Civil Engineers & Transport Planners

South Worple Way, East Sheen

Drainage Strategy

August 2023

231721/DS/AG/KL/01

Rev B

Civil Engineers & Transport Planners

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1 INTRODUCTION

1.1 Scope

1.1.1 Lanmor Consulting has been appointed to prepare a drainage strategy for the proposed development at the site of South Worple Way, East Sheen, London. This report has been commissioned to advise on the technical feasibility of providing drainage for the proposed development. Figure 1.1 below shows the location of the site.

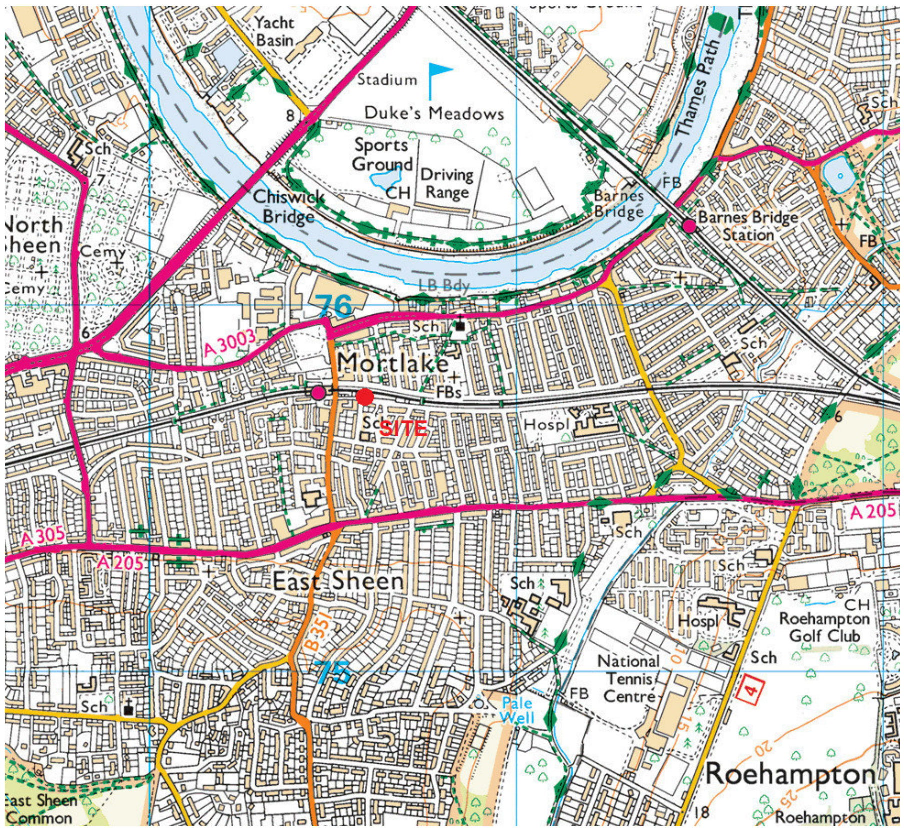


Figure 1.1 – Site Location

1.1.2 This report will consider the proposed drainage strategy for the site, it will assess the site's current Greenfield and Brownfield runoff rates, suitable methods of discharging the runoff from the development and set the drainage strategy for the proposed development, including discharge rates and any requirements for attenuation.

1.1.3 The information and details within this report will be refined, modified and updated as the detailed design is progressed, post planning. The scope of works for this drainage strategy report is outlined below:

- Review available data relating to existing on-site drainage and other drainage networks in the vicinity of the site.
- Review of the site's ground conditions for suitability of SuDS.
- Consider the use of Sustainable Drainage Systems as an option for disposal of surface water runoff from the proposed development.
- Undertake drainage assessments of proposed buildings to establish discharge rates and attenuation requirements to deal with any increased surface water runoff.

2 SITE LOCATION AND DESCRIPTION

2.1 Location

2.1.1 The land use in the area surrounding the site is heavily developed with residential properties with some commercial uses to the east and north. The site is occupied by a number of garages with parking to the front. The nearest water courses is the River Thames to the north of the site.

2.1.2 The application site covers an area of 0.05, the proposed application seeks approval to construct 5 residential dwellings.

2.2 Proposed Development

2.2.1 The proposed redevelopment will involve the construction of 5 residential properties with parking to the front of the site along South Worple Way. The proposed development is shown on Drawing 1332/03 and is included within Appendix A.

2.3 Regional Geology

2.3.1 The British Geological Survey indicates that the site has an underlying bedrock of London Clay Formation - Clay and silt. Sedimentary bedrock formed between 56 and 47.8 million years ago during the Palaeogene period.

2.3.2 Superficial deposits of the Kempton Park Gravel Member are indicated overlaying the bedrock, these consist of Sand and gravel. Sedimentary superficial deposit formed between 116 and 11.8 thousand years ago during the Quaternary period.

3 EXISTING DRAINAGE

3.1 Existing Foul Drainage

3.1.1 The site is occupied by a series of garages so there is no foul connection from the site. Thames Water sewer records were obtained. Their asset records show there is a foul sewer running along South Worple Way, it is indicated to be a 225mm diameter sewer.

3.2 Existing Surface Water Drainage

3.2.1 The site is currently drained via a dished channel and gullies, which are assumed to discharge surface water directly into the public sewer network located within South Worple Way. No SuDS have been identified on site so it is assumed that the drainage discharges direct to the adopted sewer with no control.

3.2.2 The Thames Water records also show there is an existing surface water sewer running in South Worple Way. The sewer is shown as a 225mm in diameter. The nearest surface water manhole is 5717, the depth of the sewer is indicated to be 2.5m. The Thames Water asset records are included in Appendix B of this report.

4 PROPOSED DRAINAGE REGIME

4.1 Proposed Foul Water Drainage

4.1.1 A new network of foul drainage pipes will be provided to serve the 5 new properties. Foul water will be collected through a series of pipes from the units and discharge into the existing Thames Water foul sewer towards the south of the site in South Worple Way.

4.2 Proposed Surface Water Drainage

4.2.1 Sustainable Drainage Systems (SuDS) were considered as part of this assessment for disposal of surface water runoff from the development. The residential units will have pitched roofs, so incorporating a green roof is not possible.

4.2.2 Next on the Sustainable Drainage Hierarchy is the use of ground infiltration techniques such as soakaways and infiltration basins etc. The underlaying ground consist of London clay with superficial deposits of the Kempton Park Gravel. The site is located directly south of the railway line, network rail has a requirements that no infiltration should be allowed within the 10-20m of their asset boundary, therefore, the use of infiltration techniques such as soakaways have been discounted on these grounds.

4.2.3 Next is discharge to watercourse, there are none in the vicinity of the site, so this has been discounted. A connection to a surface water sewer is next on the hierarchy so the preferred option for discharge of runoff is to attenuate runoff and discharge to the adopted surface water sewer.

4.2.4 There is a Thames Water surface water sewer located in South Worple Way, the proposed drainage strategy will provide a new connection to the public sewer at manhole 5717. The surface water sewer is 2.5m deep so a gravity connection can be provided from the site to the adopted sewer network.

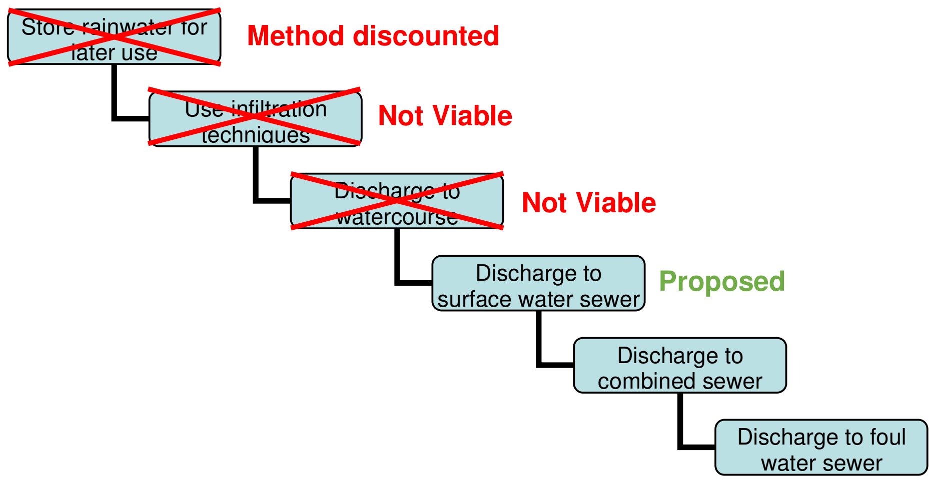


Figure 4.1 – Sustainable Drainage Hierarchy

4.2.5 The proposed drainage strategy has adopted the approach to use a rainwater garden and attenuate runoff on site in the subbase of the permeable paving to the front of the site and cascade into a cellular crate system beneath the paving area to attenuate the runoff from the development. A flood risk assessment has been prepared for the development this has identified the current discharge rate from site and that infiltration is unlikely to be viable. They estimated that existing discharge rate from the site to be 6.3 l/s and suggest that the proposed discharge rate should be restricted to 3l/s, 50% of the existing.

4.2.6 As part of this assessment the greenfield runoff rates have been assessed, the full calculations are included in Appendix C, this shows a very low discharge rate, which is not achievable so the discharge rate will be restricted to 2 l/s.

4.2.7 The attenuation will be designed to accommodate a 1 in 100 year storm plus an allowance for climate change. The climate change allowance to be included are based on the river management catchment area and lifetime for the development, for developments with a lifetime beyond 2100 the PPG recommends that the upper end allowance be used for assessing surface water flood risk. The site located in London Management Catchment area. The upper end allowance of the catchment is 40% so this will be used for the surface water design.

4.2.8 The rainwater garden will receive the runoff from half the site and cascade into the underground attenuation tank, the remainder of the roof drainage from the buildings will flow to the permeable paving to the front of the properties before entering the attenuation crates below. Infiltration is not possible so the paving will act as storage only. The sub-base has been designed with a 350mm thick granular subbase to accommodate runoff from the roofs and hardstandings for a rainfall event with a probability of 1in 100 plus a 40% allowance for climate change.

4.2.9 The discharge from the paving to the attenuation crates will be controlled via a 40mm orifice. The attenuation crates have also been designed at 2m x 14m x 0.4m deep to accommodate the runoff from an event with a probability of 1 in 100 years +40% allowance. The discharge from the crates the adopted sewer in South Worple Way will be restricted to 2 l/s controlled via a hydrobrake. The sewer in South Worple Way is 2.5m deep so a gravity connection can be provided from the development.

4.2.10 Water butts have been provided to the rear of the property at the request of the Local Planning Authority, they have no SuDS benefit as they cannot be accounted for in the attenuation calculations as there is no guarantee they will empty to receive an incoming rainfall. None have been provided to front as the RWP's discharge to the raingarden which needs the runoff from the roof to feed the plants.

4.2.11 Drawing 231666/DS/01 included in Appendix C, shows an indicative drainage layout for the development. The full calculations for each return period are included in Appendix C. The London SuDS proforma for the development is included in Appendix D.

4.3 Flood Exceedance

The site will be largely developed with buildings, so the only open area at risk is the parking area to front of the site. This area will fall to South Worple Road so the development will not be at risk of flooding as exceedance flooding will be directed away from the site and down South Worple Road.

5 SUDS TREATMENT & MANAGEMENT

5.1 SuDS Treatment

5.1.1 Section 26 of the CIRIA SuDS Manual C753, provides guidance regarding methods for managing pollution risks from surface water runoff. Part of the assessment is to determine which land use classification the proposed development falls under, Table 26.1 of the CIRIA Report C753 sets the approaches to water quality risk management. For this site the Simple Index Approach will be used.

5.1.2 Table 26.2 in C753 reproduced as Table 5.1, show the potential hazard associated with different land uses the hazard indices. The development will consist of residential houses, it is concluded that the site should be classed within the sections shown in Table 5.1 below. The roofs of the residential buildings is considered to have a "very low" pollution hazard, generating 0.2 total suspended solids, 0.2 metals and 0.05 hydro-carbons. The access and parking area is considered to have a "low" pollution hazard, generating 0.5 total suspended solids, 0.4 metals and 0.4 hydro-carbons.

TABLE 26.2 Pollution hazard indices for different land use classifications

Land use	Pollution hazard level	Total suspended solids (TSS)	Metals	Hydro-carbons
Residential roofs	Very low	0.2	0.2	0.05
Other roofs (typically commercial/ industrial roofs)	Low	0.3	0.2 (up to 0.8 where there is potential for metals to leach from the roof)	0.05
Individual property driveways, residential car parks, low traffic roads (eg cul de sacs, homezones and general access roads) and non-residential car parking with infrequent change (eg schools, offices) ie < 300 traffic movements/day	Low	0.5	0.4	0.4
Commercial yard and delivery areas, non-residential car parking with frequent change (eg hospitals, retail), all roads except low traffic roads and trunk roads/motorways[1]	Medium	0.7	0.6	0.7
Sites with heavy pollution (eg haulage yards, lorry parks, highly frequented lorry approaches to industrial estates, waste sites), sites where chemicals and fuels (other than domestic fuel oil) are to be delivered, handled, stored, used or manufactured; industrial sites; trunk roads and motorways[1]	High	0.8[2]	0.8[2]	0.9[2]

Table 5.1 – CIRIA SuDS Manual C753 Extract (Land use classifications)

5.1.3 The proposed development will incorporate permeable paving for storage. Suitable treatment measures offered by SuDS features are set out in CIRA report. Table 26.3 of C753 reproduced below as Table 5.2 sets out the mitigation indices provided by SuDS features for discharge to surface waters.

TABLE 26.3 Indicative SuDS mitigation indices for discharges to surface waters

	Mitigation indices[1]		
Type of SuDS component	TSS	Metals	Hydrocarbons
Filter strip	0.4	0.4	0.5
Filter drain	0.4[2]	0.4	0.4
Swale	0.5	0.6	0.6
Bioretention system	0.8	0.8	0.8
Permeable pavement	0.7	0.6	0.7
Detention basin	0.5	0.5	0.6
Pond[4]	0.7[3]	0.7	0.5
Wetland	0.8[3]	0.8	0.8
Proprietary treatment systems[5,6]	These must demonstrate that they can address each of the contaminant types to acceptable levels for frequent events up to approximately the 1 in 1 year return period event, for inflow concentrations relevant to the contributing drainage area.		

Table 5.2 – SuDS Manual C753 Extract (Mitigation Indices to Surface Water)

5.1.4 The permeable paving will provide mitigation of 0.7 for total suspended solids, 0.6 for metals and 0.7 for hydrocarbons. These are all greater than the pollution hazard indices identified in table 5.1 above.

5.2 SuDS Maintenance

5.2.1 Regular inspection of the surface water drainage network for blockages and clearing unwanted debris/silt from the system should improve the performance of the surface water network and decrease the need for future repairs. In the event of blockages, high pressure water jets can be used to clear the gullies and pipes to ensure they are functioning correctly, this should be undertaken by certified trained professionals.

5.2.2 The level and frequency of maintenance required on site is dependent on the type of facility. The type of maintenance will fall into one of three categories "regular maintenance", "occasional maintenance", and "remedial maintenance".

5.2.3 Regular Maintenance of the drainage and SuDS features will include, inspections, removal of litter/debris and sweeping of the surfaces. Occasional maintenance will include removal of sediment etc. and remedial maintenance may include structural repairs and infiltration reconditioning if required.

5.2.4 The drainage and SuDS elements after an initial inspection following construction should be inspected on a monthly basis for the first 12 months and after large storms, thereafter the following maintenance regime should be applied and adjusted if the 12-month monitoring process has identified any issues. Following completion of the development, a Management Company will be set up to maintain all the communal areas, including the drainage. It will be their responsibility to maintain the drainage network, including the SuDS elements

5.2.5 For the Inspection, Manhole, Catchpit Chambers and Pipes, the following maintenance will be required.

Manhole / Pipe Maintenance Schedule		
	Required Action	**Typical Frequency**
Regular maintenance	Inspect for evidence of poor operation via water level in chambers. If required, take remedial action.	3-monthly, 48 hours after large storms.
	Check and remove large vegetation growth near pipe runs.	Monthly or as required
	Remove sediment from structures.	Annually or as required
Remedial Actions	Rod through poorly performing runs as initial remediation.	As required
	If continued poor performance jet and CCTV survey poorly performing runs.	As required
Monitoring	Inspect/check all inlets, outlets, to ensure that they are in good condition and operating as designed.	Annually
	Survey inside of pipe manholes for sediment build-up and remove if necessary	Every 5 years or as required

Table 5.3 – Manhole and Pipe Maintenance Schedule

Permeable Paving

5.2.6 For permeable paving areas, the following maintenance is recommended.

Permeable Paving Maintenance Schedule		
	Required Action	**Typical Frequency**
Regular maintenance	Remove debris and leaves etc.	Once a year, after autumn leaf fall, or reduced frequency as required, based on site-specific observations of clogging or manufacturer's recommendations – pay particular attention to areas where water runs onto pervious surfaces from adjacent impermeable areas as this area is most likely to collect the most sediment.
Occasional maintenance	Stabilise and mow contributing and adjacent areas	As required
	Removal of weeds	As required- once per year on less frequently used pavements
Remedial Actions	Remediate any landscaping which, through vegetation maintenance or soil slip, has been raised to within 50 mm of the level of the paving	As required
	Remedial work to any depressions, rutting etc	As required
	Rehabilitation of surface and upper substructure	Every 10 to 15 years or as required (if infiltration performance is reduced due to significant clogging)
Monitoring	Inspect for evidence of poor operation and/or weed growth - if required, take remedial action.	Three-monthly, 48 hours after large storms in the first six months
	Inspect silt accumulation rates and establish appropriate frequencies for rehabilitation	Annually
	Monitor inspection chambers	Annually

Table 5.4 – Permeable Paving Maintenance Schedule

Attenuation Tanks

5.2.1 For the attenuation tanks, the following maintenance will be required.

Attenuation Tank Maintenance Schedule		
	Required Action	**Typical Frequency**
Regular maintenance	Inspect and identify any areas that are not operating correctly. If required, take remedial action	Annually
	Remove debris from the catchment surface (where it may cause risk to performance).	Monthly
	For systems where rainfall infiltrates in the tank from above, check surface of filter for blockage by sediment, algae or other matter, remove and replace surface infiltration medium as necessary	Annually
	Remove sediment from pre-treatment structures.	Annually or as required
Remedial Actions	Repair/rehabilitate inlets/outlets, overflows and vents.	As required
Monitoring	Inspect/check all inlets, outlets, vents and overflows to ensure that they are in good condition and operating as designed.	Annually
	Survey inside of tanks for sediment build-up and remove if necessary	Every 5 years or as required

Table 5.5 – Attenuation Tank Maintenance

6 SUMMARY AND CONCLUSION

6.1.1 This Drainage Strategy has been prepared to identify how the proposed development will discharge surface water runoff from the proposed development.

6.1.2 The proposed application site is located off South Worple Way and will consist of a development of 5 residential properties, following demolition of the existing garages on site.

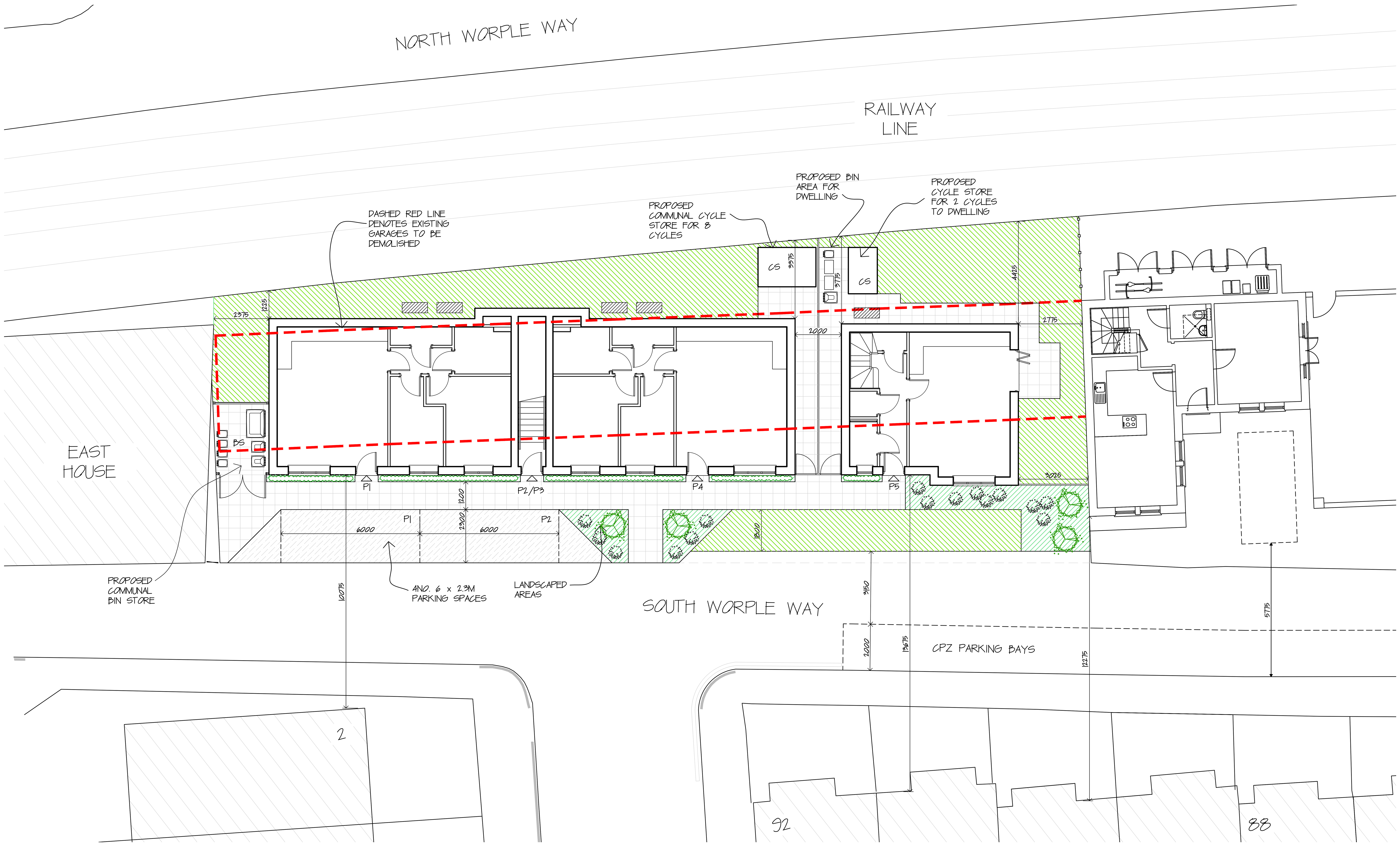
6.1.3 As part of the assessment, SuDS was considered for the discharge of surface water runoff from the proposed buildings and parking areas. The proposals will implement permeable paving and attenuation storage, that has been sized to ensure the storage in the subbase and crates caters for all events up to and including the 1 in 100 year storm plus 40% climate change allowance. The discharge from the attenuation crates will be restricted by a hyrodbrake to 2 l/s which is less than 50% of the existing discharge rate.

6.1.4 This statement clearly demonstrates that the proposed development can be served in terms of discharge of foul and surface water runoff from the site without increasing the risk of flooding in the area. Given the above we can see no reason to preclude development on this site on the grounds of there being insufficient capacity to deal with the runoff from the proposed development.

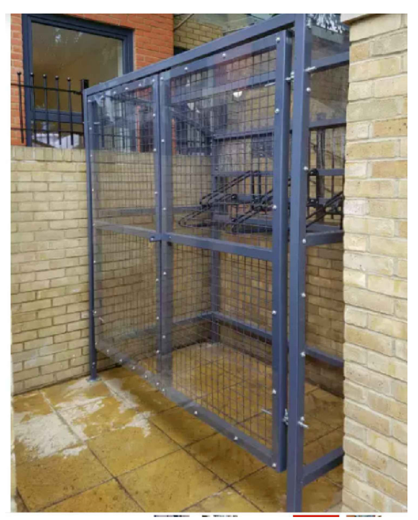
APPENDIX A

Drawing 1332/03 – Proposed Site Layout

PRIOR TO THE COMMENCEMENT OF ANY WORKS, THE BUILDER IS TO CHECK AND/OR DETERMINE ALL CONSTRUCTION DETAILS, INCLUDING CHECKING EXISTING SITE LEVELS AND DIMENSIONS.THE DRAWING IS TO BE READ IN CONJUNCTION WITH ALL OTHER PROJECT DRAWINGS, CONSTRUCTION NOTES AND/OR PROJECT SPECIFICATION. ALL DISCREPANCIES SHOULD BE REPORTED IMMEDIATELY.



ASHP LOCATIONS



INDICATIVE IMAGE OF PROPOSED COMMUNAL CYCLE STORE

WASTE CALCULATIONS

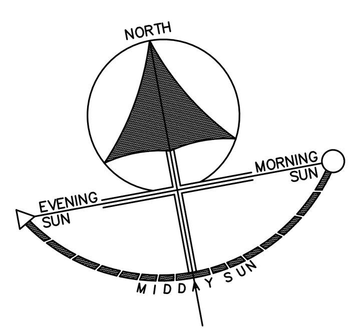
IN ACCORDANCE WITH LONDON BOROUGH OF RICHMOND 'REFUSE AND RECYCLING STORAGE REQUIREMENTS'

FOR ONE 2 BEDROOM HOUSE THE FOLLOWING SHOULD BE PROVIDED;

240L REFUSE
110L DRY RECYCLING (2 NO 55 LITRE RECYCLING BOXES)
23L FOOD PER UNIT

FOR FOUR 2 BEDROOM FLATS THE FOLLOWING SHOULD BE PROVIDED;

560L REFUSE (BASED ON 70 LITRES PER BEDROOM)
480L DRY RECYCLING (1 NO 240 LITRE BIN FOR MIXED PAPER AND 1 NO 240 LITRE BIN FOR MIXED CONTAINERS)
23L FOOD PER UNIT



0 5M 10M 20M

Rev	Date	Details	Drawn
A	05.02.24	PARKING SPACES 3 & 4 OMITTED TO ALLOW FOR FIRE BRIGADE ACCESS FOLLOWING DISCUSSIONS WITH PLANNERS.	JC

Client: BIRCHWOOD HOMES 01932 832277

Site Address:
SOUTH WORPLE WAY
EAST SHEEN, LONDON

Description:
PROPOSED SITE PLAN

Status: PLANNING

Date: NOV 2022 | Scale: 1:100@A1

Drawn: MN | Checked: TCA

Job Number: 1332 | Drawing Number: 03 | Revision: A

TCA ARCHITECTURAL DESIGN
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KT22 7PL
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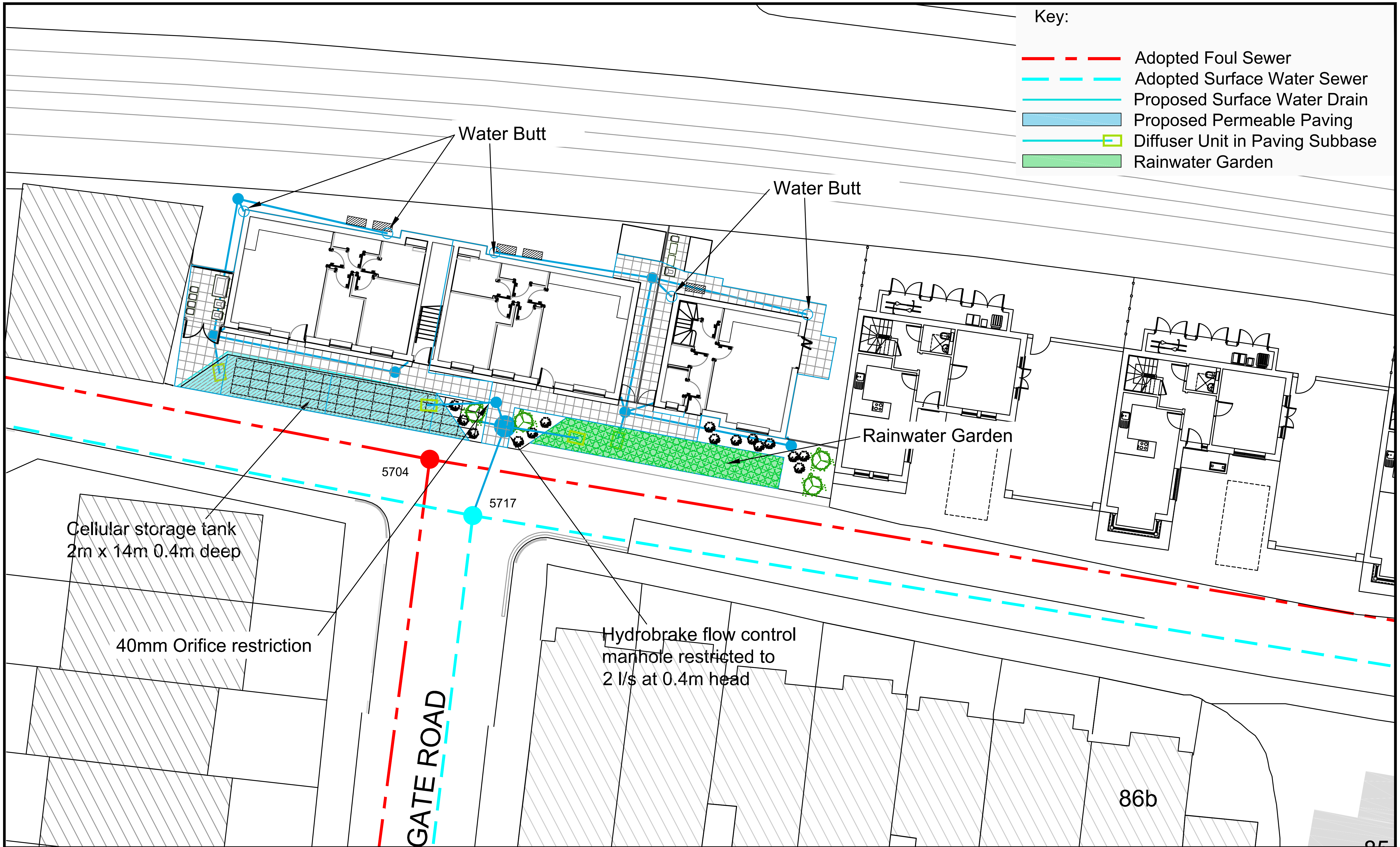
APPENDIX B

Thames Water Sewer Records


MORTLAKE
Mortlake Green
Office
Hall
Sea Scouts Centre
Scout Hut
Girl Guides Centre
Nursery
Garage
El Sub Sta
Mortlake Station
Tester Yard
Playground
Church Bridge
Bridge Cottage
Thomson House School
VERNON ROAD

APPENDIX C

Drawing 231271/DS/01 – Proposed Drainage Strategy



Birchwood
Homes

South Worple Way
East Sheen

Proposed Drainage
Strategy

SCALE 1:200	DRAWN BY KL	PRJ No. 231721	DWG No. 231721/DS/01 Rev D

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Micro Drainage – Greenfield Runoff

ICP SUDS Mean Annual Flood

Input

Return Period (years)	1	Soil	0.300
Area (ha)	0.050	Urban	0.000
SAAR (mm)	600	Region Number	Region 6

Results	**l/s**
QBAR Rural	0.1
QBAR Urban	0.1
Q1 year	0.1
Q1 year	0.1
Q30 years	0.2
Q100 years	0.2

Micro Drainage – Permeable Paving

Cascade Summary of Results for Permeable Paving.srcx

Upstream Structures	Outflow To	Overflow To
(None)	Tank.srcx	(None)

Half Drain Time : 10 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	6.060	0.060	0.0	0.7	0.7	0.5	O K
30 min Summer	6.066	0.066	0.0	0.7	0.7	0.5	O K
60 min Summer	6.066	0.066	0.0	0.7	0.7	0.5	O K
120 min Summer	6.057	0.057	0.0	0.6	0.6	0.4	O K
180 min Summer	6.051	0.051	0.0	0.5	0.5	0.4	O K
240 min Summer	6.046	0.046	0.0	0.5	0.5	0.3	O K
360 min Summer	6.040	0.040	0.0	0.4	0.4	0.3	O K
480 min Summer	6.036	0.036	0.0	0.3	0.3	0.2	O K
600 min Summer	6.033	0.033	0.0	0.3	0.3	0.2	O K
720 min Summer	6.031	0.031	0.0	0.2	0.2	0.2	O K
960 min Summer	6.027	0.027	0.0	0.2	0.2	0.1	O K
1440 min Summer	6.023	0.023	0.0	0.2	0.2	0.1	O K
2160 min Summer	6.020	0.020	0.0	0.1	0.1	0.1	O K
2880 min Summer	6.018	0.018	0.0	0.1	0.1	0.1	O K
4320 min Summer	6.016	0.016	0.0	0.1	0.1	0.0	O K
5760 min Summer	6.014	0.014	0.0	0.1	0.1	0.0	O K
7200 min Summer	6.013	0.013	0.0	0.0	0.0	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	31.195	0.0	0.7	13
30 min Summer	20.288	0.0	1.0	21
60 min Summer	12.800	0.0	1.3	38
120 min Summer	7.911	0.0	1.6	68
180 min Summer	5.941	0.0	1.8	98
240 min Summer	4.843	0.0	2.0	130
360 min Summer	3.610	0.0	2.2	190
480 min Summer	2.922	0.0	2.4	250
600 min Summer	2.479	0.0	2.6	310
720 min Summer	2.168	0.0	2.7	370
960 min Summer	1.754	0.0	2.9	492
1440 min Summer	1.302	0.0	3.2	734
2160 min Summer	0.967	0.0	3.6	1100
2880 min Summer	0.783	0.0	3.9	1468
4320 min Summer	0.581	0.0	4.2	2188
5760 min Summer	0.470	0.0	4.5	2848
7200 min Summer	0.399	0.0	4.7	3568

Cascade Summary of Results for Permeable Paving.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
8640 min Summer	6.012	0.012	0.0	0.0	0.0	0.0	O K
10080 min Summer	6.011	0.011	0.0	0.0	0.0	0.0	O K
15 min Winter	6.066	0.066	0.0	0.7	0.7	0.5	O K
30 min Winter	6.071	0.071	0.0	0.8	0.8	0.6	O K
60 min Winter	6.066	0.066	0.0	0.7	0.7	0.5	O K
120 min Winter	6.053	0.053	0.0	0.6	0.6	0.4	O K
180 min Winter	6.046	0.046	0.0	0.5	0.5	0.3	O K
240 min Winter	6.041	0.041	0.0	0.4	0.4	0.3	O K
360 min Winter	6.035	0.035	0.0	0.3	0.3	0.2	O K
480 min Winter	6.031	0.031	0.0	0.3	0.3	0.2	O K
600 min Winter	6.028	0.028	0.0	0.2	0.2	0.1	O K
720 min Winter	6.025	0.025	0.0	0.2	0.2	0.1	O K
960 min Winter	6.023	0.023	0.0	0.2	0.2	0.1	O K
1440 min Winter	6.020	0.020	0.0	0.1	0.1	0.1	O K
2160 min Winter	6.017	0.017	0.0	0.1	0.1	0.1	O K
2880 min Winter	6.015	0.015	0.0	0.1	0.1	0.0	O K
4320 min Winter	6.013	0.013	0.0	0.1	0.1	0.0	O K
5760 min Winter	6.012	0.012	0.0	0.0	0.0	0.0	O K
7200 min Winter	6.011	0.011	0.0	0.0	0.0	0.0	O K
8640 min Winter	6.010	0.010	0.0	0.0	0.0	0.0	O K
10080 min Winter	6.010	0.010	0.0	0.0	0.0	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
8640 min Summer	0.349	0.0	4.9	4304
10080 min Summer	0.312	0.0	5.0	5040
15 min Winter	31.195	0.0	0.8	14
30 min Winter	20.288	0.0	1.1	23
60 min Winter	12.800	0.0	1.4	40
120 min Winter	7.911	0.0	1.8	70
180 min Winter	5.941	0.0	2.1	100
240 min Winter	4.843	0.0	2.3	132
360 min Winter	3.610	0.0	2.5	190
480 min Winter	2.922	0.0	2.7	254
600 min Winter	2.479	0.0	2.9	314
720 min Winter	2.168	0.0	3.1	376
960 min Winter	1.754	0.0	3.3	490
1440 min Winter	1.302	0.0	3.7	710
2160 min Winter	0.967	0.0	4.1	1072
2880 min Winter	0.783	0.0	4.4	1448
4320 min Winter	0.581	0.0	4.8	2272
5760 min Winter	0.470	0.0	5.1	2864
7200 min Winter	0.399	0.0	5.4	3672
8640 min Winter	0.349	0.0	5.6	4384
10080 min Winter	0.312	0.0	5.7	5032

Cascade Rainfall Details for Permeable Paving.srcx

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	1	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.408	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 0.015

Time From:	**(mins) To:**	**Area (ha)**
0	4	0.015

Cascade Model Details for Permeable Paving.srcx

Storage is Online Cover Level (m) 6.500

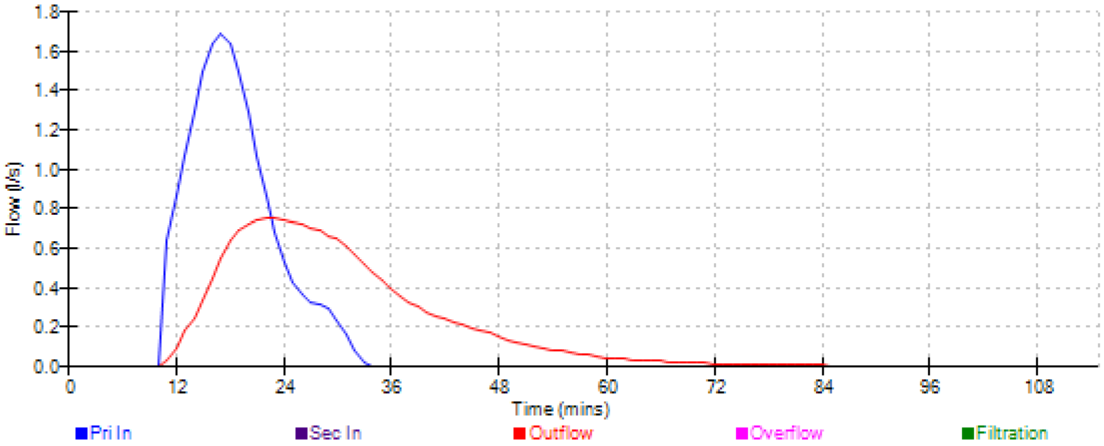
Porous Car Park Structure

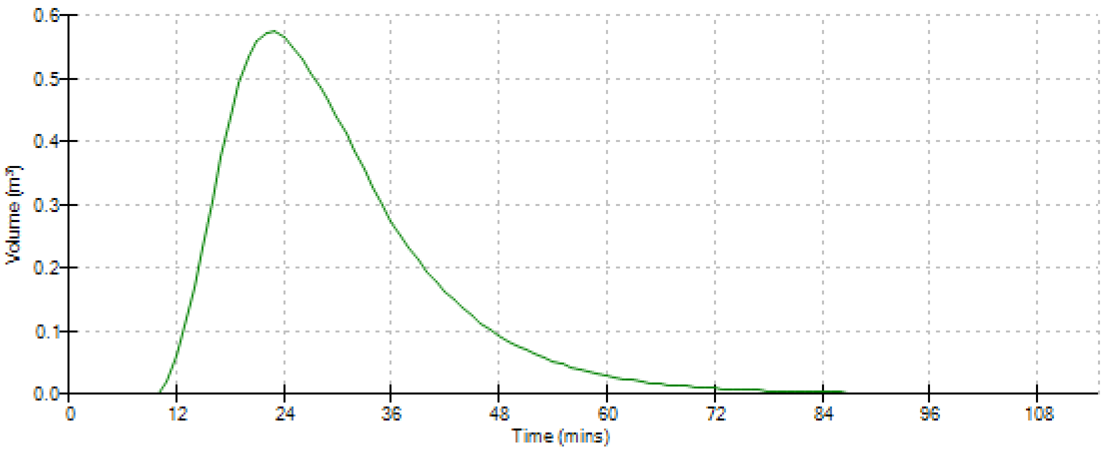
Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	2.4
Membrane Percolation (mm/hr)	1000	Length (m)	14.0
Max Percolation (l/s)	9.3	Slope (1:X)	500.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	6.000	Cap Volume Depth (m)	0.350

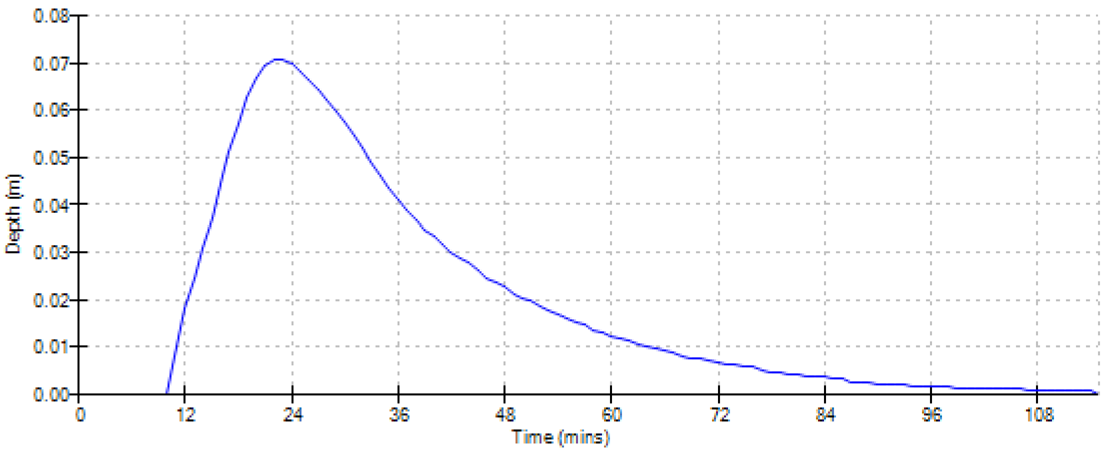
Orifice Outflow Control

Diameter (m) 0.040 Discharge Coefficient 0.600 Invert Level (m) 6.000

Cascade Event: 30 min Winter for Permeable Paving.srcx







Cascade Summary of Results for Permeable Paving.srcx

Upstream Structures	Outflow To	Overflow To
(None)	Tank.srcx	(None)

Half Drain Time : 15 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	6.152	0.152	0.0	1.2	1.2	1.4	O K
30 min Summer	6.170	0.170	0.0	1.3	1.3	1.6	O K
60 min Summer	6.166	0.166	0.0	1.3	1.3	1.5	O K
120 min Summer	6.139	0.139	0.0	1.2	1.2	1.3	O K
180 min Summer	6.116	0.116	0.0	1.0	1.0	1.0	O K
240 min Summer	6.099	0.099	0.0	0.9	0.9	0.9	O K
360 min Summer	6.076	0.076	0.0	0.8	0.8	0.6	O K
480 min Summer	6.063	0.063	0.0	0.7	0.7	0.5	O K
600 min Summer	6.055	0.055	0.0	0.6	0.6	0.4	O K
720 min Summer	6.050	0.050	0.0	0.5	0.5	0.4	O K
960 min Summer	6.044	0.044	0.0	0.4	0.4	0.3	O K
1440 min Summer	6.036	0.036	0.0	0.3	0.3	0.2	O K
2160 min Summer	6.030	0.030	0.0	0.2	0.2	0.2	O K
2880 min Summer	6.025	0.025	0.0	0.2	0.2	0.1	O K
4320 min Summer	6.021	0.021	0.0	0.1	0.1	0.1	O K
5760 min Summer	6.020	0.020	0.0	0.1	0.1	0.1	O K
7200 min Summer	6.018	0.018	0.0	0.1	0.1	0.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	76.545	0.0	2.0	14
30 min Summer	49.669	0.0	2.6	22
60 min Summer	30.811	0.0	3.3	40
120 min Summer	18.553	0.0	4.0	72
180 min Summer	13.645	0.0	4.4	102
240 min Summer	10.926	0.0	4.7	132
360 min Summer	7.968	0.0	5.2	192
480 min Summer	6.367	0.0	5.5	252
600 min Summer	5.347	0.0	5.8	308
720 min Summer	4.634	0.0	6.0	370
960 min Summer	3.696	0.0	6.4	492
1440 min Summer	2.684	0.0	7.0	734
2160 min Summer	1.947	0.0	7.6	1100
2880 min Summer	1.550	0.0	8.0	1468
4320 min Summer	1.122	0.0	8.6	2200
5760 min Summer	0.892	0.0	9.1	2880
7200 min Summer	0.746	0.0	9.4	3672

Cascade Summary of Results for Permeable Paving.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
8640 min Summer	6.017	0.017	0.0	0.1	0.1	0.0	O K
10080 min Summer	6.015	0.015	0.0	0.1	0.1	0.0	O K
15 min Winter	6.172	0.172	0.0	1.3	1.3	1.6	O K
30 min Winter	6.187	0.187	0.0	1.4	1.4	1.7	O K
60 min Winter	6.175	0.175	0.0	1.3	1.3	1.6	O K
120 min Winter	6.134	0.134	0.0	1.1	1.1	1.2	O K
180 min Winter	6.104	0.104	0.0	1.0	1.0	0.9	O K
240 min Winter	6.084	0.084	0.0	0.8	0.8	0.7	O K
360 min Winter	6.060	0.060	0.0	0.7	0.7	0.5	O K
480 min Winter	6.051	0.051	0.0	0.6	0.6	0.4	O K
600 min Winter	6.046	0.046	0.0	0.5	0.5	0.3	O K
720 min Winter	6.042	0.042	0.0	0.4	0.4	0.3	O K
960 min Winter	6.036	0.036	0.0	0.3	0.3	0.2	O K
1440 min Winter	6.030	0.030	0.0	0.2	0.2	0.2	O K
2160 min Winter	6.024	0.024	0.0	0.2	0.2	0.1	O K
2880 min Winter	6.021	0.021	0.0	0.1	0.1	0.1	O K
4320 min Winter	6.019	0.019	0.0	0.1	0.1	0.1	O K
5760 min Winter	6.016	0.016	0.0	0.1	0.1	0.0	O K
7200 min Winter	6.015	0.015	0.0	0.1	0.1	0.0	O K
8640 min Winter	6.014	0.014	0.0	0.1	0.1	0.0	O K
10080 min Winter	6.013	0.013	0.0	0.1	0.1	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
8640 min Summer	0.645	0.0	9.7	4384
10080 min Summer	0.570	0.0	9.9	5056
15 min Winter	76.545	0.0	2.2	15
30 min Winter	49.669	0.0	3.0	24
60 min Winter	30.811	0.0	3.7	42
120 min Winter	18.553	0.0	4.5	76
180 min Winter	13.645	0.0	5.0	106
240 min Winter	10.926	0.0	5.3	136
360 min Winter	7.968	0.0	5.8	194
480 min Winter	6.367	0.0	6.2	250
600 min Winter	5.347	0.0	6.5	308
720 min Winter	4.634	0.0	6.8	370
960 min Winter	3.696	0.0	7.2	492
1440 min Winter	2.684	0.0	7.8	736
2160 min Winter	1.947	0.0	8.5	1100
2880 min Winter	1.550	0.0	9.0	1488
4320 min Winter	1.122	0.0	9.7	2168
5760 min Winter	0.892	0.0	10.2	2936
7200 min Winter	0.746	0.0	10.6	3536
8640 min Winter	0.645	0.0	10.9	4408
10080 min Winter	0.570	0.0	11.2	5136

Cascade Rainfall Details for Permeable Paving.srcx

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	30	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.408	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 0.015

Time From:	**(mins) To:**	**Area (ha)**
0	4	0.015

Cascade Model Details for Permeable Paving.srcx

Storage is Online Cover Level (m) 6.500

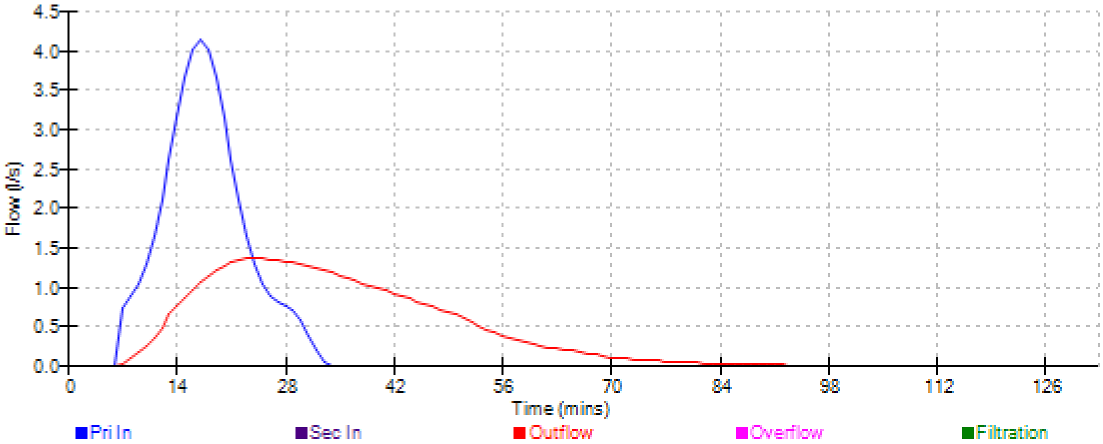
Porous Car Park Structure

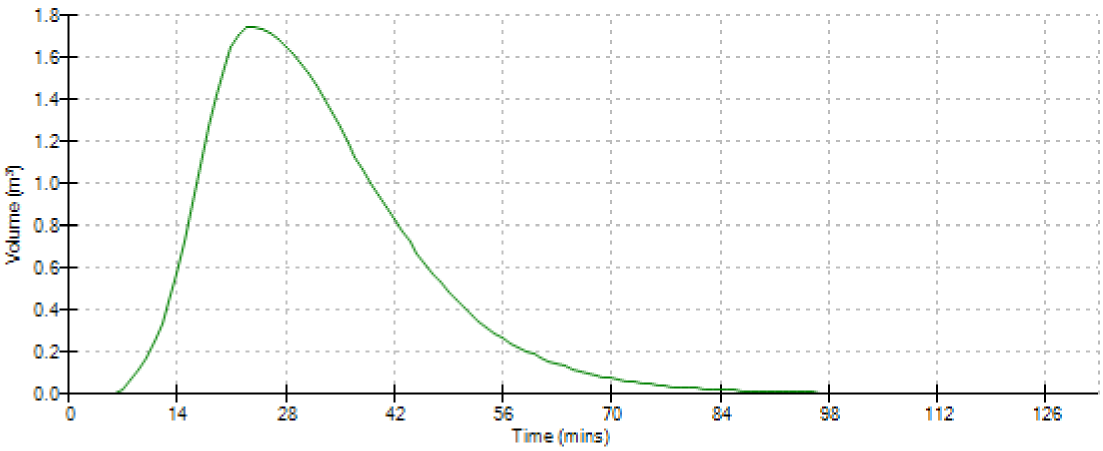
Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	2.4
Membrane Percolation (mm/hr)	1000	Length (m)	14.0
Max Percolation (l/s)	9.3	Slope (1:X)	500.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	6.000	Cap Volume Depth (m)	0.350

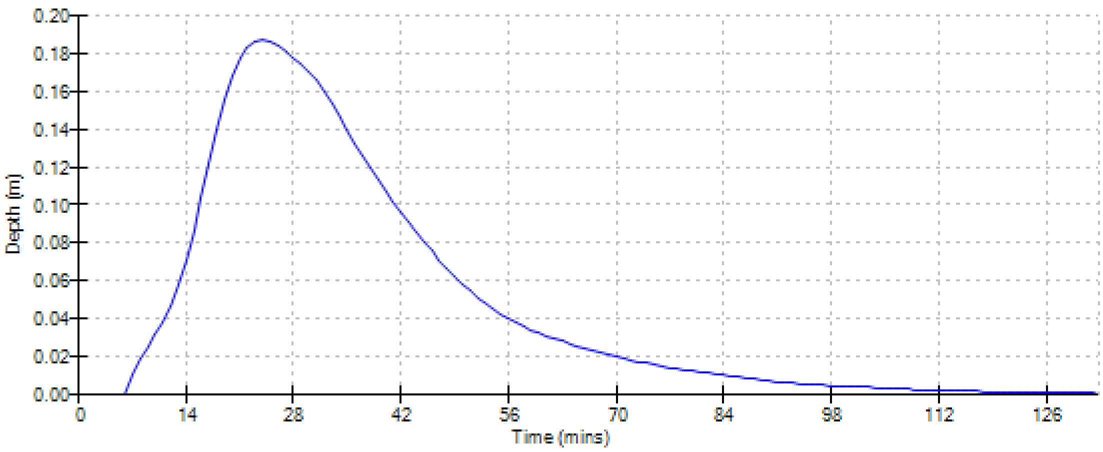
Orifice Outflow Control

Diameter (m) 0.040 Discharge Coefficient 0.600 Invert Level (m) 6.000

Cascade Event: 30 min Winter for Permeable Paving.srcx







Cascade Summary of Results for Permeable Paving.srcx

Upstream Structures	Outflow To	Overflow To
(None)	Tank.srcx	(None)

Half Drain Time : 18 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	6.202	0.202	0.0	1.4	1.4	1.9	Flood Risk
30 min Summer	6.228	0.228	0.0	1.5	1.5	2.2	Flood Risk
60 min Summer	6.227	0.227	0.0	1.5	1.5	2.1	Flood Risk
120 min Summer	6.193	0.193	0.0	1.4	1.4	1.8	O K
180 min Summer	6.162	0.162	0.0	1.3	1.3	1.5	O K
240 min Summer	6.138	0.138	0.0	1.1	1.1	1.2	O K
360 min Summer	6.104	0.104	0.0	1.0	1.0	0.9	O K
480 min Summer	6.084	0.084	0.0	0.8	0.8	0.7	O K
600 min Summer	6.070	0.070	0.0	0.7	0.7	0.6	O K
720 min Summer	6.061	0.061	0.0	0.7	0.7	0.5	O K
960 min Summer	6.052	0.052	0.0	0.6	0.6	0.4	O K
1440 min Summer	6.042	0.042	0.0	0.4	0.4	0.3	O K
2160 min Summer	6.035	0.035	0.0	0.3	0.3	0.2	O K
2880 min Summer	6.030	0.030	0.0	0.2	0.2	0.2	O K
4320 min Summer	6.024	0.024	0.0	0.2	0.2	0.1	O K
5760 min Summer	6.021	0.021	0.0	0.1	0.1	0.1	O K
7200 min Summer	6.020	0.020	0.0	0.1	0.1	0.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	99.366	0.0	2.6	14
30 min Summer	65.019	0.0	3.5	23
60 min Summer	40.510	0.0	4.4	40
120 min Summer	24.381	0.0	5.3	72
180 min Summer	17.876	0.0	5.9	104
240 min Summer	14.259	0.0	6.2	134
360 min Summer	10.337	0.0	6.8	194
480 min Summer	8.228	0.0	7.2	254
600 min Summer	6.888	0.0	7.5	314
720 min Summer	5.954	0.0	7.8	370
960 min Summer	4.728	0.0	8.3	492
1440 min Summer	3.411	0.0	8.9	734
2160 min Summer	2.457	0.0	9.6	1100
2880 min Summer	1.945	0.0	10.1	1468
4320 min Summer	1.397	0.0	10.8	2160
5760 min Summer	1.104	0.0	11.4	2888
7200 min Summer	0.919	0.0	11.7	3600

Cascade Summary of Results for Permeable Paving.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
8640 min Summer	6.019	0.019	0.0	0.1	0.1	0.1	O K
10080 min Summer	6.017	0.017	0.0	0.1	0.1	0.1	O K
15 min Winter	6.229	0.229	0.0	1.5	1.5	2.2	Flood Risk
30 min Winter	6.254	0.254	0.0	1.6	1.6	2.4	Flood Risk
60 min Winter	6.242	0.242	0.0	1.6	1.6	2.3	Flood Risk
120 min Winter	6.191	0.191	0.0	1.4	1.4	1.8	O K
180 min Winter	6.149	0.149	0.0	1.2	1.2	1.4	O K
240 min Winter	6.119	0.119	0.0	1.1	1.1	1.1	O K
360 min Winter	6.083	0.083	0.0	0.8	0.8	0.7	O K
480 min Winter	6.064	0.064	0.0	0.7	0.7	0.5	O K
600 min Winter	6.054	0.054	0.0	0.6	0.6	0.4	O K
720 min Winter	6.049	0.049	0.0	0.5	0.5	0.4	O K
960 min Winter	6.042	0.042	0.0	0.4	0.4	0.3	O K
1440 min Winter	6.035	0.035	0.0	0.3	0.3	0.2	O K
2160 min Winter	6.028	0.028	0.0	0.2	0.2	0.1	O K
2880 min Winter	6.024	0.024	0.0	0.2	0.2	0.1	O K
4320 min Winter	6.021	0.021	0.0	0.1	0.1	0.1	O K
5760 min Winter	6.019	0.019	0.0	0.1	0.1	0.1	O K
7200 min Winter	6.017	0.017	0.0	0.1	0.1	0.0	O K
8640 min Winter	6.015	0.015	0.0	0.1	0.1	0.0	O K
10080 min Winter	6.014	0.014	0.0	0.1	0.1	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
8640 min Summer	0.791	0.0	12.0	4376
10080 min Summer	0.696	0.0	12.3	5064
15 min Winter	99.366	0.0	3.0	15
30 min Winter	65.019	0.0	3.9	24
60 min Winter	40.510	0.0	4.9	42
120 min Winter	24.381	0.0	6.0	76
180 min Winter	17.876	0.0	6.6	108
240 min Winter	14.259	0.0	7.0	138
360 min Winter	10.337	0.0	7.6	198
480 min Winter	8.228	0.0	8.1	256
600 min Winter	6.888	0.0	8.5	312
720 min Winter	5.954	0.0	8.8	370
960 min Winter	4.728	0.0	9.3	492
1440 min Winter	3.411	0.0	10.0	716
2160 min Winter	2.457	0.0	10.8	1088
2880 min Winter	1.945	0.0	11.4	1468
4320 min Winter	1.397	0.0	12.2	2188
5760 min Winter	1.104	0.0	12.8	2840
7200 min Winter	0.919	0.0	13.2	3616
8640 min Winter	0.791	0.0	13.6	4352
10080 min Winter	0.696	0.0	13.9	5064

Cascade Rainfall Details for Permeable Paving.srcx

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.408	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 0.015

Time From:	(mins) To:	Area (ha)
0	4	0.015

Cascade Model Details for Permeable Paving.srcx

Storage is Online Cover Level (m) 6.500

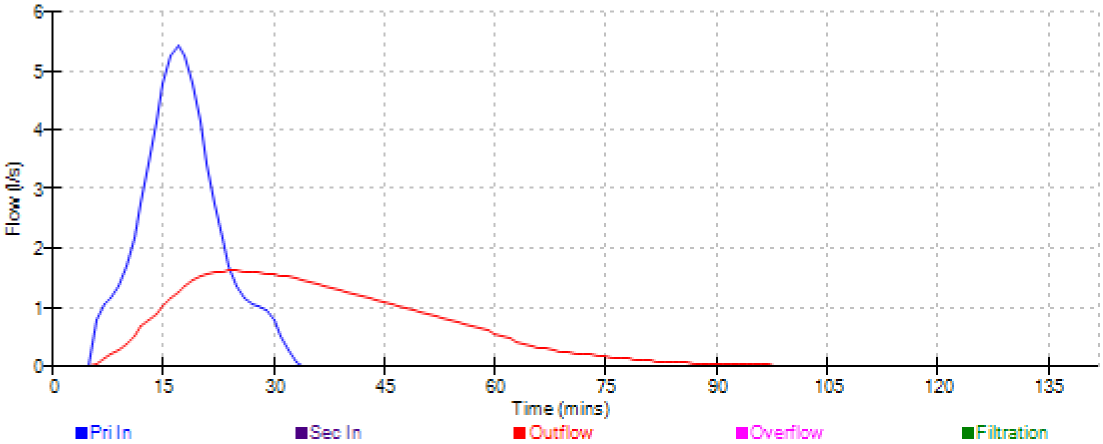
Porous Car Park Structure

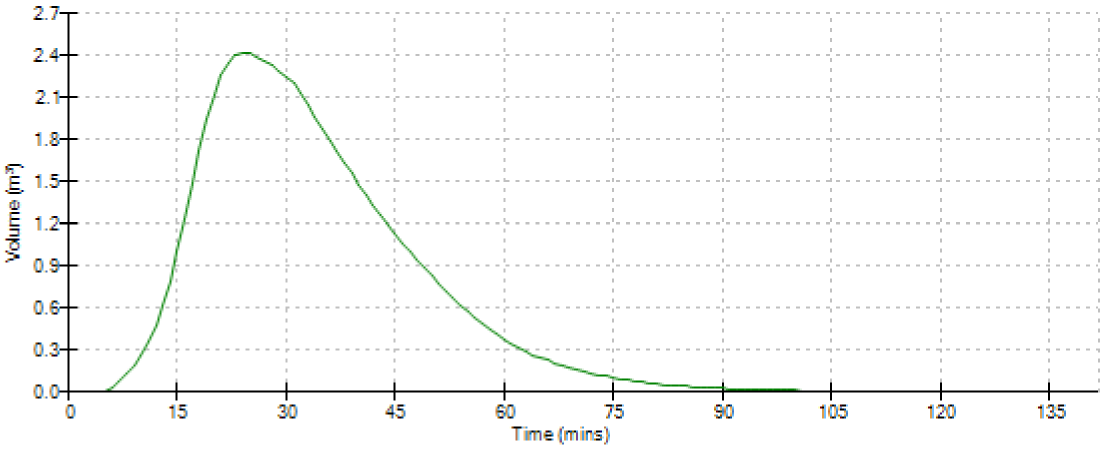
Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	2.4
Membrane Percolation (mm/hr)	1000	Length (m)	14.0
Max Percolation (l/s)	9.3	Slope (1:X)	500.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	6.000	Cap Volume Depth (m)	0.350

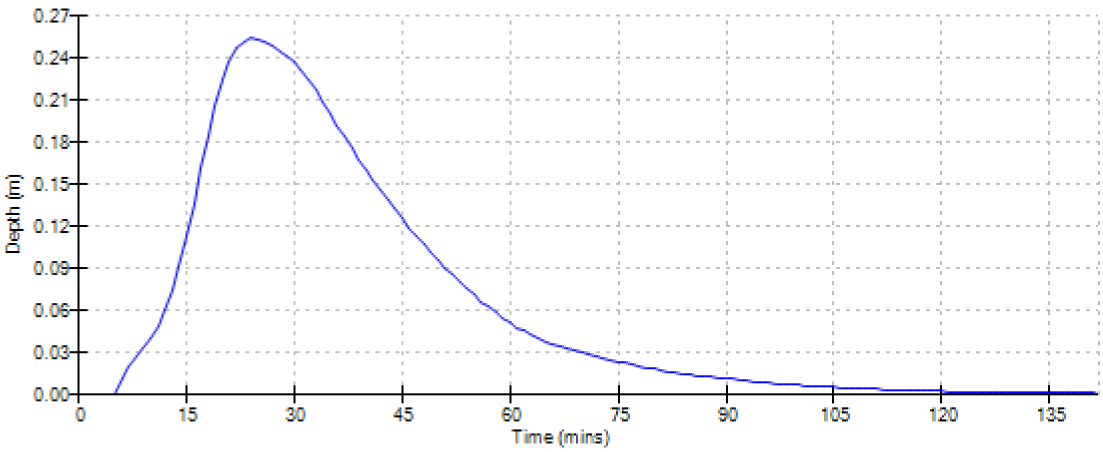
Orifice Outflow Control

Diameter (m) 0.040 Discharge Coefficient 0.600 Invert Level (m) 6.000

Cascade Event: 30 min Winter for Permeable Paving.srcx







Cascade Summary of Results for Permeable Paving.srcx

Upstream Structures	Outflow To	Overflow To
(None)	Tank.srcx	(None)

Half Drain Time : 21 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	6.292	0.292	0.0	1.7	1.7	2.8	Flood Risk
30 min Summer	6.331	0.331	0.0	1.9	1.9	3.2	Flood Risk
60 min Summer	6.333	0.333	0.0	1.9	1.9	3.2	Flood Risk
120 min Summer	6.292	0.292	0.0	1.7	1.7	2.8	Flood Risk
180 min Summer	6.249	0.249	0.0	1.6	1.6	2.4	Flood Risk
240 min Summer	6.214	0.214	0.0	1.5	1.5	2.0	Flood Risk
360 min Summer	6.164	0.164	0.0	1.3	1.3	1.5	O K
480 min Summer	6.131	0.131	0.0	1.1	1.1	1.2	O K
600 min Summer	6.108	0.108	0.0	1.0	1.0	0.9	O K
720 min Summer	6.092	0.092	0.0	0.9	0.9	0.8	O K
960 min Summer	6.071	0.071	0.0	0.8	0.8	0.6	O K
1440 min Summer	6.053	0.053	0.0	0.6	0.6	0.4	O K
2160 min Summer	6.043	0.043	0.0	0.4	0.4	0.3	O K
2880 min Summer	6.037	0.037	0.0	0.3	0.3	0.2	O K
4320 min Summer	6.030	0.030	0.0	0.2	0.2	0.2	O K
5760 min Summer	6.026	0.026	0.0	0.2	0.2	0.1	O K
7200 min Summer	6.023	0.023	0.0	0.2	0.2	0.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	139.112	0.0	3.7	15
30 min Summer	91.026	0.0	4.9	23
60 min Summer	56.713	0.0	6.2	40
120 min Summer	34.134	0.0	7.5	74
180 min Summer	25.027	0.0	8.3	106
240 min Summer	19.963	0.0	8.8	136
360 min Summer	14.472	0.0	9.6	198
480 min Summer	11.519	0.0	10.2	258
600 min Summer	9.643	0.0	10.6	316
720 min Summer	8.336	0.0	11.0	376
960 min Summer	6.619	0.0	11.7	494
1440 min Summer	4.775	0.0	12.6	734
2160 min Summer	3.440	0.0	13.6	1092
2880 min Summer	2.723	0.0	14.3	1468
4320 min Summer	1.956	0.0	15.4	2176
5760 min Summer	1.545	0.0	16.1	2928
7200 min Summer	1.287	0.0	16.7	3624

Cascade Summary of Results for Permeable Paving.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
8640 min Summer	6.021	0.021	0.0	0.1	0.1	0.1	O K
10080 min Summer	6.020	0.020	0.0	0.1	0.1	0.1	O K
15 min Winter	6.331	0.331	0.0	1.9	1.9	3.2	Flood Risk
30 min Winter	6.413	0.413	0.0	2.1	2.1	3.6	Flood Risk
60 min Winter	6.367	0.367	0.0	2.0	2.0	3.5	Flood Risk
120 min Winter	6.297	0.297	0.0	1.8	1.8	2.9	Flood Risk
180 min Winter	6.237	0.237	0.0	1.6	1.6	2.2	Flood Risk
240 min Winter	6.192	0.192	0.0	1.4	1.4	1.8	O K
360 min Winter	6.134	0.134	0.0	1.1	1.1	1.2	O K
480 min Winter	6.100	0.100	0.0	0.9	0.9	0.9	O K
600 min Winter	6.080	0.080	0.0	0.8	0.8	0.7	O K
720 min Winter	6.066	0.066	0.0	0.7	0.7	0.5	O K
960 min Winter	6.053	0.053	0.0	0.6	0.6	0.4	O K
1440 min Winter	6.043	0.043	0.0	0.4	0.4	0.3	O K
2160 min Winter	6.035	0.035	0.0	0.3	0.3	0.2	O K
2880 min Winter	6.030	0.030	0.0	0.2	0.2	0.2	O K
4320 min Winter	6.024	0.024	0.0	0.2	0.2	0.1	O K
5760 min Winter	6.021	0.021	0.0	0.1	0.1	0.1	O K
7200 min Winter	6.020	0.020	0.0	0.1	0.1	0.1	O K
8640 min Winter	6.019	0.019	0.0	0.1	0.1	0.1	O K
10080 min Winter	6.017	0.017	0.0	0.1	0.1	0.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
8640 min Summer	1.107	0.0	17.2	4368
10080 min Summer	0.975	0.0	17.6	5032
15 min Winter	139.112	0.0	4.2	15
30 min Winter	91.026	0.0	5.6	25
60 min Winter	56.713	0.0	7.0	44
120 min Winter	34.134	0.0	8.4	78
180 min Winter	25.027	0.0	9.3	110
240 min Winter	19.963	0.0	9.9	142
360 min Winter	14.472	0.0	10.7	202
480 min Winter	11.519	0.0	11.4	262
600 min Winter	9.643	0.0	11.9	320
720 min Winter	8.336	0.0	12.4	376
960 min Winter	6.619	0.0	13.1	490
1440 min Winter	4.775	0.0	14.2	734
2160 min Winter	3.440	0.0	15.3	1092
2880 min Winter	2.723	0.0	16.1	1428
4320 min Winter	1.956	0.0	17.3	2196
5760 min Winter	1.545	0.0	18.1	2824
7200 min Winter	1.287	0.0	18.8	3608
8640 min Winter	1.107	0.0	19.3	4240
10080 min Winter	0.975	0.0	19.8	4976

Cascade Rainfall Details for Permeable Paving.srcx

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.408	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.015

Time From:	**(mins) To:**	**Area (ha)**
0	4	0.015

Cascade Model Details for Permeable Paving.srcx

Storage is Online Cover Level (m) 6.500

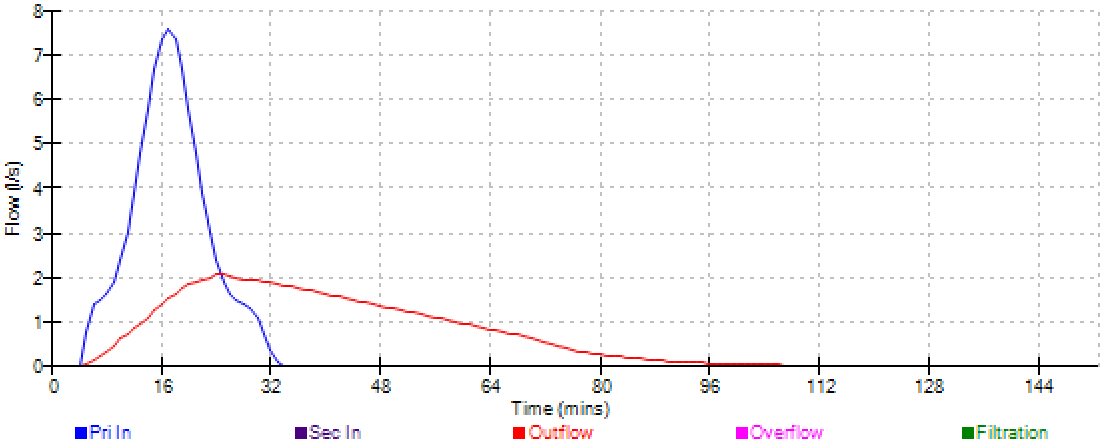
Porous Car Park Structure

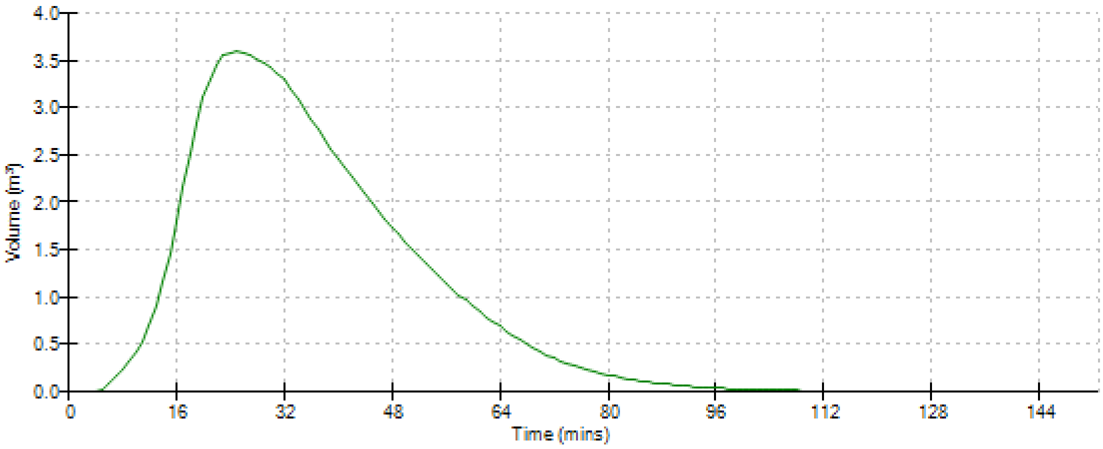
Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	2.4
Membrane Percolation (mm/hr)	1000	Length (m)	14.0
Max Percolation (l/s)	9.3	Slope (1:X)	500.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	6.000	Cap Volume Depth (m)	0.350

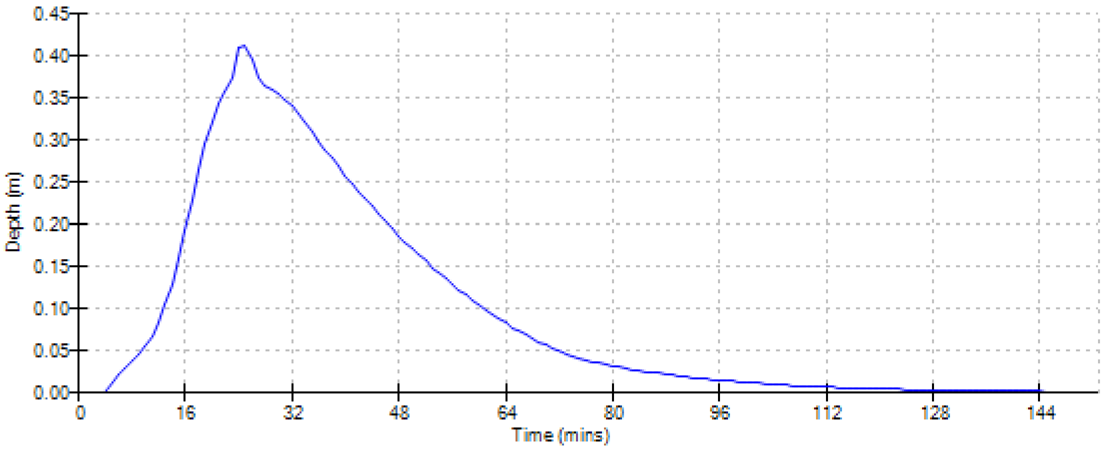
Orifice Outflow Control

Diameter (m) 0.040 Discharge Coefficient 0.600 Invert Level (m) 6.000

Cascade Event: 30 min Winter for Permeable Paving.srcx







Micro Drainage – Attenuation Crates

Cascade Summary of Results for Tank.srcx

Upstream Structures	Outflow To	Overflow To
Permeable Paving.srcx	(None)	(None)

Half Drain Time : 19 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	5.041	0.041	0.0	0.7	0.7	1.1	O K
30 min Summer	5.048	0.048	0.0	0.9	0.9	1.3	O K
60 min Summer	5.053	0.053	0.0	1.0	1.0	1.4	O K
120 min Summer	5.053	0.053	0.0	1.0	1.0	1.4	O K
180 min Summer	5.051	0.051	0.0	1.0	1.0	1.3	O K
240 min Summer	5.048	0.048	0.0	0.9	0.9	1.3	O K
360 min Summer	5.043	0.043	0.0	0.7	0.7	1.1	O K
480 min Summer	5.040	0.040	0.0	0.6	0.6	1.1	O K
600 min Summer	5.037	0.037	0.0	0.6	0.6	1.0	O K
720 min Summer	5.035	0.035	0.0	0.5	0.5	0.9	O K
960 min Summer	5.032	0.032	0.0	0.4	0.4	0.8	O K
1440 min Summer	5.027	0.027	0.0	0.3	0.3	0.7	O K
2160 min Summer	5.024	0.024	0.0	0.3	0.3	0.6	O K
2880 min Summer	5.021	0.021	0.0	0.2	0.2	0.6	O K
4320 min Summer	5.018	0.018	0.0	0.2	0.2	0.5	O K
5760 min Summer	5.016	0.016	0.0	0.1	0.1	0.4	O K
7200 min Summer	5.015	0.015	0.0	0.1	0.1	0.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	31.195	0.0	1.7	18
30 min Summer	20.288	0.0	2.3	28
60 min Summer	12.800	0.0	3.0	42
120 min Summer	7.911	0.0	3.7	74
180 min Summer	5.941	0.0	4.2	106
240 min Summer	4.843	0.0	4.6	136
360 min Summer	3.610	0.0	5.2	198
480 min Summer	2.922	0.0	5.6	258
600 min Summer	2.479	0.0	5.9	320
720 min Summer	2.168	0.0	6.2	378
960 min Summer	1.754	0.0	6.7	500
1440 min Summer	1.302	0.0	7.5	740
2160 min Summer	0.967	0.0	8.3	1100
2880 min Summer	0.783	0.0	8.9	1468
4320 min Summer	0.581	0.0	9.9	2196
5760 min Summer	0.470	0.0	10.6	2936
7200 min Summer	0.399	0.0	11.2	3632

Cascade Summary of Results for Tank.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
8640 min Summer	5.014	0.014	0.0	0.1	0.1	0.4	O K
10080 min Summer	5.013	0.013	0.0	0.1	0.1	0.3	O K
15 min Winter	5.045	0.045	0.0	0.8	0.8	1.2	O K
30 min Winter	5.053	0.053	0.0	1.0	1.0	1.4	O K
60 min Winter	5.057	0.057	0.0	1.1	1.1	1.5	O K
120 min Winter	5.054	0.054	0.0	1.1	1.1	1.4	O K
180 min Winter	5.049	0.049	0.0	0.9	0.9	1.3	O K
240 min Winter	5.045	0.045	0.0	0.8	0.8	1.2	O K
360 min Winter	5.040	0.040	0.0	0.6	0.6	1.1	O K
480 min Winter	5.036	0.036	0.0	0.5	0.5	0.9	O K
600 min Winter	5.033	0.033	0.0	0.5	0.5	0.9	O K
720 min Winter	5.031	0.031	0.0	0.4	0.4	0.8	O K
960 min Winter	5.027	0.027	0.0	0.3	0.3	0.7	O K
1440 min Winter	5.024	0.024	0.0	0.3	0.3	0.6	O K
2160 min Winter	5.020	0.020	0.0	0.2	0.2	0.5	O K
2880 min Winter	5.018	0.018	0.0	0.2	0.2	0.5	O K
4320 min Winter	5.015	0.015	0.0	0.1	0.1	0.4	O K
5760 min Winter	5.014	0.014	0.0	0.1	0.1	0.4	O K
7200 min Winter	5.013	0.013	0.0	0.1	0.1	0.3	O K
8640 min Winter	5.012	0.012	0.0	0.1	0.1	0.3	O K
10080 min Winter	5.011	0.011	0.0	0.1	0.1	0.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
8640 min Summer	0.349	0.0	11.7	4360
10080 min Summer	0.312	0.0	12.1	5048
15 min Winter	31.195	0.0	2.0	18
30 min Winter	20.288	0.0	2.6	29
60 min Winter	12.800	0.0	3.4	44
120 min Winter	7.911	0.0	4.2	78
180 min Winter	5.941	0.0	4.7	108
240 min Winter	4.843	0.0	5.2	140
360 min Winter	3.610	0.0	5.8	200
480 min Winter	2.922	0.0	6.3	266
600 min Winter	2.479	0.0	6.6	322
720 min Winter	2.168	0.0	7.0	378
960 min Winter	1.754	0.0	7.5	510
1440 min Winter	1.302	0.0	8.4	748
2160 min Winter	0.967	0.0	9.3	1096
2880 min Winter	0.783	0.0	10.0	1456
4320 min Winter	0.581	0.0	11.1	2244
5760 min Winter	0.470	0.0	11.9	2928
7200 min Winter	0.399	0.0	12.6	3632
8640 min Winter	0.349	0.0	13.2	4400
10080 min Winter	0.312	0.0	13.6	5128

Cascade Rainfall Details for Tank.srcx

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	1	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.408	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 0.018

Time From:	**(mins) To:**	**Area (ha)**
0	4	0.018

Cascade Model Details for Tank.srcx

Storage is Online Cover Level (m) 6.500

Cellular Storage Structure

Invert Level (m) 5.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	28.0	28.0	0.401	0.0	40.8
0.400	28.0	40.8			

Hydro-Brake Optimum® Outflow Control

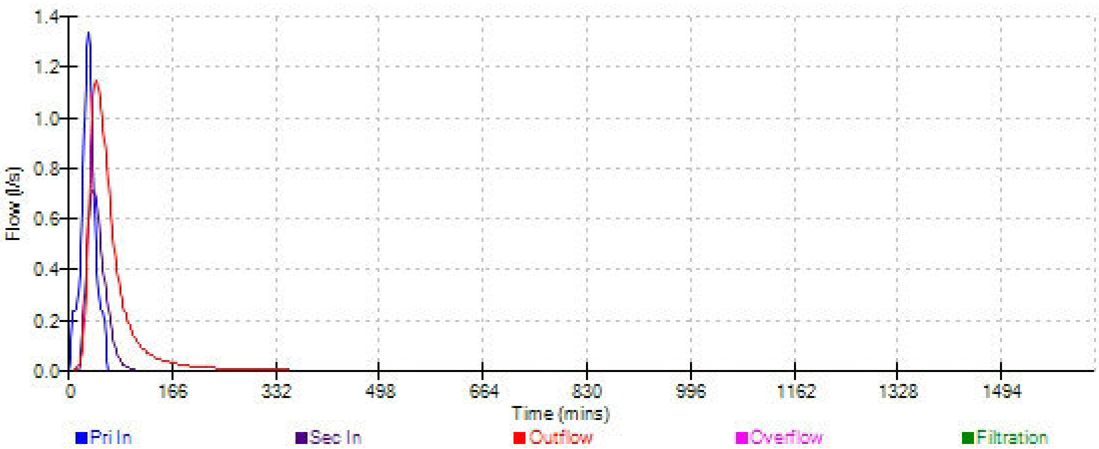
Unit Reference	MD-SHE-0075-2000-0400-2000
Design Head (m)	0.400
Design Flow (l/s)	2.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Diameter (mm)	75
Invert Level (m)	5.000
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

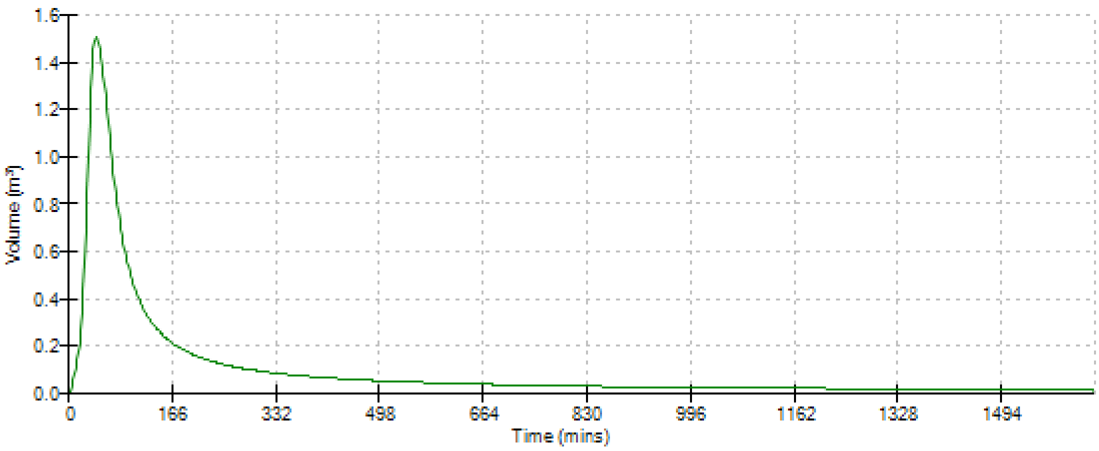
Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.400	2.0
Flush-Flo™	0.124	2.0
Kick-Flo®	0.285	1.7
Mean Flow over Head Range	-	1.6

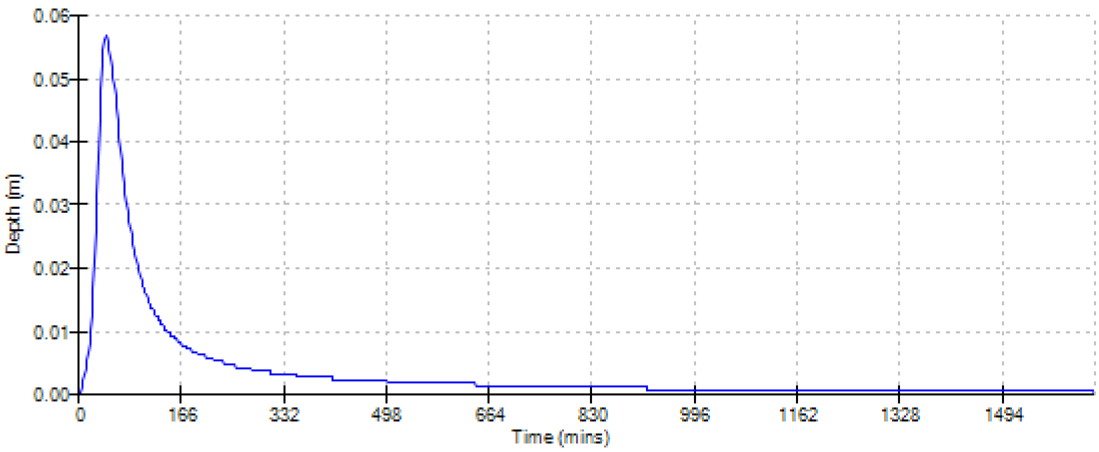
The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake Optimum® as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	2.0	1.200	3.3	3.000	5.0	7.000	7.5
0.200	1.9	1.400	3.5	3.500	5.4	7.500	7.8
0.300	1.7	1.600	3.7	4.000	5.7	8.000	8.1
0.400	2.0	1.800	3.9	4.500	6.0	8.500	8.3
0.500	2.2	2.000	4.1	5.000	6.4	9.000	8.6
0.600	2.4	2.200	4.3	5.500	6.7	9.500	8.8
0.800	2.7	2.400	4.5	6.000	7.0		
1.000	3.0	2.600	4.7	6.500	7.3		

Cascade Event: 60 min Winter for Tank.srcx







Cascade Summary of Results for Tank.srcx

Upstream Structures	Outflow To	Overflow To
Permeable Paving.srcx	(None)	(None)

Half Drain Time : 19 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	5.088	0.088	0.0	1.9	1.9	2.3	O K
30 min Summer	5.105	0.105	0.0	2.0	2.0	2.8	O K
60 min Summer	5.115	0.115	0.0	2.0	2.0	3.1	O K
120 min Summer	5.110	0.110	0.0	2.0	2.0	2.9	O K
180 min Summer	5.098	0.098	0.0	1.9	1.9	2.6	O K
240 min Summer	5.088	0.088	0.0	1.9	1.9	2.3	O K
360 min Summer	5.075	0.075	0.0	1.6	1.6	2.0	O K
480 min Summer	5.067	0.067	0.0	1.4	1.4	1.8	O K
600 min Summer	5.061	0.061	0.0	1.3	1.3	1.6	O K
720 min Summer	5.056	0.056	0.0	1.1	1.1	1.5	O K
960 min Summer	5.049	0.049	0.0	0.9	0.9	1.3	O K
1440 min Summer	5.041	0.041	0.0	0.7	0.7	1.1	O K
2160 min Summer	5.035	0.035	0.0	0.5	0.5	0.9	O K
2880 min Summer	5.031	0.031	0.0	0.4	0.4	0.8	O K
4320 min Summer	5.026	0.026	0.0	0.3	0.3	0.7	O K
5760 min Summer	5.023	0.023	0.0	0.2	0.2	0.6	O K
7200 min Summer	5.021	0.021	0.0	0.2	0.2	0.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	76.545	0.0	4.6	16
30 min Summer	49.669	0.0	6.0	28
60 min Summer	30.811	0.0	7.4	44
120 min Summer	18.553	0.0	9.0	78
180 min Summer	13.645	0.0	9.9	108
240 min Summer	10.926	0.0	10.6	138
360 min Summer	7.968	0.0	11.6	198
480 min Summer	6.367	0.0	12.4	258
600 min Summer	5.347	0.0	13.0	316
720 min Summer	4.634	0.0	13.5	376
960 min Summer	3.696	0.0	14.4	498
1440 min Summer	2.684	0.0	15.7	738
2160 min Summer	1.947	0.0	17.0	1104
2880 min Summer	1.550	0.0	18.0	1468
4320 min Summer	1.122	0.0	19.5	2196
5760 min Summer	0.892	0.0	20.6	2896
7200 min Summer	0.746	0.0	21.5	3672

Cascade Summary of Results for Tank.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
8640 min Summer	5.019	0.019	0.0	0.2	0.2	0.5	O K
10080 min Summer	5.018	0.018	0.0	0.2	0.2	0.5	O K
15 min Winter	5.099	0.099	0.0	2.0	2.0	2.6	O K
30 min Winter	5.121	0.121	0.0	2.0	2.0	3.2	O K
60 min Winter	5.129	0.129	0.0	2.0	2.0	3.4	O K
120 min Winter	5.115	0.115	0.0	2.0	2.0	3.1	O K
180 min Winter	5.094	0.094	0.0	1.9	1.9	2.5	O K
240 min Winter	5.082	0.082	0.0	1.8	1.8	2.2	O K
360 min Winter	5.067	0.067	0.0	1.4	1.4	1.8	O K
480 min Winter	5.058	0.058	0.0	1.2	1.2	1.5	O K
600 min Winter	5.052	0.052	0.0	1.0	1.0	1.4	O K
720 min Winter	5.048	0.048	0.0	0.9	0.9	1.3	O K
960 min Winter	5.042	0.042	0.0	0.7	0.7	1.1	O K
1440 min Winter	5.035	0.035	0.0	0.5	0.5	0.9	O K
2160 min Winter	5.029	0.029	0.0	0.4	0.4	0.8	O K
2880 min Winter	5.026	0.026	0.0	0.3	0.3	0.7	O K
4320 min Winter	5.022	0.022	0.0	0.2	0.2	0.6	O K
5760 min Winter	5.019	0.019	0.0	0.2	0.2	0.5	O K
7200 min Winter	5.018	0.018	0.0	0.1	0.1	0.5	O K
8640 min Winter	5.016	0.016	0.0	0.1	0.1	0.4	O K
10080 min Winter	5.015	0.015	0.0	0.1	0.1	0.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
8640 min Summer	0.645	0.0	22.2	4400
10080 min Summer	0.570	0.0	22.8	5016
15 min Winter	76.545	0.0	5.1	17
30 min Winter	49.669	0.0	6.7	30
60 min Winter	30.811	0.0	8.4	48
120 min Winter	18.553	0.0	10.1	82
180 min Winter	13.645	0.0	11.2	112
240 min Winter	10.926	0.0	11.9	142
360 min Winter	7.968	0.0	13.0	200
480 min Winter	6.367	0.0	13.9	260
600 min Winter	5.347	0.0	14.6	320
720 min Winter	4.634	0.0	15.2	378
960 min Winter	3.696	0.0	16.1	504
1440 min Winter	2.684	0.0	17.6	746
2160 min Winter	1.947	0.0	19.1	1108
2880 min Winter	1.550	0.0	20.2	1472
4320 min Winter	1.122	0.0	21.9	2200
5760 min Winter	0.892	0.0	23.2	2944
7200 min Winter	0.746	0.0	24.1	3552
8640 min Winter	0.645	0.0	25.0	4392
10080 min Winter	0.570	0.0	25.7	4968

Cascade Rainfall Details for Tank.srcx

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	30	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.408	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 0.018

Time From:	**(mins) To:**	**Area (ha)**
0	4	0.018

Cascade Model Details for Tank.srcx

Storage is Online Cover Level (m) 6.500

Cellular Storage Structure

Invert Level (m) 5.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	**Area (m²)**	**Inf. Area (m²)**	**Depth (m)**	**Area (m²)**	**Inf. Area (m²)**
0.000	28.0	28.0	0.401	0.0	40.8
0.400	28.0	40.8			

Hydro-Brake Optimum® Outflow Control

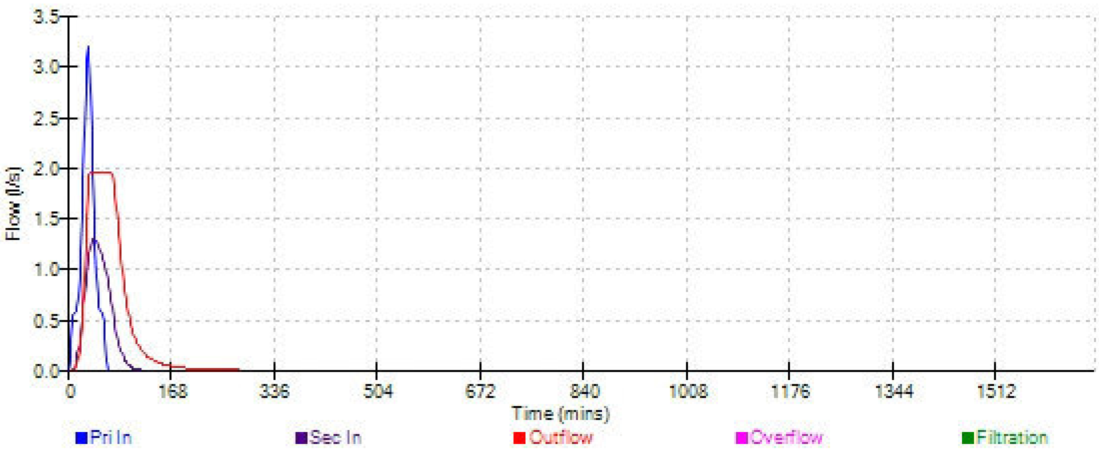
Unit Reference	MD-SHE-0075-2000-0400-2000
Design Head (m)	0.400
Design Flow (l/s)	2.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Diameter (mm)	75
Invert Level (m)	5.000
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

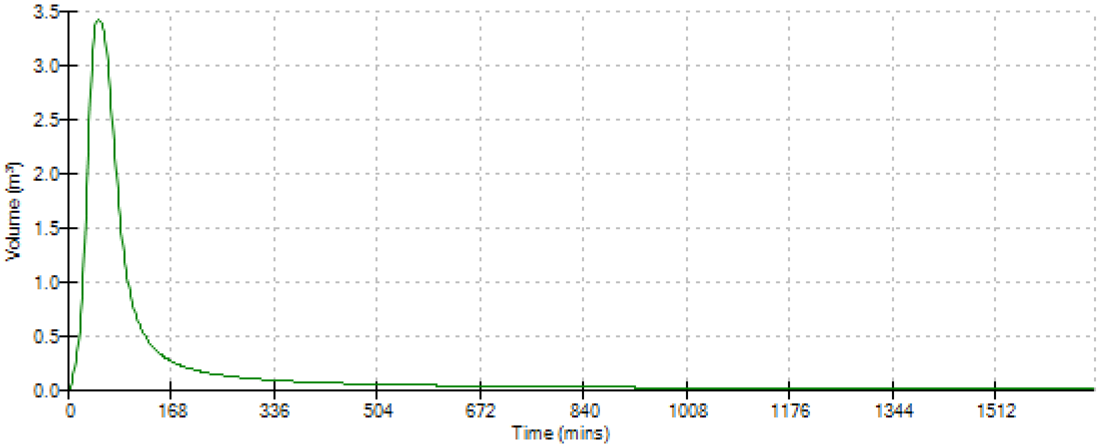
Control Points	**Head (m)**	**Flow (l/s)**
Design Point (Calculated)	0.400	2.0
Flush-Flo™	0.124	2.0
Kick-Flo®	0.285	1.7
Mean Flow over Head Range	-	1.6

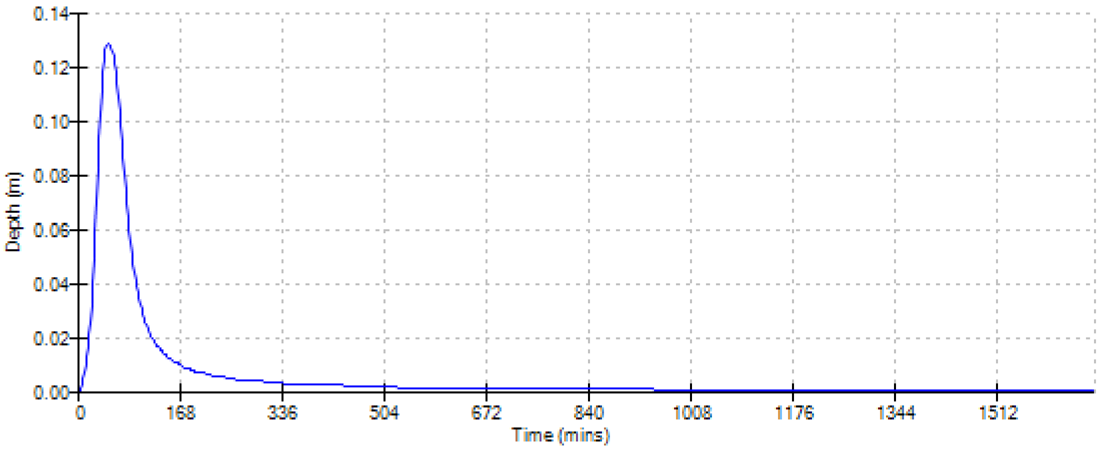
The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake Optimum® as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**
0.100	2.0	1.200	3.3	3.000	5.0	7.000	7.5
0.200	1.9	1.400	3.5	3.500	5.4	7.500	7.8
0.300	1.7	1.600	3.7	4.000	5.7	8.000	8.1
0.400	2.0	1.800	3.9	4.500	6.0	8.500	8.3
0.500	2.2	2.000	4.1	5.000	6.4	9.000	8.6
0.600	2.4	2.200	4.3	5.500	6.7	9.500	8.8
0.800	2.7	2.400	4.5	6.000	7.0		
1.000	3.0	2.600	4.7	6.500	7.3		

Cascade Event: 60 min Winter for Tank.srcx







Cascade Summary of Results for Tank.srcx

Upstream Structures	Outflow To	Overflow To
Permeable Paving.srcx	(None)	(None)

Half Drain Time : 23 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	5.116	0.116	0.0	2.0	2.0	3.1	O K
30 min Summer	5.147	0.147	0.0	2.0	2.0	3.9	O K
60 min Summer	5.164	0.164	0.0	2.0	2.0	4.4	O K
120 min Summer	5.159	0.159	0.0	2.0	2.0	4.2	O K
180 min Summer	5.142	0.142	0.0	2.0	2.0	3.8	O K
240 min Summer	5.123	0.123	0.0	2.0	2.0	3.3	O K
360 min Summer	5.095	0.095	0.0	1.9	1.9	2.5	O K
480 min Summer	5.082	0.082	0.0	1.7	1.7	2.2	O K
600 min Summer	5.073	0.073	0.0	1.6	1.6	1.9	O K
720 min Summer	5.067	0.067	0.0	1.4	1.4	1.8	O K
960 min Summer	5.058	0.058	0.0	1.2	1.2	1.5	O K
1440 min Summer	5.048	0.048	0.0	0.9	0.9	1.3	O K
2160 min Summer	5.040	0.040	0.0	0.6	0.6	1.1	O K
2880 min Summer	5.035	0.035	0.0	0.5	0.5	0.9	O K
4320 min Summer	5.029	0.029	0.0	0.4	0.4	0.8	O K
5760 min Summer	5.026	0.026	0.0	0.3	0.3	0.7	O K
7200 min Summer	5.023	0.023	0.0	0.2	0.2	0.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	99.366	0.0	6.0	17
30 min Summer	65.019	0.0	7.9	31
60 min Summer	40.510	0.0	9.8	52
120 min Summer	24.381	0.0	11.9	84
180 min Summer	17.876	0.0	13.1	116
240 min Summer	14.259	0.0	13.9	146
360 min Summer	10.337	0.0	15.1	200
480 min Summer	8.228	0.0	16.1	260
600 min Summer	6.888	0.0	16.8	320
720 min Summer	5.954	0.0	17.5	378
960 min Summer	4.728	0.0	18.5	496
1440 min Summer	3.411	0.0	20.0	736
2160 min Summer	2.457	0.0	21.6	1104
2880 min Summer	1.945	0.0	22.7	1468
4320 min Summer	1.397	0.0	24.4	2196
5760 min Summer	1.104	0.0	25.6	2912
7200 min Summer	0.919	0.0	26.6	3672

Cascade Summary of Results for Tank.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Σ Max Outflow (l/s)	Max Volume (m³)	Status
8640 min Summer	5.022	0.022	0.0	0.2	0.2	0.6	O K
10080 min Summer	5.020	0.020	0.0	0.2	0.2	0.5	O K
15 min Winter	5.132	0.132	0.0	2.0	2.0	3.5	O K
30 min Winter	5.169	0.169	0.0	2.0	2.0	4.5	O K
60 min Winter	5.191	0.191	0.0	2.0	2.0	5.1	O K
120 min Winter	5.176	0.176	0.0	2.0	2.0	4.7	O K
180 min Winter	5.145	0.145	0.0	2.0	2.0	3.9	O K
240 min Winter	5.115	0.115	0.0	2.0	2.0	3.1	O K
360 min Winter	5.084	0.084	0.0	1.8	1.8	2.2	O K
480 min Winter	5.070	0.070	0.0	1.5	1.5	1.9	O K
600 min Winter	5.062	0.062	0.0	1.3	1.3	1.6	O K
720 min Winter	5.056	0.056	0.0	1.1	1.1	1.5	O K
960 min Winter	5.049	0.049	0.0	0.9	0.9	1.3	O K
1440 min Winter	5.040	0.040	0.0	0.7	0.7	1.1	O K
2160 min Winter	5.033	0.033	0.0	0.5	0.5	0.9	O K
2880 min Winter	5.029	0.029	0.0	0.4	0.4	0.8	O K
4320 min Winter	5.025	0.025	0.0	0.3	0.3	0.7	O K
5760 min Winter	5.022	0.022	0.0	0.2	0.2	0.6	O K
7200 min Winter	5.020	0.020	0.0	0.2	0.2	0.5	O K
8640 min Winter	5.018	0.018	0.0	0.2	0.2	0.5	O K
10080 min Winter	5.017	0.017	0.0	0.1	0.1	0.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
8640 min Summer	0.791	0.0	27.4	4384
10080 min Summer	0.696	0.0	28.1	5032
15 min Winter	99.366	0.0	6.7	18
30 min Winter	65.019	0.0	8.8	32
60 min Winter	40.510	0.0	11.0	58
120 min Winter	24.381	0.0	13.3	90
180 min Winter	17.876	0.0	14.7	124
240 min Winter	14.259	0.0	15.6	152
360 min Winter	10.337	0.0	17.0	204
480 min Winter	8.228	0.0	18.0	262
600 min Winter	6.888	0.0	18.9	320
720 min Winter	5.954	0.0	19.6	378
960 min Winter	4.728	0.0	20.7	498
1440 min Winter	3.411	0.0	22.4	736
2160 min Winter	2.457	0.0	24.2	1104
2880 min Winter	1.945	0.0	25.5	1472
4320 min Winter	1.397	0.0	27.4	2192
5760 min Winter	1.104	0.0	28.8	2936
7200 min Winter	0.919	0.0	29.9	3624
8640 min Winter	0.791	0.0	30.8	4360
10080 min Winter	0.696	0.0	31.6	4992

Cascade Rainfall Details for Tank.srcx

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.408	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 0.018

Time From:	(mins) To:	Area (ha)
0	4	0.018

Cascade Model Details for Tank.srcx

Storage is Online Cover Level (m) 6.500

Cellular Storage Structure

Invert Level (m) 5.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	28.0	28.0	0.401	0.0	40.8
0.400	28.0	40.8			

Hydro-Brake Optimum® Outflow Control

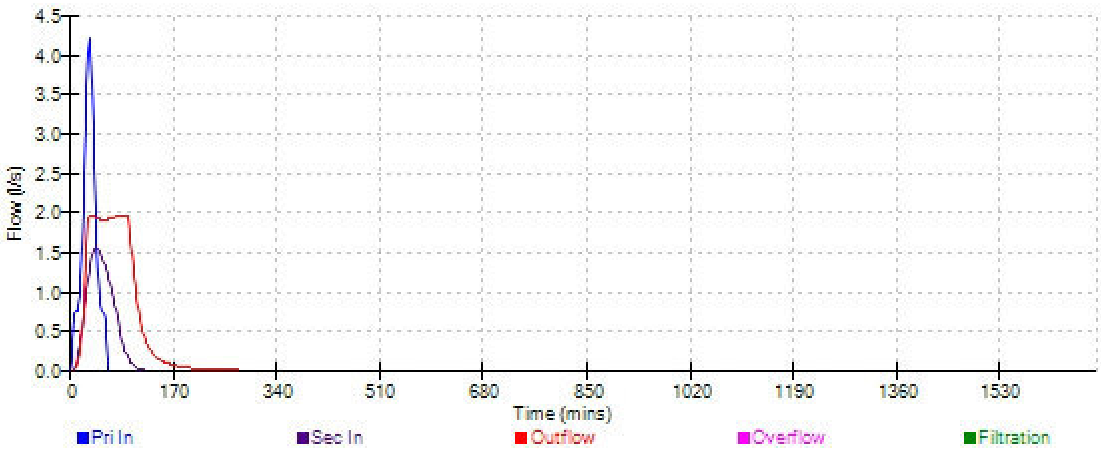
Unit Reference	MD-SHE-0075-2000-0400-2000
Design Head (m)	0.400
Design Flow (l/s)	2.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Diameter (mm)	75
Invert Level (m)	5.000
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

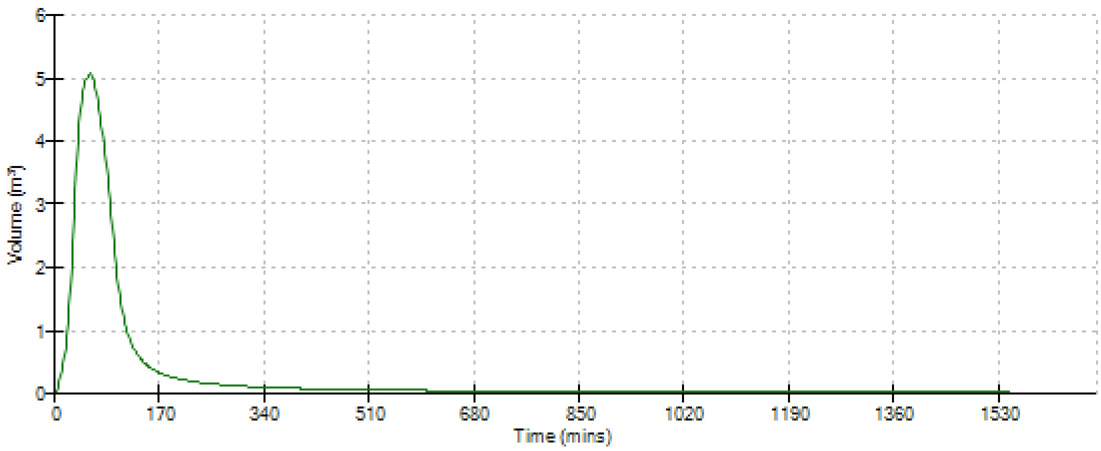
Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.400	2.0
Flush-Flo™	0.124	2.0
Kick-Flo®	0.285	1.7
Mean Flow over Head Range	-	1.6

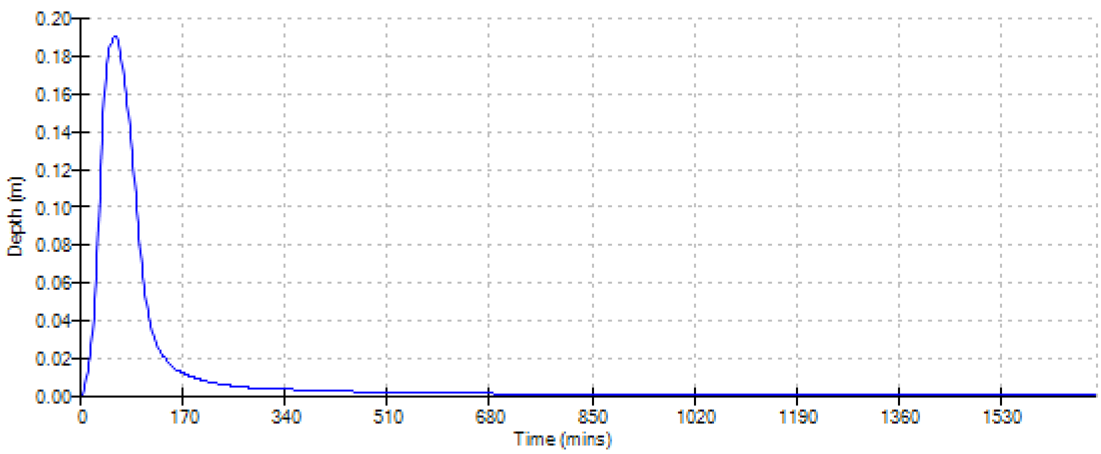
The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake Optimum® as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	2.0	1.200	3.3	3.000	5.0	7.000	7.5
0.200	1.9	1.400	3.5	3.500	5.4	7.500	7.8
0.300	1.7	1.600	3.7	4.000	5.7	8.000	8.1
0.400	2.0	1.800	3.9	4.500	6.0	8.500	8.3
0.500	2.2	2.000	4.1	5.000	6.4	9.000	8.6
0.600	2.4	2.200	4.3	5.500	6.7	9.500	8.8
0.800	2.7	2.400	4.5	6.000	7.0		
1.000	3.0	2.600	4.7	6.500	7.3		

Cascade Event: 60 min Winter for Tank.srcx







Cascade Summary of Results for Tank.srcx

Upstream Structures	Outflow To	Overflow To
Permeable Paving.srcx	(None)	(None)

Half Drain Time : 36 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	5.171	0.171	0.0	2.0	2.0	4.5	O K
30 min Summer	5.224	0.224	0.0	2.0	2.0	6.0	O K
60 min Summer	5.269	0.269	0.0	2.0	2.0	7.2	O K
120 min Summer	5.269	0.269	0.0	2.0	2.0	7.2	O K
180 min Summer	5.245	0.245	0.0	2.0	2.0	6.5	O K
240 min Summer	5.220	0.220	0.0	2.0	2.0	5.8	O K
360 min Summer	5.170	0.170	0.0	2.0	2.0	4.5	O K
480 min Summer	5.131	0.131	0.0	2.0	2.0	3.5	O K
600 min Summer	5.104	0.104	0.0	2.0	2.0	2.8	O K
720 min Summer	5.089	0.089	0.0	1.9	1.9	2.4	O K
960 min Summer	5.075	0.075	0.0	1.6	1.6	2.0	O K
1440 min Summer	5.060	0.060	0.0	1.2	1.2	1.6	O K
2160 min Summer	5.049	0.049	0.0	0.9	0.9	1.3	O K
2880 min Summer	5.043	0.043	0.0	0.7	0.7	1.1	O K
4320 min Summer	5.035	0.035	0.0	0.5	0.5	0.9	O K
5760 min Summer	5.031	0.031	0.0	0.4	0.4	0.8	O K
7200 min Summer	5.028	0.028	0.0	0.4	0.4	0.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	139.112	0.0	8.4	18
30 min Summer	91.026	0.0	11.1	33
60 min Summer	56.713	0.0	13.9	62
120 min Summer	34.134	0.0	16.7	104
180 min Summer	25.027	0.0	18.4	130
240 min Summer	19.963	0.0	19.6	160
360 min Summer	14.472	0.0	21.3	220
480 min Summer	11.519	0.0	22.6	276
600 min Summer	9.643	0.0	23.6	328
720 min Summer	8.336	0.0	24.5	382
960 min Summer	6.619	0.0	26.0	500
1440 min Summer	4.775	0.0	28.1	736
2160 min Summer	3.440	0.0	30.3	1104
2880 min Summer	2.723	0.0	32.0	1460
4320 min Summer	1.956	0.0	34.4	2200
5760 min Summer	1.545	0.0	36.1	2936
7200 min Summer	1.287	0.0	37.5	3616

Cascade Summary of Results for Tank.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Σ Max Outflow (l/s)	Max Volume (m³)	Status
8640 min Summer	5.026	0.026	0.0	0.3	0.3	0.7	O K
10080 min Summer	5.024	0.024	0.0	0.3	0.3	0.6	O K
15 min Winter	5.194	0.194	0.0	2.0	2.0	5.2	O K
30 min Winter	5.257	0.257	0.0	2.0	2.0	6.8	O K
60 min Winter	5.313	0.313	0.0	2.0	2.0	8.3	O K
120 min Winter	5.317	0.317	0.0	2.0	2.0	8.4	O K
180 min Winter	5.280	0.280	0.0	2.0	2.0	7.4	O K
240 min Winter	5.233	0.233	0.0	2.0	2.0	6.2	O K
360 min Winter	5.151	0.151	0.0	2.0	2.0	4.0	O K
480 min Winter	5.100	0.100	0.0	2.0	2.0	2.7	O K
600 min Winter	5.083	0.083	0.0	1.8	1.8	2.2	O K
720 min Winter	5.073	0.073	0.0	1.6	1.6	1.9	O K
960 min Winter	5.061	0.061	0.0	1.3	1.3	1.6	O K
1440 min Winter	5.049	0.049	0.0	0.9	0.9	1.3	O K
2160 min Winter	5.041	0.041	0.0	0.7	0.7	1.1	O K
2880 min Winter	5.035	0.035	0.0	0.5	0.5	0.9	O K
4320 min Winter	5.030	0.030	0.0	0.4	0.4	0.8	O K
5760 min Winter	5.026	0.026	0.0	0.3	0.3	0.7	O K
7200 min Winter	5.024	0.024	0.0	0.3	0.3	0.6	O K
8640 min Winter	5.022	0.022	0.0	0.2	0.2	0.6	O K
10080 min Winter	5.020	0.020	0.0	0.2	0.2	0.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
8640 min Summer	1.107	0.0	38.7	4400
10080 min Summer	0.975	0.0	39.7	5096
15 min Winter	139.112	0.0	9.5	19
30 min Winter	91.026	0.0	12.4	34
60 min Winter	56.713	0.0	15.5	62
120 min Winter	34.134	0.0	18.7	114
180 min Winter	25.027	0.0	20.6	142
240 min Winter	19.963	0.0	21.9	172
360 min Winter	14.472	0.0	23.9	228
480 min Winter	11.519	0.0	25.3	276
600 min Winter	9.643	0.0	26.5	326
720 min Winter	8.336	0.0	27.5	384
960 min Winter	6.619	0.0	29.1	498
1440 min Winter	4.775	0.0	31.5	738
2160 min Winter	3.440	0.0	34.0	1112
2880 min Winter	2.723	0.0	35.8	1472
4320 min Winter	1.956	0.0	38.6	2172
5760 min Winter	1.545	0.0	40.5	2928
7200 min Winter	1.287	0.0	42.1	3680
8640 min Winter	1.107	0.0	43.4	4352
10080 min Winter	0.975	0.0	44.5	5096

Cascade Rainfall Details for Tank.srcx

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.408	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.018

Time From:	**(mins) To:**	**Area (ha)**
0	4	0.018

Cascade Model Details for Tank.srcx

Storage is Online Cover Level (m) 6.500

Cellular Storage Structure

Invert Level (m) 5.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	**Area (m²)**	**Inf. Area (m²)**	**Depth (m)**	**Area (m²)**	**Inf. Area (m²)**
0.000	28.0	28.0	0.401	0.0	40.8
0.400	28.0	40.8			

Hydro-Brake Optimum® Outflow Control

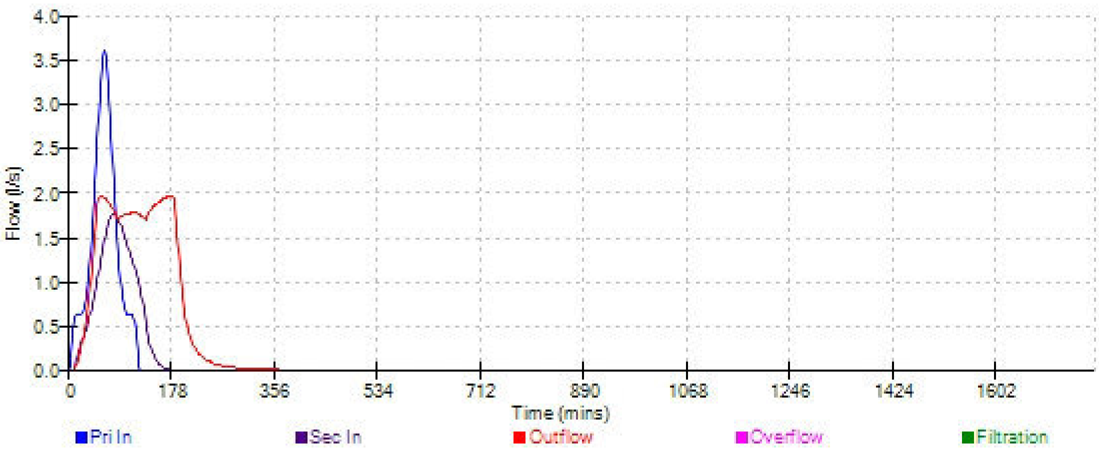
Unit Reference	MD-SHE-0075-2000-0400-2000
Design Head (m)	0.400
Design Flow (l/s)	2.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Diameter (mm)	75
Invert Level (m)	5.000
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

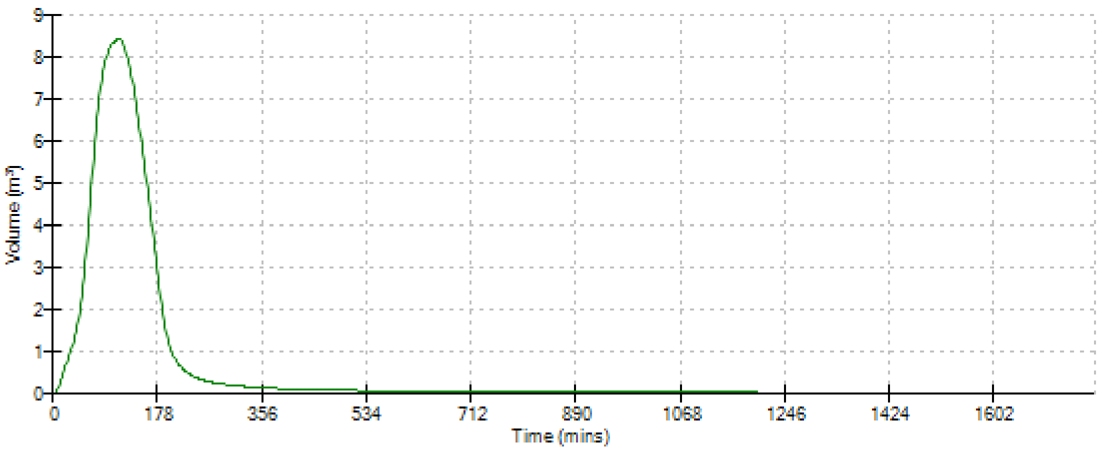
Control Points	**Head (m)**	**Flow (l/s)**
Design Point (Calculated)	0.400	2.0
Flush-Flo™	0.124	2.0
Kick-Flo®	0.285	1.7
Mean Flow over Head Range	-	1.6

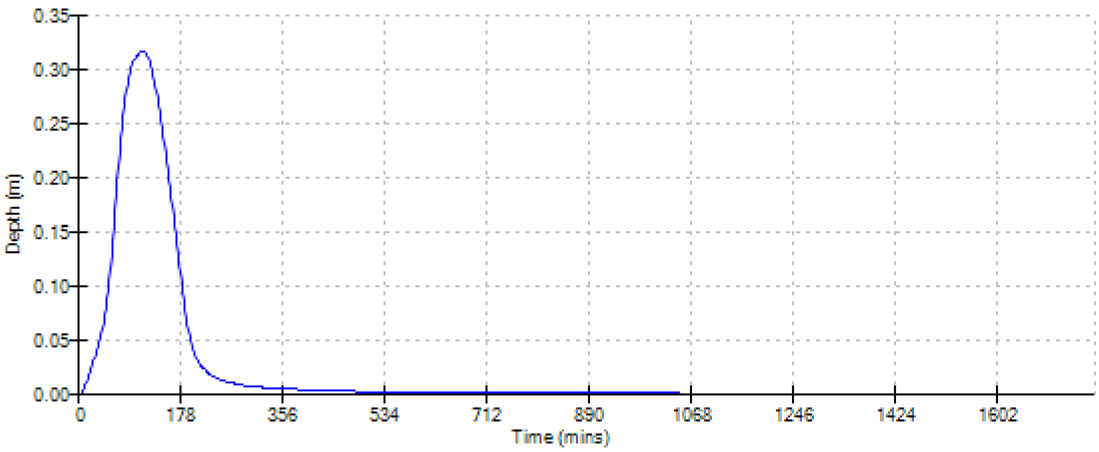
The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake Optimum® as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**
0.100	2.0	1.200	3.3	3.000	5.0	7.000	7.5
0.200	1.9	1.400	3.5	3.500	5.4	7.500	7.8
0.300	1.7	1.600	3.7	4.000	5.7	8.000	8.1
0.400	2.0	1.800	3.9	4.500	6.0	8.500	8.3
0.500	2.2	2.000	4.1	5.000	6.4	9.000	8.6
0.600	2.4	2.200	4.3	5.500	6.7	9.500	8.8
0.800	2.7	2.400	4.5	6.000	7.0		
1.000	3.0	2.600	4.7	6.500	7.3		

Cascade Event: 120 min Winter for Tank.srcx







APPENDIX D

SuDS Proforma

LONDON BOROUGH OF RICHMOND UPON THAMES

GREATER**LONDON**AUTHORITY

LoDEG

1. Project & Site Details

Project / Site Name (including sub-catchment / stage / phase where appropriate)	South Worple Way
Address & post code	South Worple Way. East Sheen
OS Grid ref. (Easting, Northing)	E 520584 N 175756
LPA reference (if applicable)	
Brief description of proposed work	Construction of 5 new residential properties
Total site Area	500 m^2
Total existing impervious area	420 m^2
Total proposed impervious area	350 m^2
Is the site in a surface water flood risk catchment (ref. local Surface Water Management Plan)?	no
Existing drainage connection type and location	Sewer
Designer Name	
Designer Position	
Designer Company	

2. Proposed Discharge Arrangements

2a. Infiltration Feasibility

Superficial geology classification	Kemton Park Gravels	
Bedrock geology classification	London Clay	
Site infiltration rate	n/a	m/s
Depth to groundwater level	n/a	m below ground level
Is infiltration feasible?	No	

2b. Drainage Hierarchy

	Feasible (Y/N)	*Proposed (Y/N)*
1 store rainwater for later use	N	N
2 use infiltration techniques, such as porous surfaces in non-clay areas	N	N
3 attenuate rainwater in ponds or open water features for gradual release	N	N
4 attenuate rainwater by storing in tanks or sealed water features for gradual release	Y	Y
5 discharge rainwater direct to a watercourse	N	N
6 discharge rainwater to a surface water sewer/drain	Y	Y
7 discharge rainwater to the combined sewer.	N	N

2c. Proposed Discharge Details

Proposed discharge location	Thames Water Surface Water Sewer
Has the owner/regulator of the discharge location been consulted?	No

3. Drainage Strategy

3a. Discharge Rates & Required Storage				
	Greenfield (GF) runoff rate (l/s)	*Existing discharge rate (l/s)*	*Required storage for GF rate (m³)*	*Proposed discharge rate (l/s)*
Qbar	0.1			
1 in 1	0.1	6.3	n/a	1.3
1 in 30	0.2	n/a	n/a	2
1 in 100	0.2	n/a	n/a	2
1 in 100 + CC			n/a	2
Climate change allowance used		40%		
3b. Principal Method of Flow Control		Hydrobrake		

3c. Proposed SuDS Measures			
	Catchment area (m²)	*Plan area (m²)*	*Storage vol. (m³)*
Rainwater harvesting	0		0
Infiltration systems	0		0
Green roofs	0	0	0
Blue roofs	0	0	0
Filter strips	0	0	0
Filter drains	0	0	0
Bioretention / tree pits	0	0	0
Pervious pavements	350	150	15
Swales	0	0	0
Basins/ponds	0	0	0
Attenuation tanks	0		10
Total	**350**	**150**	**25**

4. Supporting Information

4a. Discharge & Drainage Strategy	*Page/section of drainage report*
Infiltration feasibility (2a) – geotechnical factual and interpretive reports, including infiltration results	section 2 &4
Drainage hierarchy (2b)	Section 4
Proposed discharge details (2c) – utility plans, correspondence / approval from owner/regulator of discharge location	Appendix C
Discharge rates & storage (3a) – detailed hydrologic and hydraulic calculations	Appendix C
Proposed SuDS measures & specifications (3b)	Section 5
4b. Other Supporting Details	*Page/section of drainage report*
Detailed Development Layout	Appendix A
Detailed drainage design drawings, including exceedance flow routes	Appendix C
Detailed landscaping plans	-
Maintenance strategy	Section 5
Demonstration of how the proposed SuDS measures improve:	
a) water quality of the runoff?	Section 5
b) biodiversity?	Section 5
c) amenity?	-