			Client			
			Liverpool	Edge - Hardman	Street Limited	
			Project			
			Hardman	House & Education	onal Buildings	
	+		Section			
struc	tural		Drainage			
Project No	Page No	Revision	Ву	Date	Checked	Date
17-2383	1	-	DCS	05.07.2017		

# INTRODUCTION.

The following are the design calculations required for the above-mentioned project.

# **DESIGN PHILOSOPHY.**

Drainage is to be designed and constructed in accordance with the National Planning Policy Framework and Planning Practice Guidance.

A sustainable drainage system is to be designed for this site on affordance with DEFRA Non-statutory technical standards for sustainable drainage systems – March 2015.

# DESIGN CODES.

BS 8301	Code of Practice for Building Drainage	1985	Amendment 1991
BS 6367	Code of Practice for Drainage of roofs and	1983	
	Paved Areas		
BS 5572	Code of Practice for Sanitary Pipework	1978	Amendments 1 & 2
	Building Regulations Part H	2002	
	Sewers for Adoption		5 <sup>th</sup> Edition
	Hepworth Design Manual		

# **ASSUMPTIONS & SPECIFICATIONS**

The following calculations contain specifications and instructions concerning construction work on the project mentioned in the title block. Any INSTRUCTIONS / SPECIFICATIONS WILL BE SHOWN IN BOLD CAPITAL LETTERS.

Care has been taken using all the available information which has been provided to us to. In certain cases where information is limited, conservative assumptions are made and generally these will be satisfactory. These ASSUMPTIONS WILL BE NOTED IN RED CAPITAL LETTERS.

ANY STATED ASSUMPTIONS SHOULD BE CHECKED FOR ACCURACY PRIOR TO COMMENCEMENT OF WORKS. IF ANY ASSUMPTIONS ARE FOUND TO BE INCORRECT THEN THE ENGINEER MUST BE INFORMED OF THE NATURE OF THE DISCREPANCIES IMMEDIATELY.

IF THERE IS ANY CONFUSION OR DOUBT ABOUT THE TECHNICALITIES OF ANY INSTRUCTIONS / SPECIFICATIONS EXPRESSED HEREIN PLEASE CONTACT THE ENGINEER.

			Client			
			Liverpool	Edge - Hardman	Street Limited	
			Project			
			Hardman	House & Education	onal Buildings	
			Section			
structi	urai		Drainage			
Project No	Page No	Revision	Ву	Date	Checked	Date
17-2383	2	-	DCS	05.07.2017		

# GENERAL DESCRIPTION.

The site is covered by 2No new buildings and external hardstanding. The external hardstanding can be installed as permeable paving and therefore all rainfall will be collected form the building roofs and routed to an attenuation tank within the site.

# **DESIGN PARAMETERS.**

#### Proposed Hydraulic Design Criteria

- The drainage system is to be designed for Peak Flow Control. The peak runoff rate from the development for a 1 in 1-year rainfall event and 1 in 100-year rainfall event will not exceed the peak **BROWNFIELD** runoff rate for the same event. Betterment of 30% has been included for climate change.
- The drainage system is to be designed for a Peak Volume Control. The runoff volume from the development to any highway drain, sewer or surface water body up to the 1 in 100-year, 6 hour rainfall event should never exceed the **BROWNFIELD** runoff volume. Betterment of 30% has been included for climate change.
- Flood risk within the development will negated by means of designated attenuation tank capable of storing flows generated up to 100-year return period. Betterment of 30% has been included for climate change.
- In accordance with 'Sewers For Adoption', the general pipe drainage system is to be designed to not surcharge.

#### Wallingford: Modified Rational Method.

Location		England	(England, Ireland, Scotland, Wales)
M5 - 60	=	20	(Fig 6.1)
r	=	0.42	(Fig 6.2)
Site Area	=	0.001	km2

<u>Total Proposed Impermeable Area</u> Area (roof)

= 2610 m2

			Client								
			Liverpool	Edge - Hardman	Street Limited						
			Project								
			Hardman	Hardman House & Educational Buildings							
atur Latu	wal		Section								
structi	urai		Drainage								
Project No	Page No	Revision	Ву	Date	Checked	Date					
17-2383	1	-	DCS	05.07.2017							

#### PEAK VOLUME CONTROL

WALLINGFOR PROCEDURE - MODIFIED RATIONAL METHOD         Image: section in this column         (England in this column         (Fig 6.1)         (Fig 6.2)           Area         0.42         (Fig 6.2)         (Fig 6.3)         (Fig 6.4)         MI model in this column           Growth         Fill in this column         (Fig 6.4)         MI model in this column           Column         (Fig 6.3)         (Fig 6.4)         MI model in model in this column           S         S         MI model in this column           Column         MI model in this column         MI model in this column           Column         MI model in this column         MI model in this column           Column         MI model in this column          MI model in this column <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th>DATION</th> <th></th> <th><u></u></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th>							DATION		<u></u>									
Location         England Tr         England 0         (Fig 6.1) (Fig 6.2)         (Fig 6.2)	WAL	LING	FO	KD PROC	EDU	RE - MODIFIED	RATION		OD									
Location         England         (England, Ireland, Scotland, Wales)         Image: Column of the state of the				Fill in this														
Location       England r       England 9       mm (Fig 6.1) 0.0026       (England, Ireland, Scotland, Wales) (Fig 6.2)       image for the fig for				column														
M5 - 60       =       19       mm (Fig 6.1) (Fig 6.2)       mm (Fig 6.1) (Fig 6.3)       mm (Fig 6.1) (Fig 6.3)       mm (Fig 6.1) (Fig 6.3)       mm (Fig 6.1) (Fig 6.4)       mm (Fig 6.1) (Fig 6	Locati	tion		England		(England, Ireland	, Scotland	l, Wales)										
r       =       0.42       (Fig 6.2)       (Fig 6.2) </td <td>M5 - 6</td> <td>50</td> <td>=</td> <td>19</td> <td>mm</td> <td>(Fig 6.1)</td> <td></td>	M5 - 6	50	=	19	mm	(Fig 6.1)												
Area Growth         =         0.00261         km2 0         Mm2	r		=	0.42		(Fig 6.2)												
Growth         0         %         mins         Fill in this column         Fill in this column         Fill in this column         AVERAGE AREAL INTENSITY         NTERPOL ATED         M10         M20         M30         M50         M100         DISCHARGE           mins         (Fig 6.3b)         (Fig 6.4)         M1         M2         M3         M4         M5         M10         (mm/hr)	Area		=	0.00261	km2													
Fill in this column       Fill in this column<	Growt	th		0	%													
Image: column				Fill in this		Fill in this												
AVERAGE AREAL INTENSITY         AVERAGE AREAL INTENSITY         INTERPOL ATEO         ATEO           Image: Crip 6.3b)         (Fig 6.4)         M1         M2         M3         M4         M5         M10         M20         M30         M50         M100         DISCHARGE           Image: Crip 6.3b)         (Fig 6.4)         M1         M2         M3         M4         M5         M10         M20         M30         M50         M100         DISCHARGE           Image: Crip 6.3b)         (Fig 6.4)         M1         M2         M3         M4         M5         M10         M20         M30         M50         M100         DISCHARGE           Image: Crip 6.3b)         (Fig 6.4)         M1         M2         M3         M4         M5         M10         M20         M30         M50         M100         DISCHARGE           Image: Crip 6.3b)         (Fig 6.4)         M1         M2         M3         M4         M5         M10         M20         M30         M50         M100         DISCHARGE           Image: Crip 6.3b)         0.900         15         28.3         36.7         41.8         45.0         47.8         56.7         65.5         66.8         67.3         77.7         8				column		column												
AVERAGE AREAL INTENSITY       ATED       ATED       ATED       ATED       ATED       M1         Image: Constraint of the state o															INTERPOL			
Z1       ARF Factor       M1       M2       M3       M4       M5       M10       M20       M30       M30       M40       DISCHARGE         mins							AVERAG	GE AREAL IN	ITENSITY						ATED			
Imins         (Fig 6.3b)         (Fig 6.4)         M1         M2         M3         M4         M5         M10         M20         M30         M50         M100         DISCHARGE           mins				Z1		ARF Factor												M1
mins         mins         max         max </th <th></th> <th></th> <th></th> <th>(Fig 6.3b)</th> <th></th> <th>(Eig 6 /)</th> <th></th> <th>M14</th> <th>MO</th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th> DIA CULL DATE</th>				(Fig 6.3b)		(Eig 6 /)		M14	MO									 DIA CULL DATE
$\begin{array}{c c c c c c c c c c c c c c c c c c c $				1.19 0.001		(FIG 0.4)		IVI I	IVI Z	M3	M4	M5	M10	M20	M30	M50	M100	DISCHARGE
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	mi	ins		(		(Fig 0.4)		(mm/hr)	m∠ (mm/hr)	M3 (mm/hr)	M4 (mm/hr)	M5 (mm/hr)	M10 (mm/hr)	M20 (mm/hr)	M30 (mm/hr)	M50 (mm/hr)	M100 (mm/hr)	DISCHARGE
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	mi	ins 5	=	0.38		0.900	5	(mm/hr) 48.3	(mm/hr) 61.6	M3 (mm/hr) 69.4	M4 (mm/hr) 75.6	M5 (mm/hr) 79.5	M10 (mm/hr) 92.8	M20 (mm/hr) 106.0	M30 (mm/hr) 111.5	M50 (mm/hr) 121.6	M100 (mm/hr) 139.6	 35.08
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	mi	ins 5 10	=	0.38 0.52		0.900 0.930	5	(mm/hr) 48.3 33.6	(mm/hr) 61.6 43.6	M3 (mm/hr) 69.4 49.6	M4 (mm/hr) 75.6 53.5	M5 (mm/hr) 79.5 56.8	M10 (mm/hr) 92.8 67.3	M20 (mm/hr) 106.0 77.7	M30 (mm/hr) 111.5 82.7	M50 (mm/hr) 121.6 91.0	M100 (mm/hr) 139.6 105.3	 35.08 24.40
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	mi	ins 5 10 15	=	0.38 0.52 0.65		0.900 0.930 0.940	5 10 15	(mm/hr) 48.3 33.6 28.3	MZ (mm/hr) 61.6 43.6 36.7	M3 (mm/hr) 69.4 49.6 41.8	M4 (mm/hr) 75.6 53.5 45.0	M5 (mm/hr) 79.5 56.8 47.8	M10 (mm/hr) 92.8 67.3 56.7	M20 (mm/hr) 106.0 77.7 65.5	M30 (mm/hr) 111.5 82.7 69.7	M50 (mm/hr) 121.6 91.0 76.6	M100 (mm/hr) 139.6 105.3 88.7	35.08 24.40 20.55
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$		ins 5 10 15 30	= =	0.38 0.52 0.65 0.79		0.900 0.930 0.940 0.950	5 10 15 30	(mm/hr) 48.3 33.6 28.3 17.7	M2 (mm/hr) 61.6 43.6 36.7 22.8	M3 (mm/hr) 69.4 49.6 41.8 25.7	M4 (mm/hr) 75.6 53.5 45.0 27.7	M5 (mm/hr) 79.5 56.8 47.8 29.4	M10 (mm/hr) 92.8 67.3 56.7 35.4	M20 (mm/hr) 106.0 77.7 65.5 41.1	M30 (mm/hr) 111.5 82.7 69.7 43.6	M50 (mm/hr) 121.6 91.0 76.6 48.5	M100 (mm/hr) 139.6 105.3 88.7 56.8	35.08 24.40 20.55 12.83
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$		ins 5 10 15 30 60		0.38 0.52 0.65 0.79 1.00		0.900 0.930 0.940 0.950 0.960	5 10 15 30 60	(mm/hr) 48.3 33.6 28.3 17.7 11.7	(mm/hr) 61.6 43.6 36.7 22.8 14.8	M3 (mm/hr) 69.4 49.6 41.8 25.7 16.4	M4 (mm/hr) 75.6 53.5 45.0 27.7 17.7	M5 (mm/hr) 79.5 56.8 47.8 29.4 18.8	M10 (mm/hr) 92.8 67.3 56.7 35.4 22.6	M20 (mm/hr) 106.0 77.7 65.5 41.1 26.4	M30 (mm/hr) 111.5 82.7 69.7 43.6 28.3	M50 (mm/hr) 121.6 91.0 76.6 48.5 31.6	M100 (mm/hr) 139.6 105.3 88.7 56.8 37.0	35.08 24.40 20.55 12.83 8.47
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$		ins 5 10 15 30 60 120		0.38 0.52 0.65 0.79 1.00 1.20		0.900 0.930 0.940 0.950 0.960 0.965	5 10 15 30 60 2hr	(mm/hr) 48.3 33.6 28.3 17.7 11.7 7.3	(mm/hr) 61.6 43.6 36.7 22.8 14.8 9.0	M3 (mm/hr) 69.4 49.6 41.8 25.7 16.4 10.0	M4 (mm/hr) 75.6 53.5 45.0 27.7 17.7 10.7	M5 (mm/hr) 79.5 56.8 47.8 29.4 18.8 11.3	M10 (mm/hr) 92.8 67.3 56.7 35.4 22.6 13.6	M20 (mm/hr) 106.0 77.7 65.5 41.1 26.4 15.8	M30 (mm/hr) 111.5 82.7 69.7 43.6 28.3 16.9	M50 (mm/hr) 121.6 91.0 76.6 48.5 31.6 18.9	M100 (mm/hr) 139.6 105.3 88.7 56.8 37.0 22.1	35.08 24.40 20.55 12.83 8.47 5.27
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	r	ins 5 10 15 30 60 120 240		0.38 0.52 0.65 0.79 1.00 1.20 1.50		(+9 6.4) 0.900 0.930 0.940 0.950 0.960 0.965 0.975	5 10 15 30 60 2hr 4hr	(mm/hr) 48.3 33.6 28.3 17.7 11.7 7.3 4.7	(mm/hr) 61.6 43.6 36.7 22.8 14.8 9.0 5.8	M3 (mm/hr) 69.4 49.6 41.8 25.7 16.4 10.0 6.3	M4 (mm/hr) 75.6 53.5 45.0 27.7 17.7 10.7 6.7	M5 (mm/hr) 79.5 56.8 47.8 29.4 18.8 11.3 7.2	M10 (mm/hr) 92.8 67.3 56.7 35.4 22.6 13.6 8.6	M20 (mm/hr) 106.0 77.7 65.5 41.1 26.4 15.8 9.9	M30 (mm/hr) 111.5 82.7 69.7 43.6 28.3 16.9 10.6	M50 (mm/hr) 121.6 91.0 76.6 48.5 31.6 18.9 11.8	M100 (mm/hr) 139.6 105.3 88.7 56.8 37.0 22.1 13.7	35.08 24.40 20.55 12.83 8.47 5.27 3.43
hr       1440       =       2.10       0.990       24hr       1.2       1.4       1.5       1.6       1.7       2.0       2.3       2.4       2.7       3.1       0.84         hr       2880       =       2.50       1.000       48hr       0.7       0.8       0.9       1.0       1.0       1.2       1.3       1.4       1.6       1.8       0.52	r	ins 5 10 15 30 60 120 240 360		0.38 0.52 0.65 0.79 1.00 1.20 1.50 1.60		(+g 0.4) 0.900 0.930 0.940 0.950 0.960 0.965 0.975 0.980	5 10 15 30 60 2hr 4hr 6hr	(mm/hr) 48.3 33.6 28.3 17.7 11.7 7.3 4.7 3.4	(mm/hr) 61.6 43.6 36.7 22.8 14.8 9.0 5.8 4.1	M3 (mm/hr) 69.4 49.6 41.8 25.7 16.4 10.0 6.3 4.5	M4 (mm/hr) 75.6 53.5 45.0 27.7 17.7 10.7 6.7 4.8	M5 (mm/hr) 79.5 56.8 47.8 29.4 18.8 11.3 7.2 5.1	M10 (mm/hr) 92.8 67.3 56.7 35.4 22.6 13.6 8.6 6.2	M20 (mm/hr) 106.0 77.7 65.5 41.1 26.4 15.8 9.9 7.1	M30 (mm/hr) 111.5 82.7 69.7 43.6 28.3 16.9 10.6 7.5	M50 (mm/hr) 121.6 91.0 76.6 48.5 31.6 18.9 11.8 8.4	M100 (mm/hr) 139.6 105.3 88.7 56.8 37.0 22.1 13.7 9.8	35.08 24.40 20.55 12.83 8.47 5.27 3.43 2.45
hr 2880 = 2.50 1.000 48hr 0.7 0.8 0.9 1.0 1.0 1.2 1.3 1.4 1.6 1.8 0.52	mi 	ins 5 10 15 30 60 120 240 360 600		0.38 0.52 0.65 0.79 1.00 1.20 1.50 1.60 1.85		(+9 8.4) 0.900 0.930 0.940 0.950 0.960 0.965 0.975 0.980 0.985	5 10 15 30 60 2hr 4hr 6hr 10hr	(mm/hr) 48.3 33.6 28.3 17.7 11.7 7.3 4.7 3.4 2.4	M2 (mm/hr) 61.6 43.6 36.7 22.8 14.8 9.0 5.8 4.1 2.9	M3 (mm/hr) 69.4 49.6 41.8 25.7 16.4 10.0 6.3 4.5 3.2	M4 (mm/hr) 75.6 53.5 45.0 27.7 17.7 10.7 6.7 4.8 3.4	M5 (mm/hr) 79.5 56.8 47.8 29.4 18.8 11.3 7.2 5.1 3.5	M10 (mm/hr) 92.8 67.3 56.7 35.4 22.6 13.6 8.6 6.2 4.2	M20 (mm/hr) 106.0 77.7 65.5 41.1 26.4 15.8 9.9 7.1 4.8	M30 (mm/hr) 111.5 82.7 69.7 43.6 28.3 16.9 10.6 7.5 5.1	M50 (mm/hr) 121.6 91.0 76.6 48.5 31.6 18.9 11.8 8.4 5.7	M100 (mm/hr) 139.6 105.3 88.7 56.8 37.0 22.1 13.7 9.8 6.5	35.08           24.40           20.55           12.83           8.47           5.27           3.43           2.45           1.76
		ins 5 10 15 30 60 120 240 360 600 1440		0.38 0.52 0.65 0.79 1.00 1.20 1.50 1.60 1.85 2.10		(+9 0.4) 0.900 0.930 0.940 0.950 0.965 0.965 0.975 0.980 0.985 0.990	5 10 15 30 60 2hr 4hr 6hr 10hr 24hr	(mm/hr) 48.3 33.6 28.3 17.7 11.7 7.3 4.7 3.4 2.4 1.2	(mm/hr) 61.6 43.6 36.7 22.8 14.8 9.0 5.8 4.1 2.9 1.4	M3 (mm/hr) 69.4 49.6 41.8 25.7 16.4 10.0 6.3 4.5 3.2 1.5	M4 (mm/hr) 75.6 53.5 45.0 27.7 17.7 10.7 6.7 4.8 3.4 1.6	M5 (mm/hr) 79.5 56.8 47.8 29.4 18.8 11.3 7.2 5.1 3.5 1.7	M10 (mm/hr) 92.8 67.3 56.7 35.4 22.6 13.6 8.6 6.2 4.2 2.0	M20 (mm/hr) 106.0 77.7 65.5 41.1 26.4 15.8 9.9 7.1 4.8 2.3	M30 (mm/hr) 111.5 82.7 69.7 43.6 28.3 16.9 10.6 7.5 5.1 2.4	M50 (mm/hr) 121.6 91.0 76.6 48.5 31.6 18.9 11.8 8.4 5.7 2.7	M100 (mm/hr) 139.6 105.3 88.7 56.8 37.0 22.1 13.7 9.8 6.5 3.1	35.08           24.40           20.55           12.83           8.47           5.27           3.43           2.45           1.76           0.84
		ins 5 10 15 30 60 120 240 360 600 1440 2880		0.38 0.52 0.65 0.79 1.00 1.20 1.50 1.60 1.85 2.10 2.50		(+g 0.4) 0.900 0.930 0.940 0.950 0.960 0.965 0.975 0.980 0.985 0.990 1.000	5 10 15 30 60 2hr 4hr 6hr 10hr 24hr 24hr	(mm/hr) 48.3 33.6 28.3 17.7 11.7 7.3 4.7 3.4 2.4 1.2 0.7	(mm/hr) 61.6 43.6 36.7 22.8 14.8 9.0 5.8 4.1 2.9 1.4 0.8	M3 (mm/hr) 69.4 49.6 41.8 25.7 16.4 10.0 6.3 4.5 3.2 1.5 0.9	M4 (mm/hr) 75.6 53.5 45.0 27.7 17.7 10.7 6.7 4.8 3.4 1.6 1.0	M5 (mm/hr) 79.5 56.8 47.8 29.4 18.8 11.3 7.2 5.1 3.5 1.7 1.0	M10 (mm/hr) 92.8 67.3 56.7 35.4 22.6 13.6 8.6 6.2 4.2 2.0 1.2	M20 (mm/hr) 106.0 77.7 65.5 41.1 26.4 15.8 9.9 7.1 4.8 2.3 1.3	M30 (mm/hr) 111.5 82.7 69.7 43.6 28.3 16.9 10.6 7.5 5.1 2.4 1.4	M50 (mm/hr) 121.6 91.0 76.6 48.5 31.6 18.9 11.8 8.4 5.7 2.7 1.6	M100 (mm/hr) 139.6 105.3 88.7 56.8 37.0 22.1 13.7 9.8 6.5 3.1 1.8	35.08           24.40           20.55           12.83           8.47           5.27           3.43           2.45           1.76           0.84           0.52

Flow Restriction = 35.05 l/s

			Client								
			Liverpool	Edge - Hardman	Street Limited						
			Project								
			Hardman	Hardman House & Educational Buildings							
ature to			Section								
struct	urai		Drainage								
Project No	Page No	Revision	Ву	Date	Checked	Date					
17-2383	2	-	DCS	05.07.2017							

From spreadsheet analysis

W	ALLING	FOF	RD PROC	EDU	RE - MOD	IFIED I	RATION	IAL METH	IOD													
			Fill in this																			
			column																			
Lo	ocation		England	1	(England, I	reland,	Scotland	l, Wales)														
M	5 - 60	=	19	mm	(Fig 6.1)																	
r		=	0.42		(Fig 6.2)																	
Ar	ea	=	0.00261	km2																		
G	rowth		30	%																		
			Fill in this		Fill in this																	
			column		column																	
															INTERPOL							
							AVERA	GE AREAL II	NTENSITY						ATED							
			Z1		ARF Factor	r												M100	REDUCED		M100	
			(Fig 6.3b)		(Fig 6.4)			M1	M2	M3	M4	M5	M10	M20	M30	M50	M100	DISCHARGE	DISCHARGE	mm/hr	STORAGE	
	mins							(mm/hr)	(mm/hr)	(mm/hr)	(mm/hr)	(mm/hr)	(mm/hr)	(mm/hr)	(mm/hr)	(mm/hr)	(mm/hr)		35.05			
	5	=	0.38		0.900		5	61.8	80.1	91.2	98.3	104.4	123.7	142.9	152.1	167.3	193.6	140.48	105.43	145.31	31.60	
	10	=	0.52		0.930		10	44.4	57.3	64.5	69.5	73.8	88.9	103.2	109.7	121.8	142.6	103.48	68.43	94.32	41.03	
	15	=	0.65		0.940		15	37.4	48.3	54.3	58.6	62.2	74.9	86.9	92.4	102.6	120.1	87.16	52.11	71.82	46.86	<<
	30	=	0.79		0.950		30	23.7	30.0	33.4	36.0	38.2	46.0	53.8	57.5	64.1	75.3	54.61	19.56	26.96	35.18	
	60	=	1.00		0.960		60	15.6	19.4	21.6	23.0	24.4	29.4	34.1	36.5	40.8	47.7	34.58	-0.47	-0.65	-1.68	
2hr	120	=	1.20		0.965		2hr	9.7	11.9	13.0	13.9	14.7	17.7	20.3	21.7	24.3	28.2	20.44	-14.61	-20.13	-105.09	
4hr 👘	240	=	1.50		0.975		4hr	6.3	7.6	8.3	8.8	9.2	11.0	12.5	13.3	14.8	17.1	12.38	-22.67	-31.24	-326.12	
Shr	360	=	1.60		0.980		6hr	4.5	5.4	5.9	6.3	6.6	7.9	8.9	9.5	10.6	12.2	8.85	-26.20	-36.11	-565.43	
)hr	600	=	1.85		0.985		10hr	3.2	3.8	4.2	4.4	4.6	5.4	6.0	6.4	7.1	8.1	5.91	-29.14	-40.16	-1048.16	
hr	1440	=	2.10		0.990		24hr	1.5	1.8	2.0	2.1	2.2	2.5	2.9	3.1	3.4	3.9	2.81	-32.24	-44.43	-2783.31	
	2000	- 1	2.50		4 000		401-	0.0	1 1	1 2	1 2	1 2	15	17	4.0	20	22	1 60	22.26	45.00	E760.00	

FOR M100-6HOUR AND GREENFIELD DISCHARGE RATE OF 35.05 I/s THE REQUIRED STORAGE IS 0 m3

PEAK VOLUME OCCURS DURING 15 MINUTE STORM

WITH A GREENFIELD DISCHARGE RATE OF 35.05 I/s THE REQUIRED STORAGE IS 47 m3

			Client								
			Liverpool Project	Edge - Hardman	Street Limited						
			Hardman	Hardman House & Educational Buildings							
otraio	tural		Section								
struc	lural		Drainage								
Project No	Page No	Revision	Ву	Date	Checked	Date					
17-2383	1	-	DCS	05.07.2017							

**PIPE - OUTFALL** 

# Hydraulic – Pipe Flow Capacity Table

# Table 6 – Pipe flowing full – Roughness K<sub>s</sub>=0.60

		No						Nom	ninal Diameter (mm)								
		10	0	1	50	22	25	3	00	4	00	4	150	5	00	60	0
Hydraulic	Gradient	valocity	decharge	valoaity	discharge	valocity	decharge	valoaity	discharge	valocity	decharge	valoaity	discharge	velocity	discharge	valoaity	discharge
	1 in	m/s	Vs	ms	Vs	m/s	Vs	m/s	Vs	m/s	Vs	m/s	Vs	ms	Vs	m/s	Vs
0.0010	1000.0	0.23	1.84	0.31	5.45	0.40	16.06	0.49	34.45	0.59	73.75	0.63	100.66	0.68	132.91	0.76	214.87
0.0011	909.1	0.25	1.93	0.32	5.73	3.42	16.87	0.51	36.18	0.62	77.43	0.66	105.67	0.71	139.52	0.80	225.54
0.0012	833.3	0.26	2.02	0.34	5.99	0.44	17.64	0.54	37.83	0.64	80.95	0.69	110.48	0.74	145.84	0.83	235.74
0.0013	769.2	0.27	2.11	0.35	6.24	0.46	18.36	0.56	39.41	0.67	84.32	0.72	116.06	0.77	161.90	0.87	246.62
0.0014	/14.3	0.28	2.19	0.37	6.49	0.48	19.09	0.58	40.93	0.70	87.57	0.75	119.48	0.80	167.74	0.90	254.93
0.0015	606.7	0.29	2.21	0.38	0.72	0.50	20.44	0.60	42.40	0.72	00.70	0.78	497.00	0.83	103.30	0.06	204.01
0.0017	620.0	0.30	2.30	0.30	7.17	0.51	20.44	0.62	43.82	0.75	06.66	0.80	121.00	0.86	174.00	0.96	201.21
0.0018	555.6	0.37	2.40	0.42	7.20	0.55	21.00	33.0	46.53	0.70	00.50	0.85	125.77	0.01	170.21	1.02	200.58
0.0019	626.3	0.33	2.57	0.43	7.59	0.56	22.32	0.68	47.83	0.81	102.29	0.88	139.54	0.94	184.19	1.05	207.62
0.0020	500.0	0.34	2.64	0.44	7.80	0.58	22.02	0.69	49.10	0.84	104.99	0.90	143.23	0.96	189.05	1.08	305.45
0.0022	454.5	0.35	2.77	0.46	8,19	0.61	24.06	0.73	51.54	0.88	110.19	0.95	150.32	1.01	198.41	1.13	320.55
0.0024	416.7	0.37	2.90	0.44	8.56	0.63	25.15	0.76	53.88	0.92	115.17	0.99	157.10	1.06	207.35	1.18	334.98
0.0026	384.6	0.38	3.02	0.50	8.92	0.66	26.20	0.79	56.12	0.95	119.94	1.03	163.61	1.10	215.92	1.23	348.81
0.0028	357.1	0.40	3.14	0.52	9.27	83.0	27.21	0.82	58.27	0.99	124.53	1.07	169.87	1.14	224.18	1.28	362.13
0.0030	333.3	0.41	3.25	0.54	9.60	0.71	28.18	0.85	60.35	1.03	128.97	1.11	175.90	1.18	232.14	1.33	374.98
0.0032	312.5	0.43	3.36	0.56	9.92	0.73	29.13	0.88	62.36	1.06	133.25	1.14	181.75	1.22	239.85	1.37	387.41
0.0034	294.1	0.44	3.47	0.58	10.24	0.76	30.04	0.91	64.31	1.09	137.41	1.18	187.41	1.26	247.31	1.41	399.45
0.0036	277.8	0.45	3.57	0.60	10.64	0.78	30.92	0.94	66.20	1.13	141.44	1.21	192.90	1.30	254.55	1.45	411.15
0.0038	263.2	0.4/	3.67	0.61	10.83	0.80	31.79	0.96	68.04	1.16	145.36	1.25	198.25	1.33	261.61	1.49	422.63
0.0040	200.0	0.48	0.07	0.63	11.12	0.82	02.03	1.01	74.50	1.19	162.01	1.28	203.46	1.40	208.48	1.03	433.01
0.0042	200.1	0.49	3.87	33.0	11.69	38.0	33.44	104	73.20	1.22	156.55	1.3	213.50	1.40	201.18	1.57	444.41
3100.0	217.4	0.52	4.05	83.0	11.00	0.88	35.02	1.06	74.06	1.27	160.11	1.37	219.35	1.47	200.11	1.65	465.28
0.0048	208.3	0.53	A 1A	0.00	12.20	0.00	35.70	1.00	76.50	1.30	163.50	1.0	223.00	1.50	200.11	1.68	475.38
0.0050	200.0	0.54	4.23	0.71	12.46	0.92	36.54	1.11	78.19	1.33	167.00	1.43	227.74	1.53	300.50	1.72	485.26
0.0055	181.8	0.57	4.44	0.74	13.08	0.96	38.35	1.16	82.06	1.39	175.24	1.50	238.96	1.61	315.30	1.80	509.15
0.0060	166.7	0.59	4.64	0.77	13.67	1.01	40.08	1.21	85.75	1.46	183.11	1.57	249.69	1.68	329.45	1.88	531.97
0.0065	153.8	0.62	4.84	0.81	14.24	1.05	41.74	1.26	89.29	1.52	190.66	1.63	259.98	1.75	343.01	1.96	663.85
0.0070	142.9	0.64	5.02	0.84	14.79	1.09	43.34	1.31	92.70	1.58	197.93	1.70	269.88	1.81	356.07	2.03	674.92
0.0075	133.3	0.66	5.20	0.87	15.32	1.13	44.88	1.36	95.99	1.63	204.94	1.76	279.43	1.88	368.66	2.11	595.24
0.0080	125.0	0.68	5.38	0.90	15.83	1.17	46.37	1.40	99.17	1.68	211.72	1.82	288.67	1.94	380.85	2.17	614.89
0.0085	117.6	0.71	6.66	0.92	16.32	1.20	47.81	1.45	102.25	1.74	218.29	1.87	297.63	2.00	392.66	2.24	633.94
0.0000	111.1	0.73	6./1	0.95	16.80	1.24	49.21	1.49	105.25	1./9	224.67	1.963	306.32	2.06	404.12	2.31	652.44
0.0095	105.3	0.75	6.87	1.00	17.72	1.27	50.58	1.53	108.16	1.84	230.88	2.02	314.78	2.11	415.27	2.31	670.43
0.0100	00.0	0.01	6.02	1.00	19.60	1.31	61.MI	1.07	116.46	1.00	240.92	2.03	220.00	2.17	420.14	2.43	721.74
0.0120	80.9	0.01	6.64	1.00	10.00	1.42	56.04	1.00	121.60	2.07	240.07	2.10	264.06	2.20	447.07	2.00	754.04
0.0120	76.9	0.84	6.98	1.15	20.24	1.43	50.26	179	126.60	2.15	270.39	2.23	368.62	2.38	496.27	2.07	764.07
0.0140	714	0.91	7.15	1 10	21.02	1.55	61.52	1.86	131.51	2.23	280.66	241	382.62	2.57	504.73	2.88	814.76
0.0150	66.7	0.94	7.40	1.23	21.76	1.60	63.70	1.93	136.17	2.31	290.58	2.49	396.13	2.66	522.55	2.98	843.50
0.0160	62.5	0.97	7.65	1.27	22.48	1.66	65.81	1.99	140.67	2.39	300.17	2.57	409.20	2.75	539.78	3.08	871.30
0.0170	58.8	1.00	7.89	1.31	23.18	1.71	67.85	2.05	145.03	2.46	309.46	2.65	421.86	2.83	556.48	3.18	898.25
0.0180	55.6	1.03	8.12	1.35	23.86	1.76	69.83	2.11	149.26	2.53	318.49	2.73	434.16	2.92	572.70	3.27	924.41
0.0190	52.6	1.06	8.34	1.39	24.52	1.80	71.76	2.17	153.38	2.60	327.26	2.81	446.12	3.00	588.47	3.36	949.85
0.0200	50.0	1.09	8.56	1.42	25.17	1.85	73.64	2.23	157.39	2.67	335.81	2.88	457.77	3.08	603.84	3.45	974.64

# USE 225mm diameter pipe @ 1 in 225 (34.5 L/s)

			Client								
			Liverpool	Edge - Hardman	Street Limited						
			Project								
			Hardman	Hardman House & Educational Buildings							
	turel		Section	Section							
struc	tural		Drainage								
Project No	Page No	Revision	Ву	Date	Checked	Date					
17-2383	2	-	DCS	05.07.2017							

#### PEAK FLOW RATE CONTROL

RWPs

Area per RWP

= 300m2

#### **DESIGN RAINFALL**

#### In accordance with the Wallingford Procedure

Design rainfall intensity Location of catchment area: Liverpool Storm duration; D = 5 minReturn period; Period = 100 yr Ratio 60 min to 2 day rainfall of 5 yr return period; r = **0.400** 5-year return period rainfall of 60 minutes duration; M5 60min = 19.0 mm Increase of rainfall intensity due to global warming; pclimate = 30 % Factor Z1 (Wallingford procedure); Z1 = 0.37 Rainfall for 5min storm with 5 year return period;  $M5_5min_i = Z1 \times M5_60min \times (1 + p_{climate}) = 9.2 mm$ Factor Z2 (Wallingford procedure); Z2 = 1.89 Rainfall for 5min storm with 100 year return period; M100\_5min = Z2 × M5\_5min = 17.4 mm Design rainfall intensity; I<sub>max</sub> = M100\_5min / D = 209.3 mm/hr

#### Maximum surface water runoff

Catchment area;	$A_{catch} = 300 \text{ m}^2$
Percentage of area that is impermeable;	p = <b>100</b> %
Maximum surface water runoff;	$Q_{max} = A_{catch} \times p \times I_{max} = \textbf{17.4 I/s}$

#### **DESIGN OF A SURFACE WATER DRAIN**



ADS Structural Limited | 25 Peel House Lane | Widnes | Cheshire | WA8 6TN | 0151 541 4000 | info@adsstructural.co.uk Company No. 7888560 Vat Registration No. 135816606

TEDDS calculation version 1.0.03

Tedds calculation version 2.0.00

						1			
		Client	Client						
acs: structural				Liverpool Edge - Hardman Street Limited Project Hardman House & Educational Puildings					
			Hardman						
			Section		nai bolialings				
			Drainage	Drainage					
Project No	Page No	Revision	Ву	Date	Checked	Date			
17-2383	3	-	DCS	05.07.2017					
Using the C	Chezy equation								
Constant;			c = 56						
Diameter of	pipe required;		D = ((Qd	$_{ m esign}^2  imes$ 16) / ( $\pi^2  imes$ m	$n \times c^2 \times i \times 1 m/s^2$	) <sup>0.2</sup> = <b>144</b> mm			
Nearest pipe	e diameter;		$D_{chezy} = 1$	$D_{chezy} = 150 \text{ mm}$					
Flow velocity using Chezy;			$V_{chezy} = 0$	$V_{chezy} = c \times \sqrt{(m \times D_{chezy} \times i \times 1m/s^2)} = 1.084 \text{ m/s}$					
Using the E	Escritt equation								
Diameter of pipe required;			$D = (Q_{de}$	$D = (Q_{\text{design}} \times 1000 \times \sqrt{(1 \ / \ i)} \ / \ 0.00035 \ m^3 / s)^{0.382} \times 1 mm = \textbf{150} \ mm$					
Nearest pipe diameter;			D <sub>escritt</sub> =	D <sub>escritt</sub> = <b>150</b> mm					
Flow velocity using Escritt;			V <sub>escritt</sub> = 2	$V_{escritt} = 26.738 \times (D_{escritt} / 1mm)^{0.62} \times 1 m/s / (\sqrt{(1 / i)} \times 60) = 0.996 m/s$					
Using the C	Colebrook-White	e Equation for pi	pe running ful	l and partially full					
Design pipe	diameter;		D <sub>design</sub> =	max(D <sub>chezy</sub> , D <sub>escritt</sub> ,	D <sub>min</sub> ) = <b>150</b> mm				
Constant;			Z = √(2 >	$Z = \sqrt{(2 \times (g_{acc} / 1m/s^2) \times (D_{design} / 1000mm) \times i)} = \textbf{0.172}$					
Flow velocity:			$V_{full} = -2$	$V_{\text{full}} = -2 \times Z \times log((k_s/(3.7 \times D_{\text{design}})) + ((2.51 \times v)/(D_{\text{design}} \times Z \times 1m/s))) \times 1m/s$					
····· <b>·</b> ··· <b>·</b> ··· <b>·</b> ··· <b>·</b> ···· <b>·</b> ·······			V <sub>full</sub> = <b>1.0</b>	V <sub>full</sub> = <b>1.001</b> m/s					
Flow rate running full;			$Q_{full} = V_{fill}$	$Q_{\text{full}} = V_{\text{full}} \times \pi \times D_{\text{design}^2} / 4 = 17.7 \times 10^{-3} \text{ m}^3/\text{s}$					
<b>.</b>				PASS - Maximum flow rate is greater than design flow rate					
From Hydra	aulics Research	Tables 35 and 3	86		-	-			
Depth as pro	oportion of D;		x = <b>0.80</b>	9					
Flow velocit	y at design flow	rate;	V <sub>design</sub> =	<b>1.137</b> m/s					
				PASS -	Design velocity	∕ is greater than 0.750 m/s			

# USE 150mm diameter pipe @ 1 in 100

			Client	Client Liverpool Edge - Hardman Street Limited				
			Liverpool					
des:			Project					
			Hardman	Hardman House & Educational Buildings				
			Section					
structural		Drainage						
Project No	Page No	Revision	Ву	Date	Checked	Date		
17-2383	4	-	DCS	05.07.2017				

#### PEAK FLOW RATE CONTROL

<u>RWPs</u>

Area per RWP

= 600m2

#### **DESIGN RAINFALL**

#### In accordance with the Wallingford Procedure

Design rainfall intensity Location of catchment area: Liverpool Storm duration; D = 5 minReturn period; Period = 100 yr Ratio 60 min to 2 day rainfall of 5 yr return period; r = **0.400** 5-year return period rainfall of 60 minutes duration; M5 60min = 19.0 mm Increase of rainfall intensity due to global warming; pclimate = 30 % Factor Z1 (Wallingford procedure); Z1 = 0.37 Rainfall for 5min storm with 5 year return period;  $M5_5min_i = Z1 \times M5_60min \times (1 + p_{climate}) = 9.2 mm$ Factor Z2 (Wallingford procedure); Z2 = 1.89 Rainfall for 5min storm with 100 year return period; M100\_5min = Z2 × M5\_5min = 17.4 mm Design rainfall intensity; I<sub>max</sub> = M100\_5min / D = 209.3 mm/hr

#### Maximum surface water runoff

Catchment area;	$A_{catch} = 600 \text{ m}^2$
Percentage of area that is impermeable;	p = <b>100</b> %
Maximum surface water runoff;	$Q_{max} = A_{catch} \times p \times I_{max} = \textbf{34.9} \text{ I/s}$

#### **DESIGN OF A SURFACE WATER DRAIN**



ADS Structural Limited | 25 Peel House Lane | Widnes | Cheshire | WA8 6TN | 0151 541 4000 | info@adsstructural.co.uk Company No. 7888560 | Vat Registration No. 135816606

Tedds calculation version 2.0.00

TEDDS calculation version 1.0.03

acs: structural			<b>Liverpool</b> Project	Liverpool Edge - Hardman Street Limited Project Hardman House & Educational Buildings Section Drainage					
			Hardman						
			Section						
			Drainage						
Project No	Page No	Revision	Ву	Date	Checked	Date			
17-2383	5	-	DCS	05.07.2017					
Using the C	hezy equation								
Constant;			c = 56						
Diameter of	pipe required;		D = ((Qd	$_{ m esign}^2  imes$ 16) / ( $\pi^2  imes$ m	$n \times c^2 \times i \times 1 m/s^2$	)) <sup>0.2</sup> = <b>207</b> mm			
Nearest pipe	e diameter;		$D_{chezy} = 2$	$D_{chezy} = 225 \text{ mm}$					
Flow velocity using Chezy;			$V_{chezy} = 0$	$V_{chezy} = c \times \sqrt{(m \times D_{chezy} \times i \times 1m/s^2)} = 1.084 \text{ m/s}$					
Using the E	scritt equation								
Diameter of pipe required;			$D = (Q_{de}$	$D = (Q_{\text{design}} \times 1000 \times \sqrt{(1 \ / \ i)} \ / \ 0.00035 \ \text{m}^3/\text{s})^{0.382} \times 1\text{mm} = \textbf{211} \ \text{mm}$					
Nearest pipe diameter;			D <sub>escritt</sub> = 2	D <sub>escritt</sub> = <b>225</b> mm					
Flow velocity using Escritt;			Vescritt = 2	$V_{escritt} = 26.738 \times (D_{escritt} / 1mm)^{0.62} \times 1 m/s / (\sqrt{(1 / i)} \times 60) = 1.045 m/s$					
Using the C	olebrook-White	e Equation for pi	pe running ful	l and partially full					
Design pipe	diameter;		D <sub>design</sub> =	max(D <sub>chezy</sub> , D <sub>escritt</sub> ,	D <sub>min</sub> ) = <b>225</b> mm				
Constant;			Z = √(2 >	$Z = \sqrt{(2 \times (g_{acc} / 1m/s^2) \times (D_{design} / 1000mm) \times i)} = \textbf{0.172}$					
Flow velocity:			$V_{full} = -2$	$V_{full} = -2 \times Z \times log((k_s/(3.7 \times D_{design})) + ((2.51 \times v)/(D_{design} \times Z \times 1m/s))) \times 1m/s$					
<b></b>			V <sub>full</sub> = <b>1.0</b>	V <sub>full</sub> = <b>1.061</b> m/s					
Flow rate running full;			$Q_{full} = V_{fil}$	$Q_{\text{full}} = V_{\text{full}} \times \pi \times D_{\text{design}^2} / 4 = 42.2 \times 10^{-3} \text{ m}^3/\text{s}$					
<b>.</b>				PASS - Maximum flow rate is greater than design flow rate					
From Hydra	ulics Research	Tables 35 and 3	36		-	-			
Depth as pro	oportion of D;		x = <b>0.69</b>	5					
Flow velocity	y at design flow	rate;	V <sub>design</sub> =	<b>1.183</b> m/s					
				PASS -	Design velocity	y is greater than 0.750 m/s			

# USE 225mm diameter pipe @ 1 in 150

			Client	Client				
			Liverpool Edge - Hardman Street Limited					
			Project					
			Hardman House & Educational Buildings					
aturet			Section					
structural		Drainage						
Project No	Page No	Revision	Ву	Date	Checked	Date		
17-2383	6	-	DCS	05.07.2017				

# FOUL WATER DRAINAGE.

Design Based on Colebrook-White Equation.

Introduction.

The following calculations have been undertaken to determine the drainage requirement for the abovementioned site.

SUMMARY	Discharge	Totals	DU
	Unit		
Shower	0.6	335	201
Washbasin	0.6	350	210
WC	2.5	350	875
Urinal	0.8	10	8
Kitchen Sink	1.3	90	117
Dishwasher	0.8	90	72
Floor Drains	2	5	10
Washing Machine	0.8	90	72
			1565
Discharge Rate	20	l/sec	

Total units

Q =  $k \sqrt{(\Sigma DU)}$  = 0.5 x  $\sqrt{1565}$ 

# From peak flow rate capacity tables

100mm diameter pipe at 1:100 = 6.6 l/sec 150mm diameter pipe at 1:150 = 12.5 l/sec **225m diameter pipe at 1:225 = 29.5 l/sec** 300m diameter pipe at 1:300 = 55.2 l/sec

Max per SVP outlet to IC8 storiesDU per cluster= 13TotalQ = k  $\sqrt{(\Sigma DU)}$ = 0.5 x  $\sqrt{104}$ 

# From peak flow rate capacity tables

**100mm diameter pipe at 1:100 = 6.6 l/sec** 150mm diameter pipe at 1:150 = 12.5 l/sec

225m diameter pipe at 1:225 = 29.5 l/sec

ADS Structural Limited | 25 Peel House Lane | Widnes | Cheshire | WA8 6TN | 0151 541 4000 | info@adsstructural.co.uk Company No. 7888560 | Vat Registration No. 135816606

= 1565 = 20 l/sec

= 104 = 5 |/sec