# SELECTED REFERENCES - FLOW MEASUREMENTS

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# Volumetric Discharge Measurments (Bucket & Stopwatch)

General Formula: Flow (Gallons per minute) = 60(seconds/min) / Time (seconds) * gallons

| Time (seconds) | 125 ml Bottle | 500 ml Bottle | 1 Gallon Bucket | 2 Gallon Bucket | 2.5 Gallon Bucket | 5 Gallon Bucket |
|---|---|---|---|---|---|---|
| | GPM | GPM | GPM | GPM | GPM | GPM |
| 1 | 1.98 | 7.92 | 60 | 120.00 | 150.00 | 300.00 |
| 2 | 0.99 | 3.96 | 30.00 | 60.00 | 75.00 | 150.00 |
| 3 | 0.66 | 2.64 | 20.00 | 40.00 | 50.00 | 100.00 |
| 4 | 0.50 | 1.98 | 15.00 | 30.00 | 37.50 | 75.00 |
| 5 | 0.40 | 1.58 | 12.00 | 24.00 | 30.00 | 60.00 |
| 6 | 0.33 | 1.32 | 10.00 | 20.00 | 25.00 | 50.00 |
| 7 | 0.28 | 1.13 | 8.57 | 17.14 | 21.43 | 42.86 |
| 8 | 0.25 | 0.99 | 7.50 | 15.00 | 18.75 | 37.50 |
| 9 | 0.22 | 0.88 | 6.67 | 13.33 | 16.67 | 33.33 |
| 10 | 0.20 | 0.79 | 6.00 | 12.00 | 15.00 | 30.00 |
| 11 | 0.18 | 0.72 | 5.45 | 10.91 | 13.64 | 27.27 |
| 12 | 0.17 | 0.66 | 5.00 | 10.00 | 12.50 | 25.00 |
| 13 | 0.15 | 0.61 | 4.62 | 9.23 | 11.54 | 23.08 |
| 14 | 0.14 | 0.57 | 4.29 | 8.57 | 10.71 | 21.43 |
| 15 | 0.13 | 0.53 | 4.00 | 8.00 | 10.00 | 20.00 |
| 16 | 0.12 | 0.50 | 3.75 | 7.50 | 9.38 | 18.75 |
| 17 | 0.12 | 0.47 | 3.53 | 7.06 | 8.82 | 17.65 |
| 18 | 0.11 | 0.44 | 3.33 | 6.67 | 8.33 | 16.67 |
| 19 | 0.10 | 0.42 | 3.16 | 6.32 | 7.89 | 15.79 |
| 20 | 0.10 | 0.40 | 3.00 | 6.00 | 7.50 | 15.00 |
| 21 | 0.09 | 0.38 | 2.86 | 5.71 | 7.14 | 14.29 |
| 22 | 0.09 | 0.36 | 2.73 | 5.45 | 6.82 | 13.64 |
| 23 | 0.09 | 0.34 | 2.61 | 5.22 | 6.52 | 13.04 |
| 24 | 0.08 | 0.33 | 2.50 | 5.00 | 6.25 | 12.50 |
| 25 | 0.08 | 0.32 | 2.40 | 4.80 | 6.00 | 12.00 |
| 26 | 0.08 | 0.30 | 2.31 | 4.62 | 5.77 | 11.54 |
| 27 | 0.07 | 0.29 | 2.22 | 4.44 | 5.56 | 11.11 |
| 28 | 0.07 | 0.28 | 2.14 | 4.29 | 5.36 | 10.71 |
| 29 | 0.07 | 0.27 | 2.07 | 4.14 | 5.17 | 10.34 |
| 30 | 0.07 | 0.26 | 2.00 | 4.00 | 5.00 | 10.00 |
| 31 | 0.06 | 0.26 | 1.94 | 3.87 | 4.84 | 9.68 |
| 32 | 0.06 | 0.25 | 1.88 | 3.75 | 4.69 | 9.38 |
| 33 | 0.06 | 0.24 | 1.82 | 3.64 | 4.55 | 9.09 |
| 34 | 0.06 | 0.23 | 1.76 | 3.53 | 4.41 | 8.82 |
| 35 | 0.06 | 0.23 | 1.71 | 3.43 | 4.29 | 8.57 |
| 36 | 0.06 | 0.22 | 1.67 | 3.33 | 4.17 | 8.33 |
| 37 | 0.05 | 0.21 | 1.62 | 3.24 | 4.05 | 8.11 |
| 38 | 0.05 | 0.21 | 1.58 | 3.16 | 3.95 | 7.89 |
| 39 | 0.05 | 0.20 | 1.54 | 3.08 | 3.85 | 7.69 |
| 40 | 0.05 | 0.20 | 1.50 | 3.00 | 3.75 | 7.50 |
| 41 | 0.05 | 0.19 | 1.46 | 2.93 | 3.66 | 7.32 |
| 42 | 0.05 | 0.19 | 1.43 | 2.86 | 3.57 | 7.14 |
| 43 | 0.05 | 0.18 | 1.40 | 2.79 | 3.49 | 6.98 |
| 44 | 0.05 | 0.18 | 1.36 | 2.73 | 3.41 | 6.82 |
| 45 | 0.04 | 0.18 | 1.33 | 2.67 | 3.33 | 6.67 |
| 46 | 0.04 | 0.17 | 1.30 | 2.61 | 3.26 | 6.52 |
| 47 | 0.04 | 0.17 | 1.28 | 2.55 | 3.19 | 6.38 |
| 48 | 0.04 | 0.17 | 1.25 | 2.50 | 3.13 | 6.25 |
| 49 | 0.04 | 0.16 | 1.22 | 2.45 | 3.06 | 6.12 |
| 50 | 0.04 | 0.16 | 1.20 | 2.40 | 3.00 | 6.00 |
| 51 | 0.04 | 0.16 | 1.18 | 2.35 | 2.94 | 5.88 |
| 52 | 0.04 | 0.15 | 1.15 | 2.31 | 2.88 | 5.77 |
| 53 | 0.04 | 0.15 | 1.13 | 2.26 | 2.83 | 5.66 |
| 54 | 0.04 | 0.15 | 1.11 | 2.22 | 2.78 | 5.56 |
| 55 | 0.04 | 0.14 | 1.09 | 2.18 | 2.73 | 5.45 |
| 56 | 0.04 | 0.14 | 1.07 | 2.14 | 2.68 | 5.36 |
| 57 | 0.03 | 0.14 | 1.05 | 2.11 | 2.63 | 5.26 |
| 58 | 0.03 | 0.14 | 1.03 | 2.07 | 2.59 | 5.17 |
| 59 | 0.03 | 0.13 | 1.02 | 2.03 | 2.54 | 5.08 |
| 60 | 0.03 | 0.13 | 1.00 | 2.00 | 2.50 | 5.00 |

# $90^0$ Degree V-notch Weirs

General formula: $Q=aH^b$

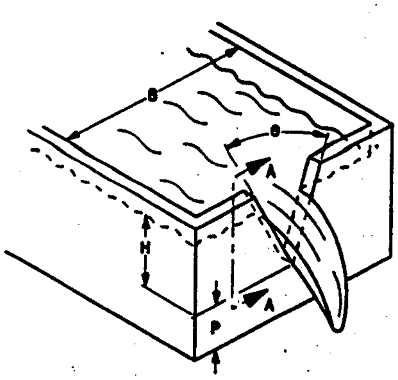
where: $Q$= Discharge ft$^3$/sec
$H$= Head of water above apex
$a$= 3.052
$b$= 2.466

| H (inches) | H (feet) | Q gal/min |
|---|---|---|
| 0.5 | 0.04167 | 0.54 |
| 0.6 | 0.05000 | 0.85 |
| 0.7 | 0.05833 | 1.24 |
| 0.8 | 0.06667 | 1.72 |
| 0.9 | 0.07500 | 2.30 |
| 1 | 0.08333 | 2.99 |
| 1.1 | 0.09167 | 3.78 |
| 1.2 | 0.10000 | 4.68 |
| 1.3 | 0.10833 | 5.71 |
| 1.4 | 0.11667 | 6.85 |
| 1.5 | 0.12500 | 8.12 |
| 1.6 | 0.13333 | 9.52 |
| 1.7 | 0.14167 | 11.06 |
| 1.8 | 0.15000 | 12.73 |
| 1.9 | 0.15833 | 14.55 |
| 2 | 0.16667 | 16.51 |
| 2.1 | 0.17500 | 18.62 |
| 2.2 | 0.18333 | 20.88 |
| 2.3 | 0.19167 | 23.30 |
| 2.4 | 0.20000 | 25.88 |
| 2.5 | 0.20833 | 28.62 |
| 2.6 | 0.21667 | 31.53 |
| 2.7 | 0.22500 | 34.60 |
| 2.8 | 0.23333 | 37.85 |
| 2.9 | 0.24167 | 41.27 |
| 3 | 0.25000 | 44.87 |
| 3.1 | 0.25833 | 48.65 |
| 3.2 | 0.26667 | 52.61 |
| 3.3 | 0.27500 | 56.76 |
| 3.4 | 0.28333 | 61.09 |
| 3.5 | 0.29167 | 65.62 |
| 3.6 | 0.30000 | 70.34 |
| 3.7 | 0.30833 | 75.26 |
| 3.8 | 0.31667 | 80.38 |
| 3.9 | 0.32500 | 85.69 |
| 4 | 0.33333 | 91.21 |
| 4.1 | 0.34167 | 96.94 |
| 4.2 | 0.35000 | 102.87 |
| 4.3 | 0.35833 | 109.02 |
| 4.4 | 0.36667 | 115.38 |
| 4.5 | 0.37500 | 121.95 |
| 4.6 | 0.38333 | 128.75 |
| 4.7 | 0.39167 | 135.76 |
| 4.8 | 0.40000 | 142.99 |
| 4.9 | 0.40833 | 150.45 |
| 5 | 0.41667 | 158.14 |
| 5.1 | 0.42500 | 166.05 |
| 5.2 | 0.43333 | 174.20 |
| 5.3 | 0.44167 | 182.57 |
| 5.4 | 0.45000 | 191.19 |
| 5.5 | 0.45833 | 200.04 |
| 5.6 | 0.46667 | 209.13 |
| 5.7 | 0.47500 | 218.46 |
| 5.8 | 0.48333 | 228.03 |
| 5.9 | 0.49167 | 237.85 |

| H (inches) | H (feet) | Q gal/min |
|---|---|---|
| 6 | 0.50000 | 247.91 |
| 6.1 | 0.50833 | 258.23 |
| 6.2 | 0.51667 | 268.79 |
| 6.3 | 0.52500 | 279.61 |
| 6.4 | 0.53333 | 290.68 |
| 6.5 | 0.54167 | 302.01 |
| 6.6 | 0.55000 | 313.60 |
| 6.7 | 0.55833 | 325.44 |
| 6.8 | 0.56667 | 337.55 |
| 6.9 | 0.57500 | 349.93 |
| 7 | 0.58333 | 362.57 |
| 7.1 | 0.59167 | 375.47 |
| 7.2 | 0.60000 | 388.65 |
| 7.3 | 0.60833 | 402.10 |
| 7.4 | 0.61667 | 415.82 |
| 7.5 | 0.62500 | 429.81 |
| 7.6 | 0.63333 | 444.08 |
| 7.7 | 0.64167 | 458.63 |
| 7.8 | 0.65000 | 473.46 |
| 7.9 | 0.65833 | 488.57 |
| 8 | 0.66667 | 503.96 |
| 8.1 | 0.67500 | 519.64 |
| 8.2 | 0.68333 | 535.60 |
| 8.3 | 0.69167 | 551.85 |
| 8.4 | 0.70000 | 568.39 |
| 8.5 | 0.70833 | 585.23 |
| 8.6 | 0.71667 | 602.35 |
| 8.7 | 0.72500 | 619.77 |
| 8.8 | 0.73333 | 637.49 |
| 8.9 | 0.74167 | 655.50 |
| 9 | 0.75000 | 673.81 |
| 9.1 | 0.75833 | 692.42 |
| 9.2 | 0.76667 | 711.34 |
| 9.3 | 0.77500 | 730.56 |
| 9.4 | 0.78333 | 750.08 |
| 9.5 | 0.79167 | 769.92 |
| 9.6 | 0.80000 | 790.05 |
| 9.7 | 0.80833 | 810.50 |
| 9.8 | 0.81667 | 831.27 |
| 9.9 | 0.82500 | 852.34 |
| 10 | 0.83333 | 873.73 |
| 10.1 | 0.84167 | 895.43 |
| 10.2 | 0.85000 | 917.45 |
| 10.3 | 0.85833 | 939.79 |
| 10.4 | 0.86667 | 962.46 |
| 10.5 | 0.87500 | 985.44 |
| 10.6 | 0.88333 | 1008.74 |
| 10.7 | 0.89167 | 1032.37 |
| 10.8 | 0.90000 | 1056.33 |
| 10.9 | 0.90833 | 1080.61 |
| 11 | 0.91667 | 1105.23 |

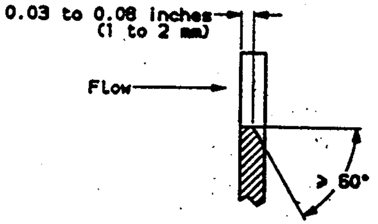
# ASTM D5242

## V NOTCH WEIRS



$$Q = (8/15)(2g)^{1/2} C_{eT} \tan(\theta/2) H^{5/2}$$

WHERE H = HEAD MEASURED IN FEET MEASURED BEHIND THE WEIR AT A DISTANCE EQUAL TO $4H_{MAX}$ TO $5H_{MAX}$ WHERE $H_{MAX}$ IS THE MAXIMUM HEAD ON THE WEIR



Notch edge section (A-A).

$g$ = ACCELERATION DUE TO GRAVITY
= 32.4 ft/sec$^2$

$\theta$ = NOTCH ANGLE

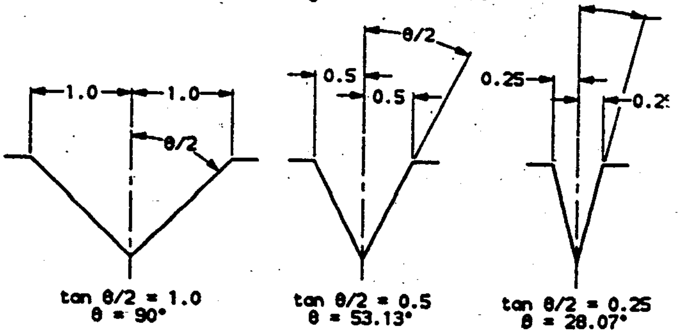


FIG. 4 Triangular Weirs

$C_{eT}$ DISCHARGE COEFFICIENT
= .579 FOR 90° WEIRS
= .576 FOR 60° WEIRS

Q = DISCHARGE IN CFS

## 90° WEIRS *

$$Q = 2.48\, H^{5/2}$$

CONDITIONS (LIMITS) →

$H/P \leq 1.2$
$H/B \leq 0.4$
$P \geq 0.3$ ft
$B \geq 2$ ft
$0.15\text{ ft} \leq H \leq 2\text{ ft}$

## 60° WEIRS

$$Q = 1.43\, H^{5/2}$$

CONDITIONS (LIMITS) →

$H/P \leq 0.4$
$H/B \leq 0.2$
$P \geq 1.5$ ft
$B \geq 3.0$ ft
$0.15\text{ ft} \leq H \leq 1.25\text{ ft}$

* FOR 90° WEIRS EPA PUBLICATION USES THE FOLLOWING EQUATION:

$Q = aH^b$ WHERE $a = 3.052$
$b = 2.466$

H IS IN FEET MEASURED AT THE NOTCH

Q = DISCHARGE IN CFS

# One and Three Foot Rectangular Weirs

$Q=3.33(L-0.2H)H^{1.5}$

where:

Q= Discharge $ft^3/sec$

L= length of weir opening in feet

H= head on weir in feet

## L= 1.0 (1 foot weir)

| H (inches) | H (feet) | $H^{1.5}$ | Q ($ft^3/sec$) | Q (gal/min) |
|---|---|---|---|---|
| 0.5 | 0.04 | 0.0085 | 0.028 | 12.61 |
| 0.6 | 0.05 | 0.0112 | 0.037 | 16.54 |
| 0.7 | 0.06 | 0.0141 | 0.046 | 20.81 |
| 0.8 | 0.07 | 0.0172 | 0.057 | 25.38 |
| 0.9 | 0.08 | 0.0205 | 0.067 | 30.24 |
| 1 | 0.08 | 0.0241 | 0.079 | 35.35 |
| 1.1 | 0.09 | 0.0278 | 0.091 | 40.72 |
| 1.2 | 0.10 | 0.0316 | 0.103 | 46.32 |
| 1.3 | 0.11 | 0.0357 | 0.116 | 52.13 |
| 1.4 | 0.12 | 0.0398 | 0.130 | 58.17 |
| 1.5 | 0.13 | 0.0442 | 0.143 | 64.40 |
| 1.6 | 0.13 | 0.0487 | 0.158 | 70.82 |
| 1.7 | 0.14 | 0.0533 | 0.173 | 77.43 |
| 1.8 | 0.15 | 0.0581 | 0.188 | 84.22 |
| 1.9 | 0.16 | 0.0630 | 0.203 | 91.18 |
| 2 | 0.17 | 0.0680 | 0.219 | 98.30 |
| 2.1 | 0.18 | 0.0732 | 0.235 | 105.58 |
| 2.2 | 0.18 | 0.0785 | 0.252 | 113.01 |
| 2.3 | 0.19 | 0.0839 | 0.269 | 120.60 |
| 2.4 | 0.20 | 0.0894 | 0.286 | 128.33 |
| 2.5 | 0.21 | 0.0951 | 0.303 | 136.19 |
| 2.6 | 0.22 | 0.1009 | 0.321 | 144.19 |
| 2.7 | 0.23 | 0.1067 | 0.339 | 152.33 |
| 2.8 | 0.23 | 0.1127 | 0.358 | 160.59 |
| 2.9 | 0.24 | 0.1188 | 0.376 | 168.97 |
| 3 | 0.25 | 0.1250 | 0.395 | 177.47 |
| 3.1 | 0.26 | 0.1313 | 0.415 | 186.09 |
| 3.2 | 0.27 | 0.1377 | 0.434 | 194.83 |
| 3.3 | 0.28 | 0.1442 | 0.454 | 203.67 |
| 3.4 | 0.28 | 0.1508 | 0.474 | 212.62 |
| 3.5 | 0.29 | 0.1575 | 0.494 | 221.68 |
| 3.6 | 0.30 | 0.1643 | 0.514 | 230.84 |
| 3.7 | 0.31 | 0.1712 | 0.535 | 240.10 |
| 3.8 | 0.32 | 0.1782 | 0.556 | 249.45 |
| 3.9 | 0.33 | 0.1853 | 0.577 | 258.90 |
| 4 | 0.33 | 0.1925 | 0.598 | 268.44 |
| 4.1 | 0.34 | 0.1997 | 0.620 | 278.07 |
| 4.2 | 0.35 | 0.2071 | 0.641 | 287.79 |
| 4.3 | 0.36 | 0.2145 | 0.663 | 297.60 |
| 4.4 | 0.37 | 0.2220 | 0.685 | 307.49 |
| 4.5 | 0.38 | 0.2296 | 0.707 | 317.46 |
| 4.6 | 0.38 | 0.2373 | 0.730 | 327.51 |
| 4.7 | 0.39 | 0.2451 | 0.752 | 337.63 |
| 4.8 | 0.40 | 0.2530 | 0.775 | 347.84 |
| 4.9 | 0.41 | 0.2609 | 0.798 | 358.11 |
| 5 | 0.42 | 0.2690 | 0.821 | 368.46 |
| 5.1 | 0.43 | 0.2771 | 0.844 | 378.88 |
| 5.2 | 0.43 | 0.2853 | 0.868 | 389.37 |
| 5.3 | 0.44 | 0.2935 | 0.891 | 399.92 |
| 5.4 | 0.45 | 0.3019 | 0.915 | 410.54 |
| 5.5 | 0.46 | 0.3103 | 0.939 | 421.23 |
| 5.6 | 0.47 | 0.3188 | 0.963 | 431.97 |
| 5.7 | 0.48 | 0.3274 | 0.987 | 442.78 |
| 5.8 | 0.48 | 0.3360 | 1.011 | 453.64 |
| 5.9 | 0.49 | 0.3448 | 1.035 | 464.57 |
| 6 | 0.50 | 0.3536 | 1.060 | 475.55 |
| 6.1 | 0.51 | 0.3624 | 1.084 | 486.58 |
| 6.2 | 0.52 | 0.3714 | 1.109 | 497.67 |
| 6.3 | 0.52 | 0.3804 | 1.134 | 508.81 |
| 6.4 | 0.53 | 0.3895 | 1.159 | 520.01 |
| 6.5 | 0.54 | 0.3987 | 1.184 | 531.25 |
| 6.6 | 0.55 | 0.4079 | 1.209 | 542.54 |
| 6.7 | 0.56 | 0.4172 | 1.234 | 553.88 |
| 6.8 | 0.57 | 0.4266 | 1.259 | 565.26 |
| 6.9 | 0.57 | 0.4360 | 1.285 | 576.69 |
| 7 | 0.58 | 0.4455 | 1.311 | 588.16 |

## L= 3.0 (3 foot weir)

| H (inches | H (feet) | Q ($ft^3/sec$) | Q (gal/min) |
|---|---|---|---|
| 0.5 | 0.04 | 0.085 | 38.03 |
| 0.6 | 0.05 | 0.111 | 49.96 |
| 0.7 | 0.06 | 0.140 | 62.92 |
| 0.8 | 0.07 | 0.171 | 76.83 |
| 0.9 | 0.08 | 0.204 | 91.63 |
| 1 | 0.08 | 0.239 | 107.26 |
| 1.1 | 0.09 | 0.276 | 123.67 |
| 1.2 | 0.10 | 0.314 | 140.84 |
| 1.3 | 0.11 | 0.354 | 158.71 |
| 1.4 | 0.12 | 0.395 | 177.27 |
| 1.5 | 0.13 | 0.438 | 196.49 |
| 1.6 | 0.13 | 0.482 | 216.35 |
| 1.7 | 0.14 | 0.528 | 236.81 |
| 1.8 | 0.15 | 0.575 | 257.86 |
| 1.9 | 0.16 | 0.623 | 279.49 |
| 2 | 0.17 | 0.672 | 301.67 |
| 2.1 | 0.18 | 0.723 | 324.40 |
| 2.2 | 0.18 | 0.775 | 347.65 |
| 2.3 | 0.19 | 0.828 | 371.41 |
| 2.4 | 0.20 | 0.882 | 395.67 |
| 2.5 | 0.21 | 0.937 | 420.42 |
| 2.6 | 0.22 | 0.993 | 445.64 |
| 2.7 | 0.23 | 1.050 | 471.33 |
| 2.8 | 0.23 | 1.108 | 497.48 |
| 2.9 | 0.24 | 1.168 | 524.07 |
| 3 | 0.25 | 1.228 | 551.10 |
| 3.1 | 0.26 | 1.289 | 578.55 |
| 3.2 | 0.27 | 1.351 | 606.43 |
| 3.3 | 0.28 | 1.414 | 634.72 |
| 3.4 | 0.28 | 1.478 | 663.41 |
| 3.5 | 0.29 | 1.543 | 692.50 |
| 3.6 | 0.30 | 1.609 | 721.98 |
| 3.7 | 0.31 | 1.675 | 751.85 |
| 3.8 | 0.32 | 1.743 | 782.09 |
| 3.9 | 0.33 | 1.811 | 812.70 |
| 4 | 0.33 | 1.880 | 843.68 |
| 4.1 | 0.34 | 1.950 | 875.02 |
| 4.2 | 0.35 | 2.020 | 906.71 |
| 4.3 | 0.36 | 2.092 | 938.75 |
| 4.4 | 0.37 | 2.164 | 971.13 |
| 4.5 | 0.38 | 2.237 | 1003.85 |
| 4.6 | 0.38 | 2.310 | 1036.91 |
| 4.7 | 0.39 | 2.385 | 1070.29 |
| 4.8 | 0.40 | 2.460 | 1104.00 |
| 4.9 | 0.41 | 2.536 | 1138.03 |
| 5 | 0.42 | 2.612 | 1172.38 |
| 5.1 | 0.43 | 2.689 | 1207.03 |
| 5.2 | 0.43 | 2.767 | 1242.00 |
| 5.3 | 0.44 | 2.846 | 1277.26 |
| 5.4 | 0.45 | 2.925 | 1312.83 |
| 5.5 | 0.46 | 3.005 | 1348.69 |
| 5.6 | 0.47 | 3.086 | 1384.85 |
| 5.7 | 0.48 | 3.167 | 1421.29 |
| 5.8 | 0.48 | 3.249 | 1458.02 |
| 5.9 | 0.49 | 3.331 | 1495.03 |
| 6 | 0.50 | 3.414 | 1532.32 |
| 6.1 | 0.51 | 3.498 | 1569.89 |
| 6.2 | 0.52 | 3.582 | 1607.72 |
| 6.3 | 0.52 | 3.667 | 1645.83 |
| 6.4 | 0.53 | 3.753 | 1684.20 |
| 6.5 | 0.54 | 3.839 | 1722.83 |
| 6.6 | 0.55 | 3.925 | 1761.73 |
| 6.7 | 0.56 | 4.013 | 1800.88 |
| 6.8 | 0.57 | 4.100 | 1840.29 |
| 6.9 | 0.57 | 4.189 | 1879.94 |
| 7 | 0.58 | 4.278 | 1919.85 |

# Two and Four Foot Rectangular Weirs

$$Q=3.33(L-0.2H)H^{1.5}$$

where:

$Q$= Discharge ft$^3$/sec

$L$= length of weir opening in feet

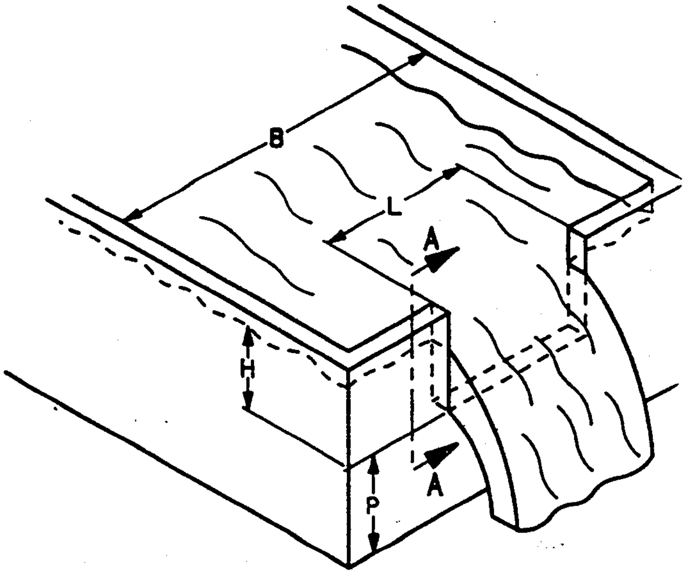
$H$= head on weir in feet

**L= 2.0 (2 foot weir)**

| H (inches) | H (feet) | $H^{1.5}$ | Q (ft$^3$/sec) | Q (gal/min) |
|---|---|---|---|---|
| 0.5 | 0.04 | 0.0085 | 0.056 | 25.32 |
| 0.6 | 0.05 | 0.0112 | 0.074 | 33.25 |
| 0.7 | 0.06 | 0.0141 | 0.093 | 41.87 |
| 0.8 | 0.07 | 0.0172 | 0.114 | 51.11 |
| 0.9 | 0.08 | 0.0205 | 0.136 | 60.93 |
| 1 | 0.08 | 0.0241 | 0.159 | 71.31 |
| 1.1 | 0.09 | 0.0278 | 0.183 | 82.19 |
| 1.2 | 0.10 | 0.0316 | 0.209 | 93.58 |
| 1.3 | 0.11 | 0.0357 | 0.235 | 105.42 |
| 1.4 | 0.12 | 0.0398 | 0.262 | 117.72 |
| 1.5 | 0.13 | 0.0442 | 0.291 | 130.45 |
| 1.6 | 0.13 | 0.0487 | 0.320 | 143.58 |
| 1.7 | 0.14 | 0.0533 | 0.350 | 157.12 |
| 1.8 | 0.15 | 0.0581 | 0.381 | 171.04 |
| 1.9 | 0.16 | 0.0630 | 0.413 | 185.33 |
| 2 | 0.17 | 0.0680 | 0.446 | 199.99 |
| 2.1 | 0.18 | 0.0732 | 0.479 | 214.99 |
| 2.2 | 0.18 | 0.0785 | 0.513 | 230.33 |
| 2.3 | 0.19 | 0.0839 | 0.548 | 246.00 |
| 2.4 | 0.20 | 0.0894 | 0.584 | 262.00 |
| 2.5 | 0.21 | 0.0951 | 0.620 | 278.31 |
| 2.6 | 0.22 | 0.1009 | 0.657 | 294.92 |
| 2.7 | 0.23 | 0.1067 | 0.695 | 311.83 |
| 2.8 | 0.23 | 0.1127 | 0.733 | 329.03 |
| 2.9 | 0.24 | 0.1188 | 0.772 | 346.52 |
| 3 | 0.25 | 0.1250 | 0.812 | 364.29 |
| 3.1 | 0.26 | 0.1313 | 0.852 | 382.32 |
| 3.2 | 0.27 | 0.1377 | 0.893 | 400.63 |
| 3.3 | 0.28 | 0.1442 | 0.934 | 419.19 |
| 3.4 | 0.28 | 0.1508 | 0.976 | 438.02 |
| 3.5 | 0.29 | 0.1575 | 1.018 | 457.09 |
| 3.6 | 0.30 | 0.1643 | 1.062 | 476.41 |
| 3.7 | 0.31 | 0.1712 | 1.105 | 495.97 |
| 3.8 | 0.32 | 0.1782 | 1.149 | 515.77 |
| 3.9 | 0.33 | 0.1853 | 1.194 | 535.80 |
| 4 | 0.33 | 0.1925 | 1.239 | 556.06 |
| 4.1 | 0.34 | 0.1997 | 1.285 | 576.54 |
| 4.2 | 0.35 | 0.2071 | 1.331 | 597.25 |
| 4.3 | 0.36 | 0.2145 | 1.377 | 618.17 |
| 4.4 | 0.37 | 0.2220 | 1.424 | 639.31 |
| 4.5 | 0.38 | 0.2296 | 1.472 | 660.65 |
| 4.6 | 0.38 | 0.2373 | 1.520 | 682.21 |
| 4.7 | 0.39 | 0.2451 | 1.569 | 703.96 |
| 4.8 | 0.40 | 0.2530 | 1.617 | 725.92 |
| 4.9 | 0.41 | 0.2609 | 1.667 | 748.07 |
| 5 | 0.42 | 0.2690 | 1.717 | 770.42 |
| 5.1 | 0.43 | 0.2771 | 1.767 | 792.96 |
| 5.2 | 0.43 | 0.2853 | 1.817 | 815.68 |
| 5.3 | 0.44 | 0.2935 | 1.869 | 838.59 |
| 5.4 | 0.45 | 0.3019 | 1.920 | 861.69 |
| 5.5 | 0.46 | 0.3103 | 1.972 | 884.96 |
| 5.6 | 0.47 | 0.3188 | 2.024 | 908.41 |
| 5.7 | 0.48 | 0.3274 | 2.077 | 932.04 |
| 5.8 | 0.48 | 0.3360 | 2.130 | 955.83 |
| 5.9 | 0.49 | 0.3448 | 2.183 | 979.80 |
| 6 | 0.50 | 0.3536 | 2.237 | 1003.94 |
| 6.1 | 0.51 | 0.3624 | 2.291 | 1028.24 |
| 6.2 | 0.52 | 0.3714 | 2.346 | 1052.70 |
| 6.3 | 0.52 | 0.3804 | 2.400 | 1077.32 |
| 6.4 | 0.53 | 0.3895 | 2.456 | 1102.10 |
| 6.5 | 0.54 | 0.3987 | 2.511 | 1127.04 |
| 6.6 | 0.55 | 0.4079 | 2.567 | 1152.13 |
| 6.7 | 0.56 | 0.4172 | 2.623 | 1177.38 |
| 6.8 | 0.57 | 0.4266 | 2.680 | 1202.77 |
| 6.9 | 0.57 | 0.4360 | 2.737 | 1228.32 |
| 7 | 0.58 | 0.4455 | 2.794 | 1254.01 |

**L= 4.0 (4 foot weir)**

| H (inches) | H (feet) | Q (ft$^3$/sec) | Q (gal/min) |
|---|---|---|---|
| 0.5 | 0.04 | 0.113 | 50.74 |
| 0.6 | 0.05 | 0.149 | 66.67 |
| 0.7 | 0.06 | 0.187 | 83.98 |
| 0.8 | 0.07 | 0.229 | 102.56 |
| 0.9 | 0.08 | 0.273 | 122.33 |
| 1 | 0.08 | 0.319 | 143.21 |
| 1.1 | 0.09 | 0.368 | 165.15 |
| 1.2 | 0.10 | 0.419 | 188.10 |
| 1.3 | 0.11 | 0.472 | 212.00 |
| 1.4 | 0.12 | 0.528 | 236.83 |
| 1.5 | 0.13 | 0.585 | 262.54 |
| 1.6 | 0.13 | 0.644 | 289.11 |
| 1.7 | 0.14 | 0.705 | 316.50 |
| 1.8 | 0.15 | 0.768 | 344.69 |
| 1.9 | 0.16 | 0.833 | 373.65 |
| 2 | 0.17 | 0.899 | 403.36 |
| 2.1 | 0.18 | 0.967 | 433.81 |
| 2.2 | 0.18 | 1.036 | 464.96 |
| 2.3 | 0.19 | 1.107 | 496.82 |
| 2.4 | 0.20 | 1.179 | 529.34 |
| 2.5 | 0.21 | 1.253 | 562.53 |
| 2.6 | 0.22 | 1.329 | 596.37 |
| 2.7 | 0.23 | 1.406 | 630.84 |
| 2.8 | 0.23 | 1.484 | 665.93 |
| 2.9 | 0.24 | 1.563 | 701.62 |
| 3 | 0.25 | 1.644 | 737.91 |
| 3.1 | 0.26 | 1.726 | 774.79 |
| 3.2 | 0.27 | 1.810 | 812.23 |
| 3.3 | 0.28 | 1.894 | 850.24 |
| 3.4 | 0.28 | 1.980 | 888.81 |
| 3.5 | 0.29 | 2.068 | 927.91 |
| 3.6 | 0.30 | 2.156 | 967.55 |
| 3.7 | 0.31 | 2.245 | 1007.72 |
| 3.8 | 0.32 | 2.336 | 1048.41 |
| 3.9 | 0.33 | 2.428 | 1089.60 |
| 4 | 0.33 | 2.521 | 1131.30 |
| 4.1 | 0.34 | 2.615 | 1173.49 |
| 4.2 | 0.35 | 2.710 | 1216.16 |
| 4.3 | 0.36 | 2.806 | 1259.32 |
| 4.4 | 0.37 | 2.903 | 1302.95 |
| 4.5 | 0.38 | 3.001 | 1347.05 |
| 4.6 | 0.38 | 3.101 | 1391.61 |
| 4.7 | 0.39 | 3.201 | 1436.62 |
| 4.8 | 0.40 | 3.302 | 1482.09 |
| 4.9 | 0.41 | 3.405 | 1527.99 |
| 5 | 0.42 | 3.508 | 1574.33 |
| 5.1 | 0.43 | 3.612 | 1621.11 |
| 5.2 | 0.43 | 3.717 | 1668.31 |
| 5.3 | 0.44 | 3.823 | 1715.94 |
| 5.4 | 0.45 | 3.930 | 1763.98 |
| 5.5 | 0.46 | 4.038 | 1812.43 |
| 5.6 | 0.47 | 4.147 | 1861.29 |
| 5.7 | 0.48 | 4.257 | 1910.55 |
| 5.8 | 0.48 | 4.368 | 1960.21 |
| 5.9 | 0.49 | 4.479 | 2010.27 |
| 6 | 0.50 | 4.592 | 2060.71 |
| 6.1 | 0.51 | 4.705 | 2111.54 |
| 6.2 | 0.52 | 4.819 | 2162.75 |
| 6.3 | 0.52 | 4.934 | 2214.34 |
| 6.4 | 0.53 | 5.050 | 2266.30 |
| 6.5 | 0.54 | 5.166 | 2318.63 |
| 6.6 | 0.55 | 5.284 | 2371.32 |
| 6.7 | 0.56 | 5.402 | 2424.38 |
| 6.8 | 0.57 | 5.521 | 2477.80 |
| 6.9 | 0.57 | 5.641 | 2531.57 |
| 7 | 0.58 | 5.761 | 2585.69 |



B= CHANNEL WIDTH

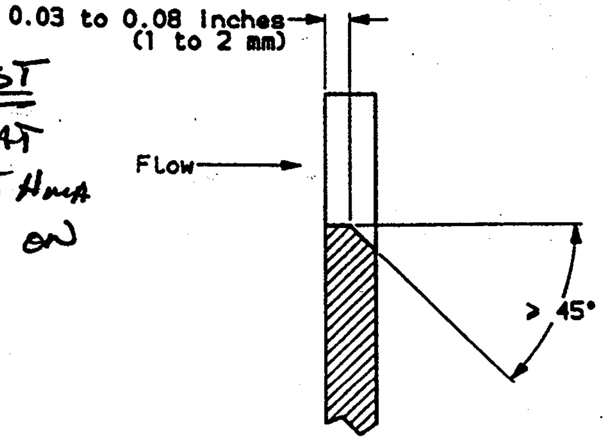
## RECTANGULAR WEIRS

$$Q = 3.33(L - 0.2H)H^{1.5}$$

$L$ = LENGHT OF WER OPENING IN FT

$H$ = HEAD ON WEIR IN FEET. HEAD <u>MUST</u> BE MEASURED BACK IN THE POOL AT A DISTANCE AT LEAST $4H_{MAX}$ TO $5H_{MA}$ WHERE $H_{MAX}$ IS THE MAXIMUM HEAD ON THE WEIR

$Q$ = DISCHARGE IN CFS



Notch edge section (A-A).

CONDITIONS (LIMITS) OF APPLICATION:

$H/P \leq 2$

$H \geq 0.1$ FT

$L \geq 0.5$ FT

$P \geq 0.3$ FT

NOTE: THE ABOVE EQUATION MAY BE INVALID FOR $L > 4.0$ FT AND/OR $H > 2.0$ FT ACCORDING TO ASTM D5242

# Stream Flow Measurements – General Notes

**Open Channel Flow:** The discharge is calculated using the following equation

$$Q = V_m * A$$

Where:
Q = Discharge in cubic feet per second
Vm = Mean (average) velocity in feet per second
A = cross-sectional area in square feet

The cross-sectional area is determined by measurements of water depth (D) and corresponding channel section length (L); $A = L*D$

In order to convert the flow in cubic feet per second (CFS) to Gallons per Minute (GPM) multiply this number by 448.8

$$Q(GPM) = Q(CFS) * 448.8$$

**Velocity Distribution:** Flow velocities vary both across the stream and also with depth. We can account for the difference across the stream section by taking a number of velocity measurements. Since the flow also varies with depth at any given point in the stream, there are also methods to deal with this problem in order to give us a reasonable estimate of the average (mean) velocity (Vm)

For stream depths of 2.5 feet or less a velocity taken at 6/10 ths of the total depth is assumed to be representative of the mean velocity (Vm)

For stream depths of 2.5 feet or greater 2 velocity measurements are made one at 2/10 ths and one at 8/10 ths of the total depth. The average of these two measurements is assumed to be the mean velocity (Vm)

When using a floating object you are actually measuring the surface velocity and this measurement should be multiplied by 0.85 in order to be representative of the mean velocity (Vm).

**Site selection:** In order to obtain the best possible accuracy you should select a portion of the stream that has the following characteristics:

1. A straight reach with flow parallel to the streambanks
2. A stable streambed free of large rocks, weeds and obstructions.
3. The channel should have as much straight run as possible look for sections which have straight upstream lenghts which are at least twice the width of the stream
4. Avoid areas immediately downstream of bridges, culverts and other obstructions.

# Stream Flow Measurment using the Floating Object Method

**Stream Station:**

**Date:**

**Method:** measure a section along the streambank and determine the time it takes for a float to travel this distance. The section length should be long enough so that the float is timed for at least 10 to 20 seconds. Do this in at least 5 (depending upon stream width) different points across the width of the stream. Repeat the measurment at least 3 times at each point and determine the average time at each point. Also measure the water depth at each point in order to determine the cross-sectional area. The Discharge (Q) is determined multiplying the velocity (v) by the cross-sectional area (A). It is important to note that the surface velocity you have determined with the floating object should be adjusted to represent the average sectional velocity. This is done by multiplying the surface velocity by 0.85.

Float Section Length = _______ feet

| Location (from left Bank) | Section width (feet) | Water Depth (feet) | Trial 1 Time (seconds) | Trial 2 Time (seconds) | Trial 3 Time (seconds) | Average Time (seconds) | Average velocity (ft/sec) | Adjusted velocity (ft/sec) | Section Discharge ($ft^3$/sec) |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
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| | | | | | | | | | |

Average Time = (Trial 1 + Trial 2 + Trial 3) / 3

Average Velocity (ft/sec) = Float Sectional Length (feet) / Average Time (seconds)

Adjusted Velocity (ft/sec) = Average velocity (ft/sec) * 0.85

Section Dischatge ($ft^3$/sec) = Section width (ft) * Water Depth (ft) * Adjusted Velocity (ft/sec)

Total Discharge ($ft^3$/sec) = sum of section discharges

Note : to convert the discharge from $ft^3$/sec (cubic feet per second) to gallons per minute multiply by 448.8

## Stream Flow Measurment using the Floating Object Method

Stream Station:

Date:

**EXAMPLE**

**Method:** measure a section along the streambank and determine the time it takes for a float to travel this distance. The section length should be long enough so that the float is timed for at least 10 to 20 seconds. Do this in at least 5 (depending upon stream width) different points across the width of the stream. Repeat the measurment at least 3 times at each point and determine the average time at each point. Also measure the water depth at each point in order to determine the cross-sectional area. The Discharge (Q) is determined multiplying the velocity (v) by the cross-sectional area (A). It is important to note that the surface velocity you have determined with the floating object should be adjusted to represent the average sectional velocity. This is done by multiplying the surface velocity by 0.85.

Float Section Length = __20_ feet

| Location (from left Bank) | Section width (feet) | Water Depth (feet) | Trial 1 Time (seconds) | Trial 2 Time (seconds) | Trial 3 Time (seconds) | Average Time (seconds) | Average velocity (ft/sec) | Adjusted velocity (ft/sec) | Section Discharge ($ft^3$/sec) |
|---|---|---|---|---|---|---|---|---|---|
| 2 | 3 | 0.2 | 20 | 25 | 24 | 23 | 0.87 | 0.74 | 0.44 |
| 4 | 2 | 0.5 | 19 | 15 | 17 | 17 | 1.18 | 1.00 | 1.00 |
| 6 | 2 | 1 | 15 | 14 | 15 | 14.7 | 1.36 | 1.16 | 2.32 |
| 8 | 2 | 0.6 | 20 | 22 | 22 | 21.3 | 0.94 | 0.80 | 0.96 |
| 10 | 3 | 0.2 | 23 | 25 | 26 | 24.7 | 0.81 | 0.69 | 0.41 |

Total Discharge = 0.44+1.00+2.32+0.96+0.41
= 5.13 ft3/sec
= 2302 gallons per minute

Average Time = (Trial 1 + Trial 2 + Trial 3) / 3
Average Velocity (ft/sec) = Float Sectional Length (feet) / Average Time (seconds)
Adjusted Velocity (ft/sec) = Average velocity (ft/sec) * 0.85
Section Dischatge ($ft^3$/sec) = Section width (ft) * Water Depth (ft) * Adjusted Velocity (ft/sec)

Total Discharge ($ft^3$/sec) = sum of section discharges

Note : to convert the discharge from $ft^3$/sec (cubic feet per second) to gallons per minute multiply by 448.8