# Hydro Site Evaluation

**This is a walk through guide for determining if your hydro site has the resources to power our hydro turbines effectively. It is very important to evaluate the site correctly because bad or missing data can lead to improper sizing of the system. To get the most out of our system, accurate measurements and appraisal allow us to design the best system for your situation.**

## Both Head and Flow are needed to determine power output.

1. **Head** (the vertical distance between water source to where the turbine sits)

2. **Flow** (water volume in gallons per minute)

## How to determine Head pressure

One foot of elevation = **.434** Pounds per Square Inch (PSI)

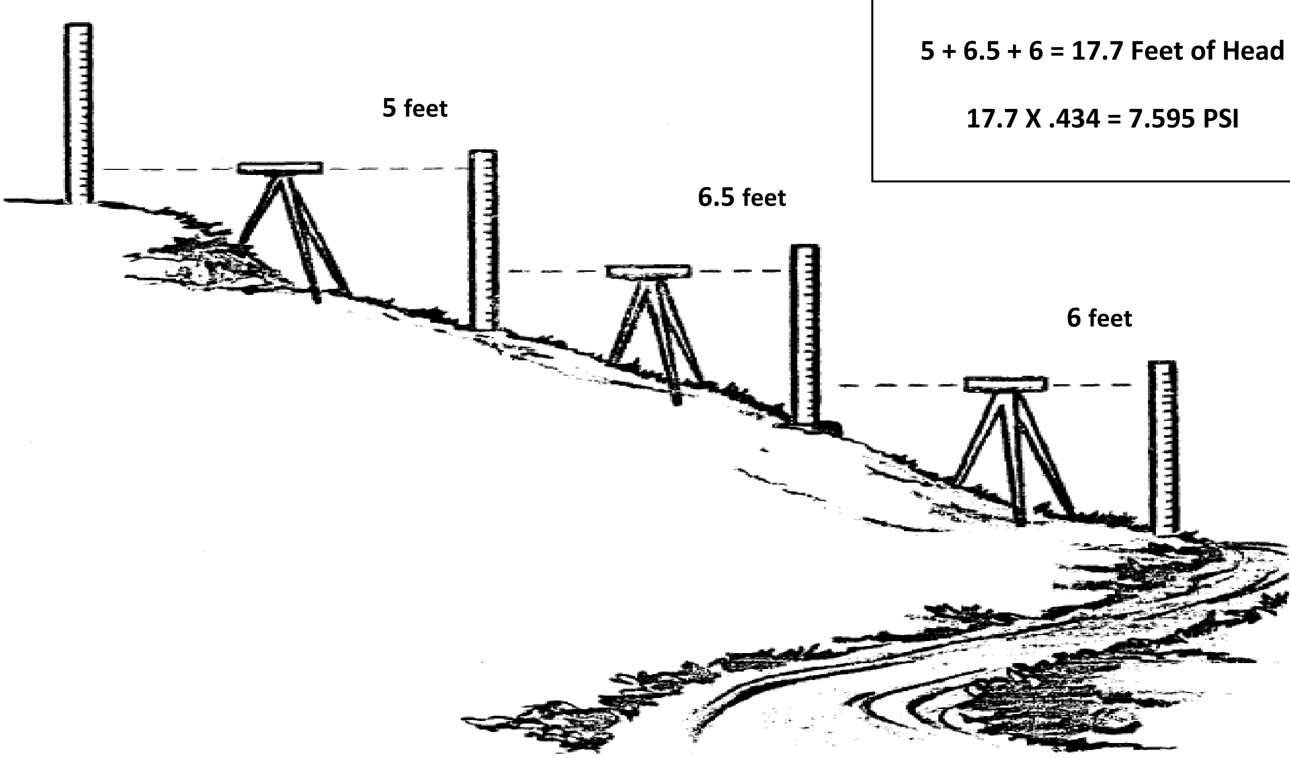
**Example:** 45 feet of Head is equal to 45 x .434 = **19.53** (PSI) Head Pressure

Below we will go through several ways of measuring Head. The first way is to use a laser level, string level or transit to measure multiple drops that will add up to the total vertical footage. Mount the laser on a tripod and level it so that it points to the bottom of the previous measurement, then point it toward the new area being measured. Use a measuring stick or tape measure to find the distance from the laser beam to the ground. Move the tripod to the new area just measured and repeat the measuring technique. When you have reached the turbine, take all the measurements and add them together to get the total vertical drop from water inlet to turbine.

**Example:**

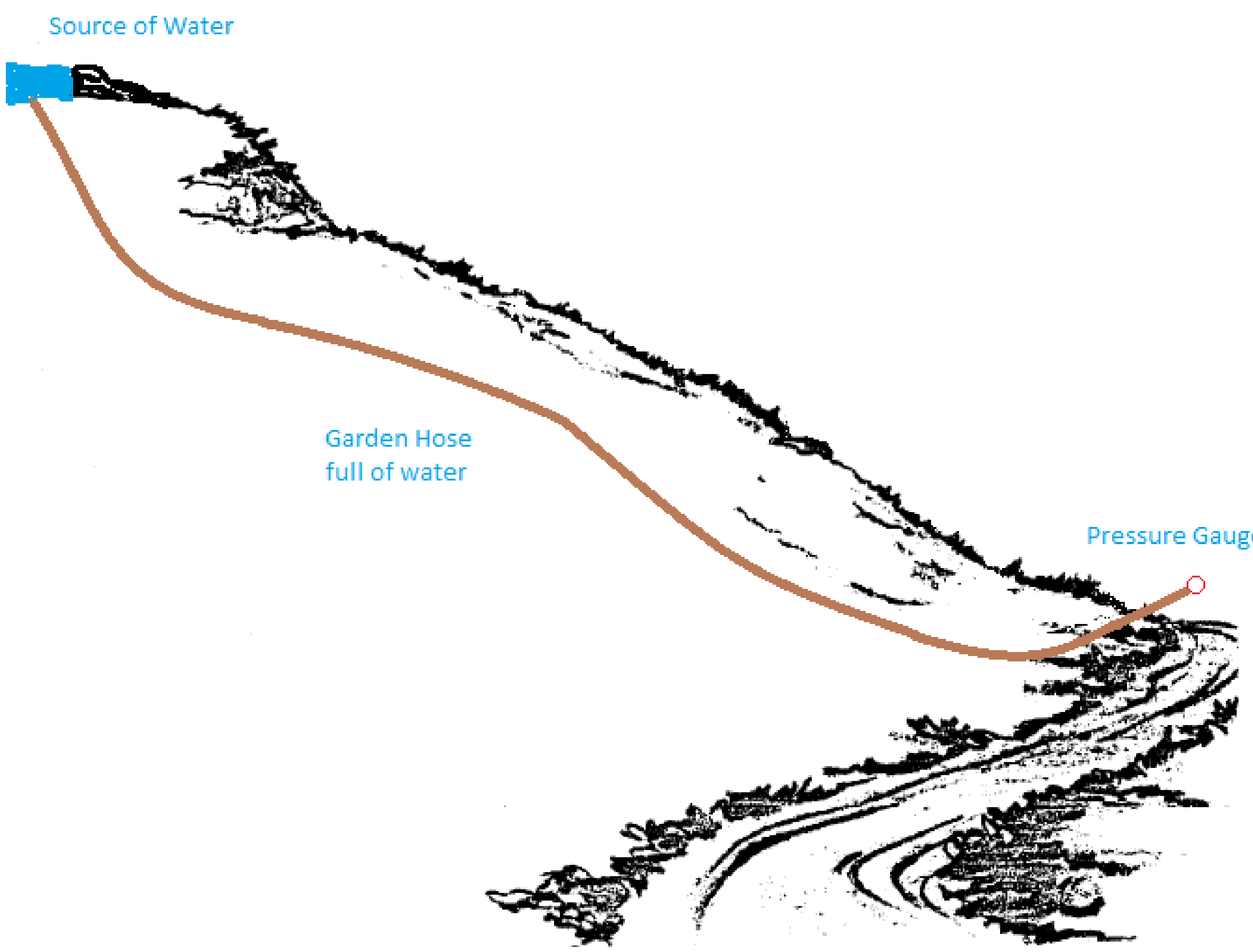
**5 + 6.5 + 6 = 17.7 Feet of Head**

**17.7 X .434 = 7.595 PSI**



Another way of measuring head is to use a random sized hose full of water that goes from the source water to the bottom where the turbine sits. On the lower end of the hose install a simple pressure water gauge that measures PSI. Be sure the gauge is able to measure more than maximum estimated pressure at the end of the hose. The PSI reading can be converted to Head by dividing.    (PSI) / .434. = HEAD

**Example:** 38 PSI divided by .434 would be 87.56 feet of Head



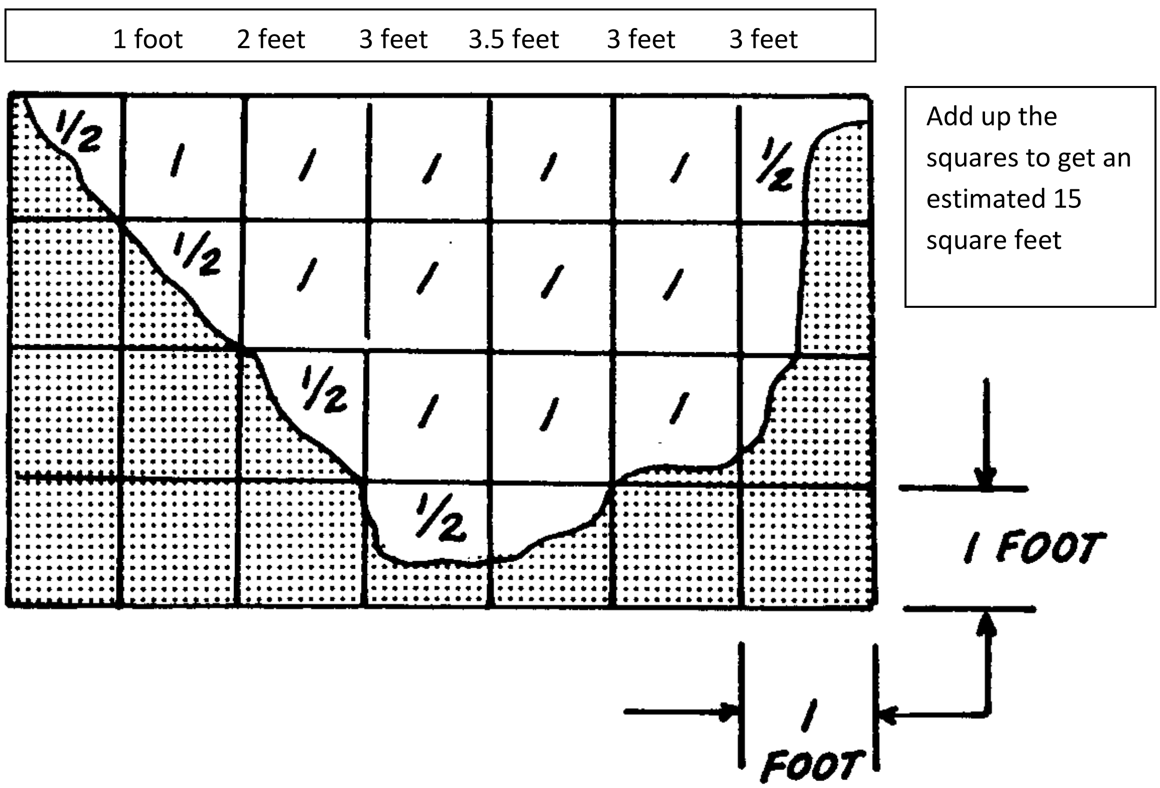
# How to determine Flow

The flow rate is the quantity of water usually measured in cubic feet or liters flowing past a point in a given time. These figures are then converted to gallons per minute. The first of three methods described here includes measuring the stream bed (creating a cross-section diagram), setting up a Weir and/or use a container to figure out gpm.

## First Method---Cross-Section Formula

1. **Find the (Area) Cross-Section of flowing water**

The stream will probably have different depths along its length so select a place where the depth of the stream is average. Draft out on graph paper based on one foot sections. Measure across the stream every foot to get the data needed. Draw in the stream contour based on the measurements taken.




Add up the square feet to get an estimated cross section figure. The about diagram shows and estimated 15 square feet.

2. **Find the velocity of flow**

Put a float in the stream and measure the distance of travel in 30 seconds or 1 minute depending on conditions. The width of the stream should be as constant as possible and free of rapids where the velocity is being measured.

A weighted float which sits upright in the water should be used instead of a light float than can be whipped around by wind and surface currents. Put float into water and start timer. Measures the distance traveled in 30 or 60 seconds. Divide by .5 if 30 second time measurement is used.

### 3. Formula

The formula is: Q = K x A x V

Q = Flow in U.S. gallons per minute

A = Cross-section of stream in square feet

V = Stream velocity in feet per minute

K = A corrected conversion factor: 6.4 for normal stages; 6.7 to 7.1 for flood stages

**Example:**

Cross-section is 15 square feet

Velocity of float = 20 feet traveled in .5 minutes (30 seconds)

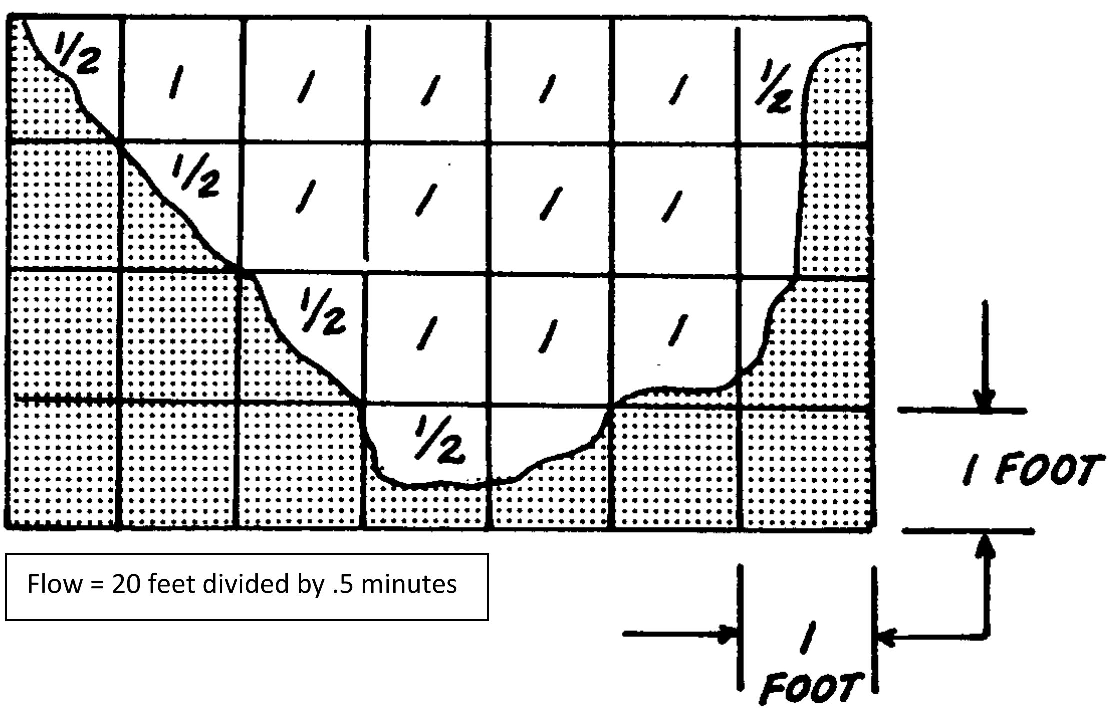
Stream Flow is normal, so use 6.4

Q = 6.4 x 15 x 20/.5

Q = 3840 gallons per minute

Cross-section = 15 square feet

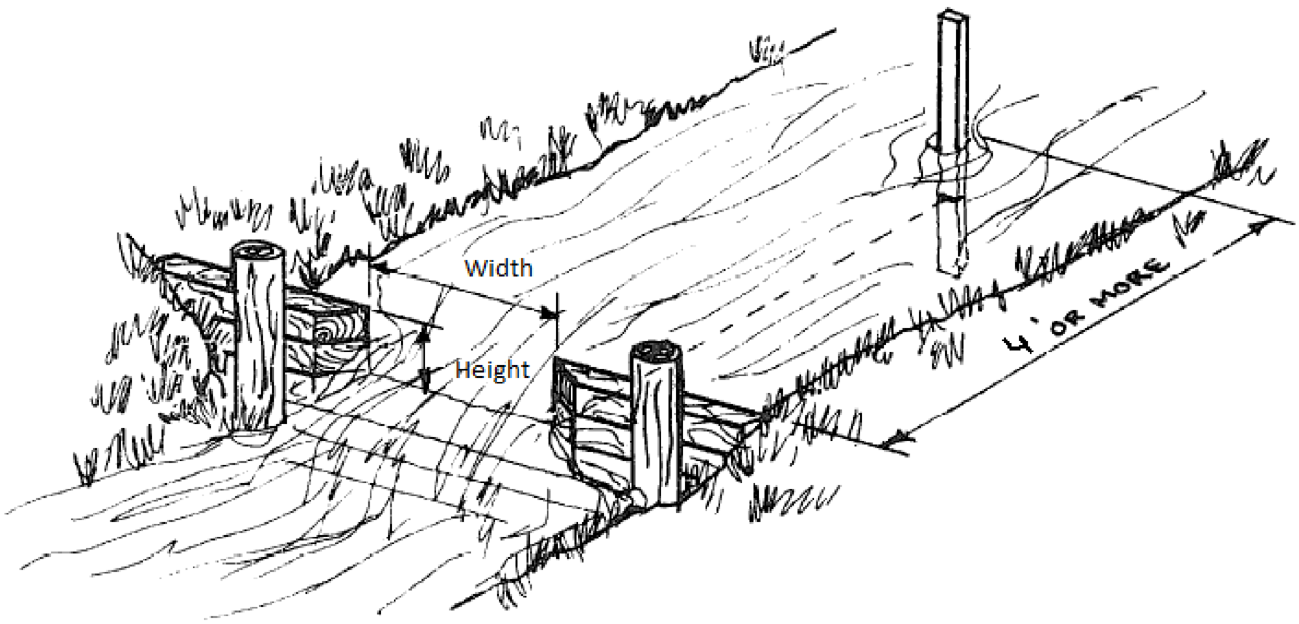
Flow is normal for average time of year




Flow = 20 feet divided by .5 minutes

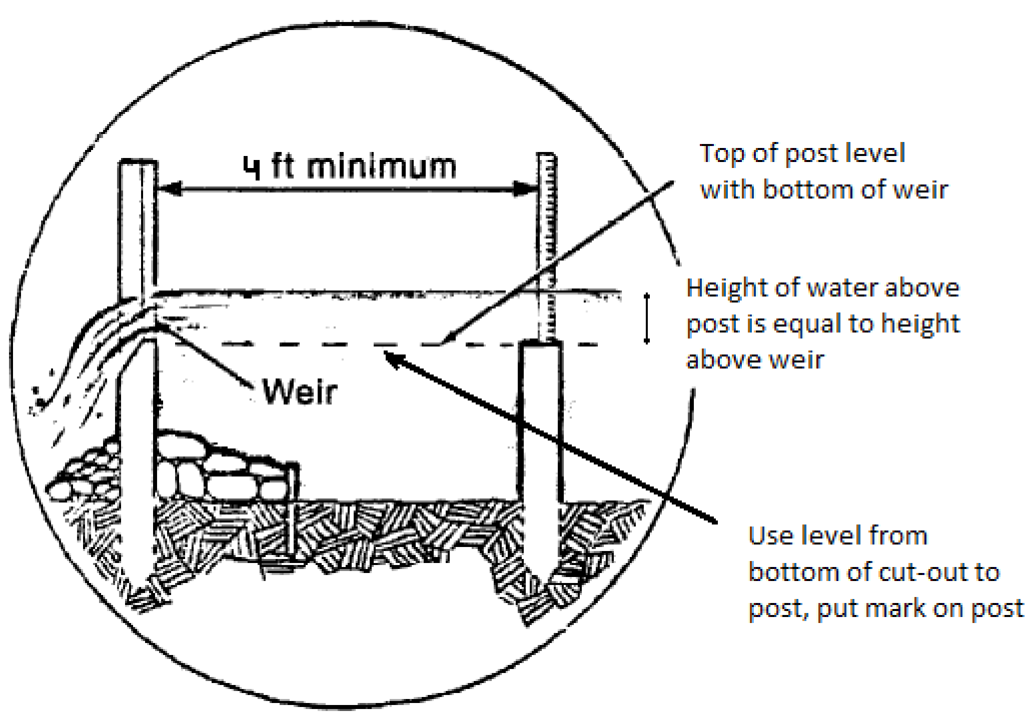
# Second Method---Weir

The Weir method of measuring uses a temperary dam control to get accurate flow measurements. The method uses a rectangle cut-out to accuratly measure the flow volume. Install a tempory dam across the stream with the cut-out match ing the stream size. A two or three foot wide flow area is standard, but may be bigger if needed. Place measuring post up stream about 4 feet to be able to measure the rise of water. The post needs to be upstream because water dept will actually be lower closer to the weir.

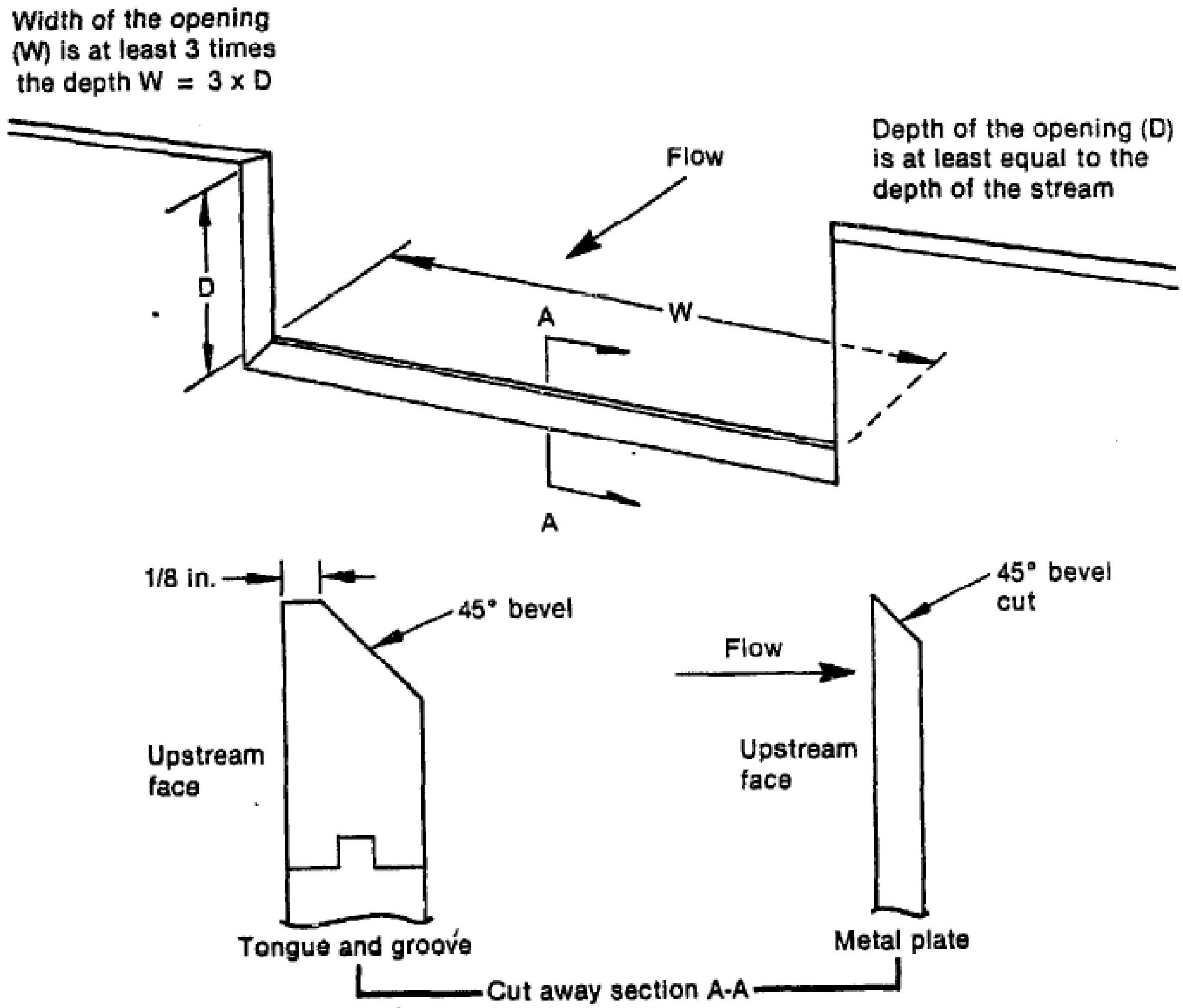



Use a 4 or 6 foot level to measure across the bottom of the rectangular cut-out over to the measuring post.

**Side View**



When building the weir rectangle cut-out, you need to use 45 degree bevel cuts to achieve more accurate water depth measurements. Anchor the sides firmly with large rocks or posts to withstand the force of the water.



**Use the following chart to estimate the flow.**

**Width**___ weir cut-out by the foot---

**Depth**____ water measured by inches at the post from level mark to top of water

| | |
|---|---|
| **Example:** | the water depth is 4 inches, 2 foot long cut-out weir |
| | 287 X 2(feet) = **574** Gallons per minute |

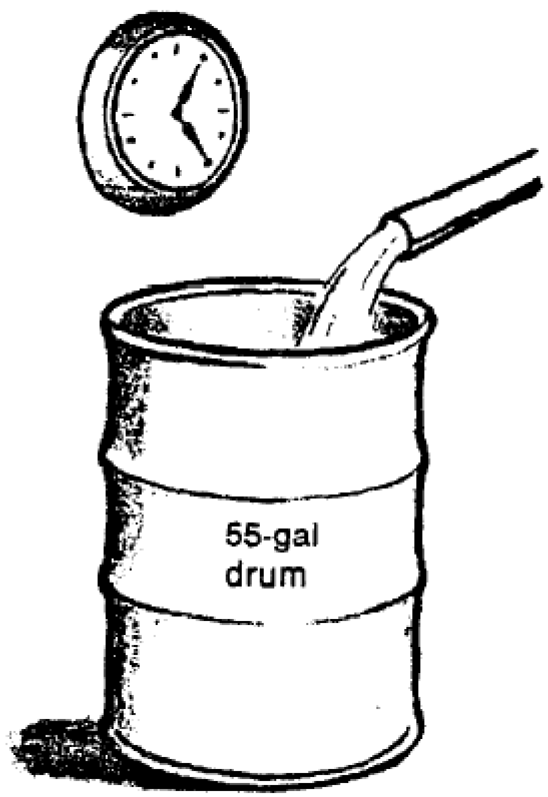
# Water Flow Estimate Over a Weir

| DEPTH (INCHES) | DISHCHARGE PER FOOT OF WEIR WIDTH | | DEPTH (INCHES) | DISHCHARGE PER FOOT OF WEIR WIDTH | |
|---|---|---|---|---|---|
| | CFS | GPM | | CFS | GPM |
| 1/2 | .03 | 13 | 7 | 1.48 | 665 |
| 3/4 | .05 | 24 | 7 1/4 | 1.56 | 702 |
| 1 | .08 | 36 | 7 1/2 | 1.65 | 738 |
| 1 1/4 | .11 | 50 | 7 3/4 | 1.73 | 776 |
| 1 1/2 | .15 | 66 | 8 | 1.81 | 814 |
| 1 3/4 | .19 | 83 | 8 1/4 | 1.90 | 853 |
| 2 | .23 | 102 | 8 1/2 | 1.98 | 890 |
| 2 1/4 | .27 | 122 | 8 3/4 | 2.07 | 930 |
| 2 1/2 | .32 | 142 | 9 | 2.16 | 971 |
| 2 3/4 | .36 | 164 | 9 1/4 | 2.25 | 1012 |
| 3 | .42 | 187 | 9 1/2 | 2.35 | 1053 |
| 3 1/4 | .47 | 211 | 9 3/4 | 2.44 | 1096 |
| 3 1/2 | .53 | 236 | 10 | 2.53 | 1136 |
| 3 3/4 | .58 | 262 | 10 1/4 | 2.63 | 1179 |
| 4 | .64 | 287 | 10 1/2 | 2.73 | 1223 |
| 4 1/4 | .70 | 315 | 10 3/4 | 2.82 | 1268 |
| 4 1/2 | .77 | 343 | 11 | 2.92 | 1312 |
| 4 3/4 | .83 | 372 | 11 1/4 | 3.03 | 1358 |
| 5 | .90 | 402 | 11 1/2 | 3.12 | 1401 |
| 5 1/4 | .97 | 433 | 11 3/4 | 3.23 | 1448 |
| 5 1/2 | 1.03 | 463 | 12 | 3.33 | 1495 |
| 5 3/4 | 1.10 | 495 | | | |
| 6 | 1.18 | 528 | | | |
| 6 1/4 | 1.25 | 562 | | | |
| 6 1/2 | 1.33 | 596 | | | |
| 6 3/4 | 1.41 | 631 | | | |

## Third Method---Bucket or Barrel

1. First take a bucket or barrel and figure out its capacity in gallons.
2. Fill up the container with water source to be measured and count the seconds it takes to fill it
3. Divide the container capacity by the seconds it took to fill
4. Take the gallons per second and times it by 60 to get gallons per minute

| | |
|---|---|
| **Example:** | **55 gallon barrel, it takes 28 seconds to fill** |
| | **55 gallons divided by 28 = 1.96 gallons per second** |
| | **1.96 X 60 = 117.6 gallons per minute** |



When the head and flow measurements are determined, we then can decide if the turbine will work for your situation. Typically a head of at least 20 feet and 300 gpm are needed. The turbine will put out voltages at lower head, but not enough to power your basic utilities.

The last step is to let us know what the site figures are so we can help you design the pipe and wire sizes. The pipe is subject to friction loss and the wire is calculated for voltage loss.

**Head**

**Flow**

**Distance of pipe from inlet to turbine**

**Distance from turbine to charge controller/battery bank or converter to grid tie**

Sometimes figuring out the details for the hydro site can be difficult. If you run into any problems please let us know and we can help you.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