



Consulting Civil Engineers

SuDS Maintenance and Management Plan

Merry England, Dappers Lane, Angmering

For

GD Group

Rev – A

Planning Application No A/91/18/PL

Reference C1149

Date 4th December 2019

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1. Introduction

CGS Civils Ltd have been appointed to undertake a detailed drainage design using sustainable techniques for a proposed development in Angmering, West Sussex.

The site will consist of the construction of 18 new dwellings. There are three private parking areas as well as individual driveways and an access road. Root protection zones run along the south of the site and in other areas. A drainage ditch runs south along the western flank of the site.

2. Sustainable Drainage Systems (SuDS)

The surface water management strategy has been developed using best practice Sustainable Drainage Systems (SuDS) techniques. Guidance on suitable techniques and methods has been obtained from the EA, and the SuDS manual (CIRIA C753).

The National Planning Policy Framework (NPPF) recognises that flood risk and other environmental damage can be managed by minimising changes in the volume and rate of surface runoff from development sites and recommends that priority is given to the use of Sustainable Drainage Systems (SuDS) in new development.

The overall philosophy of SuDS is to replicate, as closely as possible, the natural drainage process of a site prior to development to mitigate the adverse effect of storm water runoff on the environment. SuDS not only provide the ability to control surface water flows, but also improve water quality, amenity and bio-diversity within the development.

The Building Regulations Requirement H3 stipulates that rainwater from roofs and paved areas is carried away from the surface to discharge to one of the following, listed in order of priority:

- 1- Discharge into the ground
- 2- Discharge to a surface water body
- 3- Discharge to a surface water sewer

3. SuDS at Merry England

Soakage tests to the BRE 365 method were undertaken on site on 18th November 2019. Testing undertaken was terminated due to an effectively impermeable surface combined with exceptionally high groundwater in areas of the site.

Test ref	Test Depth (m)	Initial fill level (mbgl)	Elapsed Time (minutes)	Final Fill Level (mbgl)	K (m/s)
SA2 – Test 1	1.30	0.27	1500	0.38	N/A
SA3 – Test 2	1.40	0.33	1565	0.50	N/A

Tests were abandoned following approximately 1,500 minutes' observation period as the very poor infiltration rates suggested that for one test cycle a period of approximately 4-5 days would have been required. As a result the testing is invalid and it is considered that the soils should be considered to be practically impermeable.

Based on the above results the site will discharge all water into the adjacent drainage ditch via a flow control restricted to 2.3l/s which is the Qbar greenfield runoff rate for the existing site.

All driveways and private parking areas are to be constructed with a resin bound permeable surface that will be tanked with fin drains added to allow the water to enter into the main surface water drainage system. These areas will provide primary treatment of any pollutants whilst also providing a modest amount of storage.

The main SuDS feature itself will be in the form of two cellular storage attenuation tanks. Due to the high groundwater it has been necessary to have the tank manufacture design a system to counteract the effects of floatation. These details will be made available in the next revision.

All SuDS features have been designed to cater for and contain the 1 in 100-year storm + 40% below ground.

4. Managing SuDS

The SuDS have been designed for easy maintenance and comprise:

- Regular day-to-day care – litter collection, regular gardening to control vegetation growth and checking inlets where water enters the SuDS feature
- Occasional tasks – checking the SUDS feature and removing any silt that builds up in the SuDS feature
- Remedial work – repairing damage where necessary

The client will, within the first 6-12 months of construction, form a maintenance company within the structure of the current company to facilitate the maintenance of the drainage system as per the requirements and specifications within this document.

Once design life has been met on the SuDS features then these will be repaired or replaced in part in accordance with the SuDS maintenance specification in Section 6 or fully replaced in accordance with the respective manufacturer's specifications.

The existing drainage ditch will be maintained from site via the south western car park. Parking and safe access will be provided.

5. Water Quality

The new SuDS Manual (Ciria C753, November 2015) introduces slightly different approach compared to the previous version for the water quality management of surface water. The Manual describes risks posed by the surface water runoff to the receiving environment as a function of:

- The pollution hazard at a particular site (i.e. the pollution source)
- The effectiveness of SuDS treatment components in reducing levels of pollutants to environmentally acceptable levels
- The sensitivity of the receiving environment

The EA website indicates that the site does not lie within a Source Protection Zone.

The recommended approaches for water quality risk management are given in the SuDS Manual Table 26.1.

Figure 7 Approaches to Water Quality Risk Management

TABLE 26.1	Approaches to water quality risk management			
	Design method	Hazard characterisation	Risk reduction	
			For surface water	For groundwater
	Simple index approach	Simple pollution hazard indices based on land use (eg Table 26.2 or equivalent)	Simple SuDS hazard mitigation indices (eg Table 26.3 or equivalent)	Simple SuDS hazard mitigation indices (eg Table 26.4 or equivalent)
	Risk screening	Factors characterising traffic density and extent of infiltration likely to occur (eg Table 26.5 or equivalent)	N/A	Factors characterising unsaturated soil depth and type, and predominant flow type through the soils (eg Table 26.5 or equivalent)
	Detailed risk assessment	Site specific information used to define likely pollutants and their significance	More detailed, component specific performance information used to demonstrate that the proposed SuDS components reduce the hazard to acceptable levels	
	Process-based treatment modelling	Time series rainfall used with generic pollution characteristics to determine statistical distributions of likely concentrations and loadings in the runoff	Models that represent the treatment processes in the proposed SuDS components give estimates of reductions in event mean discharge concentrations and total annual load reductions delivered by the system	

As per Table 26.1 Simple Index approach will be used as a design method for this site.

Table 26.2 will provide hazard classification of different land uses. The land uses for the surface water drainage for this site are;

- Residential Roofs
- Individual Property driveways and residential car parks
- Low traffic roads

To deliver adequate treatment, the selected SuDS components should have a total pollution mitigation index for each contaminant type that equals or exceeds the pollution hazard index for each contaminant type. Therefore, the following must be achieved for the surface running off the site.

Total SuDS mitigation index $\geq$ pollution hazard index

Pollution Hazard Indices are given for different land uses in Table 26.2 of the SuDS manual;

Figure 8 Pollution Hazard Indices for Different Land Use Classifications

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

From Table 26.2 the following information is tabulated in Table 4

Table 4: Pollution hazard index and destination of runoff for the proposed site

Land Use	Destination of Runoff	Pollution Hazard Level	Total Suspended Solids	Metals	Hydrocarbons
Residential Roofs	Surface Waters	Very Low	0.2	0.2	0.05
Individual Driveways, Residential car parks and low traffic roads	Surface Waters	Low	0.5	0.4	0.4

The SuDS mitigation index will be obtained from Table 26.4 (for surface water) of the SuDS manual.

Figure 9 Indicative SuDS Mitigation Indices for discharges to surface waters

TABLE 26.3 Indicative SuDS mitigation indices for discharges to surface waters				
	Type of SuDS component	Mitigation indices ¹		
		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.		

SuDS mitigation index are tabulated in Table 5 as followed;

Runoff Source	Destination of Runoff	Mitigation Index Source	Mitigation Indices			
			Type of SuDS Component	Total Suspended Solids (TSS)	Metals	Hydrocarbons
Individual Driveways and Residential Car parks	Surface Waters	Table 26.3 (for surface waters)	Permeable Pavement	0.7	0.6	0.7

Table 5: SuDS mitigation index

The above analysis demonstrates that the SuDS devices within the design will mitigate any pollution present within the surface water system.

6. SuDS Drainage Maintenance Specification

6.1. Permeable Pavements

In order to maintain the functioning of the permeable paving, the following maintenance requirements should be adhered to:

TABLE 20.15 Operation and maintenance requirements for pervious pavements		
Maintenance schedule	Required action	Typical frequency
Regular maintenance	Brushing and vacuuming (standard cosmetic sweep over whole surface)	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 surface 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 or management using glyphosate applied directly into the weeds by an applicator rather than spraying	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 and cracked or broken blocks considered detrimental to the structural performance or a hazard to users, and replace lost jointing material	As required
	Rehabilitation of surface and upper substructure by remedial sweeping	Every 10 to 15 years or as required (if infiltration performance is reduced due to significant clogging)
Monitoring	Initial inspection	Monthly for three months after installation
	Inspect for evidence of poor operation and/or weed growth – if required, take remedial action	Three-monthly, 48 h after large storms in first six months
	Inspect silt accumulation rates and establish appropriate brushing frequencies	Annually
	Monitor inspection chambers	Annually

6.2. Attenuation Tank

In order to maintain the functioning of the attenuation tanks, the following maintenance requirements should be adhered to:

TABLE 21.3 Operation and maintenance requirements for attenuation storage tanks

Maintenance schedule	Required action	Typical frequency
Regular maintenance	Inspect and identify any areas that are not operating correctly. If required, take remedial action	Monthly for 3 months, then annually
	Remove debris from the catchment surface (where it may cause risks to performance)	Monthly
	For systems where rainfall infiltrates into 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 and/or internal forebays	Annually, or as required
Remedial actions	Repair/rehabilitate inlets, outlet, 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 tank for sediment build-up and remove if necessary	Every 5 years or as required

7. General Drainage Maintenance Specification

7.1. Inlet Structures and Inspection Chambers

- Inlet structures such as rain water downpipes, road gullies and channel drains should be free from obstruction at all times to allow free flow through the SuDS.
- Inspection Chambers and rodding eyes are used on bends or where pipes come together. They allow access and cleaning to the system if necessary.

Inlet Structures and Inspection Chambers	
Regular Maintenance	Frequency
Inlet Structures Inspect rainwater downpipes, channel drains and road gullies, removing obstructions and silt as necessary. Check that there is no physical damage. Strim vegetation 1m min surround to structures and keep area free from silt and debris	Monthly
Inspections Chambers and below ground control chambers Remove cover and inspect, ensuring that the water is flowing freely and that the exit route for water is unobstructed. Remove debris and silt. Undertake inspection after leaf fall in Autumn	Annually
Occasional Maintenance Check topsoil levels are 20mm above edges of chambers to avoid mower damage.	As necessary
Remedial Work Repair physical damage if necessary	As required

7.2. Below ground drainage pipes

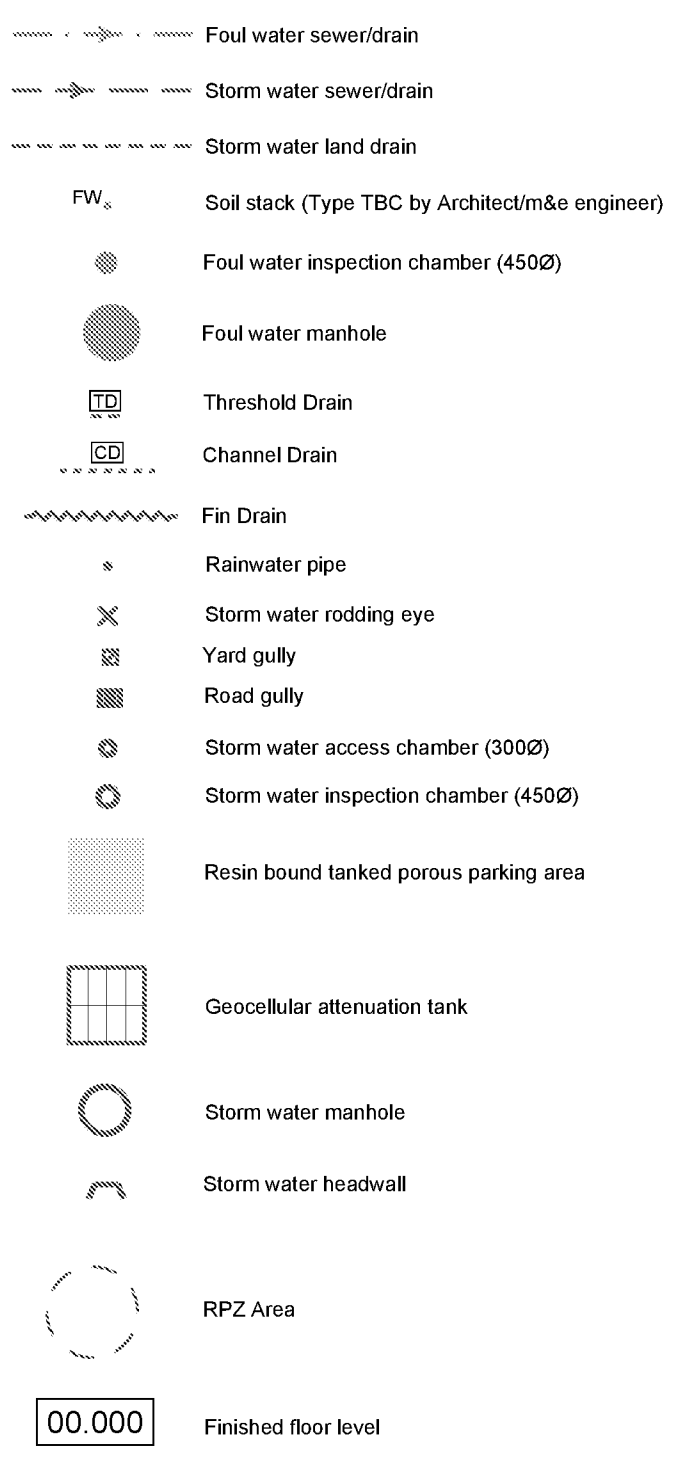
- Below ground drainage pipes convey water to the SuDS system. They should always be free from obstruction to allow free flow.

Below Ground Drainage Pipes	
Regular Maintenance	Frequency
Inspect and identify any areas that are not operating correctly. If required take remedial action.	Monthly for 3 months then annually
Remove debris from the catchment surface (where it may cause risks to performance)	Monthly
Remove sediment from pre-treatment inlet structures and inspection chambers.	Annually or as required
Maintain vegetation to designed limits within the vicinity of below ground drainage pipes and tanks to avoid	Monthly or as required
Remedial Work	
Repair physical damage if necessary	As required
Monitoring	
Inspect all inlets, outlets and vents to ensure that they are in good conditions and operating as designed.	Annually
Survey inside of pipe runs for sediment build up and remove if necessary.	Every 5 years or as required

Appendix A

Drainage Strategy

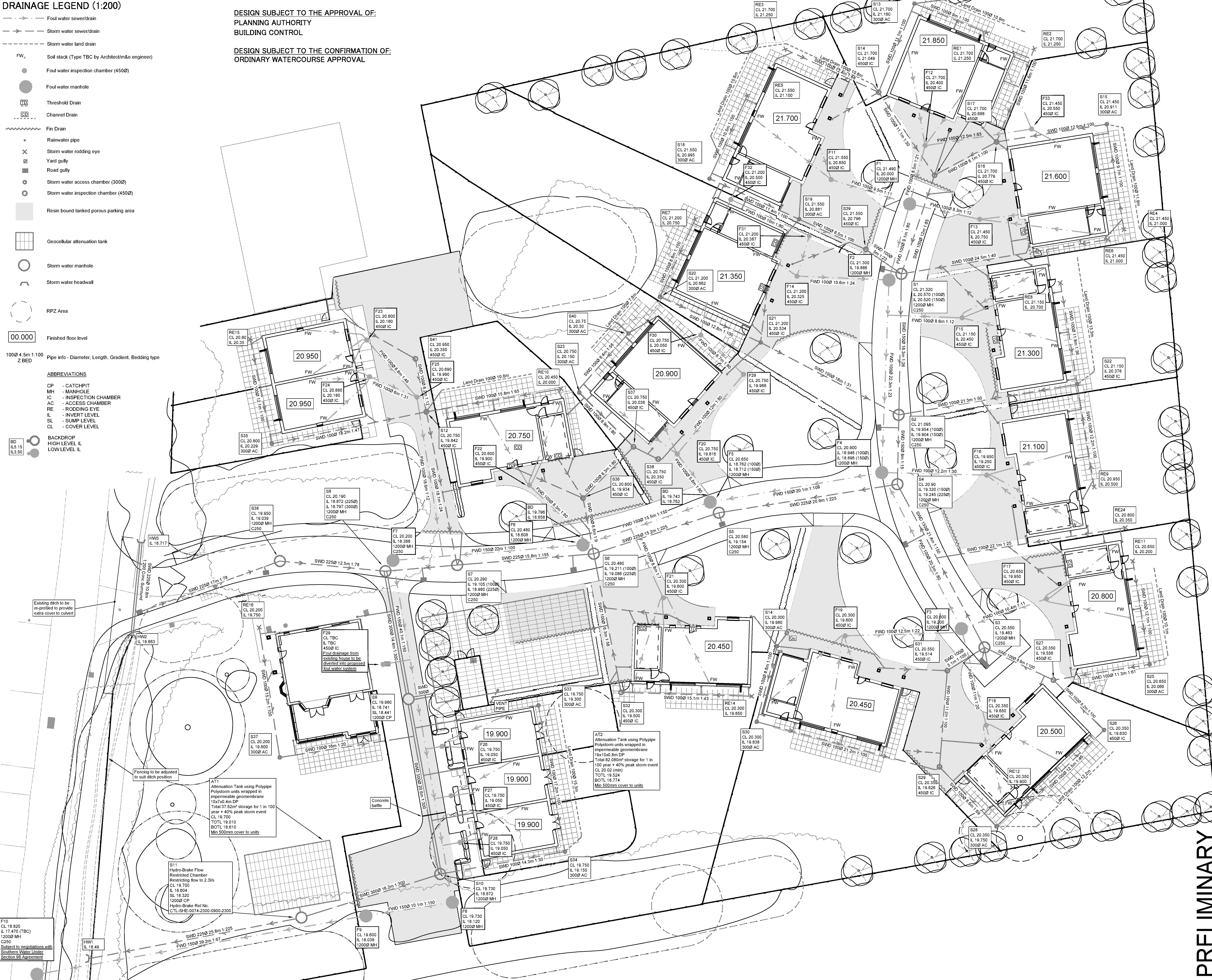
DRAINAGE LEGEND (1:200)



- ABBREVIATIONS
- CP - CATCHPIT
MH - MANHOLE
IC - INSPECTION CHAMBER
AC - ACCESS CHAMBER
RE - RODDING EYE
IL - INVERT LEVEL
SL - SUMP LEVEL
CL - COVER LEVEL
- BACKDROP
HIGH LEVEL IL
LOW LEVEL IL

DESIGN SUBJECT TO THE APPROVAL OF:
PLANNING AUTHORITY
BUILDING CONTROL

DESIGN SUBJECT TO THE CONFIRMATION OF:
ORDINARY WATERCOURSE APPROVAL



- STANDARD NOTES
- DO NOT SCALE FROM THIS DRAWING. REFER TO FIGURED DIMENSIONS ONLY. THE CONTRACTOR SHOULD CHECK ALL DIMENSIONS ON SITE.
 - ALL DIMENSIONS IN MILLIMETRES AND ALL LEVELS ARE IN METERS UNLESS NOTED OTHERWISE.
 - THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH ALL OTHER RELEVANT ARCHITECT AND ENGINEERING DETAILS, DRAWINGS AND SPECIFICATIONS.
 - ANY DISCREPANCIES SHOULD BE REPORTED TO THE ARCHITECT AND/OR ENGINEER IMMEDIATELY, SO THAT CLARIFICATION CAN BE SOUGHT PRIOR TO THE COMMENCEMENT OF WORK.
 - BEFORE COMMENCING CONSTRUCTION THE CONTRACTOR MUST CHECK THE INVERT LEVELS OF EXISTING SEWERS TO WHICH CONNECTIONS ARE MADE. IN ADDITION THE CONTRACTOR MUST LOCATE AND DETERMINE INVERT LEVELS OF THE EXISTING SPURS TO WHICH CONNECTIONS ARE PROPOSED. ANY DISCREPANCIES ARE TO BE NOTIFIED TO THE ENGINEER IMMEDIATELY. PRIOR TO CONSTRUCTION.
 - ALL DRAINAGE WORKS SHOULD COMMENCE AT THE PROPOSED DOWNSTREAM CONNECTION POINT. THE WORKS CONTINUING UPSTREAM FOLLOWING CONFIRMATION OF THE TIE-IN INVERT LEVELS TO THE ENGINEER. CONNECTIONS TO MANHOLES OR LARGER SIZED PIPES ETC. SHOULD BE SOFFIT TO SOFFIT UNLESS OTHERWISE INSTRUCTED BY THE ENGINEER. IF THIS IS NOT POSSIBLE INFORM THE ENGINEER IMMEDIATELY.
 - COVER LEVELS SHOWN ARE APPROXIMATE. COVERS AND FRAMES SHALL BE SET TO FINISHED GROUND LEVELS AND FALLS.
 - ALL UN-REFERENCED PIPES ARE ASSUMED TO BE 100mm DIA.
 - ROAD GULLY OUTLET PIPES ARE TO BE 150mm DIA. WITH CONCRETE SURROUND AND FLEXIBLE JOINTS. ALL GULLIES SHALL BE FITTED WITH GRADE D400 GRATINGS AND FRAMES TO BS EN124, UNLESS OTHERWISE STATED.
 - ALL PRIVATE DRAINAGE TO BE IN ACCORDANCE WITH THE BUILDING REGULATIONS APPROVED DOCUMENT PART-H, AND TO THE SATISFACTION OF THE BUILDING CONTROL INSPECTOR.
 - THE CONTRACTOR IS TO KEEP A RECORD OF ANY VARIATIONS MADE ON SITE, INCLUDING THE RELOCATION OF SEWERS OR DRAINS, SO THAT AN AS CONSTRUCTED DRAWING CAN BE PREPARED UPON COMPLETION OF THE PROJECT.
 - IF ANY SUB SOIL DRAINAGE SYSTEMS ARE UNCOVERED DURING THE WORKS CONTACT THE ENGINEER FOR INSTRUCTIONS. SUB SOIL DRAINS ARE TO BE DIVERTED AROUND NEW WORKS AND CONNECTED INTO THE SURFACE WATER.
 - NO PRIVATE AREAS ARE TO DRAIN ONTO ADOPTABLE AREAS AND VICE VERSA.
 - ALL EXISTING MANHOLE COVER'S, GULLIES, ETC. ARE TO BE RAISED/LOWERED TO SUIT NEW LEVELS.
 - MANHOLE AND CHAMBER COVER GRADES:
 - 'A15' IN ALL LANDSCAPED AREAS AND ON FOOTPATHS
 - 'B125' IN ALL DRIVEWAYS AND PRIVATE PARKING AREAS
 - 'C250' IN CARRIAGEWAY/ACCESS ROAD



PRELIMINARY
NOT FOR CONSTRUCTION

P2	25.11.19	UPDATED DRAINAGE LAYOUT	LH	CS	CS
P1	03.09.19	MINOR REVISIONS TO SUIT EXTERNAL WORKS LAYOUT	LH	CS	CS
P-	18.09.19	PRELIMINARY ISSUE	LH	CS	CS

REV	DATE	DESCRIPTION	BY	CHK	APP
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cgs civils
Consulting Civil Engineers

CLIENT: GD GROUP

ARCHITECT: CITYZEN

JOB TITLE: MERRY ENGLAND ANGMERING

DRAWING TITLE: DRAINAGE LAYOUT

DRAWN	ENGINEER	CHECKED	APPROVED
LH	CS	CS	

DATE: SEPT 2019 SCALE @ A1: 1:200

JOB No.	STATUS	DRAWING No.	REV
C1249	P	100	P2

PRELIMINARY

Appendix B

Greenfield Runoff Calculations

Calculated by:

Site name:

Site location:

Site coordinates

Latitude:

Longitude:

This is an estimation of the greenfield runoff rate limits that are needed to meet normal best practice criteria in line with Environment Agency guidance "Preliminary rainfall runoff management for developments", WS-074/A/TR1/1 rev. E (2012) and the SuDS Manual, C753 (Ciria, 2015). This information on greenfield runoff rates may be the basis for setting consents for the drainage of surface water runoff from sites.

Reference:

Date:

Methodology	IH124
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Site characteristics

Total site area (ha)	1.14
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Methodology

Qbar estimation method	Calculate from SPR and SAAR	
SPR estimation method	Calculate from SOIL type	
	Default	Edited
SOIL type	2	2
HOST class	---	---
SPR/SPRHOST	0.3	0.3

Hydrological characteristics

	Default	Edited
SAAR (mm)	761	761
Hydrological region	7	7
Growth curve factor: 1 year	0.85	0.85
Growth curve factor: 30 year	2.3	2.3
Growth curve factor: 100 year	3.19	3.19

Notes:

(1) Is $Q_{BAR} < 2.0$ l/s/ha?

(2) Are flow rates < 5.0 l/s?

Where flow rates are less than 5.0 l/s consents are usually set at 5.0 l/s if blockage from vegetation and other materials is possible. Lower consent flow rates may be set in which case blockage work must be addressed by using appropriate drainage elements.

(3) Is $SPR/SPRHOST \leq 0.3$?

Where groundwater levels are low enough the use of soakaways to avoid discharge offsite may be a requirement for disposal of surface water runoff.

Greenfield runoff rates

	Default	Edited
Qbar (l/s)	2.29	2.29
1 in 1 year (l/s)	1.95	1.95
1 in 30 years (l/s)	5.27	5.27
1 in 100 years (l/s)	7.31	7.31

Appendix C

Surface Water Drainage Calculations

Design Settings

Rainfall Methodology	FSR	Maximum Time of Concentration (mins)	30.00
Return Period (years)	2	Maximum Rainfall (mm/hr)	50.0
Additional Flow (%)	0	Minimum Velocity (m/s)	1.00
FSR Region	England and Wales	Connection Type	Level Soffits
M5-60 (mm)	20.000	Minimum Backdrop Height (m)	0.600
Ratio-R	0.400	Preferred Cover Depth (m)	1.200
CV	0.750	Include Intermediate Ground	✓
Time of Entry (mins)	5.00	Enforce best practice design rules	✓

Nodes

Name	Area (ha)	T of E (mins)	Cover Level (m)	Diameter (mm)	Easting (m)	Northing (m)	Depth (m)
S1	0.064	5.00	21.320	1200	507352.312	105089.631	0.800
S2	0.052	5.00	21.095	1200	507353.618	105073.686	1.191
S3	0.064	5.00	20.550	1200	507366.224	105047.965	1.087
S4	0.020	5.00	20.900	1200	507353.786	105065.559	1.655
S5	0.015	5.00	20.580	1200	507334.079	105060.292	1.426
S6	0.062	5.00	20.480	1200	507320.177	105054.080	1.394
S7	0.011	5.00	20.300	1200	507302.989	105051.499	1.320
S8			20.190	1200	507296.994	105050.492	1.393
S9	0.013	5.00	19.980	1200	507301.066	105033.576	1.239
S10	0.032	5.00	19.730	1200	507305.813	105015.324	1.058
S11			19.700	1200	507290.187	105008.599	1.096
S12	0.038	5.00	20.750	1200	507298.237	105072.915	0.700
S38	0.023	5.00	19.950	1200	507277.019	105047.901	0.911
HW1			19.250		507266.606	104999.862	0.760

Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
1.000	S1	S2	15.998	0.600	20.520	19.904	0.616	26.0	150	5.13	50.0
1.001	S2	S4	8.129	0.600	19.904	19.320	0.584	13.9	150	5.18	50.0
1.002	S3	S4	21.547	0.600	19.463	19.320	0.143	150.7	150	5.44	50.0
2.000	S4	S5	20.399	0.600	19.245	19.154	0.091	225.0	225	5.83	50.0
2.001	S5	S6	15.227	0.600	19.154	19.086	0.068	225.0	225	6.12	50.0
2.002	S6	S7	17.381	0.600	19.092	18.980	0.112	155.2	225	6.40	50.0
2.003	S7	S8	6.079	0.600	18.980	18.872	0.108	56.3	225	6.46	50.0

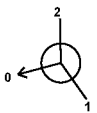
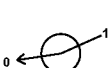
Name	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Add Inflow (l/s)
1.000	1.983	35.0	8.7	0.650	1.041	0.064	0.0
1.001	2.714	48.0	15.7	1.041	1.430	0.116	0.0
1.002	0.816	14.4	8.7	0.937	1.430	0.064	0.0
2.000	0.867	34.5	27.1	1.430	1.201	0.200	0.0
2.001	0.867	34.5	29.1	1.201	1.169	0.215	0.0
2.002	1.047	41.6	37.5	1.163	1.095	0.277	0.0
2.003	1.747	69.4	44.2	1.095	1.093	0.326	0.0

Links

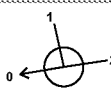
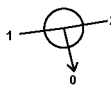
Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
3.000	S8	S9	17.399	0.600	18.797	18.741	0.056	310.7	300	6.79	50.0
3.001	S9	S10	18.859	0.600	18.741	18.672	0.069	273.3	300	7.12	50.0
3.002	S10	S11	17.012	0.600	18.672	18.604	0.068	250.2	300	7.41	50.0
3.003	S11	HW1	25.148	0.600	18.604	18.490	0.114	220.6	300	7.80	50.0
4.000	S12	S7	21.937	0.600	20.050	19.110	0.940	23.3	100	5.23	50.0
5.000	S38	S8	20.142	0.600	19.039	18.950	0.089	226.3	150	5.51	50.0

Name	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Add Inflow (l/s)
3.000	0.886	62.7	47.3	1.093	0.939	0.349	0.0
3.001	0.946	66.9	49.1	0.939	0.758	0.362	0.0
3.002	0.989	69.9	53.4	0.758	0.796	0.394	0.0
3.003	1.054	74.5	53.4	0.796	0.460	0.394	0.0
4.000	1.605	12.6	5.1	0.600	1.090	0.038	0.0
5.000	0.664	11.7	3.1	0.761	1.090	0.023	0.0

Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections	Link	IL (m)	Dia (mm)	
S1	507352.312	105089.631	21.320	0.800	1200		0	1.000	20.520	150
S2	507353.618	105073.686	21.095	1.191	1200		1	1.000	19.904	150
							0	1.001	19.904	150
S3	507366.224	105047.965	20.550	1.087	1200		0	1.002	19.463	150
S4	507353.786	105065.559	20.900	1.655	1200		1	1.002	19.320	150
							2	1.001	19.320	150
							0	2.000	19.245	225
S5	507334.079	105060.292	20.580	1.426	1200		1	2.000	19.154	225
							0	2.001	19.154	225
S6	507320.177	105054.080	20.480	1.394	1200		1	2.001	19.086	225
							0	2.002	19.092	225

Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections	Link	IL (m)	Dia (mm)	
S7	507302.989	105051.499	20.300	1.320	1200		1	4.000	19.110	100
							2	2.002	18.980	225
							0	2.003	18.980	225
S8	507296.994	105050.492	20.190	1.393	1200		1	5.000	18.950	150
							2	2.003	18.872	225
							0	3.000	18.797	300
S9	507301.066	105033.576	19.980	1.239	1200		1	3.000	18.741	300
					0		3.001	18.741	300	
S10	507305.813	105015.324	19.730	1.058	1200		1	3.001	18.672	300
							0	3.002	18.672	300
S11	507290.187	105008.599	19.700	1.096	1200		1	3.002	18.604	300
							0	3.003	18.604	300
S12	507298.237	105072.915	20.750	0.700	1200					
							0	4.000	20.050	100
S38	507277.019	105047.901	19.950	0.911	1200					
							0	5.000	19.039	150
HW1	507266.606	104999.862	19.250	0.760			1	3.003	18.490	300

Simulation Settings

Rainfall Methodology	FSR	Drain Down Time (mins)	1440
FSR Region	England and Wales	Additional Storage (m³/ha)	20.0
M5-60 (mm)	20.000	Check Discharge Rate(s)	✓
Ratio-R	0.400	1 year (l/s)	1.9
Summer CV	0.750	30 year (l/s)	5.5
Winter CV	0.840	100 year (l/s)	7.3
Analysis Speed	Normal	Check Discharge Volume	x
Skip Steady State	x		

Storm Durations

15 30 60 120 180 240 360 480 600 720 960 1440

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
10	40	0	0
100	40	0	0

Pre-development Discharge Rate

Site Makeup	Greenfield	Growth Factor 30 years	2.40
Greenfield Method	IH124	Growth Factor 100 years	3.19
Positively Drained Area (ha)	1.140	Betterment (%)	0
SAAR (mm)	761	QBar	2.3
Soil Index	2	Q 1 year (l/s)	1.9
SPR	0.30	Q 30 year (l/s)	5.5
Region	7	Q 100 year (l/s)	7.3
Growth Factor 1 year	0.85		

Node S11 Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	18.604	Product Number	CTL-SHE-0072-2300-0996-2300
Design Depth (m)	0.996	Min Outlet Diameter (m)	0.100
Design Flow (l/s)	2.3	Min Node Diameter (mm)	1200

Node S1 Carpark Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Invert Level (m)	20.520	Slope (1:X)	30.0
Side Inf Coefficient (m/hr)	0.00000	Time to half empty (mins)	0	Depth (m)	0.394
Safety Factor	2.0	Width (m)	10.000	Inf Depth (m)	
Porosity	0.30	Length (m)	24.900		

Node S2 Carpark Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Invert Level (m)	19.904	Slope (1:X)	100.0
Side Inf Coefficient (m/hr)	0.00000	Time to half empty (mins)	2	Depth (m)	0.394
Safety Factor	2.0	Width (m)	10.000	Inf Depth (m)	
Porosity	0.30	Length (m)	20.000		

Node S3 Carpark Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Invert Level (m)	19.463	Slope (1:X)	18.0
Side Inf Coefficient (m/hr)	0.00000	Time to half empty (mins)	4	Depth (m)	0.394
Safety Factor	2.0	Width (m)	10.000	Inf Depth (m)	
Porosity	0.30	Length (m)	21.400		

Node S4 Carpark Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Invert Level (m)	19.245	Slope (1:X)	128.0
Side Inf Coefficient (m/hr)	0.00000	Time to half empty (mins)	20	Depth (m)	0.394
Safety Factor	2.0	Width (m)	10.000	Inf Depth (m)	
Porosity	0.30	Length (m)	14.100		

Node S6 Carpark Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Invert Level (m)	19.086	Slope (1:X)	31.0
Side Inf Coefficient (m/hr)	0.00000	Time to half empty (mins)	630	Depth (m)	0.394
Safety Factor	2.0	Width (m)	30.000	Inf Depth (m)	
Porosity	0.30	Length (m)	11.860		

Node S7 Carpark Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Invert Level (m)	18.980	Slope (1:X)	37.0
Side Inf Coefficient (m/hr)	0.00000	Time to half empty (mins)	1050	Depth (m)	0.394
Safety Factor	2.0	Width (m)	10.000	Inf Depth (m)	
Porosity	0.30	Length (m)	6.900		

Node S9 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	18.741
Side Inf Coefficient (m/hr)	0.00000	Porosity	0.95	Time to half empty (mins)	1080

Depth (m)	Area (m ²)	Inf Area (m ²)	Depth (m)	Area (m ²)	Inf Area (m ²)	Depth (m)	Area (m ²)	Inf Area (m ²)
0.000	190.0	0.0	0.800	190.0	0.0	0.801	0.0	0.0

Node S10 Carpark Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Invert Level (m)	18.672	Slope (1:X)	1000.0
Side Inf Coefficient (m/hr)	0.00000	Time to half empty (mins)		Depth (m)	0.394
Safety Factor	2.0	Width (m)	20.000	Inf Depth (m)	
Porosity	0.30	Length (m)	10.000		

Node S11 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	18.610
Side Inf Coefficient (m/hr)	0.00000	Porosity	0.95	Time to half empty (mins)	

Depth (m)	Area (m ²)	Inf Area (m ²)	Depth (m)	Area (m ²)	Inf Area (m ²)	Depth (m)	Area (m ²)	Inf Area (m ²)
0.000	70.0	0.0	0.400	70.0	0.0	0.401	0.0	0.0

Node S12 Carpark Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Invert Level (m)	20.050	Slope (1:X)	74.0
Side Inf Coefficient (m/hr)	0.00000	Time to half empty (mins)	0	Depth (m)	0.394
Safety Factor	2.0	Width (m)	12.000	Inf Depth (m)	
Porosity	0.30	Length (m)	9.000		

Results for 10 year +40% CC Critical Storm Duration. Lowest mass balance: 95.88%

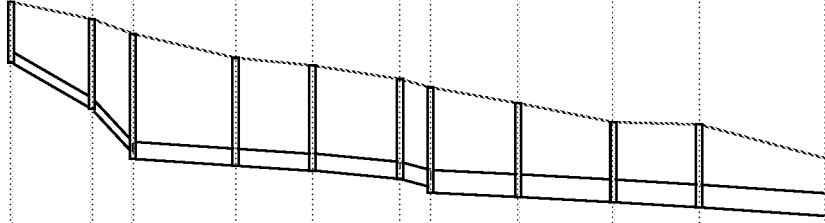
Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	S1	10	20.614	0.094	24.4	0.4564	0.0000	OK
15 minute winter	S2	12	20.025	0.121	43.8	2.4351	0.0000	OK
15 minute winter	S3	12	19.780	0.317	24.4	1.6546	0.0000	SURCHARGED
15 minute winter	S4	15	19.592	0.347	64.5	12.8182	0.0000	SURCHARGED
15 minute winter	S5	15	19.450	0.296	40.5	0.3967	0.0000	SURCHARGED
30 minute winter	S6	24	19.330	0.244	54.8	8.7990	0.0000	SURCHARGED
480 minute winter	S7	464	19.179	0.199	13.7	2.4587	0.0000	OK
480 minute winter	S8	464	19.179	0.382	14.7	0.4321	0.0000	SURCHARGED
480 minute winter	S9	464	19.179	0.438	15.0	79.6407	0.0000	SURCHARGED
480 minute winter	S10	464	19.179	0.507	8.9	24.2505	0.0000	SURCHARGED
480 minute winter	S11	464	19.179	0.575	5.8	27.3166	0.0000	SURCHARGED
15 minute winter	S12	11	20.134	0.084	14.5	1.1188	0.0000	OK
480 minute winter	S38	464	19.179	0.140	1.0	0.2291	0.0000	OK
15 minute summer	HW1	1	18.490	0.000	2.3	0.0000	0.0000	OK

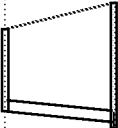
Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute winter	S1	1.000	S2	23.9	1.837	0.683	0.2115	
15 minute winter	S2	1.001	S4	39.6	2.590	0.826	0.1333	
15 minute winter	S3	1.002	S4	18.5	1.049	1.279	0.3793	
15 minute winter	S4	2.000	S5	38.6	0.971	1.120	0.8113	
15 minute winter	S5	2.001	S6	40.3	1.014	1.170	0.6056	
30 minute winter	S6	2.002	S7	45.4	1.244	1.090	0.6515	
480 minute winter	S7	2.003	S8	13.7	1.272	0.197	0.2339	
480 minute winter	S8	3.000	S9	14.5	0.724	0.232	1.2252	
480 minute winter	S9	3.001	S10	8.0	0.522	0.120	1.3280	
480 minute winter	S10	3.002	S11	5.8	0.470	0.082	1.1980	
480 minute winter	S11	Hydro-Brake®	HW1	2.3				187.5
15 minute winter	S12	4.000	S7	12.6	1.783	0.996	0.1625	
480 minute winter	S38	5.000	S8	1.2	0.418	0.105	0.3496	

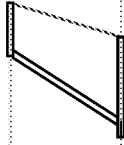
Results for 100 year +40% CC Critical Storm Duration. Lowest mass balance: 95.88%

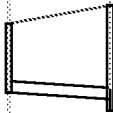
Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	S1	12	20.748	0.228	40.2	1.7540	0.0000	SURCHARGED
15 minute winter	S2	15	20.175	0.271	64.5	10.8096	0.0000	SURCHARGED
15 minute winter	S3	14	20.132	0.669	40.2	5.6010	0.0000	SURCHARGED
30 minute winter	S4	22	19.888	0.643	67.5	15.2378	0.0000	SURCHARGED
30 minute winter	S5	23	19.654	0.500	56.0	0.6702	0.0000	SURCHARGED
600 minute winter	S6	585	19.636	0.550	15.7	22.7980	0.0000	SURCHARGED
600 minute winter	S7	585	19.636	0.656	18.5	7.0907	0.0000	SURCHARGED
600 minute winter	S8	585	19.635	0.838	18.4	0.9483	0.0000	SURCHARGED
600 minute winter	S9	585	19.635	0.894	18.8	145.6896	0.0000	SURCHARGED
600 minute winter	S10	585	19.635	0.963	9.7	25.0427	0.0000	FLOOD RISK
600 minute winter	S11	585	19.635	1.031	7.5	27.8327	0.0000	FLOOD RISK
15 minute winter	S12	13	20.210	0.160	23.9	3.5855	0.0000	SURCHARGED
600 minute winter	S38	585	19.635	0.596	1.3	0.9758	0.0000	SURCHARGED
15 minute summer	HW1	1	18.490	0.000	2.3	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute winter	S1	1.000	S2	33.7	1.991	0.962	0.2816	
15 minute winter	S2	1.001	S4	41.1	2.615	0.857	0.1431	
15 minute winter	S3	1.002	S4	22.7	1.291	1.575	0.3793	
30 minute winter	S4	2.000	S5	49.9	1.256	1.448	0.8113	
30 minute winter	S5	2.001	S6	55.6	1.397	1.611	0.6056	
600 minute winter	S6	2.002	S7	15.7	0.960	0.377	0.6913	
600 minute winter	S7	2.003	S8	17.3	1.277	0.248	0.2418	
600 minute winter	S8	3.000	S9	18.1	0.760	0.289	1.2252	
600 minute winter	S9	3.001	S10	8.0	0.503	0.120	1.3280	
600 minute winter	S10	3.002	S11	7.5	0.501	0.107	1.1980	
600 minute winter	S11	Hydro-Brake®	HW1	2.3				247.8
15 minute winter	S12	4.000	S7	12.8	1.762	1.020	0.1716	
600 minute winter	S38	5.000	S8	1.2	0.429	0.102	0.3546	

Node Name	S1	S2	S4	S5	S6	S7	S8	S9	S10	S11	HW1
A4 drawing Hor Scale 1500 Ver Scale 100 Datum (m) 14.000 											
Link Name	1.000	1.000	2.000	2.001	2.002	2.003	3.000	3.001	3.002	3.003	
Section Type	150mm	150mm	225mm	225mm	225mm	225mm	300mm	300mm	300mm	300mm	
Slope (1:X)	26.0	13.9	225.0	225.0	155.2	56	310.7	273.3	250.2	220.6	
Cover Level (m)	21.320	21.095	20.900	20.580	20.480	20.300	20.190	19.980	19.730	19.700	19.700
Invert Level (m)	20.520	19.904	19.996	19.245	19.154	19.154	19.086	19.092	18.980	18.980	18.490
Length (m)	15.998	8.12	20.399	15.227	17.381	6.0	17.399	18.859	17.012	25.148	

Node Name	S3	S4
A4 drawing Hor Scale 1500 Ver Scale 100 Datum (m) 14.000		
Link Name	1.002	
Section Type	150mm	
Slope (1:X)	150.7	
Cover Level (m)	20.550	20.550
Invert Level (m)	19.463	19.320
Length (m)	21.547	

Node Name	S12	S7
A4 drawing Hor Scale 1500 Ver Scale 100 Datum (m) 14.000		
Link Name	4.000	
Section Type	100mm	
Slope (1:X)	23.3	
Cover Level (m)	20.750	20.750
Invert Level (m)	20.050	19.110
Length (m)	21.937	

Node Name	S38	S8
A4 drawing Hor Scale 1500 Ver Scale 100 Datum (m) 14.000		
Link Name	5.000	
Section Type	150mm	
Slope (1:X)	226.3	
Cover Level (m)	19.950	19.950
Invert Level (m)	19.039	18.950
Length (m)	20.142	

