Worksheet Calculating an Elevation-Discharge Relationship for a Circular Orifice or for Multiple Orifices

This calculates an elevation-discharge relationship for an orifice or group of orifices, assuming that it is submerged on the upstream side, and can discharge freely on the downstream side.

FOLLOW THE PROCEDURES BELOW, ENTERING VALUES IN THE YELLOW BOXES.

1. Enter Orifice Parameters.

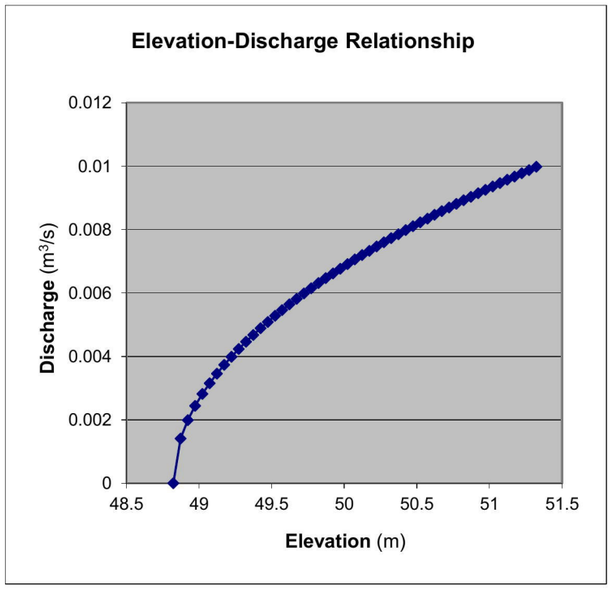
Orifice No.	1	2	3	4	5	6
Elevation of Centre of Orifice (m)	48.8225					
Orifice Diameter (mm)	55					
Orifice Factor	0.6					

Lowest Elevation
48.8225

2. Fill in the Required Heights above the Orifice Centre in the yellow column below.

3. After Checking the Relationship, copy the two orange columns and transfer these to *DRAINS* .

Height above Lowest Orifice (m)	Elevation (m AHD)	Discharge (m^3/s)	L/s
0	48.8225	0	0
0.05	48.8725	0.001411	1.411171
0.1	48.9225	0.001996	1.995697
0.15	48.9725	0.002444	2.444219
0.2	49.0225	0.002822	2.822341
0.25	49.0725	0.003155	3.155474
0.3	49.1225	0.003457	3.456648
0.35	49.1725	0.003734	3.733607
0.4	49.2225	0.003991	3.991393
0.45	49.2725	0.004234	4.233512
0.5	49.3225	0.004463	4.462514
0.55	49.3725	0.00468	4.680324
0.6	49.4225	0.004888	4.888439
0.65	49.4725	0.005088	5.088048
0.7	49.5225	0.00528	5.280117
0.75	49.5725	0.005465	5.465441
0.8	49.6225	0.005645	5.644683
0.85	49.6725	0.005818	5.818406
0.9	49.7225	0.005987	5.98709
0.95	49.7725	0.006151	6.15115
1	49.8225	0.006311	6.310947
1.05	49.8725	0.006467	6.466797
1.1	49.9225	0.006619	6.618977
1.15	49.9725	0.006768	6.767737
1.2	50.0225	0.006913	6.913296
1.25	50.0725	0.007056	7.055853
1.3	50.1225	0.007196	7.195587
1.35	50.1725	0.007333	7.332658
1.4	50.2225	0.007467	7.467213
1.45	50.2725	0.007599	7.599387
1.5	50.3225	0.007729	7.7293
1.55	50.3725	0.007857	7.857066
1.6	50.4225	0.007983	7.982787
1.65	50.4725	0.008107	8.106558

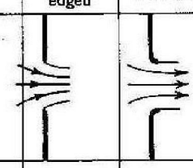
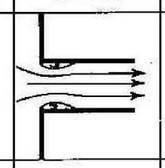
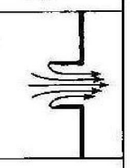


The orifice equation is: $Q = C \cdot \pi/4 \cdot D^2 \cdot (2g \cdot H)^{0.5}$

where Q is flowrate (m^3/s),
C = $C_c.C_v$ is a dimensionless contraction coefficient
where C_c allows for the vena contracta effect and C_v for a velocity correction.
D is the orifice diameter (m),
g is acceleration due to gravity (9.80 m/s^2),
H is the height of water above the centre of the orifice.

C is taken as 0.6 in *DRAINS* for a sharp-edged orifice. Other coefficients may apply in special cases, as shown below.

Orifices and their Nominal Coefficients

	Sharp edged	Rounded	Short tube	Borda
				
C	0.61	0.98	0.80	0.51
C_c	0.62	1.00	1.00	0.52
C_v	0.98	0.98	0.80	0.98

Source: Vennard, J.K. and Street, R.L.(1982) *Elementary Fluid Mechanics* , 6th Edition, Wile

The orifice equation above applies when the orifice is fully submerged on the upstream side, say when H is 1.2 times the orifice radius D/2, and where there are no tailwater effects. This will not be correct when water level (H - the centre level of the orifice) is below this. In this worksheet, this error is glossed over, assuming that errors in this range will not be significant.

1.7	50.5225	0.008228	8.228468
1.75	50.5725	0.008349	8.348598
1.8	50.6225	0.008467	8.467024
1.85	50.6725	0.008584	8.583816
1.9	50.7225	0.008699	8.69904
1.95	50.7725	0.008813	8.812758
2	50.8225	0.008925	8.925027
2.05	50.8725	0.009036	9.035901
2.1	50.9225	0.009145	9.145431
2.15	50.9725	0.009254	9.253665
2.2	51.0225	0.009361	9.360647
2.25	51.0725	0.009466	9.466421
2.3	51.1225	0.009571	9.571025
2.35	51.1725	0.009674	9.674499
2.4	51.2225	0.009777	9.776877
2.45	51.2725	0.009878	9.878195
2.5	51.3225	0.009978	9.978484

If the downstream side of the orifice becomes submerged, the orifice equation still applies, but with H being (upstream water level - tailwater level) rather than (upstream water level - orifice centre level as for a free outfall. This situation is not allowed for here, but this worksheet can be adapted to apply it.

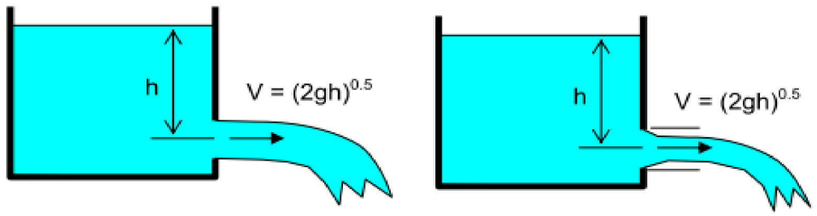


Figure 4.5 Ideal and Real Orifice Flow

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OSD structure design

New Developed area m^2	566
Council requirement for OSD m^3/ha	280
Required OSD vol m^3	15.848
Depth of water in OSD Tank m	0.9
Length m	4.6
Width m	3.828019324
Free Board m	0.1
Depth of OSD Structure	1
Depth of asphalt m	0.4
Depth to invert of OSD pit m	1.5
Proposed Orifice size m	0.055
Surface Level m	50.35
Centre of Orifice Level	48.8225

Orifice discharge rate

New Developed area m^2	566
Council requirement for PSD L/s/ha	120
New development discharge rate L/s/ha	6.792

ey, New York, Figure 11.29