45 Holmes Road, London, NW5 3AN

Surface Water Management Report

Prepared by

Nimbus
Engineering Consultants

In association with

qed

1 INTRODUCTION

1.1 Appointment

Nimbus Engineering Consultants Ltd have been appointed by QED Structures to assess and provide a solution on the management of Surface Water run off at the proposed mixed use development at 45 Holmes Road, London, NW5 3AN.

This report has been written by Sadia Luckett, who has a degree in Civil and Environmental Engineering and has 13 years of experience in drainage design, Sustainable Urban Drainage Design, and also experience of working on Flood risk assessments for small site in flood zones 1 to 3, and to larger developments over 1 hectare in flood zones 1 to 3.

1.2 Objectives

This report will address the following planning condition set by the London Borough of Camden, regarding this development:

> Prior to the relevant part of the development commencing, details of a sustainable urban drainage system shall be submitted to and approved in writing by the local planning authority. Such system shall be based on demonstrating 50% attenuation of all runoff. The system shall be implemented as part of the development and thereafter retained and maintained.
>
> Reason: To reduce the rate of surface water run-off from the buildings and limit the impact on the storm-water drainage system in accordance with policies CS13 and CS16 of the London Borough of Camden Local Development Framework Core Strategy and policies DP22, DP23 and DP32 of the London Borough of Camden Local Development Framework Development Policies.

This report will address the concerns raised by the Borough and provide details on a suitable Sustainable Urban Drainage System in order to reduce the surface water runoff leaving the site and show that the proposed development will not increase Flood Risk at the site or elsewhere.

Furthermore, our proposed drainage scheme significantly reduces the burden on the existing Thames Water mains network, by proposing a rainwater harvesting system.

Our scheme will also increase green space and softscaping which will allow biodiversity to thrive and create amenity value.

1.3 Limitations

The general limitations of this report are:

- A number of data and information sources have been used to prepare this report. Whilst Nimbus Engineering believes them to be trustworthy, Nimbus Engineering is unable to guarantee the accuracy of data and information that has been provided by others;
- This report has been prepared using best data and information that was available at the time of writing. There is the potential for further information or data to become available, leading to changes in the conclusions drawn by this report, for which Nimbus Engineering cannot be held responsible.

2 SITE DETAILS

2.1 Basic Information

Site Name	45 Holmes Road, London, NW5 3AN
Site Address	45 Holmes Road, London, NW5 3AN
Site Area	0.13 hectares
Purpose of Development	Mixed use
Existing Land Use	Brownfield
OS NGR	528791E, 185040N
County	Greater London
Country	England
Local Planning Authority	The London Borough of Camden

2.2 Site Location

The location of the project site is shown in Figure 2-1.

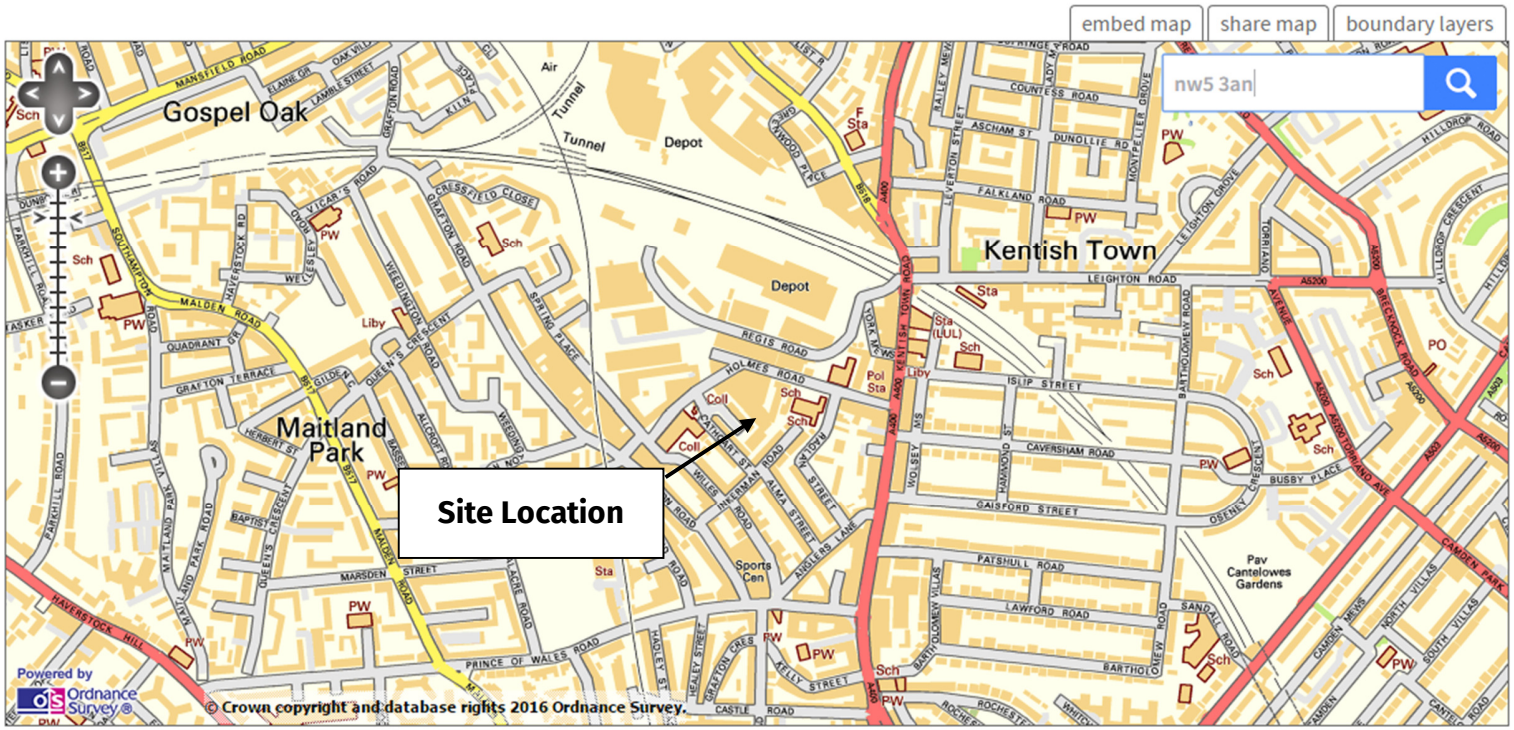

Figure 2-1. Location of project site (source: OS Opendata).

2.3 Pre-Development Site Layout

The existing site layout, with the site boundary indicated, is shown in Figure 2-2.

The site is situated on the south side of Holmes Road, to the west of Kentish Town and Kentish Town Road. The site area is 0.13 ha.

2.4 Pre-Development Site Use

The existing building on the site is a mixed use building, over a number of floors and arranged around a shared access/courtyard area. It is nether listed, nor located within a conservation area.

2.5 Post-Development Site Layout

The proposed layout for the developed site is shown in Figure 2-3.

2.6 Post-Development Site Use

The proposed development sees 8 residential units over two floors, plus a mezzanine level, above commercial units located on the ground floor.

Figure 2-2. Site layout and boundary. (care of Lynas Smith Architecture)

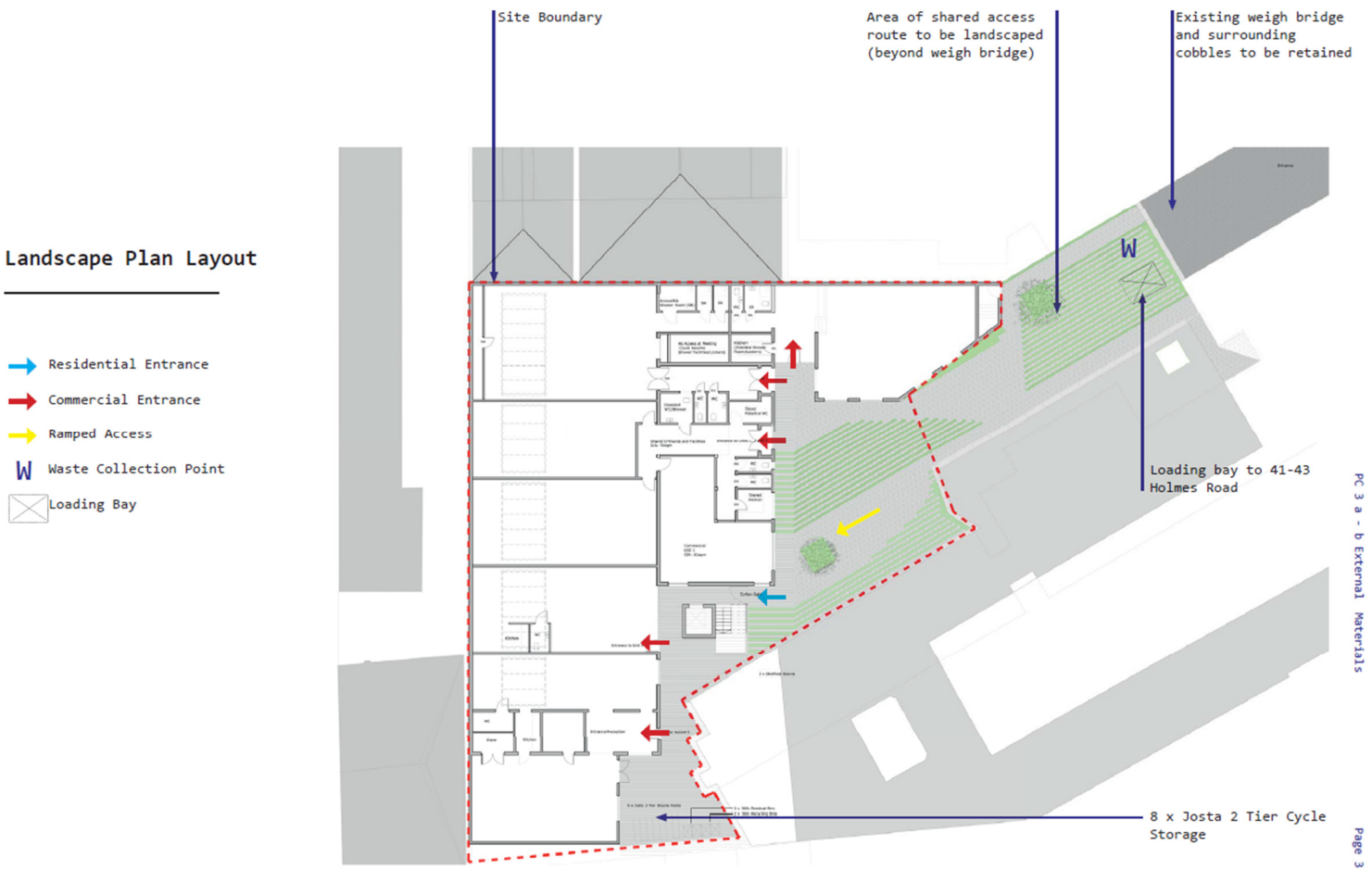

Figure 2-3. Proposed layout of developed site. (care of Lynas Smith Architecture)

3 PLANNING POLICIES

3.1 National Planning Policy

NPPF's technical guidance states:

"The effect of development is generally to reduce the permeability of at least part of the site. This markedly changes the site's response to rainfall. Without specific measures, the volume of water that runs off the site and the peak run-off flow rate is likely to increase. Inadequate surface water drainage arrangements in new development can threaten the development itself and increase the risk of flooding to others."

3.2 Local Planning Policy

This report has been written in conjunction with the following local planning policies:

- Mayor's London Plan, Policy 5.13;
- Camden Local Development Framework Core Strategy, CS13;
- Camden Local Development Policies, DP22 and DP23.

Mayor's London Plan, Policy 5.13 states that:

> 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…

CS13 of the Camden Local Development Framework Core Strategy focusses on minimising surface water flood risk, as it states by:

> h) making sure development incorporates efficient water and foul water infrastructure;

i) requiring development to avoid harm to the water environment, water quality or drainage systems and prevents or mitigates local surface water and downstream flooding, especially in areas up-hill from, and in, areas known to be at risk from surface water flooding such as South and West Hampstead, Gospel Oak and King's Cross...

DP22 of the Camden Local Development Policies requires development must:

b) incorporate green or brown roofs and green walls wherever suitable.

DP22 requires that development be resilient to climate change, by including appropriate measures. The ones relevant to this report are stated as:

g) limiting run-off;

h) reducing water consumption;

Within DP23, Camden Council requires developments to reduce their water consumption, their pressure on the combined sewer network and reduce risk of flooding, as they state by:

a) incorporating water efficient features and equipment and capturing, retaining and re-using surface water and grey water on-site;

b) limiting the amount and rate of run-off and waste water entering the combined storm water and sewer network through the methods outlined in part a) and other sustainable urban drainage methods to reduce the risk of flooding;

c) reducing the pressure placed on the combined storm water and sewer network from foul water and surface water run-off and ensuring developments in the areas identified by the North London Strategic Flood Risk Assessment and shown on Map 2 as being at risk of surface water flooding are designed to cope with the potential flooding;

d) ensuring that developments are assessed for upstream and downstream groundwater flood risks in areas where historic underground streams are known to have been present;

4 SUSTAINABLE URBAN DRAINAGE SYSTEMS

The total site area is 1300 m^2, and the impermeable areas of the site prior to development are also 1300 m^2. Pre and post development surface water runoff calculations showing the peak flow rate leaving the site can be found in Appendix A.

Following the development at this site, the impermeable areas will reduce to 900 m^2, comprising part of the roof area, as well as hard standing areas.

Surface water arising from a developed site should, as far as is practicable, be managed in a sustainable manner to mimic the surface water flows arising from the site prior to the proposed development, while reducing the flood risk to the site itself and elsewhere, taking climate change into account.

Reducing the rate of surface water discharge from urban sites is one of the most effective ways of reducing and managing flood risk.

Traditional piped surface water systems work by removing surface water from our developments as quickly as possible, however this can cause various adverse impacts:

- Increased downstream flooding, and sudden rises in flow rates and water levels in local water courses.
- Reduction in groundwater levels and dry weather flows in watercourses.
- Reduce amenity and adversely affect biodiversity due to the surface water run-off containing contaminants such as oil, organic matter and toxic materials.

SUDS are defined as a sequence of management principles and control structures designed to drain surface water in a more sustainable fashion than conventional piped drainage techniques. SUDS should utilise the natural landscape of an area which as well as slowing down the rate of runoff provides a number of environmental, ecological and social benefits.

These include:

- Protection and enhancement of water quality – As well as providing on-site attenuation, SUDS treat the water, resulting in an improved quality of water leaving the site. This is achieved when the water passes through fine soils and the roots of specially selected plants, pollutants washed off the hard landscaping by rainfall will be safely removed before the water reaches the natural receiving water course.
- A sympathetic approach to the environmental setting by providing opportunities to create habitats for flora and fauna in urban watercourses and open spaces.
- Meeting the amenity and social needs of the local community and residents in the creation of attractive green spaces.

The various types of SUDS include:

Permeable paving	
Soakaways;	

Swales and basins;	
Bioretention/ rain gardens;	
Green roofs and rainwater re-use;	
Infiltration trenches and filter drains	
Ponds and wetlands.	

Preferably a combination of these techniques should be used as part of the surface water management train, and it is important for all stakeholders, such as developers, architects, landscape architects and engineers to work together at the planning stage in order to determine a feasible solution.

Due to site constraints, mainly lack of available space, and the underlying geology at the site, soakaways, swales, ponds and wetlands and bioretention areas and filter drains are not suitable at this site.

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Regarding the drainage hierarchy cited in Policy 5.13 of the London Plan, we were not able to include the following:-

3) Attenuation in Ponds or open water features;

The inner London Urban Nature of the site restricts the use and introduction of ponds and swales.

5) Discharge rainwater to local watercourses;

There are no watercourses local to the site.

5 EXISTING DRAINAGE NETWORK

- Thames Water combined sewer assets exist on two sides of the site, on Holmes Road and Inkerman Road
- On site drainage consists of a series of poorly located gullies and slow drains and we believe local flooding will occur on a regular basis.

6 PROPOSED SOLUTION

Our proposed SUDS solution increases biodiversity and amenity space and lessens the burden on the existing Thames Water infrastructure in accordance with the London Plan and the Borough of Camden's SUDS guidelines, with the intention of treating rainfall at source across the site.

Any over land surface water run off entering the site from neighbouring properties will be caught and discharged directly to the Thames Water drainage network.

There are three main areas receiving rainfall at this site, permeable paving at ground level, a green roof and the main roof. In order to deal with as much surface water runoff generated from the proposed development site at source, we have sought to increase as much soft scape as reasonably possible.

At ground level we propose the introduction of permeable paving across the site which will further increase the soft scape. The permeable paving will sit over a substrate of free draining material such as 300mm Type 6N DoT SfHW, or similar approved. This permeable paving will also help to cleanse and filter rainwater with lessening effect from 1:1 to 1:30 year return storm events. However, due to the graded nature of the site the flow of surface water from a 1:100 year return storm event will be too intense to allow filtration. In this event the surface water will flow directly over the paving and into the network of slot drains and carrier pipes that sit in front of the building. The slot drains have been designed to accommodate a 1:100 year return storm event

The paved areas of the external ground level will fall naturally towards tree pits, which will also provide a small amount of attenuation, as well as treatment at source.

An area of green roof is proposed and this will reduce or attenuate the peak flow rate leaving this area as well as treating the rainwater by filtering solid particles such as silts. Details of this green roof can be found in the Lynas Smith

Proposed Landscape Planning document, and is also addressed by Lynas Smith in their response to Planning Condition Number 8.

Although the green roof will decrease the area of existing hardscape on the site, a large portion of the roof surface will remain impermeable. Surface water run off from both roofs will fall into rainwater pipes over a network of slot drains, as mentioned above, and conveyed to a rainwater harvesting tank. Any excess will overflow into an attenuation tank.

The proposed attenuation tank will store rainfall from a 1:100 year return storm event plus 30% for climate change before being discharging into the local Thames Water infrastructure at 18.5 l/s which is a 50 % reduction of the existing site's 1 in 1 year storm event peak flow. This in line with the requirements of the London Borough of Camden's policies for 50% attenuation of the existing 1 in 1 year peak rate of run off. Calculations showing the existing sites 1 in 1 year and 1 in 100 year peak flow rates can be found in Appendix A. The design parameters for this model were confirmed as being acceptable by the London Borough of Camden and this correspondence can be found in Appendix C. We also modelled the tank based on a 6-hour duration, however the volume produced by this was less than the peak time of 0.5 hours. The volume of the peak storm was therefore used to size the attenuation. These calculations can also be found in Appendix A.

The controlled attenuated flow will discharge in to the local Thames Water network via a small pumping station and an existing carrier run. All new connections will be made on the site of 45 Holmes Road and hence working within the public highway will not be necessary.

We believe the Sustainable Urban Drainage System hierarchy has been considered fully, and the above solution meets the requirements of the London Plan, as well as the London Borough of Camden's policies C13, DP22 and DP23, as discussed in section 1 of this report.

To help promote rainwater re-use, in line with the London Borough of Camden's policies to save water, we also propose a rain water harvesting system which will provide 8000litres of water to the commercial units at ground level. Using an assumed average annual rainfall of 650mm in London, equates to 54mm per month. Over the flat roof of 900m^2, this generates 48600litres of rainfall per month. If it takes 18 days to serve 25 people with 8000litres, 25 people would require a further 5,300litres from the Thames Water network. The rainwater harvesting system will use 16% (8000/48600) of rainfall over the roof in giving the commercial space 60% (8000/13300) of water supply that would otherwise come from the Thames Water network.

7 TIMESCALE AND MAINTENANCE OF WORKS

All drainage works will be completed prior to first occupation and there will be no adoption of any of the drainage works within the site, and the homeowner will be responsible in overseeing the long term maintenance of all the communal drains.

Aquacell (or similar) attenuation systems should be checked every 3 to 6 months for the accumulation of debris/silt and cleaned as necessary.

Any flow control device and rainwater harvesting system should be checked every 3 months for the accumulation of debris/silt, in order to ensure that there are no blockages, and cleaned as necessary.

Regular jet-washing of permeable surfacing can be used to keep joints and voids clear, this should be carried out every 6 months.

Green roofs will require a minimum of two inspections a year to ensure that the outlets etc are clear or blockages and maintained.

8 CONCLUSIONS

The purpose of this report and associated calculations and drawing, is to present a SuDS solution to satisfy the London Borough of Camden Council Planning Condition No. 7 relating to flooding and surface water flows arising due to the proposed development at this site.

Our proposed Sustainable Urban Drainage System (SUDS) at 45 Holmes Road will comprise the following attributes;

- It will increase biodiversity and enhance amenity value;
- It will significantly reduce the burden on the existing Thames Water mains network to deliver water supply by the re-use of rainwater;
- It has the ability to prevent local flooding due to rainfall across the site within a 1:100 year return storm event.

The timetable of these associated building works is to complete all drainage prior to occupation of dwellings. Maintenance requirements are also included in this report. We feel these SuDS proposals are economically proportionate to the overall development scheme at 45 Holmes Road, and we therefore consider that all requirements of the planning condition have been met, and therefore can be discharged.

APPENDIX A -SURFACE WATER RUN OFF CALCULATIONS

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Job No.	C1623
Sheet no.	1
Date	02/03/16

MasterDrain
HY 9.2

Project	45 Holmes Road	By	Checked	Reviewed
Title	Pre and post devt SW run off calcs	S.L		

Data:-

Hydrology:-

Location = Camden (G.London)		WRAP	= 4
Long reference = 525185		Grid reference	= TQ2585
M5-60 (mm)	= 21.1	SAAR (mm/yr)	= 650
r	= 0.44	Soil	=0.47
Hyd. area	= 6	Hyd. zone	= 8
Hydrograph	= Winter	Area = England and Wales	

Site values used in design:-

Total site area	= 0.1600 ha	Climate change factor	= 30%
Pre-dev area drained	= 0.1600 ha	Post-dev area drained	= 0.1300 ha
Imperm runoff factor	= 98%	Perm runoff factor	= 20%

Pre-development

Area to soakaways	= 0.0000 ha	Area to other SUDS	= 0.0000 ha
Perv. area to SUDS	= 0.0000 ha	Pre-dev flow to drain	= 0.00 l/s

Post-development

Area to soakaways	= 0.0000 ha	Area to other SUDS	= 0.0000 ha
Perv. area to SUDS	= 0.0000 ha	Post-dev flow to drain	= 0.00 l/s

Calculations:-

Revised Post-dev Imperm. area = 0.130 ha
Equiv. Post-dev Imperm. area = 0.127 ha
Equiv. Post-dev Perm. area = 0.006 ha
Total Pre-dev equiv. area ha = 0.157 ha
Total Post-dev equiv. area ha = 0.133 ha
100 yr 6 hour mean intensity = 10.51mm/hr

Results:-

Pre-dev peakflow runoff (l/s) (m^3/s)

R.P.	15	30	60	120	240	360	480	600	Max	CCF	Final	R.P.
1	37.0	24.2	15.2	9.3	5.5	4.1	3.3	2.8	37.0	N/A	37.0	1
30	90.5	57.9	35.4	21.0	12.2	8.8	7.0	5.9	90.5	N/A	90.5	30
100	117.8	76.0	46.6	27.6	15.9	11.4	9.1	7.6	117.8	N/A	117.8	100

Post-dev peakflow runoff (l/s)

R.P.	15	30	60	120	240	360	480	600	Max	CCF	Final	R.P.
1	31.5	20.6	12.9	7.9	4.6	3.5	2.8	2.3	31.5	30	40.9	1
30	77.0	49.3	30.1	17.9	10.4	7.5	6.0	5.0	77.0	30	100.1	30
100	100.2	64.6	39.6	23.5	13.5	9.7	7.7	6.4	100.2	30	130.3	100

100 year 6 hour (x Climate Change Factor) storm gives:-
Pre-dev runoff volume m^3 = 98.9m^3
Post-dev rainfall volume = 109.3m^3
Post-dev volume m^3 (excess above SUDS) = 109.3m^3
100 yr 6 hour mean intensity = 10.51mm/hr
Pre-dev volume to drain at 0 l/s = 0.0 m^3
Post-dev volume to drain at 0 l/s = 0.0 m^3
Post-dev storage volume = 109.3m^3
Post-dev 5mm imperm volume = 6.5 m^3
Post-dev 5mm perm volume = 1.5 m^3

$Q_{BAR(rural)}$ = 0.708 l/s or 4.427 l/s/ha or 0.001 cumecs - from IoH 124.

The rainfall rates are calculated using the location specific values above in accordance with the Wallingford procedure.

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Job No.	Sheet no.	Date
C1623	2	02/03/16

MasterDrain
HY 9.2

Project	By	Checked	Reviewed
45 Holmes Road	S.L		

Title: **Pre and post devt SW run off calcs**

Data summary.

Use the data below for the SUR1 form

Site areas:-

Total site area =	0.1600 ha ;1600.0 m²	[3A]
Pre-development impermeable area =	0.1600 ha	[3B]
Pre-development permeable area =	0.0000 ha	
Post-development impermeable area =	0.1300 ha	[3C]
Post-development permeable area =	0.0300 ha	

Peak runoff:-

Pre-development 1 year storm (15min) =	37.0 l/s	[6A]
Pre-development 100 year storm (15min) =	117.8 l/s	[6C]
Post-development 1 year storm (15min) =	31.5 l/s	[6B]
Post-development 100 year storm (15min)=	100.21 l/s	[6D]

Greenfield runoff:-

$Q_{BAR(rural)}$ = 0.708 l/s or 4.427 l/s/ha or 0.001 cumecs - from IoH 124.

Climate change factor:-

CCF = 30%

Volumes:-

Pre-development 100 yr/6hr storm [12A]= 128.5m³
Post-development 100 yr/6hr storm (add. volume with no SUDS) [12B]= 109.3m³
Post-development 100 yr/6hr storm (add. volume with SUDS) = 109.3m³
Post-development add. predicted volume (No SUDS) [12C] = -19.2m³

You may also require

Data relating to the infiltration test calculations (if applicable)
Evidence to show runoff reduction (if applicable)
Information on calculation methods (if applicable see next sheet)

Note

Numbers in square brackets relate to the
Nov. 2010 v1.1 / issued 11/02/10 copy of SUR1

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Job No.	Sheet no.	Date
C1623	3	02/03/16

MasterDrain
HY 9.2

Project	By	Checked	Reviewed
45 Holmes Road	S.L		

Title: **Pre and post devt SW run off calcs**

Definitions and methods

Hydrology

The hydrological constants are derived from the Wallingford maps. They are used to calculate location specific rainfall figures.

Site values and factors

Areas of the site should be entered in hectares (10000 m²). If the Pre-development site is a green field, this box is blank.
Climate Change Factor is initially set at 20% - this may be changed as required.
Greenfield runoff is calculated using the method described in IoH 124.
Runoff factors

The impermeable runoff factor is initially set at 98%
The permeable runoff factor is initially set at 20%

Note: the CCF and the runoff factors may be changed by the user to suit the development
The areas draining to soakaways and other SUDS are entered in the appropriate box (in hectares)

Calculations

The post-development area is reduced by subtracting the areas that drain to soakaways or other SUDS, to give a revised figure.
All areas are then multiplied by the appropriate runoff factor to give an equivalent area with 100% runoff.
These are then summated.
This gives a total pre-development equivalent area, and a similar figure for the post-development area.
The 'Post-dev volume to drain (no SUDS)' gives the total runoff to drain if no SUDS were used.

Results

The pre- and post-development areas are subjected to 1,30 and 100 year return period storms with a duration of 15 to 600 minutes.
The Revised Post-dev Imperm. area is the area (in ha) that is not going to SUDS x impervious runoff factor.
The runoff rates are calculated for the chosen hydrograph (Summer or Winter) as l/s. Figures in red indicate m³/s
The peak value is measured, multiplied by the CCF and the total maximum rate is shown.
The pre- and post-development volumes for a 100 year / 6 hour storm are calculated from the area under the hydrograph curve.
Post-dev volume (i.e. excess above SUDS) is that volume produced by the drained area that does not go to SUDS.
Qbar(rural) is calculated in accordance with the procedure laid down in IoH 124

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Job No.	Sheet no.	Date
C1623	1	13/03/16

MasterDrain SW

Project	By	Checked	Reviewed
45 Holmes Road	S.L		

Title: **Hydrograph storage calcs (Winter profile) for Camden (G.London)**

Data:-

Hydrology:-

Grid reference = TQ2585
M5-60 (mm) = 21.1
WRAP/Soil = 4 / 0.45
Return period = 100
Climate change factor = 30%
Pipeline storage = 0.0 m³
Offline storage = 0.0 m³

Location = Camden (G.London)
r = 0.44
SAAR (mm/yr) = 650
Mean intensity = 90.7mm/hr for a .5 hour storm
Storm duration = .5 hrs
Available MH storage = 0.0 m³

Percentage runoff = 90.0% (manual setting)

Imperv. area = 1200 m²
Total area = 1200 m²
Total runoff = 49.0 m³
Storage (m³) = 24.8 m³ (Sum of all balance quantities)
Total rainfall depth = 45.4 mm

Pervious area = 0 m²
Equiv area = 1080 m² (Tot. area x % runoff).
Discharge rate = 18.500 l/s

Calculations :-

Time (hrs)	%Mean intens	Rain mm/hr	Inflow (m3)	Outflow (m3)	Balance (m3)	Cumulative (m3)
0.005	20.0	18.1	0.098	0.333	0.000	0.000
0.010	20.0	18.1	0.098	0.333	0.000	0.000
0.015	21.0	19.0	0.103	0.333	0.000	0.000
0.020	21.0	19.0	0.103	0.333	0.000	0.000
0.025	22.0	20.0	0.108	0.333	0.000	0.000
0.030	23.0	20.9	0.113	0.333	0.000	0.000
0.035	24.0	21.8	0.118	0.333	0.000	0.000
0.040	26.0	23.6	0.127	0.333	0.000	0.000
0.045	27.0	24.5	0.132	0.333	0.000	0.000
0.050	29.0	26.3	0.142	0.333	0.000	0.000
0.055	31.0	28.1	0.152	0.333	0.000	0.000
0.060	32.0	29.0	0.157	0.333	0.000	0.000
0.065	33.0	29.9	0.162	0.333	0.000	0.000
0.070	34.0	30.8	0.167	0.333	0.000	0.000
0.075	36.0	32.7	0.176	0.333	0.000	0.000
0.080	38.0	34.5	0.186	0.333	0.000	0.000
0.085	39.0	35.4	0.191	0.333	0.000	0.000
0.090	40.0	36.3	0.196	0.333	0.000	0.000
0.095	42.0	38.1	0.206	0.333	0.000	0.000
0.100	45.0	40.8	0.220	0.333	0.000	0.000
0.105	49.0	44.4	0.240	0.333	0.000	0.000
0.110	53.0	48.1	0.260	0.333	0.000	0.000
0.115	57.0	51.7	0.279	0.333	0.000	0.000
0.120	62.0	56.2	0.304	0.333	0.000	0.000
0.125	66.0	59.9	0.323	0.333	0.000	0.000
0.130	71.0	64.4	0.348	0.333	0.015	0.015
0.135	77.0	69.8	0.377	0.333	0.044	0.059
0.140	84.0	76.2	0.411	0.333	0.078	0.137
0.145	91.0	82.5	0.446	0.333	0.113	0.250
0.150	98.0	88.9	0.480	0.333	0.147	0.397
0.155	105.0	95.2	0.514	0.333	0.181	0.579
0.160	114.0	103.4	0.558	0.333	0.225	0.804
0.165	125.0	113.4	0.612	0.333	0.279	1.083
0.170	135.0	122.5	0.661	0.333	0.328	1.412
0.175	143.0	129.7	0.700	0.333	0.367	1.779
0.180	154.0	139.7	0.754	0.333	0.421	2.200
0.185	164.0	148.8	0.803	0.333	0.470	2.671
0.190	173.0	156.9	0.847	0.333	0.514	3.185
0.195	183.0	166.0	0.896	0.333	0.563	3.748
0.200	194.0	176.0	0.950	0.333	0.617	4.366

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Job No.	Sheet no.	Date	By	Checked	Reviewed
C1623	2	13/03/16	S.L		

MasterDrain SW

Project 45 Holmes Road

Title Hydrograph storage calcs (Winter profile) for Camden (G.London)

Calculations (cont.) :-

Time (hrs)	%Mean intens	Rain mm/hr	Inflow (m3)	Outflow (m3)	Balance (m3)	Cumulative (m3)
0.205	204.0	185.0	0.999	0.333	0.666	5.032
0.210	212.0	192.3	1.038	0.333	0.705	5.737
0.215	219.0	198.7	1.073	0.333	0.740	6.477
0.220	226.0	205.0	1.107	0.333	0.774	7.251
0.225	233.0	211.4	1.141	0.333	0.808	8.060
0.230	239.0	216.8	1.171	0.333	0.838	8.897
0.235	244.0	221.3	1.195	0.333	0.862	9.760
0.240	248.0	225.0	1.215	0.333	0.882	10.641
0.245	249.0	225.9	1.220	0.333	0.887	11.528
0.250	250.0	226.8	1.225	0.333	0.892	12.420
0.255	250.0	226.8	1.225	0.333	0.892	13.311
0.260	249.0	225.9	1.220	0.333	0.887	14.198
0.265	248.0	225.0	1.215	0.333	0.882	15.080
0.270	244.0	221.3	1.195	0.333	0.862	15.942
0.275	239.0	216.8	1.171	0.333	0.838	16.780
0.280	233.0	211.4	1.141	0.333	0.808	17.588
0.285	226.0	205.0	1.107	0.333	0.774	18.362
0.290	219.0	198.7	1.073	0.333	0.740	19.102
0.295	212.0	192.3	1.038	0.333	0.705	19.807
0.300	204.0	185.0	0.999	0.333	0.666	20.473
0.305	194.0	176.0	0.950	0.333	0.617	21.091
0.310	183.0	166.0	0.896	0.333	0.563	21.654
0.315	173.0	156.9	0.847	0.333	0.514	22.168
0.320	164.0	148.8	0.803	0.333	0.470	22.639
0.325	154.0	139.7	0.754	0.333	0.421	23.060
0.330	143.0	129.7	0.700	0.333	0.367	23.428
0.335	135.0	122.5	0.661	0.333	0.328	23.756
0.340	125.0	113.4	0.612	0.333	0.279	24.035
0.345	114.0	103.4	0.558	0.333	0.225	24.261
0.350	105.0	95.2	0.514	0.333	0.181	24.442
0.355	98.0	88.9	0.480	0.333	0.147	24.589
0.360	91.0	82.5	0.446	0.333	0.113	24.702
0.365	84.0	76.2	0.411	0.333	0.078	24.780
0.370	77.0	69.8	0.377	0.333	0.044	24.824
0.375	71.0	64.4	0.348	0.333	0.015	24.839
0.380	66.0	59.9	0.323	0.333	0.000	24.829
0.385	62.0	56.2	0.304	0.333	0.000	24.800
0.390	57.0	51.7	0.279	0.333	0.000	24.746
0.395	53.0	48.1	0.260	0.333	0.000	24.673
0.400	49.0	44.4	0.240	0.333	0.000	24.580
0.405	45.0	40.8	0.220	0.333	0.000	24.467
0.410	42.0	38.1	0.206	0.333	0.000	24.340
0.415	40.0	36.3	0.196	0.333	0.000	24.203
0.420	39.0	35.4	0.191	0.333	0.000	24.061
0.425	38.0	34.5	0.186	0.333	0.000	23.914
0.430	36.0	32.7	0.176	0.333	0.000	23.758
0.435	34.0	30.8	0.167	0.333	0.000	23.591
0.440	33.0	29.9	0.162	0.333	0.000	23.420
0.445	32.0	29.0	0.157	0.333	0.000	23.244
0.450	31.0	28.1	0.152	0.333	0.000	23.062
0.455	29.0	26.3	0.142	0.333	0.000	22.871
0.460	27.0	24.5	0.132	0.333	0.000	22.671
0.465	26.0	23.6	0.127	0.333	0.000	22.465
0.470	24.0	21.8	0.118	0.333	0.000	22.250
0.475	23.0	20.9	0.113	0.333	0.000	22.029
0.480	22.0	20.0	0.108	0.333	0.000	21.804
0.485	21.0	19.0	0.103	0.333	0.000	21.574
0.490	21.0	19.0	0.103	0.333	0.000	21.344
0.495	20.0	18.1	0.098	0.333	0.000	21.109
0.500	20.0	18.1	0.098	0.333	0.000	20.874

Storage volume (m^3) = 24.8 m^3 (Sum of all balance quantities)

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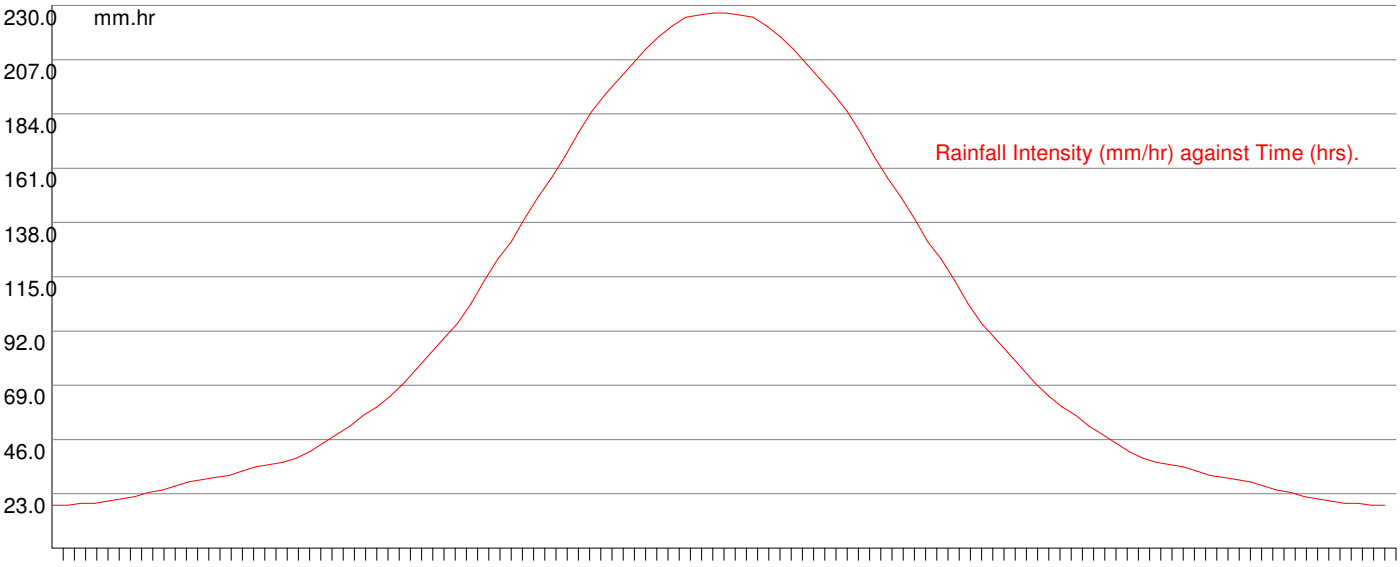
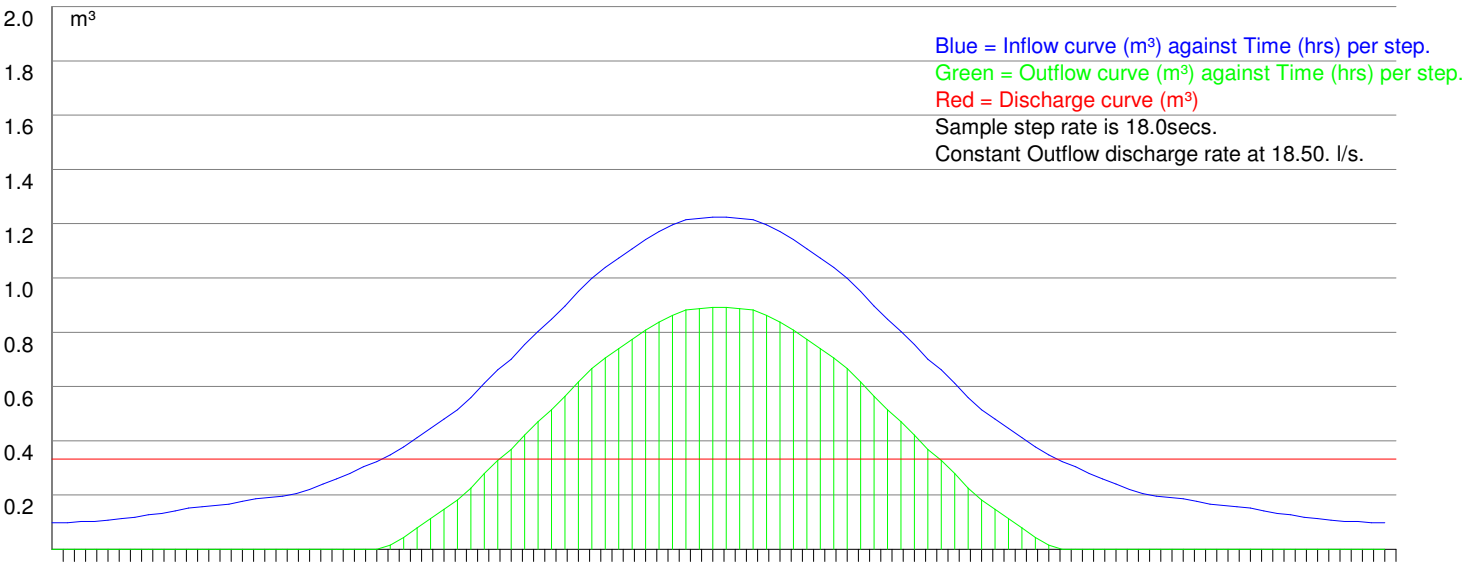
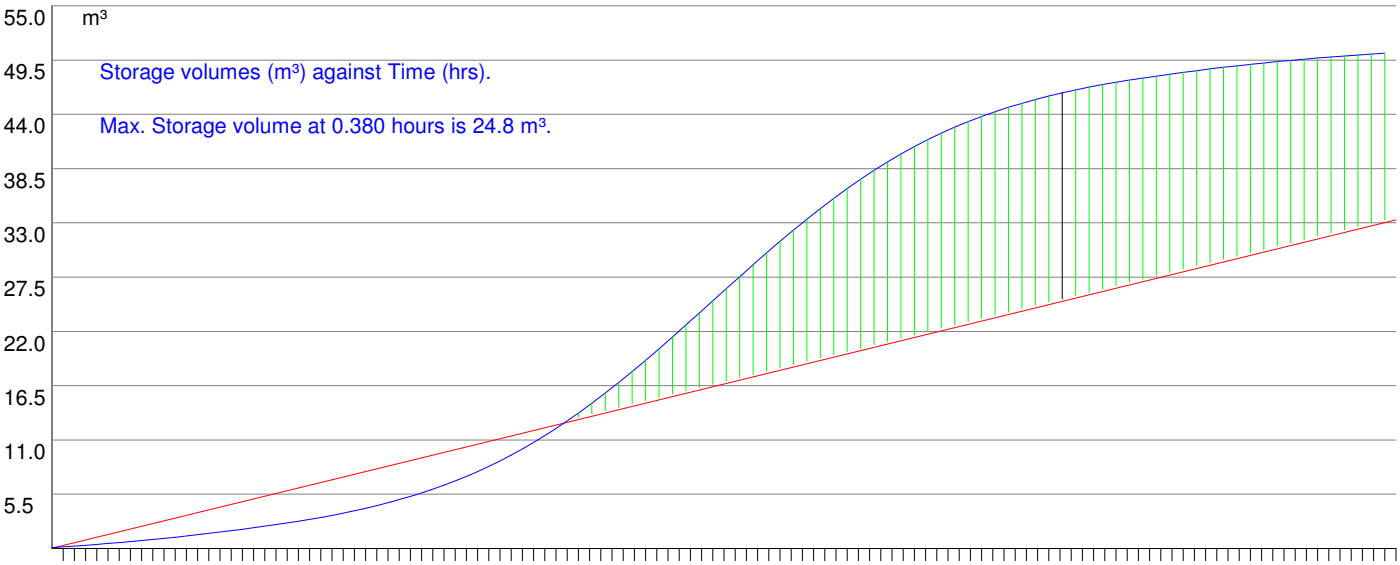
Job No.	C1623
Sheet no.	3
Date	13/03/16
By	S.L
Checked	
Reviewed	

Project **45 Holmes Road**

Title **Hydrograph storage calcs (Winter profile) for Camden (G.London)**







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Job No. C1623			
Sheet no. 4			
Date 13/03/16			
Project 45 Holmes Road	By S.L	Checked	Reviewed
Title Hydrograph storage calcs (Winter profile) for Camden (G.London)			

Maximum storage volumes for varying duration storms.

Storm length (hrs)	Max. Vol (m^3)	Max. Vol time	Mean intens (mm/hr)	Step time. (mins)	Peak found
0.25	0.00	0.00	1.35	60.0	
0.5	0.00	---	0.96	90.0	
225	0.00	---	0.68	135.0	
300	0.00	---	0.54	180.0	
375	0.00	---	0.45	225.0	
450	0.00	---	0.38	270.0	
525	0.00	---	0.34	315.0	
600	0.00	---	0.30	360.0	
675	0.00	---	0.27	405.0	
750	0.00	---	0.25	450.0	
825	0.00	---	0.23	495.0	
900	0.00	---	0.21	540.0	
975	0.00	---	0.20	585.0	
1050	0.00	---	0.19	630.0	
1125	0.00	---	0.18	675.0	
1200	0.00	---	0.17	720.0	
1275	0.00	---	0.16	765.0	
1350	0.00	---	0.15	810.0	
1425	0.00	---	0.15	855.0	
1500	0.00	---	0.14	900.0	
1575	0.00	---	0.13	945.0	
1650	0.00	---	0.13	990.0	
1725	0.00	---	0.12	1035.0	
1800	0.00	---	0.12	1080.0	
1875	0.00	---	0.12	1125.0	
1950	0.00	---	0.11	1170.0	
2025	0.00	---	0.11	1215.0	
2100	0.00	---	0.11	1260.0	
0	24.36	0.25	140.62	0.0	
0	24.84	0.50	90.71	0.0	Peak found
1	19.25	---	55.62	0.6	
2	6.51	---	32.92	1.2	
3	0.00	---	23.91	1.8	
4	0.00	---	18.95	2.4	
5	0.00	---	15.83	3.0	
6	0.00	---	13.66	3.6	
7	0.00	---	12.06	4.2	
8	0.00	---	10.82	4.8	
9	0.00	---	9.83	5.4	
10	0.00	---	9.02	6.0	
12	0.00	---	7.78	7.2	
15	0.00	---	6.48	9.0	
18	0.00	---	5.58	10.8	
20	0.00	---	5.12	12.0	
24	0.00	---	4.40	14.4	

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Job No. C1623			
Sheet no. 5			
Date 13/03/16			
Project 45 Holmes Road	By S.L	Checked	Reviewed
Title Hydrograph storage calcs (Winter profile) for Camden (G.London)			

Explanatory notes for Peak Flow Storage

1) This system uses the rainfall intensity/ duration curve calculated using either the Wallingford or FEH method as selected.
2) The balance is calculated from the inflow minus the outflow.
3) The storage volume is the maximum value of the balance curve.
4) This method was described by Davis (1963) - see Butler & Davies, 2nd edition, p294
5) References to 'storm duration' relate only to the hydrograph method (qv).
6) There are always 600 steps in the calculation process, thus a 'run' time of 10 hours will be sampled every minute,

Explanatory notes for Hydrograph Storage

1) The user has the choice of Summer or Winter curves
2) The mean intensity varies with the duration of the storm curve
3) There are always 120 steps in the calculation process, irrespective of storm duration.
4) The balance is calculated from the inflow minus the outflow.
5) The storage volume is the sum of the balance values for each step.
6) Varying durations should be tried to find the maximum storage value - this can be narrowed down very closely.

*Modelling using the flow characteristics of the restrictor is available using Vortex Control modelling function. Please be aware that this function needs the full design data file to function.

Why do the two methods give different results?

The rainfall characteristics for each method are very different.

The Peak flow (using the Intensity/Duration/Frequency curve) does not model the actual rainfall. This curve is joined points which represent the mean intensity of a storm at a given duration i.e. a value of 19.5 mm/hr for a 60 minute storm indicates that over the sixty minute period, the mean intensity was 19.5 mm/hr. The calculation method samples the IDF curve for a given location and frequency (Return Period) and calculates the storage for that rate and duration less the outflow volume. The maximum value is displayed as the 'worst case' storage.

The hydrograph method uses a standard curve for either Winter or Summer storms. Traditionally these are symmetrical about the central peak. UK rainfall does not fit into this convenient curve, so the calculations are dealing with a stylised set of data. The mean intensity for the storm is calculated from the IDF curve and applied to the curve data, calculating the storage for that step less the outflow volume. The final storage volume is the sum of the storage for all the steps.

It can be seen that these two methods are very different, and the user may have the choice of which result to use. This is not an exact science, though is often treated as such by those that do not understand the principles of the calculations.

APPENDIX B -PROPOSED SuDS DRAWING

SK_160129_01 Mezzanine Option

SITE BOUNDARY

Commercial Unit 6
GIA: 183sqm
(Incl. assooclated rooms and toilets)

Accessible Shower Room (SR)

SR

SR

WC

SR

Commercial Unit 7
GIA: 133sqm
(Incl. assooclated rooms and toilets)

No Access at Meeting (Could become Shower Facilities/Lockers)

Kitchen (Potential Shower Room/Lockers)

ACO DRAIN AT ENTRANCE TO PROPOSED DEVELOPMENT SITE TO CAPTURE FLOWS FROM ADJACENT SITE. THESE FLOWS TO BE DISCHARGED DIRECTLY INTO THAMES WATER'S SURFACE WATER SEWER

8,000 LITRE RAINWATER HARVESTING TANK - FOR DETAILS SEE DATA SHEET IN APPENDIX C

Disabled WC/Shower

WC

WC

Store/ Potential WC

Site Boundary

APPROX. LINE OF EXISTING 150mmØ THAMES WATER SEWER DISCHARGING TO HOLMES ROAD

Commercial Unit 2
GIA: 79sqm

Shared Entrance and Facilities
GIA: 59sqm

Entrance to Units 1, 2 and 3

PUMPING STATION WITH DUTY/STANDBY PUMPS BUILT OVER EXISTING SURFACE WATER LINE WITH CONTROLLED DISCHARGE

WC

WC

Shared Kitchen

Commercial Unit 3
GIA: 95sqm

Commercial Unit 1
GIA: 61sqm

Commercial Unit 4
GIA: 95sqm

Kitchen

WC

Entrance to Unit 4

Cycle Gate

2 x Sheffield Stands

Commercial Unit 5
GIA: 107sqm

WC

Store

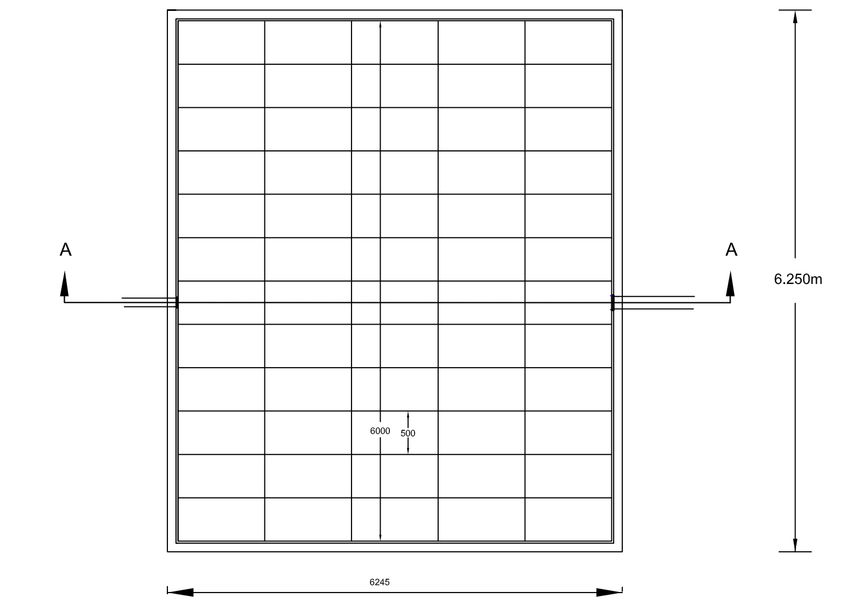
Kitchen

Entrance/Reception

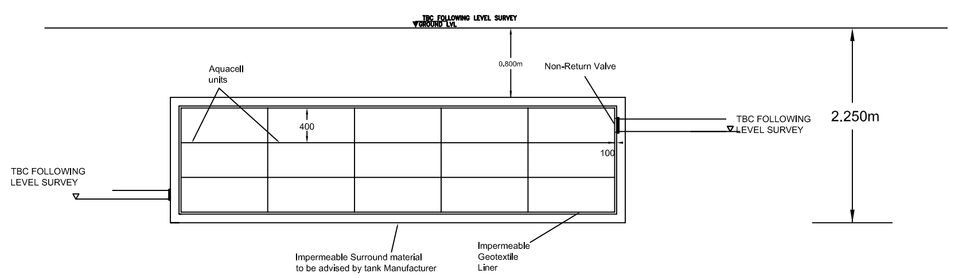
Entrance to Unit 5

8 x Josta 2-Tier Bicycle Racks

2 x 360L Residual Bins
2 x 360L Recycling Bins



PLAN OF ATTENUATION TANK



SECTION A-A ATTENUATION TANK
SCALE = 1:50

KEY

- SURFACE WATER UPVC PIPES
- SURFACE WATER INSPECTION CHAMBERS
- PERMEABLE SURFACE
- IC — INSPECTION CHAMBER

REV	DATE	DRAWN	DESCRIPTION	CHECK	APPR.
C	29.03.16	SL	gatic drain moved	SL	SL
B	14.03.16	SL	TANK RE-SIZED	SL	SL
A	04.03.16	SL	For Information	SL	SL

PROJECT
45 Holmes Road

SURFACE WATER DRAINAGE LAYOUT AND ATTENUATION DETAILS

CLIENT
QED STRUCTURES

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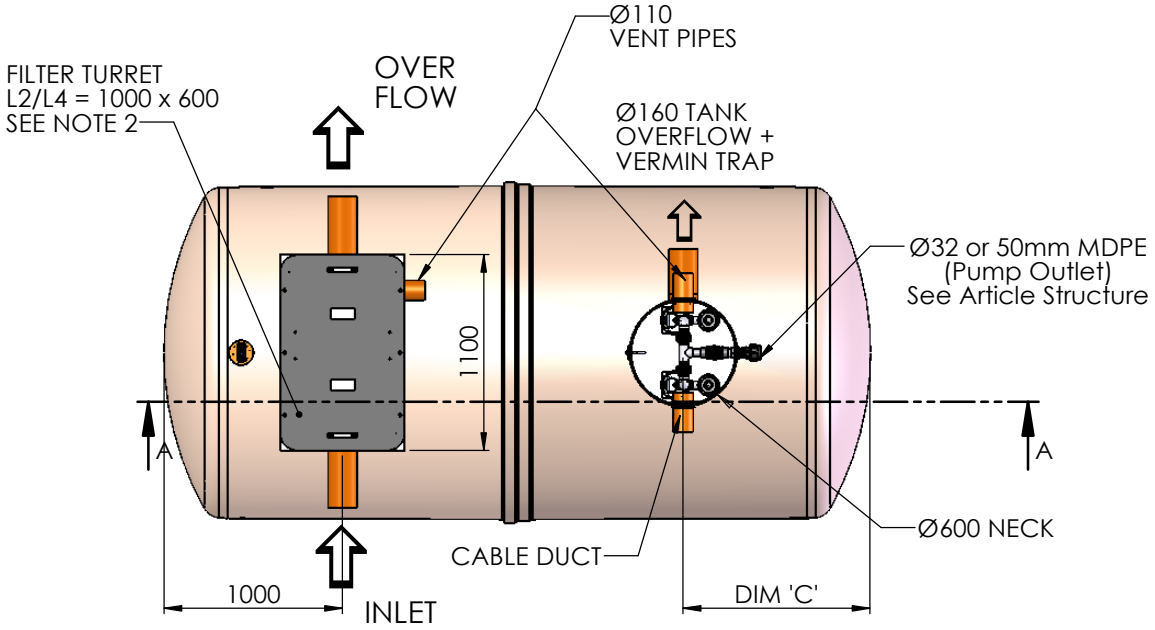
info@nimbusengineering.co.uk

CHECKED BY	DATE	APPROVED BY	DATE
S.L	29-03-16	S.L	29-03-16

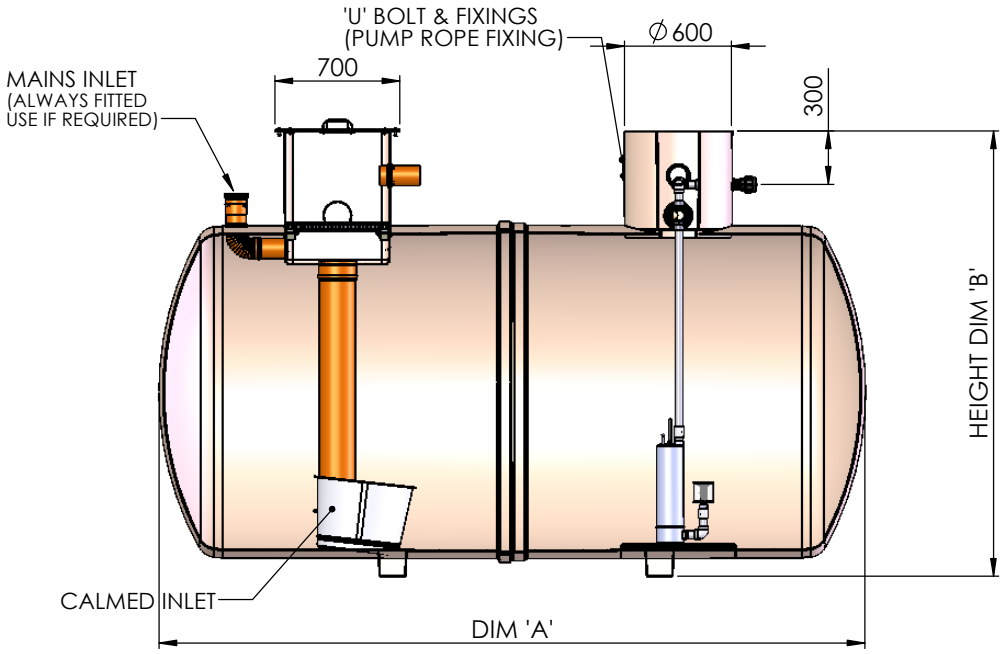
DRN BY	SCALE	DRAWING NUMBER	REV
S.L	1:100	01623-01	C
29-03-16			

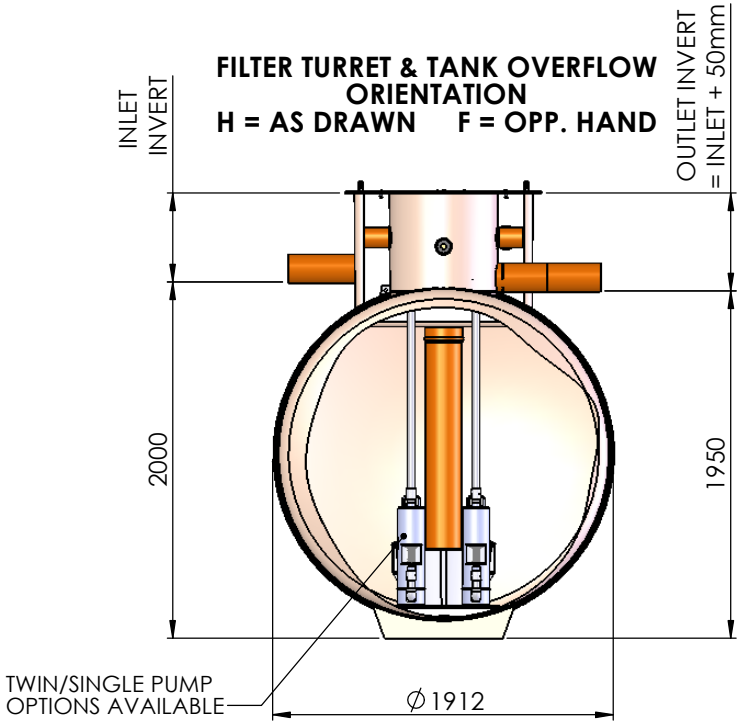
APPENDIX C -DATA SHEETS



Dimension Table Ø1.8 Tanks									
System	Dim 'A' (mm)	Height Dim 'B' (Invert Option)				Dim 'C' (mm)	Approx kg (Empty)	Volume (L)	Tank Ø (m)
		Inlet Invert 500mm	Inlet Invert 1000mm	Inlet Invert 1500mm	Inlet Invert 2000mm				
ENV0275	3240	2500	3000	3500	4000	950	435	8,000	1.8
ENV0350	3970	2500	3000	3500	4000	1050	495	10,000	1.8
ENV0485	5550	2500	3000	3500	4000	1700	560	14,000	1.8

NOTES:-
1. FOR PIPEWORK OPTIONS SEE ARTICLE STRUCTURE.
2. FILTER L2 = FLOW RATE *10ltrs/sec (AV. ROOF AREA 1440m² @ 25mm)
   FILTER L4 = FLOW RATE *40ltrs/sec (AV. ROOF AREA 5760m² @ 25mm)
3. IT IS ESSENTIAL THAT THIS DRAWING IS READ IN CONJUNCTION WITH INSTALLATION DOCUMENT (SUPPLIED WITH UNIT) GIVING INSTALLATION DETAILS. THIS DRAWING SHOULD BE USED FOR DIMENSIONAL INFORMATION ONLY.
4. IF UNIT REQUIRES NECK EXTENSIONS, CONSULT TECHNICAL SALES, PARTS TO BE ASSEMBLED ON SITE.





Filter Std. Pipe Dia's.

A=110mm
C=160mm
D=200mm
F=250mm
G=315mm
(See Article Structure)

Please check with Kingspan Environmental that this drawing is the latest issue				
Issue	Date	Drawn by	Approved by	Description
03	23.12.14	T.Kelly		CC1211 - Foot Change Affecting Height
02	26.06.12	P.T.C		CC1058

Material : Various	Tolerance :
Finish :	Thickness : n/a
Weight : 420.14 Kg Kgs	Surface Area :

Drawing : DS1161P Page 1 of 1

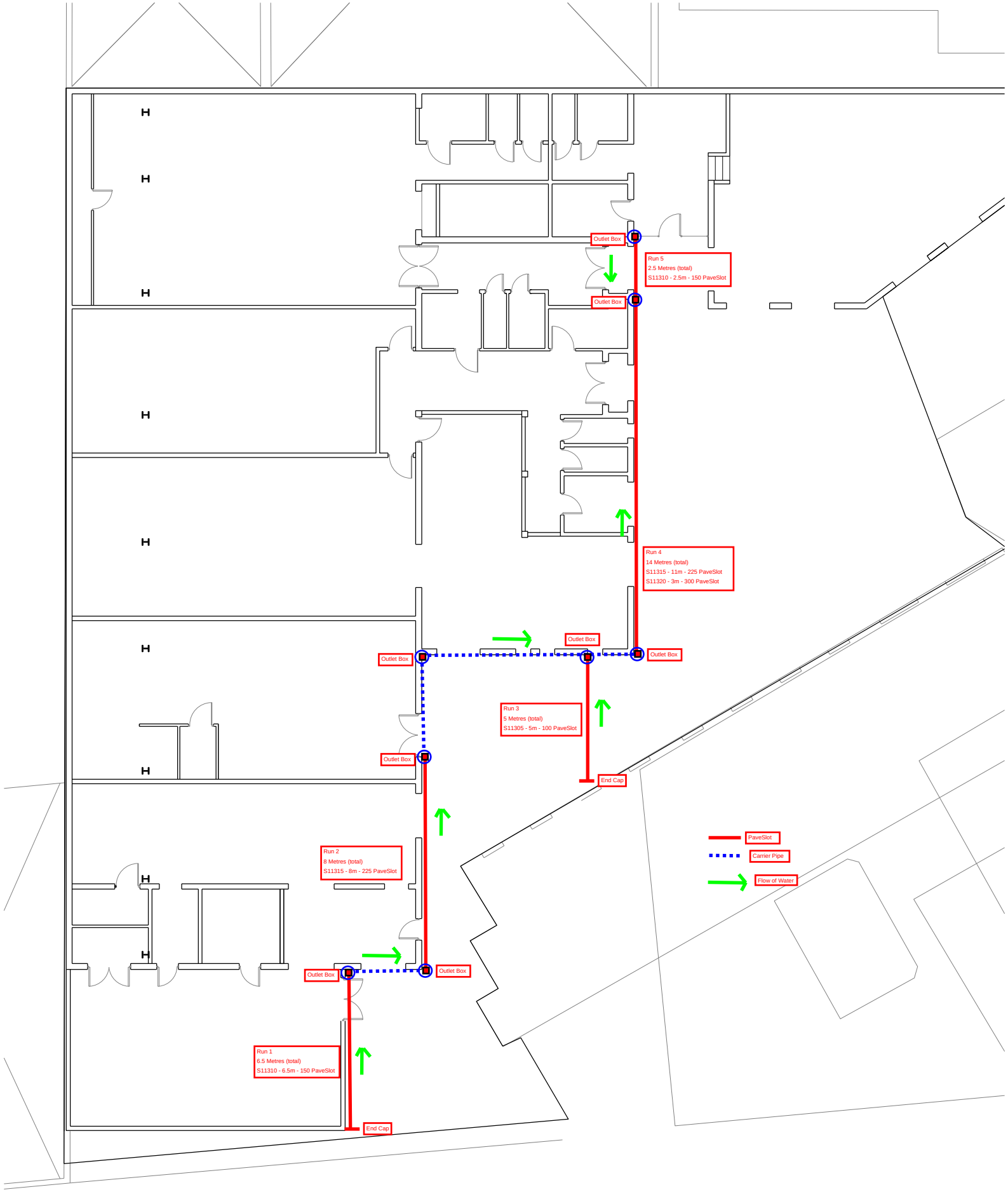
8,000L To 14,000L RWH Storage Tanks + Filter

All dimensions in mm

Scale: Not to scale

R:\Drawing Data\02 - Sales Drawings\DS\DS - 11\DS1161

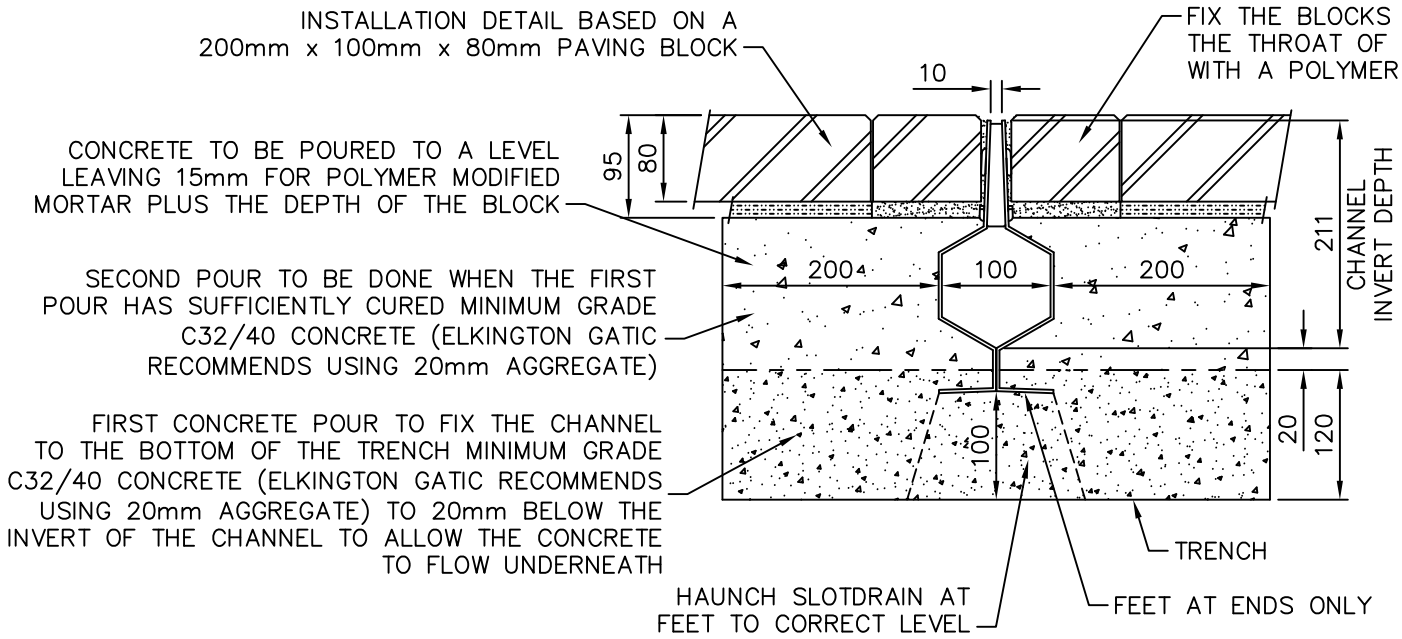
Kingspan Environmental

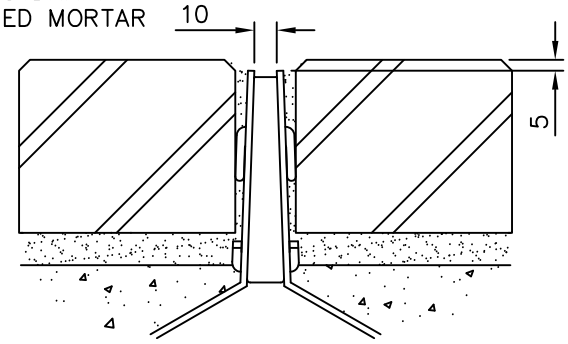


EXISTING GROUND FLOOR PLAN

(1:100)

	Revision	Date	Sig
C	THROAT SPACER UPDATED.	01:04:09	P.M.



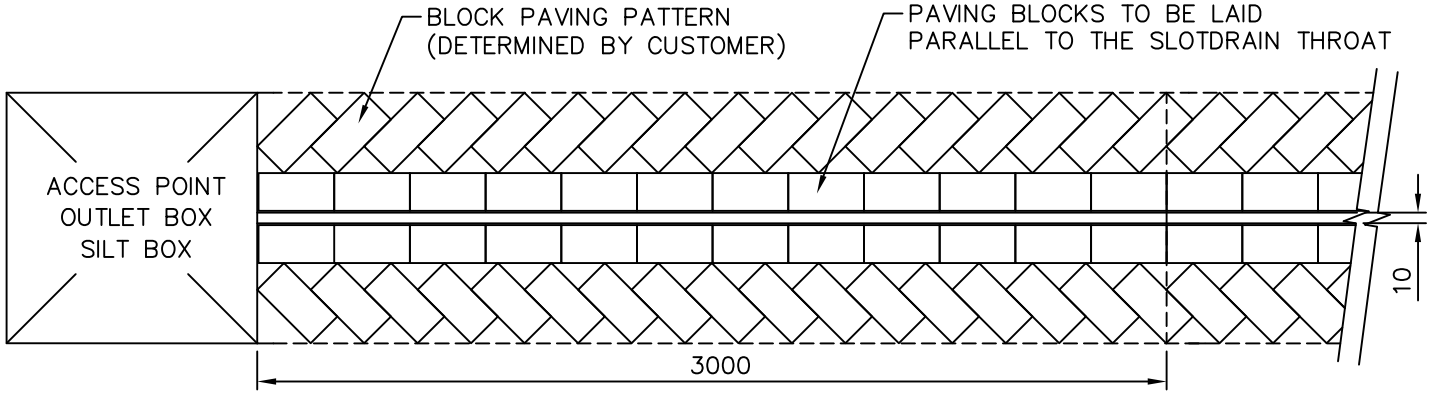


THROAT DETAILS

SCALE 1:2.5

NOTE:

THE RESPONSIBILITY TO PROVIDE THE FOUNDATION DESIGN SHOULD BE THAT OF THE PROJECT ENGINEER. THE FOUNDATION SHOULD BE STRONG ENOUGH TO TAKE THE ANTICIPATED LOADS FROM THE LARGEST AIRCRAFT/ VEHICLES THAT WILL TRAFFIC THE CHANNEL.



PLAN DETAIL

NOT TO SCALE

GATIC SLOTDRAIN
100mm PAVESLOT
S11305
SECTION AND PLAN DETAILS

BLOCK PAVING INSTALLATION

NOT TO SCALE

KM 91491
BS EN 1433

DO NOT SCALE

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Web: www.gatic.com
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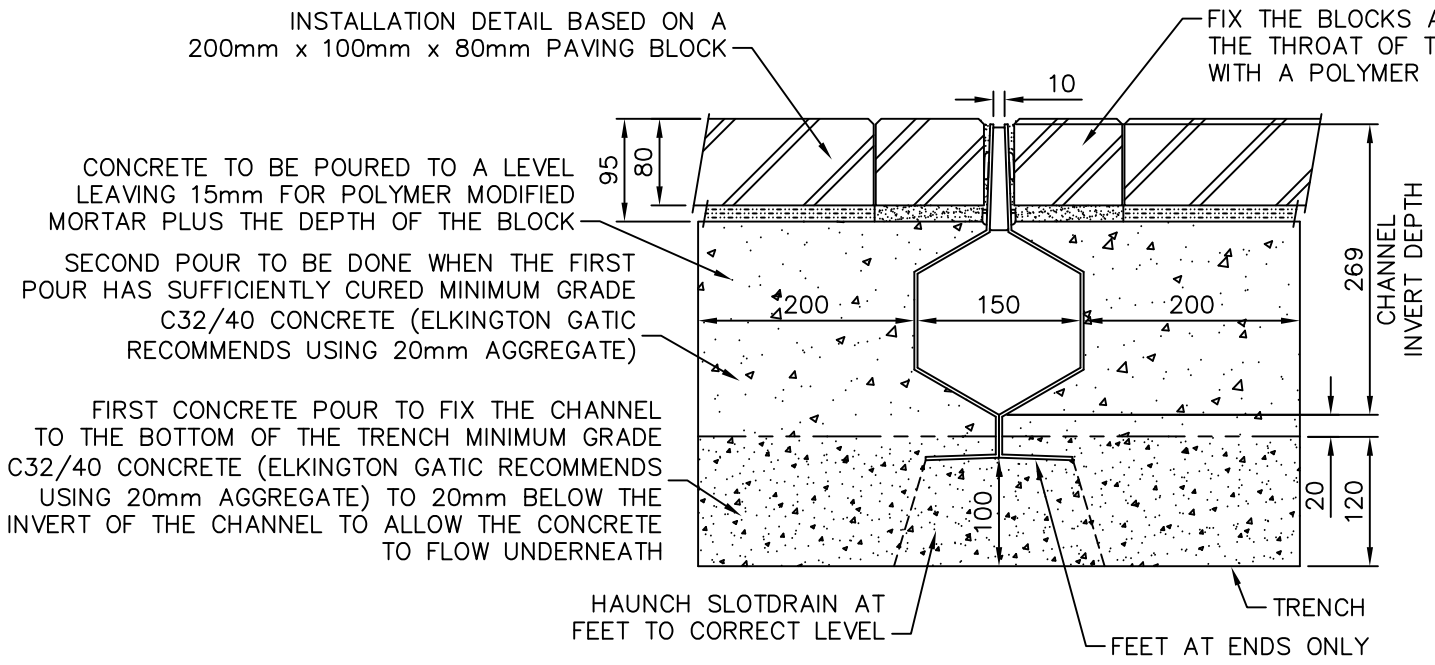
STANDARD SLOTDRAIN CROSS SECTION AND PLAN INSTALLATION DETAILS

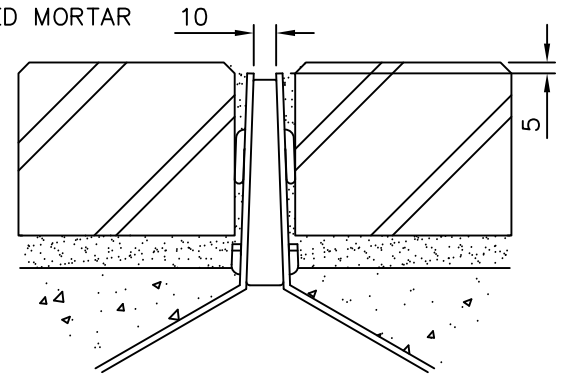
Drawn by	L.T	Date	
Checked by	S.B	Scale	1:5

Drawing Number

WC/3312/C

	Revision	Date	Sig
C	THROAT SPACER UPDATED.	01:04:09	P.M.





THROAT DETAILS
SCALE 1:2.5

NOTE:

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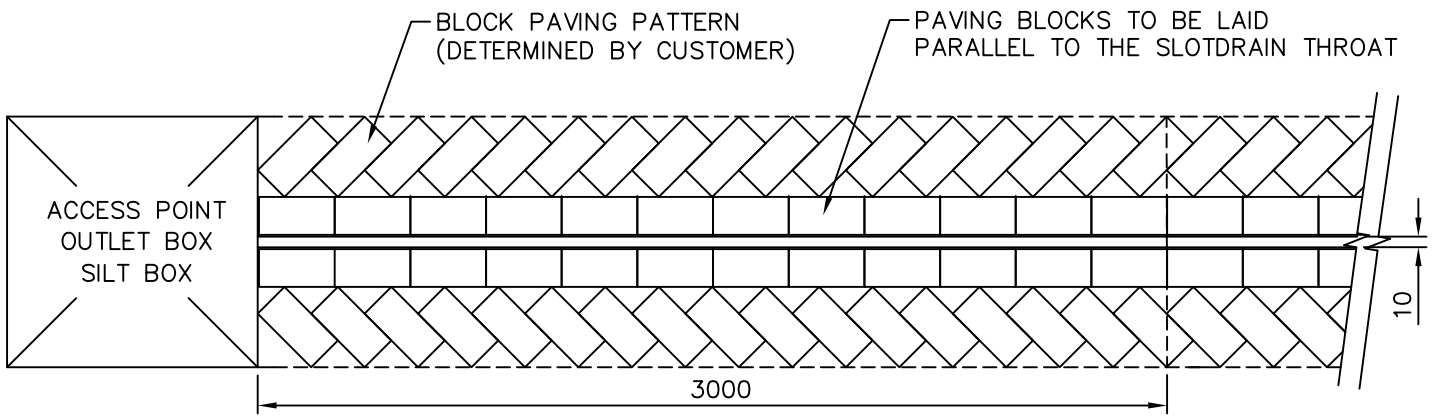

PLAN DETAIL
NOT TO SCALE

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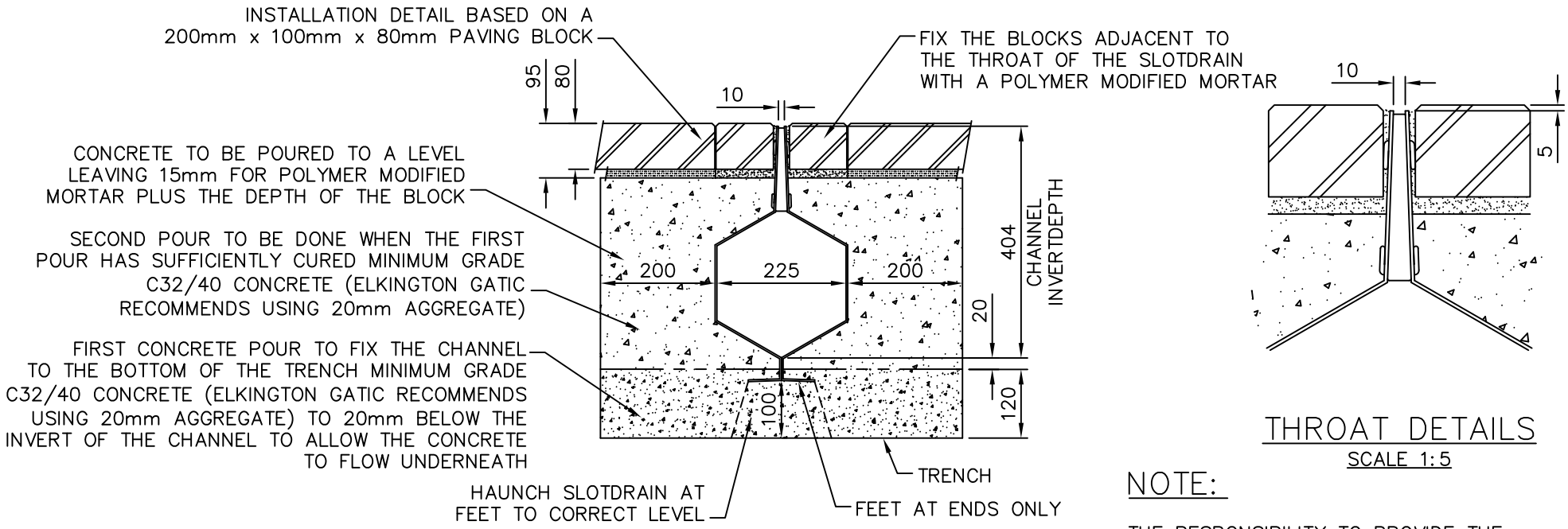
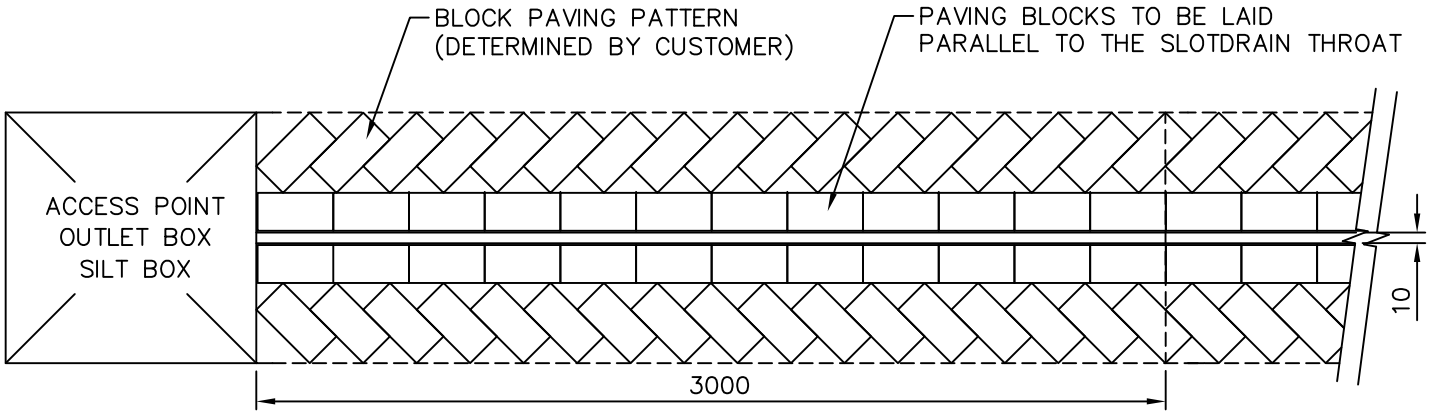
	Revision	Date	Sig
C	THROAT SPACER UPDATED.	01:04:09	P.M.



THROAT DETAILS
SCALE 1:5

NOTE:

THE RESPONSIBILITY TO PROVIDE THE FOUNDATION DESIGN SHOULD BE THAT OF THE PROJECT ENGINEER. THE FOUNDATION SHOULD BE STRONG ENOUGH TO TAKE THE ANTICIPATED LOADS FROM THE LARGEST AIRCRAFT/ VEHICLES THAT WILL TRAFFIC THE CHANNEL.



PLAN DETAIL
NOT TO SCALE

GATIC SLOTDRAIN
225mm PAVESLOT
S11315
SECTION AND PLAN DETAILS

BLOCK PAVING INSTALLATION
NOT TO SCALE

KM 91491
BS EN 1433

DO NOT SCALE

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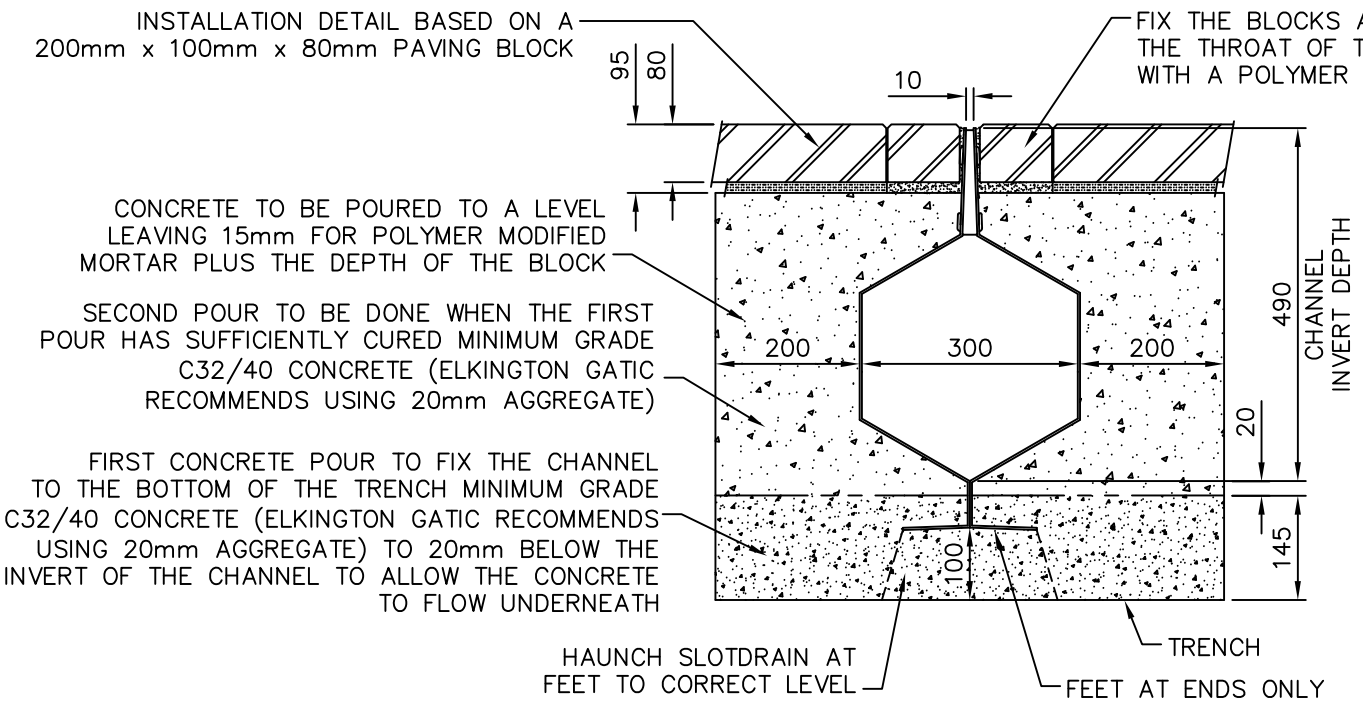
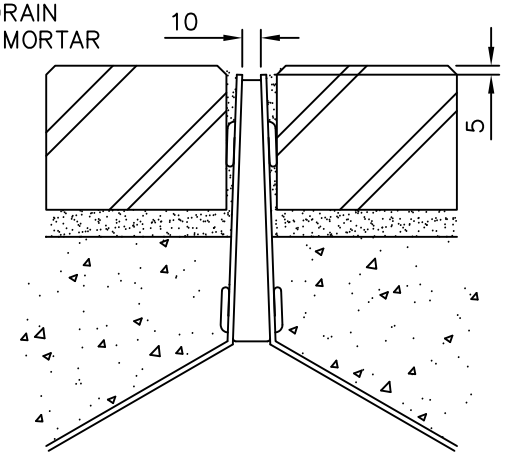
STANDARD SLOTDRAIN CROSS SECTION AND PLAN INSTALLATION DETAILS

Drawn by	L.T	Date	
Checked by	S.B	Scale	1:7.5

Drawing Number
WC/3314/C

	Revision	Date	Sig
C	THROAT SPACER UPDATED.	01:04:09	P.M.





THROAT DETAILS

SCALE 1:5

NOTE:

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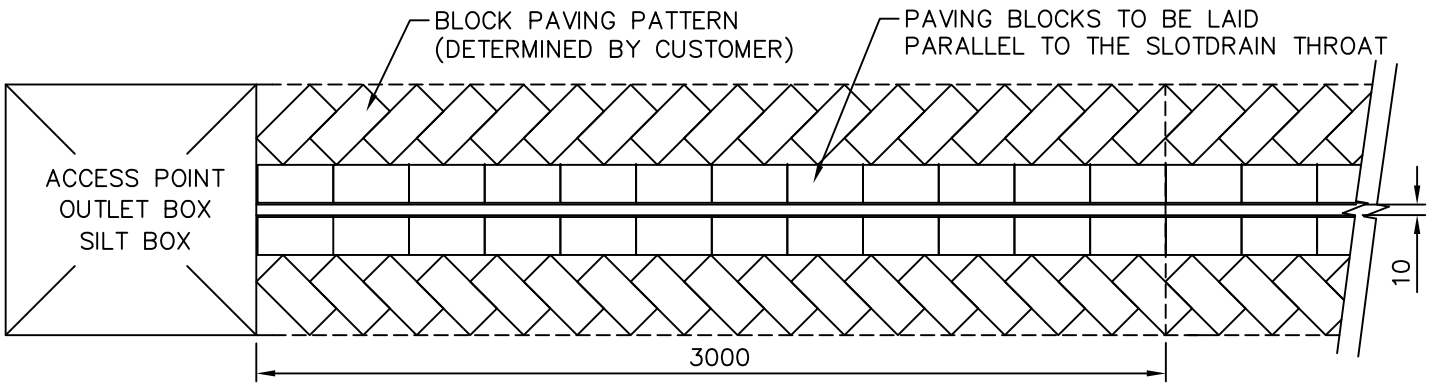

PLAN DETAIL

NOT TO SCALE

GATIC SLOTDRAIN 300mm PAVESLOT S11320 SECTION AND PLAN DETAILS

BLOCK PAVING INSTALLATION

NOT TO SCALE

KM 91491
BS EN 1433

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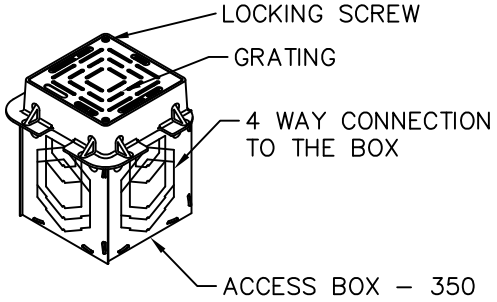
STANDARD SLOTDRAIN CROSS SECTION AND PLAN INSTALLATION DETAILS

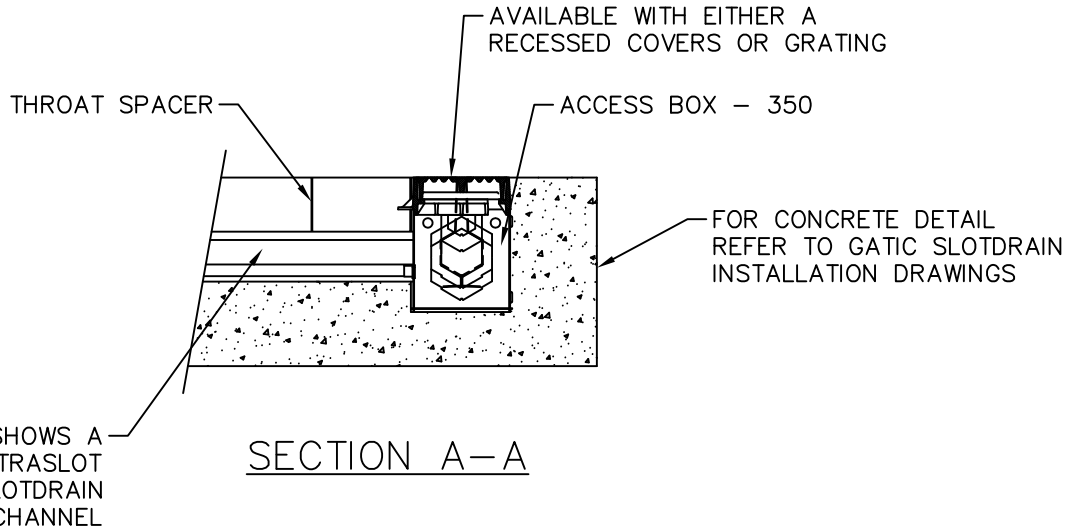
Drawn by	L.T	Date	
Checked by	S.B	Scale	1:7.5

Drawing Number

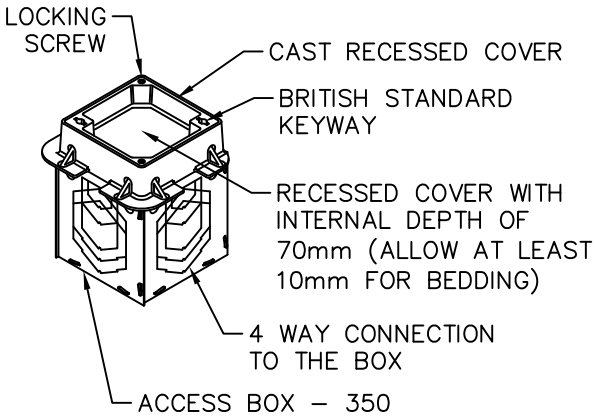
WC/3315/C

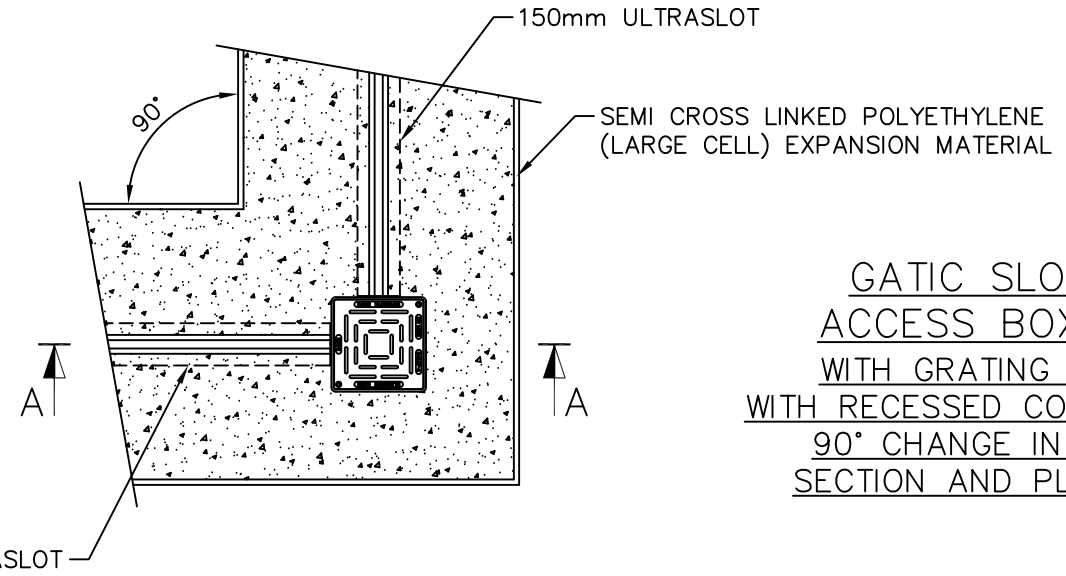
	Revision	Date	Sig
B	GRATING SLOTS REDUCED.	23:03:10	P.M.





SECTION A–A





GATIC SLOTDRAIN
ACCESS BOX – 350
WITH GRATING – S20305
WITH RECESSED COVER – S20310
90° CHANGE IN DIRECTION
SECTION AND PLAN DETAILS

CE KM 91491 BS EN 1433

DO NOT SCALE

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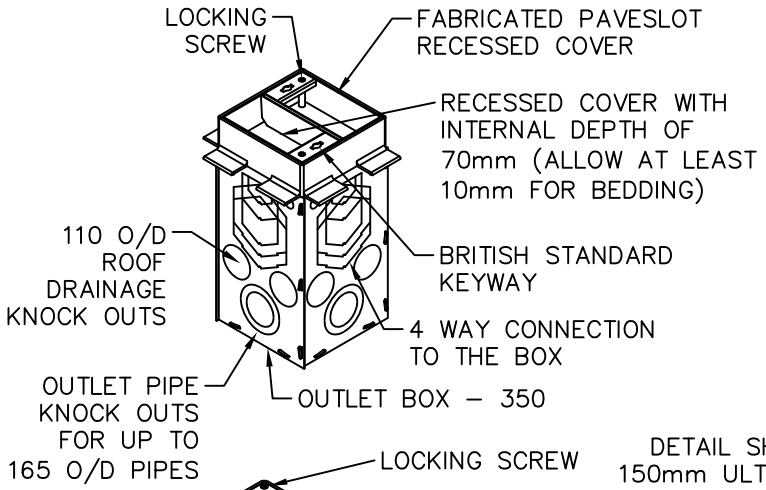
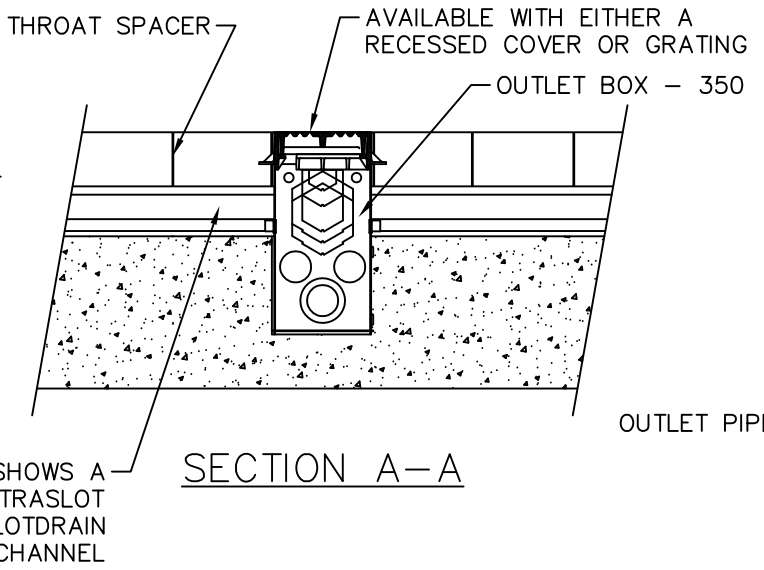
GATIC SLOTDRAIN
ACCESS BOX - 350

Drawn by	P.M.	Date	07:04:05
Checked by	S.B.	Scale	1:20

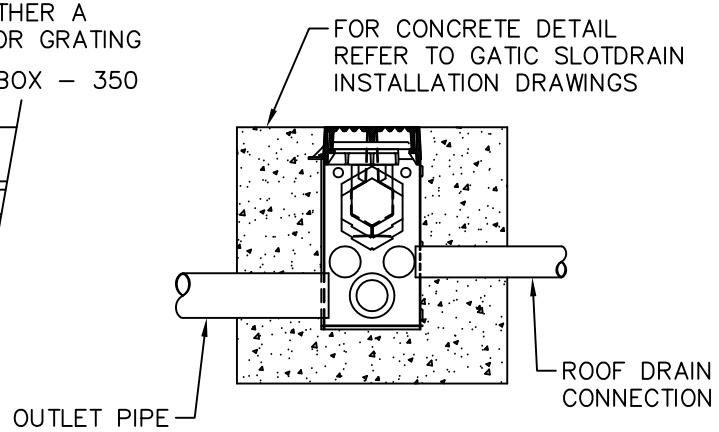
Drawing Number
WC/3405/B

	Revision	Date	Sig
B	GRATING SLOTS REDUCED.	23:03:10	P.M.

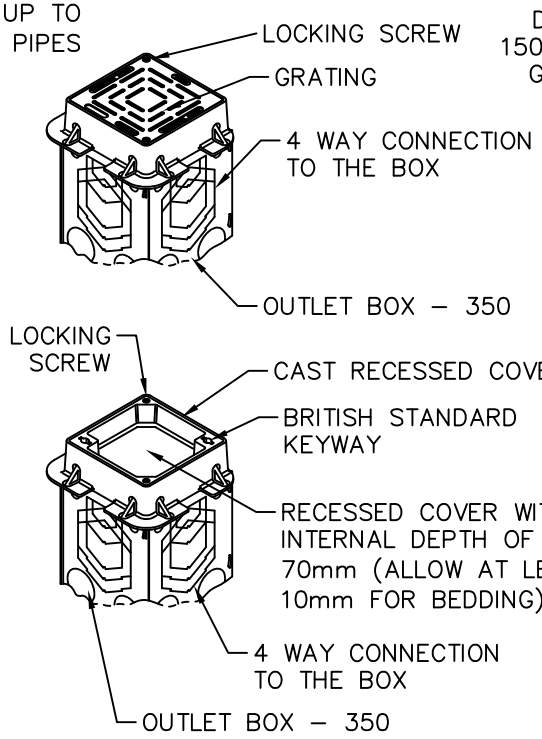


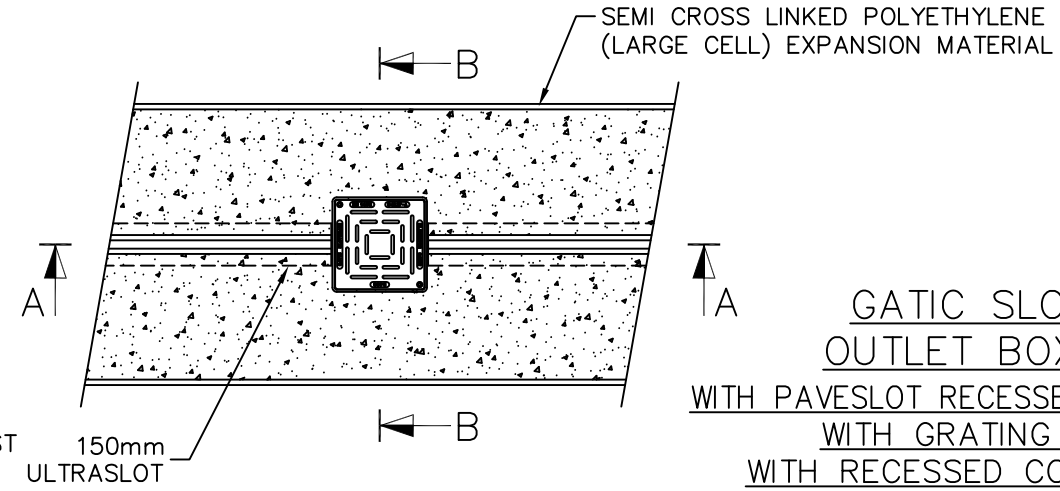


SECTION A–A



SECTION B–B





GATIC SLOTDRAIN OUTLET BOX – 350

WITH PAVESLOT RECESSED COVER – S20200
WITH GRATING – S20205
WITH RECESSED COVER – S20210
SECTION AND PLAN DETAILS

KM 91491
BS EN 1433

DO NOT SCALE

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GATIC SLOTDRAIN
OUTLET BOX - 350

Drawn by	P.M.	Date	05:04:05
Checked by	S.B.	Scale	1:20

Drawing Number
WC/3407/B

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Email: info@gatic.com Web: www.gatic.com

Designer: 09/03/2016 Ref:

Project Summary:

No Runs	5	Total Outflow	58.1 l/s	Total Controlled Outflow		58.1 l/s
Excavation	9.1 m3	Concrete	7.6 m3	Reinforcement[1]	0m (T10)	0m (T12)

Channel Quantities:

Product	Total length (m)
G11305 100 PaveSlot 3m	3
G11310 150 PaveSlot 3m	9
G11315 225 PaveSlot 3m	15
G11320 300 PaveSlot 3m	3
G11105 100 PaveSlot 1m	2
G11110 150 PaveSlot 1m	1
G11115 225 PaveSlot 1m	4
Total length of all channel types	37

Engineers or other users of this software must satisfy themselves in respect of the adequacy of their design. Gatic can not be liable for any design undertaken by users of this software.

All calculations and output generated above are unique and relevant to Gatic Slotdrain only.
They should not be used in conjunction with any other drainage products.

NOTES:

1 The T10 and T12 references refer to the European Classification of steel reinforcing bar types.

2 'Ground Slope' refers to the longitudinal gradient along which the channel is laid; if the channel is laid on level ground 0% gradient will be shown. This does NOT refer to the gradient of the Drainage Area sloping towards the channel.

3 Load classifications are based on the European Standard EN 1433: 2002 'Drainage Channels for Vehicular and Pedestrian Areas'. This is the only international standard that relates directly to grated trench drains and slot drain systems. Please refer to the Gatic Slotdrain 'Technical Brochure' for further information.

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Designer: 09/03/2016 Ref:

Calculation Summary:

Run1						
Area	Imp. Factor	Ground Slope[2]	Rainfall Rate	Flow Rate	Capacity Used	Velocity
135 m2	0.8	0.0 %	169.0 mm/h	5.1 l/s	57 %	0.5 m/s

Channel Dimensions:

Product	Width	Length	Unit Depth	Invert Depth	Throat Width	Loading[3]
PaveSlot G11310	150 mm	6.5 m	311 mm	269 mm	10 mm	D400
	Total	6.5 m	Average	269 mm		
Excavation	1.2 m3	Concrete	1.1 m3	Reinf'ment 1	0m (T10)	0m (T12)

Channel size calculations carried out using the HR method

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Designer: 09/03/2016 Ref:

Calculation Summary:

Run2						
Area	Imp. Factor	Ground Slope[2]	Rainfall Rate	Flow Rate	Capacity Used	Velocity
31 m2	0.8	0.0 %	169.0 mm/h	12.5 l/s	51 %	0.6 m/s

Point Inflows:

Link reference	Run1	
Inflow (l/s)	5.07	6.25
Distance from outfall (m)	8	8

Channel Dimensions:

Product	Width	Length	Unit Depth	Invert Depth	Throat Width	Loading[3]
PaveSlot G11315	225 mm	8 m	445 mm	404 mm	10 mm	D400
	Total	8 m	Average	404 mm		
Excavation	2.3 m3	Concrete	1.9 m3	Reinf'ment 1	0m (T10)	0m (T12)

Channel size calculations carried out using the HR method

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Designer: 09/03/2016 Ref:

Calculation Summary:

Run3						
Area	Imp. Factor	Ground Slope[2]	Rainfall Rate	Flow Rate	Capacity Used	Velocity
56 m2	0.8	0.0 %	169.0 mm/h	2.1 l/s	67 %	0.4 m/s

Channel Dimensions:

Product	Width	Length	Unit Depth	Invert Depth	Throat Width	Loading[3]
PaveSlot G11305	100 mm	5 m	251 mm	211 mm	10 mm	D400
	Total	5 m	Average	211 mm		
Excavation	0.7 m3	Concrete	0.6 m3	Reinf'ment 1	0m (T10)	0m (T12)

Channel size calculations carried out using the HR method

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Designer: 09/03/2016 Ref:

Calculation Summary:

Run4						
Area	Imp. Factor	Ground Slope[2]	Rainfall Rate	Flow Rate	Capacity Used	Velocity
171 m2	0.8	0.0 %	169.0 mm/h	27.3 l/s	34 %	1.0 m/s

Point Inflows:

Link reference	Run3	Run2	
Inflow (l/s)	2.1	12.48	6.25
Distance from outfall (m)	14	14	14

Channel Dimensions:

Product	Width	Length	Unit Depth	Invert Depth	Throat Width	Loading[3]
PaveSlot G11315	225 mm	11 m	445 mm	404 mm	10 mm	D400
PaveSlot G11320	300 mm	3 m	557 mm	490 mm	10 mm	D400
	Total	14 m	Average	422.4 mm		
Excavation	4.4 m3	Concrete	3.6 m3	Reinf'ment 1	0m (T10)	0m (T12)

Channel size calculations carried out using the HR method

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Designer: 09/03/2016 Ref:

Calculation Summary:

Run5						
Area	Imp. Factor	Ground Slope[2]	Rainfall Rate	Flow Rate	Capacity Used	Velocity
131 m2	0.8	0.0 %	169.0 mm/h	11.2 l/s	55 %	1.1 m/s

Point Inflows:

Link reference	
Inflow (l/s)	6.25
Distance from outfall (m)	2.5

Channel Dimensions:

Product	Width	Length	Unit Depth	Invert Depth	Throat Width	Loading[3]
PaveSlot G11310	150 mm	2.5 m	311 mm	269 mm	10 mm	D400
	Total	2.5 m	Average	269 mm		
Excavation	0.5 m3	Concrete	0.5 m3	Reinf'ment 1	0m (T10)	0m (T12)

Channel size calculations carried out using the HR method

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