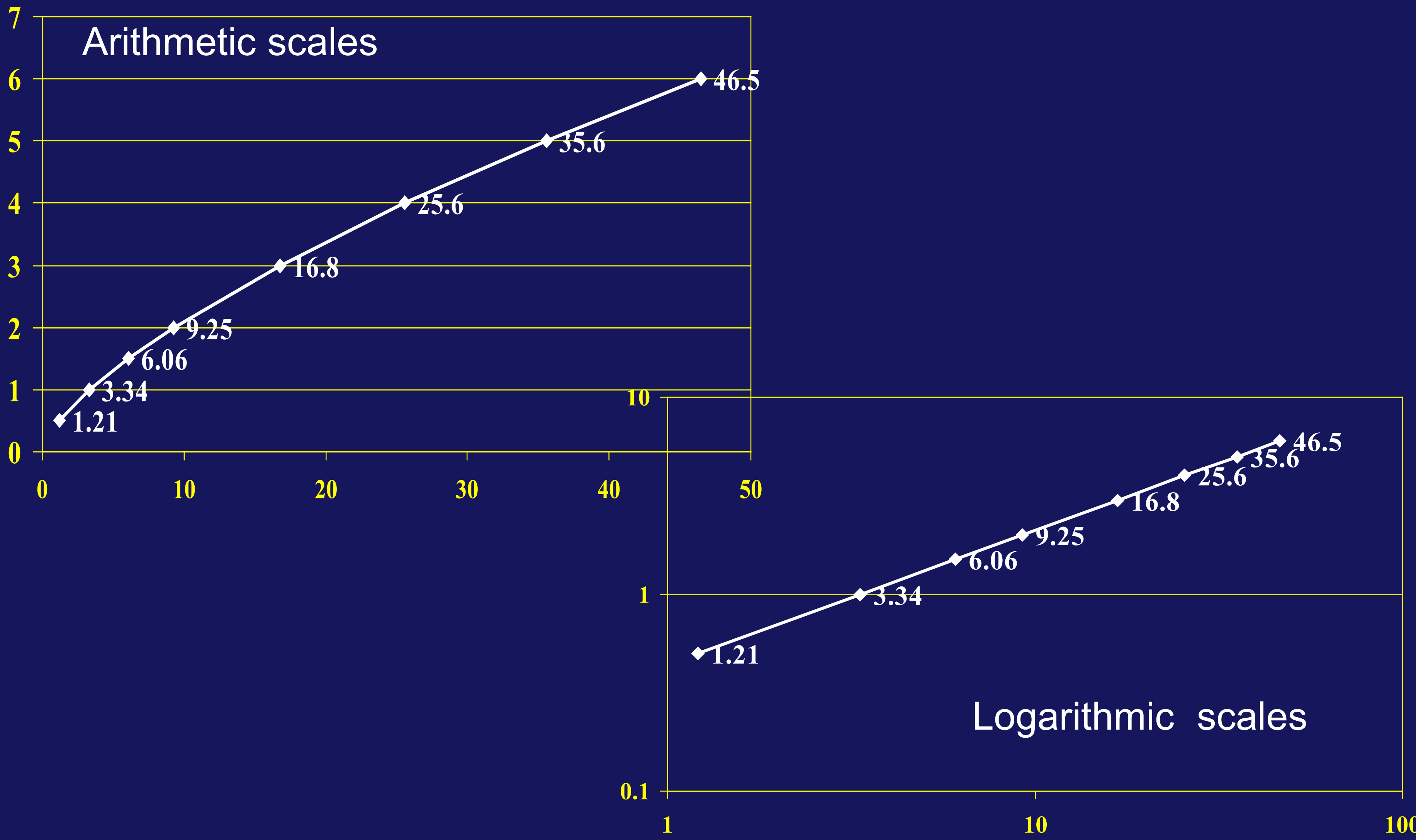
Plotting scales

The type of scale used to plot ratings can dramatically affect their shape



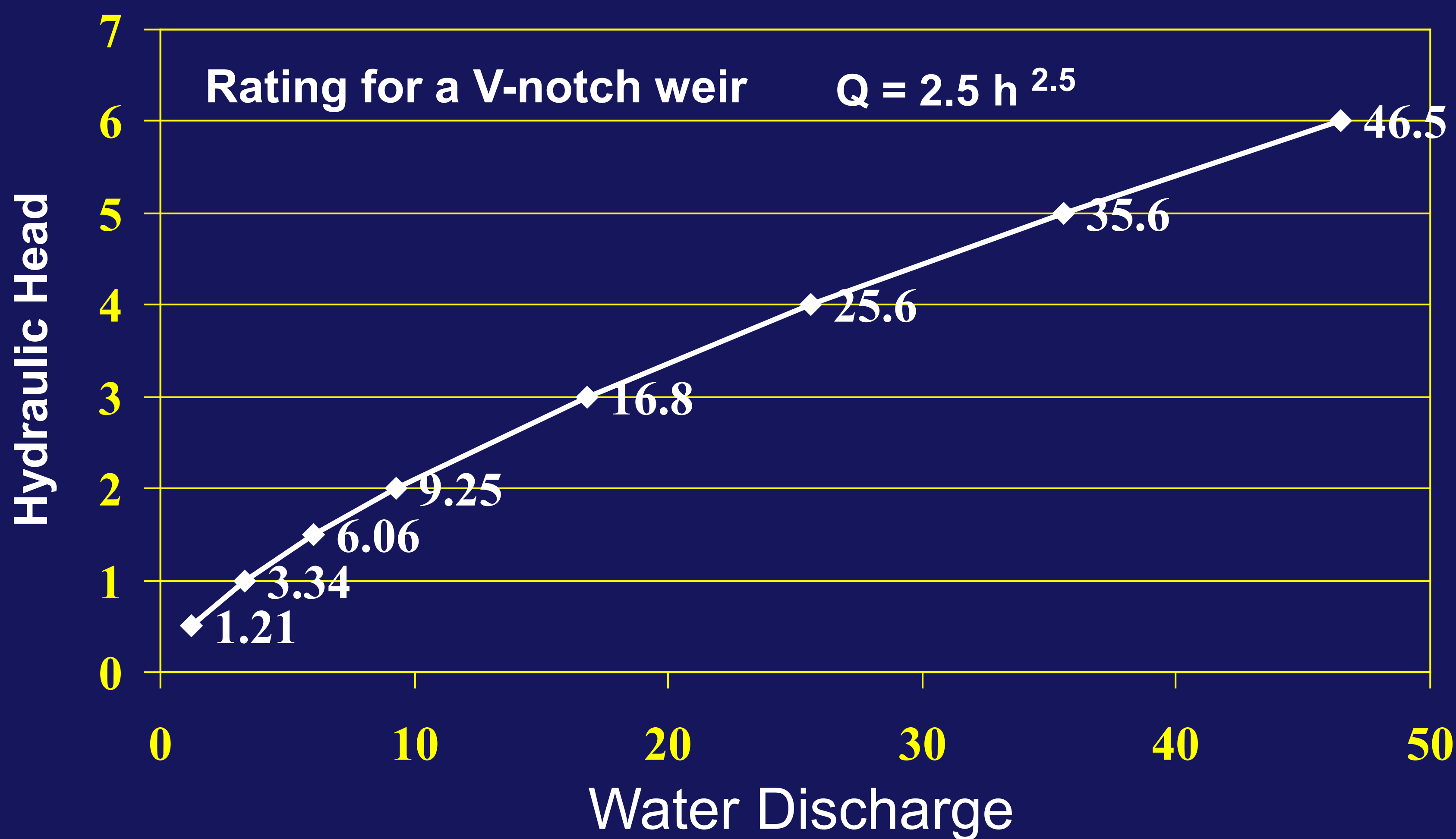
The relation between water discharge and hydraulic head (h) is well known for standard artificial controls

V-NOTCH WEIR
(90 degrees)

$$Q = 2.5\, h^{2.5}$$

Here is the rating for a V-notch weir plotted using rectangular scales

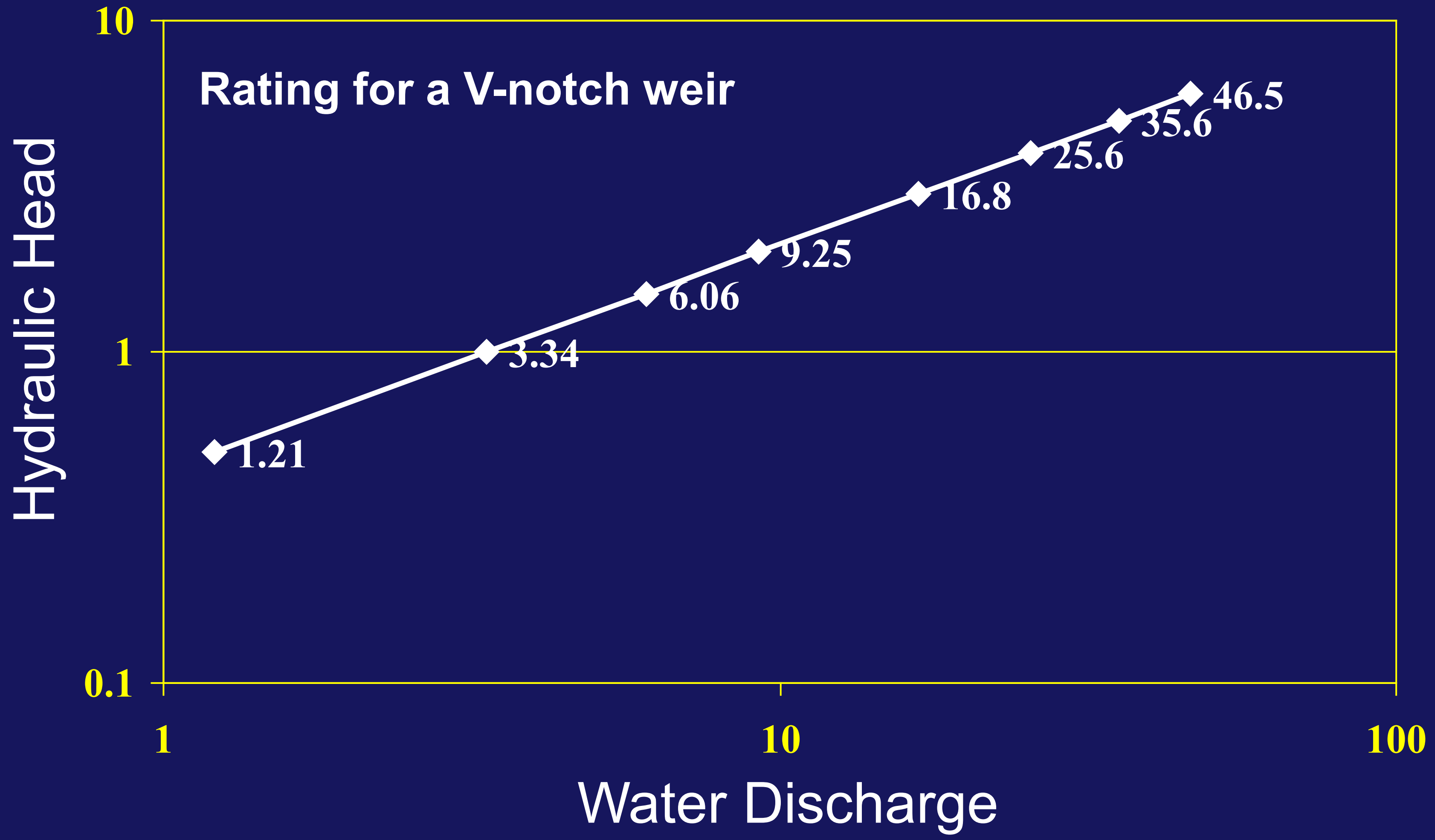
Concave downward = increasing differences



You can use log graph paper to turn the power function $Q = 2.5\ h^{2.5}$ into a straight line

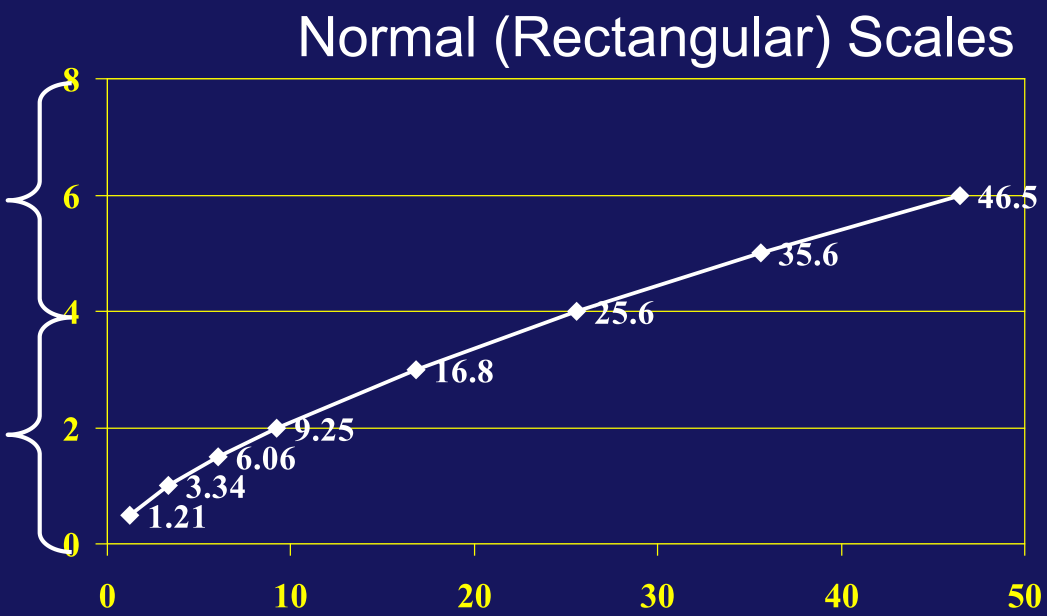
- Taking log of equation ($Q = 2.5\ h^{2.5}$) results in
  - $\text{Log } Q = 2.5 \log h + \log 2.5$
  - This is similar in form to equation for a straight line, which is $y = mx + b$
  - Causes relation between logarithms of Q and h to be linear.
- Simpler to just plot point on log paper and let the paper convert the equation to logs.

Here is the rating for a V-notch weir plotted using logarithmic scales



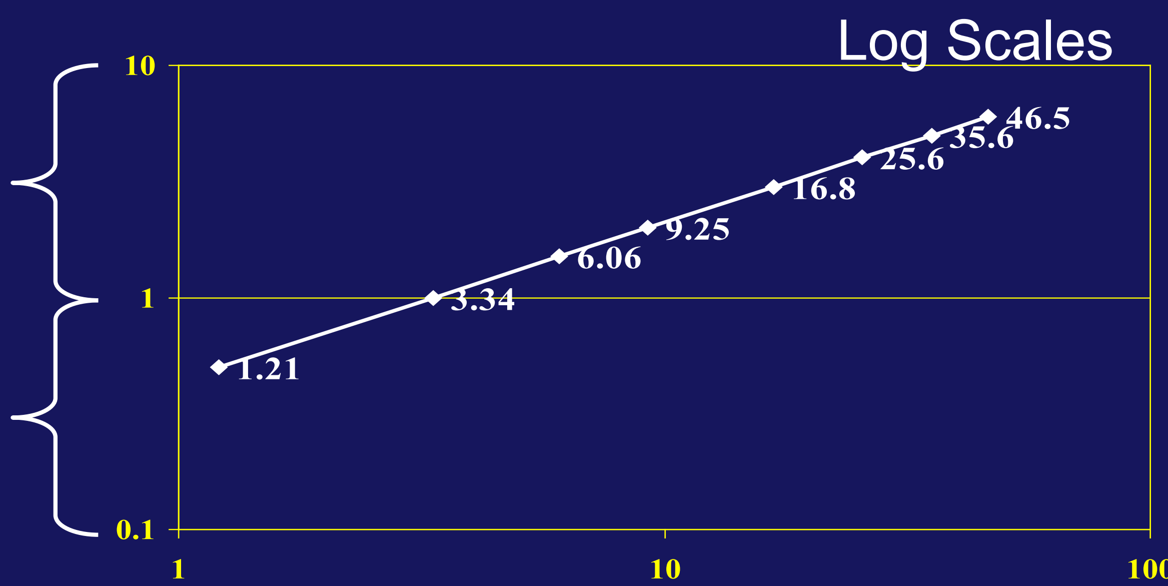
Here is how log scales are plotted

Equal distances because difference between 0 and 4 is the same as between 4 and 8

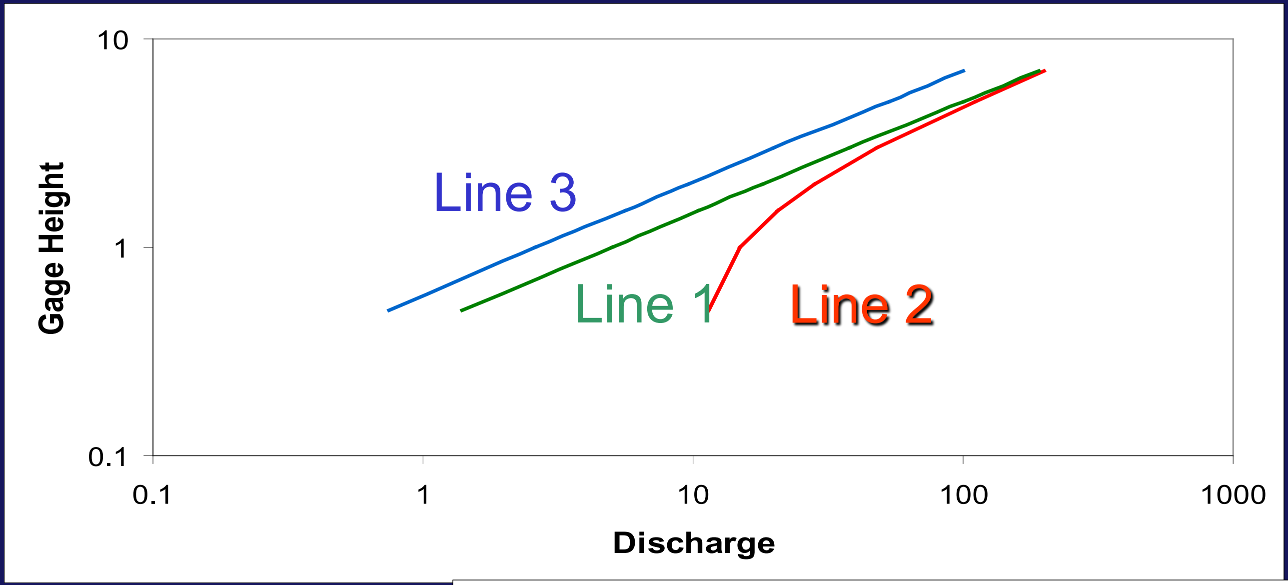


Log (0.1) = -1
Log (1) = 0
Log (10) = 1

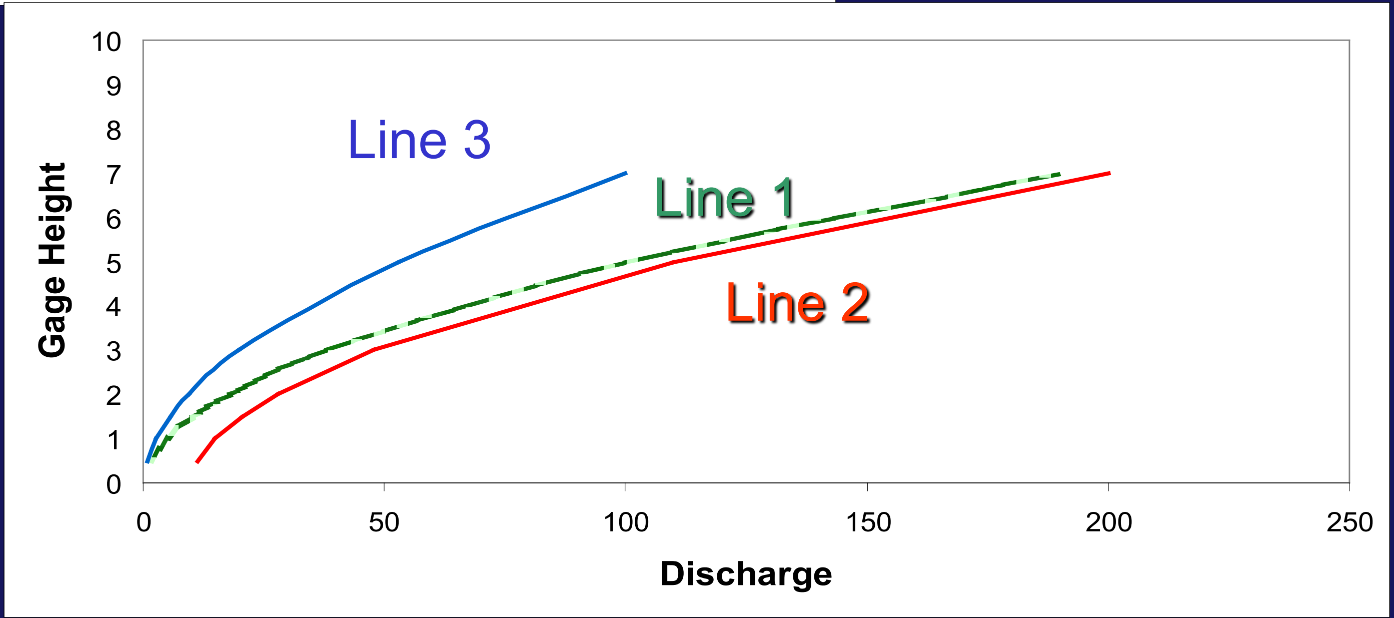
Equal distances because logarithms are equal distances apart



Here is an example of the same lines on different scale types



Log Scales



Rectangular Scales

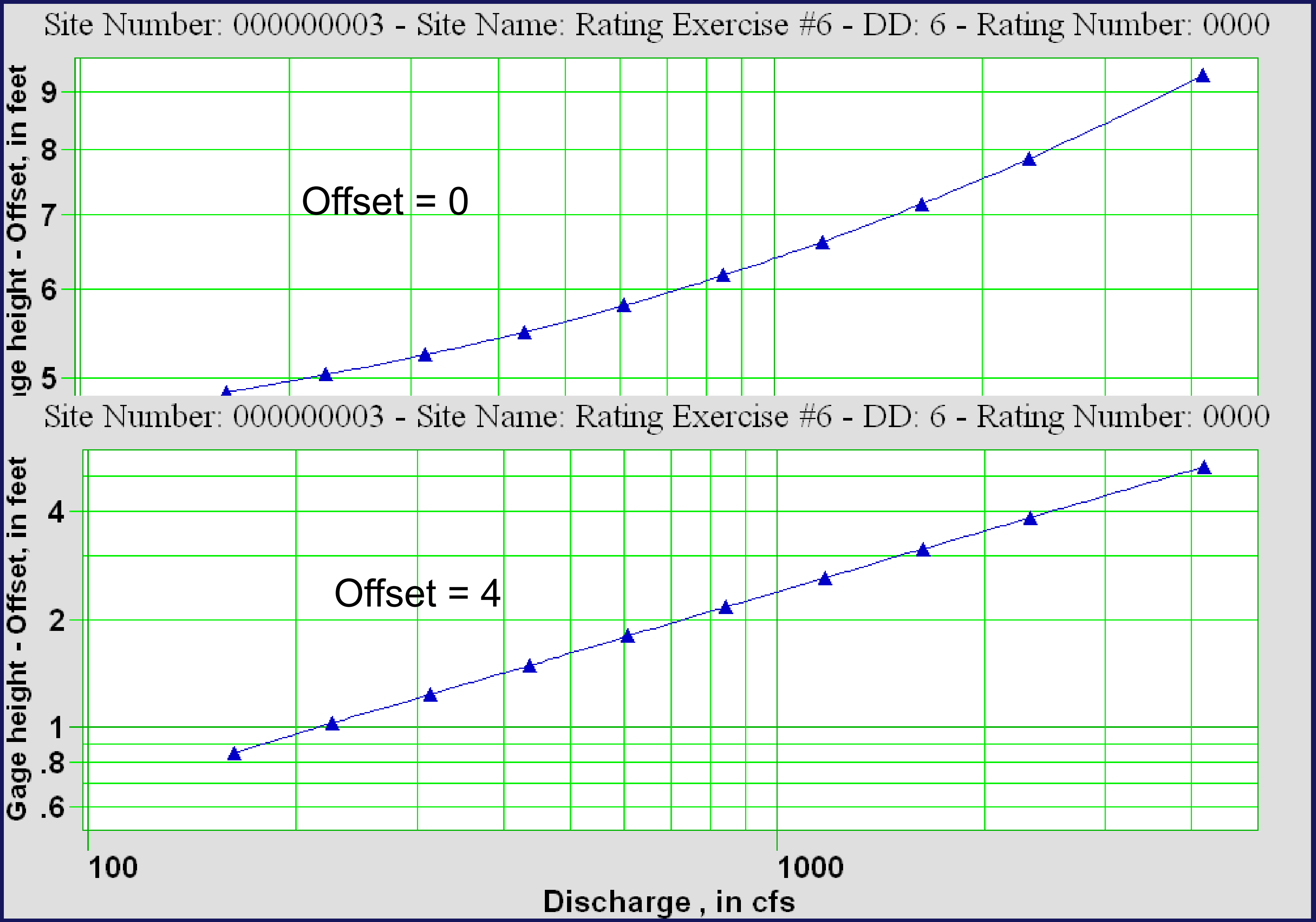
You must understand what parallel lines on graphs with different scale types represent!!

Problem: **Determine the actual differences (in cfs) and percent differences between curves 2 and 3 and curve 1**

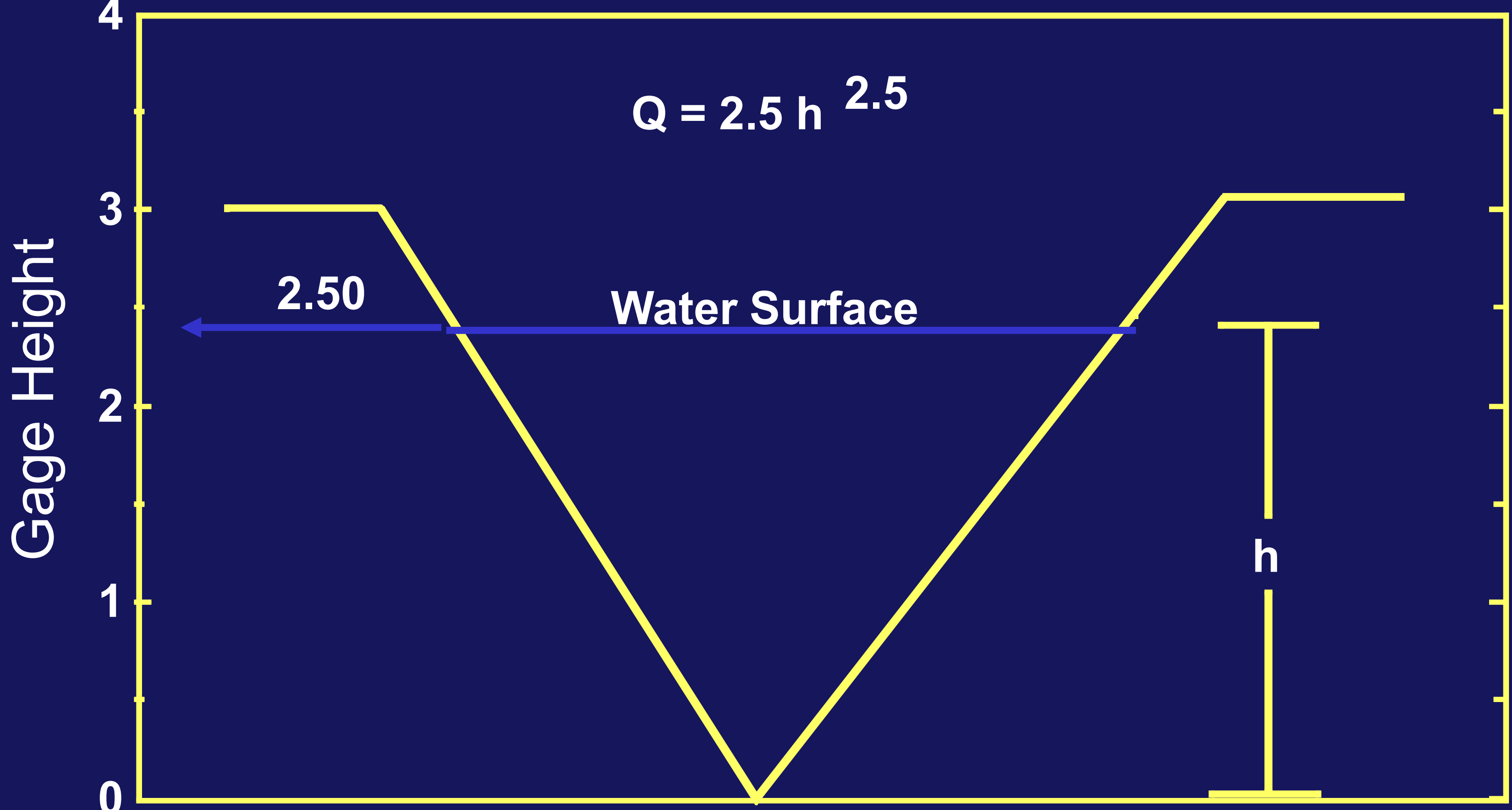
Definitions: **GH = Gage Height**
Q1,2,3 = Discharge from rating curve 1, 2 or 3
Q1-Q3 (Percent) = (Q1 - Q3)/Q1
Q2-Q1 (Percent) = (Q2 – Q1)/Q1

GH	Q3	Q1	Q2	Q1-Q3 (Actual)	Q2-Q1 (Actual)	Q1-Q3 (Percent)	Q2-Q1 (Percent)	
0.5	0.75	1.4	11.4	0.65	10	46%	714%	
1	2.6	5	15	2.4	10	48%	200%	
1.5	5.6	10.5	20.5	4.9	10	47%	95%	
2	9.6	18	28	8.4	10	47%	56%	
3	20	38	48	18	10	47%	26%	
5	53	100	110	47	10	47%	10%	
7	100	190	200	90	10	47%	5%	

Scale offsets facilitate developing straight line rating segments

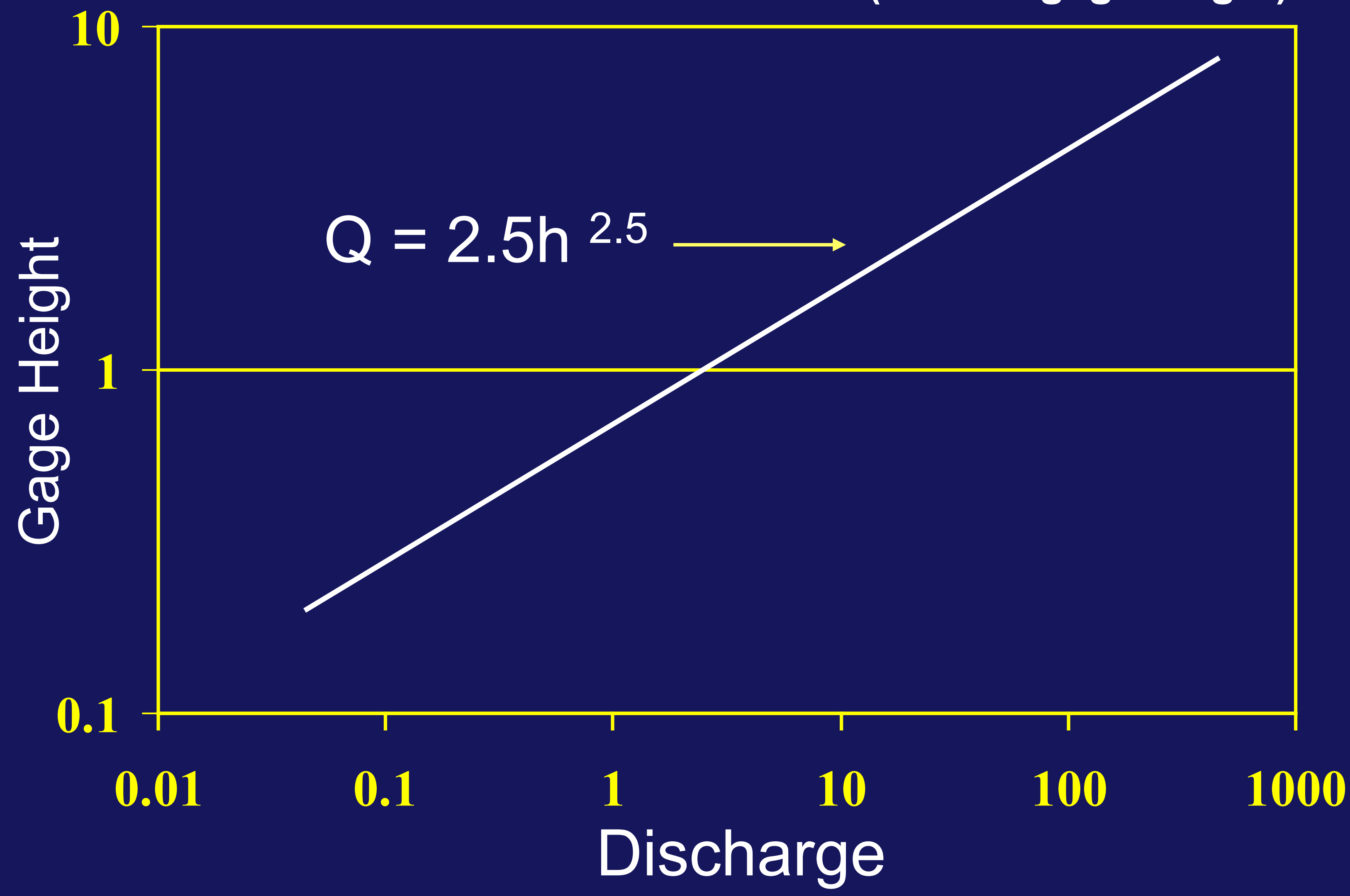


We will start studying offsets by looking at the relation between water discharge (Q) and head (h) for a v-notch weir when the point of zero flow = 0



Here is the rating curve for a v-notch weir with the GZF set at gh = 0.0

(head = gage height)

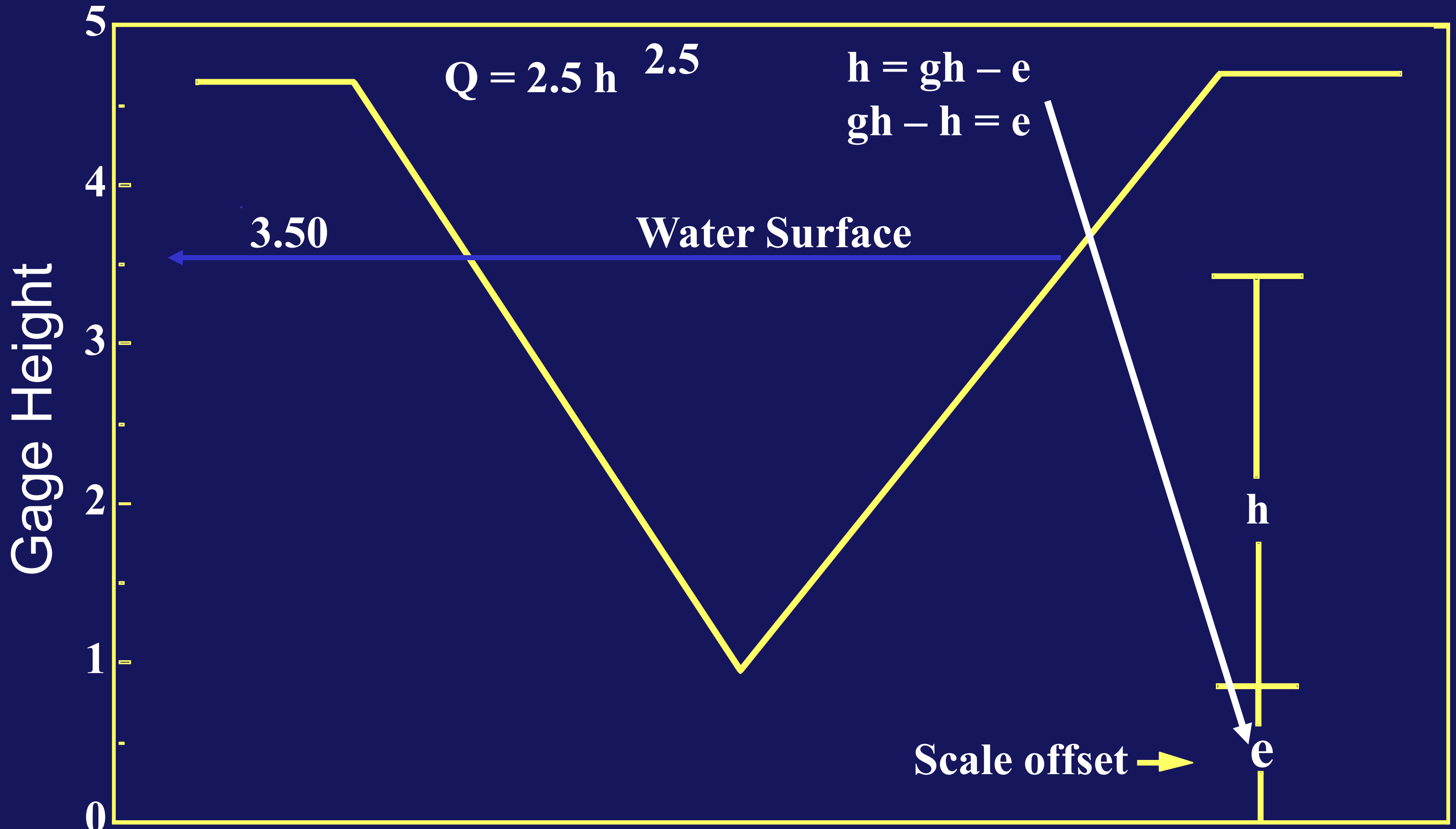


In practice gage height seldom equals head…

Head = GH - GZF

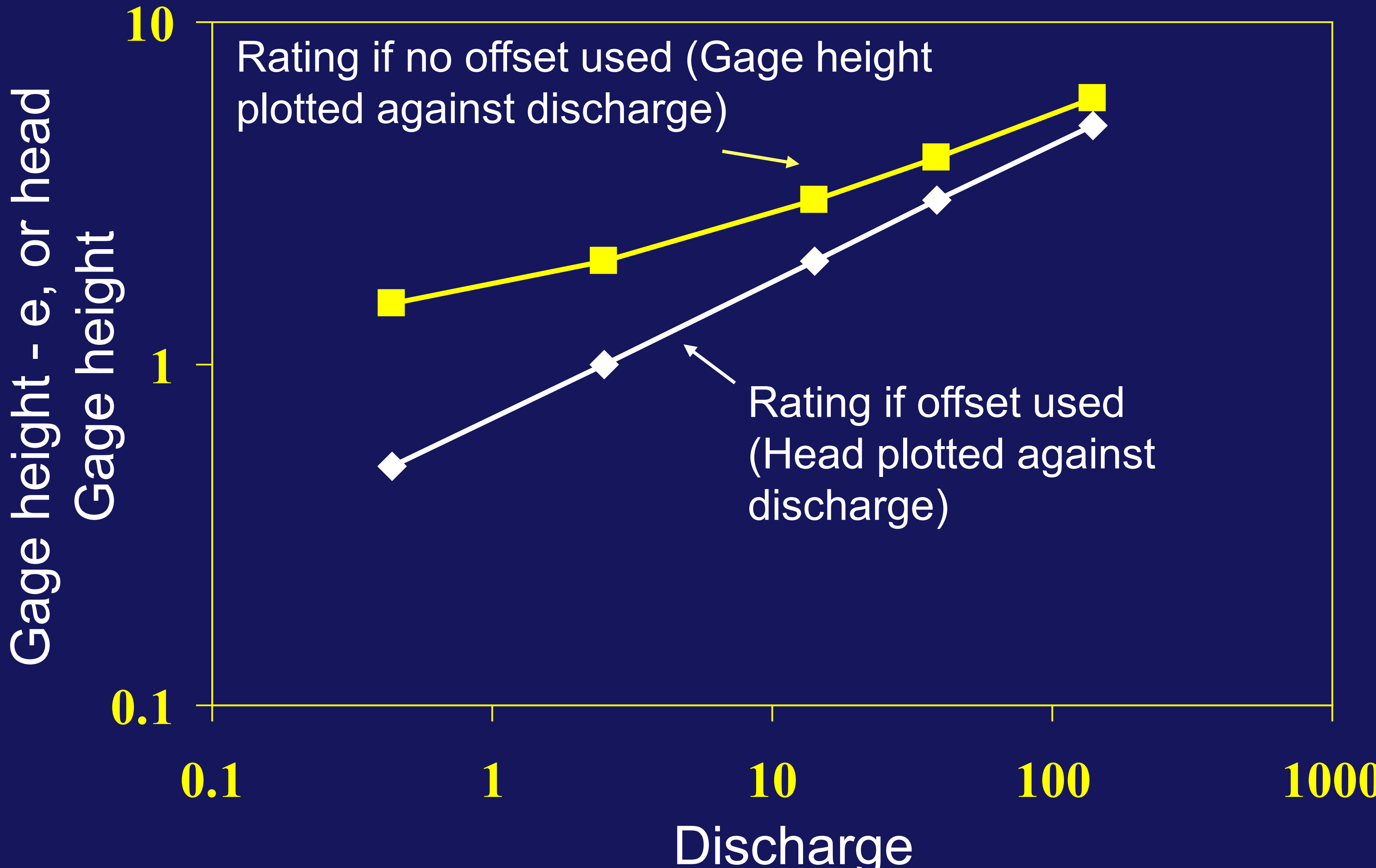
or about 0.37 (2.55 - 2.18)

You must consider a scale offset when head does not equal gage height



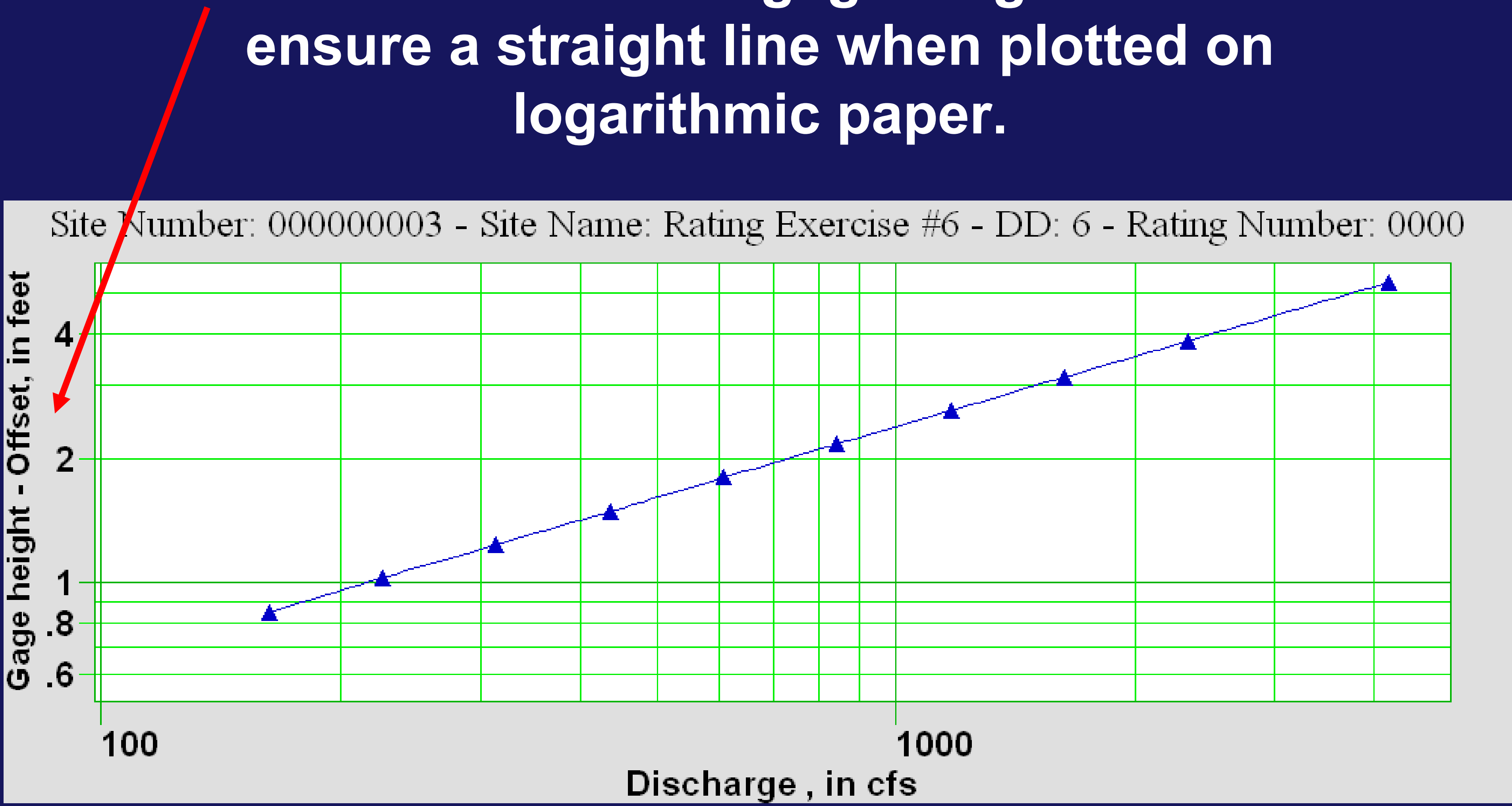
The offset (e) is the value used to convert GH to head!

In the example just shown the rating will not be straight if gage height is plotted against discharge



IT'S EASY!!

A rating curve offset is simply a constant subtracted from the gage height so as to ensure a straight line when plotted on logarithmic paper.



Scale Offset

- **The offset is usually represented by “e” in equations.**

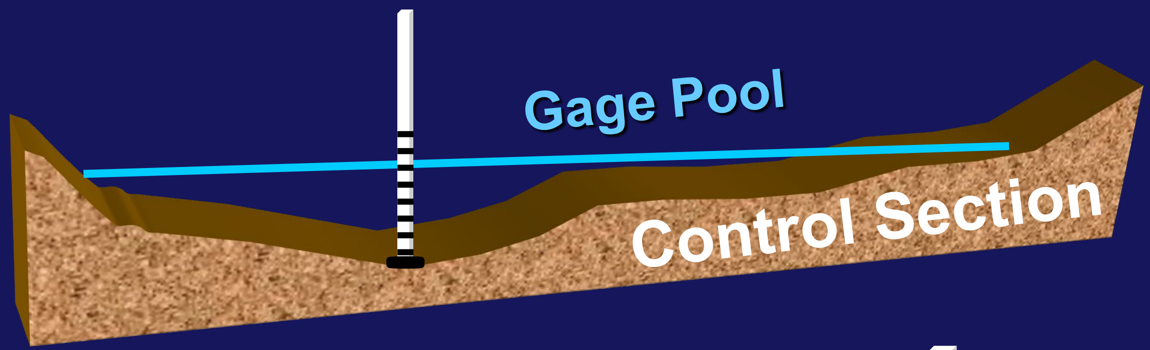
- **Used to convert gage height to head**

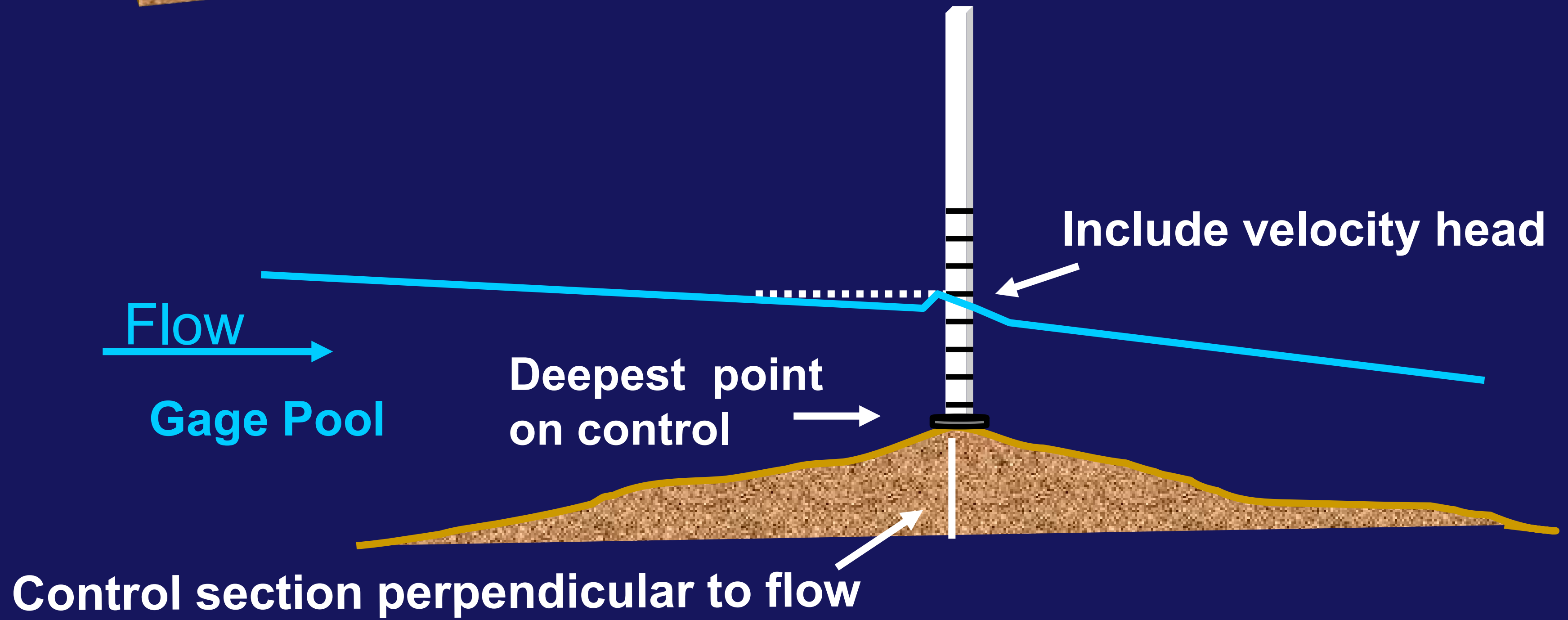
- **Will produce ratings with one or more straight line segments. This will facilitate extrapolation and interpolation of rating curves.**

- **Can use gage height of zero flow (GZF) as first approximation of “e”.**

The gage height of zero flow (GZF) should be measured whenever possible!

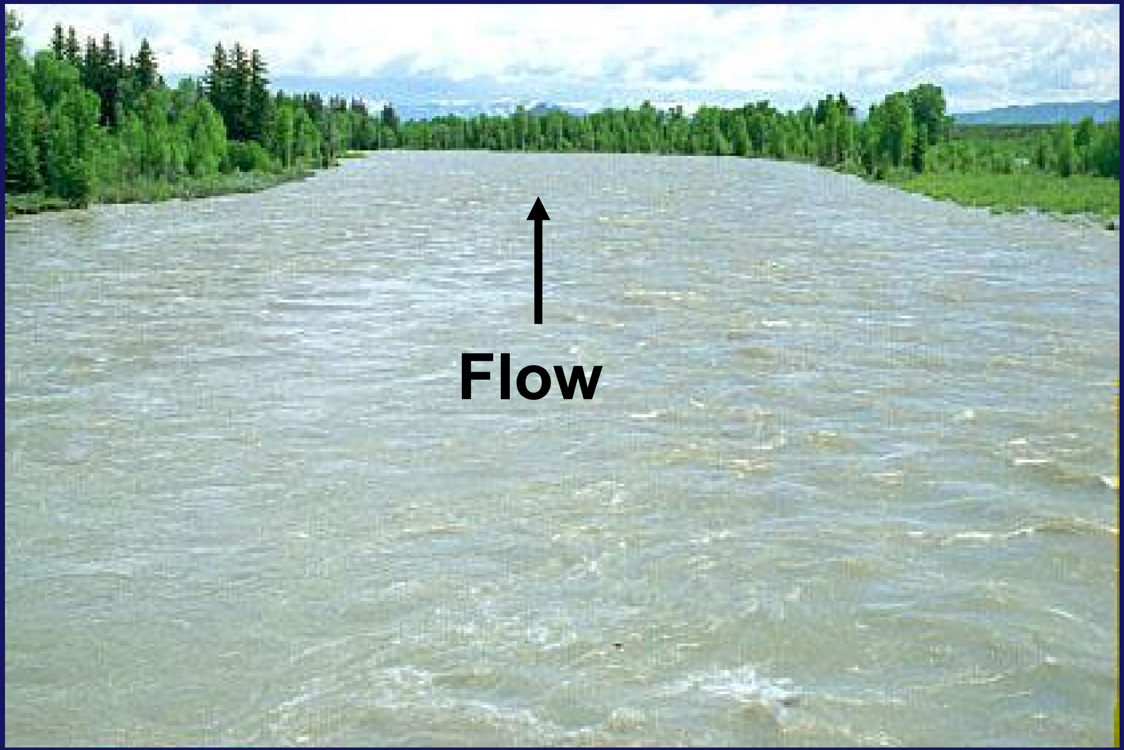
[The PZF (point of zero flow) is the physical location of the deepest point on the control]





You cannot measure the GH of zero flow when channel control is in effect

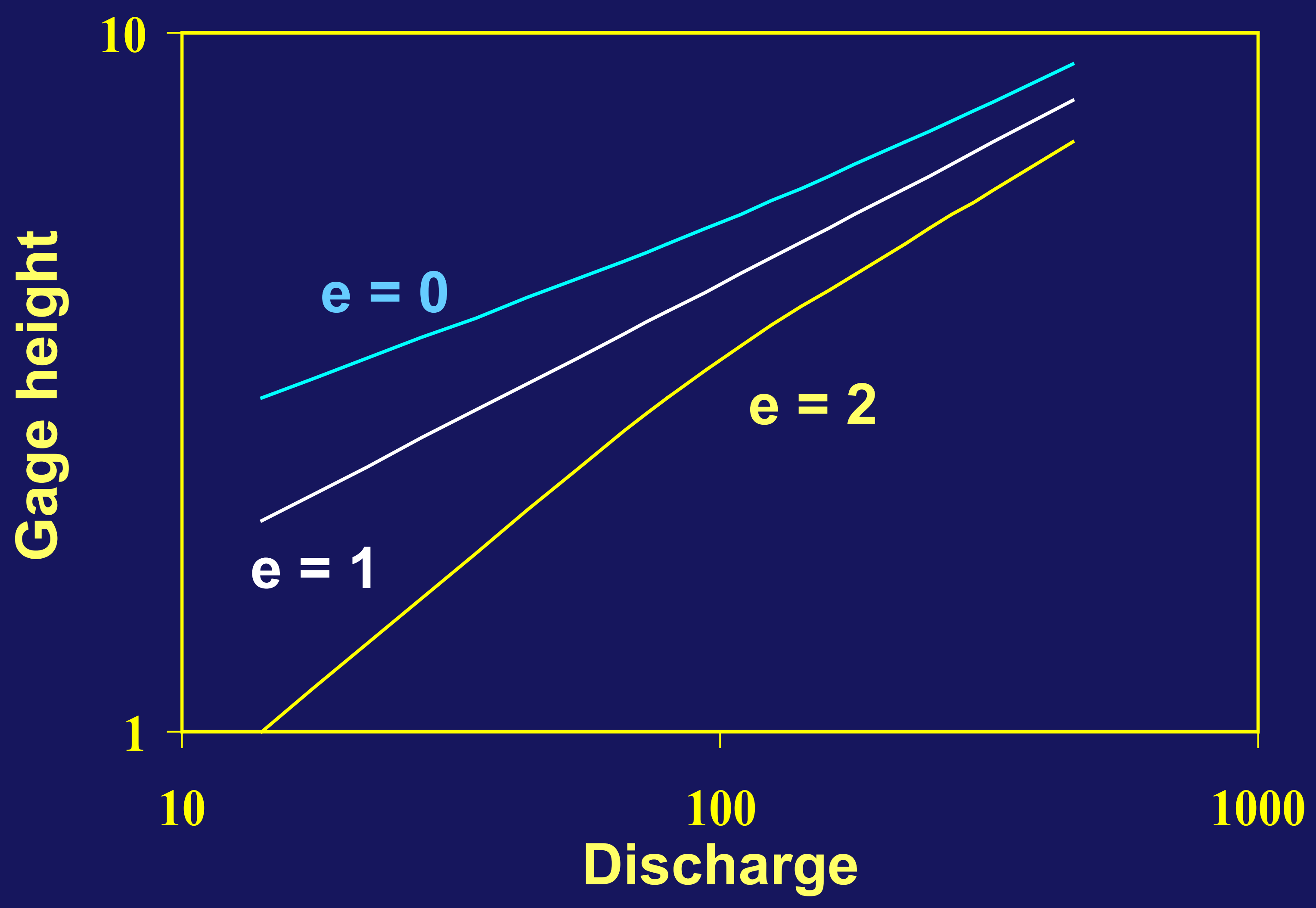
- Offset is the gage height of “effective zero flow”
- Not the gage height of some identifiable feature
- Usually determined by trial-and-error



How do I figure out what the scale offset is for an existing rating?

1. Method 1 –
   - G = g.h. at bottom (beginning) of log cycle
   - N = 0.01 if the cycle is measuring hundredths of a foot, 0.1 cycle is measuring tenths of a foot, and so forth.
   - e = offset = G-N
2. Method 2 –
   - Select one complete log cycle on the gage-height scale and pick off the upper and lower values of gage height.
   - e = offset = ((10 x lower value) – upper value)/9

The shape of the curve can tell you if the offset is too high or too low



How to select the correct offset

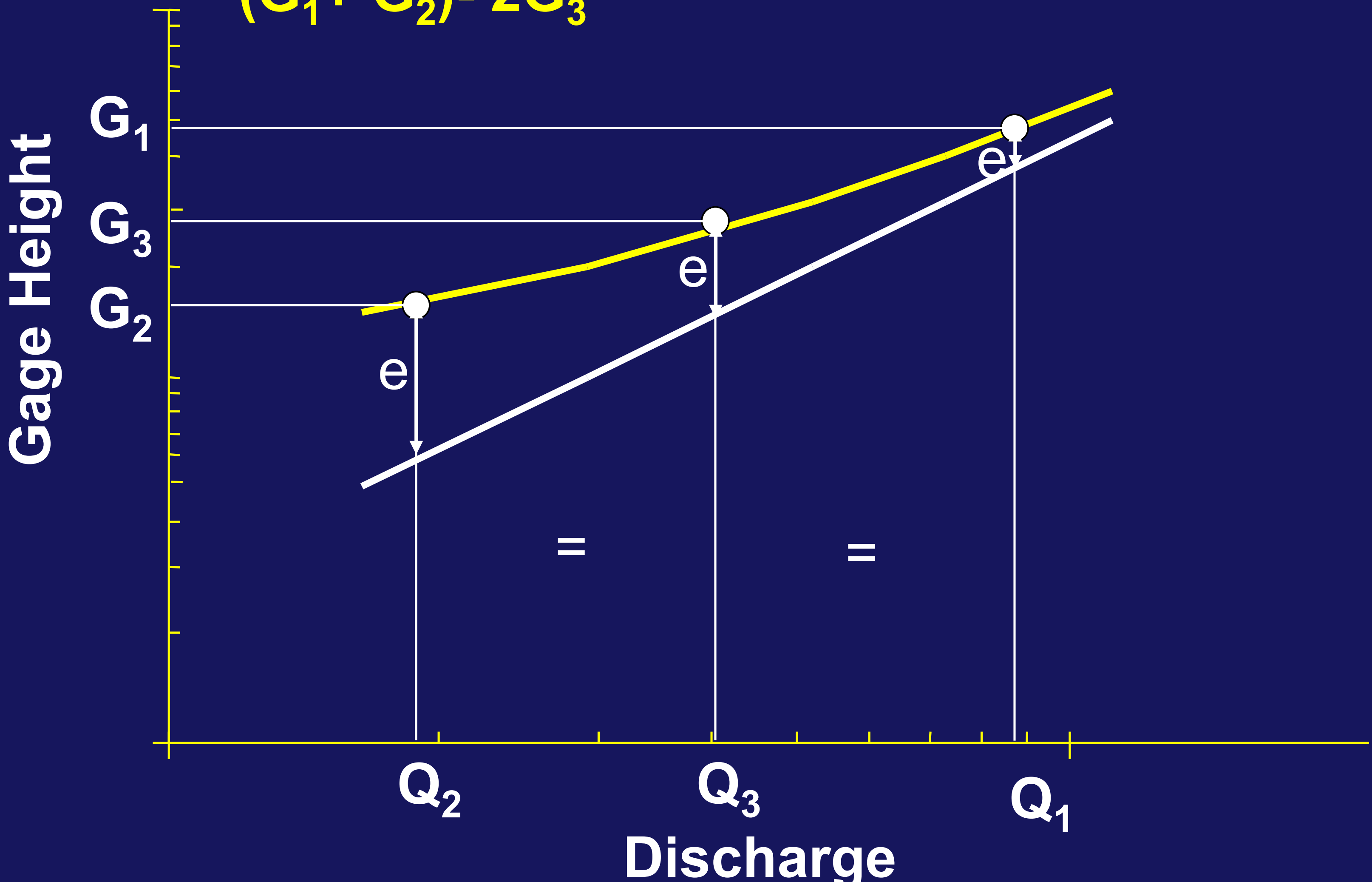
1. Johnson’s method
   A. Compute manually

2. Trial and error method
   A. Hand drawings
   B. Can be done using program such as GRSAT

Johnson's method can be used to find the scale offset

$$e = \frac{(G_1 \times G_2) - G_3^2}{(G_1 + G_2) - 2G_3}$$

$$Q_3 = (Q_1 \times Q_2)^{1/2}$$



Trial and error can be used to determine the scale offset