HEYNE | TILLETT | STEEL
STRUCTURAL ENGINEERS

Surface Water Management Analysis

73-75 Avenue Road
London

Job no: 1247

November 2014

Contents

Appendices

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Approved by:	Neil Cameron/Andy Heyne	

1 Introduction

This report has been produced to shows adequate surface water management information for Condition 10 of a planning notice for a residential development at 73-75 Avenue Road, London.

The surface water management analysis will demonstrate that suitable sustainable drainage systems (SuDS) are incorporated into the post development drainage design so that the pre and post development surface water run-off rates are not exceeded, and to demonstrate that no sub-surface water flow regimes are interrupted because of the development.

The pre development site has an area of 2400m² and currently consists of an impermeable area of 840m² (roofs, paved areas etc), and a permeable area of 1560m² (lawn, flower beds, shrubs etc).

The post development site also has an area of 2400m² and will consist of an impermeable area of 1500m² (Inc area of basement), and a permeable are of 900m².

Based on a topographical survey, there is an existing manhole and outfall pipe from the pre development site that connects to the public sewer within Avenue Road. It is proposed that the post development surface water run-off will re-use the existing outfall pipe to the public sewer.

The details of the pre development surface water network is unclear, and therefore is not accurately possible to calculate the pre development surface water run-off rates to the public sewer.

The post development surface water run-off rates are therefore to be restricted to 'greenfield' to ensure that the pre development run-off rates are not exceeded.

2 Pre-development Surface Water Run-Off Rates – 'Greenfield'

In order to know what the post development surface water run-off rates are to be, the pre development greenfield run-off rates are to be calculated.

Existing Greenfield Run-Off Rates

Relevant documents state that in order to calculate the greenfield run-off rates on small catchments less than 25km², the IH 124 QBAR equation (and the equation for the instantaneous time to peak for the unit hydrograph approach) is to be used.

The IH method is based on the Flood Studies Report (FSR) approach and is developed for use on catchments less than 25 km². It yields the Mean Annual Maximum Flood (QBAR). This reference also recommends the use of Ciria Book 14 to generate Growth Factors. These are used to convert QBAR to different return periods for different regions in the UK.

The input variables to establish QBAR are:

- Return Period (years) — Results based on a range of return periods and the specified RP.
- Area — Catchment Area (ha) which is adjusted to km² for use in the equation.
- SAAR — Average annual rainfall in mm (1941-1970) from FSR figure II.3.1.
- Soil — Soil index of the catchment from FSR figure I.4.18 and/or Wallingford Procedure Volume 3. Soil classes 1 to 5 have Soil Index values of 0.15, 0.3, 0.4, 0.45 and 0.5 respectively.
- Urban — Proportion of area urbanised expressed as a decimal
- Region Number — Region number of the catchment based on FSR Figure I.2.4.

$QBAR_{rural}$ (l/s)

The output variables to establish $QBAR_{rural}$ are calculated using the following formula (equation yields m^3/s):

$$QBAR_{rural} = 0.00108 \times AREA^{0.89} \times SAAR^{1.17} \times SOIL^{2.17}$$

The IH 124 Variables (taken from FSR) that are specific to this site are as follows:-

Return Periods 1 in 2, 1 in 30 and a 1 in 100 year storms

- Area 0.24 ha
- SAAR 600
- Soil 0.300
- Urban 0.00
- Region Number 6

Based on the above variables and formula the $QBAR_{rural}$ for the existing site = 0.37 l/s

Now that the $QBAR_{rural}$ has been calculated the existing greenfield run-off rates can be calculated for each of the storm events.

Ciria C697 Table 4.2 identifies the growth factors for each of the storm events, based on the known $QBAR_{rural}$ figure. The growth factors from the table vary depending on the site location. In this case hydrometric area (Region Number) is 10.

Based on the figures derived from the table, the growth factors and the existing greenfield run-off rates for each of the storm events is as follows:-

Storm Event	$QBAR_{rural}$	Growth Factor (C697 Table 4.2)	Existing Greenfield Run-off Rate
Q_2	0.37 l/s	0.88	**0.33 l/s**
Q_{30}	0.37 l/s	2.67	**0.99 l/s**
Q_{100}	0.37 l/s	3.19	**1.18 l/s**

Table 1

These calculations have been checked against XP Solution WinDes computer software and can be found in Appendix A. The area entered for the calculation to conform to the IH method is 50 ha. The results of this are to be pro rata to the actual area of the site (e.g. 0.24 / 50 = 0.0048, 0.024 x 76.1 l/s = 0.37 l/s)

3 Post-development Surface Water Run-Off Calculations

As previously stated the post development site will consist of an impermeable area of 1500m² / 0.15ha.

The variables and calculations to determine the post development surface water run-off rates have been checked against XP Solution WinDes computer software and can be found in Appendix B.

The variables used to calculate the surface water run-off rates for the post development site are as follows:-

- Proposed Impermeable Area = 0.15 ha
- M5 – 60 (mm) = 20.600
- Ratio R = 0.438
- C_v (Summer) = 0.750
- C_v (Winter) = 0.840
- Time of Entry = 5 minutes
- Climate Change = 30%*[1] (1 in 100 year storm)

*[1] PPS25 Table B.2 shows that the peak rainfall intensity will increase by 30% by the years 2085 to 2115. As the development is residential the life span of the building will fall in to these years.

If no SuDS or flow controls were designed in the post development surface water drainage network then the free flowing surface water run-off rates would be:

- Q_2 = 29 l/s
- Q_{30} = 52 l/s
- Q_{100} + CC = 91 l/s

4 Post-development Surface Water Management – SuDS

As the details in Sections 2.0 and 3.0 the non-restricted post development surface water run-off rate exceed the required pre development greenfield run-off rates for each of the storm events.

Therefore, SuDS features are to be used in the post development design in order to reduce the post development surface water run-off and discharge volume to the required rates.

The preferred SuDS methods are to use retention ponds, wetlands and detentions basin. Where these cannot be used soakaways, swales and other infiltration rates are preferred. If none of the above a practical then green roofs, permeable paving (non-infiltration) and flow controls can be used.

Due to the layout of the new residential building; the proposed building having a basement, and the need for a garden space for the development to be viable the use of wetlands, ponds or detention basins is not a SuDS option.

Initial geotechnical survey show that the site is highly likely to be underlined by London Clay and therefore is classed as an impermeable material. This means the use of any infiltration for the post development site is not a viable option.

Due to the ground condition the alternative would be to discharge the surface water run-off from the site to the existing public sewer within Avenue Road via a flow control manhole.

As the surface water is to connect to a public sewer, the demarcation chamber, flow control an outfall pipe are to adhere to Sewers for Adoption 7th Edition.

Sewer for Adoption 7th Edition states that the minimum diameter for an outfall pipe is to be 100mm. This is to reduce the risk of blockage within the pipe and subsequently reduce the risk of flooding on or off the development site.

As the outfall pipe / flow control is to be minimum of 100mm, the pre development greenfield run-off rates shown in Table 1 cannot be achieved. The surface water run-off rates are therefore to be reduced to 5 l/s for all storm events.

The run-off rates of 5 l/s also adheres to the requirements of Code for Sustainable Homes where is states that the post development run-off rates cannot exceed the pre development, and that if the post development discharge volume exceeds the pre development then the surface water is to be restricted to either QBAR, peak 1 in 1 year run-off rate, 2 l/s/ha, or 5 l/s whichever is the greater.

As the surface water is to be restricted there will be a requirement for below ground attenuation. This is to be achieved in the sub-base of permeable paving within the driveway and car parking area, the sub-base of the permeable paving in the terrace area, and a granular base below a lawn are for the development site.

5 Post-development Surface Water Management – Sub-Surface Water Flow

Historical information and maps show that there could be a potential sub-surface water flow at a depth of between 0.6 – 1.7m below ground.

As the proposed building has a basement the surface water flow may be interrupted.

In order to prevent the interruption of flow it is proposed that a 500mm wide granular filled trench is built around the basement wall at a depth of 1.80m.

The trench will be filled with 20mm no fines gravel which has a 30%v void ratio and will be wrapped in a permeable geotextile to stop fines and maintain the voids.

This will be built for the entire length of the basement wall and will convey the sub-surface water around the basement structure without interrupting the flow.

6 Surface Water Attenuation Requirements and Locations

The required surface water attenuation volumes for the development when restricted to 5 l/s are as follows:-

Storm Event	Restricted Discharge Rate	Flow Control Type	*1 Attenuation Range	*2 Approximate Attenuation Required
Q_2	5 l/s	Hydro-Brake	8.7m³ - 16m³	12m³
Q_{30}	5 l/s	Hydro-Brake	23m³ - 37m³	30m³
Q_{100} + 30% CC	5 l/s	Hydro-Brake	50m³ - 72m³	61m³

*1 Attenuation ranges shown in table are estimated volume for a storage structure. The required storage structure volume will vary depending upon the drainage network design, i.e. if a network consists of large pipes and manholes the storage structure required will be lower, and if the network consists of smaller pipes and manholes the storage structure required will be higher. The volume is also estimated as the critical storm duration for the proposed surface water network is not yet known.

*2 Approximate attenuation required is the average volume of the attenuation range. This figure is to be confirmed during the full design of the surface water drainage network.

These results have been calculated by the XP Solutions WinDes computer software where extracts of the results can be found in Appendix C.

Now the approximate volumes of attenuation are now know the locations of the stored volume can be accessed.

Permeable Paving – Driveway Area

Driveway area	-	$343m^2$		
Sub-base depth	-	300mm		
Sub-base material	-	20mm no fines aggregate		
Material void ration	-	30%		
Volume in sub-base	-	(343 x 0.3) x 0.3	-	**$30.9m^3$**

Permeable Paving – Terrace Area

Terrace area	-	$140m^2$		
Sub-base depth	-	300mm		
Sub-base material	-	20mm no fines aggregate		
Material void ration	-	30%		
Volume in sub-base	-	(140 x 0.3) x 0.3	-	**$12.6m^3$**

Lawn Area – Granular Sub-Base

Lawn area	-	$145m^2$		
Sub-base depth	-	300mm		
Sub-base material	-	20mm no fines aggregate		
Material void ration	-	30%		
Volume in sub-base	-	(140 x 0.3) x 0.3	-	**$13.1m^3$**

As the above calculation show the total below ground attenuation volume achieved within the base and sub-base of the driveway, terrace and lawn area is $56.6m^3$, which is adequate for the storms up to the 1 in 30 year event.

The required attenuation volume for the 1 in 100 year storm is approximately $61m^3$ which equates to an additional $4.4m^3$ of water that is to be attenuated. This additional volume of water is to be stored so that it does not flood any building on site, and does not discharge off the site.

The drainage network can be designed so that the additional volume of water can disperse onto the lawn area as this is at a lower level in the site. The depth of the water on the lawn in a 1 in 100 year storm event will be:

Additional Attention - Lawn Area

Lawn area	-	$145m^2$		
Additional Volume	-	$4.4m^3$		
Depth of Water	-	4.4 / 145	-	**30mm**

As the above calculation shows the depth of the water during the 1 in 100 year storm event will be 30mm which can be easily retained.

7 Conclusion and Recommendations

The post development surface water rates from the site are to be reduced so they do not exceed the pre development rates.

As shown in Section 2.0, the pre development greenfield run-off rates are too low for the post development rates to adhere to, as it will require an orifice that is less than 100mm in diameter and will be subjected to blockage.

The post development surface water run-off will discharge into the public sewer at a maximum rate of 5 l/s.

Due to the ground conditions not being adequate for infiltration techniques the proposed surface water discharge will be controlled via a flow control chamber.

As the proposed surface water discharge is to be restricted to that of the existing there will be a requirement for attenuation for the restricted volume of water to prevent flooding.

Regulations state that no flooding is to occur for up to a 1 in 30 year storm, and that all attenuation volumes must be stored underground.

The additional surface water volume generated in the 1 in 100 year storm event can be attenuated in the forms of ponds, swales and other above ground storage structures. Flooding during a 1 in 100 year storm event is also accepted as long as the flood water does not leave the proposed site, and does not threaten property or life.

The volume of water attenuated for up to the 1 in 30 year storm will be underground within the base and sub-base of the driveway, terrace and lawn are of the development.

The additional volume of water attenuated for up to the 100 year storm will be at surface level within a dry swale situated along the southern boundary of the site.

The sub-surface water flow will not be interrupted as a 500mm wide, 1.80m deep granular trench is to be built around the basement wall to convey any water flows around the structure.

Appendix A – Pre-development ‘Greenfield’ surface water run-off rates

IH 124 Mean Annual Flood

Input

Return Period (years)	2	Soil	0.300
Area (ha)	50.000	Urban	0.000
SAAR (mm)	600	Region Number	Region 6

Results	**l/s**
QBAR Rural	76.1
QBAR Urban	76.1
Q2 years	67.0
Q1 year	64.7
Q2 years	67.0
Q5 years	97.4
Q10 years	123.3
Q20 years	152.4
Q25 years	163.4
Q30 years	172.4
Q50 years	199.3
Q100 years	242.7
Q200 years	285.3
Q250 years	299.0
Q1000 years	392.6

Appendix B – Post-development ‘mock’ surface water run-off rates

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)	2	Add Flow / Climate Change (%)	0
M5-60 (mm)	20.600	Minimum Backdrop Height (m)	0.200
Ratio R	0.438	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

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)
1.000	10.000	0.125	80.0	0.150	5.00	0.0	0.600	o	300
1.001	10.000	0.059	169.5	0.000	0.00	0.0	0.600	o	300

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)
1.000	50.00	5.09	10.000	0.150	0.0	0.0	0.0	1.76	124.4	20.3
1.001	50.00	5.23	9.875	0.150	0.0	0.0	0.0	1.20	85.2	20.3

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.840	Foul Sewage per hectare (l/s)	0.000
Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	30.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Run Time (mins)	60
Manhole Headloss Coeff (Global)	0.500	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		

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Winter
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.600	Storm Duration (mins)	15
Ratio R	0.438		

Summary of Results for 15 minute 2 year Winter (Storm)

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

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status
1.000	Mock S1	10.118	-0.182	0.000	0.32	0.0	28.5	OK
1.001	Mock S2	10.020	-0.155	0.000	0.47	0.0	28.6	OK

Summary of Results for 15 minute 30 year Winter (Storm)

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

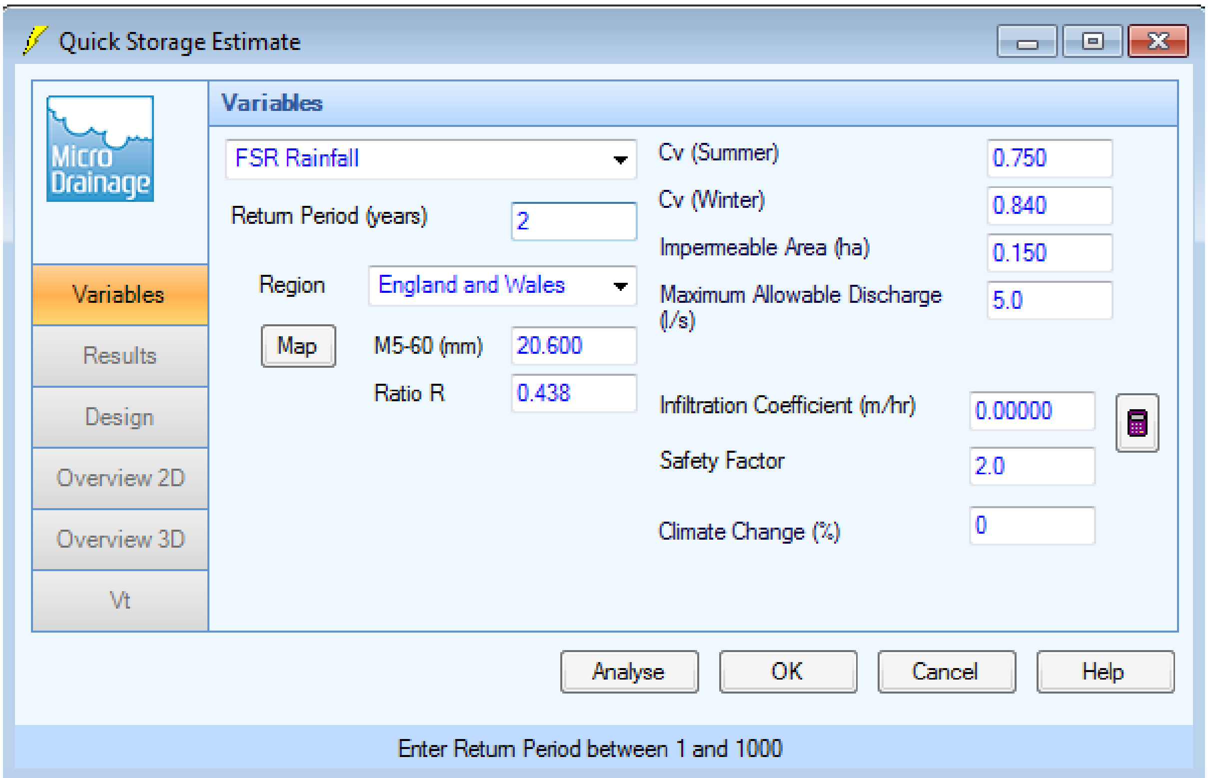
PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m^3)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status
1.000	Mock S1	10.172	-0.128	0.000	0.61	0.0	54.2	OK
1.001	Mock S2	10.097	-0.078	0.000	0.88	0.0	54.3	OK

Summary of Results for 15 minute 100 year Winter (Storm)

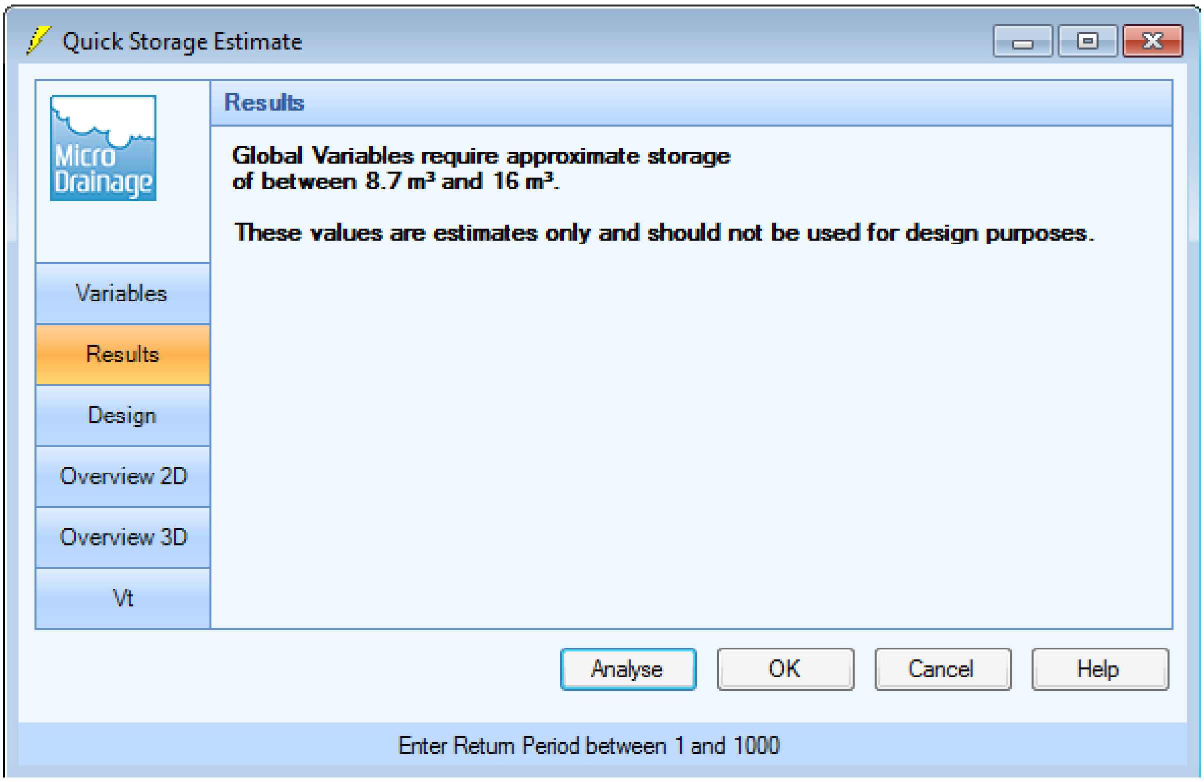
Margin for Flood Risk Warning (mm) 300.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS Status ON

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status
1.000	Mock S1	10.378	0.078	0.000	1.03	0.0	90.9	SURCHARGED
1.001	Mock S2	10.239	0.064	0.000	1.49	0.0	91.2	SURCHARGED

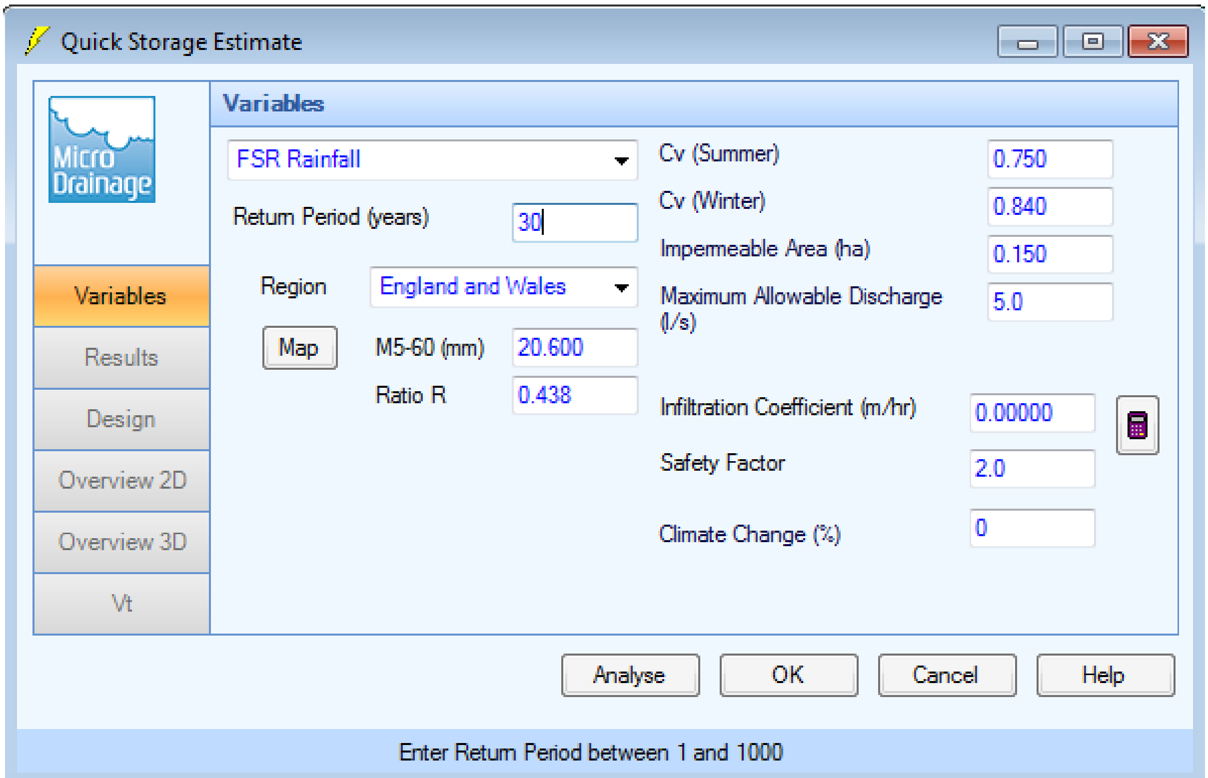
Appendix C - Approximate Attenuation Volumes



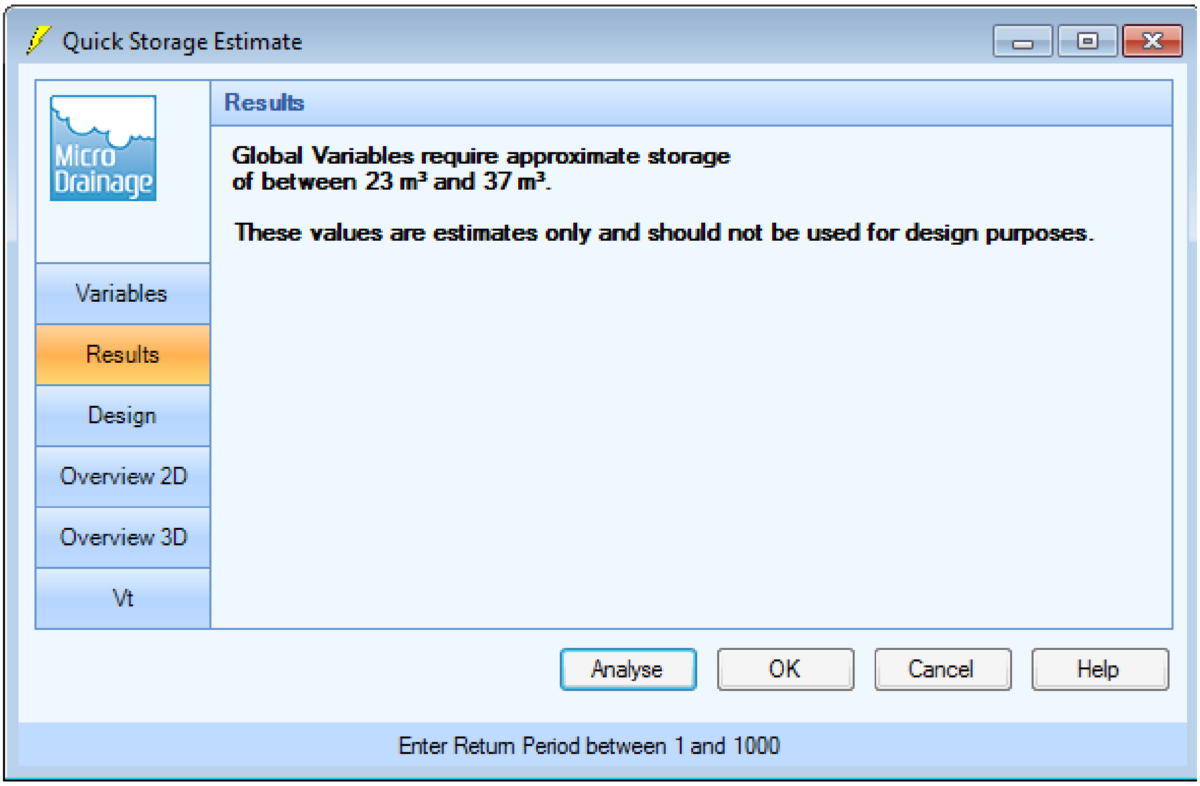
1 in 2 Year Storm Variables



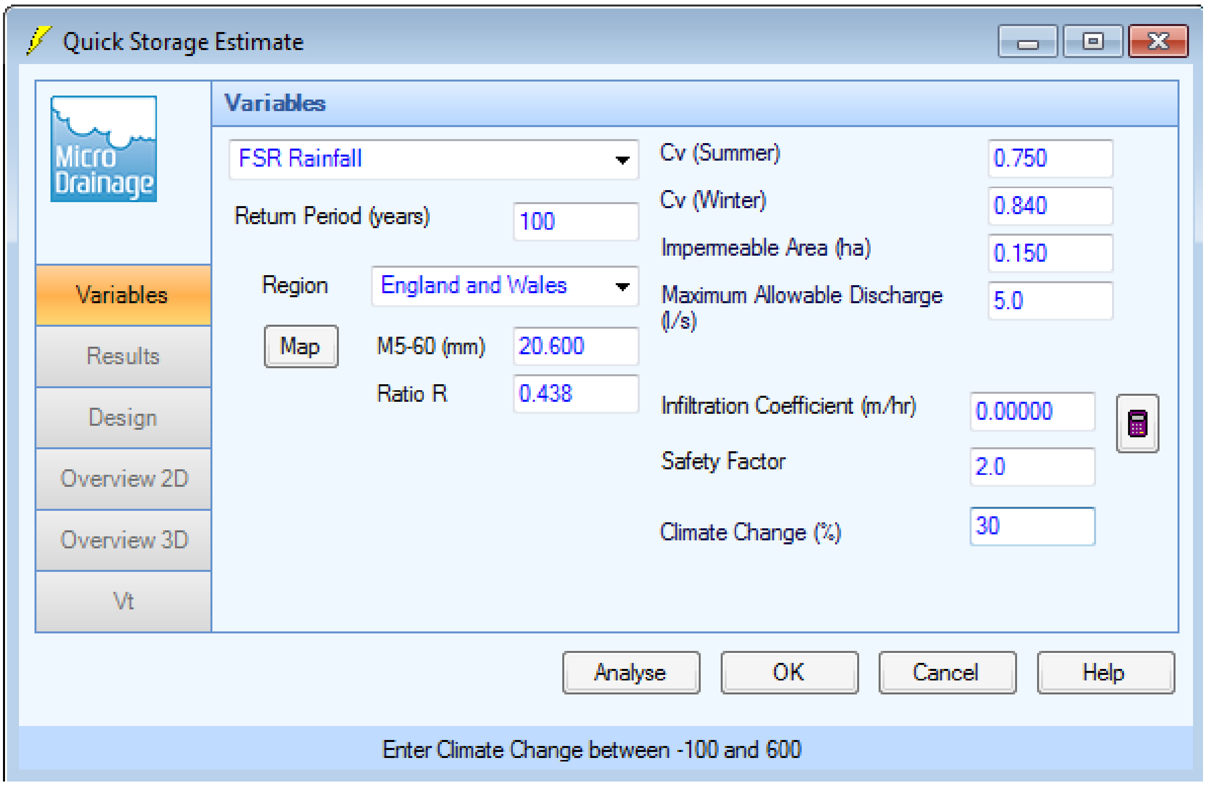
1 in 2 Year Storm Approximate Attenuation Range



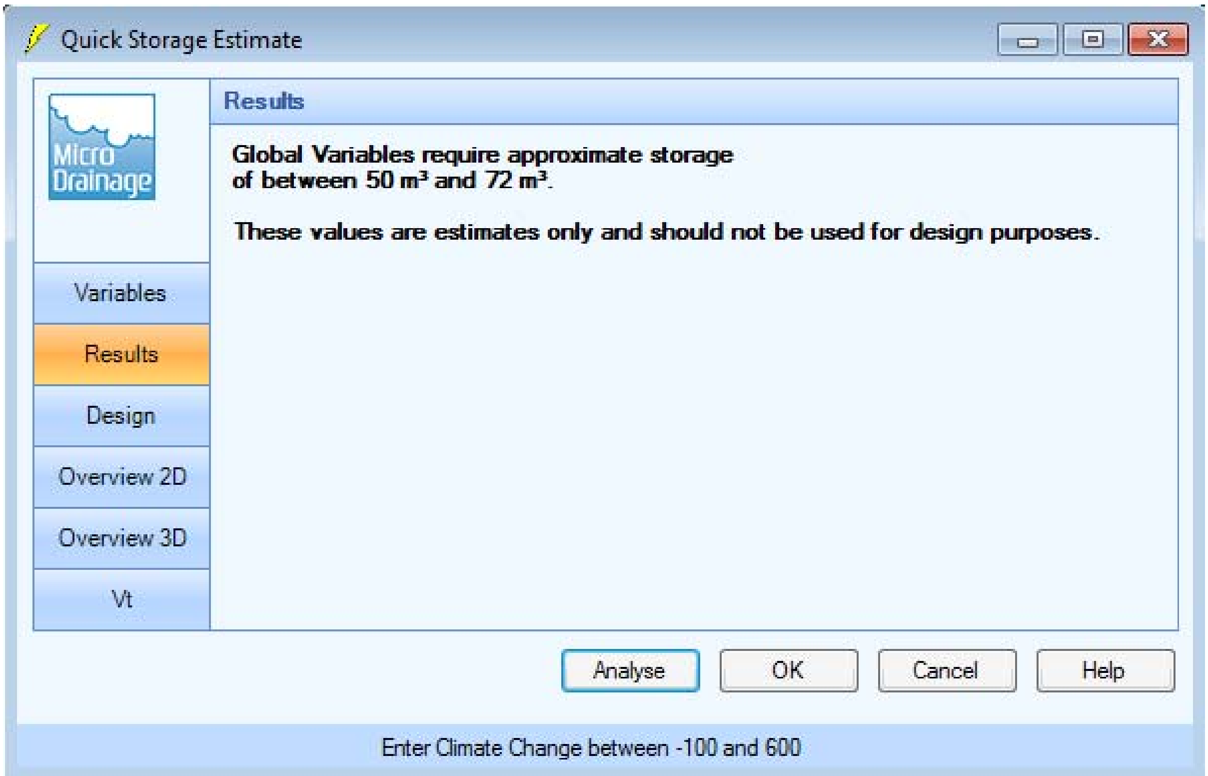
1 in 30 Year Storm Variables



1 in 30 Year Storm Approximate Attenuation Range

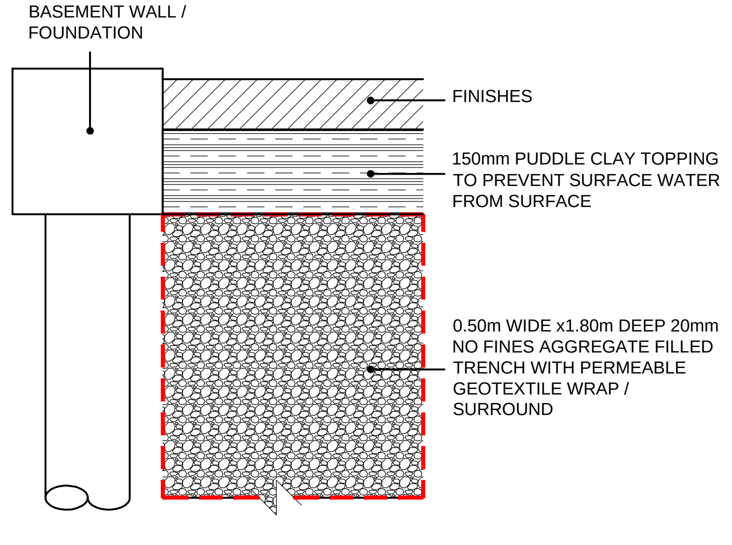


1 in 100 Year Storm Variables

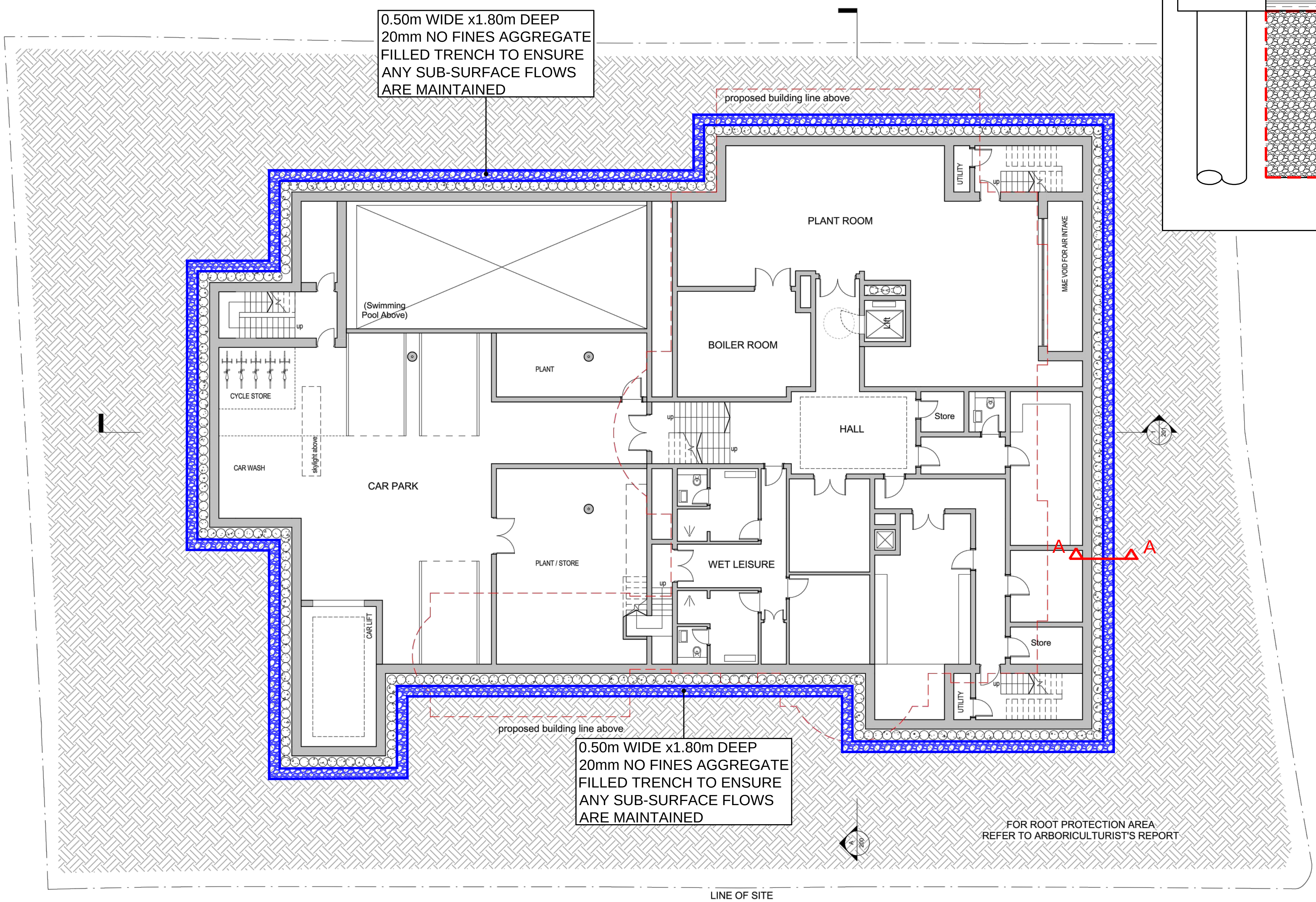


1 in 100 Year Storm + Climate Change Approximate Attenuation Range

Appendix D - Surface water management analysis
Drawing SK01& SK02



SECTION A - A



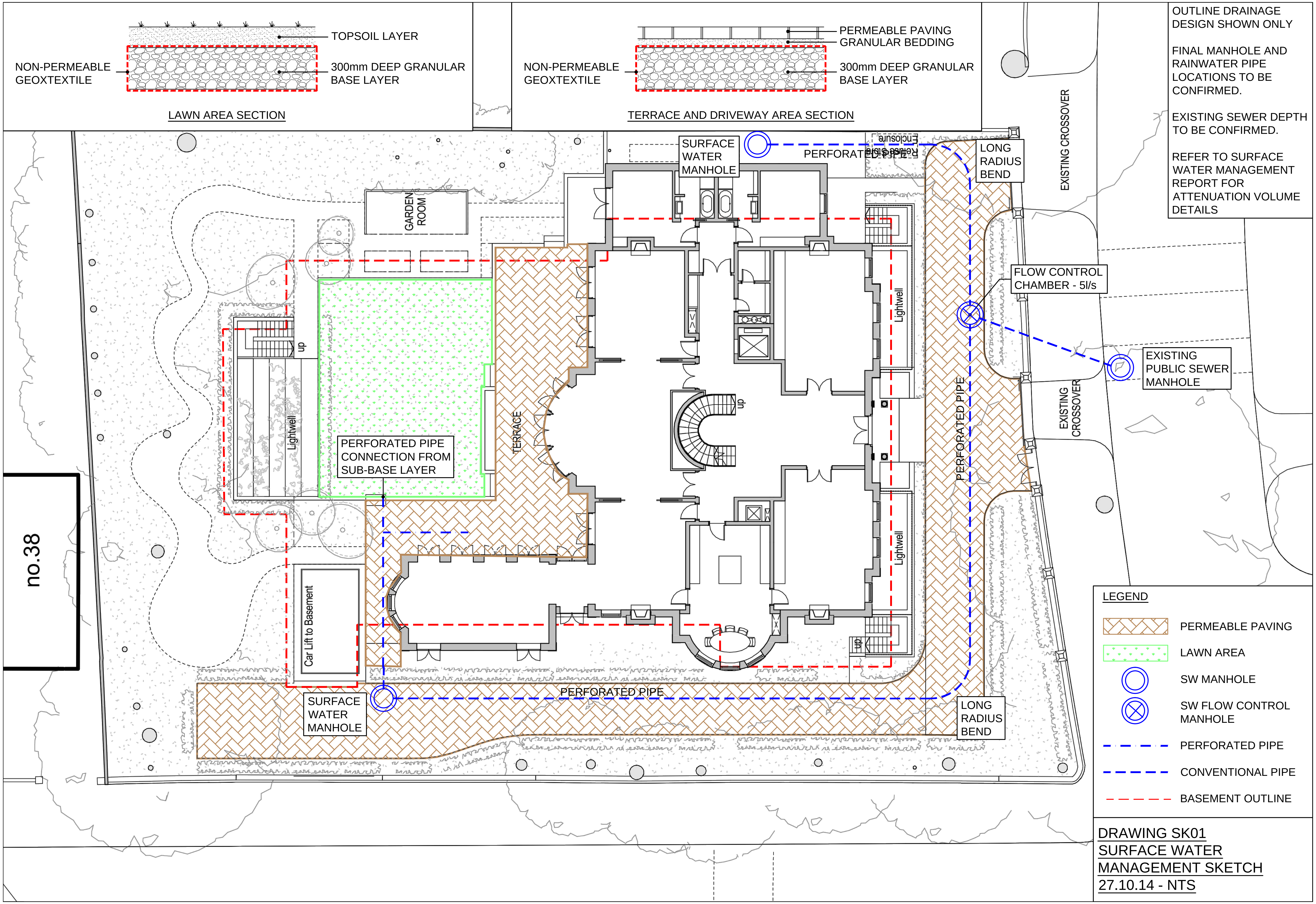
BASEMENT FLOOR PLAN

0m 1m 2m 5m
GRAPHIC SCALE

LEGEND

TRENCH ALONG BASEMENT WALL / FOUNDATIONS

DRAWING SK02
SURFACE WATER MANAGEMENT SKETCH
27.10.14 - NTS


NON-PERMEABLE GEOXTEXTILE
TOPSOIL LAYER
300mm DEEP GRANULAR BASE LAYER
LAWN AREA SECTION
NON-PERMEABLE GEOXTEXTILE
PERMEABLE PAVING
GRANULAR BEDDING
300mm DEEP GRANULAR BASE LAYER
TERRACE AND DRIVEWAY AREA SECTION
OUTLINE DRAINAGE DESIGN SHOWN ONLY
FINAL MANHOLE AND RAINWATER PIPE LOCATIONS TO BE CONFIRMED.
EXISTING SEWER DEPTH TO BE CONFIRMED.
REFER TO SURFACE WATER MANAGEMENT REPORT FOR ATTENUATION VOLUME DETAILS
SURFACE WATER MANHOLE
PERFORATED PIPE
LONG RADIUS BEND
EXISTING CROSSOVER
GARDEN ROOM
FLOW CONTROL CHAMBER - 5l/s
EXISTING PUBLIC SEWER MANHOLE
EXISTING CROSSOVER
Lightwell
up
PERFORATED PIPE CONNECTION FROM SUB-BASE LAYER
TERRACE
PERFORATED PIPE
no.38
Car Lift to Basement
SURFACE WATER MANHOLE
PERFORATED PIPE
LONG RADIUS BEND
LEGEND
PERMEABLE PAVING
LAWN AREA
SW MANHOLE
SW FLOW CONTROL MANHOLE
PERFORATED PIPE
CONVENTIONAL PIPE
BASEMENT OUTLINE
DRAWING SK01
SURFACE WATER MANAGEMENT SKETCH
27.10.14 - NTS

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