.7	22
30 min Summer	91.674	0.0	19.3	33
60 min Summer	57.005	0.0	23.9	50
120 min Summer	34.241	0.0	28.8	82
180 min Summer	25.078	0.0	31.6	114
240 min Summer	19.989	0.0	33.6	144
360 min Summer	14.479	0.0	36.5	200
480 min Summer	11.517	0.0	38.7	256
600 min Summer	9.637	0.0	40.5	312
720 min Summer	8.327	0.0	42.0	372
960 min Summer	6.608	0.0	44.4	492
1440 min Summer	4.764	0.0	48.0	734
2160 min Summer	3.429	0.0	51.8	1100
2880 min Summer	2.712	0.0	54.7	1460
4320 min Summer	1.947	0.0	58.9	2200
5760 min Summer	1.538	0.0	62.0	2920
7200 min Summer	1.280	0.0	64.5	3664

Ambiental		Page 2
Science Park Square Brighton BN1 9SB	Proposed SuDS-Geocellular S.#1 London School of Theology Contract No 3110	Micro Drainage
Date 14/03/2017 18:14 File AttenuationVolume_100yr...	Designed by Jose Tenedor Checked by Mark Naumann	
XP Solutions	Source Control 2016.1	

Cascade Summary of Results for GS1_1in100yr+40%cc_AttenuationCalcs.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
8640 min Summer	72.281	0.031	0.0	0.5	0.5	0.6	O K
10080 min Summer	72.279	0.029	0.0	0.5	0.5	0.5	O K
15 min Winter	72.859	0.609	0.0	5.0	5.0	11.6	O K
30 min Winter	73.009	0.759	0.0	5.0	5.0	14.4	O K
60 min Winter	73.019	0.769	0.0	5.0	5.0	14.6	O K
120 min Winter	72.861	0.611	0.0	5.0	5.0	11.6	O K
180 min Winter	72.669	0.419	0.0	5.0	5.0	8.0	O K
240 min Winter	72.527	0.277	0.0	5.0	5.0	5.3	O K
360 min Winter	72.386	0.136	0.0	4.5	4.5	2.6	O K
480 min Winter	72.355	0.105	0.0	3.8	3.8	2.0	O K
600 min Winter	72.340	0.090	0.0	3.2	3.2	1.7	O K
720 min Winter	72.331	0.081	0.0	2.7	2.7	1.5	O K
960 min Winter	72.319	0.069	0.0	2.2	2.2	1.3	O K
1440 min Winter	72.307	0.057	0.0	1.6	1.6	1.1	O K
2160 min Winter	72.297	0.047	0.0	1.1	1.1	0.9	O K
2880 min Winter	72.292	0.042	0.0	0.9	0.9	0.8	O K
4320 min Winter	72.285	0.035	0.0	0.6	0.6	0.7	O K
5760 min Winter	72.281	0.031	0.0	0.5	0.5	0.6	O K
7200 min Winter	72.278	0.028	0.0	0.4	0.4	0.5	O K
8640 min Winter	72.276	0.026	0.0	0.4	0.4	0.5	O K
10080 min Winter	72.274	0.024	0.0	0.3	0.3	0.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
8640 min Summer	1.101	0.0	66.6	4320
10080 min Summer	0.969	0.0	68.4	5032
15 min Winter	140.352	0.0	16.5	23
30 min Winter	91.674	0.0	21.6	35
60 min Winter	57.005	0.0	26.8	54
120 min Winter	34.241	0.0	32.2	90
180 min Winter	25.078	0.0	35.4	120
240 min Winter	19.989	0.0	37.6	148
360 min Winter	14.479	0.0	40.9	198
480 min Winter	11.517	0.0	43.3	254
600 min Winter	9.637	0.0	45.3	312
720 min Winter	8.327	0.0	47.0	370
960 min Winter	6.608	0.0	49.7	494
1440 min Winter	4.764	0.0	53.8	740
2160 min Winter	3.429	0.0	58.1	1096
2880 min Winter	2.712	0.0	61.2	1436
4320 min Winter	1.947	0.0	65.9	2152
5760 min Winter	1.538	0.0	69.4	2856
7200 min Winter	1.280	0.0	72.2	3560
8640 min Winter	1.101	0.0	74.6	4376
10080 min Winter	0.969	0.0	76.6	5072

Ambiental		Page 3
Science Park Square Brighton BN1 9SB	Proposed SuDS-Geocellular S.#1 London School of Theology Contract No 3110	
Date 14/03/2017 18:14 File AttenuationVolume_100yr...	Designed by Jose Tenedor Checked by Mark Naumann	
XP Solutions	Source Control 2016.1	

Cascade Rainfall Details for GS1_1in100yr+40%cc_AttenuationCalcs.srcx

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.100	Shortest Storm (mins)	15
Ratio R	0.412	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.048

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.016	4	8	0.016	8	12	0.016

Ambiental		Page 4
Science Park Square Brighton BN1 9SB	Proposed SuDS-Geocellular S.#1 London School of Theology Contract No 3110	
Date 14/03/2017 18:14 File AttenuationVolume_100yr...	Designed by Jose Tenedor Checked by Mark Naumann	
XP Solutions	Source Control 2016.1	

Cascade Model Details for GS1_1in100yr+40%cc_AttenuationCalcs.srcx

Storage is Online Cover Level (m) 73.450

Cellular Storage Structure

Invert Level (m) 72.250 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	20.0	0.0	1.300	0.0	0.0
0.100	20.0	0.0	1.400	0.0	0.0
0.200	20.0	0.0	1.500	0.0	0.0
0.300	20.0	0.0	1.600	0.0	0.0
0.400	20.0	0.0	1.700	0.0	0.0
0.500	20.0	0.0	1.800	0.0	0.0
0.600	20.0	0.0	1.900	0.0	0.0
0.700	20.0	0.0	2.000	0.0	0.0
0.800	20.0	0.0	2.100	0.0	0.0
0.900	20.0	0.0	2.200	0.0	0.0
1.000	20.0	0.0	2.300	0.0	0.0
1.001	0.0	0.0	2.400	0.0	0.0
1.200	0.0	0.0	2.500	0.0	0.0

Hydro-Brake Optimum® Outflow Control

Unit Reference	MD-SHE-0105-5000-1000-5000
Design Head (m)	1.000
Design Flow (l/s)	5.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	105
Invert Level (m)	72.250
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	5.0
Flush-Flo™	0.296	5.0
Kick-Flo®	0.637	4.1
Mean Flow over Head Range	-	4.3

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake Optimum® as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Ambiental	Page 5
Science Park Square Brighton BN1 9SB	Proposed SuDS-Geocellular S.#1 London School of Theology Contract No 3110
Date 14/03/2017 18:14 File AttenuationVolume_100yr...	Designed by Jose Tenedor Checked by Mark Naumann
XP Solutions	Source Control 2016.1

Hydro-Brake Optimum® Outflow Control

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.6	1.200	5.4	3.000	8.4	7.000	12.5
0.200	4.8	1.400	5.8	3.500	9.0	7.500	12.9
0.300	5.0	1.600	6.2	4.000	9.6	8.000	13.3
0.400	4.9	1.800	6.6	4.500	10.1	8.500	13.7
0.500	4.7	2.000	6.9	5.000	10.6	9.000	14.1
0.600	4.3	2.200	7.2	5.500	11.1	9.500	14.5
0.800	4.5	2.400	7.5	6.000	11.6		
1.000	5.0	2.600	7.8	6.500	12.1		

Summary of Results for Proposed SuDS - Permeable Paving

Ambiental		Page 1
Science Park Square Brighton BN1 9SB	Proposed SuDS-Permeable Paving London School of Theology Contract No 3110	
Date 14/03/2017 18:44 File VolumeCalcs_1yr+CC.casx	Designed by Jose Tenedor Checked by Mark Naumann	
XP Solutions	Source Control 2016.1	

Cascade Summary of Results for PP_1in1yr+40%cc_VolumeCalcs.srcx

Upstream Structures	Outflow To	Overflow To
(None)	GS2_1in1yr+40%cc_VolumeCalcs.srcx	(None)

Half Drain Time : 0 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	68.080	0.030	0.0	7.4	7.4	0.0	O K
30 min Summer	68.080	0.030	0.0	7.4	7.4	0.0	O K
60 min Summer	68.077	0.027	0.0	6.8	6.8	0.0	O K
120 min Summer	68.070	0.020	0.0	5.1	5.1	0.0	O K
180 min Summer	68.067	0.017	0.0	4.2	4.2	0.0	O K
240 min Summer	68.065	0.015	0.0	3.7	3.7	0.0	O K
360 min Summer	68.061	0.011	0.0	2.8	2.8	0.0	O K
480 min Summer	68.059	0.009	0.0	2.2	2.2	0.0	O K
600 min Summer	68.058	0.008	0.0	1.9	1.9	0.0	O K
720 min Summer	68.057	0.007	0.0	1.7	1.7	0.0	O K
960 min Summer	68.055	0.005	0.0	1.3	1.3	0.0	O K
1440 min Summer	68.054	0.004	0.0	1.1	1.1	0.0	O K
2160 min Summer	68.053	0.003	0.0	0.7	0.7	0.0	O K
2880 min Summer	68.052	0.002	0.0	0.6	0.6	0.0	O K
4320 min Summer	68.052	0.002	0.0	0.4	0.4	0.0	O K
5760 min Summer	68.051	0.001	0.0	0.3	0.3	0.0	O K
7200 min Summer	68.051	0.001	0.0	0.3	0.3	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	44.043	0.0	4.1	12
30 min Summer	28.612	0.0	5.8	19
60 min Summer	18.021	0.0	7.6	36
120 min Summer	11.117	0.0	9.7	66
180 min Summer	8.339	0.0	11.0	98
240 min Summer	6.792	0.0	12.1	122
360 min Summer	5.057	0.0	13.6	184
480 min Summer	4.090	0.0	14.6	238
600 min Summer	3.468	0.0	15.6	322
720 min Summer	3.031	0.0	16.3	380
960 min Summer	2.451	0.0	17.7	492
1440 min Summer	1.817	0.0	19.4	752
2160 min Summer	1.348	0.0	21.2	1328
2880 min Summer	1.090	0.0	22.7	836
4320 min Summer	0.808	0.0	24.8	2972
5760 min Summer	0.653	0.0	26.1	2312
7200 min Summer	0.554	0.0	27.3	4544

Ambiental		Page 2
Science Park Square Brighton BN1 9SB	Proposed SuDS-Permeable Paving London School of Theology Contract No 3110	Micro Drainage
Date 14/03/2017 18:44 File VolumeCalcs_1yr+CC.casx	Designed by Jose Tenedor Checked by Mark Naumann	
XP Solutions	Source Control 2016.1	

Cascade Summary of Results for PP_1inlyr+40%cc_VolumeCalcs.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
8640 min Summer	68.051	0.001	0.0	0.3	0.3	0.0	O K
10080 min Summer	68.051	0.001	0.0	0.2	0.2	0.0	O K
15 min Winter	68.083	0.033	0.0	8.3	8.3	0.0	O K
30 min Winter	68.082	0.032	0.0	8.1	8.1	0.0	O K
60 min Winter	68.075	0.025	0.0	6.3	6.3	0.0	O K
120 min Winter	68.068	0.018	0.0	4.4	4.4	0.0	O K
180 min Winter	68.063	0.013	0.0	3.3	3.3	0.0	O K
240 min Winter	68.061	0.011	0.0	2.7	2.7	0.0	O K
360 min Winter	68.058	0.008	0.0	2.0	2.0	0.0	O K
480 min Winter	68.056	0.006	0.0	1.6	1.6	0.0	O K
600 min Winter	68.056	0.006	0.0	1.4	1.4	0.0	O K
720 min Winter	68.055	0.005	0.0	1.2	1.2	0.0	O K
960 min Winter	68.054	0.004	0.0	1.0	1.0	0.0	O K
1440 min Winter	68.053	0.003	0.0	0.7	0.7	0.0	O K
2160 min Winter	68.052	0.002	0.0	0.6	0.6	0.0	O K
2880 min Winter	68.052	0.002	0.0	0.4	0.4	0.0	O K
4320 min Winter	68.051	0.001	0.0	0.3	0.3	0.0	O K
5760 min Winter	68.051	0.001	0.0	0.3	0.3	0.0	O K
7200 min Winter	68.051	0.001	0.0	0.2	0.2	0.0	O K
8640 min Winter	68.051	0.001	0.0	0.2	0.2	0.0	O K
10080 min Winter	68.051	0.001	0.0	0.2	0.2	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
8640 min Summer	0.485	0.0	28.3	4280
10080 min Summer	0.433	0.0	28.1	4368
15 min Winter	44.043	0.0	4.8	14
30 min Winter	28.612	0.0	6.6	20
60 min Winter	18.021	0.0	8.7	38
120 min Winter	11.117	0.0	11.0	70
180 min Winter	8.339	0.0	12.6	104
240 min Winter	6.792	0.0	13.7	134
360 min Winter	5.057	0.0	15.4	194
480 min Winter	4.090	0.0	16.6	196
600 min Winter	3.468	0.0	17.7	328
720 min Winter	3.031	0.0	18.5	414
960 min Winter	2.451	0.0	20.0	486
1440 min Winter	1.817	0.0	22.1	710
2160 min Winter	1.348	0.0	24.1	1952
2880 min Winter	1.090	0.0	25.9	2516
4320 min Winter	0.808	0.0	28.3	2720
5760 min Winter	0.653	0.0	29.8	4112
7200 min Winter	0.554	0.0	30.9	2720
8640 min Winter	0.485	0.0	32.3	5912
10080 min Winter	0.433	0.0	33.0	4264

Ambiental		Page 3
Science Park Square Brighton BN1 9SB	Proposed SuDS-Permeable Paving London School of Theology Contract No 3110	
Date 14/03/2017 18:44 File VolumeCalcs_1yr+CC.casx	Designed by Jose Tenedor Checked by Mark Naumann	
XP Solutions	Source Control 2016.1	

Cascade Rainfall Details for PP_1in1yr+40%cc_VolumeCalcs.srcx

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	1	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.100	Shortest Storm (mins)	15
Ratio R	0.412	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.067

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.022	4	8	0.022	8	12	0.022

Ambiental		Page 4
Science Park Square Brighton BN1 9SB	Proposed SuDS-Permeable Paving London School of Theology Contract No 3110	
Date 14/03/2017 18:44 File VolumeCalcs_1yr+CC.casx	Designed by Jose Tenedor Checked by Mark Naumann	
XP Solutions	Source Control 2016.1	

Cascade Model Details for PP_1inlyr+40%cc_VolumeCalcs.srcx

Storage is Online Cover Level (m) 68.500

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	15.0
Membrane Percolation (mm/hr)	1000	Length (m)	18.7
Max Percolation (l/s)	77.9	Slope (1:X)	10.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	68.050	Membrane Depth (m)	130

Pump Outflow Control

Invert Level (m) 68.050

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	25.0000	0.900	25.0000	1.700	25.0000	2.500	25.0000
0.200	25.0000	1.000	25.0000	1.800	25.0000	2.600	25.0000
0.300	25.0000	1.100	25.0000	1.900	25.0000	2.700	25.0000
0.400	25.0000	1.200	25.0000	2.000	25.0000	2.800	25.0000
0.500	25.0000	1.300	25.0000	2.100	25.0000	2.900	25.0000
0.600	25.0000	1.400	25.0000	2.200	25.0000	3.000	25.0000
0.700	25.0000	1.500	25.0000	2.300	25.0000		
0.800	25.0000	1.600	25.0000	2.400	25.0000		

Ambiental		Page 1
Science Park Square Brighton BN1 9SB	Proposed SuDS-Permeable Paving London School of Theology Contract No 3110	Micro Drainage
Date 14/03/2017 18:41 File VolumeCalcs_30yr+CC.casx	Designed by Jose Tenedor Checked by Mark Naumann	
XP Solutions	Source Control 2016.1	

Cascade Summary of Results for PP_1in30yr+40%cc_VolumeCalcs.srcx

Upstream Structures	Outflow To	Overflow To
(None)	GS2_1in30yr+40%cc_VolumeCalcs.srcx	(None)

Half Drain Time : 0 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	68.121	0.071	0.0	17.7	17.7	0.1	O K
30 min Summer	68.122	0.072	0.0	18.1	18.1	0.1	O K
60 min Summer	68.115	0.065	0.0	16.3	16.3	0.1	O K
120 min Summer	68.099	0.049	0.0	12.2	12.2	0.0	O K
180 min Summer	68.088	0.038	0.0	9.6	9.6	0.0	O K
240 min Summer	68.081	0.031	0.0	7.8	7.8	0.0	O K
360 min Summer	68.074	0.024	0.0	5.9	5.9	0.0	O K
480 min Summer	68.070	0.020	0.0	4.9	4.9	0.0	O K
600 min Summer	68.066	0.016	0.0	4.1	4.1	0.0	O K
720 min Summer	68.065	0.015	0.0	3.7	3.7	0.0	O K
960 min Summer	68.062	0.012	0.0	2.9	2.9	0.0	O K
1440 min Summer	68.059	0.009	0.0	2.2	2.2	0.0	O K
2160 min Summer	68.056	0.006	0.0	1.6	1.6	0.0	O K
2880 min Summer	68.055	0.005	0.0	1.2	1.2	0.0	O K
4320 min Summer	68.053	0.003	0.0	0.8	0.8	0.0	O K
5760 min Summer	68.053	0.003	0.0	0.7	0.7	0.0	O K
7200 min Summer	68.052	0.002	0.0	0.6	0.6	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	108.085	0.0	12.2	13
30 min Summer	70.019	0.0	16.2	20
60 min Summer	43.355	0.0	20.3	36
120 min Summer	26.057	0.0	24.7	68
180 min Summer	19.144	0.0	27.3	94
240 min Summer	15.318	0.0	29.2	124
360 min Summer	11.161	0.0	32.0	182
480 min Summer	8.912	0.0	34.0	244
600 min Summer	7.480	0.0	35.7	308
720 min Summer	6.481	0.0	37.1	372
960 min Summer	5.166	0.0	39.5	492
1440 min Summer	3.748	0.0	42.6	738
2160 min Summer	2.716	0.0	46.2	1072
2880 min Summer	2.160	0.0	48.6	1584
4320 min Summer	1.563	0.0	51.4	2428
5760 min Summer	1.242	0.0	53.9	1872
7200 min Summer	1.038	0.0	55.9	1920

Ambiental		Page 2
Science Park Square Brighton BN1 9SB	Proposed SuDS-Permeable Paving London School of Theology Contract No 3110	
Date 14/03/2017 18:41 File VolumeCalcs_30yr+CC.casx	Designed by Jose Tenedor Checked by Mark Naumann	
XP Solutions	Source Control 2016.1	

Cascade Summary of Results for PP_1in30yr+40%cc_VolumeCalcs.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
8640 min Summer	68.052	0.002	0.0	0.6	0.6	0.0	O K
10080 min Summer	68.052	0.002	0.0	0.4	0.4	0.0	O K
15 min Winter	68.129	0.079	0.0	19.8	19.8	0.1	O K
30 min Winter	68.129	0.079	0.0	19.7	19.7	0.1	O K
60 min Winter	68.111	0.061	0.0	15.3	15.3	0.1	O K
120 min Winter	68.090	0.040	0.0	9.9	9.9	0.0	O K
180 min Winter	68.080	0.030	0.0	7.4	7.4	0.0	O K
240 min Winter	68.074	0.024	0.0	5.9	5.9	0.0	O K
360 min Winter	68.069	0.019	0.0	4.7	4.7	0.0	O K
480 min Winter	68.065	0.015	0.0	3.7	3.7	0.0	O K
600 min Winter	68.064	0.014	0.0	3.4	3.4	0.0	O K
720 min Winter	68.061	0.011	0.0	2.7	2.7	0.0	O K
960 min Winter	68.060	0.010	0.0	2.6	2.6	0.0	O K
1440 min Winter	68.056	0.006	0.0	1.5	1.5	0.0	O K
2160 min Winter	68.054	0.004	0.0	1.1	1.1	0.0	O K
2880 min Winter	68.053	0.003	0.0	0.8	0.8	0.0	O K
4320 min Winter	68.053	0.003	0.0	0.7	0.7	0.0	O K
5760 min Winter	68.052	0.002	0.0	0.6	0.6	0.0	O K
7200 min Winter	68.052	0.002	0.0	0.4	0.4	0.0	O K
8640 min Winter	68.051	0.001	0.0	0.3	0.3	0.0	O K
10080 min Winter	68.051	0.001	0.0	0.3	0.3	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
8640 min Summer	0.897	0.0	57.6	3928
10080 min Summer	0.792	0.0	58.5	3400
15 min Winter	108.085	0.0	13.8	14
30 min Winter	70.019	0.0	18.3	22
60 min Winter	43.355	0.0	22.9	34
120 min Winter	26.057	0.0	27.9	66
180 min Winter	19.144	0.0	30.8	98
240 min Winter	15.318	0.0	32.9	128
360 min Winter	11.161	0.0	36.0	176
480 min Winter	8.912	0.0	38.4	256
600 min Winter	7.480	0.0	40.3	286
720 min Winter	6.481	0.0	41.8	360
960 min Winter	5.166	0.0	44.3	496
1440 min Winter	3.748	0.0	48.1	782
2160 min Winter	2.716	0.0	52.1	1444
2880 min Winter	2.160	0.0	54.8	1860
4320 min Winter	1.563	0.0	57.9	2296
5760 min Winter	1.242	0.0	60.6	3152
7200 min Winter	1.038	0.0	63.6	2504
8640 min Winter	0.897	0.0	64.7	4520
10080 min Winter	0.792	0.0	66.7	7360

Ambiental		Page 3
Science Park Square Brighton BN1 9SB	Proposed SuDS-Permeable Paving London School of Theology Contract No 3110	Micro Drainage
Date 14/03/2017 18:41 File VolumeCalcs_30yr+CC.casx	Designed by Jose Tenedor Checked by Mark Naumann	
XP Solutions	Source Control 2016.1	

Cascade Rainfall Details for PP_1in30yr+40%cc_VolumeCalcs.srcx

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	30	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.100	Shortest Storm (mins)	15
Ratio R	0.412	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.067

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.022	4	8	0.022	8	12	0.022

Ambiental		Page 4
Science Park Square Brighton BN1 9SB	Proposed SuDS-Permeable Paving London School of Theology Contract No 3110	Micro Drainage
Date 14/03/2017 18:41 File VolumeCalcs_30yr+CC.casx	Designed by Jose Tenedor Checked by Mark Naumann	
XP Solutions	Source Control 2016.1	

Cascade Model Details for PP_1in30yr+40%cc_VolumeCalcs.srcx

Storage is Online Cover Level (m) 68.500

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	15.0
Membrane Percolation (mm/hr)	1000	Length (m)	18.7
Max Percolation (l/s)	77.9	Slope (1:X)	10.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	68.050	Membrane Depth (m)	130

Pump Outflow Control

Invert Level (m) 68.050

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	25.0000	0.900	25.0000	1.700	25.0000	2.500	25.0000
0.200	25.0000	1.000	25.0000	1.800	25.0000	2.600	25.0000
0.300	25.0000	1.100	25.0000	1.900	25.0000	2.700	25.0000
0.400	25.0000	1.200	25.0000	2.000	25.0000	2.800	25.0000
0.500	25.0000	1.300	25.0000	2.100	25.0000	2.900	25.0000
0.600	25.0000	1.400	25.0000	2.200	25.0000	3.000	25.0000
0.700	25.0000	1.500	25.0000	2.300	25.0000		
0.800	25.0000	1.600	25.0000	2.400	25.0000		

Ambiental		Page 1
Science Park Square Brighton BN1 9SB	Proposed SuDS-Permeable Paving London School of Theology Contract No 3110	
Date 14/03/2017 18:09 File AttenuationVolume_100yr...	Designed by Jose Tenedor Checked by Mark Naumann	
XP Solutions	Source Control 2016.1	

Cascade Summary of Results for PP_1in100yr+cc_AttenuationVol.srcx

Upstream Structures	Outflow To	Overflow To
(None)	GS2_1in100yr+40%cc_AttenuationCalcs.srcx	(None)

Half Drain Time : 0 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	68.141	0.091	0.0	22.8	22.8	0.2	O K
30 min Summer	68.145	0.095	0.0	23.7	23.7	0.2	O K
60 min Summer	68.136	0.086	0.0	21.4	21.4	0.2	O K
120 min Summer	68.113	0.063	0.0	15.7	15.7	0.1	O K
180 min Summer	68.099	0.049	0.0	12.3	12.3	0.1	O K
240 min Summer	68.091	0.041	0.0	10.3	10.3	0.0	O K
360 min Summer	68.081	0.031	0.0	7.7	7.7	0.0	O K
480 min Summer	68.075	0.025	0.0	6.2	6.2	0.0	O K
600 min Summer	68.073	0.023	0.0	5.7	5.7	0.0	O K
720 min Summer	68.069	0.019	0.0	4.7	4.7	0.0	O K
960 min Summer	68.065	0.015	0.0	3.8	3.8	0.0	O K
1440 min Summer	68.061	0.011	0.0	2.7	2.7	0.0	O K
2160 min Summer	68.058	0.008	0.0	1.9	1.9	0.0	O K
2880 min Summer	68.056	0.006	0.0	1.5	1.5	0.0	O K
4320 min Summer	68.054	0.004	0.0	1.1	1.1	0.0	O K
5760 min Summer	68.053	0.003	0.0	0.8	0.8	0.0	O K
7200 min Summer	68.053	0.003	0.0	0.7	0.7	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	140.352	0.0	16.2	13
30 min Summer	91.674	0.0	21.6	21
60 min Summer	57.005	0.0	27.2	36
120 min Summer	34.241	0.0	32.9	66
180 min Summer	25.078	0.0	36.3	98
240 min Summer	19.989	0.0	38.6	126
360 min Summer	14.479	0.0	41.9	192
480 min Summer	11.517	0.0	44.5	244
600 min Summer	9.637	0.0	46.5	312
720 min Summer	8.327	0.0	48.3	372
960 min Summer	6.608	0.0	51.0	498
1440 min Summer	4.764	0.0	55.0	720
2160 min Summer	3.429	0.0	59.0	976
2880 min Summer	2.712	0.0	61.8	1344
4320 min Summer	1.947	0.0	65.4	2428
5760 min Summer	1.538	0.0	67.9	2784
7200 min Summer	1.280	0.0	70.4	5456

Ambiental		Page 2
Science Park Square Brighton BN1 9SB	Proposed SuDS-Permeable Paving London School of Theology Contract No 3110	Micro Drainage
Date 14/03/2017 18:09 File AttenuationVolume_100yr...	Designed by Jose Tenedor Checked by Mark Naumann	
XP Solutions	Source Control 2016.1	

Cascade Summary of Results for PP_1in100yr+cc_AttenuationVol.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
8640 min Summer	68.052	0.002	0.0	0.6	0.6	0.0	O K
10080 min Summer	68.052	0.002	0.0	0.6	0.6	0.0	O K
15 min Winter	68.173	0.123	0.0	25.0	25.0	0.3	O K
30 min Winter	68.170	0.120	0.0	25.0	25.0	0.3	O K
60 min Winter	68.130	0.080	0.0	20.1	20.1	0.1	O K
120 min Winter	68.102	0.052	0.0	13.1	13.1	0.1	O K
180 min Winter	68.089	0.039	0.0	9.8	9.8	0.0	O K
240 min Winter	68.081	0.031	0.0	7.8	7.8	0.0	O K
360 min Winter	68.073	0.023	0.0	5.7	5.7	0.0	O K
480 min Winter	68.069	0.019	0.0	4.7	4.7	0.0	O K
600 min Winter	68.066	0.016	0.0	3.9	3.9	0.0	O K
720 min Winter	68.065	0.015	0.0	3.7	3.7	0.0	O K
960 min Winter	68.061	0.011	0.0	2.8	2.8	0.0	O K
1440 min Winter	68.058	0.008	0.0	1.9	1.9	0.0	O K
2160 min Winter	68.055	0.005	0.0	1.3	1.3	0.0	O K
2880 min Winter	68.054	0.004	0.0	1.1	1.1	0.0	O K
4320 min Winter	68.053	0.003	0.0	0.8	0.8	0.0	O K
5760 min Winter	68.052	0.002	0.0	0.6	0.6	0.0	O K
7200 min Winter	68.052	0.002	0.0	0.6	0.6	0.0	O K
8640 min Winter	68.052	0.002	0.0	0.4	0.4	0.0	O K
10080 min Winter	68.052	0.002	0.0	0.4	0.4	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
8640 min Summer	1.101	0.0	71.7	4768
10080 min Summer	0.969	0.0	72.9	4952
15 min Winter	140.352	0.0	18.3	15
30 min Winter	91.674	0.0	24.4	23
60 min Winter	57.005	0.0	30.6	36
120 min Winter	34.241	0.0	37.0	64
180 min Winter	25.078	0.0	40.8	96
240 min Winter	19.989	0.0	43.4	120
360 min Winter	14.479	0.0	47.2	184
480 min Winter	11.517	0.0	50.2	250
600 min Winter	9.637	0.0	52.4	296
720 min Winter	8.327	0.0	54.2	376
960 min Winter	6.608	0.0	57.3	522
1440 min Winter	4.764	0.0	61.7	676
2160 min Winter	3.429	0.0	66.3	1172
2880 min Winter	2.712	0.0	69.7	1540
4320 min Winter	1.947	0.0	74.5	2348
5760 min Winter	1.538	0.0	75.9	4440
7200 min Winter	1.280	0.0	78.5	2968
8640 min Winter	1.101	0.0	81.0	1824
10080 min Winter	0.969	0.0	82.9	7824

Ambiental		Page 3
Science Park Square Brighton BN1 9SB	Proposed SuDS-Permeable Paving London School of Theology Contract No 3110	
Date 14/03/2017 18:09 File AttenuationVolume_100yr...	Designed by Jose Tenedor Checked by Mark Naumann	
XP Solutions	Source Control 2016.1	

Cascade Rainfall Details for PP_1in100yr+cc_AttenuationVol.srcx

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.100	Shortest Storm (mins)	15
Ratio R	0.412	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.067

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.022	4	8	0.022	8	12	0.022

Ambiental		Page 4
Science Park Square Brighton BN1 9SB	Proposed SuDS-Permeable Paving London School of Theology Contract No 3110	
Date 14/03/2017 18:09 File AttenuationVolume_100yr...	Designed by Jose Tenedor Checked by Mark Naumann	
XP Solutions	Source Control 2016.1	

Cascade Model Details for PP_1in100yr+cc_AttenuationVol.srcx

Storage is Online Cover Level (m) 68.500

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	15.0
Membrane Percolation (mm/hr)	1000	Length (m)	18.7
Max Percolation (l/s)	77.9	Slope (1:X)	10.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	68.050	Membrane Depth (m)	130

Pump Outflow Control

Invert Level (m) 68.050

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	25.0000	0.900	25.0000	1.700	25.0000	2.500	25.0000
0.200	25.0000	1.000	25.0000	1.800	25.0000	2.600	25.0000
0.300	25.0000	1.100	25.0000	1.900	25.0000	2.700	25.0000
0.400	25.0000	1.200	25.0000	2.000	25.0000	2.800	25.0000
0.500	25.0000	1.300	25.0000	2.100	25.0000	2.900	25.0000
0.600	25.0000	1.400	25.0000	2.200	25.0000	3.000	25.0000
0.700	25.0000	1.500	25.0000	2.300	25.0000		
0.800	25.0000	1.600	25.0000	2.400	25.0000		

Summary of Results for Proposed SuDS - Geocellular System No 2

Ambiental		Page 1
Science Park Square Brighton BN1 9SB	Proposed SuDS-Geocellular S.#2 London School of Theology Contract No 3110	Micro Drainage
Date 15/03/2017 19:42 File VolumeCalcs_1yr+CC.casx	Designed by Jose Tenedor Checked by Mark Naumann	
XP Solutions	Source Control 2016.1	

Cascade Summary of Results for GS2_1in1yr+40%cc_VolumeCalcs.srcx

Upstream Structures	Outflow To	Overflow To
GS1_1in1yr+40%cc_VolumeCalcs.srcx PIPE_1in1yr+40%cc_VolumeCalcs.srcx PP_1in1yr+40%cc_VolumeCalcs.srcx	(None)	(None)

Half Drain Time : 51 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Σ Max Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	69.495	0.095	0.0	2.8	2.8	9.4	O K
30 min Summer	69.521	0.121	0.0	3.4	3.4	12.1	O K
60 min Summer	69.542	0.142	0.0	3.5	3.5	14.2	O K
120 min Summer	69.553	0.153	0.0	3.6	3.6	15.3	O K
180 min Summer	69.553	0.153	0.0	3.6	3.6	15.3	O K
240 min Summer	69.549	0.149	0.0	3.5	3.5	14.9	O K
360 min Summer	69.535	0.135	0.0	3.5	3.5	13.5	O K
480 min Summer	69.521	0.121	0.0	3.4	3.4	12.1	O K
600 min Summer	69.511	0.111	0.0	3.2	3.2	11.0	O K
720 min Summer	69.503	0.103	0.0	3.0	3.0	10.2	O K
960 min Summer	69.491	0.091	0.0	2.7	2.7	9.0	O K
1440 min Summer	69.476	0.076	0.0	2.2	2.2	7.6	O K
2160 min Summer	69.464	0.064	0.0	1.7	1.7	6.3	O K
2880 min Summer	69.457	0.057	0.0	1.4	1.4	5.6	O K
4320 min Summer	69.448	0.048	0.0	1.1	1.1	4.8	O K
5760 min Summer	69.442	0.042	0.0	0.8	0.8	4.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	44.043	0.0	12.1	25
30 min Summer	28.612	0.0	16.3	36
60 min Summer	18.021	0.0	21.0	56
120 min Summer	11.117	0.0	26.2	88
180 min Summer	8.339	0.0	29.7	122
240 min Summer	6.792	0.0	32.3	154
360 min Summer	5.057	0.0	36.2	218
480 min Summer	4.090	0.0	39.1	278
600 min Summer	3.468	0.0	41.4	336
720 min Summer	3.031	0.0	43.5	398
960 min Summer	2.451	0.0	46.9	518
1440 min Summer	1.817	0.0	51.9	756
2160 min Summer	1.348	0.0	57.5	1116
2880 min Summer	1.090	0.0	61.9	1476
4320 min Summer	0.808	0.0	68.2	2208
5760 min Summer	0.653	0.0	73.0	2944

Ambiental		Page 2
Science Park Square Brighton BN1 9SB	Proposed SuDS-Geocellular S.#2 London School of Theology Contract No 3110	Micro Drainage
Date 15/03/2017 19:42 File VolumeCalcs_1yr+CC.casx	Designed by Jose Tenedor Checked by Mark Naumann	
XP Solutions	Source Control 2016.1	

Cascade Summary of Results for GS2_1in1yr+40%cc_VolumeCalcs.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
7200 min Summer	69.439	0.039	0.0	0.7	0.7	3.9	O K
8640 min Summer	69.436	0.036	0.0	0.6	0.6	3.6	O K
10080 min Summer	69.434	0.034	0.0	0.6	0.6	3.3	O K
15 min Winter	69.507	0.107	0.0	3.1	3.1	10.7	O K
30 min Winter	69.539	0.139	0.0	3.5	3.5	13.9	O K
60 min Winter	69.563	0.163	0.0	3.6	3.6	16.2	O K
120 min Winter	69.570	0.170	0.0	3.6	3.6	17.0	O K
180 min Winter	69.564	0.164	0.0	3.6	3.6	16.3	O K
240 min Winter	69.553	0.153	0.0	3.6	3.6	15.3	O K
360 min Winter	69.529	0.129	0.0	3.4	3.4	12.9	O K
480 min Winter	69.511	0.111	0.0	3.3	3.3	11.1	O K
600 min Winter	69.499	0.099	0.0	2.9	2.9	9.9	O K
720 min Winter	69.490	0.090	0.0	2.7	2.7	9.0	O K
960 min Winter	69.478	0.078	0.0	2.2	2.2	7.8	O K
1440 min Winter	69.464	0.064	0.0	1.7	1.7	6.4	O K
2160 min Winter	69.454	0.054	0.0	1.3	1.3	5.4	O K
2880 min Winter	69.448	0.048	0.0	1.1	1.1	4.8	O K
4320 min Winter	69.440	0.040	0.0	0.8	0.8	4.0	O K
5760 min Winter	69.436	0.036	0.0	0.6	0.6	3.6	O K
7200 min Winter	69.433	0.033	0.0	0.5	0.5	3.2	O K
8640 min Winter	69.431	0.031	0.0	0.5	0.5	3.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
7200 min Summer	0.554	0.0	77.1	3672
8640 min Summer	0.485	0.0	80.6	4408
10080 min Summer	0.433	0.0	82.5	5136
15 min Winter	44.043	0.0	13.8	25
30 min Winter	28.612	0.0	18.4	37
60 min Winter	18.021	0.0	23.7	58
120 min Winter	11.117	0.0	29.6	94
180 min Winter	8.339	0.0	33.4	130
240 min Winter	6.792	0.0	36.4	164
360 min Winter	5.057	0.0	40.8	226
480 min Winter	4.090	0.0	44.0	284
600 min Winter	3.468	0.0	46.7	346
720 min Winter	3.031	0.0	48.9	406
960 min Winter	2.451	0.0	52.8	526
1440 min Winter	1.817	0.0	58.6	770
2160 min Winter	1.348	0.0	64.8	1124
2880 min Winter	1.090	0.0	69.7	1496
4320 min Winter	0.808	0.0	77.0	2216
5760 min Winter	0.653	0.0	82.4	2960
7200 min Winter	0.554	0.0	86.7	3640
8640 min Winter	0.485	0.0	90.8	4384

Ambiental		Page 3
Science Park Square Brighton BN1 9SB	Proposed SuDS-Geocellular S.#2 London School of Theology Contract No 3110	
Date 15/03/2017 19:42 File VolumeCalcs_1yr+CC.casx	Designed by Jose Tenedor Checked by Mark Naumann	
XP Solutions	Source Control 2016.1	

Cascade Summary of Results for GS2_1in1yr+40%cc_VolumeCalcs.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
10080 min Winter	69.429	0.029	0.0	0.4	0.4	2.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
10080 min Winter	0.433	0.0	93.9	5000

Ambiental		Page 4
Science Park Square Brighton BN1 9SB	Proposed SuDS-Geocellular S.#2 London School of Theology Contract No 3110	
Date 15/03/2017 19:42 File VolumeCalcs_1yr+CC.casx	Designed by Jose Tenedor Checked by Mark Naumann	
XP Solutions	Source Control 2016.1	

Cascade Rainfall Details for GS2_1in1yr+40%cc_VolumeCalcs.srcx

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	1	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.100	Shortest Storm (mins)	15
Ratio R	0.412	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.052

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.017	4	8	0.017	8	12	0.017

Ambiental		Page 5
Science Park Square Brighton BN1 9SB	Proposed SuDS-Geocellular S.#2 London School of Theology Contract No 3110	
Date 15/03/2017 19:42 File VolumeCalcs_1yr+CC.casx	Designed by Jose Tenedor Checked by Mark Naumann	
XP Solutions	Source Control 2016.1	

Cascade Model Details for GS2_1in1yr+40%cc_VolumeCalcs.srcx

Storage is Online Cover Level (m) 70.500

Cellular Storage Structure

Invert Level (m) 69.400 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	105.0	0.0	1.300	0.0	0.0
0.100	105.0	0.0	1.400	0.0	0.0
0.200	105.0	0.0	1.500	0.0	0.0
0.300	105.0	0.0	1.600	0.0	0.0
0.400	105.0	0.0	1.700	0.0	0.0
0.500	105.0	0.0	1.800	0.0	0.0
0.600	105.0	0.0	1.900	0.0	0.0
0.700	105.0	0.0	2.000	0.0	0.0
0.800	105.0	0.0	2.100	0.0	0.0
0.900	105.0	0.0	2.200	0.0	0.0
1.000	105.0	0.0	2.300	0.0	0.0
1.001	0.0	0.0	2.400	0.0	0.0
1.200	0.0	0.0	2.500	0.0	0.0

Hydro-Brake Optimum® Outflow Control

Unit Reference	MD-SHE-0093-3840-1000-3840
Design Head (m)	1.000
Design Flow (l/s)	3.8
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	93
Invert Level (m)	69.400
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	3.8
Flush-Flo™	0.299	3.8
Kick-Flo®	0.632	3.1
Mean Flow over Head Range	-	3.3

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake Optimum® as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Ambiental		Page 6
Science Park Square Brighton BN1 9SB	Proposed SuDS-Geocellular S.#2 London School of Theology Contract No 3110	Micro Drainage
Date 15/03/2017 19:42 File VolumeCalcs_1yr+CC.casx	Designed by Jose Tenedor Checked by Mark Naumann	
XP Solutions	Source Control 2016.1	

Hydro-Brake Optimum® Outflow Control

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.0	1.200	4.2	3.000	6.4	7.000	9.6
0.200	3.7	1.400	4.5	3.500	6.9	7.500	9.9
0.300	3.8	1.600	4.8	4.000	7.3	8.000	10.2
0.400	3.8	1.800	5.0	4.500	7.8	8.500	10.5
0.500	3.6	2.000	5.3	5.000	8.1	9.000	10.8
0.600	3.3	2.200	5.5	5.500	8.5	9.500	11.1
0.800	3.5	2.400	5.8	6.000	8.9		
1.000	3.8	2.600	6.0	6.500	9.2		

Ambiental		Page 1
Science Park Square Brighton BN1 9SB	Proposed SuDS-Geocellular S.#2 London School of Theology Contract No 3110	Micro Drainage
Date 15/03/2017 19:42 File VolumeCalcs_1yr+CC.casx	Designed by Jose Tenedor Checked by Mark Naumann	
XP Solutions	Source Control 2016.1	

Cascade Summary of Results for GS2_1in1yr+40%cc_VolumeCalcs.srcx

Upstream Structures	Outflow To	Overflow To
GS1_1in1yr+40%cc_VolumeCalcs.srcx PIPE_1in1yr+40%cc_VolumeCalcs.srcx PP_1in1yr+40%cc_VolumeCalcs.srcx	(None)	(None)

Half Drain Time : 51 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	69.495	0.095	0.0	2.8	2.8	9.4	O K
30 min Summer	69.521	0.121	0.0	3.4	3.4	12.1	O K
60 min Summer	69.542	0.142	0.0	3.5	3.5	14.2	O K
120 min Summer	69.553	0.153	0.0	3.6	3.6	15.3	O K
180 min Summer	69.553	0.153	0.0	3.6	3.6	15.3	O K
240 min Summer	69.549	0.149	0.0	3.5	3.5	14.9	O K
360 min Summer	69.535	0.135	0.0	3.5	3.5	13.5	O K
480 min Summer	69.521	0.121	0.0	3.4	3.4	12.1	O K
600 min Summer	69.511	0.111	0.0	3.2	3.2	11.0	O K
720 min Summer	69.503	0.103	0.0	3.0	3.0	10.2	O K
960 min Summer	69.491	0.091	0.0	2.7	2.7	9.0	O K
1440 min Summer	69.476	0.076	0.0	2.2	2.2	7.6	O K
2160 min Summer	69.464	0.064	0.0	1.7	1.7	6.3	O K
2880 min Summer	69.457	0.057	0.0	1.4	1.4	5.6	O K
4320 min Summer	69.448	0.048	0.0	1.1	1.1	4.8	O K
5760 min Summer	69.442	0.042	0.0	0.8	0.8	4.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	44.043	0.0	12.1	25
30 min Summer	28.612	0.0	16.3	36
60 min Summer	18.021	0.0	21.0	56
120 min Summer	11.117	0.0	26.2	88
180 min Summer	8.339	0.0	29.7	122
240 min Summer	6.792	0.0	32.3	154
360 min Summer	5.057	0.0	36.2	218
480 min Summer	4.090	0.0	39.1	278
600 min Summer	3.468	0.0	41.4	336
720 min Summer	3.031	0.0	43.5	398
960 min Summer	2.451	0.0	46.9	518
1440 min Summer	1.817	0.0	51.9	756
2160 min Summer	1.348	0.0	57.5	1116
2880 min Summer	1.090	0.0	61.9	1476
4320 min Summer	0.808	0.0	68.2	2208
5760 min Summer	0.653	0.0	73.0	2944

Ambiental		Page 2
Science Park Square Brighton BN1 9SB	Proposed SuDS-Geocellular S.#2 London School of Theology Contract No 3110	Micro Drainage
Date 15/03/2017 19:42 File VolumeCalcs_1yr+CC.casx	Designed by Jose Tenedor Checked by Mark Naumann	
XP Solutions	Source Control 2016.1	

Cascade Summary of Results for GS2_1in1yr+40%cc_VolumeCalcs.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
7200 min Summer	69.439	0.039	0.0	0.7	0.7	3.9	O K
8640 min Summer	69.436	0.036	0.0	0.6	0.6	3.6	O K
10080 min Summer	69.434	0.034	0.0	0.6	0.6	3.3	O K
15 min Winter	69.507	0.107	0.0	3.1	3.1	10.7	O K
30 min Winter	69.539	0.139	0.0	3.5	3.5	13.9	O K
60 min Winter	69.563	0.163	0.0	3.6	3.6	16.2	O K
120 min Winter	69.570	0.170	0.0	3.6	3.6	17.0	O K
180 min Winter	69.564	0.164	0.0	3.6	3.6	16.3	O K
240 min Winter	69.553	0.153	0.0	3.6	3.6	15.3	O K
360 min Winter	69.529	0.129	0.0	3.4	3.4	12.9	O K
480 min Winter	69.511	0.111	0.0	3.3	3.3	11.1	O K
600 min Winter	69.499	0.099	0.0	2.9	2.9	9.9	O K
720 min Winter	69.490	0.090	0.0	2.7	2.7	9.0	O K
960 min Winter	69.478	0.078	0.0	2.2	2.2	7.8	O K
1440 min Winter	69.464	0.064	0.0	1.7	1.7	6.4	O K
2160 min Winter	69.454	0.054	0.0	1.3	1.3	5.4	O K
2880 min Winter	69.448	0.048	0.0	1.1	1.1	4.8	O K
4320 min Winter	69.440	0.040	0.0	0.8	0.8	4.0	O K
5760 min Winter	69.436	0.036	0.0	0.6	0.6	3.6	O K
7200 min Winter	69.433	0.033	0.0	0.5	0.5	3.2	O K
8640 min Winter	69.431	0.031	0.0	0.5	0.5	3.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
7200 min Summer	0.554	0.0	77.1	3672
8640 min Summer	0.485	0.0	80.6	4408
10080 min Summer	0.433	0.0	82.5	5136
15 min Winter	44.043	0.0	13.8	25
30 min Winter	28.612	0.0	18.4	37
60 min Winter	18.021	0.0	23.7	58
120 min Winter	11.117	0.0	29.6	94
180 min Winter	8.339	0.0	33.4	130
240 min Winter	6.792	0.0	36.4	164
360 min Winter	5.057	0.0	40.8	226
480 min Winter	4.090	0.0	44.0	284
600 min Winter	3.468	0.0	46.7	346
720 min Winter	3.031	0.0	48.9	406
960 min Winter	2.451	0.0	52.8	526
1440 min Winter	1.817	0.0	58.6	770
2160 min Winter	1.348	0.0	64.8	1124
2880 min Winter	1.090	0.0	69.7	1496
4320 min Winter	0.808	0.0	77.0	2216
5760 min Winter	0.653	0.0	82.4	2960
7200 min Winter	0.554	0.0	86.7	3640
8640 min Winter	0.485	0.0	90.8	4384

Ambiental		Page 3
Science Park Square Brighton BN1 9SB	Proposed SuDS-Geocellular S.#2 London School of Theology Contract No 3110	Micro Drainage
Date 15/03/2017 19:42 File VolumeCalcs_1yr+CC.casx	Designed by Jose Tenedor Checked by Mark Naumann	
XP Solutions	Source Control 2016.1	

Cascade Summary of Results for GS2_1in1yr+40%cc_VolumeCalcs.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control Σ (l/s)	Max Outflow (l/s)	Max Volume (m³)	Status
10080 min Winter	69.429	0.029	0.0	0.4	0.4	2.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
10080 min Winter	0.433	0.0	93.9	5000

Ambiental		Page 4
Science Park Square Brighton BN1 9SB	Proposed SuDS-Geocellular S.#2 London School of Theology Contract No 3110	Micro Drainage
Date 15/03/2017 19:42 File VolumeCalcs_1yr+CC.casx	Designed by Jose Tenedor Checked by Mark Naumann	
XP Solutions	Source Control 2016.1	

Cascade Rainfall Details for GS2_1in1yr+40%cc_VolumeCalcs.srcx

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	1	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.100	Shortest Storm (mins)	15
Ratio R	0.412	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.052

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.017	4	8	0.017	8	12	0.017

Ambiental		Page 5
Science Park Square Brighton BN1 9SB	Proposed SuDS-Geocellular S.#2 London School of Theology Contract No 3110	
Date 15/03/2017 19:42 File VolumeCalcs_1yr+CC.casx	Designed by Jose Tenedor Checked by Mark Naumann	
XP Solutions	Source Control 2016.1	

Cascade Model Details for GS2_1in1yr+40%cc_VolumeCalcs.srcx

Storage is Online Cover Level (m) 70.500

Cellular Storage Structure

Invert Level (m) 69.400 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	105.0	0.0	1.300	0.0	0.0
0.100	105.0	0.0	1.400	0.0	0.0
0.200	105.0	0.0	1.500	0.0	0.0
0.300	105.0	0.0	1.600	0.0	0.0
0.400	105.0	0.0	1.700	0.0	0.0
0.500	105.0	0.0	1.800	0.0	0.0
0.600	105.0	0.0	1.900	0.0	0.0
0.700	105.0	0.0	2.000	0.0	0.0
0.800	105.0	0.0	2.100	0.0	0.0
0.900	105.0	0.0	2.200	0.0	0.0
1.000	105.0	0.0	2.300	0.0	0.0
1.001	0.0	0.0	2.400	0.0	0.0
1.200	0.0	0.0	2.500	0.0	0.0

Hydro-Brake Optimum® Outflow Control

Unit Reference	MD-SHE-0093-3840-1000-3840
Design Head (m)	1.000
Design Flow (l/s)	3.8
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	93
Invert Level (m)	69.400
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	3.8
Flush-Flo™	0.299	3.8
Kick-Flo®	0.632	3.1
Mean Flow over Head Range	-	3.3

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake Optimum® as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Ambiental		Page 6
Science Park Square Brighton BN1 9SB	Proposed SuDS-Geocellular S.#2 London School of Theology Contract No 3110	Micro Drainage
Date 15/03/2017 19:42 File VolumeCalcs_1yr+CC.casx	Designed by Jose Tenedor Checked by Mark Naumann	
XP Solutions	Source Control 2016.1	

<u>Hydro-Brake Optimum® Outflow Control</u>

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.0	1.200	4.2	3.000	6.4	7.000	9.6
0.200	3.7	1.400	4.5	3.500	6.9	7.500	9.9
0.300	3.8	1.600	4.8	4.000	7.3	8.000	10.2
0.400	3.8	1.800	5.0	4.500	7.8	8.500	10.5
0.500	3.6	2.000	5.3	5.000	8.1	9.000	10.8
0.600	3.3	2.200	5.5	5.500	8.5	9.500	11.1
0.800	3.5	2.400	5.8	6.000	8.9		
1.000	3.8	2.600	6.0	6.500	9.2		

Ambiental		Page 1
Science Park Square Brighton BN1 9SB	Proposed SuDS-Geocellular S.#2 London School of Theology Contract No 3110	Micro Drainage
Date 15/03/2017 19:39 File AttenuationVolume_100yr...	Designed by Jose Tenedor Checked by Mark Naumann	
XP Solutions	Source Control 2016.1	

Cascade Summary of Results for GS2_1in100yr+40%cc_AttenuationCalcs.srcx

Upstream Structures	Outflow To	Overflow To
PP_1in100yr+cc_AttenuationVol.srcx GS1_1in100yr+40%cc_AttenuationCalcs.srcx PIPE_1in100yr+40%cc_AttenuationCalcs.srcx	(None)	(None)

Half Drain Time : 182 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	69.732	0.332	0.0	3.8	3.8	33.1	O K
30 min Summer	69.836	0.436	0.0	3.8	3.8	43.5	O K
60 min Summer	69.950	0.550	0.0	3.8	3.8	54.9	O K
120 min Summer	70.070	0.670	0.0	3.8	3.8	66.9	O K
180 min Summer	70.089	0.689	0.0	3.8	3.8	68.7	O K
240 min Summer	70.073	0.673	0.0	3.8	3.8	67.1	O K
360 min Summer	70.032	0.632	0.0	3.8	3.8	63.1	O K
480 min Summer	69.985	0.585	0.0	3.8	3.8	58.4	O K
600 min Summer	69.940	0.540	0.0	3.8	3.8	53.8	O K
720 min Summer	69.897	0.497	0.0	3.8	3.8	49.6	O K
960 min Summer	69.819	0.419	0.0	3.8	3.8	41.8	O K
1440 min Summer	69.696	0.296	0.0	3.8	3.8	29.5	O K
2160 min Summer	69.583	0.183	0.0	3.7	3.7	18.3	O K
2880 min Summer	69.527	0.127	0.0	3.4	3.4	12.6	O K
4320 min Summer	69.491	0.091	0.0	2.7	2.7	9.1	O K
5760 min Summer	69.475	0.075	0.0	2.2	2.2	7.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	140.352	0.0	44.4	52
30 min Summer	91.674	0.0	58.5	74
60 min Summer	57.005	0.0	73.3	100
120 min Summer	34.241	0.0	88.3	134
180 min Summer	25.078	0.0	97.1	178
240 min Summer	19.989	0.0	103.3	208
360 min Summer	14.479	0.0	112.2	268
480 min Summer	11.517	0.0	119.0	332
600 min Summer	9.637	0.0	124.4	396
720 min Summer	8.327	0.0	129.1	460
960 min Summer	6.608	0.0	136.5	586
1440 min Summer	4.764	0.0	147.4	828
2160 min Summer	3.429	0.0	158.9	1168
2880 min Summer	2.712	0.0	167.2	1504
4320 min Summer	1.947	0.0	178.8	2208
5760 min Summer	1.538	0.0	187.4	2936

Ambiental		Page 2
Science Park Square Brighton BN1 9SB	Proposed SuDS-Geocellular S.#2 London School of Theology Contract No 3110	Micro Drainage
Date 15/03/2017 19:39 File AttenuationVolume_100yr...	Designed by Jose Tenedor Checked by Mark Naumann	
XP Solutions	Source Control 2016.1	

Cascade Summary of Results for GS2_1in100yr+40%cc_AttenuationCalcs.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
7200 min Summer	69.467	0.067	0.0	1.8	1.8	6.6	O K
8640 min Summer	69.460	0.060	0.0	1.5	1.5	6.0	O K
10080 min Summer	69.456	0.056	0.0	1.4	1.4	5.6	O K
15 min Winter	69.771	0.371	0.0	3.8	3.8	37.0	O K
30 min Winter	69.891	0.491	0.0	3.8	3.8	48.9	O K
60 min Winter	70.028	0.628	0.0	3.8	3.8	62.6	O K
120 min Winter	70.154	0.754	0.0	3.8	3.8	75.2	O K
180 min Winter	70.198	0.798	0.0	3.8	3.8	79.6	O K
240 min Winter	70.176	0.776	0.0	3.8	3.8	77.4	O K
360 min Winter	70.125	0.725	0.0	3.8	3.8	72.3	O K
480 min Winter	70.068	0.668	0.0	3.8	3.8	66.6	O K
600 min Winter	69.996	0.596	0.0	3.8	3.8	59.4	O K
720 min Winter	69.925	0.525	0.0	3.8	3.8	52.4	O K
960 min Winter	69.806	0.406	0.0	3.8	3.8	40.5	O K
1440 min Winter	69.634	0.234	0.0	3.8	3.8	23.4	O K
2160 min Winter	69.519	0.119	0.0	3.4	3.4	11.9	O K
2880 min Winter	69.493	0.093	0.0	2.8	2.8	9.3	O K
4320 min Winter	69.471	0.071	0.0	2.0	2.0	7.1	O K
5760 min Winter	69.461	0.061	0.0	1.6	1.6	6.0	O K
7200 min Winter	69.455	0.055	0.0	1.3	1.3	5.5	O K
8640 min Winter	69.450	0.050	0.0	1.1	1.1	4.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
7200 min Summer	1.280	0.0	194.7	3656
8640 min Summer	1.101	0.0	200.0	4360
10080 min Summer	0.969	0.0	204.6	5120
15 min Winter	140.352	0.0	49.9	59
30 min Winter	91.674	0.0	65.7	82
60 min Winter	57.005	0.0	82.2	110
120 min Winter	34.241	0.0	99.0	142
180 min Winter	25.078	0.0	109.0	178
240 min Winter	19.989	0.0	115.8	228
360 min Winter	14.479	0.0	125.9	284
480 min Winter	11.517	0.0	133.6	364
600 min Winter	9.637	0.0	139.6	434
720 min Winter	8.327	0.0	144.7	500
960 min Winter	6.608	0.0	153.1	626
1440 min Winter	4.764	0.0	165.2	854
2160 min Winter	3.429	0.0	178.2	1160
2880 min Winter	2.712	0.0	187.7	1496
4320 min Winter	1.947	0.0	201.4	2200
5760 min Winter	1.538	0.0	209.7	2920
7200 min Winter	1.280	0.0	217.8	3672
8640 min Winter	1.101	0.0	224.7	4312

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Science Park Square Brighton BN1 9SB	Proposed SuDS-Geocellular S.#2 London School of Theology Contract No 3110	
Date 15/03/2017 19:39 File AttenuationVolume_100yr...	Designed by Jose Tenedor Checked by Mark Naumann	
XP Solutions	Source Control 2016.1	

Cascade Summary of Results for GS2_1in100yr+40%cc_AttenuationCalcs.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
10080 min Winter	69.446	0.046	0.0	1.0	1.0	4.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
10080 min Winter	0.969	0.0	230.5	5152

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Science Park Square Brighton BN1 9SB	Proposed SuDS-Geocellular S.#2 London School of Theology Contract No 3110	
Date 15/03/2017 19:39 File AttenuationVolume_100yr...	Designed by Jose Tenedor Checked by Mark Naumann	
XP Solutions	Source Control 2016.1	

Cascade Rainfall Details for GS2_1in100yr+40%cc_AttenuationCalcs.srcx

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.100	Shortest Storm (mins)	15
Ratio R	0.412	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.052

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.017	4	8	0.017	8	12	0.017

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Science Park Square Brighton BN1 9SB	Proposed SuDS-Geocellular S.#2 London School of Theology Contract No 3110	Micro Drainage
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XP Solutions	Source Control 2016.1	

Cascade Model Details for GS2_1in100yr+40%cc_AttenuationCalcs.srcx

Storage is Online Cover Level (m) 70.500

Cellular Storage Structure

Invert Level (m) 69.400 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	105.0	0.0	1.300	0.0	0.0
0.100	105.0	0.0	1.400	0.0	0.0
0.200	105.0	0.0	1.500	0.0	0.0
0.300	105.0	0.0	1.600	0.0	0.0
0.400	105.0	0.0	1.700	0.0	0.0
0.500	105.0	0.0	1.800	0.0	0.0
0.600	105.0	0.0	1.900	0.0	0.0
0.700	105.0	0.0	2.000	0.0	0.0
0.800	105.0	0.0	2.100	0.0	0.0
0.900	105.0	0.0	2.200	0.0	0.0
1.000	105.0	0.0	2.300	0.0	0.0
1.001	0.0	0.0	2.400	0.0	0.0
1.200	0.0	0.0	2.500	0.0	0.0

Hydro-Brake Optimum® Outflow Control

Unit Reference	MD-SHE-0093-3840-1000-3840
Design Head (m)	1.000
Design Flow (l/s)	3.8
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	93
Invert Level (m)	69.400
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	3.8
Flush-Flo™	0.299	3.8
Kick-Flo®	0.632	3.1
Mean Flow over Head Range	-	3.3

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake Optimum® as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

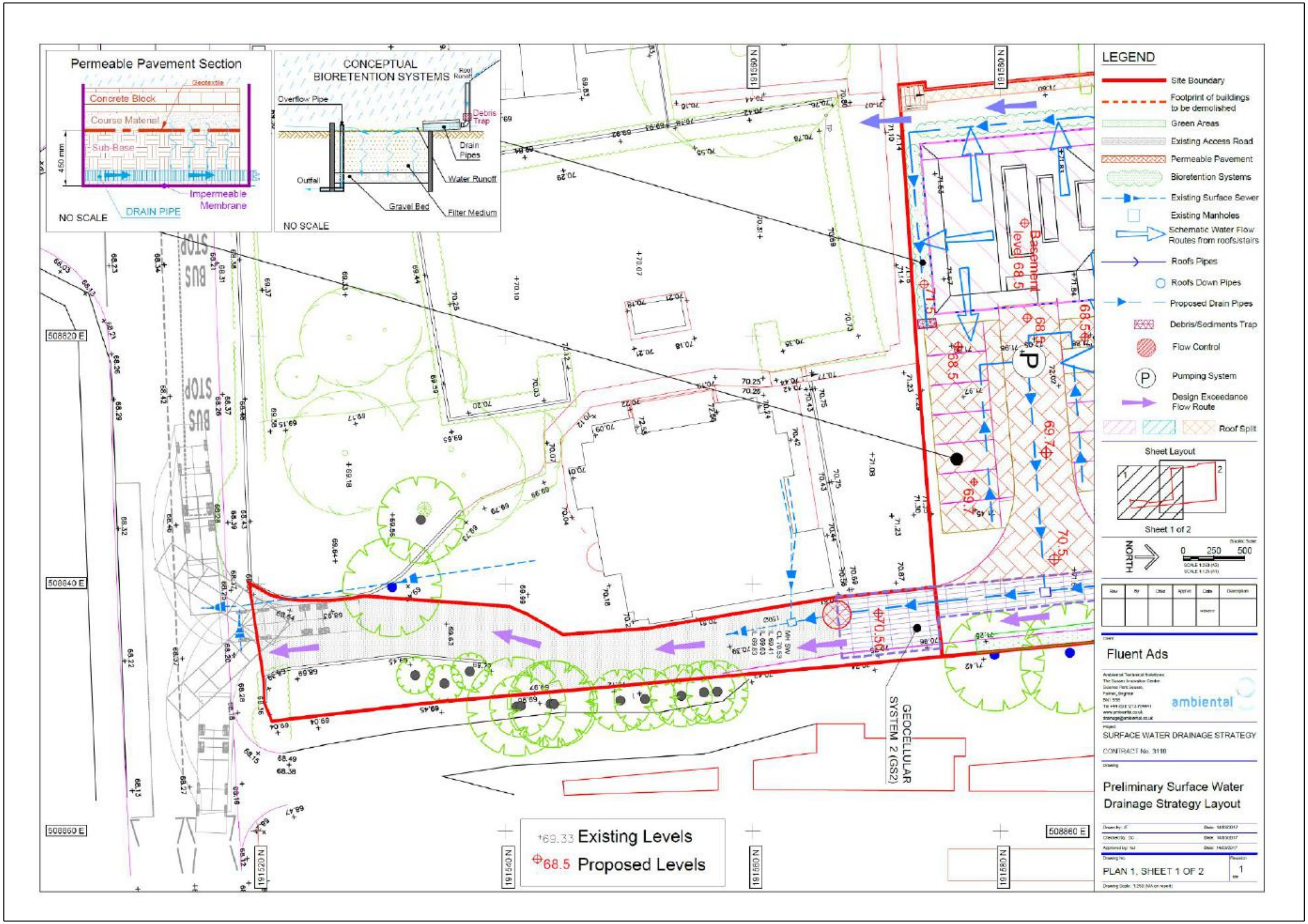
Ambiental		Page 6
Science Park Square Brighton BN1 9SB	Proposed SuDS-Geocellular S.#2 London School of Theology Contract No 3110	Micro Drainage
Date 15/03/2017 19:39 File AttenuationVolume_100yr...	Designed by Jose Tenedor Checked by Mark Naumann	
XP Solutions	Source Control 2016.1	

Hydro-Brake Optimum® Outflow Control

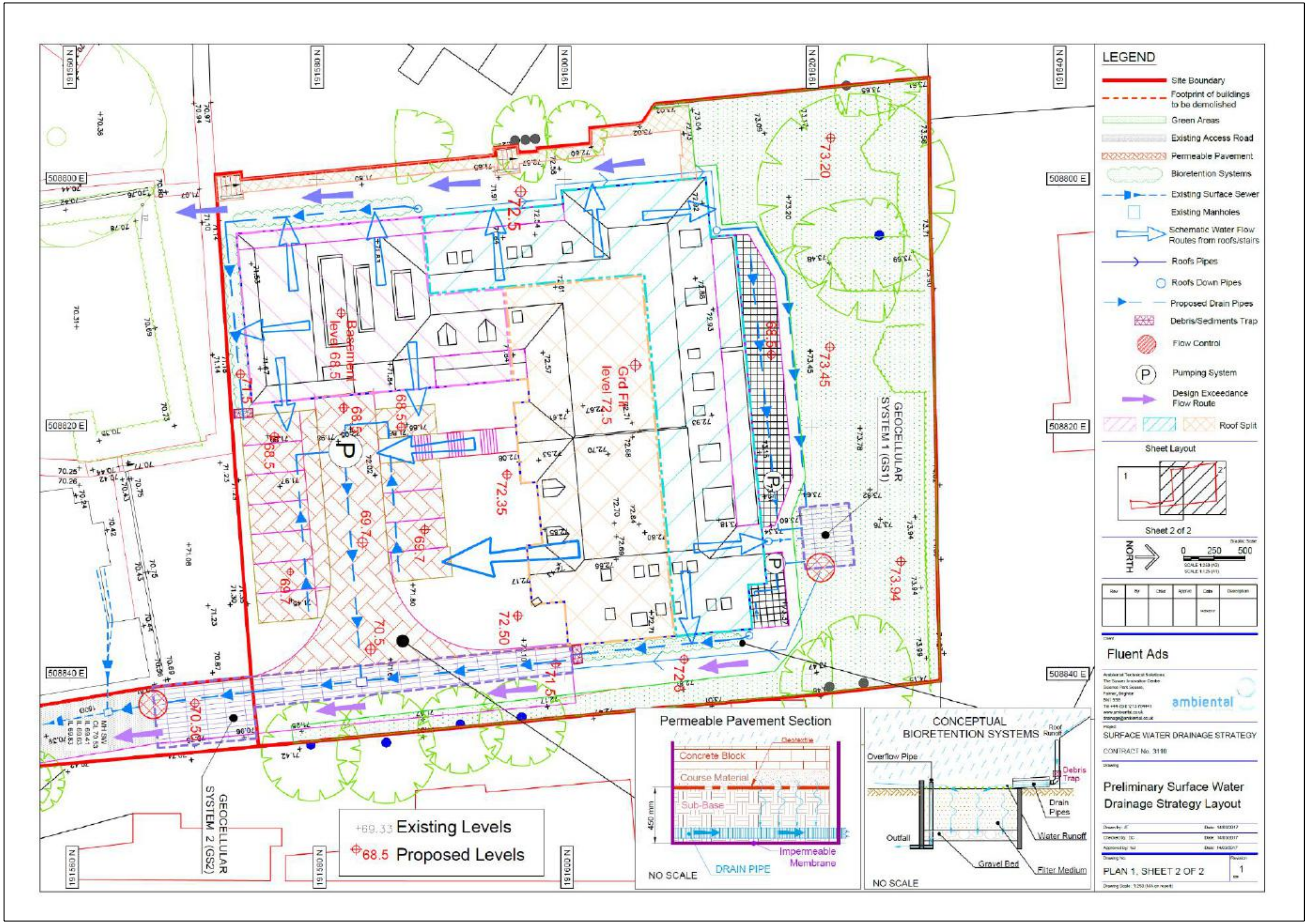
Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	2.9	1.200	4.1	3.000	6.3	7.000	9.5
0.200	3.7	1.400	4.4	3.500	6.8	7.500	9.8
0.300	3.8	1.600	4.7	4.000	7.3	8.000	10.1
0.400	3.7	1.800	5.0	4.500	7.7	8.500	10.4
0.500	3.6	2.000	5.2	5.000	8.1	9.000	10.7
0.600	3.3	2.200	5.5	5.500	8.4	9.500	10.9
0.800	3.4	2.400	5.7	6.000	8.8		
1.000	3.8	2.600	5.9	6.500	9.1		

Appendix 4 – Proposed Surface Water Drainage Strategy

- *Plan 1 – Preliminary Drainage Strategy Layout, Sheet 1 of 2*
- *Plan 1 – Preliminary Drainage Strategy Layout, Sheet 2 of 2*



Appendix 4, Plan 1 – Preliminary Drainage Strategy Layout, Sheet 1 of 2



Appendix 4, Plan 2 – Preliminary Drainage Strategy Layout, Sheet 2 of 2

Appendix 5 – Information

Rainfall data has been extracted from the FEH CD-ROM for several storm duration events for a number of return periods, including 1:1.01 year, 1:10 year and 1:100 year storm events. These return periods are industry standard, however it is important to be aware that return periods less than 1:2 years are not considered reliable and should not be used in detailed design calculations.

The 1:100 year with an allowance for climate change has `been based on a 40% increase to the 1:100 year rainfall intensity and not the rainfall depth. This is to provide the most conservative runoff rates for the site possible.

Greenfield runoff rates have been calculated using The Institute of Hydrology Report 124 Marshall and Bayliss, 1994 method, as recommended in the SuDS Manual CIRIA (C753). In keeping with standard practice, the calculations are based on calculating the Greenfield runoff rates for a 50 Ha site and then factored to account for the actual site size.