



Company Remote Engineering Design Services				Project Big Green Farm - Penley	
Item Attenuation storage volume for house Type 2B				Job Ref RED-EDL-001	Sheet no. 1
MasterDrain	Calc. by JGW	Date 10/11/20	Checked by KB	Date	Approved by Date

Hydrological region	(R)	9		Note 1
Hydrological rainfall zone	(Z)	4		Note 2
Development area - ha	(A)	0.004	ha	Note 3
Proport. of imp.area requiring storage	(a)	1.000		Note 4
Greenfield flow rate per unit area	(Q_{BAR}/A)	4.26	1/s/ha	Note 5
% impermeable area of catchment	(PIMP)	100.0	%	Note 6

Attenuation storage volumes per unit area:-

(Uvol _{1yr})	170.0	m ³ /ha	Note 7
(Uvol _{30yr})	350.0	m ³ /ha	
(Uvol _{100yr})	430.0	m ³ /ha	

Basic storage volumes :-

(Uvol x a x A)	(BSV _{1yr})	0.6	m ³	Note 8
	(BSV _{30yr})	1.2	m ³	
	(BSV _{100yr})	1.5	m ³	

Climate change factor	(CC)	1.1		Note 9
FEH factor		1.0		Note 10
Critical storm duration		13.0	hrs	Note 11

FEH Rainfall factor :-

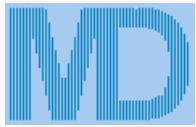
(FF _{1yr})	1.30	Note 12
(FF _{30yr})	1.40	
(FF _{100yr})	1.40	

**Storage volume ratio :-
f (CC/FF)**

(SVR _{1yr})	0.772	Note 13
(SVR _{30yr})	0.683	
(SVR _{100yr})	0.683	

**Adjusted storage volumes :-
(SVR x BSV)**

(ASV _{1yr})	0.5	m ³	Note 14
(ASV _{30yr})	0.84	m ³	
(ASV _{100yr})	1.0	m ³	



Company Remote Engineering Design Services				Project	
Item Attenuation storage volume for WREXHAM				Job Ref	Sheet no. 2
MasterDrain	Calc. by	Date 10/11/20	Checked by	Date	Approved by Date

Growth curve factors :-

(GC _{1yr})	0.85	Note 15
(GC _{30yr})	1.33	
(GC _{100yr})	1.59	

Hydrological region volume storage ratio :-

(HR _{1yr})	0.97	Note 16
(HR _{30yr})	1.07	
(HR _{100yr})	1.12	

Final estimated attenuation storage volumes:-

(HR x ASV)	(AtVol _{1yr})	0.4	m ³	Note 17
	(AtVol _{30yr})	0.9	m ³	
	(AtVol _{100yr})	1.1	m ³	

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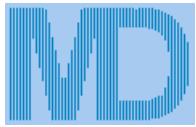


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Item Attenuation storage volume for WREXHAM				Job Ref	Sheet no. 3
MasterDrain	Calc. by	Date 10/11/20	Checked by	Date	Approved by Date

Notes:-

References to Appendix 1 refer to 'R&D Technical Report W5-074/A - Preliminary rainfall runoff management for developments (Revision E) Defra/EA

- Note 1 - UK is divided into 10 Hydrological regions reflecting the different flood frequency growth curves (Appendix 1, fig 1.1). This data is included in the database.
- Note 2 - Zones 1 - 8 based on FSR rainfall characteristics. This data is included in the database.
- Note 3 - Excluding public open spaces not modified Or drained by the proposed development.
- Note 4 - Impermeable area served by direct drainage / total area of impermeable surface.
- Note 5 - From previous calculation.
- Note 6 - For catchments where the PIMP value is less than 50%, a more detailed study should be made as the storage estimates may be undersized.
- Note 7 - These values are generated by the program, based on the graphs in Appendix 1, figures 7.1 - 7.8.
- Note 8 - Storage units may serve areas of different densities of development. If necessary, calculations should be based on each development zone, then cumulated.
- Note 9 - The Defra guidance on the impact of climate change on river flows is to apply a factor of 1.2. As there is a non-linear relationship between rainfall and runoff, it is suggested that a factor of 1.1 should be applied to rainfall +depths in this procedure.
- Note 10 - FEH factor is calculated by the program. It is used to derive the critical storm duration for the appropriate hydrological zone. (App. 1, fig. 11)
- Note 11 - The critical storm duration for the location. This should be used to select the FSR/FEH ratio map in Appendix 1, figures 6.1.1 to 6.3.4.
- Note 12 - This is derived from the maps in Appendix 1, 6.1.1 to 6.3.4
- Note 13 - This is a function of the Climate change factor and the FEH rainfall factor. See App 1, Figs 8.1 to 8.8
- Note 14 - Storage volumes adjusted for climate change and FEH rainfall.
- Note 15 - Growth curve factors for each hydrological region obtained from Appendix 1, figure 1.2 (table inset in figure).
- Note 16 - These are a function of the Storage Volume Ratio and the growth curves.
- Note 17 - Required attenuation storage.



Company Remote Engineering Design Services				Project Big Green Farm - Penley	
Item Attenuation storage volume for House Type 3B				Job Ref RED-EDL-001	Sheet no. 1
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Hydrological region	(R)	5		Note 1
Hydrological rainfall zone	(Z)	8		Note 2
Development area - ha	(A)	0.005	ha	Note 3
Proport. of imp.area requiring storage	(a)	1.000		Note 4
Greenfield flow rate per unit area	(Q_{BAR}/A)	4.26	l/s/ha	Note 5
% impermeable area of catchment	(PIMP)	100.0	%	Note 6

Attenuation storage volumes per unit area:-

(Uvol _{1yr})	160.0	m ³ /ha	Note 7
(Uvol _{30yr})	350.0	m ³ /ha	
(Uvol _{100yr})	440.0	m ³ /ha	

Basic storage volumes :-

(Uvol x a x A)	(BSV _{1yr})	0.8	m ³	Note 8
	(BSV _{30yr})	1.8	m ³	
	(BSV _{100yr})	2.3	m ³	

Climate change factor	(CC)	1.3		Note 9
FEH factor		1.0		Note 10
Critical storm duration		6.0	hrs	Note 11

FEH Rainfall factor :-

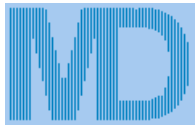
(FF _{1yr})	1.40	Note 12
(FF _{30yr})	1.40	
(FF _{100yr})	1.40	

Storage volume ratio :-

f (CC/FF)	(SVR _{1yr})	0.907	Note 13
	(SVR _{30yr})	0.907	
	(SVR _{100yr})	0.907	

Adjusted storage volumes :-

(SVR x BSV)	(ASV _{1yr})	0.8	m ³	Note 14
	(ASV _{30yr})	1.65	m ³	
	(ASV _{100yr})	2.1	m ³	



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Item Attenuation storage volume for House Type 3B				Job Ref	Sheet no. 2
MasterDrain	Calc. by JGW	Date 18/11/20	Checked by	Date	Approved by Date

Growth curve factors :-

(GC _{1yr})	0.85	Note 15
(GC _{30yr})	1.00	
(GC _{100yr})	1.00	

Hydrological region volume storage ratio :-

(HR _{1yr})	0.97	Note 16
(HR _{30yr})	1.00	
(HR _{100yr})	1.00	

Final estimated attenuation storage volumes:-

(HR x ASV)	(AtVol _{1yr})	0.7	m ³	Note 17
	(AtVol _{30yr})	1.7	m ³	
	(AtVol _{100yr})	2.1	m ³	

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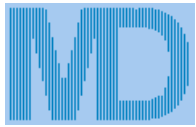


Company Remote Engineering Design Services				Project Penley	
Item Attenuation storage volume for House Type 3B				Job Ref	Sheet no. 3
MasterDrain	Calc. by JGW	Date 18/11/20	Checked by	Date	Approved by
					Date

Notes:-

References to Appendix 1 refer to 'R&D Technical Report W5-074/A - Preliminary rainfall runoff management for developments (Revision E) Defra/EA

- Note 1 - UK is divided into 10 Hydrological regions reflecting the different flood frequency growth curves (Appendix 1, fig 1.1). This data is included in the database.
- Note 2 - Zones 1 - 8 based on FSR rainfall characteristics. This data is included in the database.
- Note 3 - Excluding public open spaces not modified Or drained by the proposed development.
- Note 4 - Impermeable area served by direct drainage / total area of impermeable surface.
- Note 5 - From previous calculation.
- Note 6 - For catchments where the PIMP value is less than 50%, a more detailed study should be made as the storage estimates may be undersized.
- Note 7 - These values are generated by the program, based on the graphs in Appendix 1, figures 7.1 - 7.8.
- Note 8 - Storage units may serve areas of different densities of development. If necessary, calculations should be based on each development zone, then cumulated.
- Note 9 - The Defra guidance on the impact of climate change on river flows is to apply a factor of 1.2. As there is a non-linear relationship between rainfall and runoff, it is suggested that a factor of 1.1 should be applied to rainfall +depths in this procedure.
- Note 10 - FEH factor is calculated by the program. It is used to derive the critical storm duration for the appropriate hydrological zone. (App. 1, fig. 11)
- Note 11 - The critical storm duration for the location. This should be used to select the FSR/FEH ratio map in Appendix 1, figures 6.1.1 to 6.3.4.
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- Note 14 - Storage volumes adjusted for climate change and FEH rainfall.
- Note 15 - Growth curve factors for each hydrological region obtained from Appendix 1, figure 1.2 (table inset in figure).
- Note 16 - These are a function of the Storage Volume Ratio and the growth curves.
- Note 17 - Required attenuation storage.



Company Remote Engineering Design Services				Project Big Green Farm - Penley	
Item Attenuation storage volume for House Type 4B				Job Ref RED-EDL-001	Sheet no. 1
MasterDrain	Calc. by JGW	Date 18/11/20	Checked by KB	Date	Approved by

Hydrological region	(R)	9		Note 1
Hydrological rainfall zone	(Z)	4		Note 2
Development area - ha	(A)	0.009	ha	Note 3
Proport. of imp.area requiring storage	(a)	1.000		Note 4
Greenfield flow rate per unit area	(Q _{BAR} /A)	4.26	l/s/ha	Note 5
% impermeable area of catchment	(PIMP)	100.0	%	Note 6

Attenuation storage volumes per unit area:-

(Uvol _{1yr})	170.0	m ³ /ha	Note 7
(Uvol _{30yr})	350.0	m ³ /ha	
(Uvol _{100yr})	430.0	m ³ /ha	

Basic storage volumes :-

(Uvol x a x A)	(BSV _{1yr})	1.5	m ³	Note 8
	(BSV _{30yr})	3.1	m ³	
	(BSV _{100yr})	3.9	m ³	

Climate change factor	(CC)	1.3		Note 9
FEH factor		1.0		Note 10
Critical storm duration		13.0	hrs	Note 11

FEH Rainfall factor :-

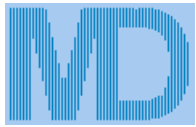
(FF _{1yr})	1.40	Note 12
(FF _{30yr})	1.40	
(FF _{100yr})	1.40	

Storage volume ratio :-

f (CC/FF)	(SVR _{1yr})	0.894	Note 13
	(SVR _{30yr})	0.894	
	(SVR _{100yr})	0.894	

Adjusted storage volumes :-

(SVR x BSV)	(ASV _{1yr})	1.4	m ³	Note 14
	(ASV _{30yr})	2.82	m ³	
	(ASV _{100yr})	3.5	m ³	



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Item Attenuation storage volume for House Type 4B				Job Ref	Sheet no. 2
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Growth curve factors :-

(GC _{1yr})	0.85	Note 15
(GC _{30yr})	1.33	
(GC _{100yr})	1.59	

Hydrological region volume storage ratio :-

(HR _{1yr})	0.97	Note 16
(HR _{30yr})	1.07	
(HR _{100yr})	1.12	

Final estimated attenuation storage volumes:-

(HR x ASV)	(AtVol _{1yr})	1.3	m³	Note 17
	(AtVol _{30yr})	3.0	m³	
	(AtVol _{100yr})	3.9	m³	

Printed from Masterdrain Hydrology program.

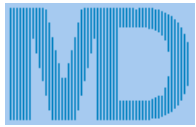


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Item Attenuation storage volume for House Type 4B				Job Ref	Sheet no. 3
MasterDrain	Calc. by JGW	Date 18/11/20	Checked by	Date	Approved by Date

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Company Remote Engineering Design Services				Project Big Green Farm Penley	
Item Hydrograph storage calcs (Summer profile) for Big Green Farm Penley				Job Ref RED-EDL-001	Sheet no. 1
MasterDrain	Calc. by JGW	Date 27/11/20	Checked by KB	Date	Approved by

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 = 86.0 Climate change = 40%

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 = 38.0% calculated from:-

Percentage runoff = (0.829*PIMP) + (25*SOIL) + (0.078*UCWI) - 20.7

where

PIMP = ImpervArea*100/(ImpervArea+PervArea) = 48.7

UCWI = Calculated value for Wetness Index = 86.0

Imperv. area = 1850 m² Pervious area = 1950 m²
 Total area = 3800 m² Equiv area = 1444 m² (Tot. area x % runoff).
 Total runoff = 92.7 m³ Discharge rate = 16.692 l/s
 Storage (m³) = 26.5 m³ (Sum of all balance quantities)
 Total rainfall depth = 64.2 mm

Calculations :-

Time (hrs)	%Mean intens	Rain mm/hr	Inflow (m3)	Outflow (m3)	Balance (m3)	Cumulative (m3)
0.020	32.0	10.3	0.297	1.202	0.000	0.000
0.040	33.0	10.6	0.306	1.202	0.000	0.000
0.060	33.0	10.6	0.306	1.202	0.000	0.000
0.080	34.0	10.9	0.315	1.202	0.000	0.000
0.100	34.0	10.9	0.315	1.202	0.000	0.000
0.120	35.0	11.2	0.325	1.202	0.000	0.000
0.140	35.0	11.2	0.325	1.202	0.000	0.000
0.160	36.0	11.6	0.334	1.202	0.000	0.000
0.180	36.0	11.6	0.334	1.202	0.000	0.000
0.200	37.0	11.9	0.343	1.202	0.000	0.000
0.220	37.0	11.9	0.343	1.202	0.000	0.000
0.240	38.0	12.2	0.352	1.202	0.000	0.000
0.260	38.0	12.2	0.352	1.202	0.000	0.000
0.280	39.0	12.5	0.362	1.202	0.000	0.000
0.300	40.0	12.8	0.371	1.202	0.000	0.000
0.320	42.0	13.5	0.389	1.202	0.000	0.000
0.340	42.0	13.5	0.389	1.202	0.000	0.000
0.360	43.0	13.8	0.399	1.202	0.000	0.000
0.380	44.0	14.1	0.408	1.202	0.000	0.000
0.400	45.0	14.4	0.417	1.202	0.000	0.000
0.420	46.0	14.8	0.427	1.202	0.000	0.000
0.440	48.0	15.4	0.445	1.202	0.000	0.000
0.460	49.0	15.7	0.454	1.202	0.000	0.000
0.480	51.0	16.4	0.473	1.202	0.000	0.000
0.500	52.0	16.7	0.482	1.202	0.000	0.000
0.520	54.0	17.3	0.501	1.202	0.000	0.000
0.540	56.0	18.0	0.519	1.202	0.000	0.000
0.560	58.0	18.6	0.538	1.202	0.000	0.000
0.580	61.0	19.6	0.566	1.202	0.000	0.000
0.600	64.0	20.6	0.593	1.202	0.000	0.000
0.620	68.0	21.8	0.631	1.202	0.000	0.000
0.640	72.0	23.1	0.668	1.202	0.000	0.000
0.660	78.0	25.0	0.723	1.202	0.000	0.000
0.680	84.0	27.0	0.779	1.202	0.000	0.000
0.700	91.0	29.2	0.844	1.202	0.000	0.000
0.720	99.0	31.8	0.918	1.202	0.000	0.000
0.740	110.0	35.3	1.020	1.202	0.000	0.000

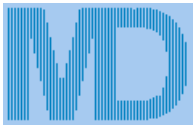


Company Remote Engineering Design Services				Project	
Item Hydrograph storage calcs (Summer profile) for Penley WREXHAM				Job Ref	Sheet no. 2
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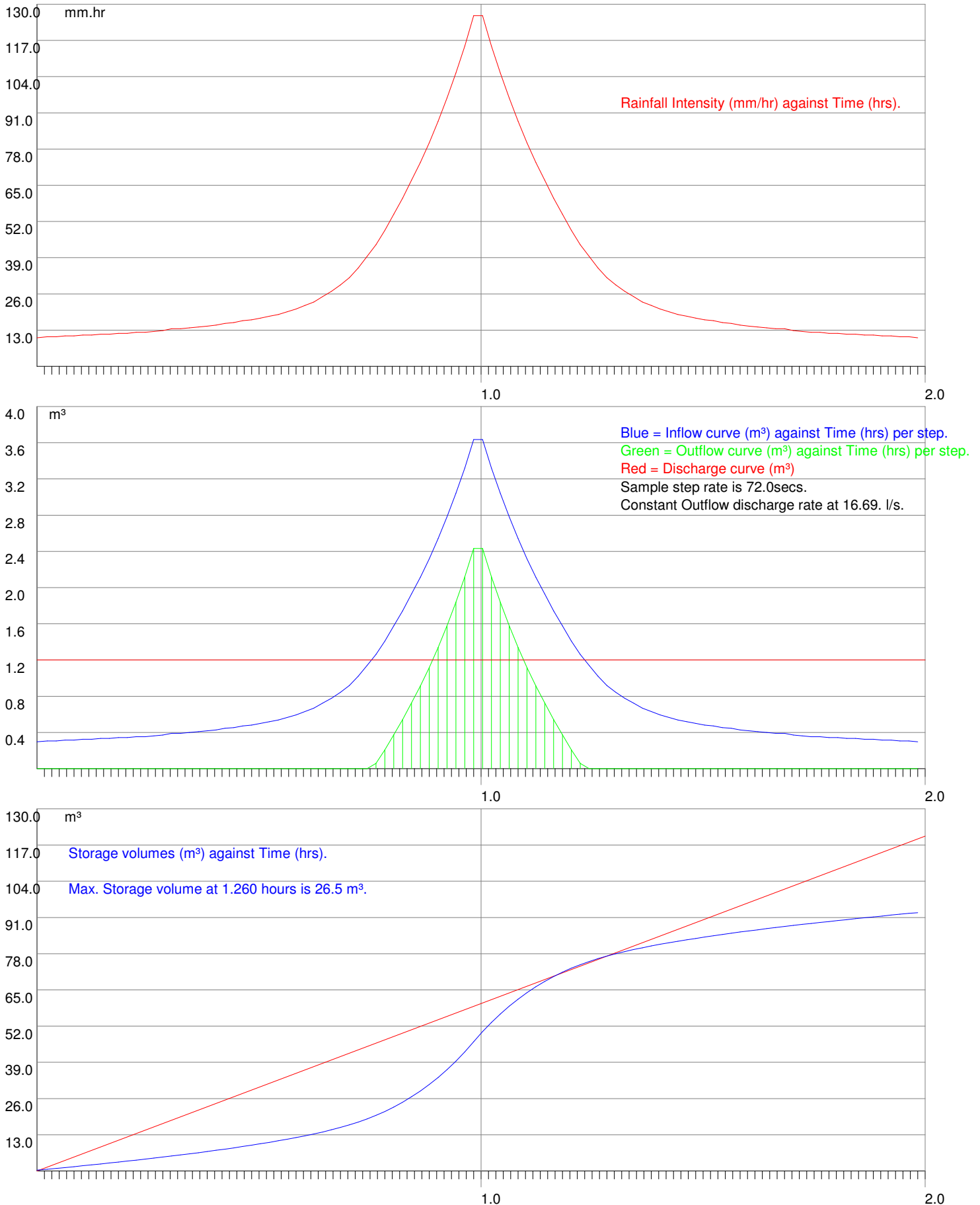
Calculations (cont.) :-

Time (hrs)	%Mean intens	Rain mm/hr	Inflow (m3)	Outflow (m3)	Balance (m3)	Cumulative (m3)
0.820	170.0	54.6	1.576	1.202	0.375	0.642
0.840	188.0	60.4	1.743	1.202	0.542	1.183
0.860	208.0	66.8	1.929	1.202	0.727	1.910
0.880	228.0	73.2	2.114	1.202	0.913	2.823
0.900	250.0	80.3	2.318	1.202	1.117	3.939
0.920	274.0	88.0	2.541	1.202	1.339	5.278
0.940	300.0	96.3	2.782	1.202	1.580	6.859
0.960	328.0	105.3	3.042	1.202	1.840	8.699
0.980	358.0	115.0	3.320	1.202	2.118	10.817
1.000	392.0	125.9	3.635	1.202	2.433	13.250
1.020	392.0	125.9	3.635	1.202	2.433	15.683
1.040	358.0	115.0	3.320	1.202	2.118	17.801
1.060	328.0	105.3	3.042	1.202	1.840	19.641
1.080	300.0	96.3	2.782	1.202	1.580	21.221
1.100	274.0	88.0	2.541	1.202	1.339	22.560
1.120	250.0	80.3	2.318	1.202	1.117	23.677
1.140	228.0	73.2	2.114	1.202	0.913	24.589
1.160	208.0	66.8	1.929	1.202	0.727	25.317
1.180	188.0	60.4	1.743	1.202	0.542	25.858
1.200	170.0	54.6	1.576	1.202	0.375	26.233
1.220	152.0	48.8	1.410	1.202	0.208	26.440
1.240	136.0	43.7	1.261	1.202	0.059	26.500
1.260	123.0	39.5	1.141	1.202	0.000	26.439
1.280	110.0	35.3	1.020	1.202	0.000	26.257
1.300	99.0	31.8	0.918	1.202	0.000	25.973
1.320	91.0	29.2	0.844	1.202	0.000	25.615
1.340	84.0	27.0	0.779	1.202	0.000	25.192
1.360	78.0	25.0	0.723	1.202	0.000	24.714
1.380	72.0	23.1	0.668	1.202	0.000	24.180
1.400	68.0	21.8	0.631	1.202	0.000	23.608
1.420	64.0	20.6	0.593	1.202	0.000	23.000
1.440	61.0	19.6	0.566	1.202	0.000	22.364
1.460	58.0	18.6	0.538	1.202	0.000	21.700
1.480	56.0	18.0	0.519	1.202	0.000	21.018
1.500	54.0	17.3	0.501	1.202	0.000	20.316
1.520	52.0	16.7	0.482	1.202	0.000	19.597
1.540	51.0	16.4	0.473	1.202	0.000	18.868
1.560	49.0	15.7	0.454	1.202	0.000	18.121
1.580	48.0	15.4	0.445	1.202	0.000	17.364
1.600	46.0	14.8	0.427	1.202	0.000	16.589
1.620	45.0	14.4	0.417	1.202	0.000	15.804
1.640	44.0	14.1	0.408	1.202	0.000	15.010
1.660	43.0	13.8	0.399	1.202	0.000	14.207
1.680	42.0	13.5	0.389	1.202	0.000	13.395
1.700	42.0	13.5	0.389	1.202	0.000	12.583
1.720	40.0	12.8	0.371	1.202	0.000	11.752
1.740	39.0	12.5	0.362	1.202	0.000	10.911
1.760	38.0	12.2	0.352	1.202	0.000	10.062
1.780	38.0	12.2	0.352	1.202	0.000	9.213
1.800	37.0	11.9	0.343	1.202	0.000	8.354
1.820	37.0	11.9	0.343	1.202	0.000	7.495
1.840	36.0	11.6	0.334	1.202	0.000	6.627
1.860	36.0	11.6	0.334	1.202	0.000	5.759
1.880	35.0	11.2	0.325	1.202	0.000	4.882
1.900	35.0	11.2	0.325	1.202	0.000	4.005
1.920	34.0	10.9	0.315	1.202	0.000	3.118
1.940	34.0	10.9	0.315	1.202	0.000	2.232
1.960	33.0	10.6	0.306	1.202	0.000	1.336
1.980	33.0	10.6	0.306	1.202	0.000	0.440
2.000	32.0	10.3	0.297	1.202	0.000	0.000

Storage volume (m³) = 26.5 m³ (Sum of all balance quantities)



Company Remote Engineering Design Services				Project	
Item Hydrograph storage calcs (Summer profile) for Penley WREXHAM				Job Ref	Sheet no. 3
MasterDrain	Calc. by JGW	Date 27/11/20	Checked by	Date	Approved by Date





MasterDrain

Company Remote Engineering Design Services				Project	
Item Hydrograph storage calcs (Summer profile) for Penley WREXHAM				Job Ref	Sheet no. 4
Calc. by JGW	Date 27/11/20	Checked by	Date	Approved by	Date

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.

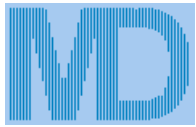
Why do the two methods give different results?

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.



Company Remote Engineering Design Services				Project Big Green Farm - Penley	
Item Hydrograph storage calcs (Winter profile) for Big Green Farm Penley				Job Ref RED-EDL-001	Sheet no. 1
MasterDrain	Calc. by JGW	Date 27/11/20	Checked by KB	Date	Approved by

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 = 86.0 Climate change = 40%

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 = 38.0% calculated from:-

Percentage runoff = (0.829*PIMP) + (25*SOIL) + (0.078*UCWI) - 20.7

where

PIMP = ImpervArea*100/(ImpervArea+PervArea) = 48.7

UCWI = Calculated value for Wetness Index = 86.0

Imperv. area = 1850 m² Pervious area = 1950 m²
 Total area = 3800 m² Equiv area = 1444 m² (Tot. area x % runoff).
 Total runoff = 92.7 m³ Discharge rate = 16.692 l/s
 Storage (m³) = 23.5 m³ (Sum of all balance quantities)
 Total rainfall depth = 64.2 mm

Calculations :-

Time (hrs)	%Mean intens	Rain mm/hr	Inflow (m3)	Outflow (m3)	Balance (m3)	Cumulative (m3)
0.020	20.0	6.4	0.185	1.202	0.000	0.000
0.040	20.0	6.4	0.185	1.202	0.000	0.000
0.060	21.0	6.7	0.195	1.202	0.000	0.000
0.080	21.0	6.7	0.195	1.202	0.000	0.000
0.100	22.0	7.1	0.204	1.202	0.000	0.000
0.120	23.0	7.4	0.213	1.202	0.000	0.000
0.140	24.0	7.7	0.223	1.202	0.000	0.000
0.160	26.0	8.3	0.241	1.202	0.000	0.000
0.180	27.0	8.7	0.250	1.202	0.000	0.000
0.200	29.0	9.3	0.269	1.202	0.000	0.000
0.220	31.0	10.0	0.287	1.202	0.000	0.000
0.240	32.0	10.3	0.297	1.202	0.000	0.000
0.260	33.0	10.6	0.306	1.202	0.000	0.000
0.280	34.0	10.9	0.315	1.202	0.000	0.000
0.300	36.0	11.6	0.334	1.202	0.000	0.000
0.320	38.0	12.2	0.352	1.202	0.000	0.000
0.340	39.0	12.5	0.362	1.202	0.000	0.000
0.360	40.0	12.8	0.371	1.202	0.000	0.000
0.380	42.0	13.5	0.389	1.202	0.000	0.000
0.400	45.0	14.4	0.417	1.202	0.000	0.000
0.420	49.0	15.7	0.454	1.202	0.000	0.000
0.440	53.0	17.0	0.491	1.202	0.000	0.000
0.460	57.0	18.3	0.529	1.202	0.000	0.000
0.480	62.0	19.9	0.575	1.202	0.000	0.000
0.500	66.0	21.2	0.612	1.202	0.000	0.000
0.520	71.0	22.8	0.658	1.202	0.000	0.000
0.540	77.0	24.7	0.714	1.202	0.000	0.000
0.560	84.0	27.0	0.779	1.202	0.000	0.000
0.580	91.0	29.2	0.844	1.202	0.000	0.000
0.600	98.0	31.5	0.909	1.202	0.000	0.000
0.620	105.0	33.7	0.974	1.202	0.000	0.000
0.640	114.0	36.6	1.057	1.202	0.000	0.000
0.660	125.0	40.1	1.159	1.202	0.000	0.000
0.680	135.0	43.3	1.252	1.202	0.050	0.050
0.700	143.0	45.9	1.326	1.202	0.124	0.174
0.720	154.0	49.4	1.428	1.202	0.226	0.401
0.740	164.0	52.7	1.521	1.202	0.319	0.720

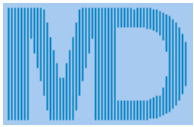


Company Remote Engineering Design Services				Project	
Item Hydrograph storage calcs (Winter profile) for Penley WREXHAM				Job Ref	Sheet no. 2
MasterDrain	Calc. by JGW	Date 27/11/20	Checked by	Date	Approved by
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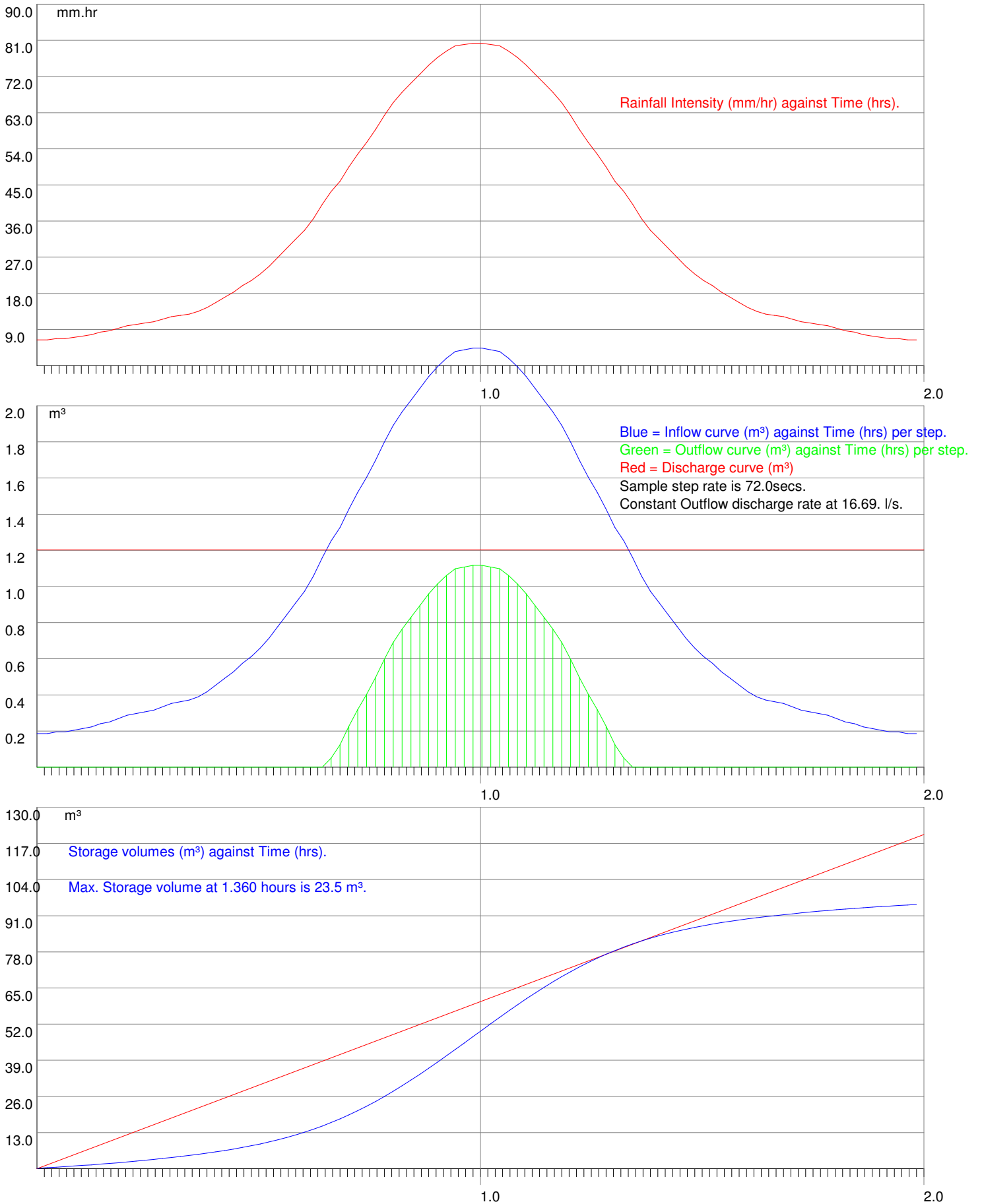
Calculations (cont.) :-

Time (hrs)	%Mean intens	Rain mm/hr	Inflow (m3)	Outflow (m3)	Balance (m3)	Cumulative (m3)
0.820	204.0	65.5	1.892	1.202	0.690	2.904
0.840	212.0	68.1	1.966	1.202	0.764	3.669
0.860	219.0	70.3	2.031	1.202	0.829	4.498
0.880	226.0	72.6	2.096	1.202	0.894	5.392
0.900	233.0	74.8	2.161	1.202	0.959	6.351
0.920	239.0	76.7	2.216	1.202	1.015	7.365
0.940	244.0	78.3	2.263	1.202	1.061	8.426
0.960	248.0	79.6	2.300	1.202	1.098	9.524
0.980	249.0	80.0	2.309	1.202	1.107	10.631
1.000	250.0	80.3	2.318	1.202	1.117	11.748
1.020	250.0	80.3	2.318	1.202	1.117	12.864
1.040	249.0	80.0	2.309	1.202	1.107	13.971
1.060	248.0	79.6	2.300	1.202	1.098	15.069
1.080	244.0	78.3	2.263	1.202	1.061	16.130
1.100	239.0	76.7	2.216	1.202	1.015	17.145
1.120	233.0	74.8	2.161	1.202	0.959	18.104
1.140	226.0	72.6	2.096	1.202	0.894	18.998
1.160	219.0	70.3	2.031	1.202	0.829	19.827
1.180	212.0	68.1	1.966	1.202	0.764	20.591
1.200	204.0	65.5	1.892	1.202	0.690	21.281
1.220	194.0	62.3	1.799	1.202	0.597	21.878
1.240	183.0	58.8	1.697	1.202	0.495	22.373
1.260	173.0	55.6	1.604	1.202	0.402	22.776
1.280	164.0	52.7	1.521	1.202	0.319	23.095
1.300	154.0	49.4	1.428	1.202	0.226	23.321
1.320	143.0	45.9	1.326	1.202	0.124	23.445
1.340	135.0	43.3	1.252	1.202	0.050	23.495
1.360	125.0	40.1	1.159	1.202	0.000	23.453
1.380	114.0	36.6	1.057	1.202	0.000	23.308
1.400	105.0	33.7	0.974	1.202	0.000	23.080
1.420	98.0	31.5	0.909	1.202	0.000	22.787
1.440	91.0	29.2	0.844	1.202	0.000	22.429
1.460	84.0	27.0	0.779	1.202	0.000	22.006
1.480	77.0	24.7	0.714	1.202	0.000	21.518
1.500	71.0	22.8	0.658	1.202	0.000	20.975
1.520	66.0	21.2	0.612	1.202	0.000	20.385
1.540	62.0	19.9	0.575	1.202	0.000	19.758
1.560	57.0	18.3	0.529	1.202	0.000	19.085
1.580	53.0	17.0	0.491	1.202	0.000	18.375
1.600	49.0	15.7	0.454	1.202	0.000	17.627
1.620	45.0	14.4	0.417	1.202	0.000	16.843
1.640	42.0	13.5	0.389	1.202	0.000	16.030
1.660	40.0	12.8	0.371	1.202	0.000	15.200
1.680	39.0	12.5	0.362	1.202	0.000	14.359
1.700	38.0	12.2	0.352	1.202	0.000	13.510
1.720	36.0	11.6	0.334	1.202	0.000	12.642
1.740	34.0	10.9	0.315	1.202	0.000	11.755
1.760	33.0	10.6	0.306	1.202	0.000	10.860
1.780	32.0	10.3	0.297	1.202	0.000	9.955
1.800	31.0	10.0	0.287	1.202	0.000	9.040
1.820	29.0	9.3	0.269	1.202	0.000	8.107
1.840	27.0	8.7	0.250	1.202	0.000	7.156
1.860	26.0	8.3	0.241	1.202	0.000	6.195
1.880	24.0	7.7	0.223	1.202	0.000	5.216
1.900	23.0	7.4	0.213	1.202	0.000	4.227
1.920	22.0	7.1	0.204	1.202	0.000	3.230
1.940	21.0	6.7	0.195	1.202	0.000	2.222
1.960	21.0	6.7	0.195	1.202	0.000	1.215
1.980	20.0	6.4	0.185	1.202	0.000	0.199
2.000	20.0	6.4	0.185	1.202	0.000	0.000

Storage volume (m³) = 23.5 m³ (Sum of all balance quantities)



Company Remote Engineering Design Services				Project	
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MasterDrain

Company Remote Engineering Design Services				Project	
Item Hydrograph storage calcs (Winter profile) for Penley WREXHAM				Job Ref	Sheet no. 4
Calc. by JGW	Date 27/11/20	Checked by	Date	Approved by	Date

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.
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Explanatory notes for Hydrograph Storage

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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.

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Job No.

RED-ERL-001

Sheet no.

1

Date

20/10/20

Project **Big Green Farm Penley**

By

JGW

Checked

KB

Reviewed

Title

IoH 124 Greenfield Runoff calcs for Big Green Farm = Penley

Hydrological Data:-

FSR Hydrology:-

Location = WREXHAM

M5-60 (mm) = 18

Soil runoff = 0.45

WRAP = 4

Hydrological area = 9

Grid reference = SJ3349

r = 0.32

SAAR (mm/yr) = 800

Area = England & Wales

Hydrological zone = 4

Soil classification for WRAP type 4

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

Design data:-

Area = 0.0038 Km² - 0.38 Ha - 3800 m²

Calculation method:-

Runoff is calculated from:-

$$Q_{\text{BAR(rural)}} = 0.00108 \text{ AREA}^{0.89} \cdot \text{SAAR}^{1.17} \cdot \text{SOIL}^{2.17}$$

where

AREA = Site area in Km²

SAAR = Standard Average Annual Rainfall (mm/yr)

SOIL = Soil value derived from Winter Rainfall Acceptance Potential

$Q_{\text{BAR(rural)}}$ = Runoff (cumecs)

$Q_{\text{BAR(rural)}}$ is then multiplied by a growth factor - GC(T) - for different storm return periods derived from EA publication W5-074/A.

Calculated data:-

For areas less than 50Ha, a modified calculation which multiplies the 50Ha runoff value by the ratio of the site area to 50Ha is used
Reducing factor used for these calculations is 0.008

Mean Annual Peak Flow $Q_{\text{BAR(rural)}}$ = 1.95 l/s



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Job No.
RED-ERL-001

Sheet no. **2**

Date **20/10/20**

Project
Penley Housing Site

Title
loH 124 Runoff calcs for WREXHAM

By
KB

Checked

Reviewed

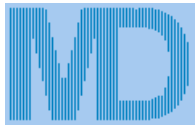
Values for $Q_{\text{BAR(rural)}}$

Ret. per. 1yr	m ³ /hr 5.972	1/s 1.659	1/s/ha 4.366	Ret. per. 100yr	m ³ /hr 15.317	1/s 4.255	1/s/ha 11.196
2yr	6.534	1.815	4.776	100yr+20%	18.380	5.106	13.436
5yr	8.572	2.381	6.266	100yr+30%	19.912	5.531	14.555
10yr	9.977	2.771	7.293	200yr	17.565	4.879	12.840
30yr	12.296	3.415	8.988	200yr + 30%	22.835	6.343	16.692
50yr	13.630	3.786	9.964	500yr	20.094	5.582	14.689
				1000yr	22.413	6.226	16.384

Growth factors -

1yr	2yr	5yr	10yr	30yr	50yr	100yr	200yr	500yr	1000yr
0.85	0.93	1.22	1.42	1.75	1.94	2.18	2.50	2.86	3.19

The above is based on the Institute of Hydrology Report 124
to which you are referred for further details (see Sect 7).
Note that the 200 and above year growth curves were taken from W5-074.



Company Remote Engineering Design Services				Project Big Green Farm - Penley	
Item Infil. coeff.calcs for Big Green Farm Penley - TP1				Job Ref RED-EDL-001	Sheet no. 1
MasterDrain	Calc. by JGW	Date 09/11/20	Checked by	Date	Approved by Date

SOIL INFILTRATION TEST

Location data

Location : TP1

Soil type:

Trial pit data

Pit dimensions : Length = 1500mm Width = 800mm Depth = 1700mm

Trial pit number: 1 Test number: 1 Date of test:

SEEPAGE TEST RESULTS

Depth	Time	Mins		Depth	Time	Mins		Depth	Time	Mins
425	8:08	0								
850	8:20	12								
1275	9:30	82								

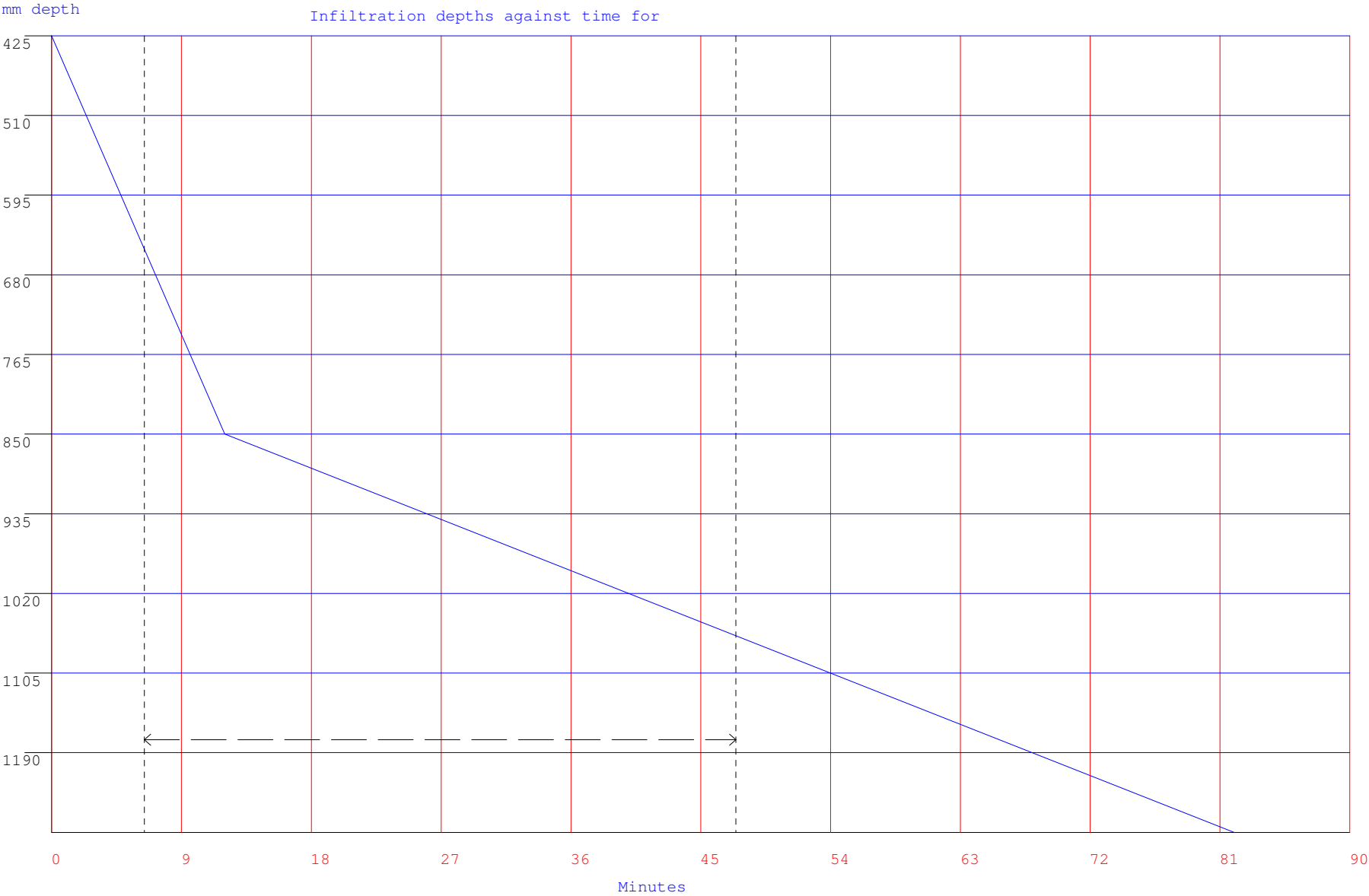
Infiltration test time (25% to 75%) = 41 mins

Infiltration coefficient = 0.2366 m/hr

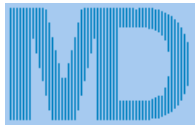
Infiltration coefficient = 6.571E-5 m/sec



Company Remote Engineering Design Services				Project Penley	
Item Infilt. coeff. calcs for				Job Ref	Sheet no. 2
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Test pit No. 1 Test No. 1 Test date Inf.time = 41 mins.



Company Remote Engineering Design Services				Project Big Green Farm -Penley	
Item Infilt. coeff. calcs for Big Green Farm - Penley				Job Ref RED-EDL-001	Sheet no. 1
MasterDrain	Calc. by JGW	Date 09/11/20	Checked by	Date	Approved by Date

SOIL INFILTRATION TEST

Location data

Location :

Soil type:

Trial pit data

Pit dimensions : Length = 1500mm Width = 800mm Depth = 1700mm

Trial pit number: 2 Test number: 1 Date of test:

SEEPAGE TEST RESULTS

Depth	Time	Mins		Depth	Time	Mins		Depth	Time	Mins
425	6:56	0								
850	7:34	38								
1275	8:19	83								

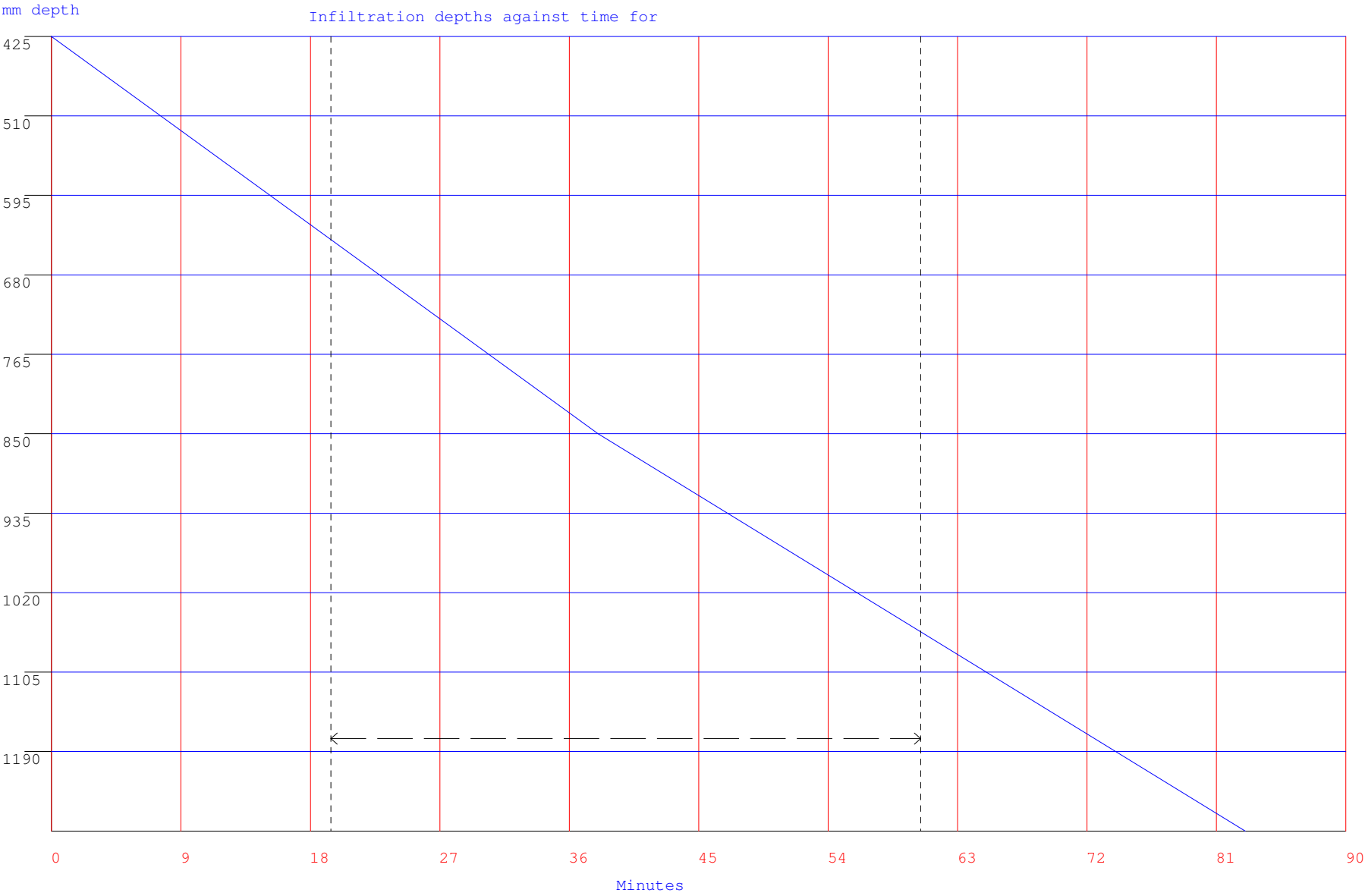
Infiltration test time (25% to 75%) = 42 mins

Infiltration coefficient = 0.2309 m/hr

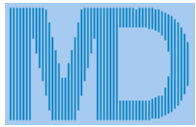
Infiltration coefficient = 6.415E-5 m/sec



Company Remote Engineering Design Services				Project Penley	
Item Infilt. coeff. calcs for				Job Ref	Sheet no. 2
MasterDrain	Calc. by JGW	Date 09/11/20	Checked by	Date	Approved by Date



Test pit No. 2 Test No. 1 Test date Inf.time = 41 mins.



Company Remote Engineering Design Services				Project Big Green Farm Penley	
Item Infiltration coefficient calculations for Big Green Farm Penley - TP3				Job Ref RED-EDL-001	Sheet no. 1
MasterDrain	Calc. by JGW	Date 09/11/20	Checked by	Date	Approved by
					Date

SOIL INFILTRATION TEST

Location data

Location :

Soil type:

Trial pit data

Pit dimensions : Length = 1500mm Width = 800mm Depth = 1700mm

Trial pit number: 3 Test number: 1 Date of test:

SEEPAGE TEST RESULTS

Depth	Time	Mins		Depth	Time	Mins		Depth	Time	Mins
425	5:40	0								
850	6:20	40								
1275	7:30	110								

Infiltration test time (25% to 75%) = 56 mins

Infiltration coefficient = 0.1732 m/hr

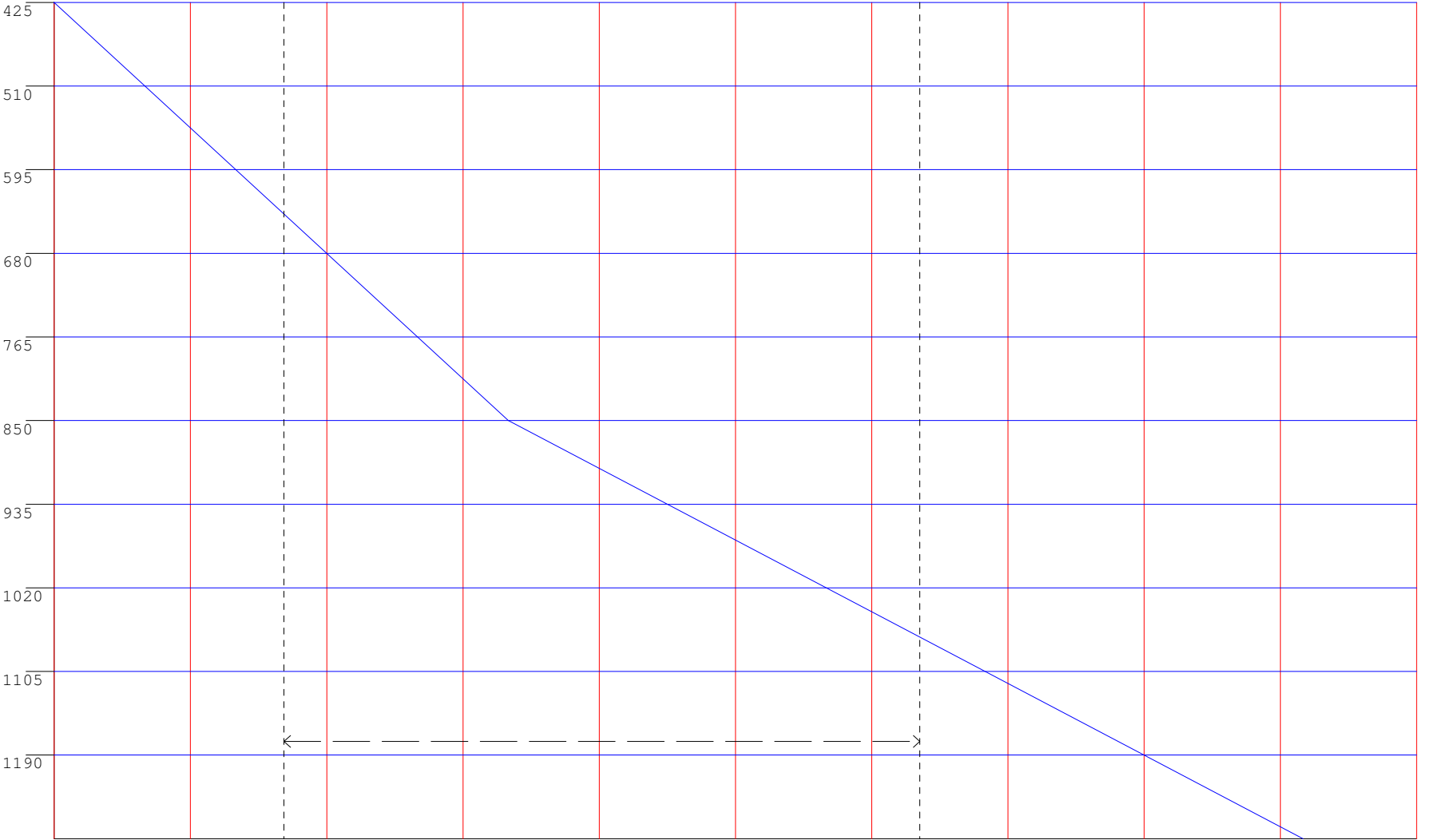
Infiltration coefficient = 4.811E-5 m/sec



Company Remote Engineering Design Services				Project Penley	
Item Infilt. coeff. calcs for TP3				Job Ref	Sheet no. 2
MasterDrain	Calc. by JGW	Date 09/11/20	Checked by	Date	Approved by Date

mm depth

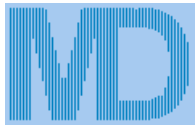
Infiltration depths against time for



0 12 24 36 48 60 72 84 96 108 120

Minutes

Test pit No. 3 Test No. 1 Test date Inf.time = 56 mins.



Company Remote Engineering Design Services				Project Big Green Farm Penley	
Item Infiltration coefficient calculations for Big Green Farm Penley - TP4				Job Ref RED-EDL-001	Sheet no. 1
MasterDrain	Calc. by JGW	Date 09/11/20	Checked by	Date	Approved by Date

SOIL INFILTRATION TEST

Location data

Location :

Soil type:

Trial pit data

Pit dimensions : Length = 1500mm Width = 800mm Depth = 1700mm

Trial pit number: 4 Test number: 1 Date of test:

SEEPAGE TEST RESULTS

Depth	Time	Mins		Depth	Time	Mins		Depth	Time	Mins
425	7:20	0								
850	8:30	70								
1275	9:20	120								

Infiltration test time (25% to 75%) = 60 mins

Infiltration coefficient = 0.1616 m/hr

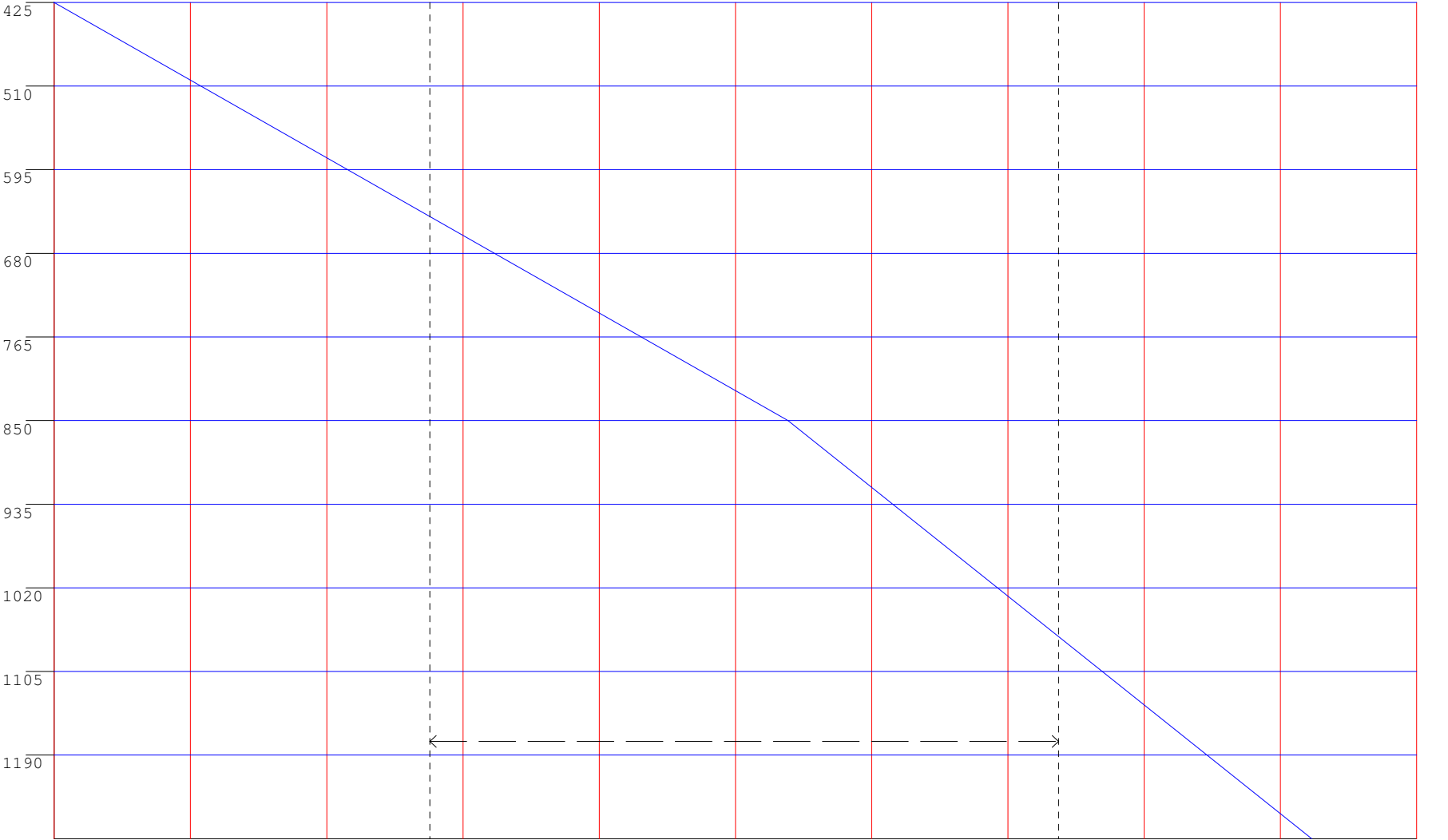
Infiltration coefficient = 4.490E-5 m/sec



Company Remote Engineering Design Services				Project Penley	
Item Infilt. coeff. calcs for TP4				Job Ref	Sheet no. 2
MasterDrain	Calc. by JGW	Date 09/11/20	Checked by	Date	Approved by Date

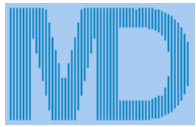
mm depth

Infiltration depths against time for



Minutes

Test pit No. 4 Test No. 1 Test date Inf.time = 60 mins.



Company Remote Engineering Design Services				Project Big Green Farm - Penley	
Item Infiltration coefficient calculations for Big Green Farm Penley-TP5				Job Ref RED-EDL-001	Sheet no. 1
MasterDrain	Calc. by JGW	Date 09/11/20	Checked by	Date	Approved by Date

SOIL INFILTRATION TEST

Location data

Location :

Soil type:

Trial pit data

Pit dimensions : Length = 1500mm Width = 800mm Depth = 1700mm

Trial pit number: 5 Test number: 1 Date of test:

SEEPAGE TEST RESULTS

Depth	Time	Mins		Depth	Time	Mins		Depth	Time	Mins
425	5:30	0								
850	6:20	50								
1275	7:00	90								

Infiltration test time (25% to 75%) = 45 mins

Infiltration coefficient = 0.2155 m/hr

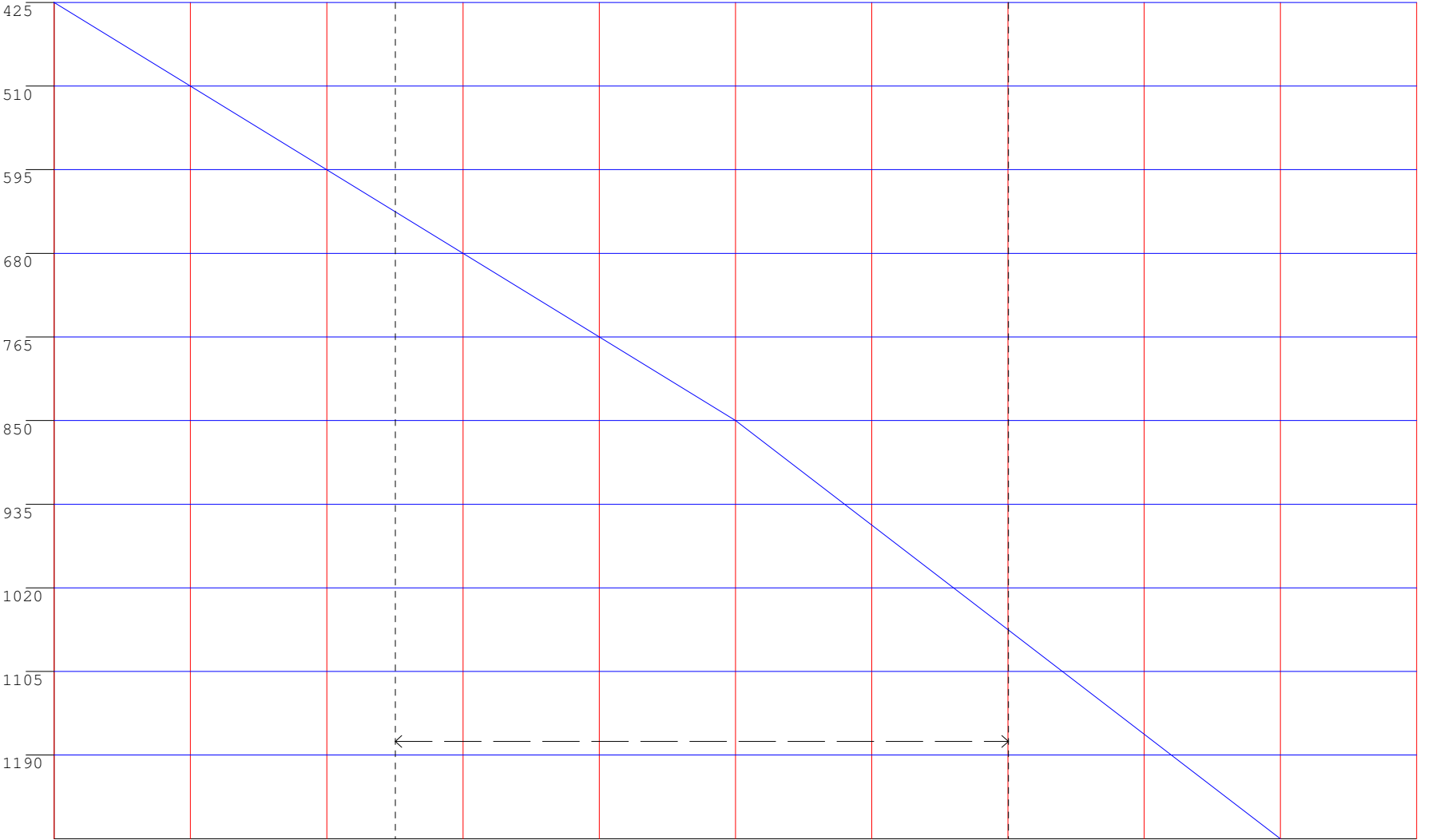
Infiltration coefficient = 5.987E-5 m/sec



Company Remote Engineering Design Services				Project Penley	
Item Infilt. coeff. calcs for TP5				Job Ref	Sheet no. 2
MasterDrain	Calc. by JGW	Date 09/11/20	Checked by	Date	Approved by Date

mm depth

Infiltration depths against time for



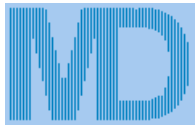
Minutes

Test pit No. 5

Test No. 1

Test date

Inf.time = 45 mins.



Company Remote Engineering Design Services				Project Big Green Farm Penley	
Item Infiltration coefficient calculations for Big Green Farm Penley - TP6				Job Ref RED-EDL-001	Sheet no. 1
MasterDrain	Calc. by JGW	Date 09/11/20	Checked by	Date	Approved by
					Date

SOIL INFILTRATION TEST

Location data

Location :

Soil type:

Trial pit data

Pit dimensions : Length = 1500mm Width = 800mm Depth = 1700mm

Trial pit number: 6 Test number: 1 Date of test:

SEEPAGE TEST RESULTS

Depth	Time	Mins		Depth	Time	Mins		Depth	Time	Mins
425	4:30	0								
850	5:40	70								
1275	5:50	80								

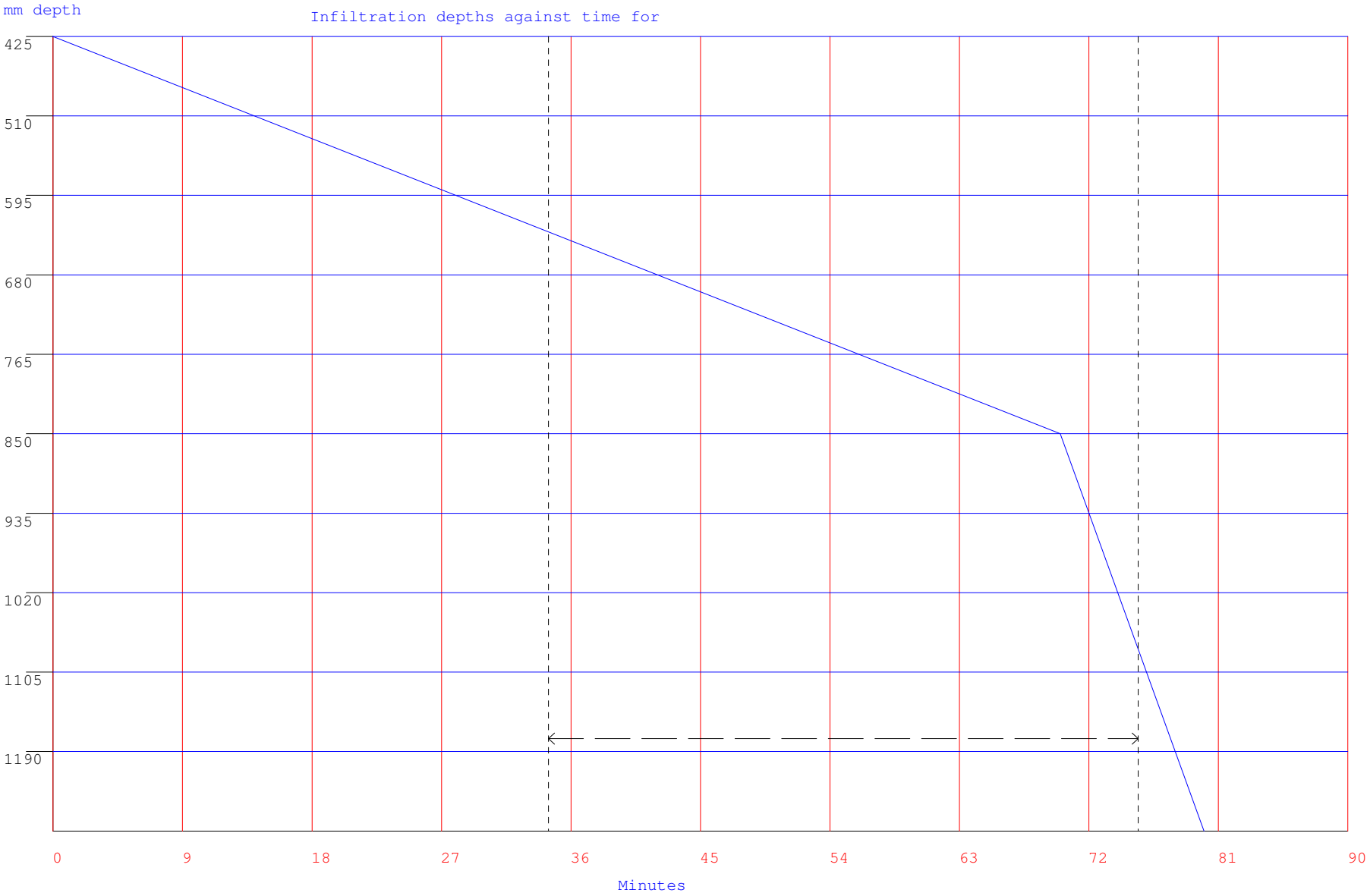
Infiltration test time (25% to 75%) = 41 mins

Infiltration coefficient = 0.2366 m/hr

Infiltration coefficient = 6.571E-5 m/sec



Company Remote Engineering Design Services				Project Penley	
Item Infilt. coeff. calcs for TP6				Job Ref	Sheet no. 2
MasterDrain	Calc. by JGW	Date 09/11/20	Checked by	Date	Approved by Date



Test pit No. 6 Test No. 1 Test date Inf.time = 41 mins.