



MasterDrain
SW

Muir Associates (UK) Limited

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Job No. 18-1022		
Sheet no. 1		
Date 31/07/18		
By	Checked	Reviewed

Project **Bridge Road North Wrexham**

Title **Preliminary Attenuation Calculations 1 in 30 + 30% Climate Change**

Data:-

Location = WREXHAM Grid reference = SJ3349
M5-60 (mm) = 18 r = 0.32
Soil index = 0.45 SAAR (mm/yr) = 800
Return period = 30 WRAP = 4
UCWI = 0.0 Climate change = 30%

Clayey, or loamy over clayey soils with an impermeable layer at shallow depth.

Pipeline storage = 0.0 m³ Available MH storage = 0.0 m³
Offline storage = 0.0 m³

Percentage runoff = 95.0% (manual setting)

Imperv. area = 7250 m² Pervious area = 0 m²
Total area = 7250 m² Equiv area = 6888 m² (Tot. area x % runoff).
Total runoff = 552.8 m³ Discharge rate = 3.830 l/s
Storage (m³) = 377.8 m³ (Sum of all balance quantities)
Total rainfall depth = 80.3 mm

Calculations :-

Time (hrs)	%Mean intens	Rain mm/hr	Inflow (m3)	Outflow (m3)	Balance (m3)	Cumulative (m3)
0.150	20.0	1.1	1.106	2.068	0.000	0.000
0.300	20.0	1.1	1.106	2.068	0.000	0.000
0.450	21.0	1.1	1.161	2.068	0.000	0.000
0.600	21.0	1.1	1.161	2.068	0.000	0.000
0.750	22.0	1.2	1.216	2.068	0.000	0.000
0.900	23.0	1.2	1.272	2.068	0.000	0.000
1.050	24.0	1.3	1.327	2.068	0.000	0.000
1.200	26.0	1.4	1.437	2.068	0.000	0.000
1.350	27.0	1.4	1.493	2.068	0.000	0.000
1.500	29.0	1.6	1.603	2.068	0.000	0.000
1.650	31.0	1.7	1.714	2.068	0.000	0.000
1.800	32.0	1.7	1.769	2.068	0.000	0.000
1.950	33.0	1.8	1.824	2.068	0.000	0.000
2.100	34.0	1.8	1.880	2.068	0.000	0.000
2.250	36.0	1.9	1.990	2.068	0.000	0.000
2.400	38.0	2.0	2.101	2.068	0.033	0.033
2.550	39.0	2.1	2.156	2.068	0.088	0.121
2.700	40.0	2.1	2.211	2.068	0.143	0.264
2.850	42.0	2.2	2.322	2.068	0.254	0.517
3.000	45.0	2.4	2.488	2.068	0.420	0.937
3.150	49.0	2.6	2.709	2.068	0.641	1.578
3.300	53.0	2.8	2.930	2.068	0.862	2.440
3.450	57.0	3.1	3.151	2.068	1.083	3.523
3.600	62.0	3.3	3.428	2.068	1.359	4.882
3.750	66.0	3.5	3.649	2.068	1.581	6.463
3.900	71.0	3.8	3.925	2.068	1.857	8.320
4.050	77.0	4.1	4.257	2.068	2.189	10.509
4.200	84.0	4.5	4.644	2.068	2.576	13.084
4.350	91.0	4.9	5.031	2.068	2.963	16.047
4.500	98.0	5.2	5.418	2.068	3.350	19.397
4.650	105.0	5.6	5.805	2.068	3.737	23.133
4.800	114.0	6.1	6.302	2.068	4.234	27.368
4.950	125.0	6.7	6.911	2.068	4.842	32.210
5.100	135.0	7.2	7.463	2.068	5.395	37.605
5.250	143.0	7.7	7.906	2.068	5.838	43.443
5.400	154.0	8.2	8.514	2.068	6.446	49.888
5.550	164.0	8.8	9.067	2.068	6.998	56.887
5.700	173.0	9.3	9.564	2.068	7.496	64.383
5.850	183.0	9.8	10.117	2.068	8.049	72.432
6.000	194.0	10.4	10.725	2.068	8.657	81.089



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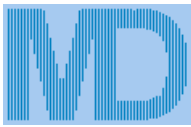
Project **Bridge Road North Wrexham**

Title **Preliminary Attenuation Calculations 1 in 30 + 30% Climate Change**

Calculations (cont.) :-

Time (hrs)	%Mean intens	Rain mm/hr	Inflow (m3)	Outflow (m3)	Balance (m3)	Cumulative (m3)
6.150	204.0	10.9	11.278	2.068	9.210	90.299
6.300	212.0	11.3	11.720	2.068	9.652	99.951
6.450	219.0	11.7	12.107	2.068	10.039	109.990
6.600	226.0	12.1	12.494	2.068	10.426	120.416
6.750	233.0	12.5	12.881	2.068	10.813	131.229
6.900	239.0	12.8	13.213	2.068	11.145	142.374
7.050	244.0	13.1	13.489	2.068	11.421	153.795
7.200	248.0	13.3	13.711	2.068	11.642	165.438
7.350	249.0	13.3	13.766	2.068	11.698	177.136
7.500	250.0	13.4	13.821	2.068	11.753	188.889
7.650	250.0	13.4	13.821	2.068	11.753	200.642
7.800	249.0	13.3	13.766	2.068	11.698	212.339
7.950	248.0	13.3	13.711	2.068	11.642	223.982
8.100	244.0	13.1	13.489	2.068	11.421	235.403
8.250	239.0	12.8	13.213	2.068	11.145	246.548
8.400	233.0	12.5	12.881	2.068	10.813	257.361
8.550	226.0	12.1	12.494	2.068	10.426	267.787
8.700	219.0	11.7	12.107	2.068	10.039	277.826
8.850	212.0	11.3	11.720	2.068	9.652	287.478
9.000	204.0	10.9	11.278	2.068	9.210	296.688
9.150	194.0	10.4	10.725	2.068	8.657	305.345
9.300	183.0	9.8	10.117	2.068	8.049	313.394
9.450	173.0	9.3	9.564	2.068	7.496	320.890
9.600	164.0	8.8	9.067	2.068	6.998	327.889
9.750	154.0	8.2	8.514	2.068	6.446	334.334
9.900	143.0	7.7	7.906	2.068	5.838	340.172
10.050	135.0	7.2	7.463	2.068	5.395	345.567
10.200	125.0	6.7	6.911	2.068	4.842	350.409
10.350	114.0	6.1	6.302	2.068	4.234	354.644
10.500	105.0	5.6	5.805	2.068	3.737	358.380
10.650	98.0	5.2	5.418	2.068	3.350	361.730
10.800	91.0	4.9	5.031	2.068	2.963	364.693
10.950	84.0	4.5	4.644	2.068	2.576	367.269
11.100	77.0	4.1	4.257	2.068	2.189	369.457
11.250	71.0	3.8	3.925	2.068	1.857	371.314
11.400	66.0	3.5	3.649	2.068	1.581	372.895
11.550	62.0	3.3	3.428	2.068	1.359	374.254
11.700	57.0	3.1	3.151	2.068	1.083	375.337
11.850	53.0	2.8	2.930	2.068	0.862	376.199
12.000	49.0	2.6	2.709	2.068	0.641	376.840
12.150	45.0	2.4	2.488	2.068	0.420	377.260
12.300	42.0	2.2	2.322	2.068	0.254	377.513
12.450	40.0	2.1	2.211	2.068	0.143	377.657
12.600	39.0	2.1	2.156	2.068	0.088	377.744
12.750	38.0	2.0	2.101	2.068	0.033	377.777
12.900	36.0	1.9	1.990	2.068	0.000	377.699
13.050	34.0	1.8	1.880	2.068	0.000	377.511
13.200	33.0	1.8	1.824	2.068	0.000	377.267
13.350	32.0	1.7	1.769	2.068	0.000	376.968
13.500	31.0	1.7	1.714	2.068	0.000	376.613
13.650	29.0	1.6	1.603	2.068	0.000	376.148
13.800	27.0	1.4	1.493	2.068	0.000	375.573
13.950	26.0	1.4	1.437	2.068	0.000	374.942
14.100	24.0	1.3	1.327	2.068	0.000	374.201
14.250	23.0	1.2	1.272	2.068	0.000	373.404
14.400	22.0	1.2	1.216	2.068	0.000	372.552
14.550	21.0	1.1	1.161	2.068	0.000	371.645
14.700	21.0	1.1	1.161	2.068	0.000	370.738
14.850	20.0	1.1	1.106	2.068	0.000	369.775
15.000	20.0	1.1	1.106	2.068	0.000	368.813

Storage volume (m³) = 377.8 m³ (Sum of all balance quantities)



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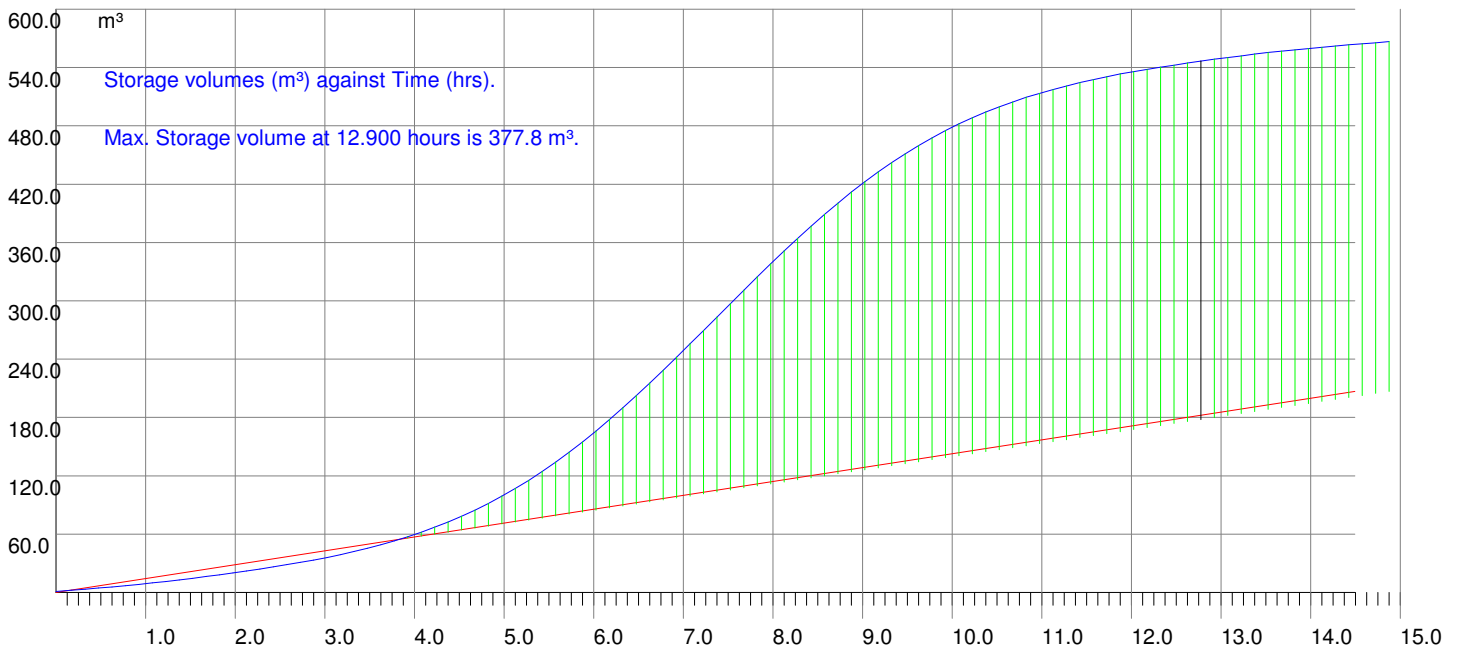
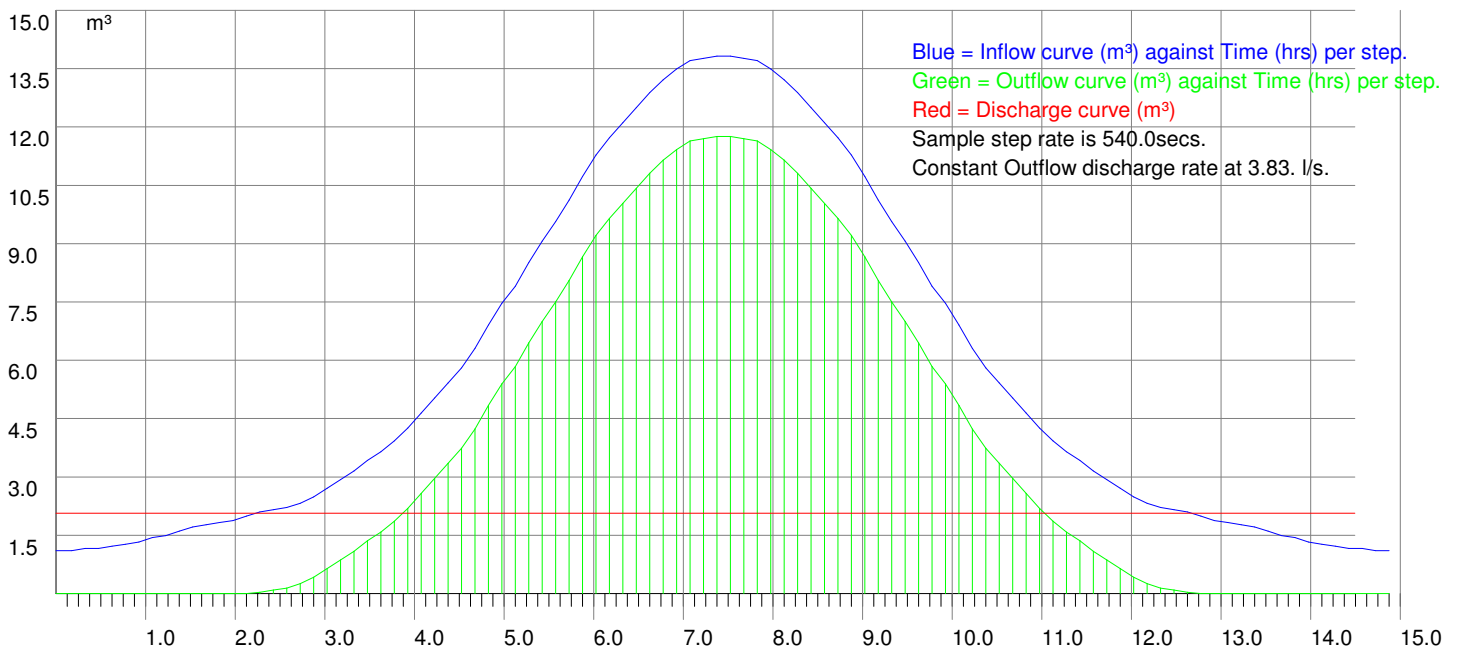
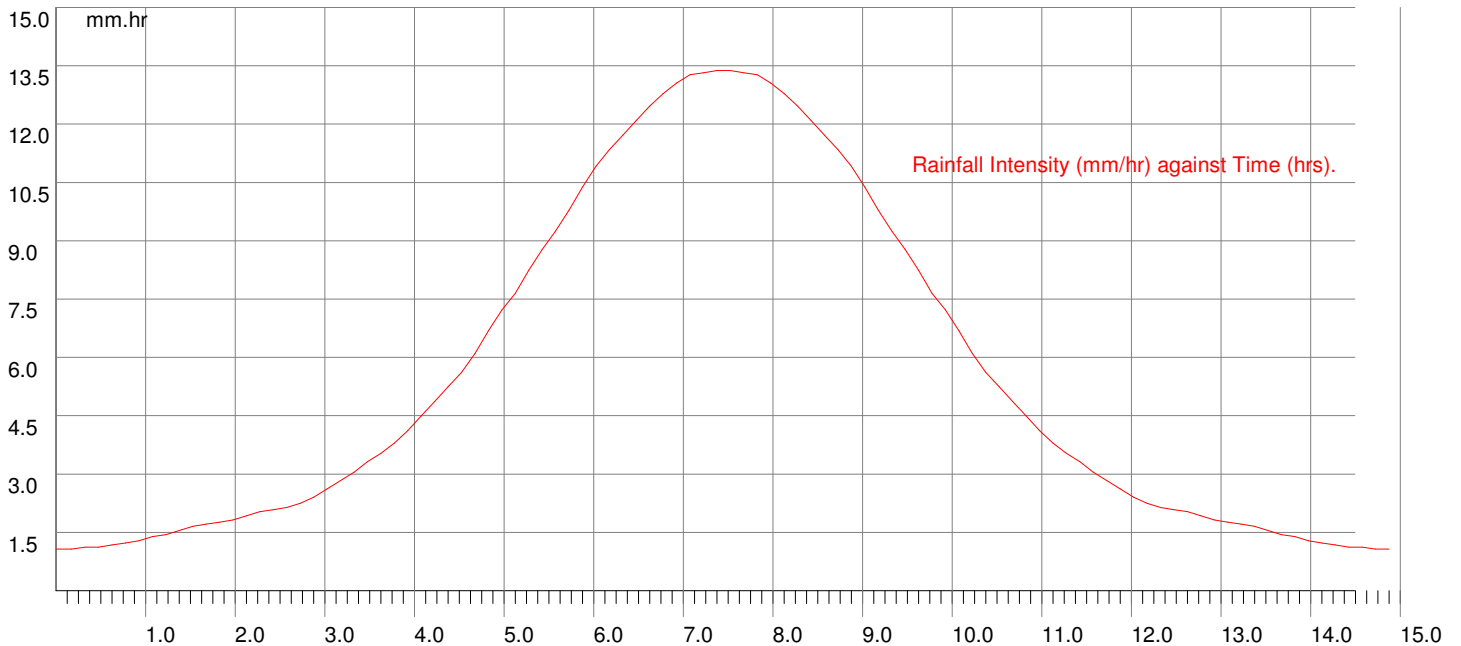
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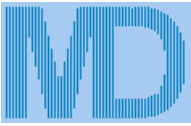
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Maximum storage volumes for varying duration storms.

Storm length (hrs)	Max. Vol (m ³)	Max. Vol time	Mean intens (mm/hr)	Step time. (mins)	Peak found
0.25	141.24	0.25	81.98	0.2	
0.5	188.67	0.50	55.40	0.3	
1	240.00	1.00	35.95	0.6	
2	292.52	2.00	22.67	1.2	
3	321.16	3.00	17.12	1.8	
4	338.79	4.00	13.95	2.4	
5	350.07	5.00	11.87	3.0	
6	358.27	6.00	10.41	3.6	
7	364.17	7.00	9.32	4.2	
8	368.74	8.00	8.46	4.8	
9	372.10	9.00	7.76	5.4	
10	374.51	10.00	7.19	6.0	
12	377.04	12.00	6.30	7.2	
15	377.78	15.00	5.35	9.0	Peak found
18	376.33	----	4.68	10.8	
20	374.44	----	4.33	12.0	
24	368.50	----	3.79	14.4	
30	356.28	----	3.21	18.0	
36	341.81	----	2.81	21.6	
42	326.13	----	2.51	25.2	
48	309.42	----	2.27	28.8	
54	292.23	----	2.08	32.4	
60	274.95	----	1.92	36.0	
66	257.82	----	1.79	39.6	
72	240.72	----	1.68	43.2	
84	206.40	----	1.49	50.4	
96	173.81	----	1.35	57.6	
120	114.11	----	1.14	72.0	
150	52.45	----	0.97	90.0	
175	15.31	----	0.86	105.0	
200	0.00	----	0.78	120.0	
250	0.00	----	0.66	150.0	
300	0.00	----	0.58	180.0	
375	0.00	----	0.49	225.0	
500	0.00	----	0.40	300.0	
750	0.00	----	0.30	450.0	
1000	0.00	----	0.24	600.0	
1250	0.00	----	0.21	750.0	
1500	0.00	----	0.18	900.0	
1570	0.00	----	0.17	942.0	
2000	0.00	----	0.15	1200.0	
2500	0.00	----	0.12	1500.0	
3000	0.00	----	0.11	1800.0	
3500	0.00	----	0.10	2100.0	
4000	0.00	----	0.09	2400.0	



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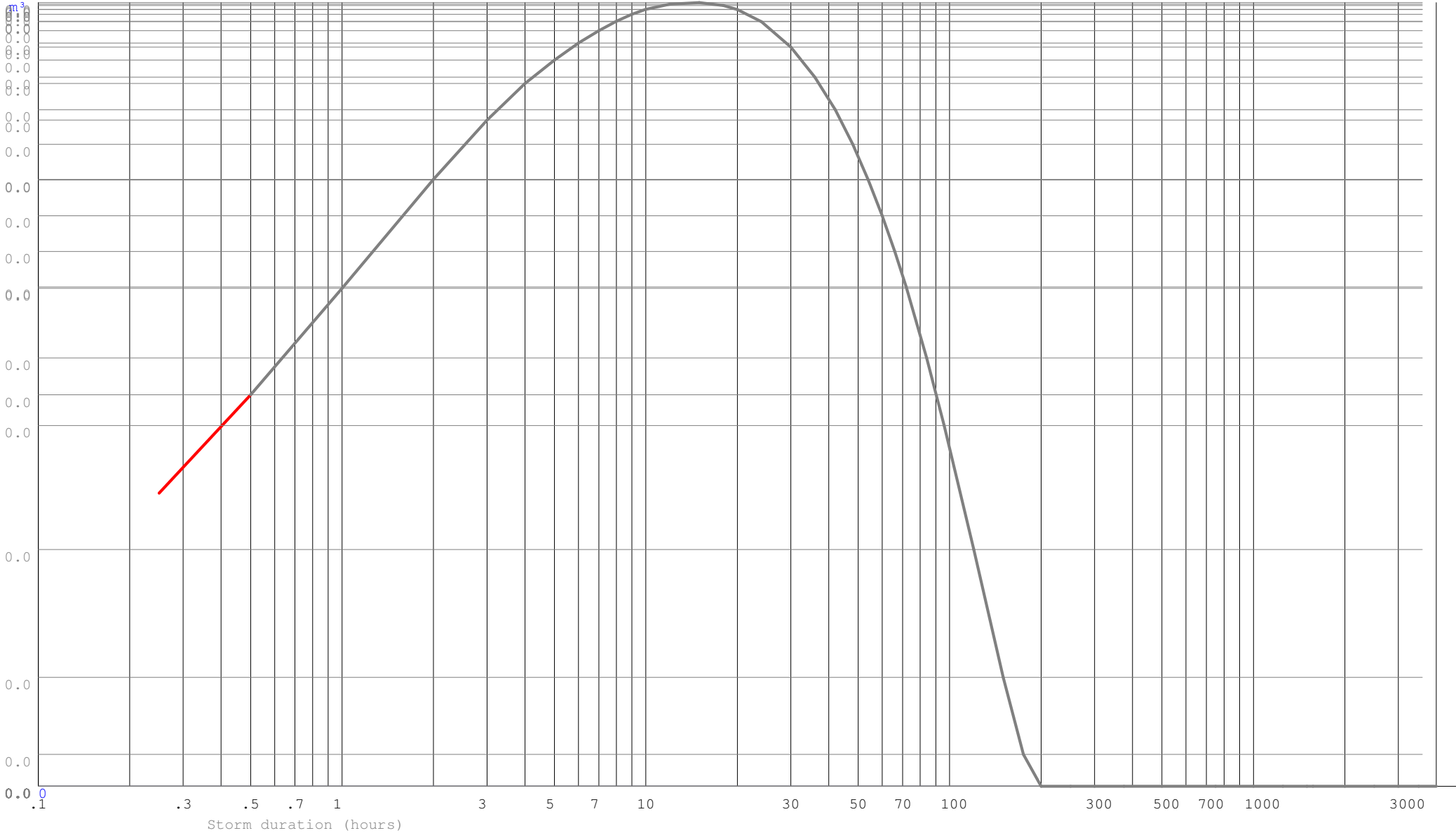
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Title **Preliminary Attenuation Calculations 1 in 30 + 30% Climate Change**

Sequential storage volume at specific storm durations.





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Explanatory notes for Peak Flow Storage

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

Explanatory notes for Hydrograph Storage

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

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

Why do the two methods give different results?

The rainfall characteristics for each method are very different.

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

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

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