

How weirs store floodwater to attenuate flow and thus reduce downstream flooding

For uniform open channel flow Manning's formula applies:-

$$V = R^{2/3} S^{1/2} / n$$

where R is the hydraulic radius (water area/ wetted perimeter)

S is the slope (0.001 in this case)

n is a constant (Manning's n, which is typically around 0.05 for a river)

For flow over a weir the 'general weir equation' applies:-

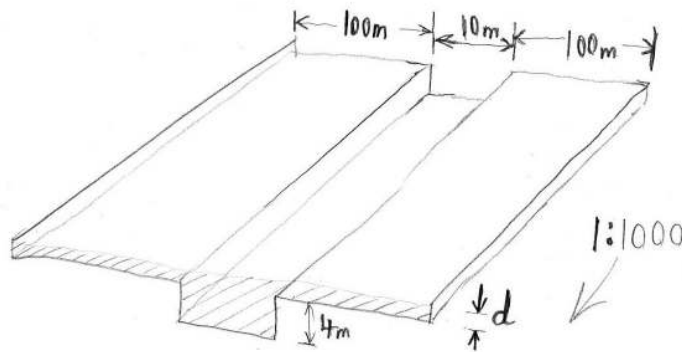
$$Q = C L H^{3/2}$$

where C is a constant weir coefficient which is typically 0.616 for a long weir

L is the length of the weir (10m in this case)

H is the height of water upstream of the weir over the weir crest

Consider a 'simplified example' valley (as sketched below) with various steady-state floodwater depths (d) of 0m, 0.5m and 1.0m:-



For the floodplain (alone) of the simplified valley:-

	d=0m	d=0.5m	d=1m
Water area	0	0.5x200=100	1.0x200=200
Wetted perimeter	0	2x(100+0.5)=201	2x(100+1)=202
R	0	100/201=0.498m	200/202=0.99m
$V = R^{2/3} 0.001^{1/2} / 0.05$	0	0.397m/s	0.628m/s
$Q = V \times \text{Water Area}$	0	39.7m ³ /s	125.6m ³ /s

For the unobstructed river channel:-

	d=0m	d=0.5m	d=1m
Water area	4x10=40	4.5x10=45	5.0x10=50
Wetted perimeter	4+10+4=18	18	18
R	40/18=2.22m	45/18=2.5m	50/18=2.78m
$V = R^{2/3} 0.001^{1/2} / 0.05$	1.08m/s	1.16m/s	1.25m/s
$Q = V \times \text{Water Area}$	43.2m ³ /s	52.2m ³ /s	62.5m ³ /s

For the river channel obstructed by a weir (set 0.1m below the general floodplain level):-

	d=0m	d=0.5m	d=1m
H	0.1m	0.6m	1.1m
$Q = 0.616 \times 10 \times H^{3/2}$	0.2m ³ /s	2.8m ³ /s	7.1m ³ /s

Total flows (m³/s) are:-

	d=0m	d=0.5m	d=1m
Without weir	43.2	91.9	188.1
With a weir	0.2	42.5	132.7

Consider a flood that rises from a low flow and peaks at 43m³/s:-

Without weir: Flood level (d) is 0m. Water storage is the channel cross-section area = 40m².

With a weir: Flood level (d) is 0.5m. Water storage is 0.5m depth over a width of 200m+10m = 105m².

The flood storage with a weir may be further increased using low-level sluices (such as used to exist at Fletching) controlled by telemetry to draw down the pound before anticipated floods. Radial gate low-level sluices would not be damaged by debris such as straw bales.