



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 100 + 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 = 100 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 = 704.9 m³ Discharge rate = 3.830 l/s
Storage (m³) = 524.2 m³ (Sum of all balance quantities)
Total rainfall depth = 102.3 mm

Calculations :-

Time (hrs)	%Mean intens	Rain mm/hr	Inflow (m3)	Outflow (m3)	Balance (m3)	Cumulative (m3)
0.150	20.0	1.4	1.410	2.068	0.000	0.000
0.300	20.0	1.4	1.410	2.068	0.000	0.000
0.450	21.0	1.4	1.480	2.068	0.000	0.000
0.600	21.0	1.4	1.480	2.068	0.000	0.000
0.750	22.0	1.5	1.551	2.068	0.000	0.000
0.900	23.0	1.6	1.621	2.068	0.000	0.000
1.050	24.0	1.6	1.692	2.068	0.000	0.000
1.200	26.0	1.8	1.833	2.068	0.000	0.000
1.350	27.0	1.8	1.903	2.068	0.000	0.000
1.500	29.0	2.0	2.044	2.068	0.000	0.000
1.650	31.0	2.1	2.185	2.068	0.117	0.117
1.800	32.0	2.2	2.256	2.068	0.187	0.304
1.950	33.0	2.3	2.326	2.068	0.258	0.562
2.100	34.0	2.3	2.397	2.068	0.328	0.891
2.250	36.0	2.5	2.538	2.068	0.469	1.360
2.400	38.0	2.6	2.679	2.068	0.610	1.970
2.550	39.0	2.7	2.749	2.068	0.681	2.651
2.700	40.0	2.7	2.819	2.068	0.751	3.402
2.850	42.0	2.9	2.960	2.068	0.892	4.295
3.000	45.0	3.1	3.172	2.068	1.104	5.398
3.150	49.0	3.3	3.454	2.068	1.386	6.784
3.300	53.0	3.6	3.736	2.068	1.668	8.452
3.450	57.0	3.9	4.018	2.068	1.950	10.401
3.600	62.0	4.2	4.370	2.068	2.302	12.703
3.750	66.0	4.5	4.652	2.068	2.584	15.287
3.900	71.0	4.8	5.005	2.068	2.936	18.223
4.050	77.0	5.3	5.428	2.068	3.359	21.583
4.200	84.0	5.7	5.921	2.068	3.853	25.435
4.350	91.0	6.2	6.414	2.068	4.346	29.782
4.500	98.0	6.7	6.908	2.068	4.840	34.621
4.650	105.0	7.2	7.401	2.068	5.333	39.954
4.800	114.0	7.8	8.036	2.068	5.967	45.921
4.950	125.0	8.5	8.811	2.068	6.743	52.664
5.100	135.0	9.2	9.516	2.068	7.448	60.112
5.250	143.0	9.8	10.080	2.068	8.011	68.123
5.400	154.0	10.5	10.855	2.068	8.787	76.910
5.550	164.0	11.2	11.560	2.068	9.492	86.402
5.700	173.0	11.8	12.194	2.068	10.126	96.528
5.850	183.0	12.5	12.899	2.068	10.831	107.359
6.000	194.0	13.2	13.674	2.068	11.606	118.965



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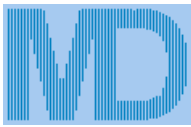
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Title **Preliminary Attenuation Calculations 1 in 100 + 30% Climate Change**

Calculations (cont.) :-

Time (hrs)	%Mean intens	Rain mm/hr	Inflow (m3)	Outflow (m3)	Balance (m3)	Cumulative (m3)
6.150	204.0	13.9	14.379	2.068	12.311	131.276
6.300	212.0	14.5	14.943	2.068	12.875	144.151
6.450	219.0	14.9	15.437	2.068	13.368	157.520
6.600	226.0	15.4	15.930	2.068	13.862	171.381
6.750	233.0	15.9	16.423	2.068	14.355	185.737
6.900	239.0	16.3	16.846	2.068	14.778	200.515
7.050	244.0	16.6	17.199	2.068	15.131	215.646
7.200	248.0	16.9	17.481	2.068	15.413	231.058
7.350	249.0	17.0	17.551	2.068	15.483	246.541
7.500	250.0	17.1	17.622	2.068	15.554	262.095
7.650	250.0	17.1	17.622	2.068	15.554	277.648
7.800	249.0	17.0	17.551	2.068	15.483	293.132
7.950	248.0	16.9	17.481	2.068	15.413	308.544
8.100	244.0	16.6	17.199	2.068	15.131	323.675
8.250	239.0	16.3	16.846	2.068	14.778	338.453
8.400	233.0	15.9	16.423	2.068	14.355	352.808
8.550	226.0	15.4	15.930	2.068	13.862	366.670
8.700	219.0	14.9	15.437	2.068	13.368	380.039
8.850	212.0	14.5	14.943	2.068	12.875	392.914
9.000	204.0	13.9	14.379	2.068	12.311	405.225
9.150	194.0	13.2	13.674	2.068	11.606	416.831
9.300	183.0	12.5	12.899	2.068	10.831	427.662
9.450	173.0	11.8	12.194	2.068	10.126	437.788
9.600	164.0	11.2	11.560	2.068	9.492	447.280
9.750	154.0	10.5	10.855	2.068	8.787	456.067
9.900	143.0	9.8	10.080	2.068	8.011	464.078
10.050	135.0	9.2	9.516	2.068	7.448	471.526
10.200	125.0	8.5	8.811	2.068	6.743	478.268
10.350	114.0	7.8	8.036	2.068	5.967	484.236
10.500	105.0	7.2	7.401	2.068	5.333	489.569
10.650	98.0	6.7	6.908	2.068	4.840	494.408
10.800	91.0	6.2	6.414	2.068	4.346	498.754
10.950	84.0	5.7	5.921	2.068	3.853	502.607
11.100	77.0	5.3	5.428	2.068	3.359	505.966
11.250	71.0	4.8	5.005	2.068	2.936	508.903
11.400	66.0	4.5	4.652	2.068	2.584	511.487
11.550	62.0	4.2	4.370	2.068	2.302	513.789
11.700	57.0	3.9	4.018	2.068	1.950	515.738
11.850	53.0	3.6	3.736	2.068	1.668	517.406
12.000	49.0	3.3	3.454	2.068	1.386	518.792
12.150	45.0	3.1	3.172	2.068	1.104	519.895
12.300	42.0	2.9	2.960	2.068	0.892	520.788
12.450	40.0	2.7	2.819	2.068	0.751	521.539
12.600	39.0	2.7	2.749	2.068	0.681	522.220
12.750	38.0	2.6	2.679	2.068	0.610	522.830
12.900	36.0	2.5	2.538	2.068	0.469	523.299
13.050	34.0	2.3	2.397	2.068	0.328	523.628
13.200	33.0	2.3	2.326	2.068	0.258	523.885
13.350	32.0	2.2	2.256	2.068	0.187	524.073
13.500	31.0	2.1	2.185	2.068	0.117	524.190
13.650	29.0	2.0	2.044	2.068	0.000	524.166
13.800	27.0	1.8	1.903	2.068	0.000	524.001
13.950	26.0	1.8	1.833	2.068	0.000	523.765
14.100	24.0	1.6	1.692	2.068	0.000	523.389
14.250	23.0	1.6	1.621	2.068	0.000	522.942
14.400	22.0	1.5	1.551	2.068	0.000	522.424
14.550	21.0	1.4	1.480	2.068	0.000	521.836
14.700	21.0	1.4	1.480	2.068	0.000	521.248
14.850	20.0	1.4	1.410	2.068	0.000	520.590
15.000	20.0	1.4	1.410	2.068	0.000	519.931

Storage volume (m³) = 524.2 m³ (Sum of all balance quantities)



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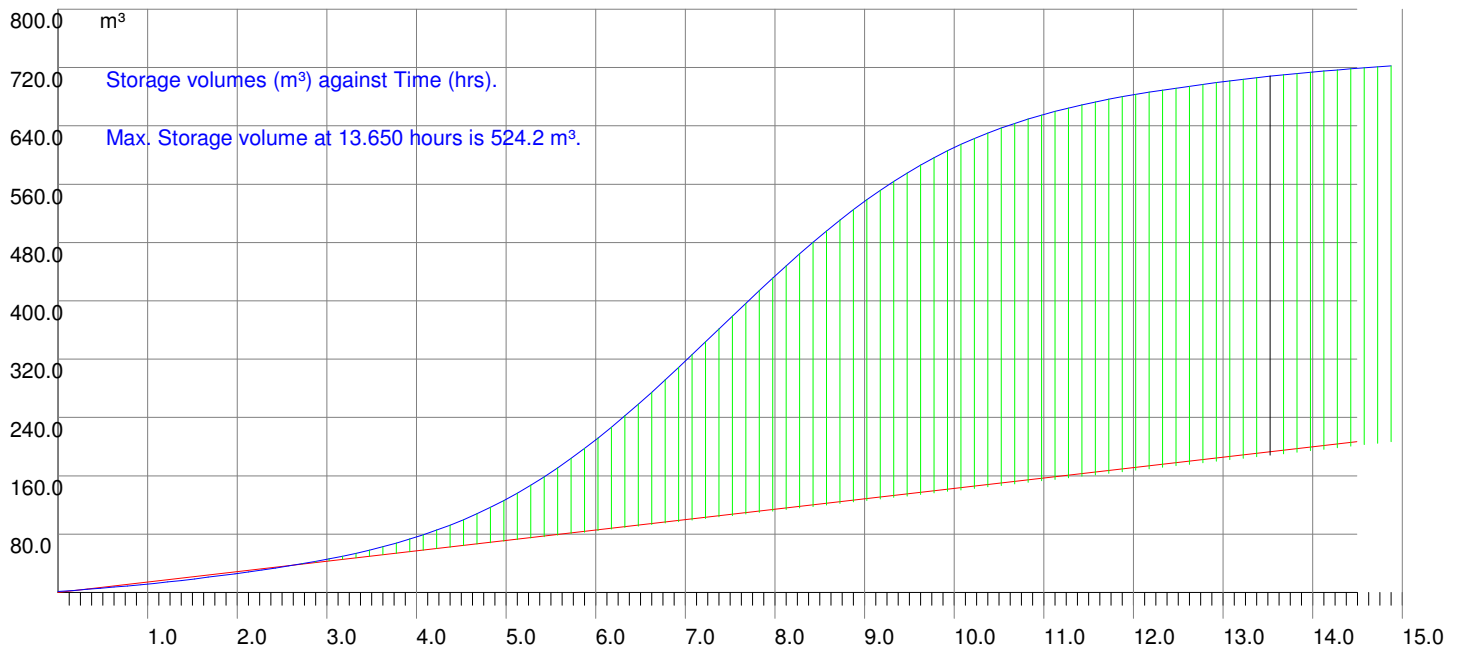
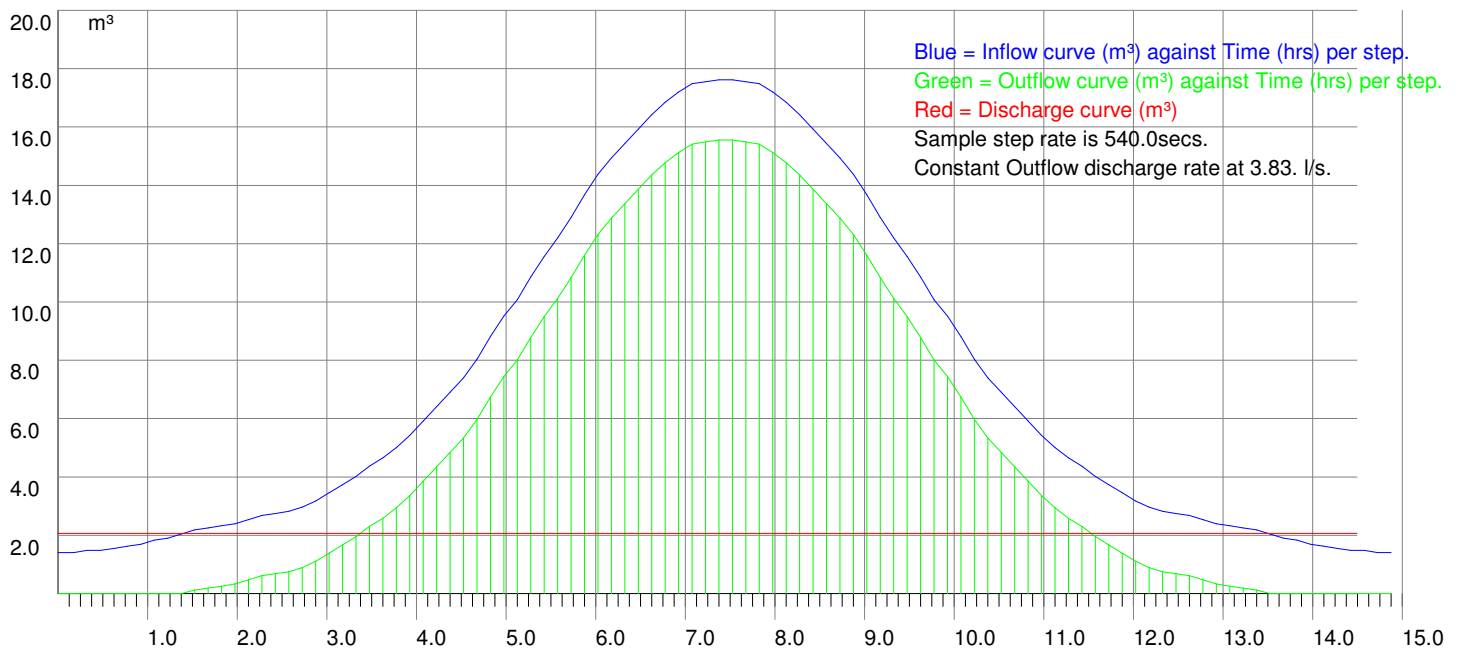
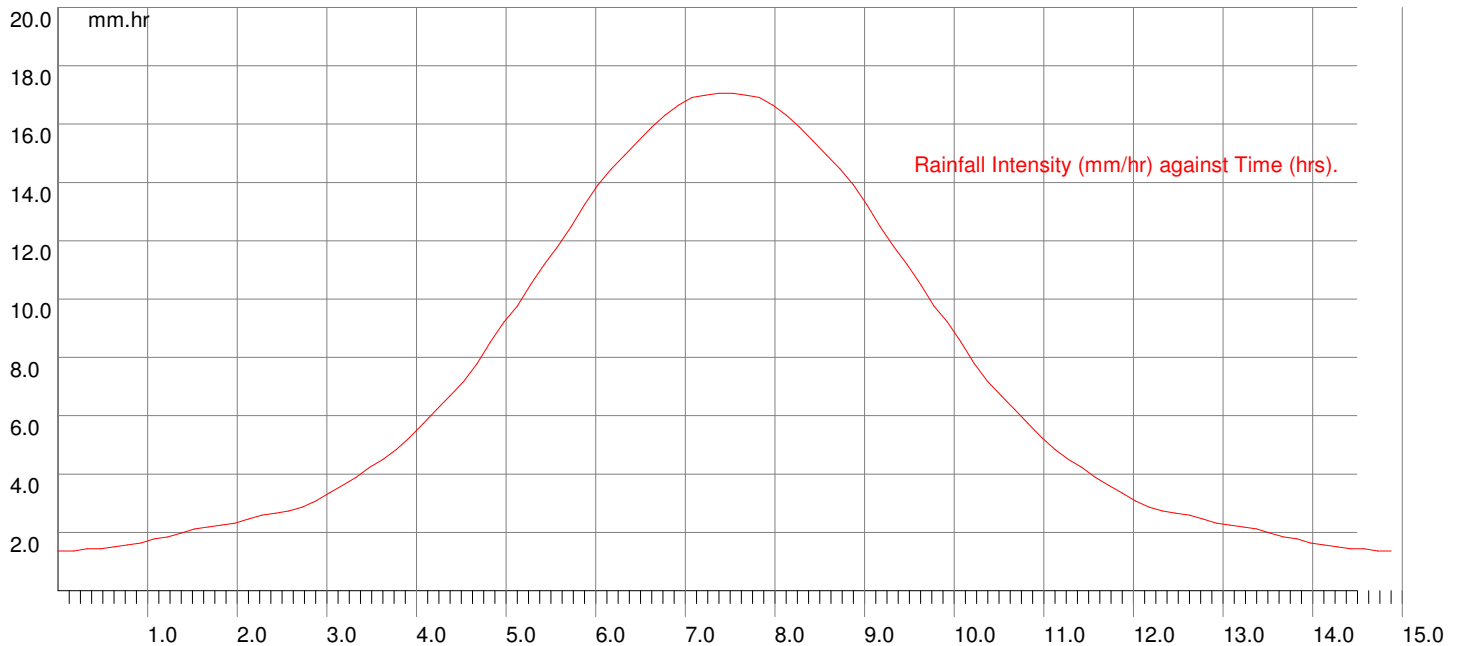
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Maximum storage volumes for varying duration storms.

Storm length (hrs)	Max. Vol (m ³)	Max. Vol time	Mean intens (mm/hr)	Step time. (mins)	Peak found
0.25	183.09	0.25	105.69	0.2	
0.5	247.91	0.50	72.19	0.3	
1	319.31	1.00	47.18	0.6	
2	393.41	2.00	29.82	1.2	
3	434.26	3.00	22.46	1.8	
4	459.59	4.00	18.23	2.4	
5	476.09	5.00	15.44	3.0	
6	489.21	6.00	13.50	3.6	
7	498.93	7.00	12.05	4.2	
8	506.09	8.00	10.91	4.8	
9	511.23	9.00	10.00	5.4	
10	515.32	10.00	9.24	6.0	
12	520.95	12.00	8.07	7.2	
15	524.19	15.00	6.82	9.0	Peak found
18	523.51	----	5.95	10.8	
20	521.97	----	5.49	12.0	
24	516.96	----	4.78	14.4	
30	506.04	----	4.04	18.0	
36	491.52	----	3.51	21.6	
42	475.04	----	3.12	25.2	
48	457.31	----	2.81	28.8	
54	438.97	----	2.57	32.4	
60	419.96	----	2.37	36.0	
66	400.62	----	2.20	39.6	
72	381.31	----	2.06	43.2	
84	343.16	----	1.83	50.4	
96	305.38	----	1.64	57.6	
120	233.64	----	1.38	72.0	
150	153.77	----	1.16	90.0	
175	96.67	----	1.03	105.0	
200	49.02	----	0.93	120.0	
250	0.00	----	0.79	150.0	
300	0.00	----	0.68	180.0	
375	0.00	----	0.58	225.0	
500	0.00	----	0.46	300.0	
750	0.00	----	0.34	450.0	
1000	0.00	----	0.28	600.0	
1250	0.00	----	0.24	750.0	
1500	0.00	----	0.21	900.0	
1570	0.00	----	0.20	942.0	
2000	0.00	----	0.17	1200.0	
2500	0.00	----	0.14	1500.0	
3000	0.00	----	0.12	1800.0	
3500	0.00	----	0.11	2100.0	
4000	0.00	----	0.10	2400.0	



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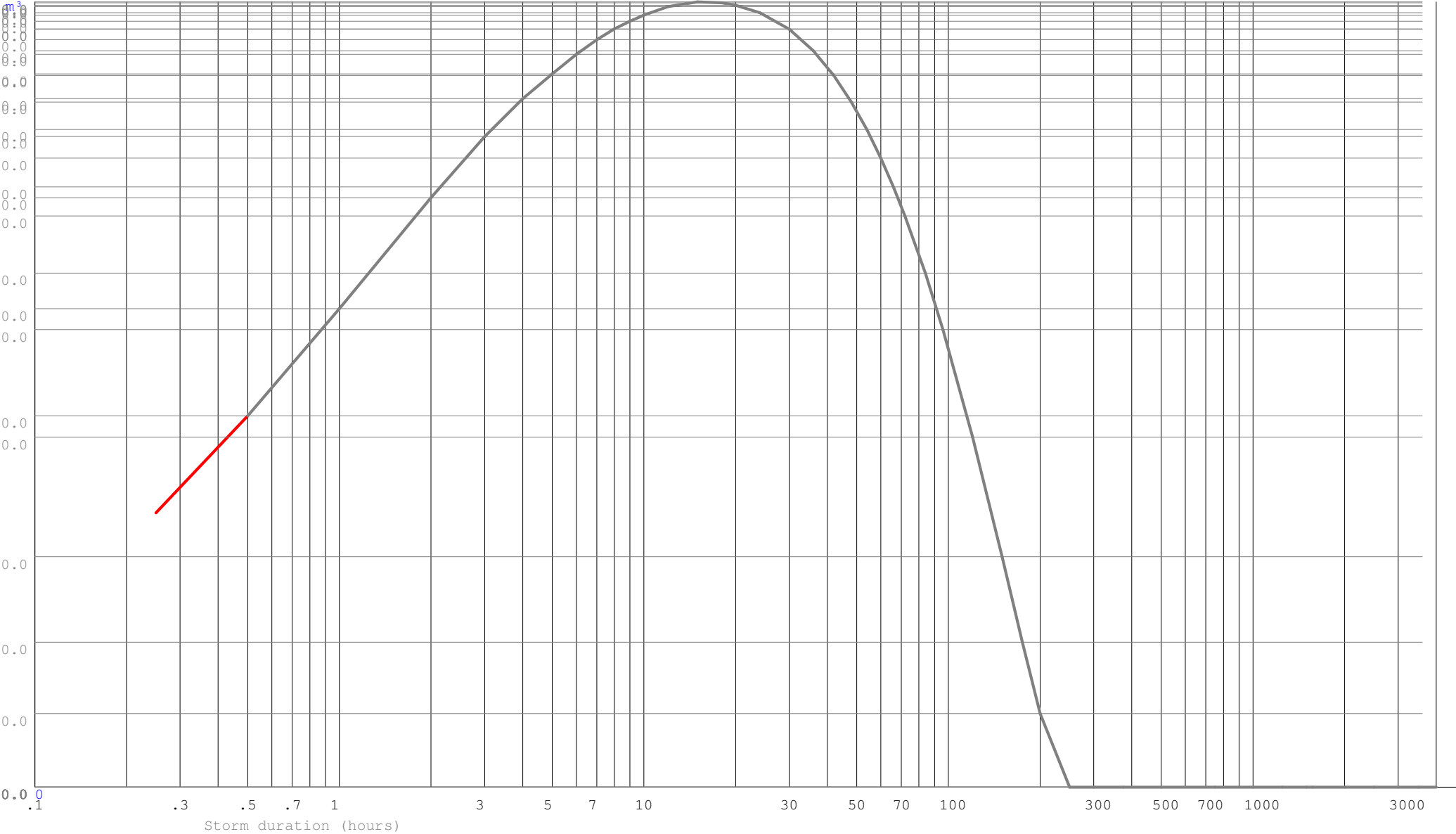
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Sequential storage volume at specific storm durations.





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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.