

Appendix 3A

SETTLEMENT POND HYDRAULIC DESIGN

The design runoff rate, used for the drainage design, is calculated using the Modified Rational Approach formula:

$$Q = 2.78 C_v C_r i A_i$$

where C_v is the volumetric coefficient which is dependent upon the catchment characteristics. It is assumed to be 0.84 for the winter profiles as stated in the Flood Studies Report,

C_r is the routing coefficient, the Wallingford recommends this to be 1.3.

i is the rainfall intensity in mm/hr, and

A_i is the impervious area drained surface area in ha. The percentage imperviousness (PIMP) obtained by dividing the total directly connected impervious area (A_i) by the total contributing area (A). PIMP is assumed to be equal to 70% for the hardcore surface. ($A_i = \text{PIMP} \times A$)

For a rainfall intensity of 20mm/hour and a total drained area of 1,200m² the runoff rate is:

$$\begin{aligned} Q &= 2.78 \times 0.84 \times 1.3 \times 20 \times (0.70 \times 1,200) \text{ litres/second} \\ &= 5.10 \text{ litres/second (0.0051m}^3\text{/s)} \end{aligned}$$

The main design parameter for the settlement pond is the water surface area. The required surface area is the design flow rate in m³/s divided by the particle settlement velocity (V_s) in m/sec (Area = Q/V_s m²)

The particle settlement velocity is determined using the formula derived by Stokes in 1851 as follows:

$$V_s = \frac{2 r^2 (D_p - D_f)}{9 \eta}$$

where V_s is the particle settlement velocity (m/sec),

r is the radius of the particle (metres),

D_p is the density of the particles (kg/m³),

D_f is the density of the fluid (kg/m³), and

η is the viscosity of the fluid (0.000133 kg sec/m² @ 10°C).

For a particle density of 2,400kg/m³, water density of 1,000kg/m³ and particle diameter of 20 microns (radius=1*10⁻⁵ metres) the settlement velocity, V_s , is:

$$\begin{aligned} V_s &= \frac{2 \times (10^{-5})^2 \times (2,400 - 1,000)}{9 \times 0.000133} \\ &= \frac{2 \times 10^{-10} \times 1,400}{0.001197} \\ &= 0.000234 \text{ m/sec.} \end{aligned}$$

The required settlement pond surface area is

$$\begin{aligned} A_p &= \frac{Q}{V_s} \\ &= \frac{0.0051}{0.000234} \end{aligned}$$

= 21.79m²

**Table Error! No text of specified style in document.-1 Met Éireann point rainfall frequency table
(rainfall depth in mm)**

Storm Duration	Return Period (Years)							
	0.5	1	2	5	10	20	50	100
5 min	2.7	3.6	4.1	5.8	7.0	8.4	10.5	12.5
10 min	3.7	5.1	5.8	8.0	9.8	11.7	14.7	17.4
15 min	4.4	6.0	6.8	9.5	11.5	13.7	17.3	20.4
30 min	5.8	7.8	8.8	12.1	14.6	17.3	21.5	25.2
60 min	7.6	10.1	11.4	15.5	18.5	21.7	26.8	31.2
2 hours	10.1	13.2	14.8	19.8	23.4	27.4	33.3	38.6
3 hours	11.9	15.4	17.2	22.8	26.9	31.3	37.9	43.7
4 hours	13.4	17.2	19.2	25.3	29.7	34.4	41.5	47.7
6 hours	15.7	20.1	22.4	29.2	34.1	39.3	47.2	54.0
9 hours	18.5	23.5	26.0	33.7	39.2	45.0	53.7	61.2
12 hours	20.8	26.3	29.0	37.3	43.2	49.5	58.8	66.8
18 hours	24.5	30.7	33.7	43.0	49.6	56.6	66.8	75.6
24 hours	27.5	34.2	37.6	47.7	54.8	62.2	73.2	82.6

**Table Error! No text of specified style in document.-2 Met Éireann point rainfall frequency table
(rainfall intensity rate in mm per hour)**

Storm Duration	Return Period (Years)							
	0.5	1	2	5	10	20	50	100
5 min	32.41	43.22	49.22	69.63	84.03	100.84	126.05	150.06
10 min	22.16	30.54	34.73	47.90	58.68	70.06	88.02	104.19
15 min	17.60	24.00	27.20	38.00	46.00	54.80	69.20	81.60
30 min	11.60	15.60	17.60	24.20	29.20	34.60	43.00	50.40
60 min	7.60	10.10	11.40	15.50	18.50	21.70	26.80	31.20
2 hours	5.05	6.60	7.40	9.90	11.70	13.70	16.65	19.30
3 hours	3.97	5.13	5.73	7.60	8.97	10.43	12.63	14.57
4 hours	3.35	4.30	4.80	6.33	7.43	8.60	10.38	11.93
6 hours	2.62	3.35	3.73	4.87	5.68	6.55	7.87	9.00
9 hours	2.06	2.61	2.89	3.74	4.36	5.00	5.97	6.80
12 hours	1.73	2.19	2.42	3.11	3.60	4.13	4.90	5.57
18 hours	1.36	1.71	1.87	2.39	2.76	3.14	3.71	4.20
24 hours	1.15	1.43	1.57	1.99	2.28	2.59	3.05	3.44