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Project: Surface Water Drainage Strategy (SWDS)

Prepared for: BB Partnership Ltd

Reference: 2918

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Site Location: 62 Avenue Road, Camden, London, NW8 6HT.

Proposed Development: It is understood that the development is for the erection of a two storey, single family dwelling house with basement and accommodation in the roof space, following the demolition of the existing main dwelling house.

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Contents

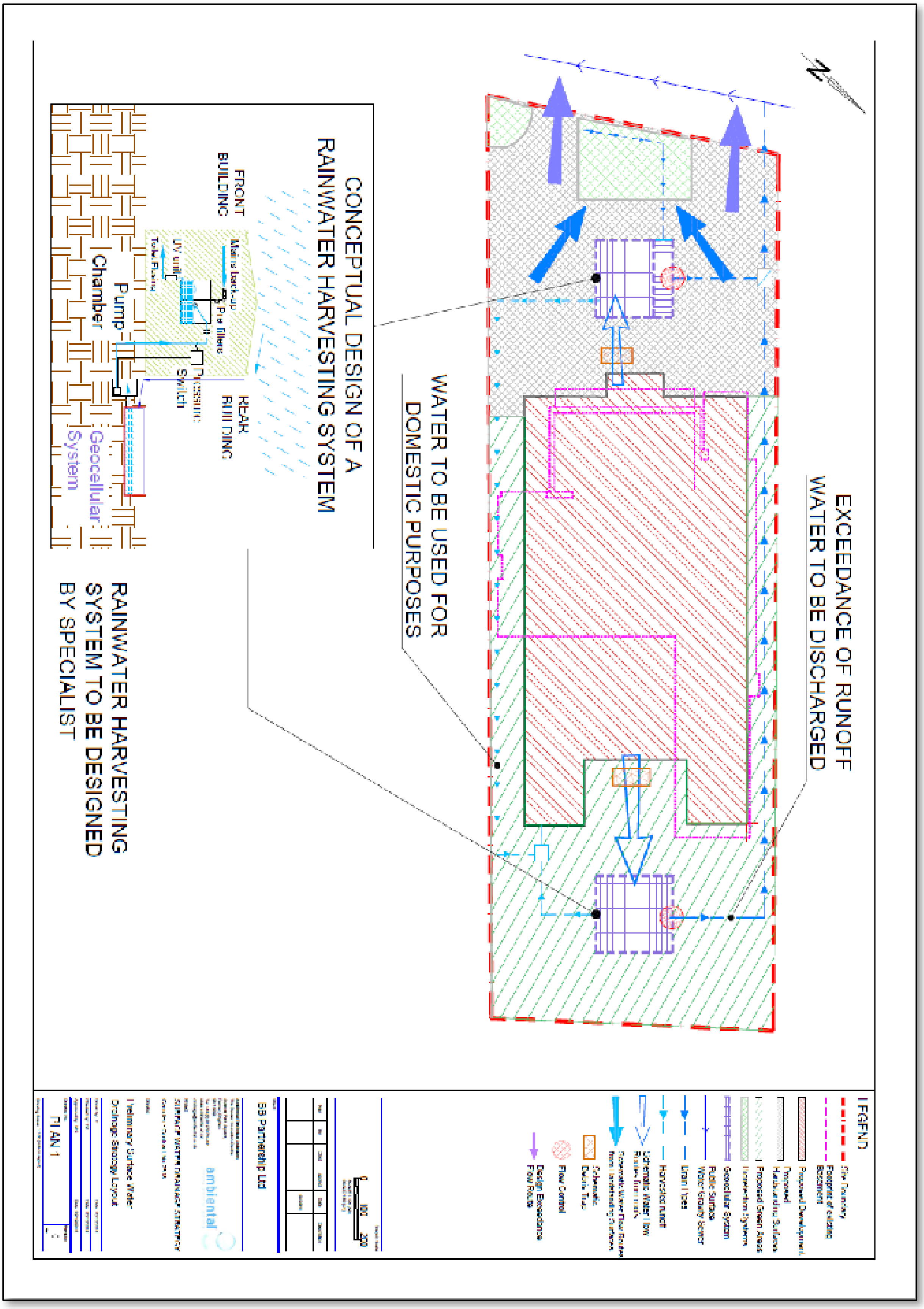
1. Summary

SITE DETAILS			
Site Name	Avenue Road, 62 Avenue Road, Camden, London, NW8 6HT		
Total Site Area	0.11 ha		
Site Area which is positively drained	0.11 ha		
Open Space	0.00 ha		
Predevelopment Use	Site already developed for residential purposes.		
Site Constraints	- Residential Site		
	- Groundwater Source Protection Zone:	Outer zone (Zone 2)	
	- Groundwater Vulnerability Zone:	N/A	
	- Poor Infiltration Soils		
	- Unknown Groundwater Table		
IMPERMEABLE AREA			
	EXISTING	PROPOSED	DIFFERENCE (Proposed - Existing)
Impermeable Area (Ha)	0.088 ha	0.074 ha	-0.014 ha
Drainage Method (Infiltration/Sewer/Watercourse)		Sewer	N/A
PROPOSED TO DISCHARGE SURFACE WATER VIA			
	YES	NO	EVIDENCE
Infiltration		X	Soils with Poor Infiltration Media.
To Watercourse		X	No watercourse close to the site.
To Surface water sewer	X		Use of the Existing Public Sewer Network.
Combination of above		X	
PEAK DISCHARGE RATES			
	Greenfield Rates (l/s)	Development Pre-mitigation Rates (l/s)	Proposed Rates (l/s)
Greenfield Q_{BAR}	0.48 l/s	N/A	-
1 in 1	0.41 l/s	17.20 l/s	5.00 l/s
1 in 20	-	30.70 l/s	5.00 l/s
1 in 30	1.17 l/s	32.80 l/s	5.00 l/s
1 in 100	1.52 l/s	34.60 l/s	5.00 l/s
1 in 100 plus climate change	N/A	N/A	5.00 l/s

DISCHARGE VOLUMES (m^3)				
Return Period	Greenfield Volume (m^3)	Existing Volume (m^3)	Proposed Volume (m^3)	DIFFERENCE (m^3) (Proposed - Existing)
1 in 1	8.96	9.79	8.23	-1.56
1 in 30	20.78	40.04	33.67	-6.37
1 in 100	28.30	56.73	47.70	-9.02
1 in 100 + CC	39.62	79.42	66.78	-12.63
SITE STORAGE VOLUME				
Source Control Provided	Yes			
Interception Volume (Capture and retention on site of the first 5 litres of the majority of all rainfall events)	3.26 m^3			
Attenuation Storage (Storage – 1 in 100 year + CC) Volume to control discharge rate				
Storage Attenuation volume (Flow rate control) required to meet greenfield run off rates	52.9 m^3	Flow Control: 0.48 l/s		
Storage Attenuation volume (Flow rate control) required to reduce rates by 50%	21.00 m^3	Flow Control: 16.8 l/s		
Storage Attenuation volume (Flow rate control) required to meet OTHER RUN OFF RATE (as close to greenfield rate as possible)	28.20 m^3	Flow Control: 5.0 l/s		
Storage Attenuation volume (Flow rate control) required to retain rates as existing	14.60 m^3	Flow Control: 32.8 l/s (1:30)		
Percentage of attenuation volume stored above ground	10.80%	3.04 m^3	Use of buried Geocellular System to be used as deposit for a Rainwater Harvesting System	
Proposed Attenuation Volume (Storage - 1 in 100 year + CC) Volume to control discharge rate (5 l/s)	28.20 m^3	0.03 m^3/m^2	Use of Geocellular System & Hydrobrake	
Total site Storage	31.5 m^3			

INFILTRATION FEASIBILITY ANALYSIS		
Site's Geology	London Clay Formation Clay	
Infiltration Rates	< 1.08×10^{-6} 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	Higher than 3 mBGL	
Is the site within a known Source Protection Zones (SPZ)? Yes/No?	YES	
Is Infiltration feasible?	Infiltration is not feasible due to the low rate of infiltration of the soils's site.	
Site's Contamination	Site already developed, thus there is a potential contamination due to petrochemical pollutants of the cars.	
Infiltration Feasibility	NO	Infiltration is NOT feasible due to the poor permeability of the soils underlying the site.
If Infiltration is not feasible, how is the Storage Requirements Approach?	OPTION 1. Simple Approach. Store both the additional volume and attenuation volume in order to make a final discharge from site at the greenfield run off rate.	

PROPOSED DRAINAGE COMPONENTS		
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.	
Rainwater Harvesting System	Rainwater Harvesting (RWH) is the collection of rainwater runoff for use. Runoff can be collected from roofs and other impermeable areas, stored, treated (where required) and then used as a supply of water for domestic and commercial properties.	
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 (Hydrobrakes)	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	Bioretention Systems + Rainwater Harvesting System (using Geocellular Systems)	
How are rates being restricted	Use of Hydrobrakes & Orifices	
Key Drainage component	Geocellular System	
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	1.0 hours	


EXCEEDANCE OF RUNOFF WATER TO BE DISCHARGED
WATER TO BE USED FOR DOMESTIC PURPOSES
CONCEPTUAL DESIGN OF A RAINWATER HARVESTING SYSTEM
FRONT BUILDING
REAR BUILDING
Pump
Chamber
Geocellular System
RAINWATER HARVESTING SYSTEM TO BE DESIGNED BY SPECIALIST
LEGEND
BB Partnership Ltd
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PLAN 1

2. Introduction

2.1 This Surface Water Drainage Strategy has been prepared by Ambiental Technical Solutions, in respect of a planning application for the development at 62 Avenue Road, Camden, London, NW8 6HT. Coordinates: X = 526938; Y = 183925. See Appendix 1, Plan 1 – Site Location and Figure 1 below.

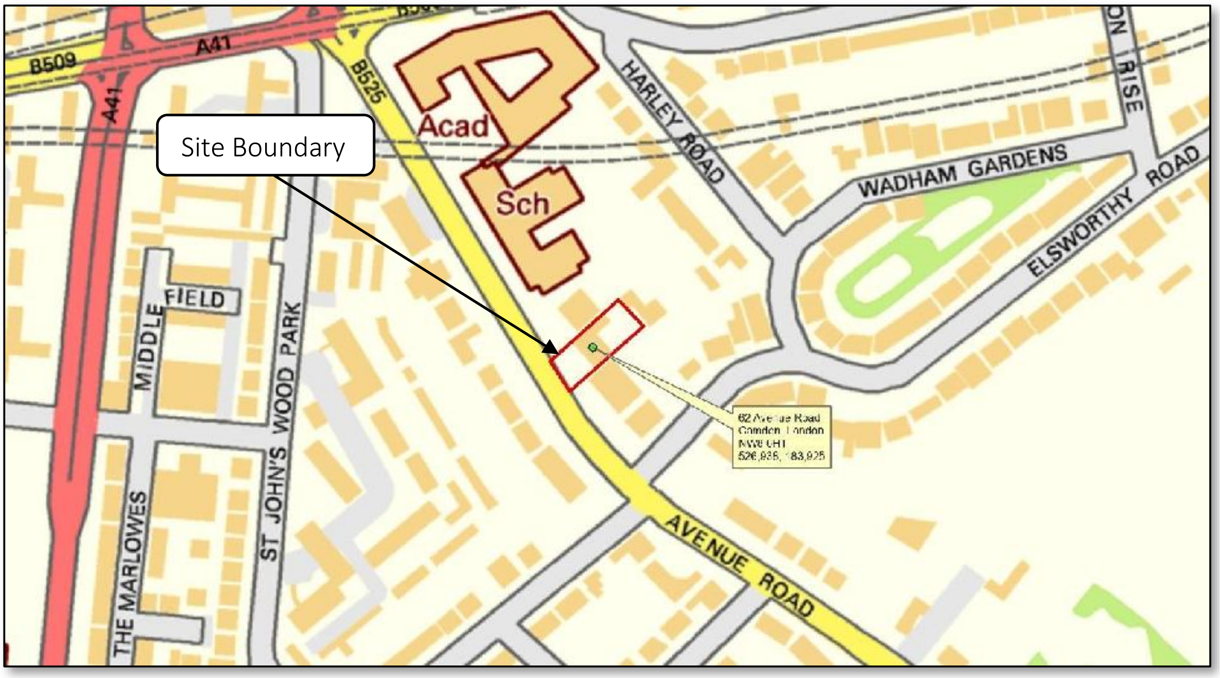

Figure 1 – Site Location. (Source: OS-Street View)

Development Proposal

2.2 It is understood that the development is for the erection of a two storey, single family dwelling house with basement and accommodation in the roof space, following the demolition of the existing main dwelling house.

2.3 This study is based on plans included on the Appendix 1 (see Plans 1 to 10 provided by the client, BB Partnership Ltd).

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 is located to the west of the London Borough of Camden. Specifically, it is to the east of Avenue Road, being bounded by this street to the west of the property and by other developments to the east, north and south. See Appendix 1, Plan 1 – Site Location and Plan 2 – Existing Site Plan & Topography as well as the Figures 1 & 2.

Figure 2 – Aerial View of Development Site (Source: ESRI).

3.2 It is understood that the development is for the erection of a 2 storey, single family dwelling house with basement and accommodation in the roof space, following the demolition of the existing main dwelling house. See Appendix 1, from Plans 4 to Plan 10 as well as an extract of the Plan 4 – Proposed Site on the Figure 3 below.

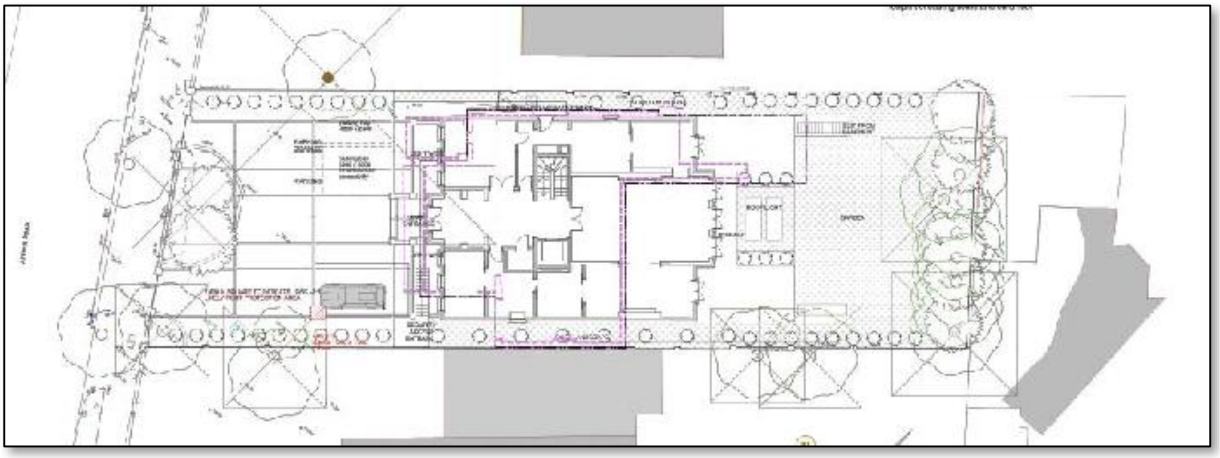

Figure 3 – Extract of Plan 4, Proposed Site Plan.

3.3 Based on the plans provided by the client, the total area of the site is approximately 1080 m^2 (0.108 Ha). As the existing site is developed, it is considered that there is an impervious surface of approximately 880 m^2 (0.09 Ha), thus the existing pervious surface is 200 m^2 (0.02 Ha). Following development, there will be a decrease of the impervious areas to 740 m^2 (approximately 0.074 Ha), hence the pervious areas will be increased to approximately 340 m^2 (0.034 Ha).

3.4 Based on the topographical survey provided by the client, the topography of the site ranges between approximately 48.73 mAOD[1] and 45.98 mAOD. Thus, it is considered there is likelihood of runoff to the west of the site (Avenue Road). See Appendix 1, (Appendix 1, Plan 2 – Existing Site Plan and Topography) and an extract of it on the Figure 4 below.

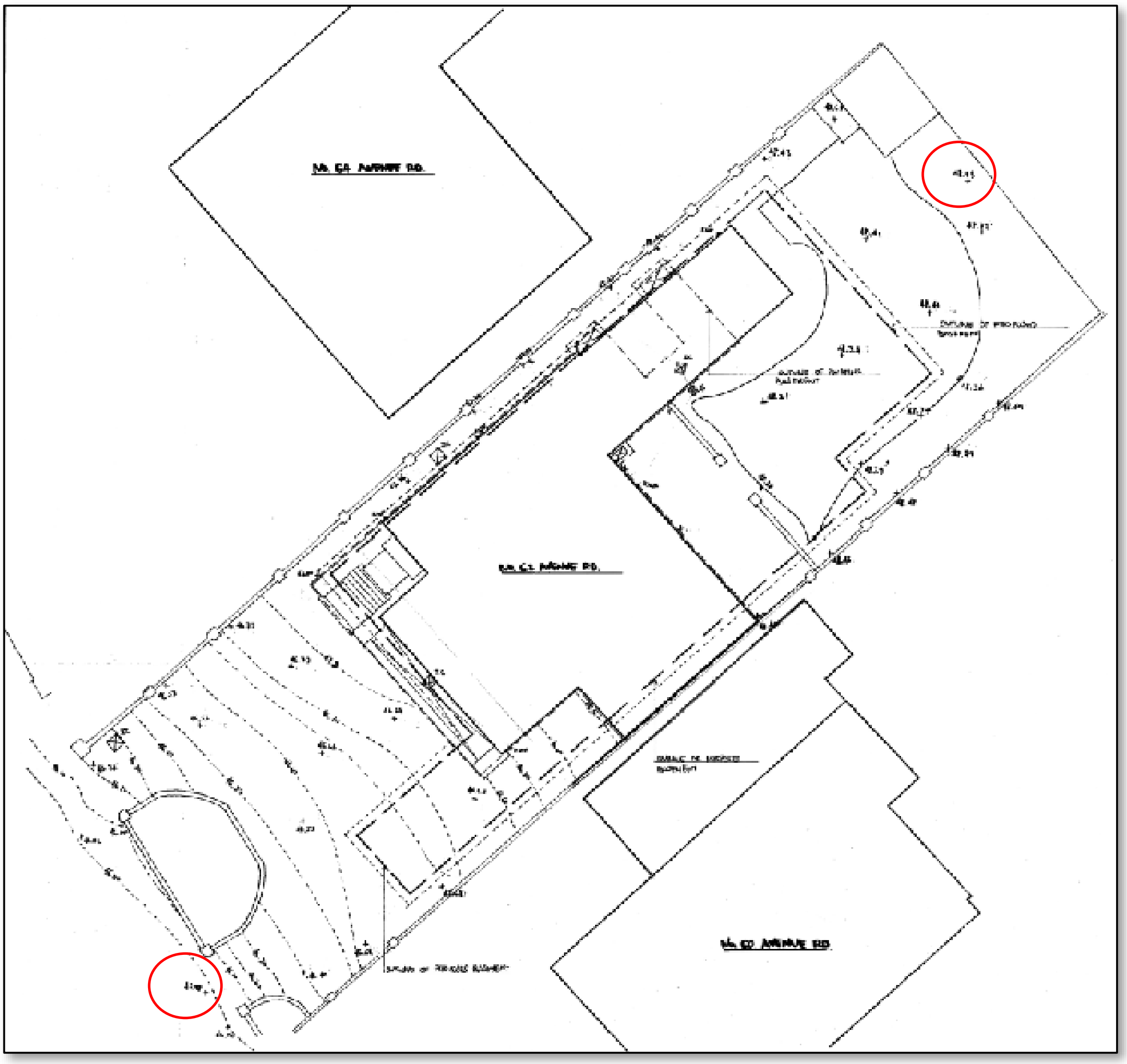

Figure 4 – Extract of the Appendix 1, Plan 2 – Existing Site Plan and Topography

[1] mAOD: Meters Above Ordnance Datum

Existing Drainage Infrastructure

3.5 No utilities sewers records were provided by the client.

3.6 The existing site is currently developed being used for residential purpose and, hence, partly impermeable. Therefore it is likely that there is existing drainage infrastructure within the site. This is confirmed on the Appendix 1, Plan 3 Summary of ABA understanding of Existing Statutory Services. Refer to Appendix 1, Plan 3 and an extract of it on the Figure 5 below. Any other existing drainage infrastructure or data on site has not been addressed by the client.

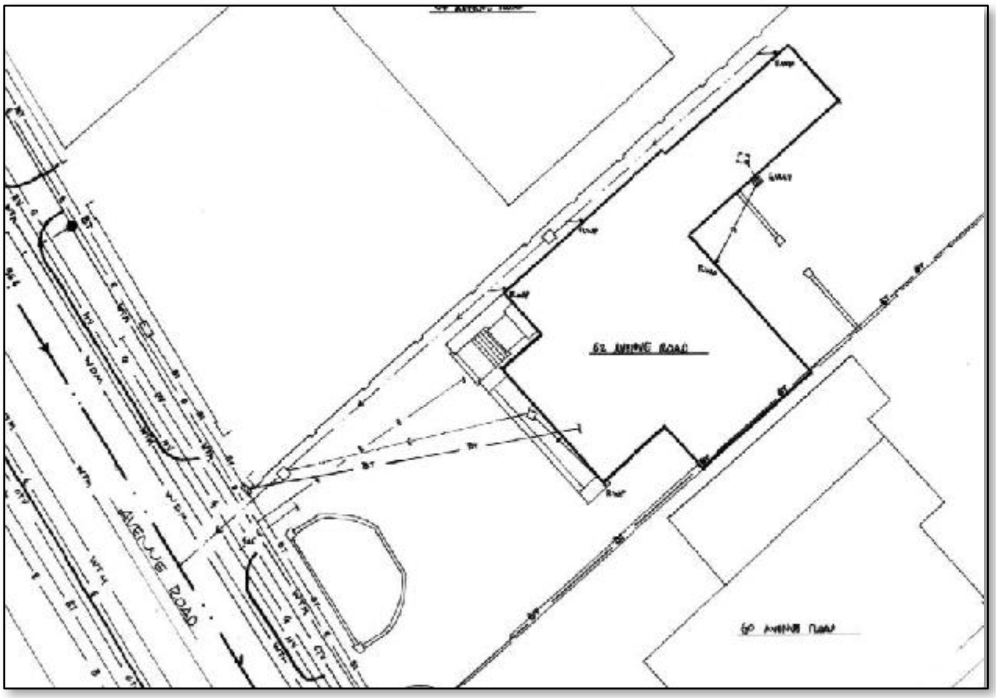

Figure 5 – Extract of the Appendix 1, Plan 3 – Summary of ABA understanding of Existing Statutory Services

3.7 This location and features of an existing drainage infrastructure must be confirmed by the client and the local water company.

Existing Ground Conditions

3.8 The client provided an extract of the 1987 British Geological Survey Map TQ27NE. Refer to Appendix 2, Plan 1 – Local Geology and Ground Conditions. This plan indicates that the bedrock underlying the site is the London Clay Formation - Clay and Silt. 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. These rocks were formed from infrequent slurries of shallow water sediments which were then redeposited as graded beds.

3.9 Besides that, a geological investigation of the site was carried out. According to the extracted data from the boreholes, it is concluded that the site is predominantly underlying by clayey soils. See Appendix 2, Plan 2 as well as the Figures from 1 to 6 within this appendix. Standard values from the specialized literature CIRIA 753 'The SUDS Manual' suggest the infiltration coefficient of these types of soils is less than 0.000108 m/h (3×10^{-8} m/s).

3.10 See Table 1 – Typical Infiltration Coefficients based on Soil Texture below. It is highly 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)
Very Poor Infiltration media	
Clay	< 0.00000108

Table 1 – Typical Infiltration Coefficients based on Soil Texture

3.11 The site lies in an aquifer in which flow is virtually all through fractures and other discontinuities and considered as *Rocks with essentially no groundwater* according to the BGS hydrogeological database (*see Appendix 2, Plan 3 – Hydrogeology*). Based on the data of the geological investigation provided by the client, the groundwater level is higher than 3 metres below ground level.

3.12 The *Environmental Agency's Groundwater Source Protection Zone Map* confirms that the site lies within a Source Protection Zone (Outer zone, Zone 2). Nevertheless, the site does not lie within any area considered as a Groundwater Vulnerability Zone by the EA[2]. See Appendix 2, Plan 4 - Groundwater Source Protection Zones and Plan 5 – Groundwater Vulnerability Zones.

Nearby Watercourses and Drainage

3.13 The Regent's Canal is located **750 metres** to the south-east from the site boundary.

3.14 **Thus, it is considered that there is no watercourse close enough to the site to be used within the drainage scheme.**

[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, thus it is considered brownfield. In accordance with the provided plans for the proposed development, the proposed development will decrease the impermeable surface covers to the site by approximately 140 m^2, based on the plans provided. The runoff arising from the development will need to be managed in accordance with the National Planning Policy Framework (NPPF) policy which requires the use of SuDS[3] to be prioritised where appropriate for new developments.

Infiltration Potential

4.3 British geological survey records indicate the site is predominantly underlain by clays which is unlikely to be suitable for infiltration drainage due to its extremely poor permeability as it was stated in the section 3.9.

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

Runoff rates

4.5 The London Borough of Camden's '*Surface Water Drainage Pro-forma for new developments'', Section 7,* provides two approaches guidance for the rates of discharge in relation to the storage requirements and how to limit the rate of discharge:

- Option 1 - Simple

  *"Store both the additional volume and attenuation volume in order to make a final discharge from site at the **greenfield run off rate**. This is preferred if no infiltration can be made on site. This very simply satisfies the runoff rates and volume criteria.*

- Option 2 - Complex

  "If some of the additional volume of water can be infiltrated back into the ground, the remainder can be discharged at a very low rate of 2 l/sec/hectare. A combined storage calculation using the partial permissible rate of 2 l/sec/hectare and the attenuation rate used to slow the runoff from site."

4.6 As Infiltration techniques are not viable and there is an existing drainage network on site, it is proposed that **all the runoff above 1 in 1 year event will be released up to a maximum rate given by the flow based on the greenfield runoff rate (Q_{BAR}) as defined by *Option 1*.**

[3] SuDS: Sustainable Drainage Systems. SuDS mimic natural drainage processes through a series of features that collect and convey water at or near the surface.

4.7 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*).

4.8 The Greenfield runoff rates for the several storm duration 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.

4.9 Preliminary calculations based on Equation 1 show that the *Greenfield Runoff Rate* ($Q_{BAR,rural}$) from 50Ha is 220.95 l/s, therefore the rate per hectare is 4.42 l/s/ha. According to the size area positively drained (0.11 ha), **the *Greenfield Runoff Rate* from the area of the site is 0.48 l/s**. 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*.

4.10 It is important to be highlighted the guidance given by 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"*.

4.11 The section 2.10 of the *Advice Note on contents of a Surface Water Drainage Statement'* by the London Borough of Camden's specifies that the Camden Planning Guidance 3 (CPG3) requires developments to achieve greenfield runoff rates once SuDS have been installed. It is also indicated on this section, that a minimum 50% reduction in runoff rate is required if it is demonstrated that the greenfield runoff rate is not feasible.

4.12 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 for a variety of rainfall events are shown on the Appendix 3 – Calculations and a summary of them on the Table 2.

4.13 It is worthy to point out that *DEFRA* Report '*Rainfall runoff management for Developments'* recommends that the design principle is to limit the runoff for events of similar frequency of occurrence to the same peak rate of run as that which takes place from greenfield sites. However, there are two situations where the greenfield flow rate is not actually applied to define the limiting discharge rates (based on this literature as well):

a) The limit of discharges based on Q_{BAR} that are less than 1 l/s/ha for permeable sites as this is seen as being an unreasonable requirement (producing very large storage volumes). Q_{BAR} is then set to 1 l/s/ha;

b) Small sites would require impractically small controls to achieve the required flow rates where these are calculated to be less than 5 l/s and therefore in this case a **minimum flow of 5 l/s is used**.

4.14 Therefore, should it be concluded that due to the fact that the Greenfield Runoff Rate (Q_{BAR}) is **0.48 l/s, extremely low**, the limiting discharge rate based on this value may be increased to 5 l/s to avoid any blockage in compliance with the Sustainable Design and Construction SPG by the Mayor of London and the DEFRA Report *Rainfall runoff management for Developments'*. Additionally, the proposed rate is lower than the 50% of the existing pre-development runoff rates as required by the Camden Planning Guidance 3 (CPG3).

4.15 **Hence, a limiting discharge of 5 l/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 year	30 year	100 year
Greenfield Site	0	0.48	0.41	-	1.17	1.52
Proposed Discharge Rates for Greenfield Site	0	5.0	5.0	5.0	5.0	5.0
Existing Site (Using Microdrainage)	880	-	17.2	30.7	32.8	34.6
Reduction of 50% for the Existing Site	880	-	8.6	15.35	16.4	17.3
Limiting Discharge for Proposed Site	740	-	5.0 < 8.6	5.0 < 15.35	5.0 < 16.4	5.0 < 17.3
Designed Discharge for Proposed Site (from calculations in Appendix 3)	**740**	**-**	**5.0**	**-**	**5.0**	**5.0**

Table 2 – Surface Water Discharge Rates Summary.

Interception Storage

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

4.17 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% have been taken into account.

4.18 **Based on the size of the whole area of the site, the UCF and the Runoff Percentage, the Interception Storage is 3.26 m^3.**

Additional Volumes for Storage

4.19 Due to the increase of hard surfaces, the amount of storm water that could go to the ground would be restricted. Hence, this potential increase of runoff volume needs to be controlled to avoid an increase of flood risk for downstream properties of the site.

4.20 As it is required on The London Borough of Camden's '*Surface Water Drainage Pro-forma for new developments*', these additional volumes for storage have been calculated for a range of several return periods that includes 1:1; 1:30; 1:100, 6 hours & 1:100, 6 hours plus climate change for the greenfield, existing and proposed site states.

4.21 The greenfield runoff volumes of the site have been obtained using the industry standard software, Microdrainage v2016.1. The results for a variety of rainfall events are shown on the Appendix 3 – Calculations and a summary of them on the Table 3 – Surface Water Discharge Rates Summary below.

4.22 See values for each variable in the Table 3 below:

Greenfield Runoff Volumes	
AREA (ha)	0.11
SOIL TYPE	4
SPR	0.47
Return Period	**Greenfield Volume (m^3)**
1	8.96 m^3
30	20.78 m^3
100	28.30 m^3
100 + CC (40%)	**39.62 m^3**

Table 3 - Values for Long-Term Storage Volume Equation

4.23 As recommended in the *CIRIA 753 'The SUDS Manual'*, the Discharge Volumes for the existing and the proposed development has been calculated according to the following formula:

$$Vol_{XS} = 10 \cdot RD \cdot A \left[\frac{PIMP}{100} (0.8) \right]$$

Where,

Vol_{xs}: Extra runoff volume (m^3) of development runoff over Greenfield runoff.

RD: Rainfall Depth for the 100 year, 6 hour event (mm).

PIMP: Impermeable Area as a percentage of the Total Area.

A: Area of the site (ha).

SPR: "SPR" Index for the FSR SOIL type.

Equation 2 - Long-Term Volume Storage Equation.

4.24 See values for each variable of the Existing Discharge Volumes and Proposed Discharge Volumes in the Table 4 & 5 respectively:

EXISTING RUNOFF RATES CALCULATION SUMMARY		
PARAMETERS		
Area	1080.00 m^2	0.11 ha
Runoff Rate	80%	
PIMP	81.5%	
Return Period	**Rainfall Depth (mm)**	
1	13.91	
30	56.87	
100	80.58	
100 + CC	112.81	
Return Period	**Existing Runoff Volume (m^3)**	
1	9.79 m^3	
30	40.04 m^3	
100	56.73 m^3	
100 + CC	**79.42 m^3**	

Table 4 – Existing Discharge Volumes

PROPOSED RUNOFF RATES CALCULATION SUMMARY		
PARAMETERS		
Area	1080.00 m^2	0.11 ha
Runoff Rate	80%	
PIMP	68.5%	
Return Period	**Rainfall Depth (mm)**	
1	13.91	
30	56.87	
100	80.58	
100 + CC	112.81	
Return Period	**Proposed Runoff Volume (m^3)**	
1	8.23	
30	33.67	
100	47.70	
100 + CC	**66.78**	

Table 5 – Proposed Discharge Volumes

4.25 While the Table 6 summarizes the difference between the Proposed and the Existing Discharge Volumes:

DIFFERENCE BETWEEN THE EXISTING AND PROPOSED DISCHARGE VOLUMES				
Impermeable Area (m^2)	Discharge Volumes (m^3)			
	1 year	30 year	30 year	100 year
Existing Discharge Volume	9.79 m^3	40.04 m^3	56.73 m^3	79.42 m^3
Proposed Discharge Volume	8.23 m^3	33.67 m^3	47.70 m^3	66.78 m^3
DIFFERENCE	-1.56 m^3	-6.37 m^3	-9.02 m^3	-12.63 m^3

Table 6 – Difference between the Existing and Proposed Discharge Volumes

4.26 **Hence, it is considered that there is no an additional discharge volume to be taken into account as the difference of volumes between the proposed and the existing site states are negative due to the fact that the impervious surfaces will be decreased.**

Attenuation Storage

4.27 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.

4.28 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 the existing Q_{BAR} runoff rate, 5.0 l/s. In addition to this, the Urban Creep Factor, 10%, is applied for the impervious surface. See summary calculations in Appendix 3, Calculations.

4.29 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.

4.30 In terms of storage, for a 100 years storm event with an allowance for climate change, the **Critical Durations is 60 minutes**, being the largest volume per square metre of **0.0346 m^3/m^2**. Therefore, the **Attenuation Storage Volume required for the whole site is 28.2 m^3**. See Appendix 3, Calculations.

4.31 As required by the London Borough of Camden's '*Surface Water Drainage Pro-forma for new developments*', other attenuation volumes depending on the flow rate control has been calculated. See Appendix 3, Calculations and a summary of them on the Table 7.

Attenuation Storage Calculation		
Criteria	Flow Rate Control (l/s)	Attenuation Volume (m^3)
Storage Attenuation volume required **to meet greenfield run off rates** (m^3)	0.48 l/s	52.9 m^3
Storage Attenuation volume required to **reduce rates by 50%** (m^3)	16.8 l/s	21.0 m^3
Storage Attenuation volume required **to meet OTHER RUN OFF RATE** (as close to greenfield rate as possible (m^3)	5.0 l/s	28.2 m^3
Storage Attenuation volume required **to retain rates as existing** (m^3)	32.6 l/s	14.6 m^3

Table 7 – Summary of Attenuation Storage Volumes.

On Site Drainage and Storage Systems

4.32 **Preliminary calculations indicate that approximately 28.2 m^3 of storage will be to attenuate runoff from the 1:100 year +40% climate change events and with a 10% or Urban Creep Factor. 3.26 m^3 of storage are required for the day-to-day rainfall as Interception Volume.**

4.33 **Thus a Total Storage of approximately 31.5 m^3 is required to be managed through SuDS techniques.**

SuDS Assessment

4.34 SuDS components have been designed to accommodate and dispose of runoff from storms up to and including the 1:100 year + 40% climate change event without flooding.

4.35 In accordance with the 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 following the hierarchy line according to *The London Plan 2011, Policy 5.13, Sustainable Drainage*:

> *"Development should utilise sustainable urban drainage systems (SUDS) 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".*

4.36 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.

4.37 <u>Infiltrating SuDS</u>

Infiltration components of SuDS, such as soakaways, are deemed **unsuitable** due to the poor rate of permeability of the underlying soils of the site.

4.38 <u>Source Control Components</u>

- *Permeable Pavement*
  Given the expected low permeability of the subsoils and the proposed layout of the site, the use of permeable paving is deemed **inappropriate**.

- *Green Roofs*
  Options to attenuate at roof level have been considered and are useful to attenuate runoff due to storms up to a two-year return period event, also they are able to contribute to attenuation of flows from larger storms. However, options for this choice are **discounted** based on their limited ability to be applied on residential roofs.

- *Rainwater Harvesting*
  Rainwater from roofs can be stored and used in and around properties. The collected water can be used potentially for a range of non-potable purposes. Given the nature of the proposed development, this option it is deemed appropriate for the proposed development. Moreover, this SuDS device is awarded with extra 0.5 points to achieve the Sustainability Rating given by the Code for Sustainable Homes using the Building Research Establishment's (BRE) EcoHomes Systems.

4.39 <u>Swales</u>

This type of SuDS technique is well considered to convey and treat water runoff. Nevertheless, there is insufficient space within the proposed layout to practically offer these features as viable SuDS option, and as such they are deemed **unsuitable**.

4.40 <u>Rills and channels</u>

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. Therefore this options is considered **suitable**.

4.41 <u>Bioretention Systems</u>

Runoff water from hardstanding surfaces and roofs can be intercepted or attenuated through this SuDS technique whereby the water is infiltrated or taken up the plants. Besides this, other amenity benefits are included as space to relax and play and provide ecology benefits such as reduction in water, air and noise pollution. Given the proposed developed layout, this SuDS component is deemed to be **suitable** as long as the construction constraints (The Building Regulations 2000, Section 3.25) are taken into account and they are lined. See Appendix 4, Plan 1 – Preliminary Surface Water Drainage Strategy Layout.

4.42 Retention and Detention Components

- *Geocellular Systems*
  This SuDS option can be tailored to most places owing to its modular nature to store and it is able to attenuate the water runoff, being used either as a soakaway or as a storage tank. This could be considered **suitable** to be used as storage tank.

- *Retention Ponds* and *Detention Basins*
  They cannot be considered as a SuDS option for this site owing to the fact that they are appropriate to manage high volumes of surface water from bigger sites, such as a neighbourhood. As such they are deemed **unsuitable** for this development.

4.43 Consequently, several SuDS components are deemed appropriate to be used in the following SuDS management train. It is suggested the use of ***Rainwater Harvesting System (RWH*** from now on) using a **Geocellular System** as deposit, **lined Bioretention Systems** and **Rills/Channels** following the drainage hierarchy of the London Plan 2011. See Appendix 4, Plan 1 – Preliminary Surface Water Drainage Strategy Layout.

4.44 It is proposed to set up *Pumped RWH System* which is the most common type. In general terms, the runoff management layout of this type of *RWH* is to store water underground or at ground level and then pump it out for supply purposes.

- Runoff from the roofs is collected and conveyed to an underground 'Storage Tank'.
- From there the water is pumped to a 'Header Tank' at the top of the building to feed by gravity the domestic applications.
- If no rainwater is left in the tank, the mains water back up will supply mains water into the tank.
- If the tank is full, the exceeding volume of water is released to the existing sewer network. See *Appendix 4, Figure 1 – Preliminary Surface Water Drainage Strategy Layout*.
- *Sediment Traps* must be set up to remove any debris/silt in the pipes that collect the runoff to avoid any blockage or distribution to the proper functioning on the system. See Appendix 4, Figure 1 – Preliminary Surface Water Drainage Strategy Layout.

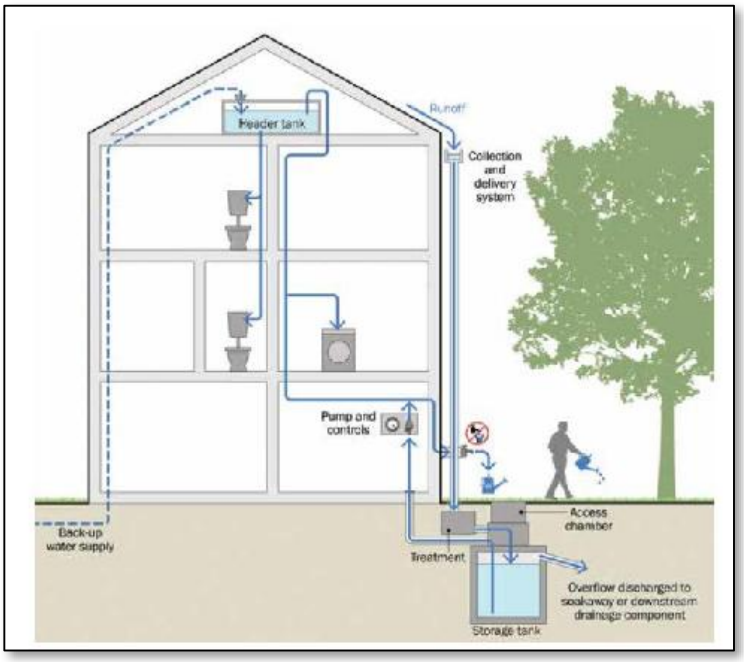

Figure 6 – A conceptual pumped Rainwater Harvesting System.

4.45 There are a number of options when it comes to the details of the RWH scheme, and these should be reviewed and analysed in greater detail to determine the most suitable option for the site.

4.46 Proper maintenance includes inspection and cleaning of collection systems, filters, throttles, vales and pumps. The supplier of the RWH system should provide guidance on maintenance.

4.47 It is suggested to install Bioretention Systems at the front of the site to collect and convey water runoff due to the day-to-day storms (Interception Volume) from these hardstanding surfaces. See conceptual design of this SuDS technique on Figure 7.

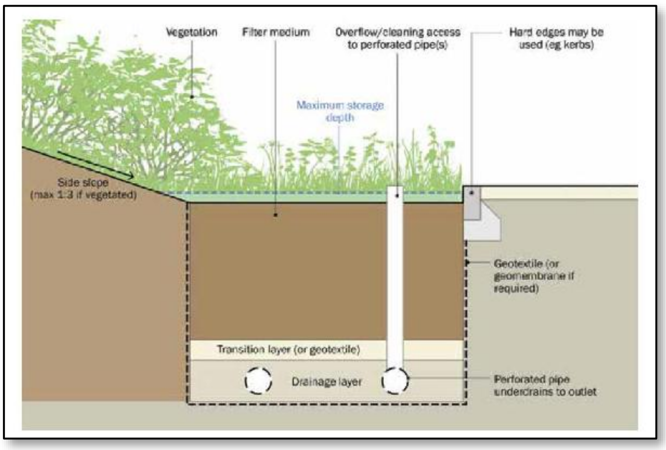

Figure 7 – Conceptual Design of the Components of a Bioretention System.

4.48 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.

4.49 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.

4.50 Throttle devices such as a Hydrobrakes must be set up to control the flow rates up to a maximum rate of 5 l/s before being discharged to the sewer network. See Appendix 4, Plan 1 – Preliminary Surface Water Drainage Strategy Layout.

Drainage Strategy

4.51 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 provided by the specialized literature CIRIA 753 'The SUDS Manual', Section 3.2.3:

"The destination for surface water runoff that is not collected to be used must be prioritised in the following order:

1. *Infiltration.*
2. *Discharge to surface waters.*
3. *Discharge to a surface water sewer, highway drain or another drainage system.*
4. *Discharge to a combined sewer.*

Discharge to a foul sewer should not be considered as a possible option. (…)".

4.52 As it was stated in the sections 3.9 and 4.3, infiltration techniques are not feasible owing to the poor infiltration coefficient of the soils underlying the site.

4.53 Discharge to a surface water is also dismissed owing to the long distance to the nearest watercourse as it was stated in the sections 3.13 & 3.14.

4.54 Hence, it is proposed to discharge to the public sewer network owing to the fact that there is an existing drainage infrastructure within the site connected to the public sewer network as it was suggested in the section 3.6.

4.55 Permission to discharge to the local off site sewers maintained by Thames Water should be sought. In order to adequately manage the arising runoff, the site is divided in two zones: Front and Rear. See Appendix 4, Plan 1 – Preliminary Surface Water Drainage Strategy Layout.

4.56 External hard landscaping should be laid at the front of the site such that the arising runoff from these can be collected and managed by the proposed SuDS train. Besides this, Rills/Channels are suggested as an option to convey this runoff.

4.57 Water runoff from the front of the site will be conveyed by either appropriate landscaping or Rills/Channels to the Bioretention System. The excess of volume from this SuDS device is to be piped through orifices to a Geocellular System where it will be stored before being discharged to the sewer network. Debris/sediment traps must be installed in the outfalls of the Bioretention Systems and the Geocellular System to avoid any blockage. See Appendix 4, Plan 1 – Preliminary Surface Water Drainage Strategy Layout.

4.58 It is proposed to collect the water runoff from the roofs through down pipes to the buried Geocellular Systems located to the front and the rear of the development to be stored and conveniently used by the RWH. Debris traps must be installed in the down pipes to avoid any blockage. See Appendix 4, Plan 1 – Preliminary Surface Water Drainage Strategy Layout.

4.59 It is worth to point out that the Geocellular System to the front of the site must be split into two chambers in order to avoid mixing the water from the roofs and the Bioretention Systems.

4.60 The proposed surface water strategy will be able to manage the Interception and the Attenuation Volumes before discharging to the existing sewer network, therefore the capacity of the 'storage tanks' should be at least 31.5 m^3. The discharge will be limited by a throttle device such as Hydrobrakes up to 5l/s.

4.61 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.

4.62 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

4.63 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:

$$Total\ SuDS\ Mitigation\ Index\ \geq Pollution\ Hazard\ Index$$

4.64 The Pollution Hazard Indices are summarized in Table 8 – Summary of Pollution Hazard Indices for different Land Use below:

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, home zones 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 8 – Summary of Pollution Hazard Indices for different Land Use.

4.65 Runoff from roof areas is considered to be uncontaminated, being treated by *Sediments Traps* and through the proposed *Geocellular Systems*.

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4.66 The Mitigation Indices of the proposed SuDS techniques are summarized in the Table 9 - 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

Table 9 – Indicative SuDS Mitigation Indices

4.67 Table 10 – Pollution Treatment below, summarizes the water treatment:

POLLUTION HAZARD TREATMENT					
LAND USE	Treatment	Pollution Hazard Level	Total suspended Solids (TSS)	Metals	Hydrocarbons
Car Facilities / Pedestrian Accesses	Bioretention Systems	Low	0.8 > 0.5	0.8 > 0.4	0.8 > 0.4

Table 10 - Pollution Treatment

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

Design Exceedance

4.69 In the event of drainage system failure under extreme rainfall events or blockage, flooding may occur within the site. In the event of the extension's drainage system failure, the runoff flow will be dictated as per the existing situation. This will not impact on the site or nearby dwellings.

4.70 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. See plans on Appendix 4, Plan 1 - Preliminary Surface Water Drainage Strategy Layout.

Adoption and Maintenance

4.71 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

Table 11 – Proposed Schedule of Maintenance for Below Ground Drainage.

5. Conclusions

5.1 This study has been undertaken in accordance with the principles set out in NPPF. We can conclude that providing the development adheres to the conditions advised in the conclusions of this report, the said development proposals can be accommodated without increasing flood risk within the locality in accordance with objectives set by Central Government and the EA.

5.2 The strategy for drainage of this site is to discharge to the public sewer network utilising a Rainwater Harvesting System using Geocellular Systems as 'storage tanks', Bioretention Systems and Rills/Channels with managed offsite flows controlled by hydrobrake, or similar flow control, as necessary up to 5 l/s.

5.3 Initial calculations indicate a storage requirement of approximately 31.5 m^3, being properly managed by the proposed SuDS train.

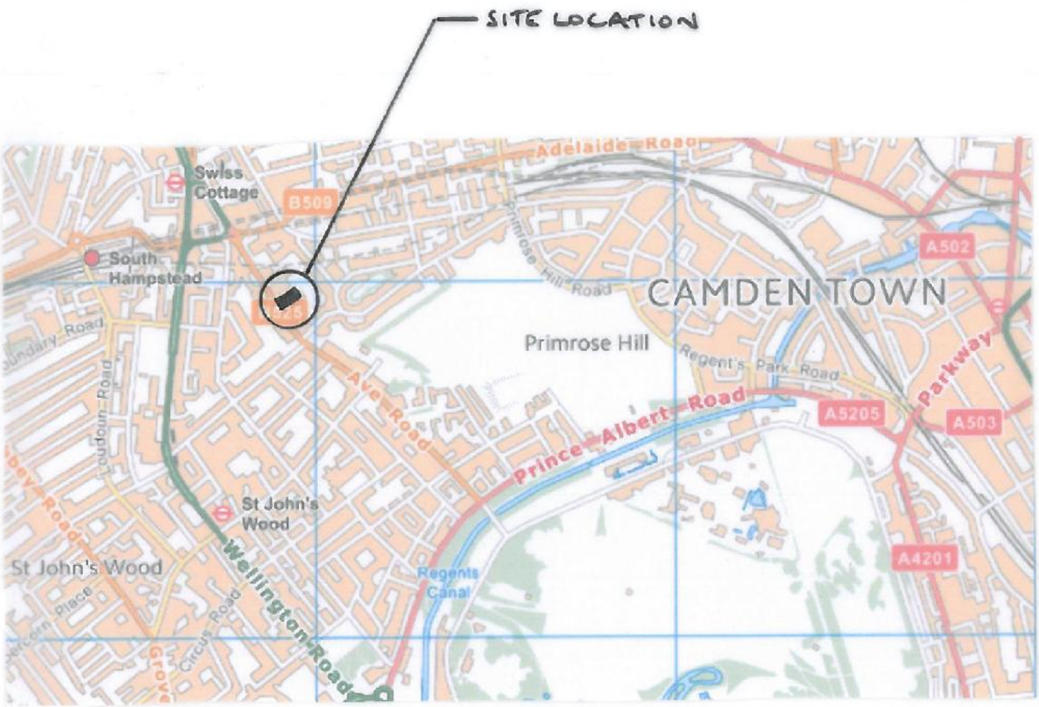
5.4 The Treatment train of RWH Systems + Geocellular System and Bioretention is suitable to offer acceptable contamination treatment to runoff prior to being discharged to the local public sewer network.

5.5 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. December 2016

Appendix 1 – Plans

- *Plan 1 – Site Location*
- *Plan 2 – Existing Site Plan and Topography*
- *Plan 3 – Summary of ABA understanding of Existing Statutory Services*
- *Plan 4 – Proposed Site Plan*
- *Plan 5 –Proposed Ground Floor Plan*
- *Plan 6 – Proposed Front Elevation*
- *Plan 7 – Proposed Rear Elevation*
- *Plan 8.1 – Proposed Side Elevation*
- *Plan 8.2 – Proposed Side Elevation*
- *Plan 9 – Proposed Section AA*
- *Plan 10 – Proposed Section BB*



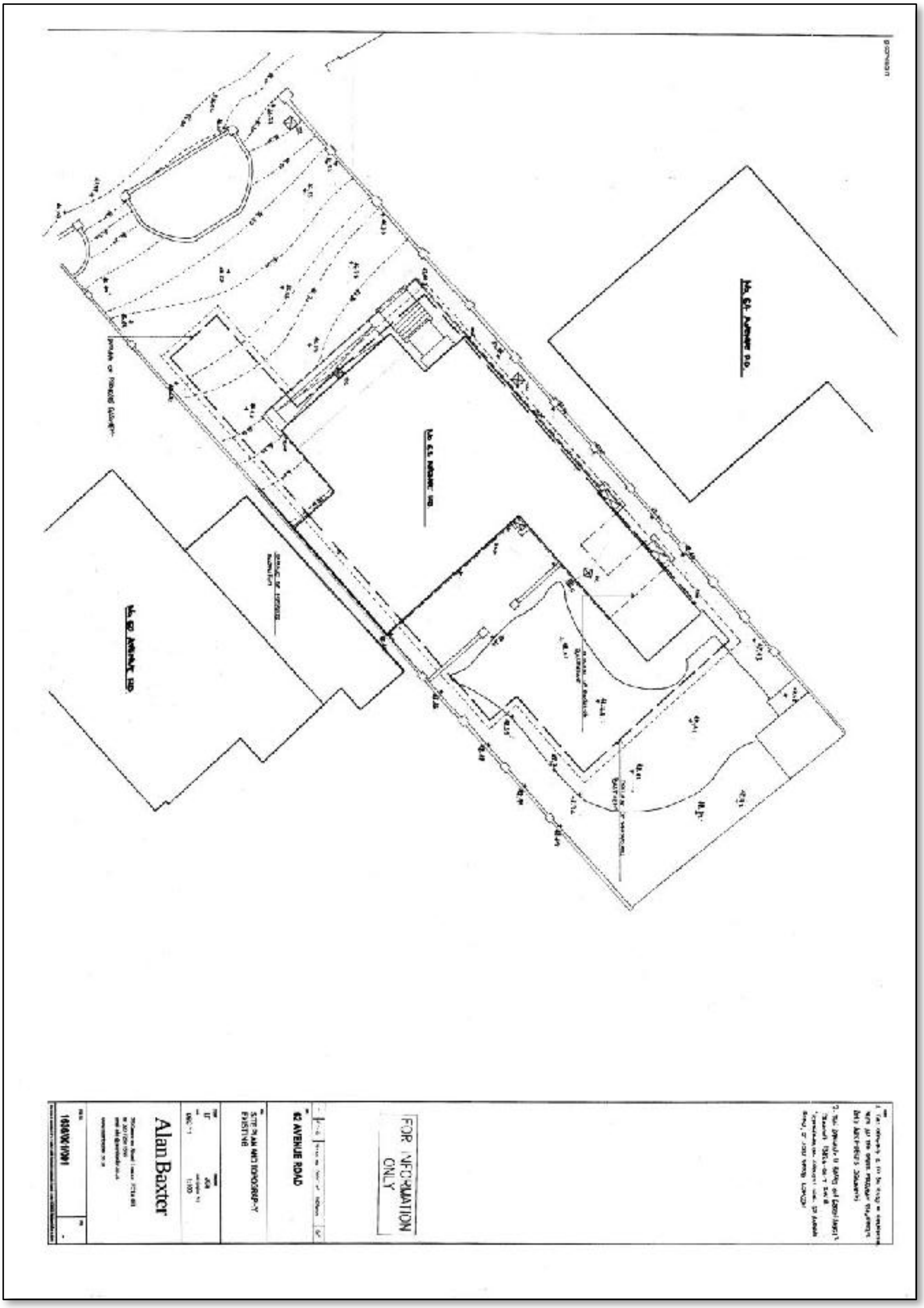
-	2.9.16	ISSUED AS PART OF REPORT	DP

date	drawn	checked	scale (original - A4)	
AUG '16	DP	LF	NTS	AlanBaxter

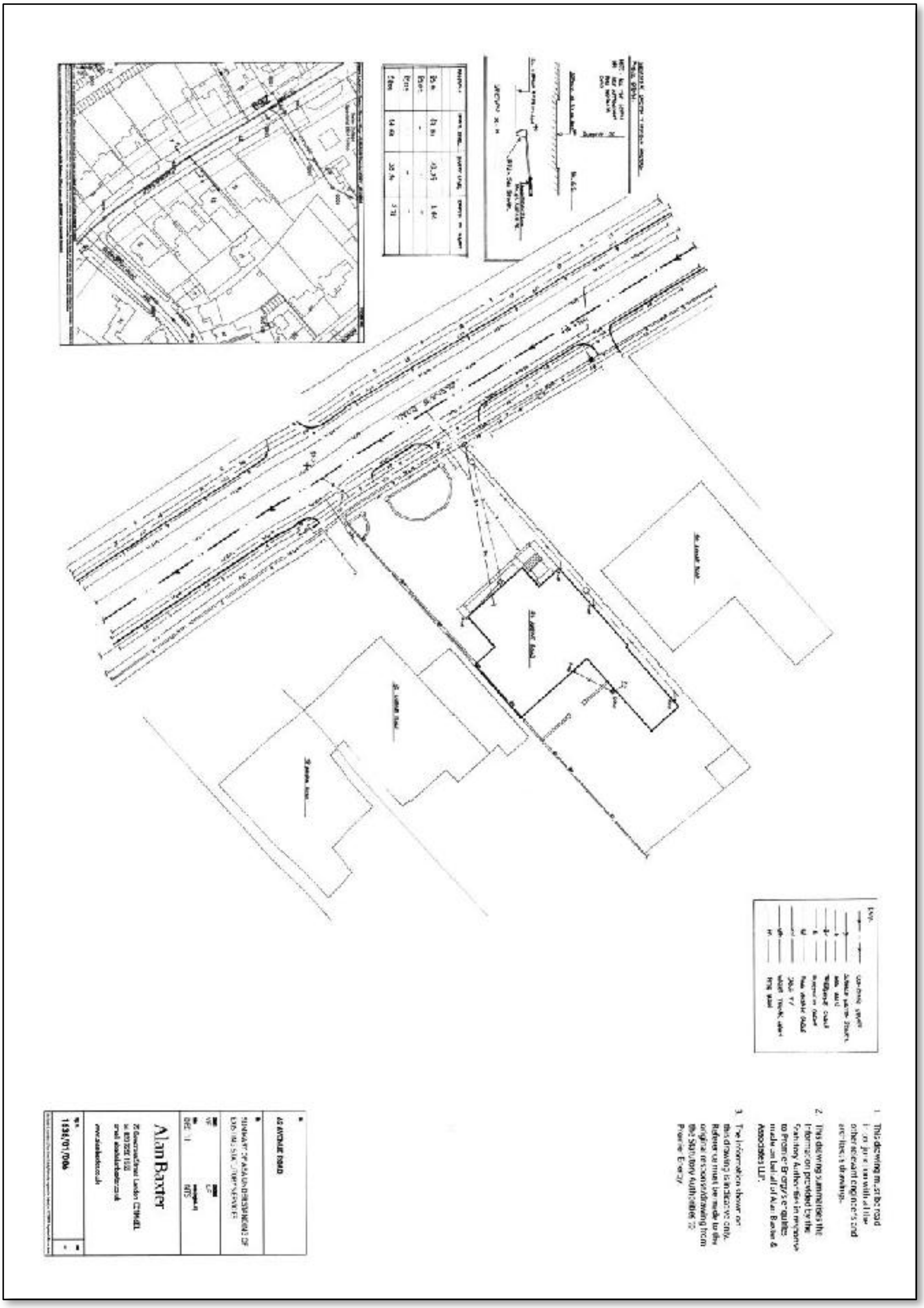
job	dwg.	drg. no.	rev.	
62 AVENUE ROAD, NW8	LOCATION PLAN	1636/01/00	-	75 Cowcross Street London EC1M 6EL tel 020 7250 1555 email aba@alanbaxter.co.uk www.alanbaxter.co.uk

Alan Baxter Ltd is a limited company registered in England and Wales, number 06600598. Registered office as above.

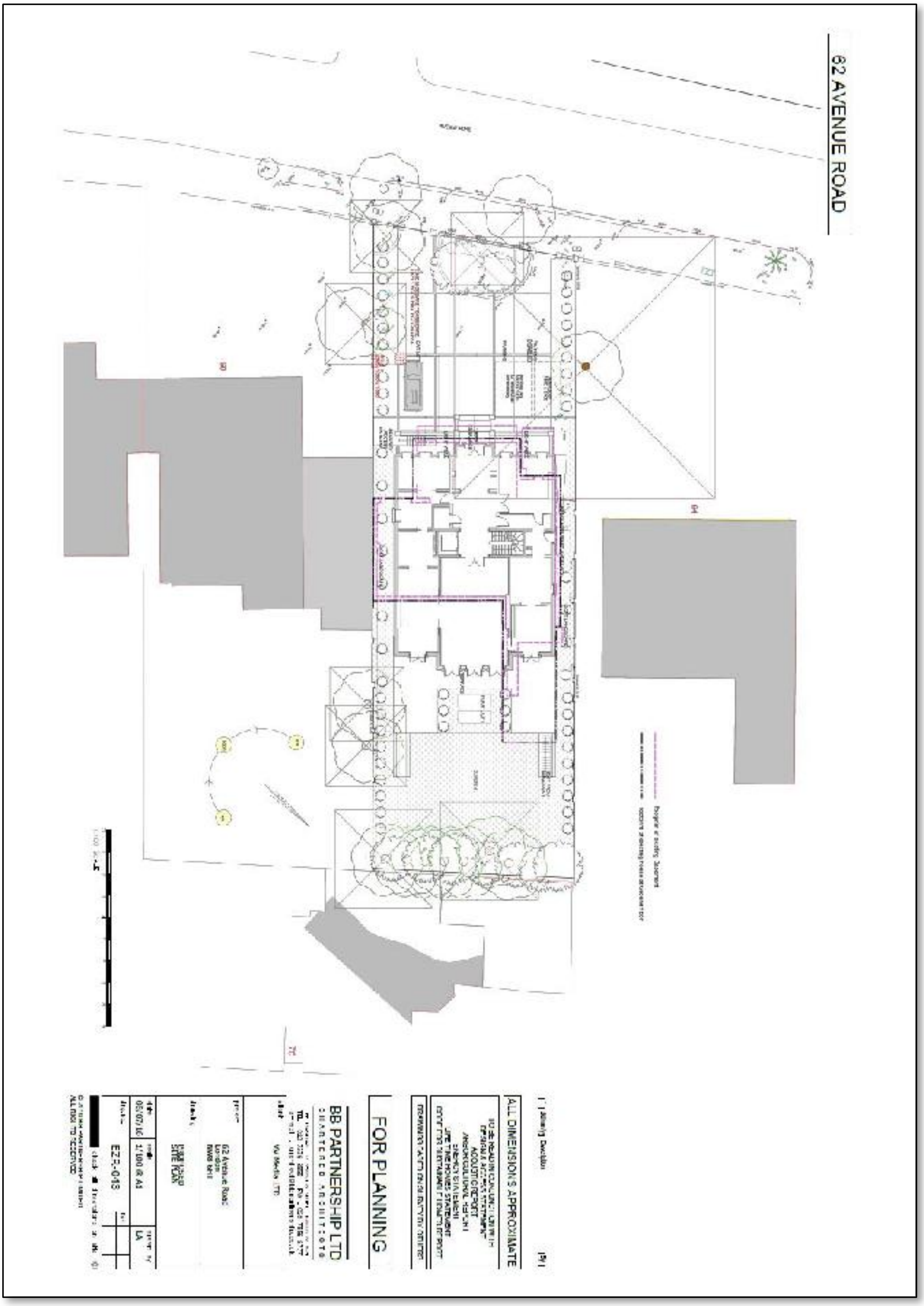
Appendix 1, Plan 1 – Site Location



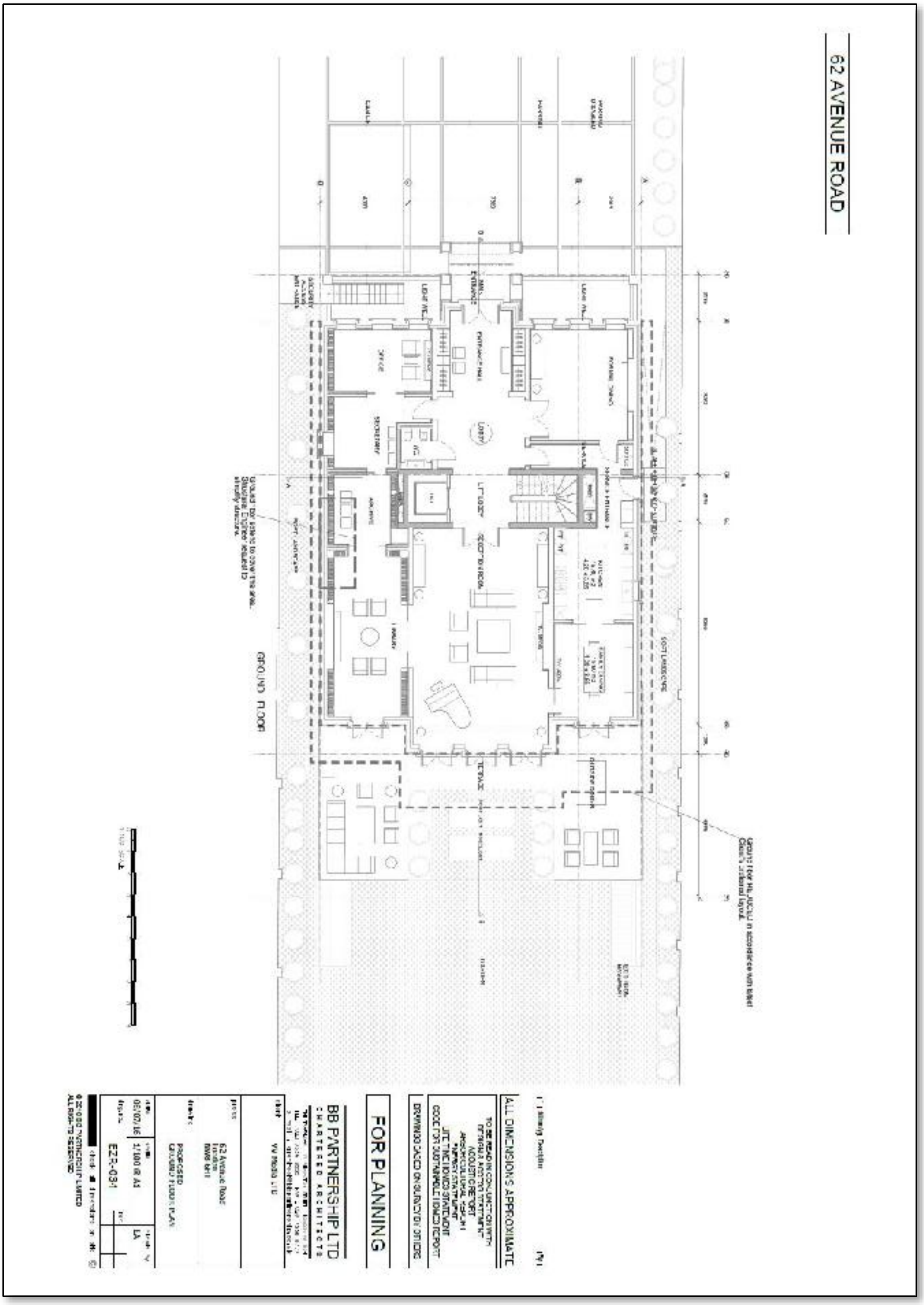
Appendix 1, Plan 2 – Existing Site Plan and Topography



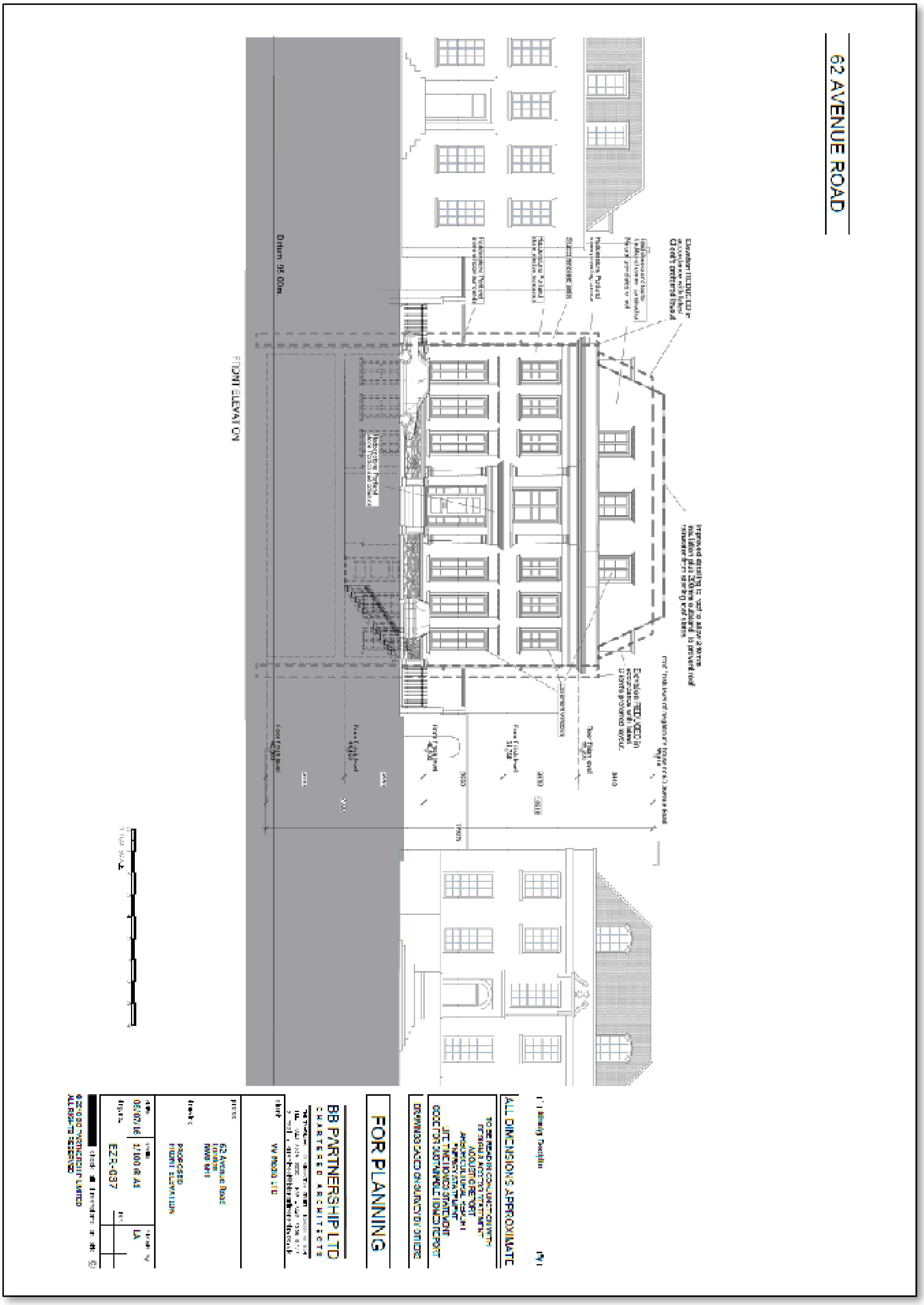
Appendix 1, Plan 3 – Summary of ABA understanding of Existing Statutory Services



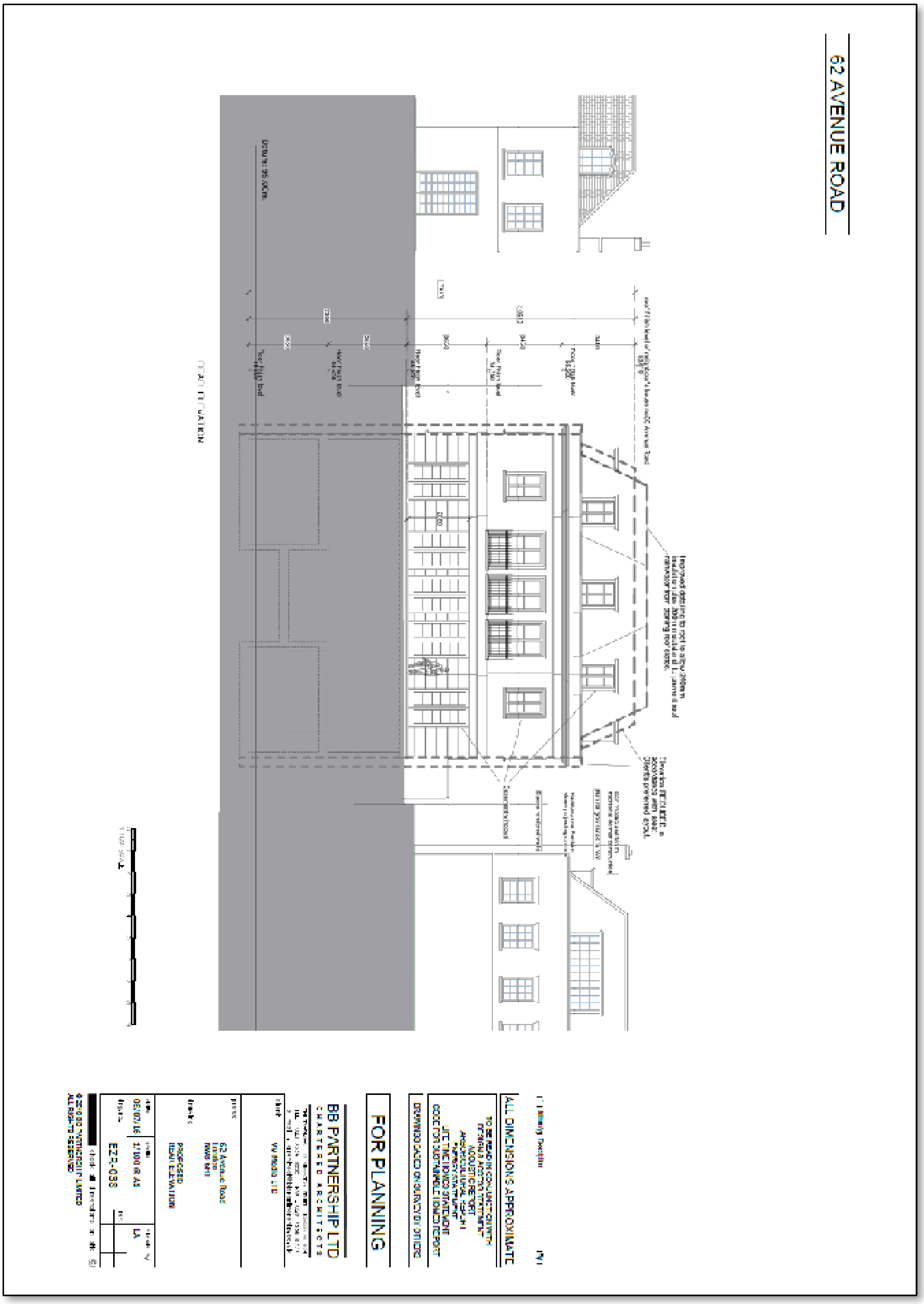
Appendix 1, Plan 4 – Proposed Site Plan



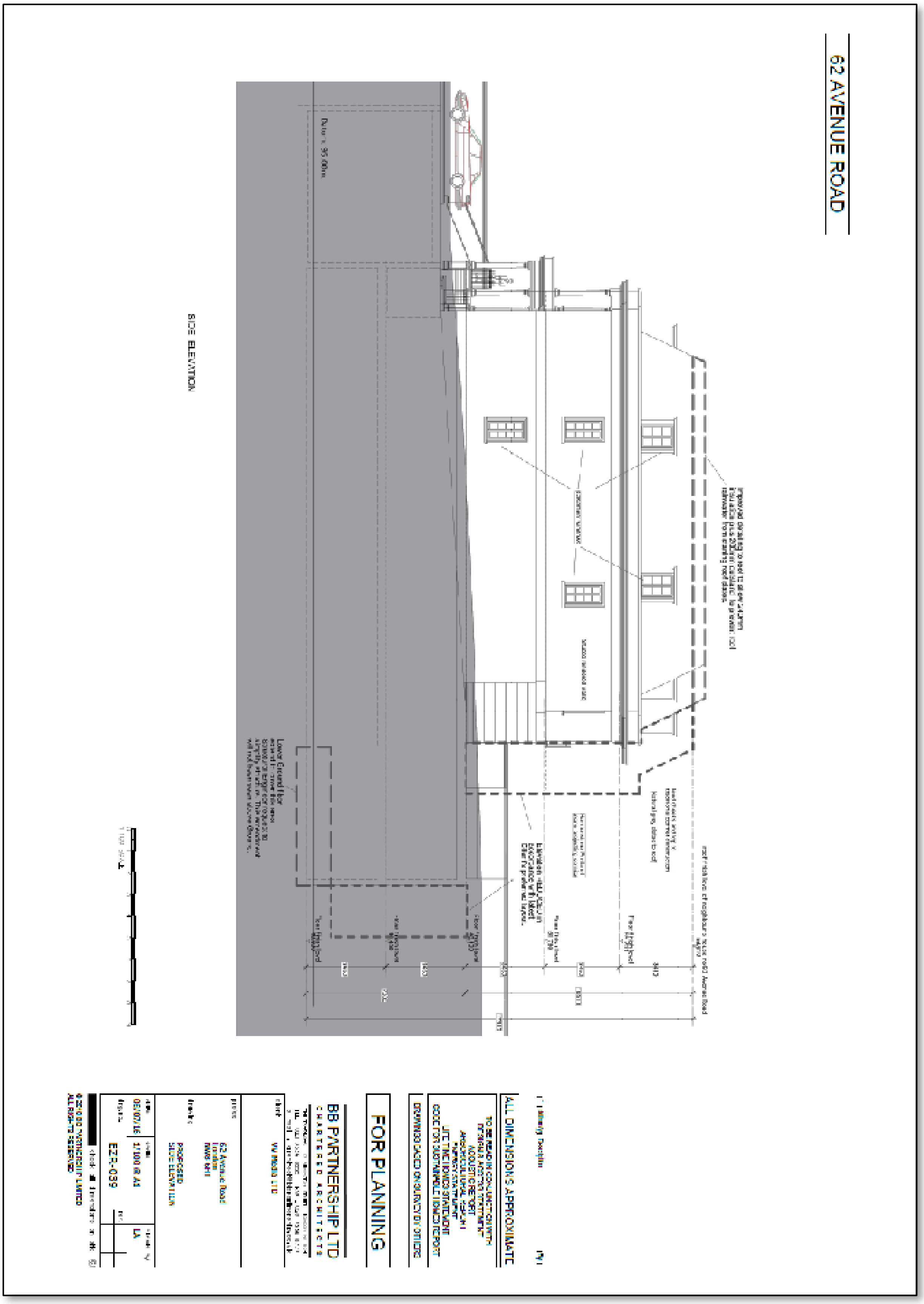
Appendix 1, Plan 5 – Proposed Ground Floor Plan



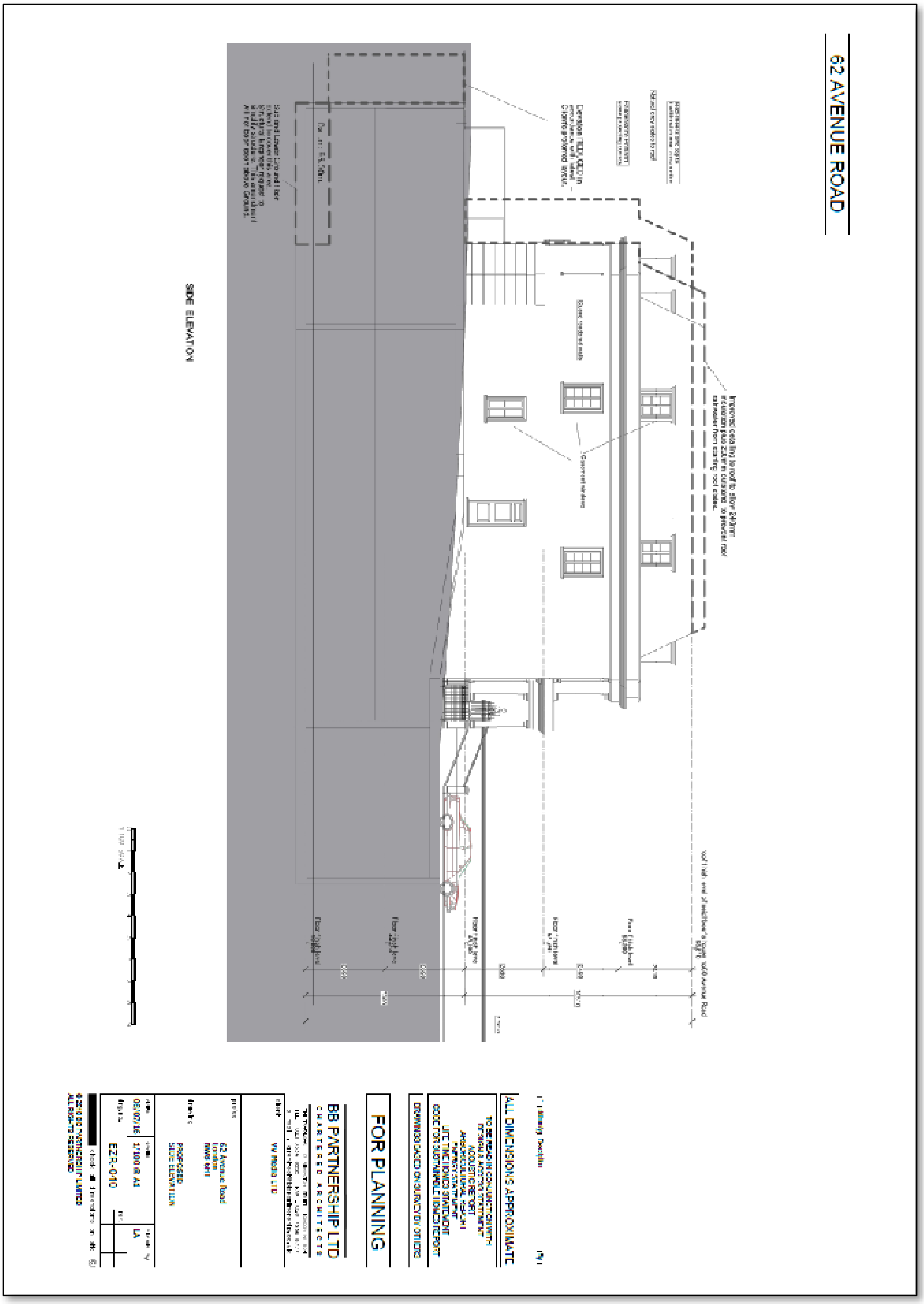
Appendix 1, Plan 6 – Proposed Front Elevation



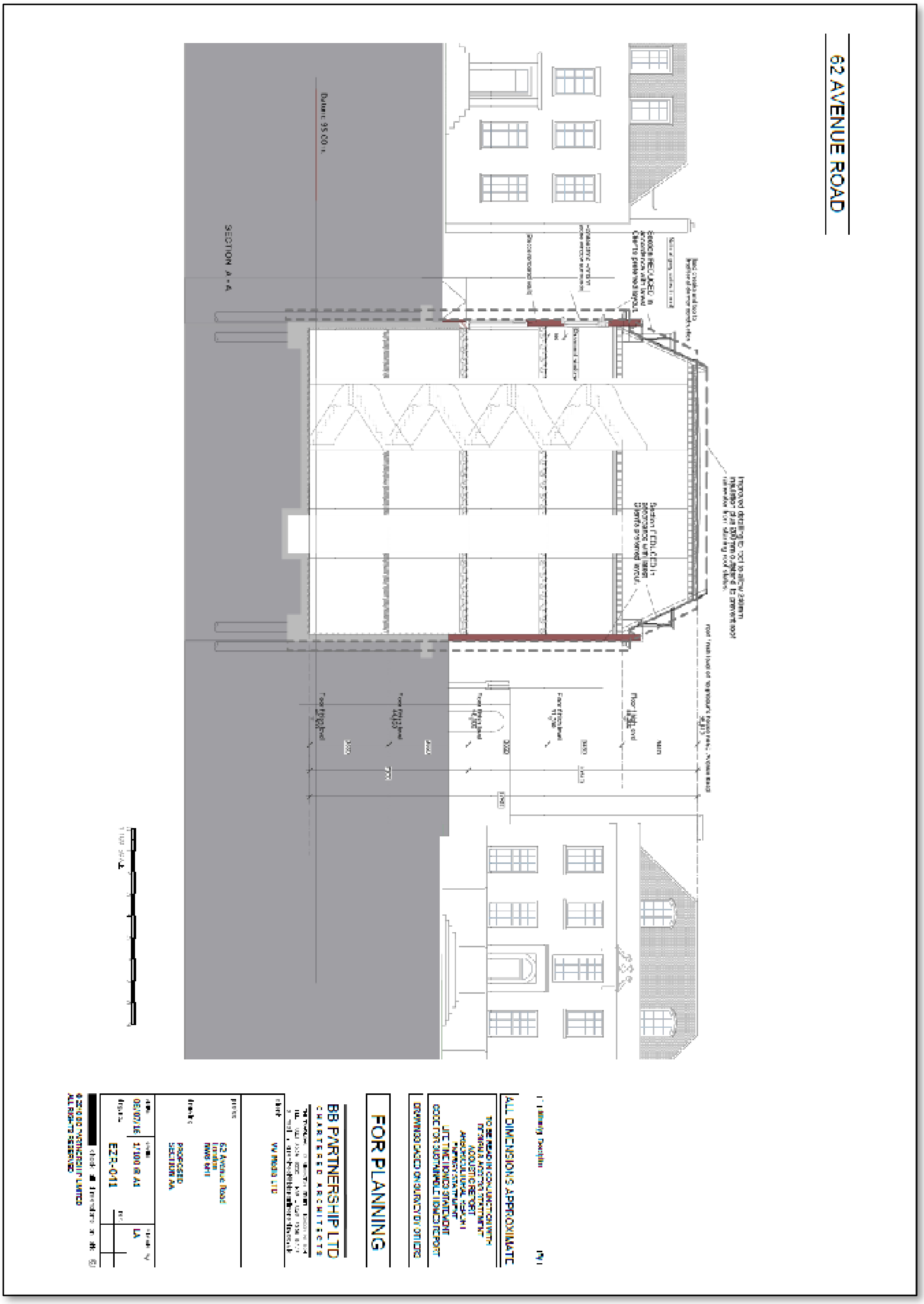
Appendix 1, Plan 7 – Proposed Rear Elevation



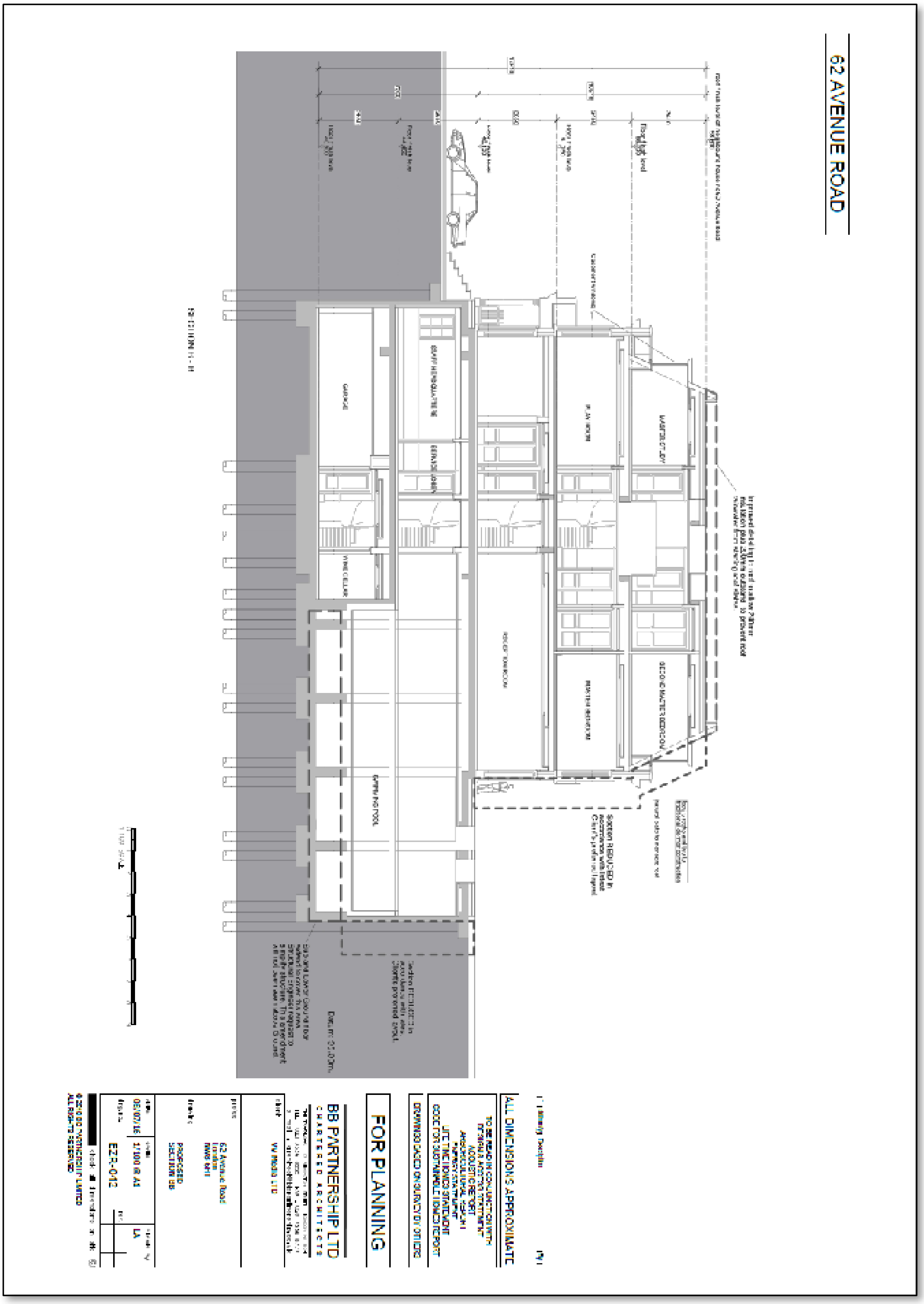
Appendix 1, Plan 8.1 – Proposed Side Elevation



Appendix 1, Plan 8.2 – Proposed Side Elevation



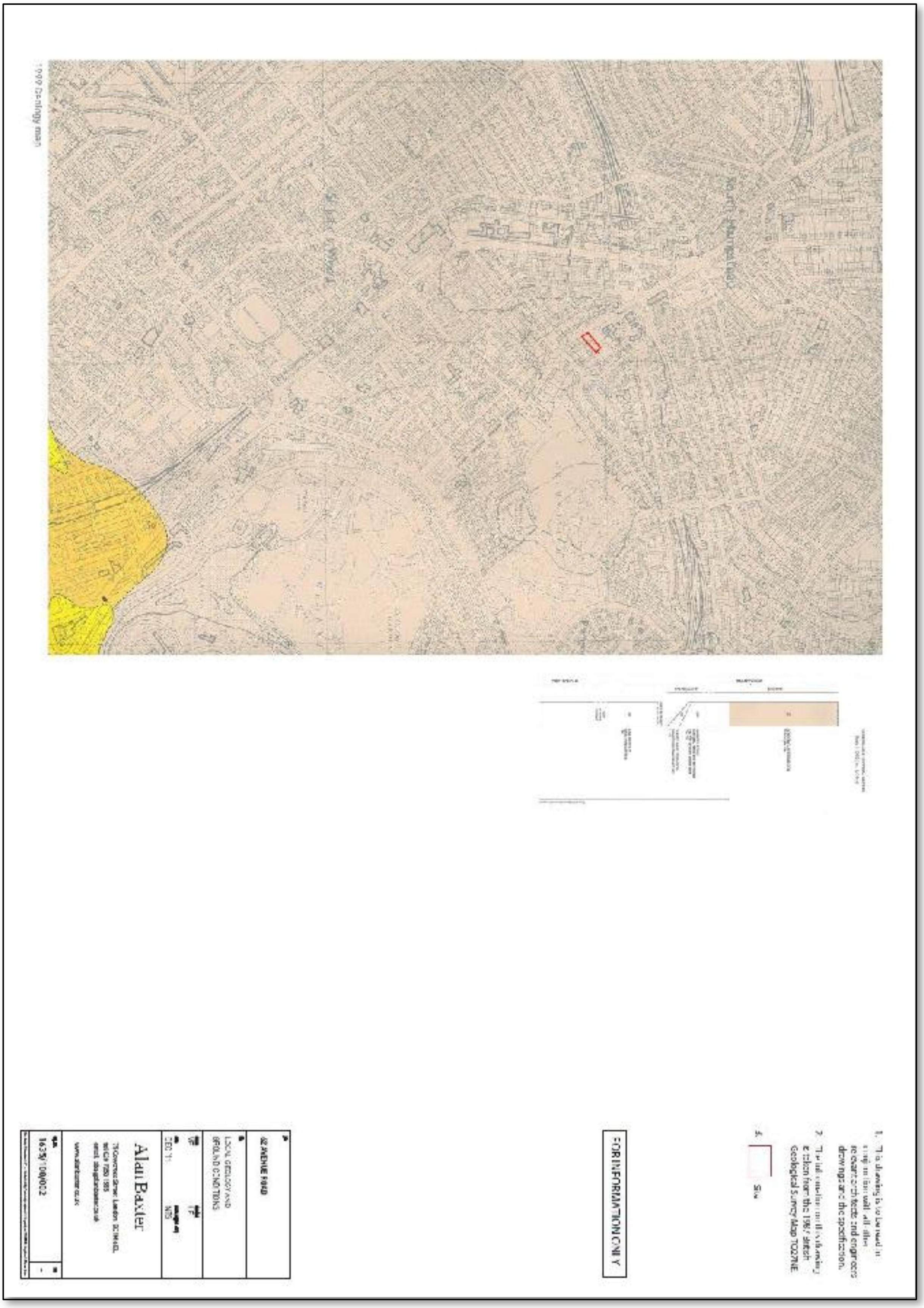
Appendix 1, Plan 9 – Proposed Section AA



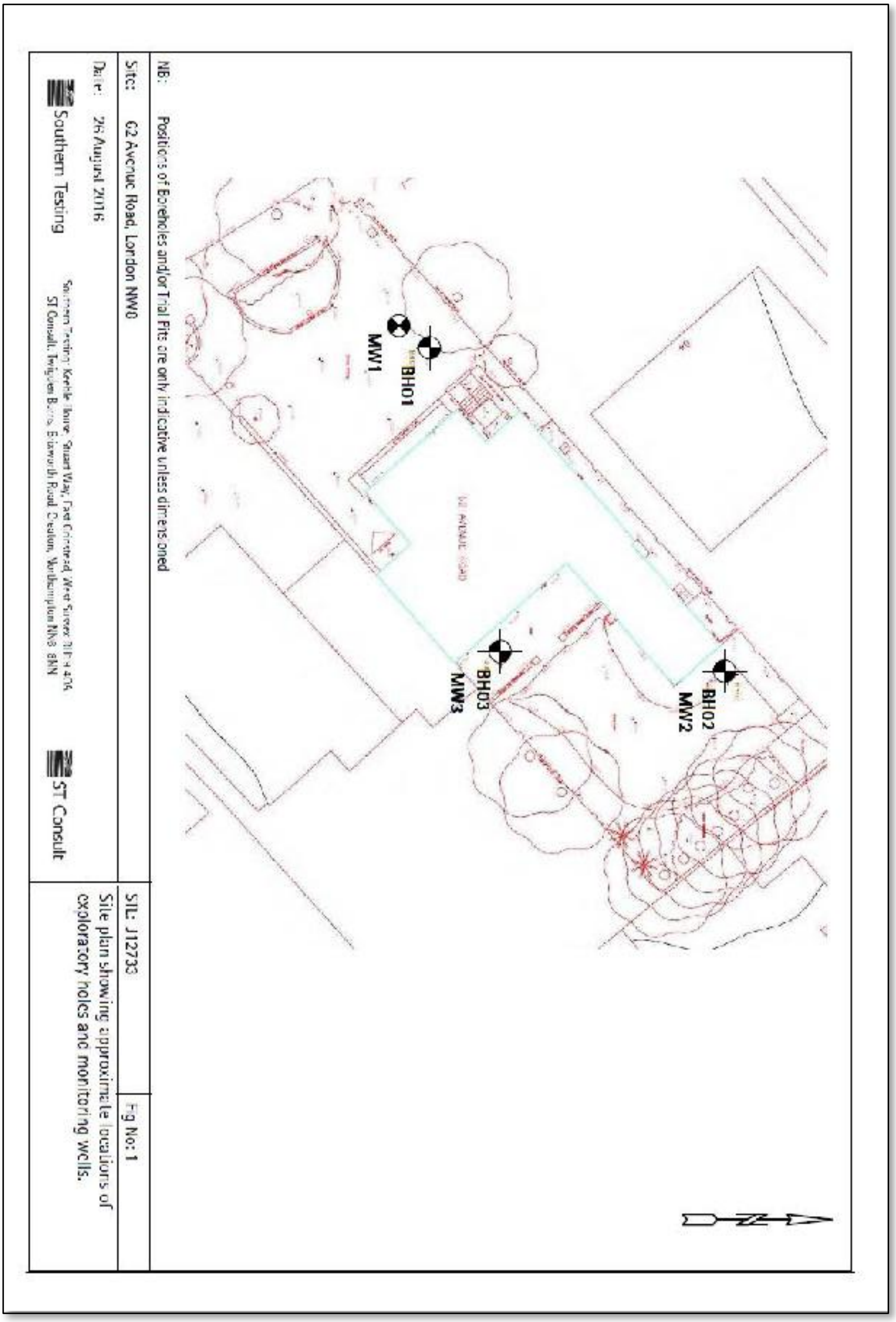
Appendix 1, Plan 10 – Proposed Section BB

Appendix 2 – Site Geology Investigations

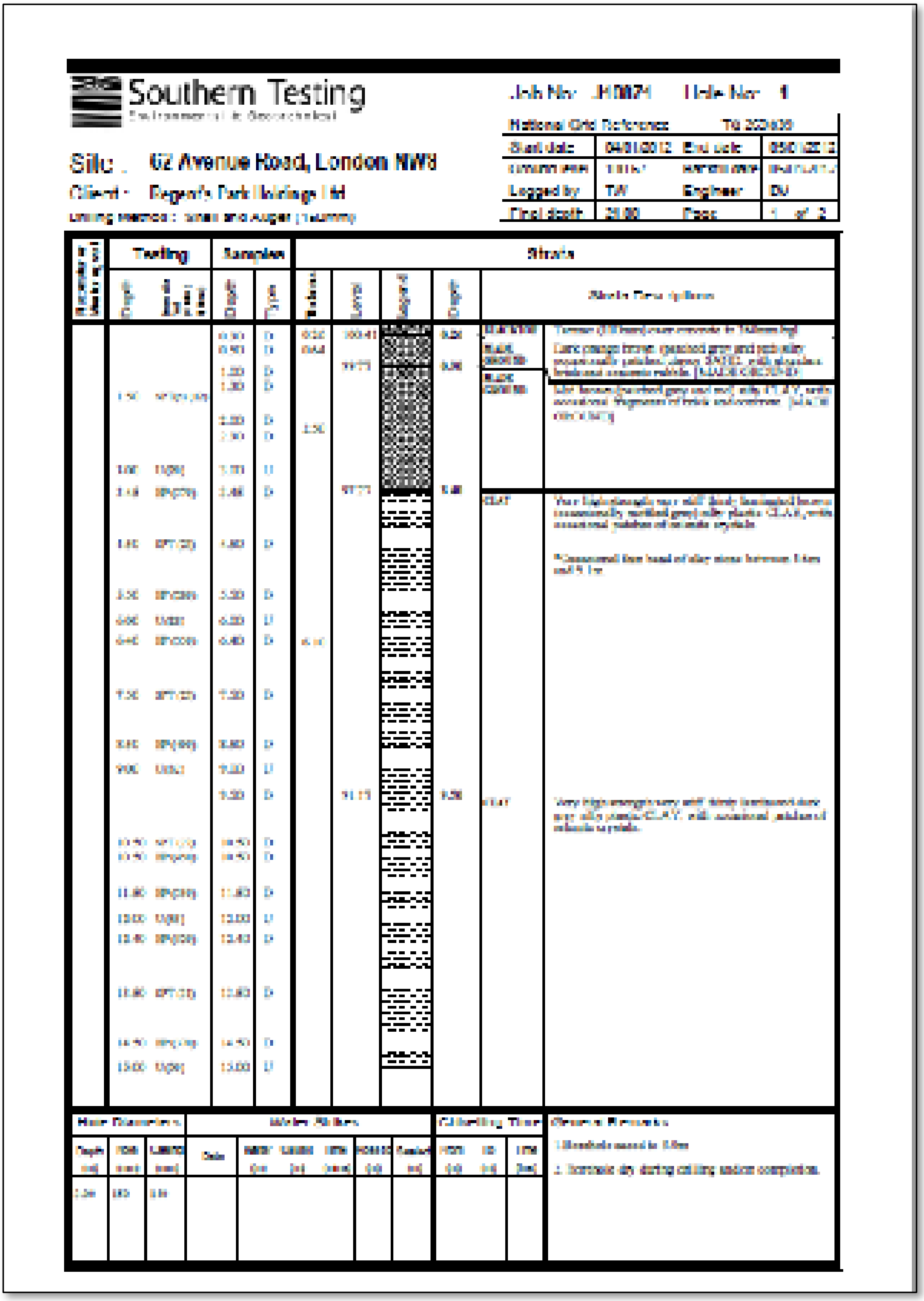
- *Plan 1 – Local Geology and Ground Conditions*
- *Plan 2 – Site Boreholes Study*
- *Figure 1 – Borehole No 1*
- *Figure 2 – Borehole No 2*
- *Figure 3 – Borehole No 3*
- *Figure 4 – MW1*
- *Figure 5 – MW2*
- *Figure 6 – MW3*
- *Plan 3 – Hydrogeology*
- *Plan 4 - Groundwater Source Protection Zones*
- *Plan 5 – Groundwater Vulnerability Zones*



Appendix 2, Plan 1 – Local Geology and Ground Conditions



Appendix 2, Plan 2 – Site Boreholes Location



Appendix 2, Figure 1 – Borehole No 1

Southern Testing Environmental & Geotechnical

Job No	J10071	Hole No	2
National Grid Reference	TQ [illegible]		
Start date	[illegible]	End date	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
Logged by	TW	Engineer	DV
Final depth	25.00	Page	1 of 2

Site : 62 Avenue Road, London NW8

Client Regent's Park Holdings Ltd

Drilling method : Shell and Auger (150mm)

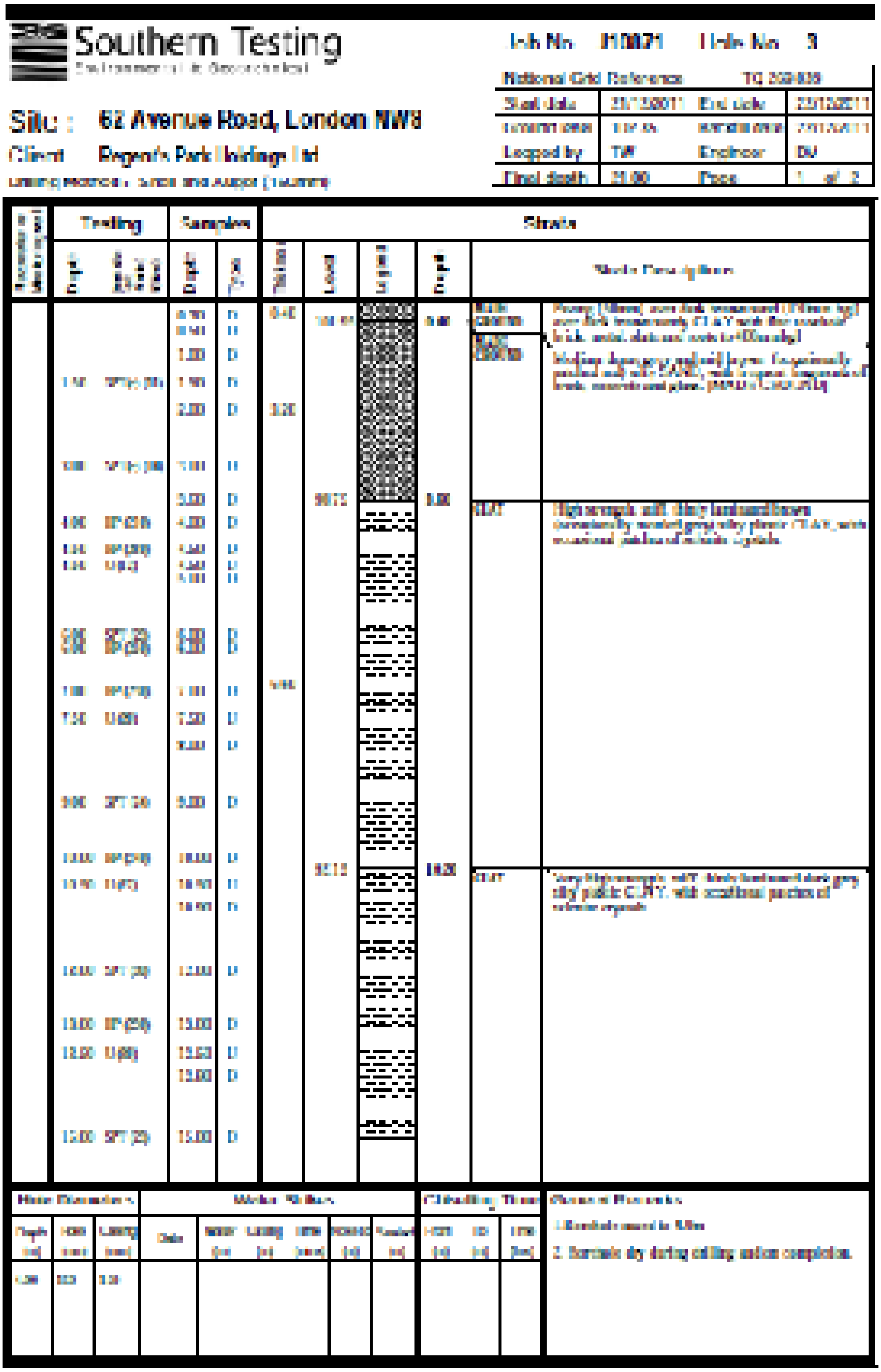
Testing Depth	Testing Type	Samples Depth	Samples Type	Strata Water	Strata Level	Strata Depth	Strata Description
		0.30	D	0.20	102.15	0.20	TOPSOIL: [illegible] dark brown sandy topsoil
		0.70	D	0.45	101.45	0.85	MADE GROUND: Dark brown sandy CLAY with fine to medium [illegible] fragments. (MADE GROUND)
1.00	SPT(s) [illegible]	1.00	D				CLAY: High strength stiff thinly laminated brown [illegible] mottled grey silty plastic CLAY with occasional patches of [illegible] crystals
1.00	HP [illegible]	1.45	D				
2.50	HP [illegible]	2.50	D				
2.50	U [illegible]	2.60	U				
2.85	HP [illegible]	2.85	D				
4.00	SPT [illegible]	4.00	D				
5.00	U [illegible]	5.00	U	8.15			
		5.45	U				
5.50	HP [illegible]	5.50	D				
		5.50	D				
7.00	SPT [illegible]	7.00	D				
8.00	HP [illegible]	8.00	D				
8.50	U [illegible]	8.50	U				
		8.95	U				
		9.00	U		93.53	9.00	CLAY: Very high strength very stiff thinly laminated dark grey silty plastic CLAY, with occasional patches of [illegible] crystals
10.00	SPT [illegible]	10.00	D				
11.00	HP [illegible]	11.00	D				
11.50	U [illegible]	11.50	U				
		11.00	D				
13.00	SPT [illegible]	13.00	D				
14.00	HP [illegible]	14.00	D				
14.50	U [illegible]	14.50	U				
		14.95	D				

Hole Diameters Depth (m)	Hole Diameters [illegible]	Hole Diameters Casing (mm)	Water Strikes Date	Water Strikes [illegible]	Water Strikes [illegible]	Water Strikes [illegible]	Water Strikes [illegible]	Water Strikes [illegible]	Chiselling Times [illegible]	Chiselling Times [illegible]	Chiselling Times [illegible]
1.50	150	150									

General Remarks

1. Borehole cased to [illegible]
2. Borehole dry during drilling and on completion.

Appendix 2, Figure 2 - Borehole No 2


Southern Testing

Site : 62 Avenue Road, London NW8

Client Regent's Park Holdings Ltd

National Grid Reference TQ

Logged by TW Engineer DV

Final depth 21.00

Testing

Samples

Strata

Strata Descriptions

General Remarks

2. Borehole dry during drilling and on completion.

Appendix 2, Figure 3 – Borehole No 3

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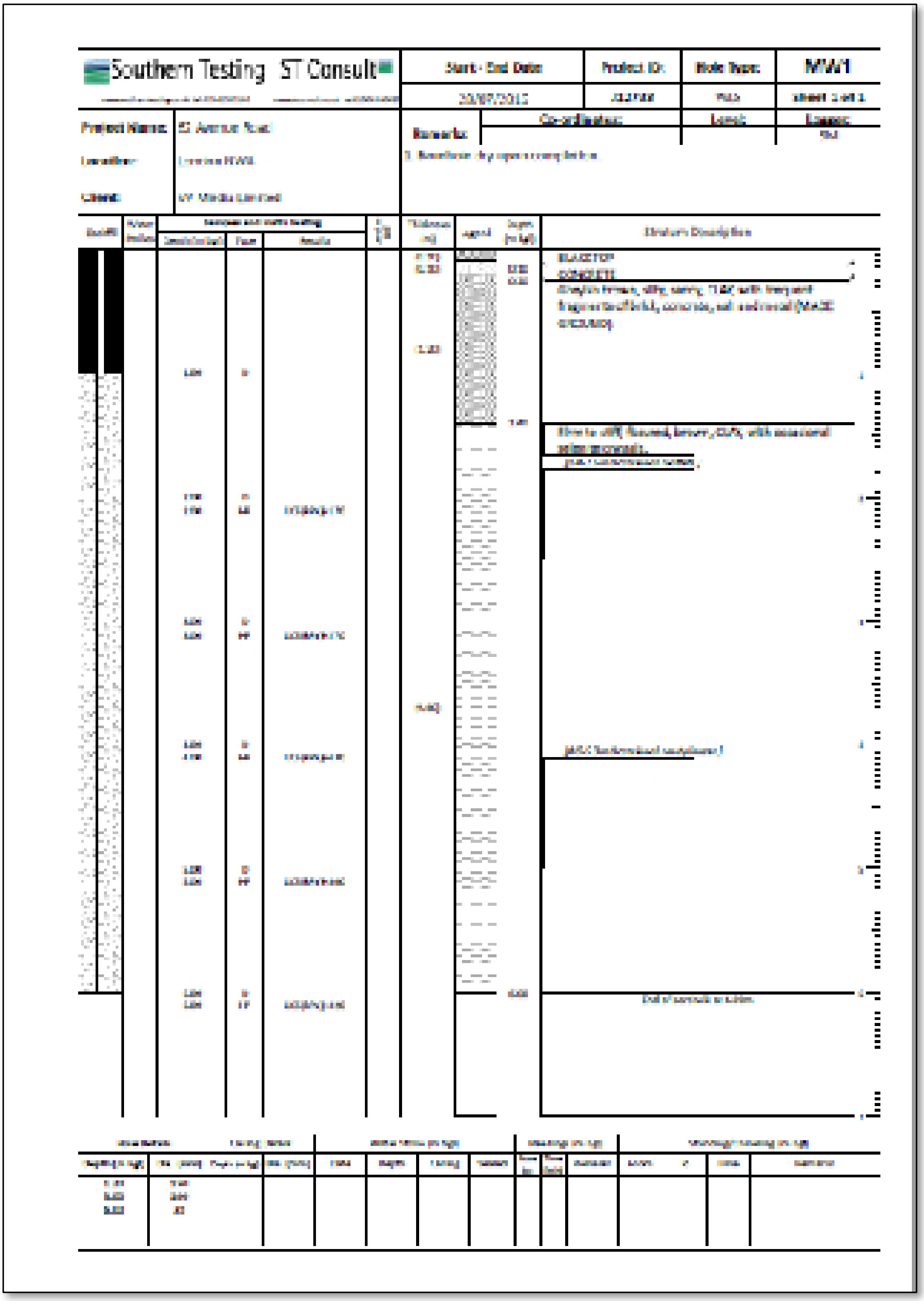
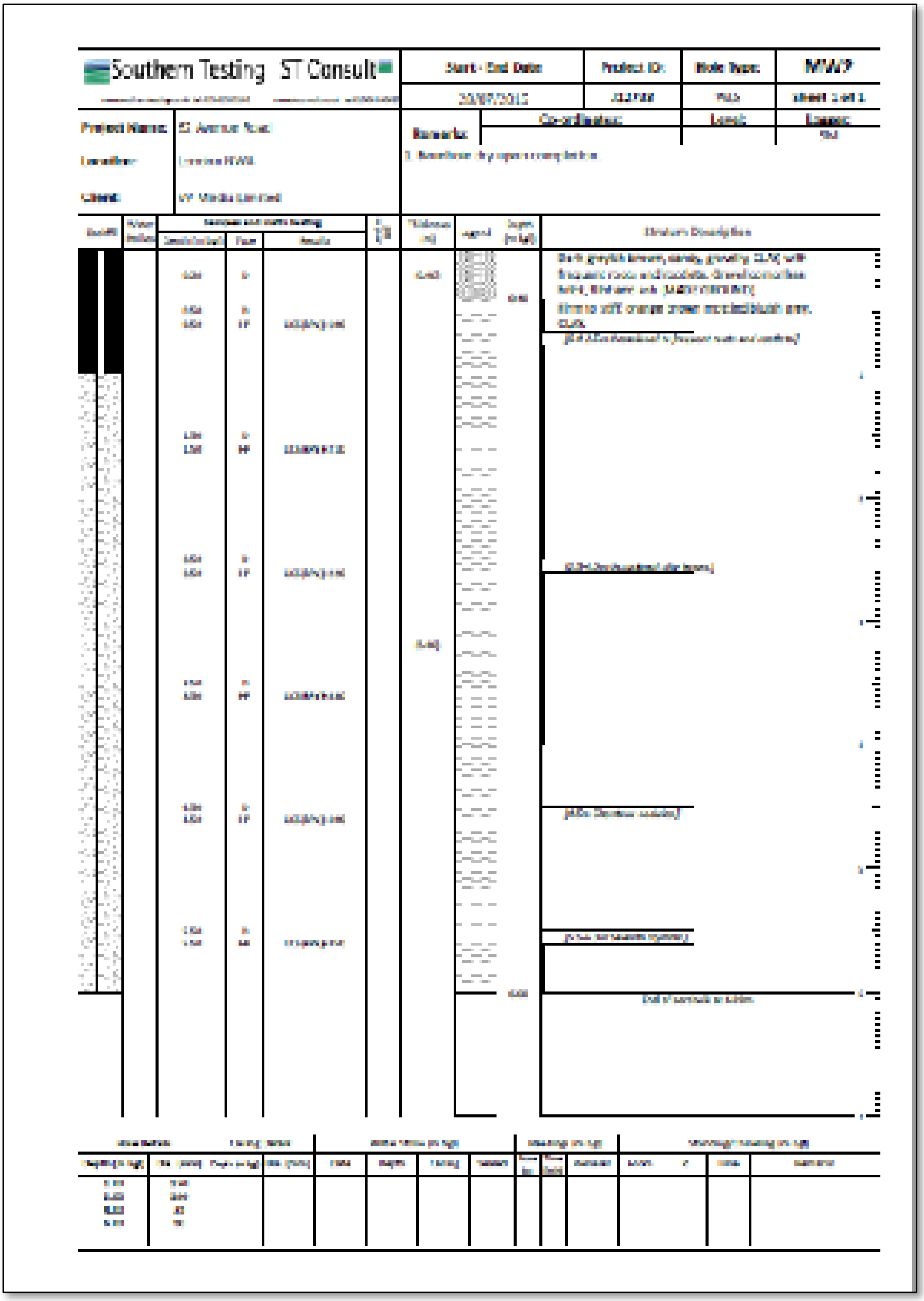
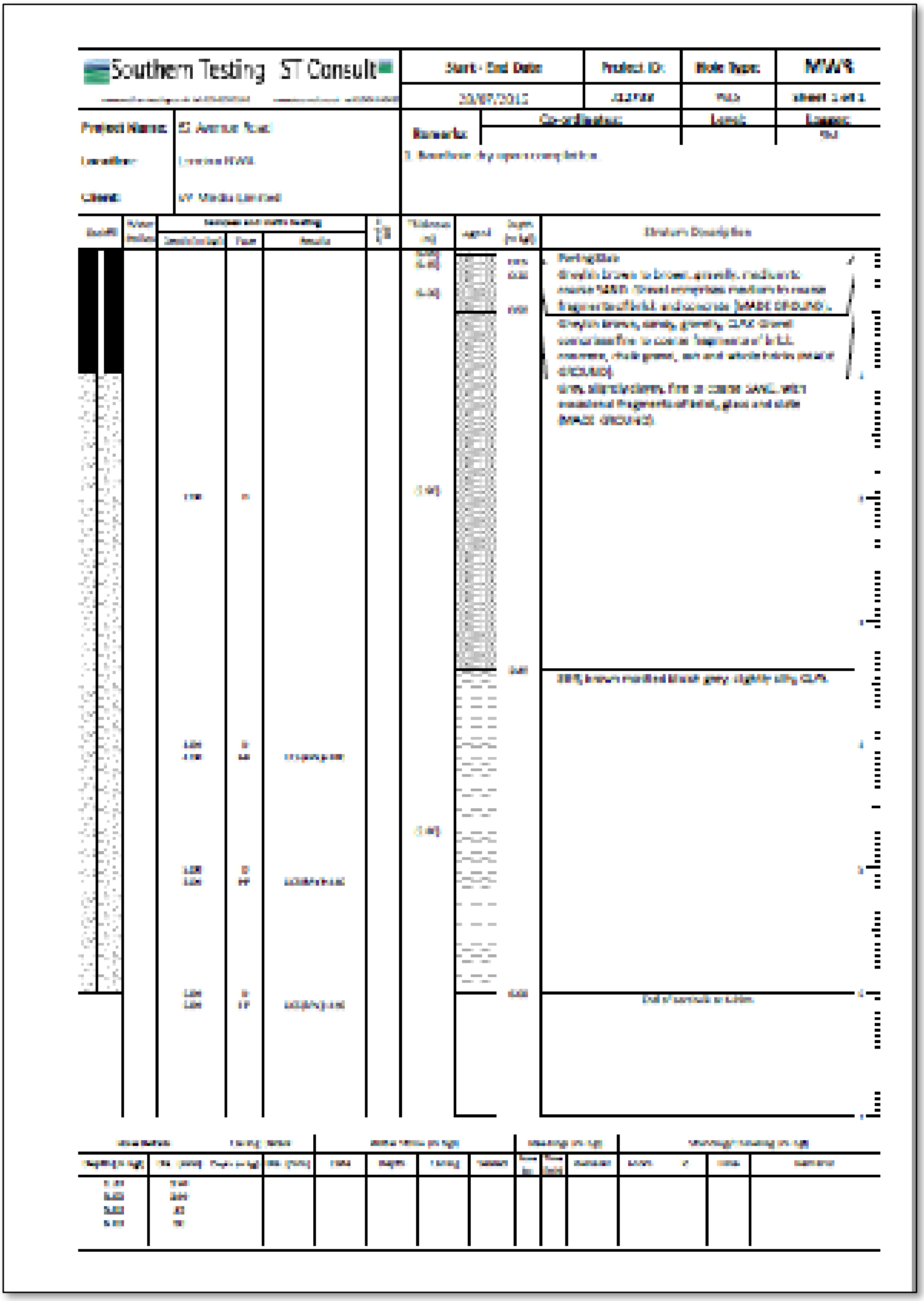


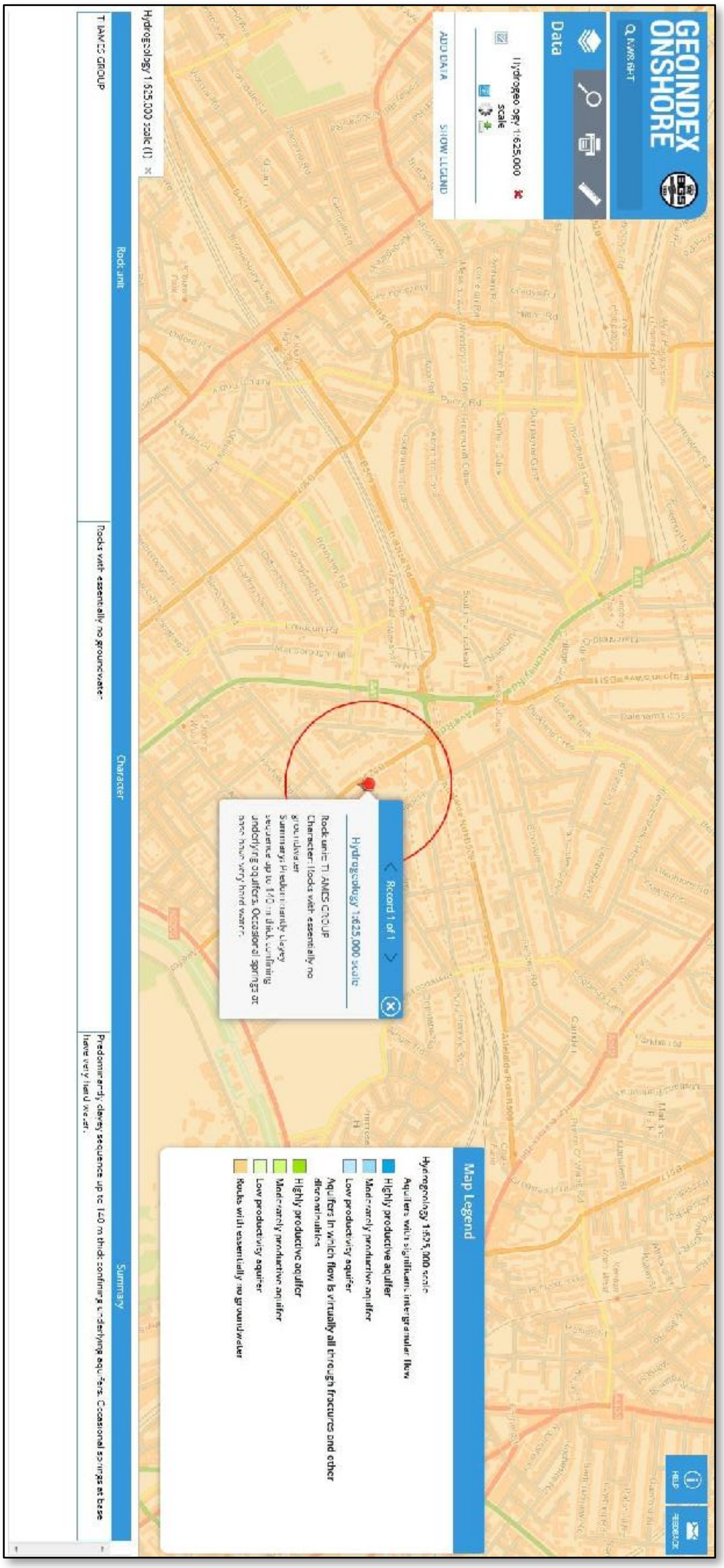
Appendix 2, Figure 4 – MW1



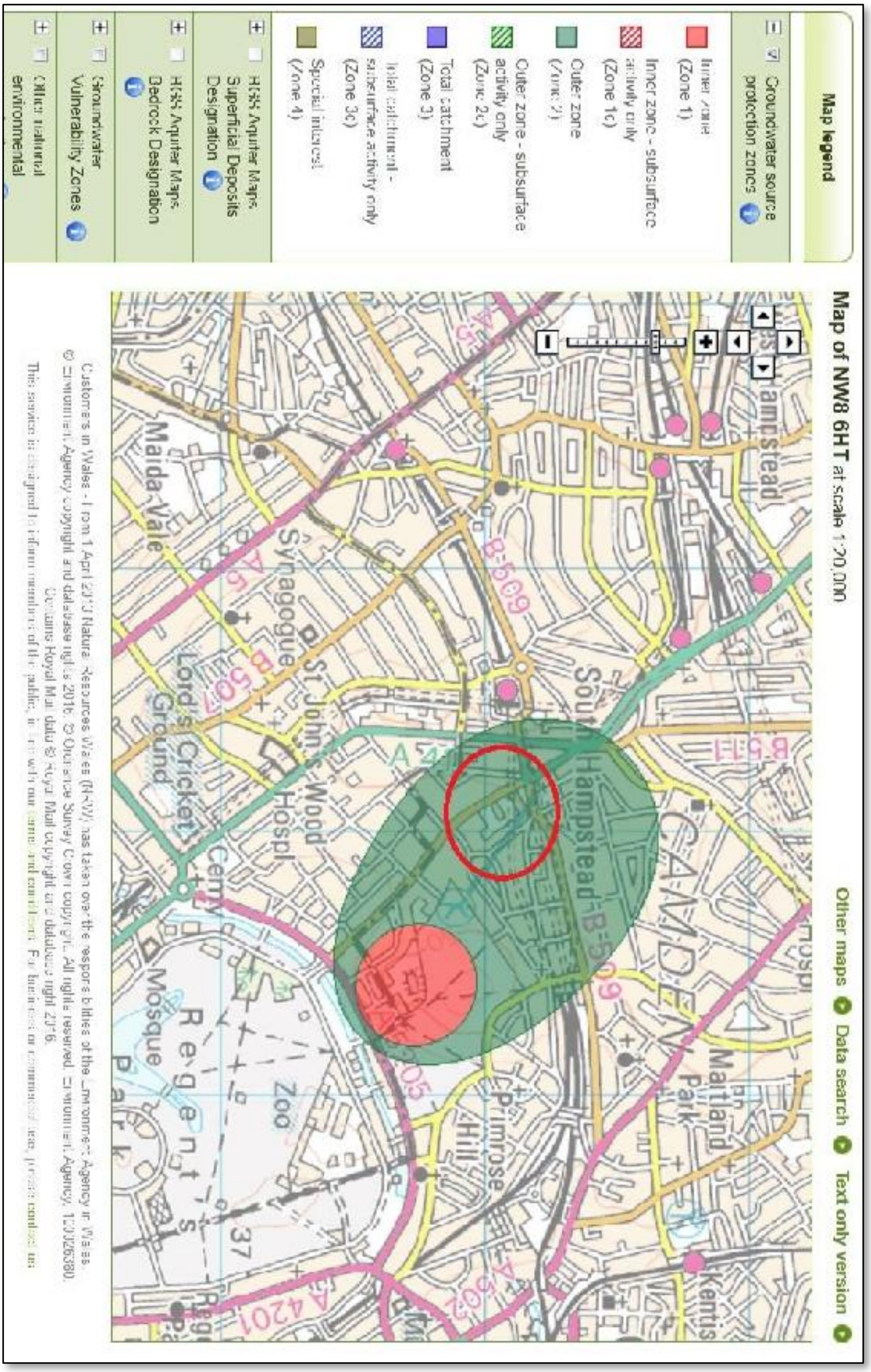
Appendix 2, Figure 5 – MW2



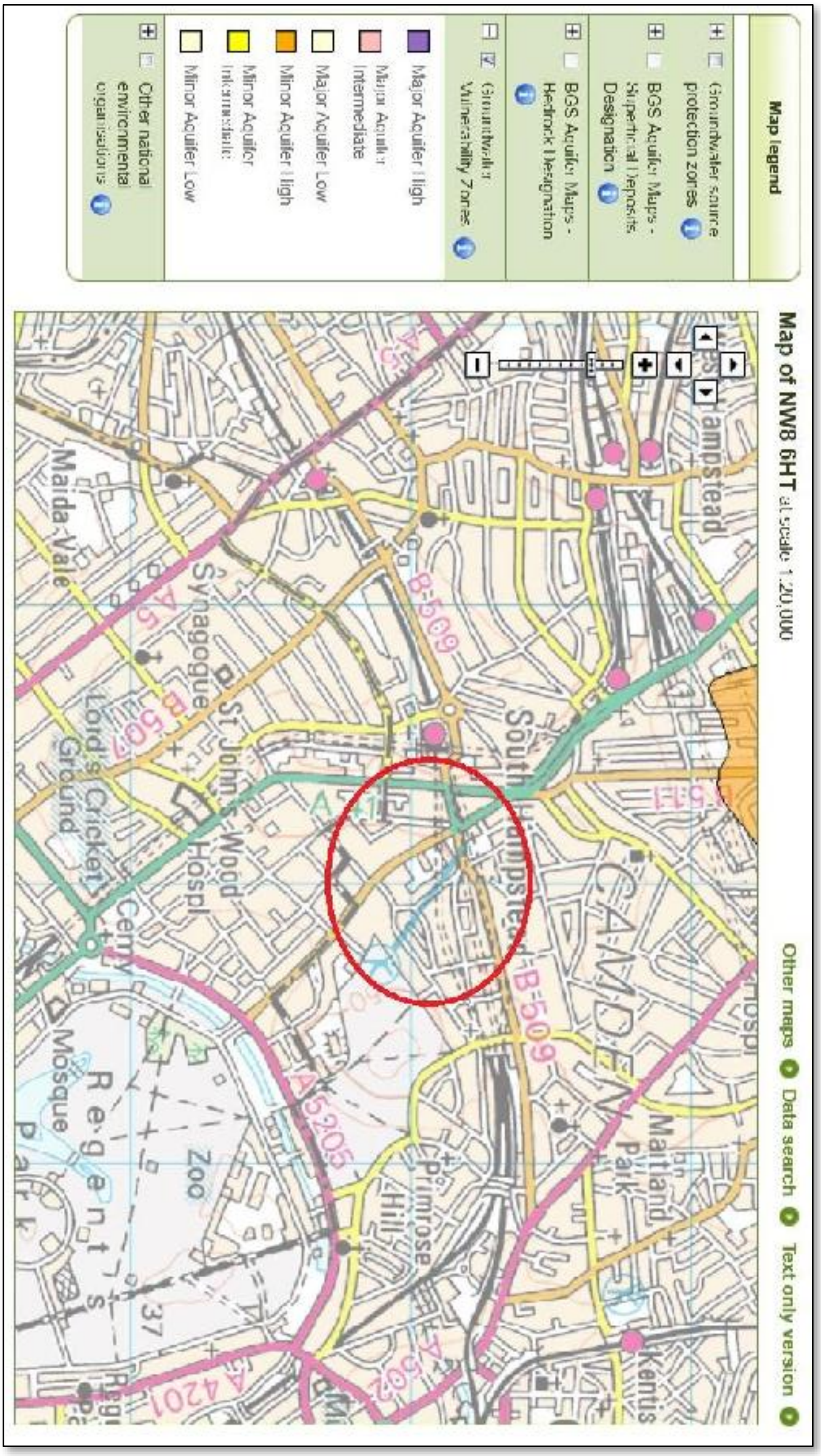
Appendix 2, Figure 6 – MW3



Appendix 2, Plan 3 – Hydrogeology



Appendix 2, Plan 4 – Groundwater Source Protection Zones



Appendix 2, Plan 5 – Groundwater Vulnerability Zones

Appendix 3 – Calculations

- *Table 1 – Greenfield Runoff Rates Calculation Summary*
- *Design Simulation of the Existing Storm Sewer*
- *Greenfield Runoff Volume for 1 year Return Period*
- *Greenfield Runoff Volume for 30 year Return Period*
- *Greenfield Runoff Volume for 100 year Return Period*
- *Summary of Attenuation Volume Results for 100 year Return Period (+40%); Flow Control to Greenfield Runoff Rate (0.48 l/s)*
- *Summary of Attenuation Volume Results for 100 year Return Period (+40%); Flow Control to 50% of Existing Rate (16.8 l/s)*
- *Summary of Attenuation Volume Results for 100 year Return Period (+40%); Flow Control to Existing Rate (32.6 l/s)*
- *Summary of Attenuation Volume Results for 1 year Return Period (+40%); Flow Control to 5 l/s*
- *Summary of Attenuation Volume Results for 30 year Return Period (+40%); Flow Control to 5 l/s*
- *Summary of Attenuation Volume Results for 100 year Return Period (+40%); Flow Control to 5 l/s*

GREENFIELD RUNOFF RATES CALCULATION SUMMARY		
PARAMETERS		
Catchment Area	1080.00 m^2	0.11 ha
Open Public Space	0.00 m^2	0.00 ha
Area Positively Drained	1080.00 m^2	0.11 ha
SAAR (mm)	649 mm	
SOIL	4	
SPR	0.47	
$Q_{BAR,rural}$ (l/s) for 50 Ha	**220.95 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	4.42	
1	3.76	
30	10.87	
100	14.1	
Return Period	**Greenfield Runoff (l/s)**	
QBAR	**0.48**	
1	0.41	
30	1.17	
100	1.52	

Appendix 3, Table 1 - Greenfield Runoff Rates Calculation Summary

Ambiental		Page 1
Science Park Square	Existing Storm Sewer Design	
Brighton	52 Avenue Road, Camden	
BN1 9SB	Contract No 2918	
Date 02/12/2016 14:07	Designed by Jose Tenedor	
File Existing Runoff Rates#2...	Checked by Mary Neumann	
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)	21.000	Minimum Backdrop Height (m)	0.200
Ratio R	0.435	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 at outfall S (pipe S1000.000)

Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.096	4-8	0.012

Total Area Contributing (ha) = 0.108

Total Pipe Volume (m^3) = 0.530

Time Area Diagram at outfall S (pipe S1001.000)

Time (mins)	Area (ha)
0-4	0.006

Total Area Contributing (ha) = 0.006

Total Pipe Volume (m^3) = 0.471

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
S1000.000	30.000	0.375	80.0	0.108	4.00	0.0	0.600	o	150	Pipe/Conduit	[illegible]

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)
S1000.000	50.00	4.46	46.500	0.108	0.0	0.0	0.0	1.03	18.2	14.6

Ambiental		Page 2
Science Park Square Brighton BN1 9SB	Existing Storm Sewer Design 52 Avenue Road, Camden Contract No 2918	Micro Drainage
Date 02/12/2016 14:07 File Existing Runoff Rates@2...	Designed by Jose Teneder Checked by Mark Mermenr	
XP Solutions	Network 2016.1	

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
S1001.000	60.000	0.750	80.0	0.000	4.00	0.0	0.600	o	100	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
[illegible]	50.00	[illegible]	[illegible]	0.000	0.0	0.0	0.0	[illegible]	[illegible]	0.0

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S1000.000	S	47.500	45.125	0.000	0	0

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S1001.000	S	46.320	39.650	0.000	0	0

Simulation Criteria for Storm

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

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

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	21.000	Storm Duration (mins)	30
Ratio R	0.435		

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Ambiental		Page 3
Science Park Square Brighton BN1 9SB	Existing Storm Sewer Design 52 Avenue Road, Camden Contract No 2918	Micro Drainage
Date 02/12/2016 14:07 File Existing Runoff Rates#2...	Designed by Jose Teneder Checked by Mary Maumam	
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 Coefficient 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 0.355
Region England and Wales Cv (Summer) 0.750
M5-60 (mm) 21.000 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.
S1.000	S1	15 Winter	1	+20%	30/15 Summer	100/15 Summer		
S1.001	S2	360 Winter	1	+20%				

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S1.000	S1	48.612	-0.038	0.000	0.90		27.2	OK	6
S1.001	S2	35.400	-0.181	0.000	0.00		0.0	OK	

Ambiental		Page 6
Science Park Square	Existing Storm Sewer Design	
Brighton	52 Avenue Road, Camden	
BN1 9SB	Contract No 2918	
Date 02/12/2016 14:07	Designed by Jose Tenedor	
File Existing Runoff Rates#2....	Checked by Mary Maumann	
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 Coefficient 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 0.335
Region England and Wales Cv (Summer) 0.750
M5-60 (mm) 21.000 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.
S1000.000	S1	15 Winter	20	+0%	20/15 Summer	100/15 Summer		
S1001.000	S2	360 Winter	20	+0%				

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S1000.000	S1	47.256	1.616	0.000	1.61		30.7	FLOOD RISK	1
S1001.000	S2	39.400	-0.100	0.000	0.00		0.0	OK	

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Ambiental		Page 5
Science Park Square	Existing Storm Sewer Design	
Brighton	57 Avenue Road, Camden	
BN1 9SB	Contract No 2918	
Date 02/12/2016 14:07	Designed by Jose Tenedor	
File Existing Runoff Rates#2...	Checked by Mary Mermaer	
XP Solutions	Network 2016.1	

30 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 Coefficient 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 0.335
Region England and Wales Cv (Summer) 0.750
M5-60 (mm) 21.000 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.
S1000.000	S1	15 Winter	30	+0%	30/15 Summer	100/15 Summer		
S1001.000	S2	360 Winter	30	+0%				

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S1000.000	S1	47.410	1.760	0.000	1.72		32.6	FLOOD RISK	4
S1001.000	S2	39.400	-1.100	0.000	0.00		0.0	OK	

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Ambiental		Page 6
Science Park Square Brighton BN1 9SB	Existing Storm Sewer Design 52 Avenue Road, Camden Contract No 2918	Micro Drainage
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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 0.335
Region England and Wales Cv (Summer) 0.750
M5-60 (mm) 21.000 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.
S1000.000	S1	15 Winter	100	+24%	20/15 Summer	100/15 Summer		
S1001.000	S2	360 Winter	100	+24%				

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S1000.000	S1	47.502	0.857	1.516	1.81		34.5	FLOOD	4
S1001.000	S2	35.400	-0.100	0.000	0.00		0.0	OK	

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Ambiental		Page 1
Science Park Square	62 Road Avenue - Camden	
Brighton	Contract No 2918	
BN1 9SB	HB Partnership	
Date 05/12/2016 21:07	Designed by Jose Tenedor	
File	Checked by Mark Neumann	
XP Solutions	Source Control 2015.1	

Greenfield Runoff Volume

FSR Data

Return Period (years)	1
Storm Duration (mins)	360
Region	England and Wales
M5-60 (mm)	21.000
Ratio R	0.425
Areal Reduction Factor	1.00
Area (ha)	0.108
SAAR (mm)	600
CWI	87.000
Urban	0.000
SPR	47.000

Results

Percentage Runoff (%)	37.50
Greenfield Runoff Volume (m^3)	8.962

Ambiental		Page 1
Science Park Square	62 Road Avenue - Camden	
Brighton	Contract No 2918	
BN1 9SB	BB Partnership	
Date 05/12/2016 21.08	Designed by Jose Tavadez	
File	Checked by Mark Neumann	
XP Solutions	Source Control 2016.1	

Greenfield Runoff Volume

FSR Data

Return Period (years)	30
Storm Duration (mins)	360
Region	England and Wales
M5-60 (mm)	21.000
Ratio R	0.425
Areal Reduction Factor	1.00
Area (ha)	0.108
SAAR (mm)	600
CWI	87.000
Urban	0.000
SPR	47.000

Results

Percentage Runoff (%)	39.54
Greenfield Runoff Volume (m^3)	20.7[illegible]

Ambiental		Page 1
Science Park Square	62 Avenue Road - Camden	
Brighton	Contract No 2918	
BN1 9SB	BB Partnership	
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XP Solutions	Source Control 2016.1	

Greenfield Runoff Volume

FSR Data

Return Period (years)	100
Storm Duration (mins)	360
Region	England and Wales
M5-60 (mm)	21.000
Ratio R	0.425
Areal Reduction Factor	1.00
Area (ha)	0.108
SAAR (mm)	600
CWI	87.000
Urban	0.000
SPR	47.000

Results

Percentage Runoff (%)	41.55
Greenfield Runoff Volume (m³)	25.309

ambiental

Ambiental		Page 1
Science Park Square	Attenuation Vol Greenfield	
Brighton	Avenue Road, Camden	
BN1 9SB	Contract No 2318	
Date 05/12/2016 10:22	Designed by Jose Teneder	
File ATTENUATIONVOLCALC_11Y...	Checked by Mark Marmann	
XP Solutions	Source Control [illegible]	

Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	47.749	0.448	0.4	22.4	O K
30 min Summer	47.873	0.575	0.4	28.8	O K
60 min Summer	47.998	0.698	0.4	34.9	O K
120 min Summer	48.107	0.807	0.5	40.4	Flood Risk
180 min Summer	48.159	0.859	0.5	42.9	Flood Risk
240 min Summer	48.186	0.886	0.5	44.3	Flood Risk
360 min Summer	48.214	0.914	0.5	45.7	Flood Risk
480 min Summer	48.222	0.922	0.5	46.1	Flood Risk
600 min Summer	48.218	0.918	0.5	45.9	Flood Risk
720 min Summer	48.207	0.907	0.5	45.4	Flood Risk
960 min Summer	48.183	0.883	0.5	44.2	Flood Risk
1440 min Summer	48.137	0.837	0.5	41.8	Flood Risk
2160 min Summer	48.073	0.773	0.4	38.6	O K
2880 min Summer	48.016	0.716	0.4	35.8	O K
4320 min Summer	47.918	0.618	0.4	30.9	O K
5760 min Summer	47.835	0.535	0.4	26.7	O K
7200 min Summer	47.761	0.461	0.4	23.1	O K
8640 min Summer	47.696	0.396	0.3	19.8	O K
10080 min Summer	47.635	0.335	0.3	16.7	O K
15 min Winter	47.802	0.502	0.4	25.1	O K
30 min Winter	47.946	0.646	0.4	32.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	150.356	0.0	22.4	27
30 min Summer	97.000	0.0	28.2	41
60 min Summer	59.509	0.0	30.1	70
120 min Summer	35.366	0.0	42.8	130
180 min Summer	25.717	0.0	46.7	188
240 min Summer	20.358	0.0	49.4	246
360 min Summer	14.717	0.0	53.4	364
480 min Summer	11.664	0.0	56.4	482
600 min Summer	9.733	0.0	58.7	602
720 min Summer	8.392	0.0	60.6	700
960 min Summer	6.636	0.0	62.7	804
1440 min Summer	4.761	0.0	61.8	1054
2160 min Summer	3.411	0.0	71.5	1468
2880 min Summer	2.690	0.0	78.4	1876
4320 min Summer	1.923	0.0	83.9	2688
5760 min Summer	1.514	0.0	88.3	3512
7200 min Summer	1.257	0.0	91.6	4320
8640 min Summer	1.079	0.0	94.4	5096
10080 min Summer	0.949	0.0	96.8	5856
15 min Winter	150.356	0.0	25.0	26
30 min Winter	97.000	0.0	29.8	41

Ambiental		Page 2
Science Park Square Brighton BN1 9SB	Attenuation Vol - Greenfield Avenue Road, Camden Contract No 2918	
Date 05/12/2016 10:22 File ATTENUATIONVOLCALC_1IN...	Designed by Jose Tenedor Checked by Mark Mermann	
XP Solutions	Source Control 2015.1	

Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	48.081	0.781	0.4	35.2	O K
120 min Winter	48.110	0.810	0.5	41.5	Flood Risk
180 min Winter	48.171	0.871	0.5	45.5	Flood Risk
240 min Winter	48.304	1.004	0.5	50.2	Flood Risk
360 min Winter	48.342	1.042	0.5	52.1	Flood Risk
480 min Winter	48.355	1.056	0.5	52.8	Flood Risk
600 min Winter	48.357	1.057	0.5	52.9	Flood Risk
720 min Winter	48.351	1.051	0.5	52.5	Flood Risk
960 min Winter	48.325	1.025	0.5	51.2	Flood Risk
1440 min Winter	48.268	0.968	0.5	48.4	Flood Risk
2160 min Winter	48.184	0.884	0.5	44.2	Flood Risk
2880 min Winter	48.104	0.804	0.5	40.2	Flood Risk
4320 min Winter	47.964	0.664	0.4	33.2	O K
5760 min Winter	47.845	0.545	0.4	27.2	O K
7200 min Winter	47.742	0.442	0.4	22.1	O K
8640 min Winter	47.646	0.346	0.3	17.3	O K
10080 min Winter	47.521	0.221	0.3	11.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	59.609	0.0	46.4	70
120 min Winter	35.866	0.0	48.0	126
180 min Winter	25.717	0.0	52.3	184
240 min Winter	20.358	0.0	55.3	242
360 min Winter	14.717	0.0	59.7	358
480 min Winter	11.564	0.0	52.9	472
600 min Winter	9.733	0.0	57.0	584
720 min Winter	8.387	0.0	56.0	694
960 min Winter	6.136	0.0	56.1	900
1440 min Winter	4.761	0.0	65.1	1116
2160 min Winter	3.411	0.0	83.5	1580
2880 min Winter	2.690	0.0	87.8	2024
4320 min Winter	1.923	0.0	94.0	2900
5760 min Winter	1.514	0.0	90.8	3752
7200 min Winter	1.257	0.0	112.8	4608
8640 min Winter	1.079	0.0	115.7	5448
10080 min Winter	0.939	0.0	118.4	6048

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Ambiental		Page 3
Science Park Square	Attenuation Vol - Greenfield	
Brighton	Avenue Road, Camden	
BN1 9SB	Contract No 2118	
Date 05/12/2016 10:22	Designed by Jose Tenedor	
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XP Solutions	Source Control 2015.1	

Rainfall Details

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)	21.[illegible]00	Shortest Storm (mins)	15
Ratio R	0.435	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.0[illegible]

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.02[illegible]	4	8	0.[illegible]	8	12	0.02[illegible]

Ambiental		Page 6
Science Park Square Brighton BN1 9SB	Attenuation Vol - Greenfield Avenue Road, Camden Contract No 2918	
Date 05/12/2016 10:22 File ATTENUATIONVOLCALC_1IN...	Designed by Jose Tenedor Checked by Mary Mermans	
XP Solutions	Source Control 2015.1	

Model Details

Storage is Online Cover Level (m) 48.400

Tank or Pond Structure

Invert Level (m) 37.300

Depth (m)	Area (m²)
0.000	50.0

Hydro-Brake Optimum® Outflow Control

Unit Reference	MD-SHE-0032-5000-1000-5000
Design Head (m)	1.000
Design Flow (l/s)	0.5
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	32
Invert Level (m)	41.300
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	0.5
Flush-Flo™	0.143	0.3
Kick-Flo®	0.207	0.3
Mean Flow over Head Range		0.4

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	0.3	1.200	0.5	3.000	0.8	7.000	1.2
0.200	0.3	1.400	0.6	3.500	0.9	7.500	1.2
0.300	0.3	1.600	0.6	4.000	0.9	8.000	1.3
0.400	0.3	1.800	0.6	4.500	1.0	8.500	1.3
0.500	[illegible]	2.000	0.7	5.000	1.0	9.000	1.3
0.600	0.4	2.200	0.7	5.500	1.1	9.500	1.4
0.800	0.5	2.400	0.7	6.000	1.1		
1.000	0.5	2.600	0.8	6.500	1.2		

Ambiental		Page 1
Science Park Square	Attenuation 50% Runoff Rate	
Brighton	Avenue Road, Camden	
BN1 9SB	Contract No 2918	
Date 05/12/2016 10:24	Designed by Jose Tenedor	
File AttenuationVo Calc_lin...	Checked by Mark Marmann	
XP Solutions	Source Control 2015.1	

Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	47.618	0.318	9.5	15.9	O K
30 min Summer	47.672	0.372	10.3	18.6	O K
60 min Summer	47.672	0.372	10.3	18.6	O K
120 min Summer	47.621	0.321	9.6	16.0	O K
180 min Summer	47.568	0.268	8.8	13.4	O K
240 min Summer	47.524	0.224	8.1	11.2	O K
360 min Summer	47.456	0.156	7.7	7.8	O K
480 min Summer	47.429	0.129	6.8	6.4	O K
600 min Summer	47.413	0.113	5.9	5.7	O K
720 min Summer	47.402	0.102	5.2	5.1	O K
960 min Summer	47.389	0.089	4.2	4.4	O K
1440 min Summer	47.373	0.073	3.1	3.7	O K
2160 min Summer	47.361	0.061	2.3	3.0	O K
2880 min Summer	47.353	0.053	1.8	2.7	O K
4320 min Summer	47.344	0.044	1.3	2.2	O K
5760 min Summer	47.339	0.039	1.0	2.0	O K
7200 min Summer	47.335	0.035	0.8	1.8	O K
8640 min Summer	47.333	0.033	0.7	1.6	O K
10080 min Summer	47.331	0.031	0.6	1.5	O K
15 min Winter	47.660	0.360	10.1	18.0	O K
30 min Winter	47.719	0.419	10.9	21.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	150.356	0.0	22.8	21
30 min Summer	97.300	0.0	29.4	30
60 min Summer	59.509	0.0	30.2	46
120 min Summer	35.366	0.0	42.9	78
180 min Summer	25.717	0.0	46.8	110
240 min Summer	20.358	0.0	49.5	140
360 min Summer	14.717	0.0	53.6	198
480 min Summer	11.644	0.0	56.7	256
600 min Summer	9.733	0.0	59.1	314
720 min Summer	8.392	0.0	61.2	376
960 min Summer	6.636	0.0	64.5	494
1440 min Summer	4.761	0.0	65.4	736
2160 min Summer	3.411	0.0	71.6	1100
2880 min Summer	2.690	0.0	78.4	1452
4320 min Summer	1.923	0.0	84.1	2200
5760 min Summer	1.514	0.0	88.3	2904
7200 min Summer	1.257	0.0	91.6	3672
8640 min Summer	1.079	0.0	94.4	4400
10080 min Summer	0.949	0.0	96.8	5056
15 min Winter	150.356	0.0	25.5	21
30 min Winter	97.300	0.0	33.0	31

Ambiental		Page 2
Science Park Square	Attenuation 50% Runoff Rate	
Brighton	Avenue Road, Camden	
BN1 9SB	Contract No 2918	
Date 05/12/2016 10:24	Designed by Jose Teneder	
File Attenuation% Calc_lin'...	Checked by Mark Harmann	
XP Solutions	Source Control 2015.1	

Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	47.708	0.408	10.7	20.4	O K
120 min Winter	47.626	0.326	9.7	16.3	O K
180 min Winter	47.551	0.251	8.5	12.5	O K
240 min Winter	47.488	0.188	7.7	9.4	O K
360 min Winter	47.427	0.127	6.7	6.3	O K
480 min Winter	47.406	0.106	5.4	5.3	O K
600 min Winter	47.394	0.094	4.6	4.7	O K
720 min Winter	47.385	0.085	4.0	4.3	O K
960 min Winter	47.374	0.074	3.1	3.7	O K
1440 min Winter	47.361	0.061	2.3	3.1	O K
2160 min Winter	47.351	0.051	1.6	2.5	O K
2880 min Winter	47.345	0.045	1.3	2.2	O K
4320 min Winter	47.337	0.037	0.9	1.9	O K
5760 min Winter	47.333	0.033	0.7	1.6	O K
7200 min Winter	47.330	0.030	0.6	1.5	O K
8640 min Winter	47.328	0.028	0.5	1.4	O K
10080 min Winter	47.326	0.026	0.5	1.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	59.569	0.0	40.5	48
120 min Winter	35.366	0.0	48.1	82
180 min Winter	25.717	0.0	52.5	116
240 min Winter	20.358	0.0	55.5	146
360 min Winter	14.717	0.0	60.1	198
480 min Winter	11.964	0.0	63.5	256
600 min Winter	9.733	0.0	66.2	316
720 min Winter	8.282	0.0	68.5	376
960 min Winter	6.536	0.0	72.2	498
1440 min Winter	4.761	0.0	77.7	740
2160 min Winter	3.411	0.0	83.5	1089
2880 min Winter	2.690	0.0	87.8	1472
4320 min Winter	1.923	0.0	94.2	2164
5760 min Winter	1.514	0.0	98.8	2944
7200 min Winter	1.257	0.0	102.6	3672
8640 min Winter	1.079	0.0	105.7	4424
10080 min Winter	0.939	0.0	108.4	5184

Ambiental		Page 3
Science Park Square Brighton BN1 9SB	Attenuation - 50% Runoff Rate Avenue Road, Camden Contract No 2418	
Date 05/12/2016 10:29 File AttenuationVo Calc_116...	Designed by Jose Tenedor Checked by Mary Mermant	
XP Solutions	Source Control 2015.1	

Rainfall Details

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)	21.000	Shortest Storm (mins)	15
Ratio R	0.435	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.903

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.02[illegible]	4	8	0.[illegible]	8	12	0.02[illegible]

Ambiental		Page 6
Science Park Square Brighton BN1 9SB	Attenuation - 50% Runoff Rate Avenue Road, Camden Contract No 2918	
Date 05/12/2016 10:29 File AttenuationVb Calc_116...	Designed by Jose Tenedor Checked by Mark Moreman	
XP Solutions	Source Control 2015.1	

Model Details

Storage is Online Cover Level (m) 48.400

Tank or Pond Structure

Invert Level (m) 37.300

Depth (m)	Area (m²)
0.000	50.0

Hydro-Brake Optimum® Outflow Control

Unit Reference	MD-SCU-0127-1610-1000-1610
Design Head (m)	1.000
Design Flow (l/s)	15.4
Flush-Flo™	Calculated
Objective	Minimise discharge profile
Application	Surface
Sump Available	Yes
Diameter (mm)	128
Invert Level (m)	41.300
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	15.4
Flush-Flo™	0.151	7.7
Kick-Flo®	0.150	7.5
Mean Flow over Head Range		11.8

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	[illegible]	1.200	17.9	3.000	27.5	7.000	41.[illegible]
0.200	7.7	1.400	19.3	3.500	29.4	7.500	43.[illegible]
0.300	[illegible]	1.600	20.5	4.000	31.[illegible]	8.000	44.5
0.400	10.6	1.800	21.7	4.500	33.[illegible]	8.500	46.[illegible]
0.500	11.8	2.000	22.8	5.000	35.5	9.000	47.[illegible]
0.600	12.9	2.200	23.9	5.500	37.[illegible]	9.500	48.[illegible]
0.800	14.8	2.400	24.9	6.000	38.[illegible]		
1.000	15.4	2.600	25.9	6.500	40.[illegible]		

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Ambiental		Page 1
Science Park Square	Attenuation Existing Rate	Micro Drainage
Brighton	Avenue Road, Camden	
BN1 9SB	Contract No 2918	
Date 05/12/2016 10:23	Designed by Jose Teneder	
File AttenuationVo Calc_lin'...	Checked by Mark Mermann	
XP Solutions	Source Control 2015.1	

Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	47.331	0.231	18.1	11.5	O K
30 min Summer	47.360	0.260	18.1	13.0	O K
60 min Summer	47.337	0.237	18.1	11.9	O K
120 min Summer	47.284	0.184	16.6	9.2	O K
180 min Summer	47.255	0.155	13.8	7.7	O K
240 min Summer	47.237	0.137	11.6	6.8	O K
360 min Summer	47.215	0.115	8.9	5.8	O K
480 min Summer	47.202	0.102	7.3	5.1	O K
600 min Summer	47.192	0.092	6.1	4.6	O K
720 min Summer	47.185	0.085	5.3	4.3	O K
960 min Summer	47.175	0.075	4.3	3.8	O K
1440 min Summer	47.163	0.063	3.1	3.2	O K
2160 min Summer	47.153	0.053	2.3	2.6	O K
2880 min Summer	47.147	0.047	1.8	2.4	O K
4320 min Summer	47.140	0.040	1.3	2.0	O K
5760 min Summer	47.135	0.035	1.0	1.7	O K
7200 min Summer	47.132	0.032	0.8	1.6	O K
8640 min Summer	47.129	0.029	0.7	1.5	O K
10080 min Summer	47.121	0.021	0.6	1.4	O K
15 min Winter	47.364	0.264	18.1	13.2	O K
30 min Winter	47.372	0.272	18.3	13.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	150.356	0.0	22.8	19
30 min Summer	97.300	0.0	29.4	27
60 min Summer	59.509	0.0	36.2	42
120 min Summer	35.366	0.0	42.9	72
180 min Summer	25.717	0.0	46.8	102
240 min Summer	20.358	0.0	49.5	132
360 min Summer	14.717	0.0	53.6	192
480 min Summer	11.664	0.0	56.7	252
600 min Summer	9.733	0.0	59.1	312
720 min Summer	8.382	0.0	61.2	372
960 min Summer	6.636	0.0	64.5	494
1440 min Summer	4.761	0.0	69.4	736
2160 min Summer	3.411	0.0	71.6	1104
2880 min Summer	2.690	0.0	78.4	1468
4320 min Summer	1.923	0.0	84.1	2184
5760 min Summer	1.514	0.0	88.3	2936
7200 min Summer	1.257	0.0	91.6	3504
8640 min Summer	1.079	0.0	94.4	4352
10080 min Summer	0.949	0.0	96.8	5128
15 min Winter	150.356	0.0	25.5	19
30 min Winter	97.300	0.0	33.0	28

ambiental

Ambiental		Page 2
Science Park Square Brighton BN1 9SB	Attenuation - Existing Rate Avenue Road, Camden Contract No 2918	
Date 05/12/2016 10:23 File AttenuationCalc_116...	Designed by Jose Venedez Checked by Mark Neumann	
XP Solutions	Source Control 2015.1	

Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	47.540	0.240	18.1	12.0	O K
120 min Winter	47.467	0.167	15.0	8.3	O K
180 min Winter	47.437	0.137	11.8	6.8	O K
240 min Winter	47.419	0.119	9.4	6.0	O K
360 min Winter	47.399	0.099	6.9	4.9	O K
480 min Winter	47.387	0.087	5.5	4.3	O K
600 min Winter	47.378	0.078	4.6	3.9	O K
720 min Winter	47.372	0.072	4.0	3.6	O K
960 min Winter	47.364	0.064	3.2	3.2	O K
1440 min Winter	47.354	0.054	2.3	2.7	O K
2160 min Winter	47.345	0.045	1.6	2.2	O K
2880 min Winter	47.340	0.040	1.3	2.0	O K
4320 min Winter	47.333	0.033	0.9	1.7	O K
5760 min Winter	47.330	0.030	0.7	1.5	O K
7200 min Winter	47.327	0.027	0.6	1.3	O K
8640 min Winter	47.325	0.025	0.5	1.2	O K
10080 min Winter	47.323	0.023	0.5	1.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	58.509	0.0	46.5	44
120 min Winter	35.866	0.0	48.1	72
180 min Winter	25.717	0.0	52.5	102
240 min Winter	20.398	0.0	55.5	132
360 min Winter	14.717	0.0	60.1	192
480 min Winter	11.884	0.0	63.5	252
600 min Winter	9.733	0.0	66.2	314
720 min Winter	8.397	0.0	68.5	374
960 min Winter	6.136	0.0	72.2	494
1440 min Winter	4.761	0.0	77.7	736
2160 min Winter	3.411	0.0	83.5	1104
2880 min Winter	2.690	0.0	87.8	1468
4320 min Winter	1.923	0.0	94.7	2204
5760 min Winter	1.514	0.0	100.8	2928
7200 min Winter	1.257	0.0	102.6	3644
8640 min Winter	1.179	0.0	115.7	4320
10080 min Winter	0.939	0.0	118.4	5080

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Ambiental		Page 3
Science Park Square	Attenuation - Existing Rate	
Brighton	Avenue Road, Camden	
BN1 9SB	Contract No 2118	
Date 05/12/2016 10-23	Designed by Jose Tenedor	
File AttenuationV5 Calc_116...	Checked by Mary Maumann	
XP Solutions	Source Control 2015.1	

Rainfall Details

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)	21.[illegible]00	Shortest Storm (mins)	15
Ratio R	0.435	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.903

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.02[illegible]	4	8	0.[illegible]	8	12	0.02[illegible]

Ambiental		Page [illegible]
Science Park Square	Attenuation - Existing Rate	
Brighton	Avenue Road, Camden	
BN1 9SB	Contract No 2918	
Date 05/12/2016 10:23	Designed by Jose Tenedor	
File AttenuationVb Calc_1167...	Checked by Mary Marmane	
XP Solutions	Source Control 2015.1	

Model Details

Storage is Online Cover Level (m) 48.400

Tank or Pond Structure

Invert Level (m) 17.300

Depth (m)	Area (m²)
0.000	50.0

Hydro-Brake Optimum® Outflow Control

Unit Reference	MD-SCU-0182-32[illegible]0-1000-3280
Design Head (m)	1.000
Design Flow (l/s)	32.8
Flush-Flo™	Calculated
Objective	Minimise discharge profile
Application	Surface
Sump Available	Yes
Diameter (mm)	182
Invert Level (m)	41.300
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	32.8
Flush-Flo™	0.314	18.1
Kick-Flo®	0.272	17.6
Mean Flow over Head Range		21.8

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	7.0	1.200	35.8	3.000	55.7	7.000	84.[illegible]
0.200	1[illegible].0	1.400	38.6	3.500	60.1	7.500	87.[illegible]
0.300	1[illegible].5	1.600	41.1	4.000	64.1	8.000	89.[illegible]
0.400	21.2	1.800	43.5	4.500	67.[illegible]	8.500	92.[illegible]
0.500	2[illegible].5	2.000	45.8	5.000	71.[illegible]	9.000	95.1
0.600	2[illegible].7	2.200	48.0	5.500	74.[illegible]	9.500	97.[illegible]
0.800	2[illegible]	2.400	50.0	6.000	78.1		
1.000	3[illegible].8	2.600	52.0	6.500	81.[illegible]		

ambiental

Ambiental		Page 1
Science Park Square	Proposed SUDS	Micro Drainage
Brighton	Avenue Road, Camden	
BN1 9SB	Contract No 2918	
Date 02/12/2016 18:22	Designed by Jose Tenedor	
File AttenuationVo Calc_1in...	Checked by Mark Naumann	
XP Solutions	Source Control 2015.1	

Summary of Results for 1 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	47.602	0.102	3.8	5.1	O K
30 min Summer	47.615	0.115	4.3	5.8	O K
60 min Summer	47.619	0.119	4.4	5.9	O K
120 min Summer	47.610	0.110	4.1	5.5	O K
180 min Summer	47.599	0.099	3.7	5.0	O K
240 min Summer	47.591	0.091	3.3	4.6	O K
360 min Summer	47.579	0.079	2.7	4.0	O K
480 min Summer	47.571	0.071	2.3	3.6	O K
600 min Summer	47.566	0.066	2.1	3.3	O K
720 min Summer	47.561	0.061	1.8	3.1	O K
960 min Summer	47.555	0.055	1.5	2.8	O K
1440 min Summer	47.547	0.047	1.2	2.4	O K
2160 min Summer	47.540	0.040	0.9	2.0	O K
2880 min Summer	47.536	0.036	0.7	1.8	O K
4320 min Summer	47.531	0.031	0.5	1.5	O K
5760 min Summer	47.527	0.027	0.4	1.4	O K
7200 min Summer	47.525	0.025	0.4	1.3	O K
8640 min Summer	47.523	0.023	0.3	1.2	O K
10080 min Summer	47.522	0.022	0.3	1.1	O K
15 min Winter	47.612	0.112	4.2	5.6	O K
30 min Winter	47.626	0.126	4.7	6.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	46.342	0.0	7.1	20
30 min Summer	30.335	0.0	9.2	28
60 min Summer	18.934	0.0	11.5	44
120 min Summer	11.565	0.0	14.0	76
180 min Summer	8.522	0.0	15.7	106
240 min Summer	6.952	0.0	17.0	136
360 min Summer	5.153	0.0	18.8	196
480 min Summer	4.157	0.0	20.2	258
600 min Summer	3.514	0.0	21.3	318
720 min Summer	3.062	0.0	22.3	378
960 min Summer	2.465	0.0	23.9	498
1440 min Summer	1.816	0.0	26.4	740
2160 min Summer	1.348	0.0	29.2	1104
2880 min Summer	1.077	0.0	31.4	1472
4320 min Summer	0.793	0.0	34.6	2200
5760 min Summer	0.638	0.0	37.2	2936
7200 min Summer	0.539	0.0	39.3	3624
8640 min Summer	0.470	0.0	41.1	4408
10080 min Summer	0.419	0.0	42.7	5088
15 min Winter	46.342	0.0	7.9	29
30 min Winter	30.335	0.0	10.3	29

Ambiental		Page 2
Science Park Square	Proposed SUDS	
Brighton	Avenue Road, Camden	
BN1 9SB	Contract No 2918	
Date 07/12/2016 18:22	Designed by Jose Venedor	
File AttenuationVo Calc_1in1...	Checked by Mark Mermann	
XP Solutions	Source Control 2015.1	

Summary of Results for 1 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	47.425	0.125	6.7	6.2	O K
120 min Winter	47.407	0.107	4.5	5.4	O K
180 min Winter	47.393	0.093	3.4	4.7	O K
240 min Winter	47.383	0.083	3.5	4.2	O K
360 min Winter	47.371	0.071	2.3	3.5	O K
480 min Winter	47.363	0.063	1.9	3.1	O K
600 min Winter	47.357	0.057	1.6	2.9	O K
720 min Winter	47.353	0.053	1.5	2.7	O K
960 min Winter	47.347	0.047	1.2	2.4	O K
1440 min Winter	47.340	0.040	0.9	2.0	O K
2160 min Winter	47.334	0.034	0.6	1.7	O K
2880 min Winter	47.330	0.030	0.5	1.5	O K
4320 min Winter	47.326	0.026	0.4	1.3	O K
5760 min Winter	47.323	0.023	0.3	1.2	O K
7200 min Winter	47.321	0.021	0.3	1.1	O K
8640 min Winter	47.320	0.020	0.2	1.0	O K
10080 min Winter	47.319	0.019	0.2	0.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	18.334	0.0	12.9	46
120 min Winter	11.565	0.0	15.7	78
180 min Winter	8.822	0.0	17.6	108
240 min Winter	6.992	0.0	19.0	140
360 min Winter	5.163	0.0	21.1	200
480 min Winter	4.157	0.0	22.6	260
600 min Winter	3.514	0.0	23.9	320
720 min Winter	3.107	0.0	25.0	388
960 min Winter	2.465	0.0	26.8	502
1440 min Winter	1.816	0.0	29.6	744
2160 min Winter	1.338	0.0	32.8	1092
2880 min Winter	1.077	0.0	35.2	1480
4320 min Winter	0.793	0.0	38.8	2272
5760 min Winter	0.638	0.0	41.7	2936
7200 min Winter	0.539	0.0	44.0	3688
8640 min Winter	0.470	0.0	46.1	4432
10080 min Winter	0.419	0.0	47.8	5136

Ambiental		Page 3
Science Park Square	Proposed SUDS	
Brighton	Avenue Road, Camden	
BN1 9SB	Contract No 2118	
Date 07/12/2016 16:22	Designed by [illegible]	
File Attenuation Calc_1...	Checked by [illegible]	
XP Solutions	Source Control 2015.1	

Rainfall Details

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)	21.[illegible]	Shortest Storm (mins)	15
Ratio R	0.435	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.903

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.02[illegible]	4	8	0.[illegible]	8	12	0.02[illegible]

Ambiental		Page 6
Science Park Square Brighton BN1 9SB	Proposed SUDS Avenue Road, Camden Contract No 2918	
Date 07/12/2016 18:22 File Attenuation Calc_1in...	Designed by Jose Venedez Checked by Mary Mermer	
XP Solutions	Source Control 2015.1	

Model Details

Storage is Online Cover Level (m) 48.400

Tank or Pond Structure

Invert Level (m) 37.500

Depth (m)	Area (m²)
3.000	50.0

Hydro-Brake Optimum® Outflow Control

Unit Reference	MD-SHE-0109-5000-0800-5000
Design Head (m)	0.800
Design Flow (l/s)	5.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	109
Invert Level (m)	41.500
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.800	5.0
Flush-Flo™	0.241	5.0
Kick-Flo®	0.573	4.2
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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.7	1.200	6.0	3.000	9.3	7.000	13.8
0.200	[illegible]	1.400	6.5	3.500	10.0	7.500	14.4
0.300	5.0	1.600	6.9	4.000	10.6	8.000	14.8
0.400	4.8	1.800	7.3	4.500	11.3	8.500	15.2
0.500	4.5	2.000	7.7	5.000	11.8	9.000	15.7
0.600	4.4	2.200	8.0	5.500	12.4	9.500	16.1
0.800	[illegible]	2.400	8.4	6.000	12.9		
1.000	[illegible]	2.600	8.7	6.500	13.4		

Ambiental		Page 1
Science Park Square	Proposed SuDS	
Brighton	Avenue Road, Camden	
BN1 9SB	Contract No 2918	
Date 02/12/2016 18:21	Designed by Jose Teneder	
File AttenuationVo Calc_1in3...	Checked by Mark Mermenr	
XP Solutions	Source Control 2015.1	

Summary of Results for 30 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	47.768	0.268	5.0	13.4	O K
30 min Summer	47.823	0.323	5.0	16.1	O K
60 min Summer	47.837	0.337	5.0	16.8	O K
120 min Summer	47.807	0.307	5.0	15.4	O K
180 min Summer	47.766	0.266	5.0	13.3	O K
240 min Summer	47.728	0.228	5.0	11.4	O K
360 min Summer	47.670	0.170	4.9	8.5	O K
480 min Summer	47.634	0.134	4.7	6.7	O K
600 min Summer	47.616	0.116	4.3	5.8	O K
720 min Summer	47.604	0.104	3.9	5.2	O K
960 min Summer	47.589	0.089	3.2	4.4	O K
1440 min Summer	47.573	0.073	2.4	3.6	O K
2160 min Summer	47.560	0.060	1.8	3.0	O K
2880 min Summer	47.553	0.053	1.4	2.6	O K
4320 min Summer	47.544	0.044	1.0	2.2	O K
5760 min Summer	47.539	0.039	0.8	1.9	O K
7200 min Summer	47.535	0.035	0.7	1.8	O K
8640 min Summer	47.533	0.033	0.6	1.6	O K
10080 min Summer	47.531	0.031	0.5	1.5	O K
15 min Winter	47.800	0.300	5.0	15.0	O K
30 min Winter	47.870	0.370	5.0	18.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	115.362	0.0	17.5	21
30 min Summer	73.982	0.0	22.4	32
60 min Summer	45.320	0.0	27.5	50
120 min Summer	26.834	0.0	32.7	84
180 min Summer	19.600	0.0	35.8	116
240 min Summer	15.659	0.0	38.0	146
360 min Summer	11.356	0.0	41.4	206
480 min Summer	9.034	0.0	43.9	262
600 min Summer	7.561	0.0	45.9	318
720 min Summer	6.535	0.0	47.6	378
960 min Summer	5.189	0.0	50.4	498
1440 min Summer	3.746	0.0	53.6	738
2160 min Summer	2.701	0.0	59.0	1100
2880 min Summer	2.141	0.0	62.4	1448
4320 min Summer	1.541	0.0	67.4	2200
5760 min Summer	1.220	0.0	71.1	2880
7200 min Summer	1.018	0.0	74.2	3640
8640 min Summer	0.877	0.0	[illegible]	4344
10080 min Summer	0.774	0.0	80.9	5112
15 min Winter	115.362	0.0	19.6	22
30 min Winter	73.982	0.0	25.1	33

Ambiental		Page 2
Science Park Square Brighton BN1 9SB	Proposed SUDS Avenue Road, Camden Contract No 2918	Micro Drainage
Date 02/12/2016 18:21 File AttenuationVa Calc_1163...	Designed by Jose Tenedor Checked by Mary Maumann	
XP Solutions	Source Control 2015.1	

Summary of Results for 30 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	47.883	0.383	5.3	19.1	O K
120 min Winter	47.833	0.333	5.5	16.6	O K
180 min Winter	47.767	0.267	5.5	13.4	O K
240 min Winter	47.710	0.210	5.5	10.5	O K
360 min Winter	47.636	0.136	4.7	6.8	O K
480 min Winter	47.609	0.109	4.1	5.5	O K
600 min Winter	47.595	0.095	3.5	4.7	O K
720 min Winter	47.585	0.085	3.1	4.3	O K
960 min Winter	47.573	0.073	2.4	3.7	O K
1440 min Winter	47.560	0.060	1.8	3.0	O K
2160 min Winter	47.550	0.050	1.3	2.5	O K
2880 min Winter	47.544	0.044	1.0	2.2	O K
4320 min Winter	47.537	0.037	0.7	1.8	O K
5760 min Winter	47.533	0.033	0.6	1.6	O K
7200 min Winter	47.530	0.030	0.5	1.5	O K
8640 min Winter	47.527	0.027	0.4	1.4	O K
10080 min Winter	47.525	0.025	0.4	1.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	45.320	0.0	30.8	64
120 min Winter	26.344	0.0	34.6	90
180 min Winter	19.590	0.0	38.1	124
240 min Winter	15.859	0.0	42.6	154
360 min Winter	11.356	0.0	48.2	208
480 min Winter	9.334	0.0	49.1	262
600 min Winter	7.501	0.0	51.4	322
720 min Winter	6.515	0.0	53.3	380
960 min Winter	5.109	0.0	56.5	502
1440 min Winter	3.716	0.0	61.1	742
2160 min Winter	2.702	0.0	69.1	1108
2880 min Winter	2.141	0.0	69.9	1452
4320 min Winter	1.541	0.0	75.5	2208
5760 min Winter	1.226	0.0	78.7	2904
7200 min Winter	1.018	0.0	81.1	3744
8640 min Winter	0.877	0.0	85.9	4408
10080 min Winter	0.774	0.0	88.4	5136

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Ambiental		Page 3
Science Park Square	Proposed SuDS	
Brighton	Avenue Road, Camden	
BN1 9SB	Contract No 2918	
Date 02/12/2016 [illegible]	Designed by Jose Benedet	
File AttenuationVo Calc_1163...	Checked by Mary [illegible]	
XP Solutions	Source Control 2015.1	

Rainfall Details

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)	21.[illegible]	Shortest Storm (mins)	15
Ratio R	0.435	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.081

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	0.027	4	8	0.027	8	12	0.027

Ambiental		Page 6
Science Park Square	Proposed SUDS	Micro Drainage
Brighton	Avenue Road, Camden	
BN1 9SB	Contract No 2918	
Date 07/12/2016 16:21	Designed by Jose Venedez	
File AttenuationVo Calc_1163...	Checked by Mary Maumann	
XP Solutions	Source Control 2015.1	

Model Details

Storage is Online Cover Level (m) 48.400

Tank or Pond Structure

Invert Level (m) 37.500

Depth (m)	Area (m²)
0.000	50.0

Hydro-Brake Optimum® Outflow Control

Unit Reference	MD-SHE-0109-5000-0800-5000
Design Head (m)	0.800
Design Flow (l/s)	5.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	109
Invert Level (m)	37.500
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.800	5.0
Flush-Flo™	0.241	5.0
Kick-Flo®	0.573	4.2
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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.7	1.200	6.0	3.000	9.3	7.000	13.[illegible]
0.200	[illegible].0	1.400	6.5	3.500	10.0	7.500	14.4
0.300	[illegible].0	1.600	6.9	4.000	10.6	8.000	14.[illegible]
0.400	[illegible].8	1.800	7.3	4.500	11.3	8.500	15.2
0.500	[illegible].5	2.000	7.7	5.000	11.8	9.000	15.7
0.600	4.4	2.200	8.0	5.500	12.4	9.500	16.1
0.800	[illegible].0	2.400	8.4	6.000	12.9		
1.000	[illegible].5	2.600	8.7	6.500	13.4		

Ambiental		Page 1
Science Park Square	Proposed SUDS	
Brighton	Avenue Road, Camden	
BN1 9SB	Contract No 2918	
Date 02/12/2016 18:15	Designed by Jose Tenedor	
File AttenuationVo Calc_1in'...	Checked by Mark Marmann	
XP Solutions	Source Control 2015.1	

Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	47.466	0.366	5.0	18.3	O K
30 min Summer	47.551	0.451	5.0	22.5	O K
60 min Summer	47.583	0.483	5.0	24.2	O K
120 min Summer	47.553	0.453	5.0	22.6	O K
180 min Summer	47.502	0.402	5.0	20.1	O K
240 min Summer	47.451	0.351	5.0	17.6	O K
360 min Summer	47.366	0.266	5.0	13.3	O K
480 min Summer	47.303	0.203	5.0	10.2	O K
600 min Summer	47.261	0.161	4.9	8.0	O K
720 min Summer	47.233	0.133	4.7	6.7	O K
960 min Summer	47.208	0.108	4.1	5.4	O K
1440 min Summer	47.185	0.085	3.1	4.3	O K
2160 min Summer	47.169	0.069	2.2	3.5	O K
2880 min Summer	47.160	0.060	1.8	3.0	O K
4320 min Summer	47.150	0.050	1.3	2.5	O K
5760 min Summer	47.144	0.044	1.0	2.2	O K
7200 min Summer	47.140	0.040	0.8	2.0	O K
8640 min Summer	47.136	0.036	0.7	1.8	O K
10080 min Summer	47.134	0.034	0.6	1.7	O K
15 min Winter	47.517	0.417	5.0	20.9	O K
30 min Winter	47.618	0.518	5.0	25.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	150.356	0.0	22.7	22
30 min Summer	97.300	0.0	29.4	34
60 min Summer	59.509	0.0	36.2	56
120 min Summer	35.366	0.0	42.9	88
180 min Summer	25.717	0.0	46.8	120
240 min Summer	20.358	0.0	49.5	152
360 min Summer	14.717	0.0	53.6	214
480 min Summer	11.864	0.0	56.7	272
600 min Summer	9.793	0.0	59.1	328
720 min Summer	8.382	0.0	61.1	382
960 min Summer	6.776	0.0	64.5	500
1440 min Summer	4.761	0.0	69.4	738
2160 min Summer	3.411	0.0	71.6	1104
2880 min Summer	2.830	0.0	78.4	1468
4320 min Summer	1.923	0.0	84.0	2200
5760 min Summer	1.514	0.0	88.3	2896
7200 min Summer	1.257	0.0	91.6	3640
8640 min Summer	1.079	0.0	94.4	4400
10080 min Summer	0.949	0.0	96.8	5104
15 min Winter	150.356	0.0	25.5	23
30 min Winter	97.300	0.0	33.0	35

Ambiental		Page 2
Science Park Square	Proposed SUDS	
Brighton	Avenue Road, Camden	
BN1 9SB	Contract No 2918	
Date 07/12/2016 10:15	Designed by Jose Tenedor	
File AttenuationVo Calc_116...	Checked by Mary Maumann	
XP Solutions	Source Control 2015.1	

Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	48.068	0.563	5.5	29.2	O K
120 min Winter	48.014	0.514	5.5	25.7	O K
180 min Winter	47.934	0.434	5.5	21.7	O K
240 min Winter	47.855	0.355	5.5	17.7	O K
360 min Winter	47.729	0.229	5.5	11.5	O K
480 min Winter	47.653	0.153	4.9	7.6	O K
600 min Winter	47.619	0.119	4.4	6.0	O K
720 min Winter	47.603	0.103	3.9	5.2	O K
960 min Winter	47.587	0.087	3.1	4.3	O K
1440 min Winter	47.570	0.070	2.3	3.5	O K
2160 min Winter	47.557	0.057	1.6	2.9	O K
2880 min Winter	47.550	0.050	1.3	2.5	O K
4320 min Winter	47.542	0.042	0.9	2.1	O K
5760 min Winter	47.537	0.037	0.7	1.8	O K
7200 min Winter	47.533	0.033	0.6	1.7	O K
8640 min Winter	47.531	0.031	0.5	1.5	O K
10080 min Winter	47.529	0.029	0.5	1.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	59.505	0.0	40.5	60
120 min Winter	35.366	0.0	48.1	96
180 min Winter	25.717	0.0	52.5	130
240 min Winter	20.358	0.0	55.5	164
360 min Winter	14.717	0.0	60.1	224
480 min Winter	11.664	0.0	63.5	276
600 min Winter	9.733	0.0	66.2	324
720 min Winter	8.397	0.0	68.5	387
960 min Winter	6.136	0.0	72.2	500
1440 min Winter	4.761	0.0	77.7	742
2160 min Winter	3.411	0.0	83.5	1104
2880 min Winter	2.690	0.0	87.8	1448
4320 min Winter	1.923	0.0	94.1	2160
5760 min Winter	1.514	0.0	98.8	2928
7200 min Winter	1.257	0.0	102.6	3656
8640 min Winter	1.079	0.0	105.7	4472
10080 min Winter	0.939	0.0	108.4	5168

Ambiental		Page 3
Science Park Square	Proposed SUDS	
Brighton	Avenue Road, Camden	
BN1 9SB	Contract No 2118	
Date 07/12/2016 18:15	Designed by Jose Tenedor	
File AttenuationVo Calc_116...	Checked by Mark Neumann	
XP Solutions	Source Control 2015.1	

Rainfall Details

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)	21.[illegible]00	Shortest Storm (mins)	15
Ratio R	0.435	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.903

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	0.02[illegible]	4	8	0.2[illegible]	8	12	0.02[illegible]

Ambiental		Page 6
Science Park Square Brighton BN1 9SB	Proposed SUDS Avenue Road, Camden Contract No 2918	Micro Drainage
Date 02/12/2016 10:15 File AttenuationVo Calc_1in...	Designed by Jose Tenedor Checked by Mary Marmont	
XP Solutions	Source Control 2015.1	

Model Details

Storage is Online Cover Level (m) 48.400

Tank or Pond Structure

Invert Level (m) 37.500

Depth (m)	Area (m²)
0.000	50.0

Hydro-Brake Optimum® Outflow Control

Unit Reference	MD-SHE-0109-5000-0800-5000
Design Head (m)	0.800
Design Flow (l/s)	5.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	109
Invert Level (m)	41.500
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.800	5.0
Flush-Flo™	0.241	5.0
Kick-Flo®	0.577	4.?
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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.7	1.200	6.0	3.000	9.3	7.000	13.8
0.200	5.0	1.400	6.5	3.500	10.0	7.500	14.4
0.300	5.0	1.600	6.9	4.000	10.6	8.000	14.8
0.400	4.8	1.800	7.3	4.500	11.3	8.500	15.2
0.500	4.5	2.000	7.7	5.000	11.8	9.000	15.7
0.600	4.4	2.200	8.0	5.500	12.4	9.500	16.1
0.800	5.0	2.400	8.4	6.000	12.9		
1.000	5.5	2.600	8.7	6.500	13.4		

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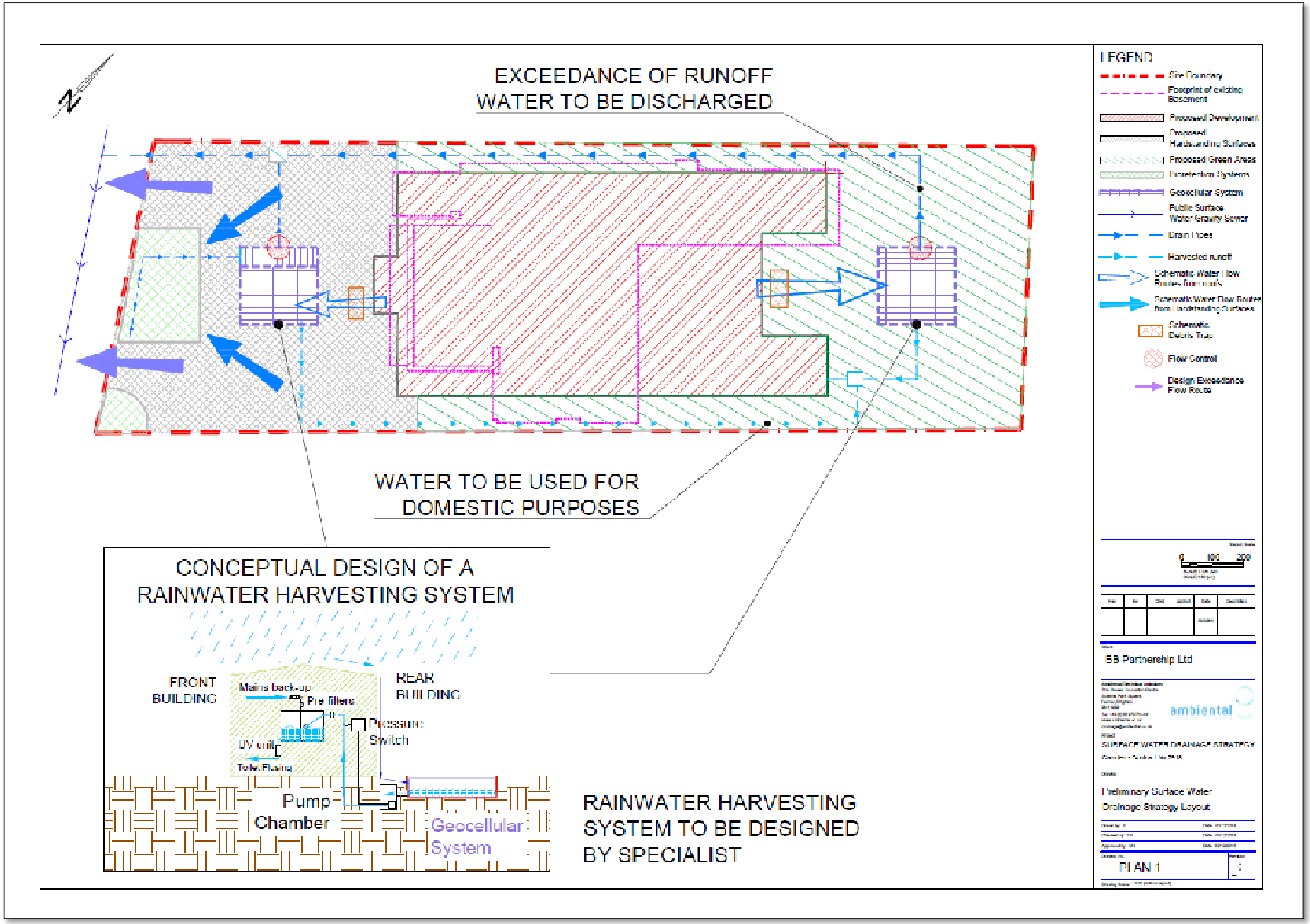
Appendix 4 – Proposed Drainage Strategy

- *Plan 1 – Preliminary Surface Water Drainage Strategy Layout*



Appendix 4, Plan 1 – Preliminary Surface Water Drainage Strategy Layout

Appendix 5 – Information

Surface Water Runoff Calculation Method

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.

Impermeable runoff rates have been calculated using the Modified Rational Method for the impermeable surfaces on site only.

Throughout the calculations a weighted co-efficient has been used, allowing different materials of surface covering on site to be taken into account.

These runoff rates have then been combined to provide the most accurate runoff rate possible for both the existing and proposed site.

Appendix 6 – Surface Water Drainage Pro-forma for new developments

Surface Water Drainage Pro-forma for new developments

This pro forma accompanies our advice note on surface water drainage. Developers should complete this form and submit it to the Local Planning Authority, referencing from where in their submission documents this information is taken. The pro-forma is supported by the Defra/EA guidance on Rainfall Runoff Management and uses the storage calculator on www.UKsuds.com. This pro-forma is based on current industry best practice and focuses on ensuring surface water drainage proposals meet national and local policy requirements. The pro-forma should be considered alongside other supporting SuDS Guidance.

1. Site Details

Site	32 Avenue Road, Camden
Address & post code or LPA reference	32 Avenue Road, Camden, London, NW8 6HT.
Grid reference	526938,183926; TQ269539 / TQ2693883926
Is the existing site developed or Greenfield?	Developed
Is the development in a LFRZ **or in an area known to be at risk of surface or ground water flooding? If yes, please demonstrate how this is managed, in line with** DP23?	No
Total Site Area served by drainage system (excluding open space) **(Ha)***	0.108

* The Greenfield runoff off rate from the development which is to be used for assessing the requirements for limiting discharge flow rates and attenuation storage from a site should be calculated for the area that forms the drainage network for the site whatever size of site and type of drainage technique. Please refer to the Rainfall Runoff Management document or CIRIA manual for detail on this.

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2. Impermeable Area

	Existing	Proposed	Difference (Proposed-Existing)	Notes for developers
Impermeable area (ha)	0.088	0.074	-0.014	If the proposed amount of impermeable surface is greater, then runoff rates and volumes will increase. Section 6 must be filled in. If proposed impermeability is equal or less than existing, then section 6 can be skipped and section 7 filled in.
Drainage Method (infiltration/sewer/watercourse)	Sewer	Sewer	N/A	If different from the existing, please fill in section 3. If existing drainage is by infiltration and the proposal is not, discharge volumes may increase. Fill in section 6

3. Proposing to Discharge Surface Water via

	Yes	No	Evidence that this is possible	Notes for developers
Existing and proposed MicroDrainage calculations	X			Please provide MicroDrainage calculations of existing and proposed run-off rates and volumes in accordance with a recognised methodology or the results of a full infiltration test (see line below) if infiltration is proposed
Infiltration		x	Soils with Poor Infiltration Media.	e.g. soakage tests. Section 6 (infiltration) must be filled in if infiltration is proposed
To watercourse		x	There is not a watercourse close enough to the site.	e.g. Is there a watercourse nearby?
To surface water sewer	x		Use of the Existing Public Sewer Network.	Confirmation from sewer provider that sufficient capacity exists for this connection.
Combination of above		x		e.g. part infiltration part discharge to sewer or watercourse. Provide evidence above.
Has the drainage proposal had regard to the SuDS hierarchy?	X			Evidence must be provided to demonstrate that the proposed Sustainable Drainage strategy has had regard to the SuDS hierarchy as outlined in Section 2.5 above.
Layout plan showing where the sustainable drainage infrastructure will be located on site.	x		See Ambiental SWDS Ref:2918 - Appendix 4, Plan 1 - Preliminary Surface Water Drainage Strategy Layout	Please provide plan reference numbers showing the details of the site layout showing where the sustainable drainage infrastructure will be located on the site. If the development is to be constructed in phases this should be shown on a separate plan and confirmation should be provided that the sustainable drainage proposal for each phase can be constructed and can operate independently and is not reliant on any later phase of development.

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4. Peak Discharge Rates – This is the maximum flow rate at which storm water runoff leaves the site during a particular storm event.

	Existing Rates (l/s)	Proposed Rates (l/s)	Difference (l/s) (Proposed-Existing)	% Difference (difference /existing x 100)	Notes for developers
Greenfield QBAR	0.48	N/A	N/A	N/A	QBAR is approx. 1 in 2 storm event. Provide this if Section 6 (QBAR) is proposed.
1 in 1	17.30	5	-12.2	-71%	Proposed discharge rates (with mitigation) should aim to be equivalent to greenfield rates for all corresponding storm events. As a minimum, peak discharge rates must be reduced by 50% from the existing sites for all corresponding rainfall events.
1 in 30	32.30	5	-27.3	-84%	
1in 100	34.70	5	-29.6	-85%	
1 in 100 plus climate change	N/A	5	N/A	N/A	The proposed 1 in 100 +CC peak discharge rate (with mitigation) should aim to be equivalent to greenfield rates. As a minimum, proposed 1 in 100 +CC peak discharge rate must be reduced by 50% from the existing 1 in 100 runoff rate sites.

5. Calculate additional volumes for storage –The total volume of water leaving the development site. New hard surfaces potentially restrict the amount of stormwater that can go to the ground, so this needs to be controlled so not to make flood risk worse to properties downstream.

	Greenfield runoff volume (m^3)	Existing Volume (m^3)	Proposed Volume (m^3)	Difference (m^3) (Proposed Existing)	Notes for developers
1 in 1	[illegible]	5.79	[illegible]	[illegible]	Proposed discharge volumes (with mitigation) should be constrained to a value as close as is reasonably practicable to the greenfield runoff volume wherever practicable and as a minimum should be no greater than existing volumes for all corresponding storm events. Any increase in volume increases flood risk elsewhere. Where volumes are increased section 6 must be filled in.
1 in 30	20.74	[illegible]	33.67	[illegible]	
1in 100 6 hour	28.3	56.73	47.7	-9.02	
1 in 100 6 hour plus climate change	39.62	79.42	66.78	-12.63	The proposed 1 in 100 +CC discharge volume should be constrained to a value as close as is reasonably practicable to the greenfield runoff volume wherever practicable. As a minimum, to mitigate for climate change the proposed 1 in 100 +CC volume discharge from site must be no greater than the existing 1 in 100 storm event. If not, flood risk increases under climate change.

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6. Calculate attenuation storage – Attenuation storage is provided to enable the rate of runoff from the site into the receiving watercourse to be limited to an acceptable rate to protect against erosion and flooding downstream. The attenuation storage volume is a function of the degree of development relative to the greenfield discharge rate.

		Notes for developers
Storage Attenuation volume (Flow rate control) required to meet greenfield run off rates (m^3)	52.9	Volume of water to attenuate on site if discharging at a greenfield run off rate. Can't be used where discharge volumes are increasing
Storage Attenuation volume (Flow rate control) required to **reduce rates by 50%** (m^3)	21	Volume of water to attenuate on site if discharging at a 50% reduction from existing rates. Can't be used where discharge volumes are increasing
Storage Attenuation volume (Flow rate control) required to meet [OTHER RUN OFF RATE (as close to greenfield rate as possible)] (m^3)	28.2	Volume of water to attenuate on site if discharging at a rate different from the above – please state in 1st column what rate this volume corresponds to. On previously developed sites, runoff rates should not be more than three times the calculated greenfield rate. Can't be used where discharge volumes are increasing
Storage Attenuation volume (Flow rate control) required to **retain rates as existing** (m^3)	14.6	Volume of water to attenuate on site if discharging at existing rates. Can't be used where discharge volumes are increasing
Percentage of attenuation volume stored above ground,	10.795% Bioretention	Percentage of attenuation volume which will be held above ground in swales/ponds/basins/green roofs etc. If 0, please demonstrate why.

7. How is Storm Water stored on site?

Storage is required for the additional volume from site but also for holding back water to slow down the rate from the site. This is known as attenuation storage and long term storage. The idea is that the additional volume does not get into the watercourses, or if it does it is at an exceptionally low rate. You can either infiltrate the stored water back to ground, or if this isn't possible hold it back with on site storage. Firstly, can infiltration work on site?

			Notes for developers
Infiltration	**State the Site's Geology** and known **Source** Protection Zones (SPZ)	London Clay Formation - Clay; Outer Zone (Zone [illegible])	Avoid infiltrating in made ground. Infiltration rates are highly variable and refer to Environment Agency website to identify and source protection zones (SPZ)
	Are infiltration rates suitable?	No	Infiltration rates should be no lower than $1x10^{-6}$ m/s
	State the distance between a proposed infiltration device **base and the ground water** (GW) level	Higher than 3 mBGL	Need 1m (min) between the base of the infiltration device & the water table to protect Groundwater quality & ensure GW doesn't enter infiltration devices. Avoid infiltration where this isn't possible.

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	Were infiltration rates obtained by desk study or infiltration test?	By desk study.	Infiltration rates can be estimated from desk studies at most stages of the planning system if a back up attenuation scheme is provided.
	Is the site contaminated? If yes, consider advice from others on whether infiltration can happen.	Site already developed, thus there is a potential contamination due to petrochemical pollutants of the cars.	Advice on contaminated Land in Camden can be found on our supporting documents webpage Water should not be infiltrated through land that is contaminated. The Environment Agency may provide bespoke advice in planning consultations for contaminated sites that should be considered.
In light of the above, is infiltration feasible?	Yes/No? If the answer is No, please identify how the storm water will be stored prior to release	NO. The storm water will be stored in site cellular storage and bioretention	If infiltration is not feasible how will the additional volume be stored?. The applicant should then consider the following options in the next section.

Storage requirements

The developer must confirm that either of the two methods for dealing with the amount of water that needs to be stored on site.

Option 1 Simple – Store both the additional volume and attenuation volume in order to make a final discharge from site at the greenfield run off rate. This is preferred if no infiltration can be made on site. This very simply satisfies the runoff rates and volume criteria.

Option 2 Complex – If some of the additional volume of water can be infiltrated back into the ground, the remainder can be discharged at a very low rate of 2 l/sec/hectare. A combined storage calculation using the partial permissible rate of 2 l/sec/hectare and the attenuation rate used to slow the runoff from site

		Notes for developers
Please confirm what option has been chosen and how much storage is required on site.	Simple	The developer at this stage should have an idea of the site characteristics and be able to explain what the storage requirements are on site and how it will be achieved.

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8. Please confirm

		Notes for developers
Which Drainage Systems measures have been used, including green roofs?	It is proposed to use cellular storage and Detention Systems	SUDS can be adapted for most situations even where infiltration isn't feasible e.g. impermeable liners beneath some SUDS devices allows treatment but not infiltration. See CIRIA SUDS Manual C697.
Drainage system can contain in the 1 in 30 storm event without flooding	Yes	This a requirement for sewers for adoption & is good practice even where drainage system is not adopted.
Will the drainage system contain the 1 in 100 +CC storm event? If no please demonstrate how buildings and utility plants will be protected.	Yes.	National standards require that the drainage system is designed so that flooding does not occur during a 1 in 100 year rainfall event in any part of: a building (including a basement); or in any utility plant susceptible to water (e.g. pumping station or electricity substation) within the development.
Any flooding between the 1 in 30 & 1 in 100 plus climate change storm events will be safely contained on site.	Yes	Safely: not causing property flooding or posing a hazard to site users i.e. no deeper than 300mm on roads/footpaths. Flood waters must drain away at section 6 rates. Existing rates can be used where runoff volumes are not increased.
How will exceedance events be catered on site without increasing flood risks (both on site and outside the development)?	Exceedance flow routes have been provided.	Safely: not causing property flooding or posing a hazard to site users i.e. no deeper than 300mm on roads/footpaths. Flood waters must drain away at section 6 rates. Existing rates can be used where runoff volumes are not increased. Exceedance events are defined as those larger than the 1 in 100 +CC event.
How are rates being restricted (vortex control, orifice etc)	Orifices and Hydrobrakes.	Detail of how the flow control systems have been designed to avoid pipe blockages and ease of maintenance should be provided.
Please confirm the owners/adopters of the entire drainage systems throughout the development. Please list all the owners.	Property owner will be responsible for maintenance	If these are multiple owners then a drawing illustrating exactly what features will be within each owner's remit must be submitted with this Proforma.
How is the entire drainage system to be maintained?	Details of maintenance are provided within the attached documentation. Also, suppliers must provide appropriate maintenance documentation.	If the features are to be maintained directly by the owners as stated in answer to the above question please answer yes to this question and submit the relevant maintenance schedule for each feature. If it is to be maintained by others than above please give details of each feature and the maintenance schedule. Clear details of the maintenance proposals of all elements of the proposed drainage system must be provided. Details must demonstrate that maintenance and operation requirements are economically proportionate. Poorly maintained drainage can lead to increased flooding problems in the future.

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9. Evidence Please identify where the details quoted in the sections above were taken from. i.e. Plans, reports etc. Please also provide relevant drawings that need to accompany your proforma, in particular exceedance routes and ownership and location of SuDS (maintenance access strips etc

Pro-forma Section	Document reference where details quoted above are taken from	Page Number
Section 2	Surface Water Drainage Strategy Report. Section 3 - Development Description and Site Area. Paragraph 3.3	10
Section 3	Surface Water Drainage Strategy Report . Section 4 - Drainage Strategy	24
Section 4	Surface Water Drainage Strategy Report . Section 4 - Runoff Rates: Appendix 3 - Calculations	14 to 15: 53
Section 5	Surface Water Drainage Strategy Report . Section 4 - Additional Volumes for Storage: Appendix 3. Calculations	17 to 19: 60 to 62
Section 6	Surface Water Drainage Strategy Report . Section 4 - Attenuation Storage. Appendix 3. Calculations	19 to 20: 53 to 89
Section 7	Surface Water Drainage Strategy Report . Section 4 - Drainage Strategy. Appendix 4. Plan 1.	24 to 25: 88
Section 8	Surface Water Drainage Strategy Report . Section 4 - Drainage Strategy. Appendix 4. Plan 1.	24 to 25: 88

The above form should be completed using evidence from the Flood Risk Assessment and site plans. It should serve as a summary sheet of the drainage proposals and should clearly show that the proposed rate and volume as a result of development will not be increasing. If there is an increase in rate or volume, the rate or volume section should be completed to set out how the additional rate/volume is being dealt with.

This form is completed using factual information from the Flood Risk Assessment and Site Plans and can be used as a summary of the surface water drainage strategy on this site.

Form Completed By [illegible]

Qualification of person responsible for signing off this pro-forma [illegible]

Company Ambiental

On behalf of (Client's details) BB Partnership Ltd

Date [illegible]

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