waterco consultants	Eden Court, Lon Parcwr, Ruthin, 01824 702220	Calculations	ref **w3138**

Client :	Lofthouse Property Ltd.	no of pages attached: 1of 14	
Scheme :	Woods Mill, Glossop	prefix SWR	revision A
Section :	Surface Water Runoff		

prepared by: Angharad Llewelyn date: 07/08/2014

checked by: Aled Williams date: 08/08/2014

approved by: Deepak Kharat date: 08/08/2014

Comparison of pre-development and post-development run-off rates and volumes for greenfield or brownfield sites up to 200 Ha

Site description
Proposed development of land at adjacent to Glossop Brook, Woods Mill, Glossop, Derbyshire.
Development includes the erection of a superstore with associated car parking area, and residential builidngs with associated landscaped and hard standing areas see page SWR14.
National Grid Reference (centre of site) approx. 403855E 394000N

Design Brief
To calculate both pre and post development rainfall runoff in accordance with the requirements of the Interim Code of Practice for Sustainable Drainage Systems. The peak runoff rates are to be estimated for return periods of up to 100 years and the runoff volumes are also to be calculated for a 1 in 100 year event of 6 hour duration. An allowance for climate change should be included only in the case of the post-development runoff calculation.

Documents Referenced
1. Interim Code of Practice for Sustainable Drainage Systems (ICP-SUDS)(July 2004)
2. I o H Report 124 - Flood Estimation for Small Catchments (Marshall & Bayliss, 1994)
3. FSSR 16 runoff model - Fixed Percentage Runoff Method
4. Wallingford Procedure 1981
5. CIRIA C697 - The SUDS Manual (Feb 2007)

Basis of estimates
The Interim Code of Practice for Sustainable Drainage Systems (July 2004)[1] recommends the use of I o H 124[2] for calculating peak greenfield runoff rates for sites up to 200 Ha. For site less than 50 Ha, the runoff should be calculated for 50 Ha and adjusted in proportion for the actual area. For sites greater than 200 Ha, the FEH runoff model should be used. CIRIA C697[5] recommends the use of the FSSR 16[3] runoff method for calculating the runoff volume for greenfield sites.

For brownfield sites with a recognised drainage system, the Rational Method[4] has been used to calculate the runoff for the impermeable portions of the catchment (pre- & post development). For sites without a proper drainage system, the pre-development runoff is calclulated as for a greenfield site, assuming soil type 5, regardless of type indicated on mapping.

In accordance with National Planning Policy Framework (NPPF) and assuming a 100yr projection, a 30% on peak rainfall intensity increase in rainfall / runoff has been included to allow for the climate change anticipated in the years 2085 - 2115.

Rainfall data is taken from maps in Defra / EA Tech Report W5-074/A Rev D (see page SWR10 & 11).

Standard Average Annual Rainfall and Soil classification from maps in FSR Report (see page SWR8 & 9).

N.B. These calculations are for planning purposes only and will need to be reviewed at the detailed design stage.

waterco consultants	Eden Court, Lon Parcwr, Ruthin, 01824 702220	Calculations	ref : **w3138**
			prefix - page no. SWR2
Scheme :	Woods Mill, Glossop		dated :
Section :	Surface Water Runoff		07/08/2014

Basis of calculations

Peak run-off rate based on combination of IOH 124 method & Rational method

Run-off volume based on combination of FSSR 16 method & Rational method

N.B. Rational method used for impervious portion of total area for both pre and post development, allowing for pre-development of site where appropriate.

Catchment Details - input data

Proportions of soil type (from maps)

Prop S1	(fraction)		(x 0.15)
Prop S2	(fraction)		(x 0.30)
Prop S3	(fraction)		(x 0.40)
Prop S4	(fraction)	1.000	(x 0.45)
Prop S5	(fraction)		(x 0.50)
Total fraction		1.000	OK - total = 1
Calculated value of SOIL		0.450	
Calculated value of SPR		47.000	

SOIL = (0.15S1+0.3S2+0.4S3+0.45S4+0.5S5) / (S1+S2+S3+S4+S5)
SPR = 10S1 + 30S2 + 37S3 + 47S4 + 53S5

Region number		10	Select from list
AREA	(Ha)	3.8000	(1Ha =0.01Km^2)
SOIL	(fraction)	0.450	Calculated above
SAAR	(mm)	1150	From FSR maps
CWI		124.5	From FSR graph
M5-60 rainfall (mm)		20.00	From Defra / EA maps
Ratio M5-60/M5-2d		0.30	From Defra / EA maps
M100-6hr rainfall (mm)		70.00	From Defra / EA maps
Storm duration (min)		15	**(To give peak run-off-15 min for small site)**
PIMP Pre-develop (%)		42.00	Provided by client
PIMP Post-develop (%)		58.00	Provided by client
Pre-dev drain system?		**Yes**	If "No", whole site assumed pervious - Soil type 5 & pre-dev PIMP taken as zero in following calcs
Climate change			
Rainfall increase (%)		30	Based on NPPF (for years 2085 - 2115) Applied to post development case only

N.B. These calculations are for planning purposes only and will need to be reviewed at the detailed design stage.

waterco consultants	Eden Court, Lon Parcwr, Ruthin, 01824 702220	Calculations	ref : **w3138**
			prefix - page no. SWR3
Scheme :	Woods Mill, Glossop		dated :
Section :	Surface Water Runoff		07/08/2014

Pre- & Post-development peak run-off - Rational Method
(for impervious portions of catchment only)

Input data from sheet 2

Total area (Ha)	3.8000	from sht 2
Pre dev PIMP (%)	42.00	from sht 2 Or zero if no pre-development drainage
Post dev PIMP (%)	58.00	from sht 2
Pre-dev Imp area (Ha)	1.5960	calculated
Post-dev Imp area (Ha)	2.2040	calculated
M5-60min rain (mm)	20.00	from sht 2
Ratio "r"	0.30	from sht 2
Climate change (%)	30	from sht 2
Storm duration (min)	15.00	from sht 2

Rational Method

Peak run-off Qi = 2.78 Cv Cr i A

Z1 Factor from table	0.590	pro-rata
Volume coeff Cv	0.75	(Typical 0.75)
Routing coeff Cr	1.30	(Standard value 1.3)

Calculation

M5-Dmin rain (mm)	11.800	M5-60min * Z1 factor
Climate change factor	1.30	Applied to post-development run-off only

Return period	1 yr	30 yr	100 yr
Z2 factor from table	0.614	1.531	1.939
Rainfall (mm)	7.25	18.07	22.88
Rainfall intensity (mm/hr)	29.0	72.3	91.5
Rainfall + CC (mm)	9.43	23.49	29.74
R. Intensity + CC (mm/hr)	37.7	94.0	119.0

Peak run-off rate

Pre-development Qi (l/s)	125.45	312.77	395.83
Post-development Qi(l/s)	225.22	561.55	710.90

N.B. These calculations are for planning purposes only and will need to be reviewed at the detailed design stage.

waterco consultants	Eden Court, Lon Parcwr, Ruthin, 01824 702220	Calculations	ref : **w3138**
			prefix - page no. SWR4
Scheme :	Woods Mill, Glossop		dated :
Section :	Surface Water Runoff		07/08/2014

Pre & Post development peak run-off
IOH124 method for pervious areas - Rational method for impervious areas

Input data from sheet 2

Total Area (Ha)	3.8000	from sht 2
Pre-dev PIMP (%)	42.00	from sht 2 Or zero if no pre-development drainage
Post-dev PIMP (%)	58.00	from sht 3
Pre-dev Perv area (Ha)	2.2040	Calculated **< 50 Ha or 0.5 Km2**
Post-dev Perv area (Ha)	1.5960	Calculated **< 50 Ha or 0.5 Km2**

Region number		10	from sht 2	Pre-dev		
SOIL	(fraction)	0.450	from sht 2	SOIL	0.450	from sht 2 or fixed 0.5
SAAR	(mm)	1150	from sht 2			if no drainage system

Regional growth factors

Multiplier for 1/1 yrs	0.83	FSSR 14 table 1 (lookup table)
Multiplier for 1/30 yrs	1.69	FSSR 14 table 1
Multiplier for 1/100 yrs	2.08	FSSR 14 table 1

Climate change factor 1.3 Applied to post-development run-off only

Mean annual flood Qbar = 0.00108*(AREA/100)^0.89*SAAR^1.17*SOIL^2.17

	Pre-development		Post development	
Qbar' (for 50 Ha) (m3/s)	0.39264	basis of pro-rata	0.39264	basis of pro-rata
Qbar (actual area) (m3/s)	0.01731	pro-rata (A/50)*Qbar'	0.01253	pro-rata (A/50)*Qbar'

Peak flows (IoH 124)

Return period	1 yr	30 yr	100 yr	1 yr	30 yr	100 yr
Multiplier	0.830	1.690	2.080	0.830	1.690	2.080
Peak run-off (m^3/s)	0.01437	0.02925	0.03600	0.01040	0.02118	0.02607
Peak + CC Qp (m^3/s)	n/a	n/a	n/a	0.01352	0.02753	0.03389

Total peak flows (l/s)

Perv area flow-Qp (l/s)	14.37	29.25	36.00	13.52	27.53	33.89
Imp area flow -Qi (l/s)	125.45	312.77	395.83	225.22	561.55	710.90
Total peak flow Q (l/s)	139.82	342.02	431.83	238.74	589.08	744.79
Peak flow increase (l/s)				98.92	247.06	312.96

N.B. These calculations are for planning purposes only and will need to be reviewed at the detailed design stage.

waterco consultants	Eden Court, Lon Parcwr, Ruthin, 01824 702220	Calculations	ref : **w3138**
			prefix - page no. SWR5
Scheme :	Woods Mill, Glossop		dated :
Section :	Surface Water Runoff		07/08/2014

Pre & Post development run-off volume - FSSR 16
Applied to pervious and impervious areas
For 1 in 100yr 6hr storm

Input data from sheet 2

Total area (Ha)		3.8000	from sht 2			
Pre-dev PIMP (%)		42.00	from sht 2	Or zero if no pre-development drainage		
Post-dev PIMP (%)		58.00	from sht 2			
Pre-dev Perv Area (Ha)		2.2040	calculated			
Pre-dev Imp Area (Ha)		1.5960	calculated			
Post-dev Perv Area (Ha)		1.5960	calculated	**Rainfall data**		
Post-dev Imp Area (Ha)		2.2040	calculated	(M100-360 min)		
SAAR (mm)		1150.0	from sht 2	**Rainfall P (mm)**	70.00	from sht 2
CWI		124.5	from sht 2	CC factor	1.30	from sht 2
SPR (%)		47.00	from sht 2	**Rainfall Pcc (mm)**	91.00	calculated
DPR_{CWI} (%)		-0.125	calc	0.25*(CWI-125)		
DPR_{RAIN} (%)		7.055	calc	0.45*(P-40)^0.7 for P>40mm		
PR_p (%)	(perv area)	53.930	calc	SPR + DPR_{CWI} + DPR_{RAIN}		
PRi (%)	(imp area)	100.000	defined	100% of impervious area		
Storm duration (mins)		360	defined			

Run-off volume V = PR/100 * A*10000 * P/1000 = PR * A * P / 10 (m3)

where PR = Percentage run-off (PR_p or PRi (%))
A = Catchment area (A_p or A_i (Ha))
P = Rainfall depth (M100-360) (P or Pcc (mm))
(including climate change for post development only)

	Pre-dev	Post dev
	-	incl CC
Run-off volume- Pervious area (m3)	832.03	783.26
Run-off volume- Impervious area (m3)	1117.20	2005.64
Total run-off volume (m3)	1949.23	2788.90
Volume increase (m3)		839.67

N.B. These calculations are for planning purposes only and will need to be reviewed at the detailed design stage.

waterco consultants	Eden Court, Lon Parcwr, Ruthin, 01824 702220	Calculations	ref : **w3138**
			prefix - page no. SWR6
Scheme :	Woods Mill, Glossop		dated :
Section :	Surface Water Runoff		07/08/2014

Z1 Factor for England & Wales (Values from BRE 365 - Table 1)

Ratio	Rainfall Duration (mins)					
r	15	30	60	120	240	360
0.12	0.450	0.670	1.000	1.480	2.170	2.750
0.15	0.480	0.690	1.000	1.420	2.020	2.460
0.18	0.510	0.710	1.000	1.360	1.860	2.250
0.20	0.530	0.723	1.000	1.340	1.800	2.163
0.21	0.540	0.730	1.000	1.330	1.770	2.120
0.24	0.560	0.750	1.000	1.300	1.710	2.000
0.25	0.567	0.753	1.000	1.290	1.687	1.960
0.27	0.580	0.760	1.000	1.270	1.640	1.880
0.30	0.590	0.770	1.000	1.250	1.570	1.780
0.33	0.610	0.780	1.000	1.230	1.530	1.730
0.35	0.617	0.787	1.000	1.223	1.497	1.690
0.36	0.620	0.790	1.000	1.220	1.480	1.670
0.39	0.630	0.800	1.000	1.210	1.460	1.620
0.40	0.633	0.803	1.000	1.207	1.447	1.603
0.42	0.640	0.810	1.000	1.200	1.420	1.570
0.45	0.650	0.820	1.000	1.190	1.380	1.510

Z2 Factors for England & Wales from table 6.2 - Wallingford Procedure

M5 Rain (mm)	Diff (mm)	M1	M30	M100
		1	**30**	100
5.00	5	0.62	**1.45**	1.79
10.00	5	0.61	**1.52**	1.91
15.00	5	0.62	**1.55**	1.99
20.00	5	0.64	**1.58**	2.03
25.00	5	0.66	**1.57**	2.01
30.00	10	0.68	**1.55**	1.97
40.00	10	0.70	**1.50**	1.89
50.00	25	0.72	**1.45**	1.84
75.00	25	0.76	**1.36**	1.64
100.00	50	0.78	**1.32**	1.54
150.00	50	0.78	**1.26**	1.45
200.00		0.78	**1.24**	1.40
N.B. M30 Factors interpolated graphically				

N.B. These calculations are for planning purposes only and will need to be reviewed at the detailed design stage.

Hydrological Regions (From Defra / EA R&D Tech Report W5-074/A Rev D)

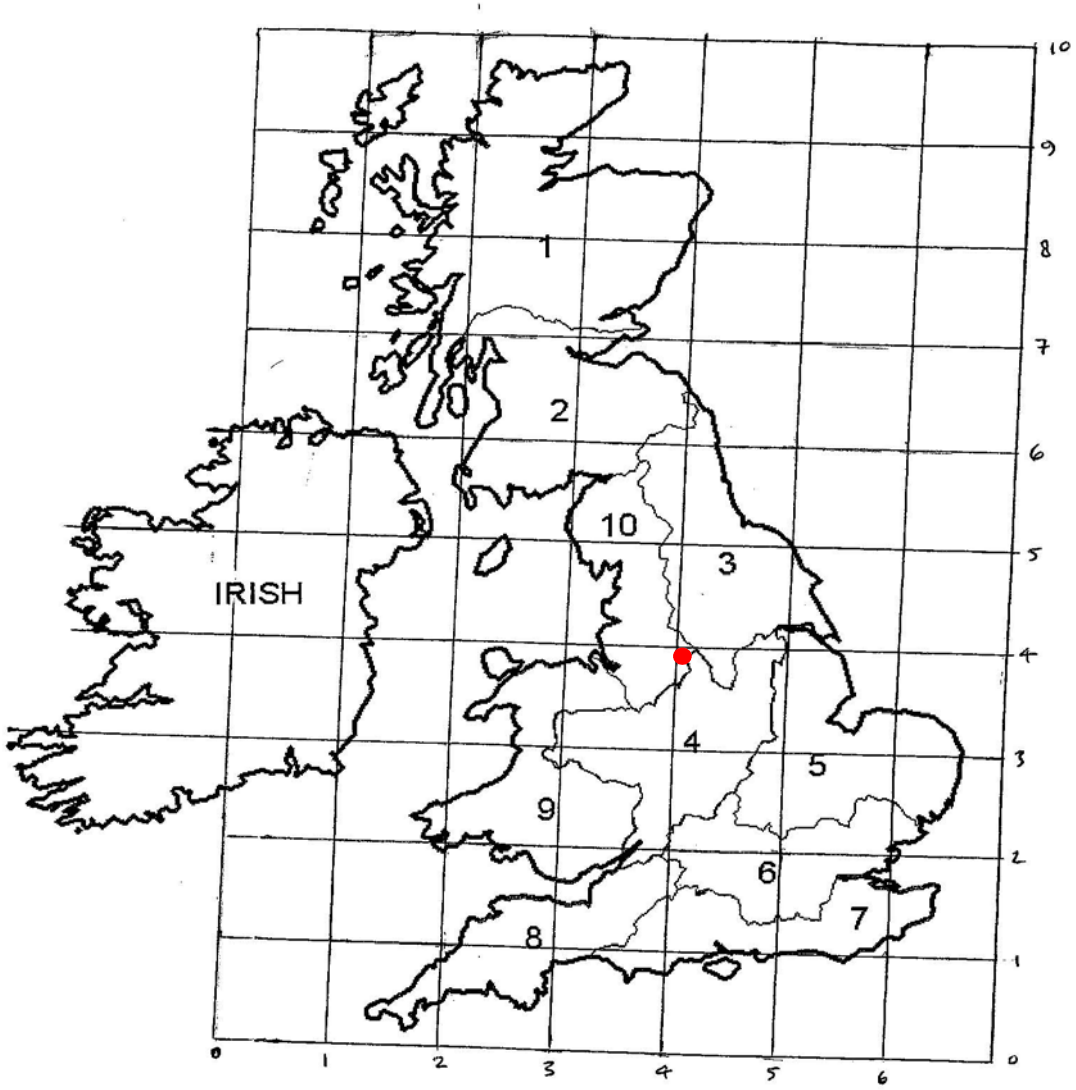


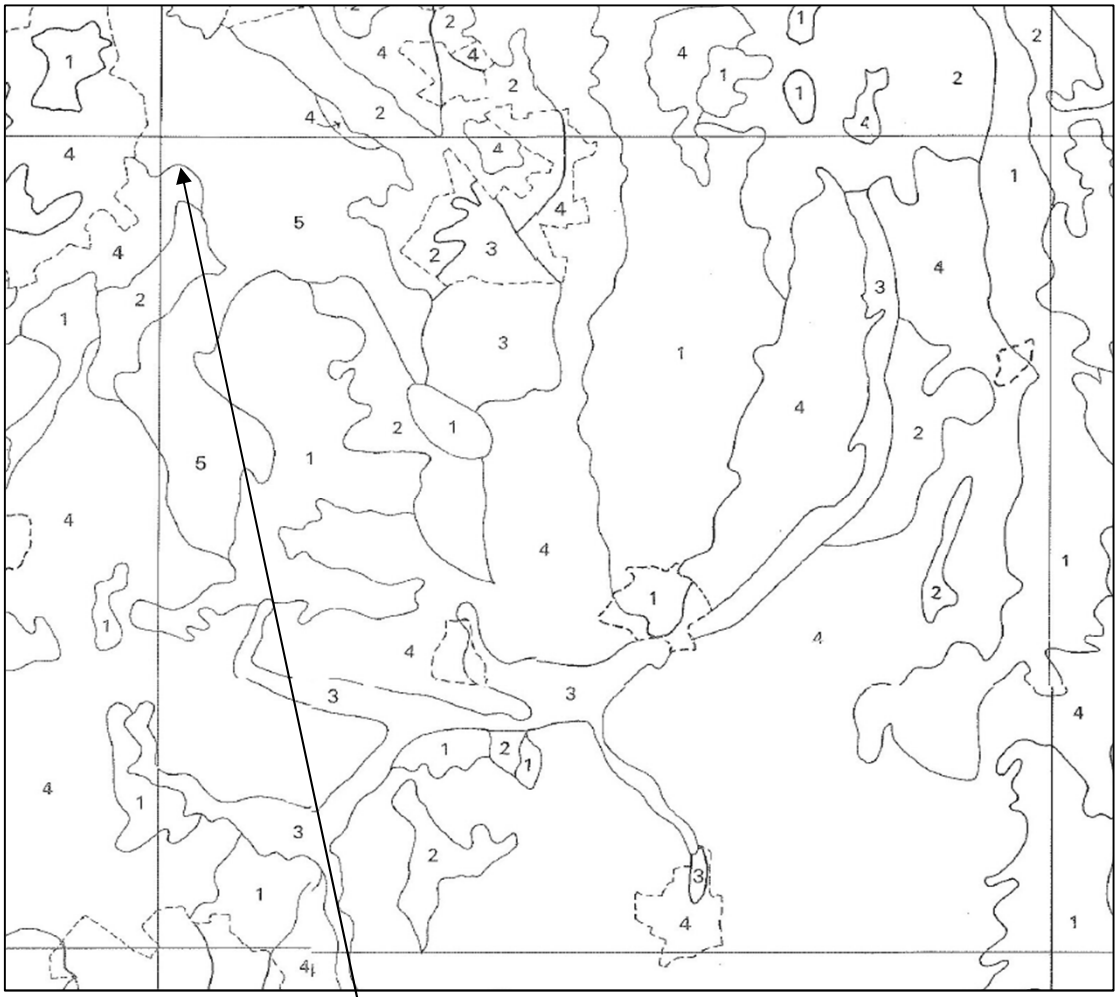
Figure 1.1 Hydrological regions of UK

Grid Ref: - 403855E 393999N - Hydrological region 10

N.B. These calculations are for planning purposes only and will need to be reviewed at the detailed design stage.

waterco consultants	Eden Court, Lon Parcwr, Ruthin, 01824 702220	Calculations	ref : **w3138**
			prefix - page no. SWR8
Scheme :	Woods Mill, Glossop		dated :
Section :	Surface Water Runoff		07/08/2014

Soil Classification Chart

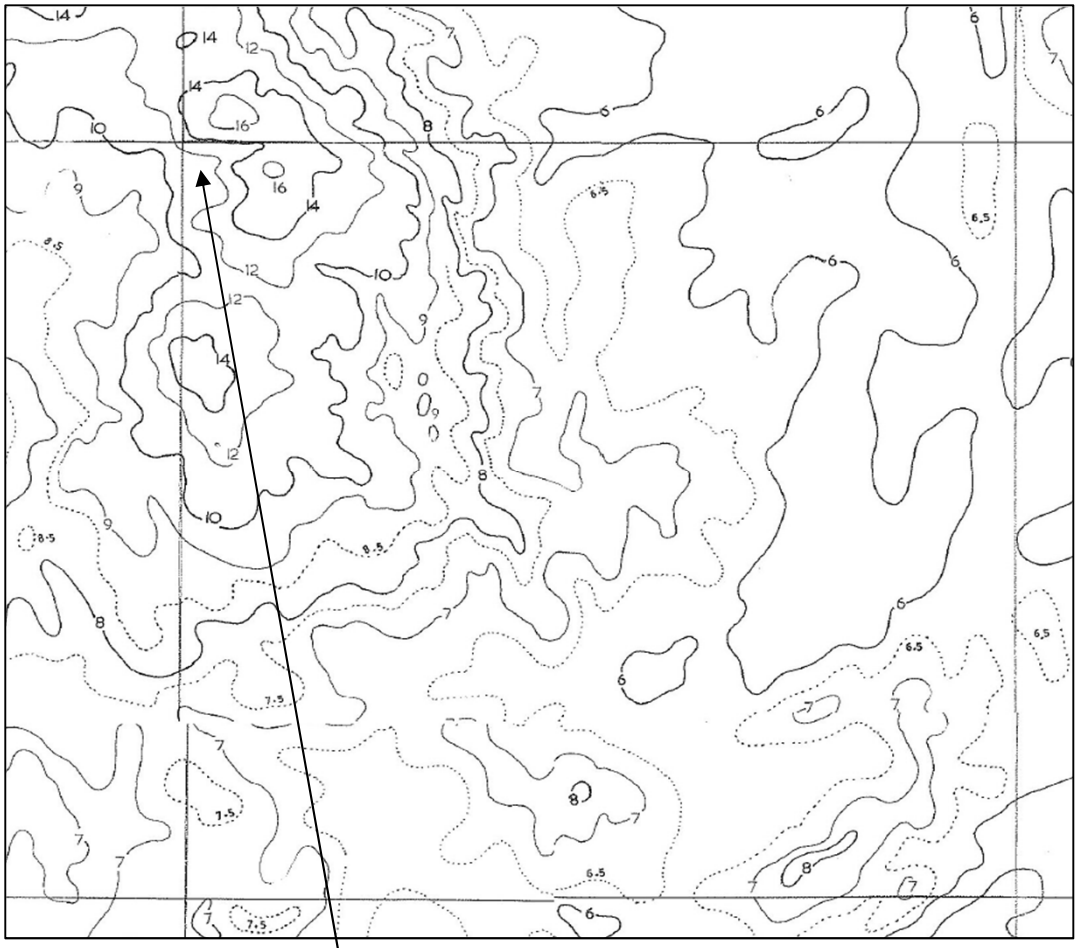


Grid Ref: - 403855E 393999N - Soil Classification = 4

N.B. These calculations are for planning purposes only and will need to be reviewed at the detailed design stage.

waterco consultants	Eden Court, Lon Parcwr, Ruthin, 01824 702220	Calculations	ref : **w3138**
			prefix - page no. SWR9
Scheme :	Woods Mill, Glossop		dated :
Section :	Surface Water Runoff		07/08/2014

Standard Annual Average Rainfall (SAAR) Chart



Grid Ref: - 403855E 393999N - SAAR = 1150mm

N.B. These calculations are for planning purposes only and will need to be reviewed at the detailed design stage.

M5-60min Rainfall + r (From Defra / EA R&D Tech Report W5-074/A Rev D)

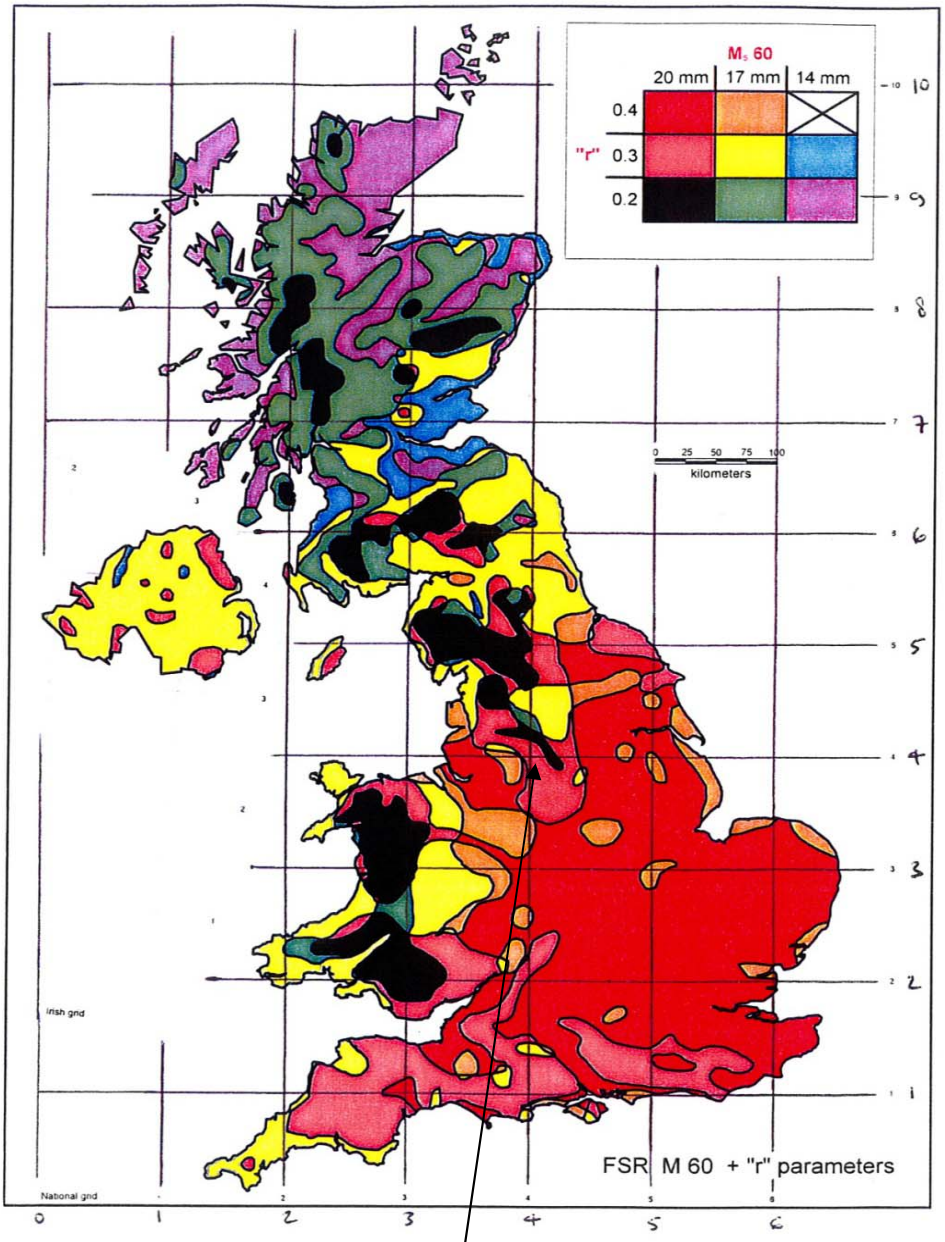


Figure 2 Hydrological rainfall zones of UK

Grid Ref: - 403855E 393999N - M5-60 = 20mm, 'r' = 0.3

N.B. These calculations are for planning purposes only and will need to be reviewed at the detailed design stage.

waterco consultants	Eden Court, Lon Parcwr, Ruthin, 01824 702220	Calculations	ref : **w3138**
			prefix - page no. SWR11
Scheme :	Woods Mill, Glossop		dated :
Section :	Surface Water Runoff		07/08/2014

M100 6hr Rainfall (From Defra / EA R&D Tech Report W5-074/A Rev D)

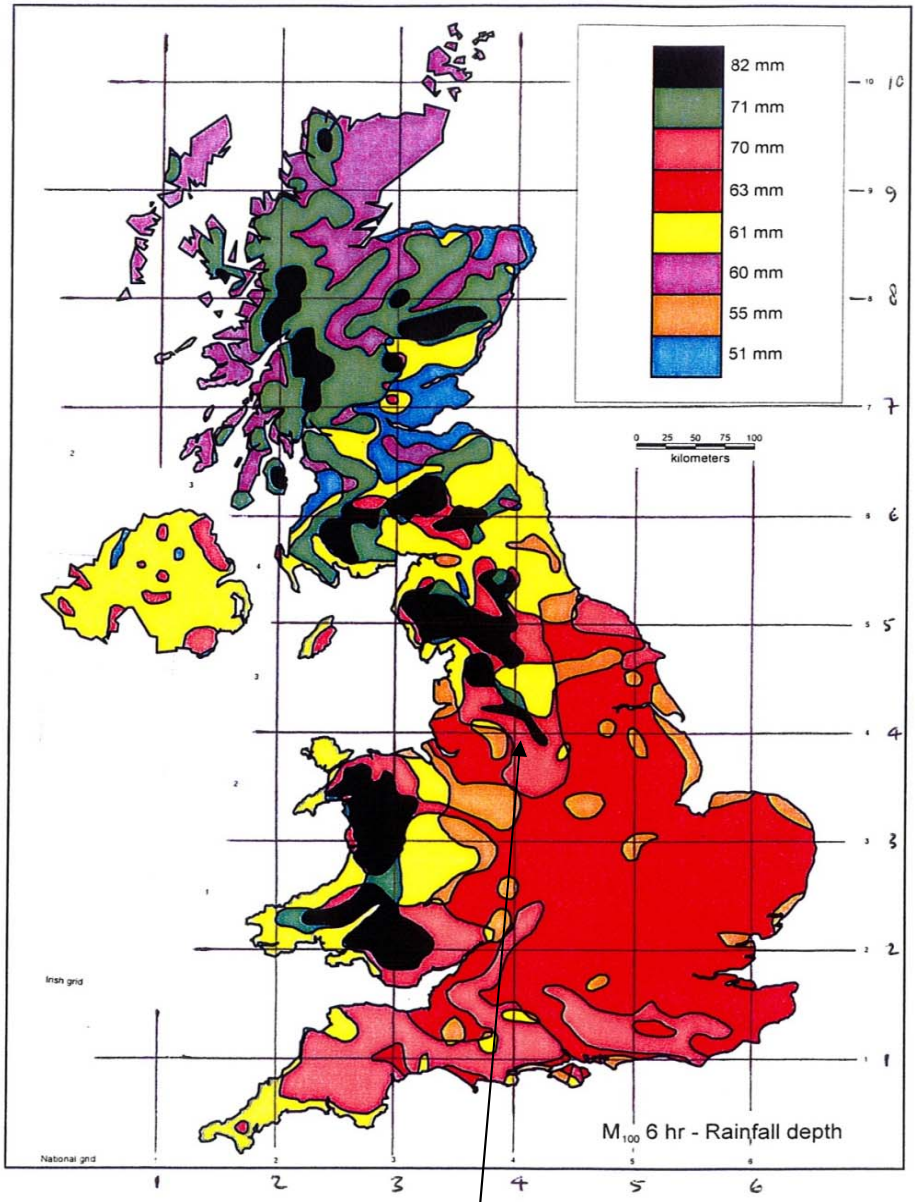


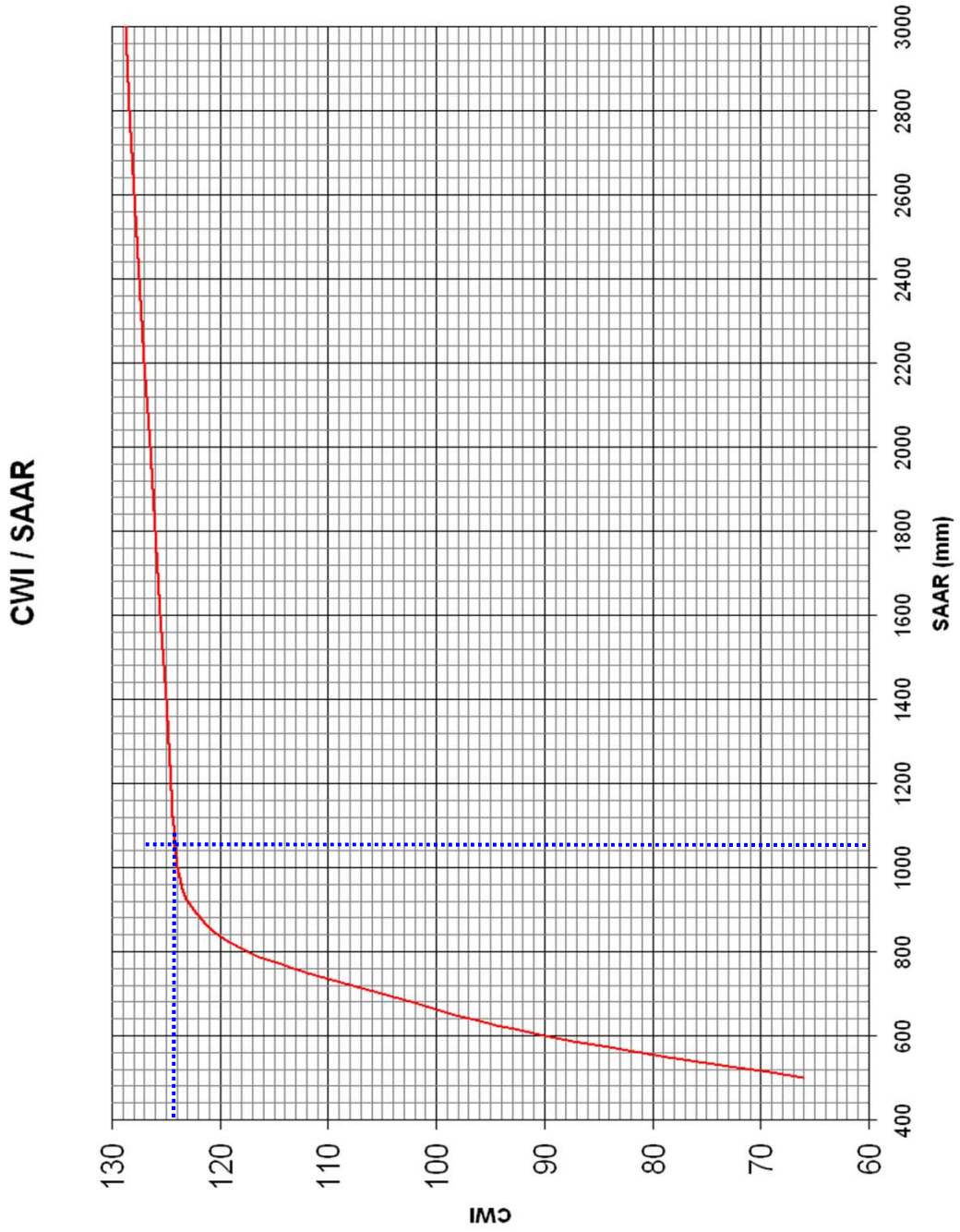
Figure 3.1 100 year 6 hour rainfall depths of UK

Grid Ref: - 403855E 393999N - M100-6hr Rainfall = 70mm

N.B. These calculations are for planning purposes only and will need to be reviewed at the detailed design stage.

waterco consultants	Eden Court, Lon Parcwr, Ruthin, 01824 702220	Calculations	ref : **w3138**
			prefix - page no. SWR12
Scheme :	Woods Mill, Glossop		dated :
Section :	Surface Water Runoff		07/08/2014

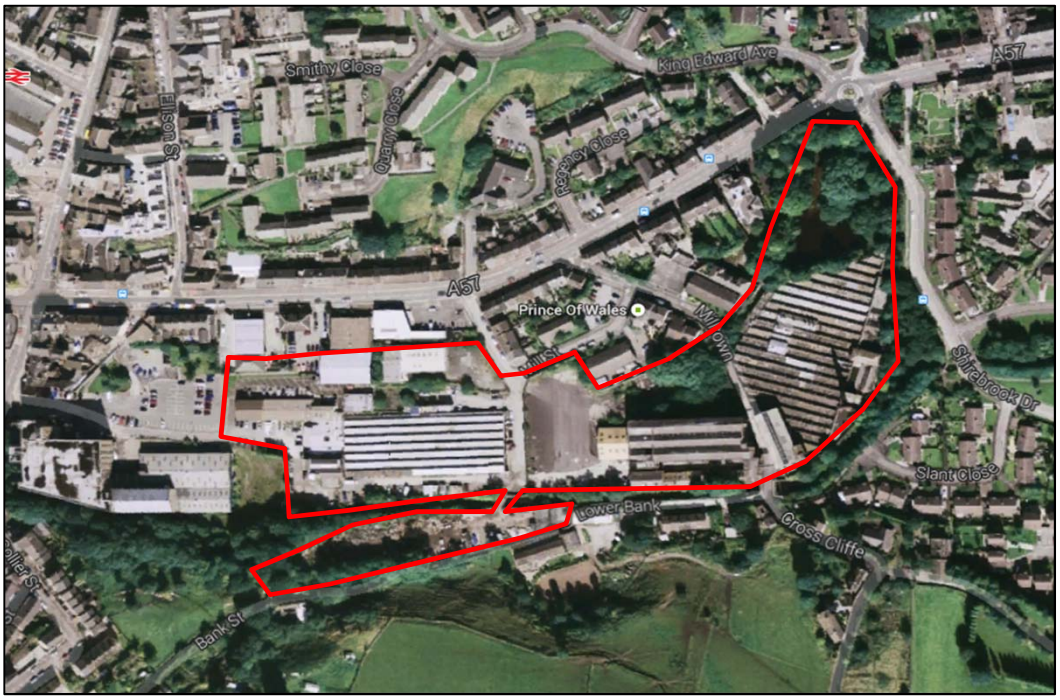
Catchment Wetness Index (CWI) vs Standard Annual Average Rainfall (SAAR)



N.B. These calculations are for planning purposes only and will need to be reviewed at the detailed design stage.

waterco consultants	Eden Court, Lon Parcwr, Ruthin, 01824 702220	Calculations	ref : **w3138**
			prefix - page no. SWR13
Scheme :	Woods Mill, Glossop		dated : 07/08/2014
Section :	Surface Water Runoff		

Pre-development Area



Total Area = 3.8ha

Permeable Area = 58% = 6,460m² (includes hard standing areas with no formal drainage systems).

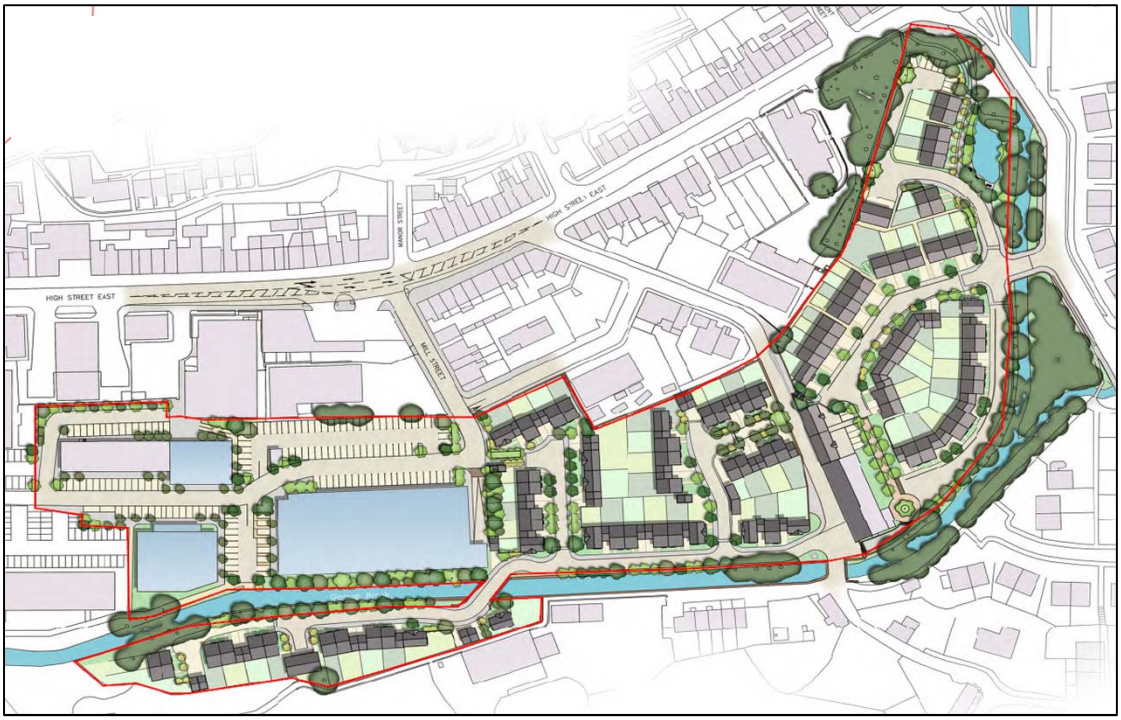
Impermeable Area (buildings only) = 42% = 16,000m²

= Site Boundary

N.B. These calculations are for planning purposes only and will need to be reviewed at the detailed design stage.

waterco consultants	Eden Court, Lon Parcwr, Ruthin, 01824 702220	Calculations	ref : **w3138**
			prefix - page no. SWR14
Scheme :	Woods Mill, Glossop		dated : 07/08/2014
Section :	Surface Water Runoff		

Post-development Area



Total Area = 38,000m²
Permeable Area = 42% = 15,960m²

Impermeable Area = 58% = 22,040m²

= Site Boundary

N.B. These calculations are for planning purposes only and will need to be reviewed at the detailed design stage.

waterco	Eden Court, Lon Parcwr, Ruthin, 01824 702220	**Calculations**	ref	w3138
Client:	Lofhouse Property Ltd		Page 1 of	1
Scheme:	Woods Mill, Glossop		Prefix	SWS
Section:	Storm Water Storage		revision	A
Prepared by:	Angharad Llewelyn		date:	19/09/2014
Checked by:	Aled Williams		date:	19/09/2014
Approved by:	Aled Williams		date:	19/09/2014

Surface Water Attenuation - Required Storage Volume

Storm return frequency-once in	**100**	**years**	
M5-60 min rainfall	**20**	**mm**	(from map)
Ratio M5-60 / M5-2day - R	**0.3**	**ratio**	(from map)
Climate change increase	**30**	**%**	
Impervious Area (A) (Ha)	**2.2040**	**Ha**	
Allowable discharge (Qa)	**140.000**	**l/s**	(subject to agreement)
Discharge Coefficient (Cd)	**0.840**		(typical 0.75 summer / 0.84 winter)
Routing Coefficient (Cr)	**1.300**		(standard value)
O/A Coefficient (C = Cd * Cr)	**1.092**		
Climate change adj factor (Fc)	**1.300**		

Storage Volume required = (Qr-Qa)*D*60 (Litres)

SW Run-off (Qr) = 2.78 C i A * Fc

Storm duration (D) (Minutes)	(Hrs)	rainfall (mm/hr)	Run-off rate (L/s)	Storage Vol (m3)	
5	0.08	139.6	1213.949	322.2	
10	0.17	107.6	936.308	477.8	
15	0.25	88.7	771.540	568.4	
30	0.5	61.4	533.959	709.1	
45	0.75	48.3	419.866	755.6	
60	1	40.6	353.141	767.3	**Critical storm
90	1.5	31.0	270.038	702.2	
120	2	25.6	222.256	592.2	
150	2.5	21.8	189.689	447.2	
180	3	19.2	167.069	292.4	
240	4	15.6	135.610	0.0	
360	6	11.7	101.518	0.0	
480	8	9.5	82.210	0.0	
600	10	8.1	70.262	0.0	
720	12	7.1	61.398	0.0	
1440	24	4.2	36.819	0.0	
2880	48	2.5	21.385	0.0	

Design Storage requirement **767.3** **m3**