Water Gardening Design
"Rules of Thumb" For Beginners

happy ponds
WATER GARDEN SPECIALISTS

DEPTH:
Depth for overwintering fish outdoors:
- Goldfish, Shubunkin, Comets = 3 feet
- Koi = 4 feet minimum, 5 feet better

CALCULATING VOLUME OF WATER:
- Cubic inches ÷ 231 = gallons
- Cubic feet x 7.5 = gallons
- For a rectangle, cubic feet or inches = Length x Width x Depth
- For a Cylinder, cubic feet or inches = 3.14 x Depth x Radius x Radius
- Example, a round pond 2 feet deep and 10 feet across:
  - 3.14 x 2 feet deep x 5 feet radius x 5 feet radius x 7.5 = 1,177 gallons
- Example, a rectangular pond 2 feet deep, 10 feet wide, and 5 feet long:
  - 2 x 10 x 5 x 7.5 = 750 gallons
- Simpler methods:
  - Check your water meter before & after filling your pond! Just make sure no one is showering, washing clothes or dishes at the time.
  - Time how long it takes to fill a 5 gallon bucket. Time how long it takes to fill the pond. Divide pond fill time by 5 gallon bucket time and multiply by 5 gallons. There is a fairly large margin of error in this method depending upon your precision in filling & timing the filling of the bucket.
  - Example, it takes 15 seconds to fill a 5 gallon bucket. It took 1.5 hours to fill the pond. 1.5 hours x 60 minutes/hour x 60 seconds/minute ÷ 15 seconds/bucket x 5 gallons/bucket = 1800 gallons.

QUANTITY OF FISH:
One inch of fish for every 10 gallons of water. Example, a 500 gallon pond will adequately support 50 inches of fish. This can be two large 25" koi, or 10 smaller 5" comets. Always remember: fish grow & multiply! And its not so much the length that matters, as the girth.

ROCKS (given by the people who sell rocks):
Rock quantity & size for a pond 2 feet deep:
- Length x Width x 3 ÷ 65 = tons of boulder
- Ratio of boulder size (small 4-6" : medium ~ 12" : large 18-24") 1:2:1
- Additional river rock = 40-50% of boulder weight
- Example: a 2 foot deep pond 10 feet by 6 ½ feet would need
  - 10 x 6.5 x 3 / 65 = 3 tons of boulders made up of
    - 0.75 tons of small 4-6" rocks
    - 0.75 tons of large 18-24" rocks
    - 1.5 tons of medium 12" rocks
  - plus 1.5 tons of river rock

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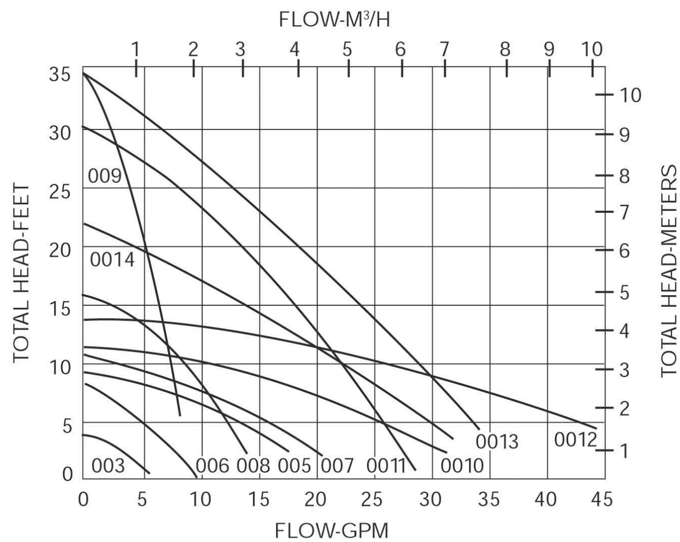
LINERS:
Take 3 measurements from excavated pond: d=depth; l=longest point edge to edge; w= widest point that is perpendicular to l. Extend liner at least 1-2 feet beyond the edge of pond on all sides. Don't forget that depth gets multiplied by two because you have to go down and then back up with the liner. The formula for the liner then would be:
Liner Length = l + (2xd) + 2 + 2
Liner Width = w + (2xd) + 2 + 2

Example, an oval pond about 10 feet at the longest point and 5.5 feet at the fattest width and 3 feet at the deepest point would need a liner sized:

- Length = 10 + 3 + 3 + 2 + 2 = 20 feet long
- Width = 5.5 + 3 + 3 + 2 + 2 = 15.5 feet wide. Most liners are sold in widths of 5, 10, 15, 25 feet, in this case, it would be acceptable to purchase a liner that is 15 feet wide.

PUMP SIZE:
Find out which method gives you the largest water flow. Take the larger of the two numbers, then calculate losses through plumbing and pump efficiency to get the actual size of the pump.

1. Filtration turns. (How many hours does it take the pump to move the entire volume of water?) Small ponds, ponds with fish that are fed frequently, or if "rule of thumb" quantity of fish is at max, should turn the volume 100% in 1 hour. Large ponds with few fish fed infrequently can turn 100% of the volume in 4 hours.
2. Waterfalls. For a clean "sheet" of water to flow over a flat weir rock is 100 gallons per hour for every inch of waterfall width. This assumes your rock is flat & even throughout the entire width. Use a higher rate for uneven rocks, and if you want a lot of flow up to 250 gallons per hour for every inch of waterfall width.
3. Calculating losses through plumbing. This includes losses through pipe diameter, fittings (like elbows), and rise (how high is it from your pump to the top of the waterfall) See below friction loss charts are from the website: http://www.plumbingmart.com/flowchart.html This chart will calculate what load the pump will see as virtual "rise". Add the actual rise to the final calculation, and then check the efficiency for your specific pump.
4. Example: a 1,000 gallon pond, has a pump in a skimmer box that sits about 2 feet below the surface of the water, and has a waterfall that starts about 3 feet above the surface of the pond. You want to keep fish, and know that over time, the fish will grow & multiply. The largest waterfall width is 15". The distance from the pump to the top of the waterfall will need 20 feet of return pipe. You will be using a pipe diameter of 1 ½ ", and you have two 90 degree elbows. Based upon filtration turns, you would need 1,000 gph of flow, but based upon the stream, you would need 1,500 gph of flow. Use the larger number: 1,500gph. The friction loss flowchart works on gallons per minute. 1,500gph ÷ 60 minutes per hour = 25 gpm. Based upon the chart for every 100 feet of 1 ½ " diameter pipe, it looks to the pump like 3.95 feet of rise. A 90 degree 1 ½ inch elbow looks like another 4 feet of pipe. You have two elbows, so add 8 feet of pipe to your calculation. You have 28 feet of pipe, so you would take 3.95 feet of rise x 28feet ÷ 100feet = 1.1 feet. Your pond has 2 + 3 feet of rise (pump below water plus waterfall above the surface). Therefore, you need a pump that will pump 1,500 gallons per hour at 6 feet of rise. (2+3+1.1). Using the pump efficiency graph & chart below, acceptable pumps would be either pump model 0011 from the graph or pump PW2000 from the chart. Notice how pump model 0011 is more efficient at higher head heights. All things being equal (energy efficiency, cost), the better choice would be model 0011.



Waterfall Utility Pump Performance Chart

WATERFALL PUMPS

MODEL	AMPS (MIN/MAX)	WATTS (MIN/MAX)	MAX FLOW	MAX HT.	1′	5′	10′	20′	25′	30′	35′	40′	45′
PW2000	1.96 - 2.80	236 - 347	2110	28.4′	2000	1555	1125	420	120				
PW3000	2.17 - 3.71	263 - 449	3000	34.2′	2900	2600	2200	1310	830	320			
PW4000	2.43 - 5.06	301 - 616	4525	41.1′	4450	4080	3610	2590	2020	1400	730		
PW5000	4.10 - 6.90	442 - 825	5020	49.2′	4975	4620	4200	3300	2800	2300	1750	1130	500

**Figures indicate gallons per hour (gph)*

Friction Loss per 100 feet of Plastic Pipe

GPM	Pipe Diameter									
	1/2 in.	3/4 in.	1 in.	1 1/4 in.	1 1/2 in.	2 in.	2 1/2 in.	3 in.	4 in.	5 in.
1	2.08	0.51								
2	4.16	1.02	0.55	0.14	0.07					
5	23.44	5.73	1.72	0.44	0.22	0.066	0.038	0.015		
7	43.06	10.52	3.17	0.81	0.38	0.11	0.051	0.021		
10	82.02	20.04	6.02	1.55	0.72	0.21	0.09	0.03		
15		42.46	12.77	3.28	1.53	0.45	0.19	0.07		
20		72.34	21.75	5.59	2.61	0.76	0.32	0.11	0.03	
25			32.88	8.45	3.95	1.15	0.49	0.17	0.04	
30			46.08	11.85	5.53	1.62	0.68	0.23	0.06	0.02
35				15.76	7.36	2.15	0.91	0.31	0.08	0.03
40				20.18	9.43	2.75	1.16	0.40	0.11	0.03
45				25.10	11.73	3.43	1.44	0.50	0.13	0.04
50				30.51	14.25	4.16	1.75	0.60	0.16	0.05
60					19.98	5.84	2.46	0.85	0.22	0.07
70						7.76	3.27	1.13	0.30	0.10
75						8.82	3.71	1.28	0.34	0.11
80						9.94	4.19	1.44	0.38	0.13
90						12.37	5.21	1.80	0.47	0.16
100						15.03	6.33	2.18	0.58	0.19

Friction Loss in PVC Fittings

The follow table lists friction loss in PVC pipefittings as a measure of the amount of friction in an equivalent length (ft) of straight pipe.

PVC Part	Normal Pipe Size (in)								
	1/2"	3/4"	1"	1 1/4"	1 1/2"	2"	2 1/2"	3"	4"
90° elbow, standard	1.5	2.0	2.25	4.0	4.0	6.0	8.0	8.0	12.0
45° elbow, standard	0.75	1.0	1.4	1.75	2.0	2.5	3.0	4.0	5.0
Insert Coupling	0.5	0.75	1.0	1.25	1.5	2.0	3.0	3.0	4.0
Gate Value	0.3	0.4	0.6	0.8	1.0	1.5	1.6	2.0	3.0
Male-Female Adapter	1.0	1.5	2.0	2.75	3.5	4.5	-	6.5	9.0
Tee-Flow through Run	1.0	1.4	1.7	2.3	2.7	4.3	5.1	6.3	8.3
Tee-Flow through Branch	4.0	5.0	6.0	7.0	8.0	12.0	15.0	16.0	22.0