ANSI-15 and ANSI-7 Flow Requirements and TDH

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APSP/ANSI-7 Writing Committee

APSP/ANSI/ICC-15 Writing Committee

APSP/ANSI/ICC-5 Writing Committee (Chairman)

International Swimming Pool & Spa Code Writing Committee

APSP Technical Committee

Why do We Have These Standards?

ANSI/APSP/ICC-15 @ Energy

ANSI/APSP-7 @ Safety

Because We Need Them

Before we had the
ANSI-7 Standard and the ANSI-15 Standard

"garden variety" circulation systems:

- offered little protection against entrapment
- typically wasted vast amounts of energy

How did we Get Here?

- State law requirement to provide pool and spa energy efficiency
- Florida Building Commission implemented the state law with the 2010 Code & remains with slight changes in the 5th edition Code
- FEEC, Chapter 4, Section R403.9 - Residential, along with ANSI/APSP-14 and ANSI/APSP-15
- FEEC, Chapter 5, Section C404.7 - Commercial
- Went into effect in March 15th (2012)

ANSI/APSP-7 has been in effect since 2007

Learning Objectives

- Understanding the difference in flow requirements of the ANSI-15 Energy Standard and the ANSI-7 Suction Entrapment Avoidance Standard.
- Calculating volume and required/desired flow rate(s).
- Sizing the piping system and selecting a pump compliant with ANSI-15.
- Calculating Total Dynamic Head.
- Sizing the piping system, selecting and installing the right cover per ANSI-7.
- Verifying Total Dynamic Head for Safety.

Three Step Design Process

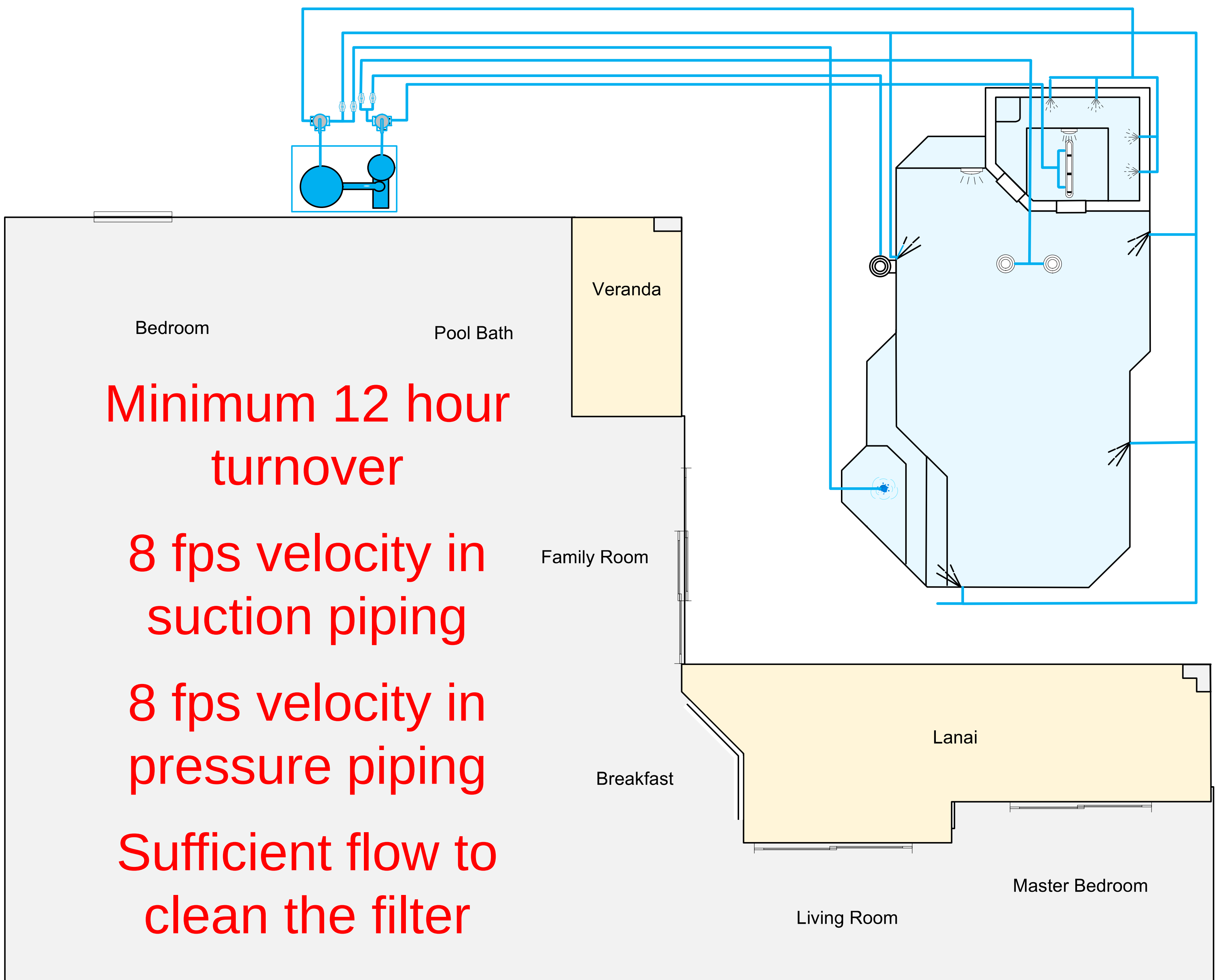
1St APSP-5 Residential Pools

2nd APSP-15 Energy Efficiency

3rd APSP-7 Suction Safety


STOP

Step 1 ANSI-5



Minimum 12 hour turnover

8 fps velocity in suction piping

8 fps velocity in pressure piping

Sufficient flow to clean the filter

1St APSP-5 Residential Pools

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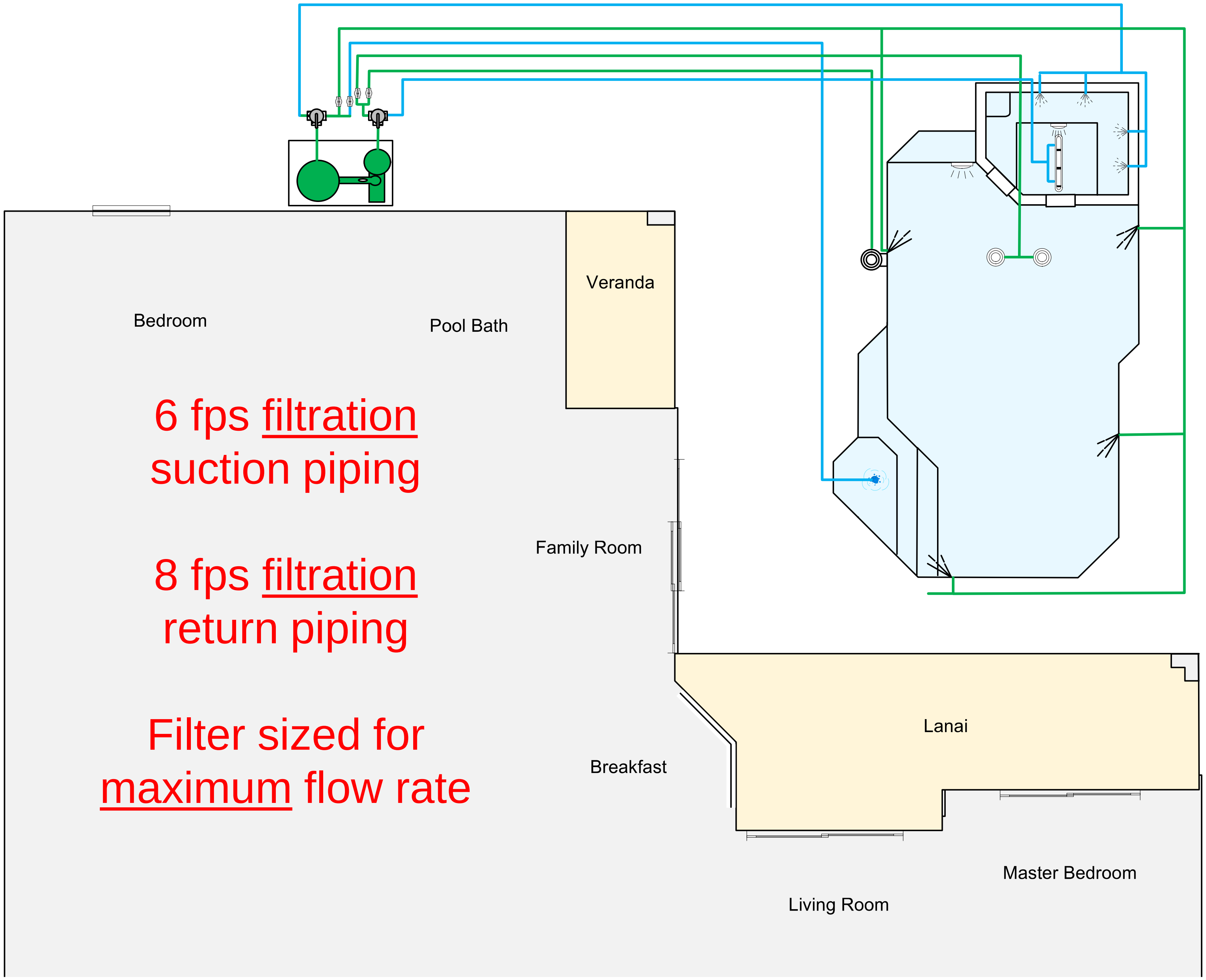
Step 2 ANSI-15

Minimum 6 hour filtration cycle, longer cycles are encouraged



Additional Requirements ANSI-15

- Specify controller for multi-speed pumps – must default to low speed within 24 hours.
- Show efficiency rating for heaters
- Minimum 4 pipe diameters in front of pump
- Minimum 18" pipe after filter for future solar
- Directional return fittings must be used

ANSI-15 Design Requirements

Maximum flow rates per Filter Type:

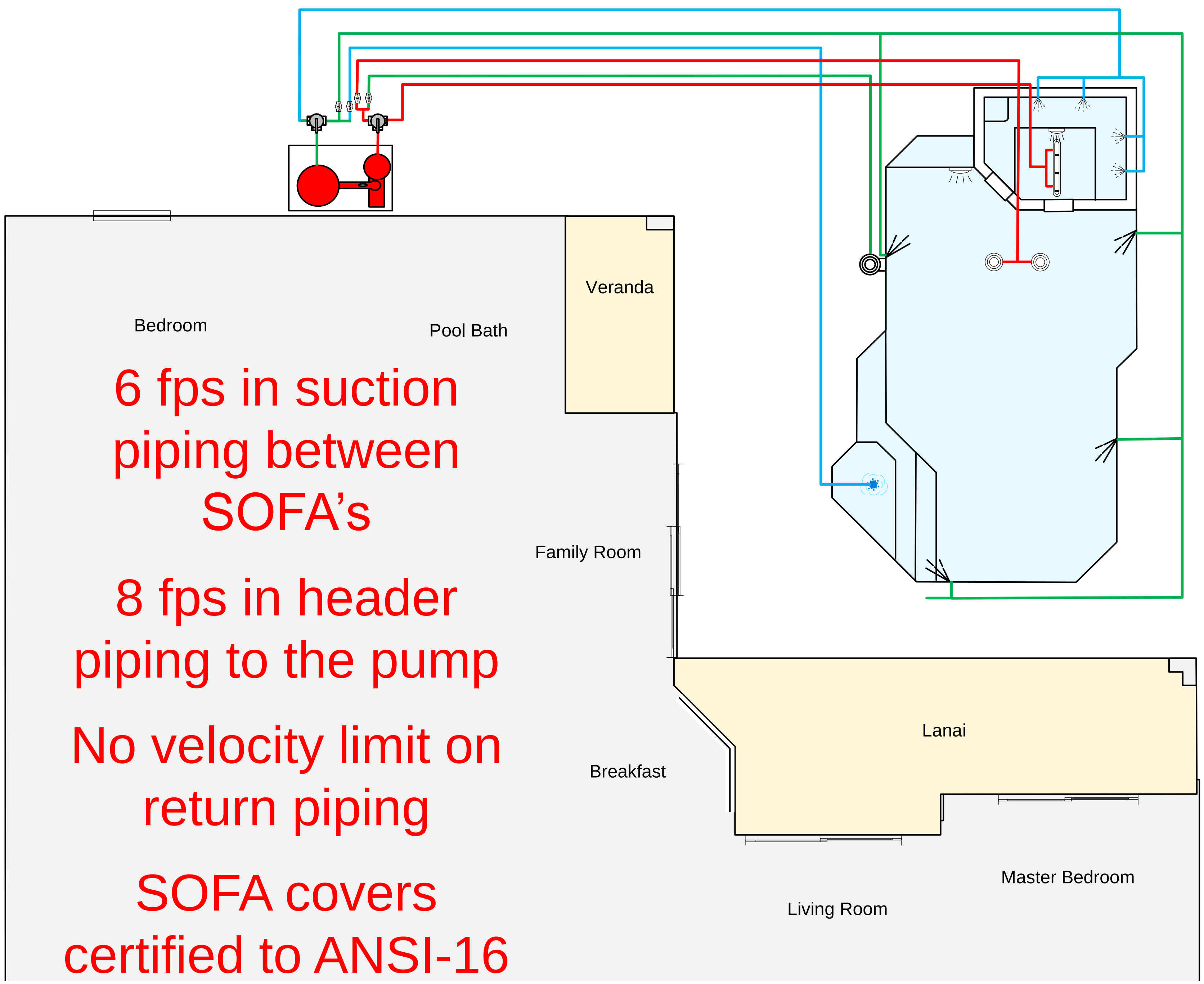
Cartridge	.375 gpm per sq. ft.
Sand	15 gpm per sq. ft.
Diatomaceous Earth	2 gpm per sq. ft.

1st APSP-5 Residential Pools ✔

2nd APSP-15 Energy Efficiency ✔

3rd APSP-7 Suction Safety

Step 3 ANSI-7



6 fps in suction piping between SOFA's

8 fps in header piping to the pump

No velocity limit on return piping

SOFA covers certified to ANSI-16

1st APSP-5 Residential Pools

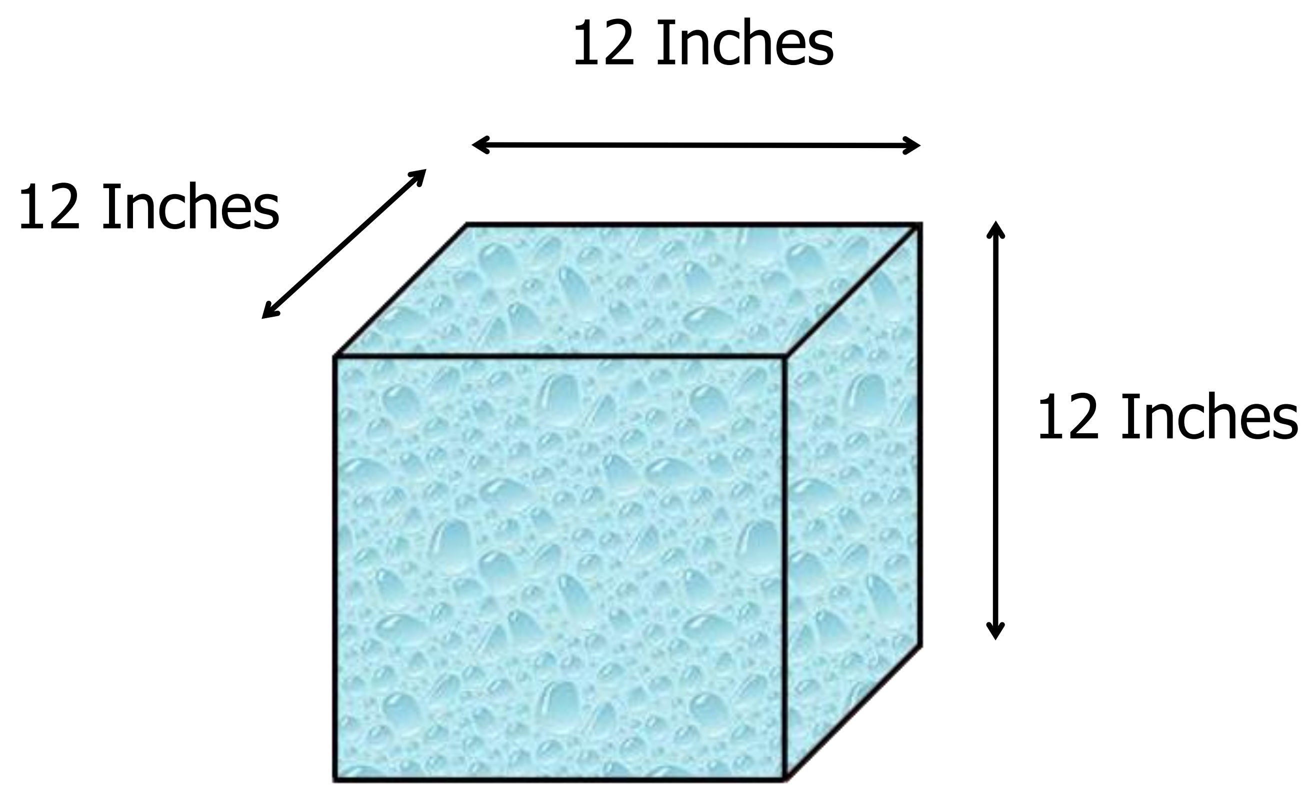
2nd APSP-15 Energy Efficiency

3rd APSP-7 Suction Safety

Lets Start the ANSI-15 Process
“Design Standard”

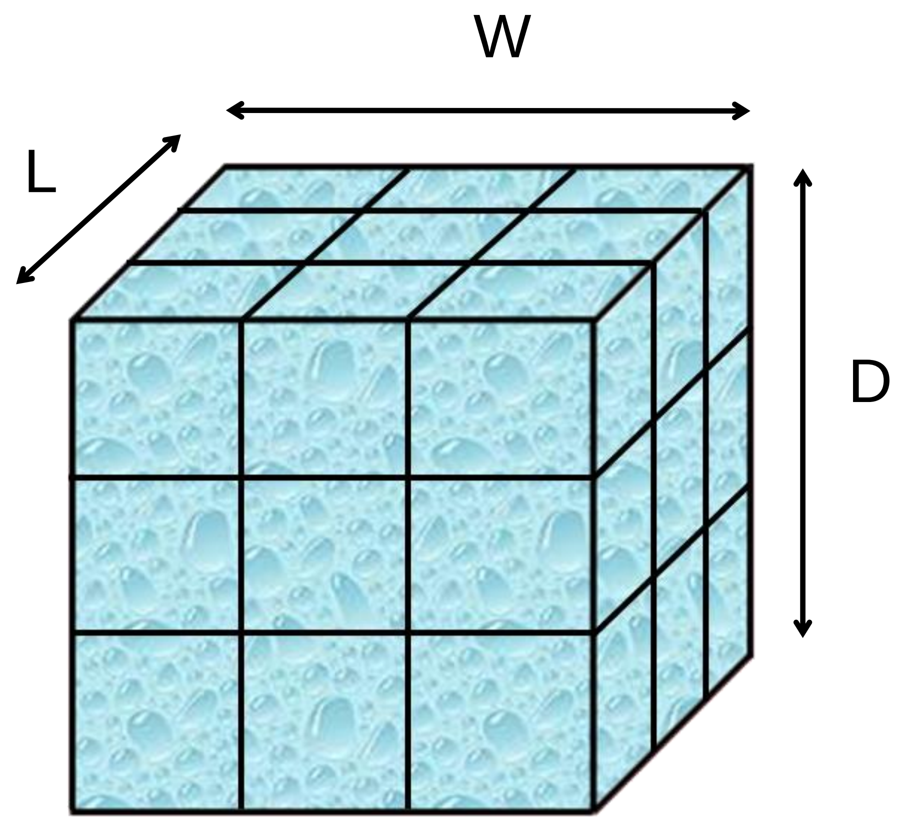
- Determine volume
- Calculate filtration flow rate
- Select a pump from the database
- Determine auxiliary flow rate
- Size the piping system and filter

Calculating volume



1 Cubic Foot = 7.48 Gallons of Water

Calculating volume

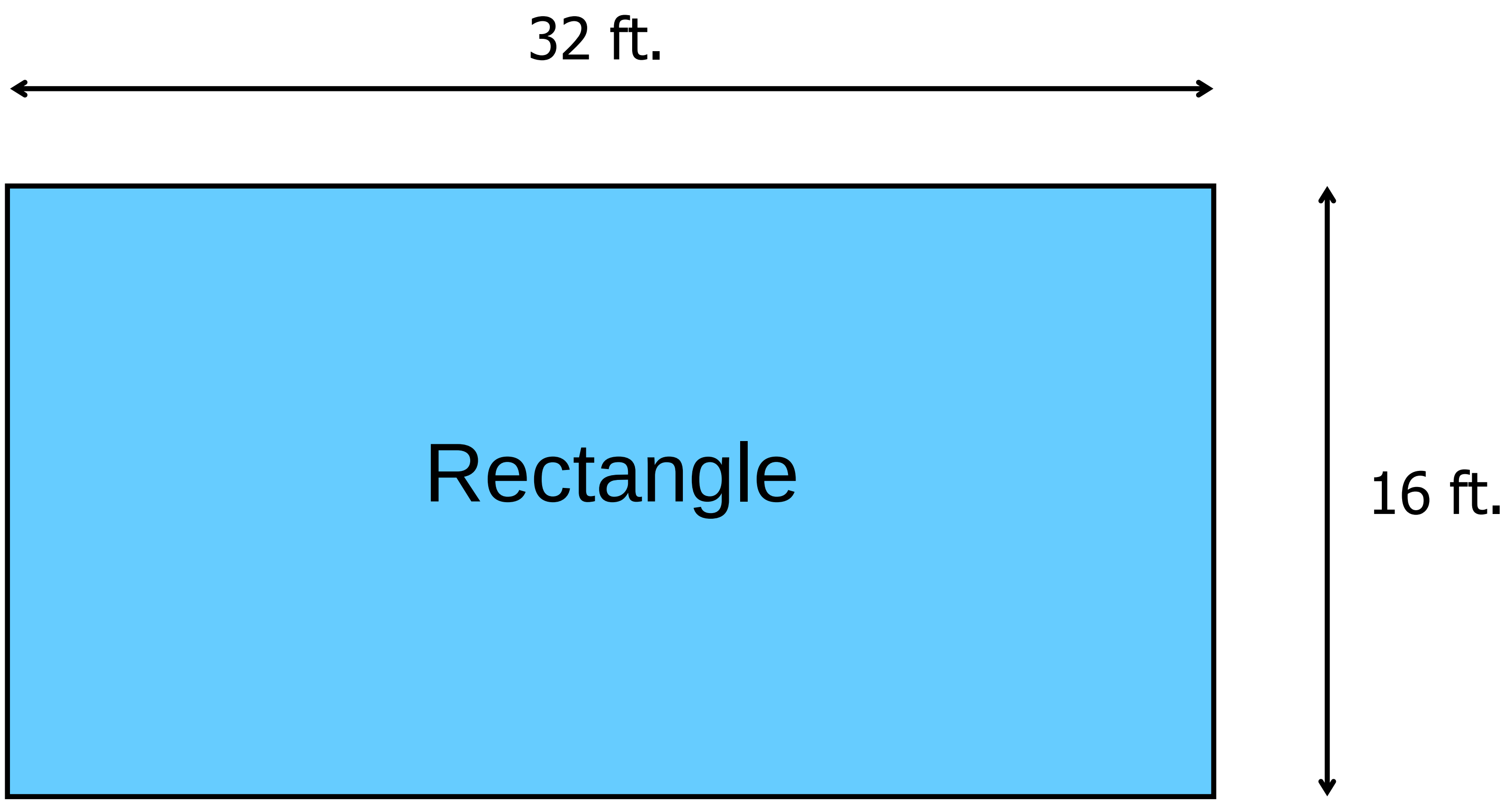


L X W X D = Cubic Feet

27 X 7.48 = 201.96 Gallons

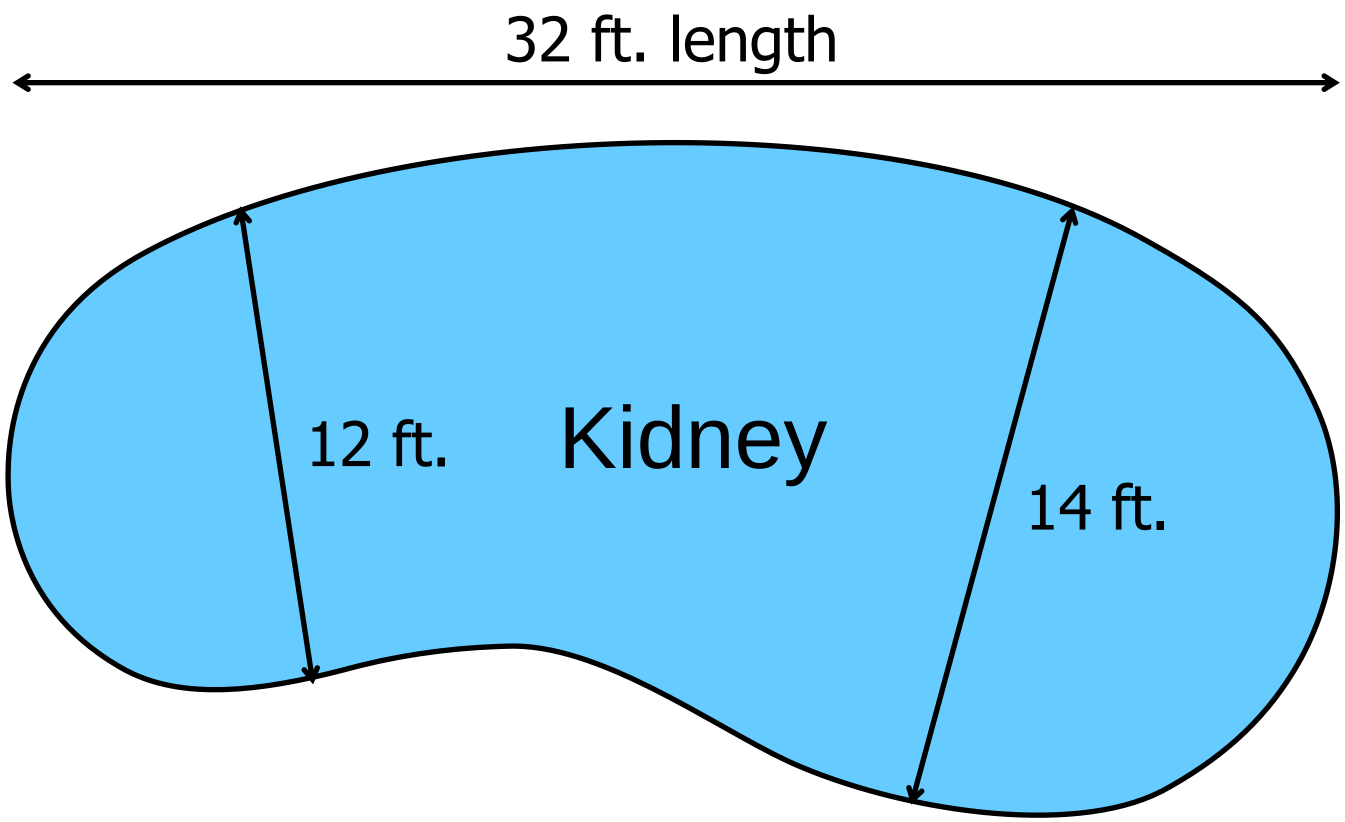
Calculating pool volume

Start with Surface Area



16 ft. x 32 ft. = 512 sq. ft.

Surface area



12 ft. end = 6 x 6 x 3.14 = 113 sq ft. ÷ 2 = 56.5 sq.ft.

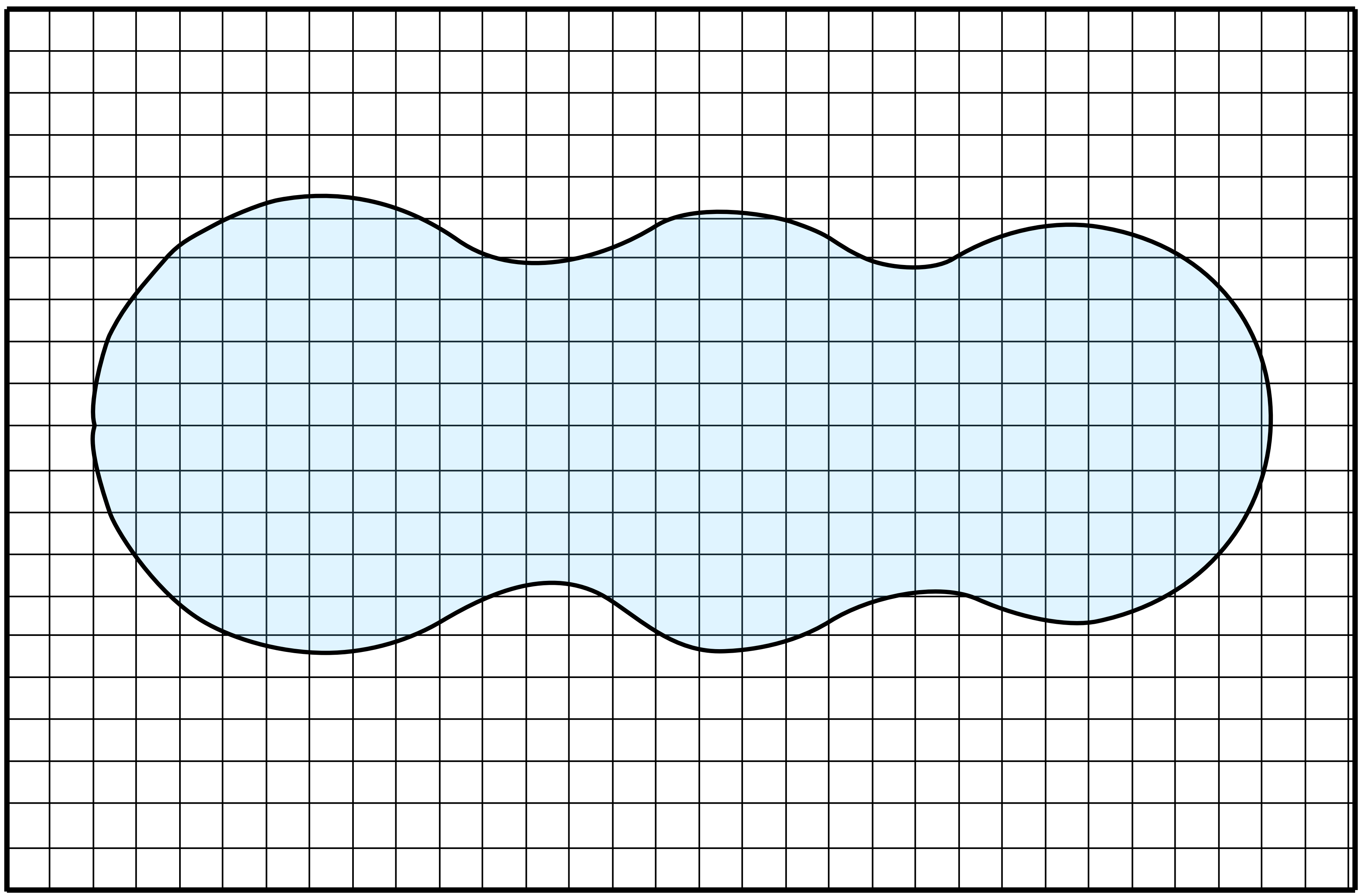
14 ft. end = 7 x 7 x 3.14 = 154 sq ft. ÷ 2 = 77 sq.ft.

32 -13 (6 + 7) = 19 x 13 (avg. width) = 247

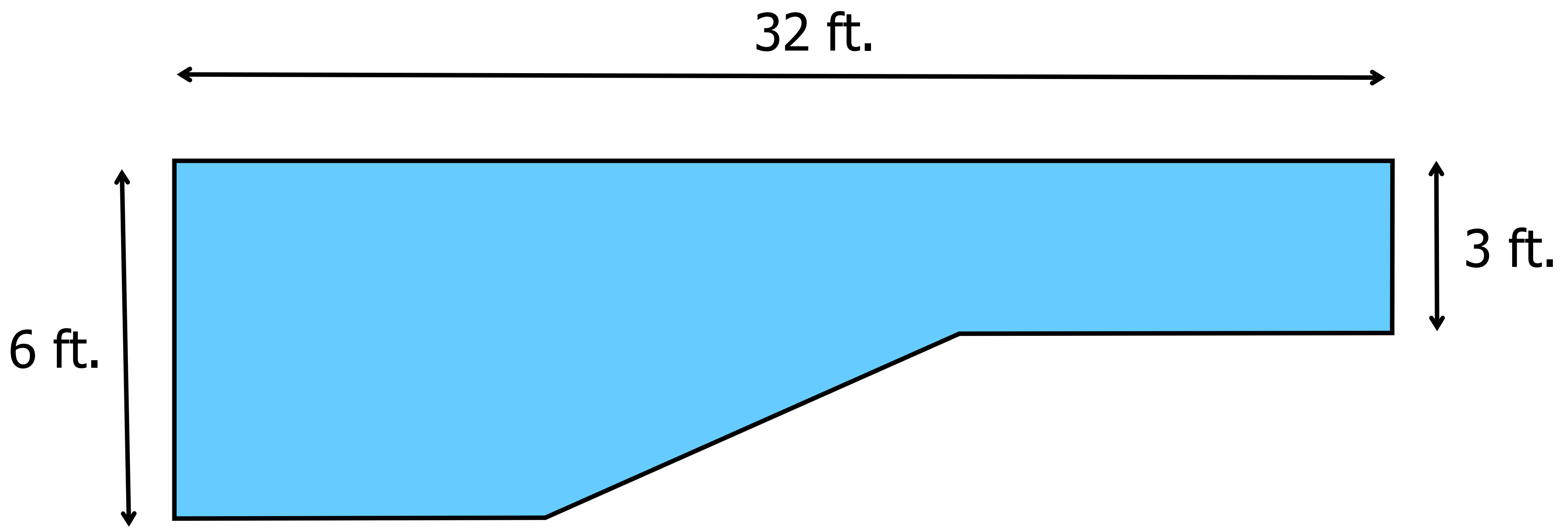
56.5 + 77 + 247 = 380.5 sq. ft. (381)

Count the squares

1 square = 1 sq. ft.

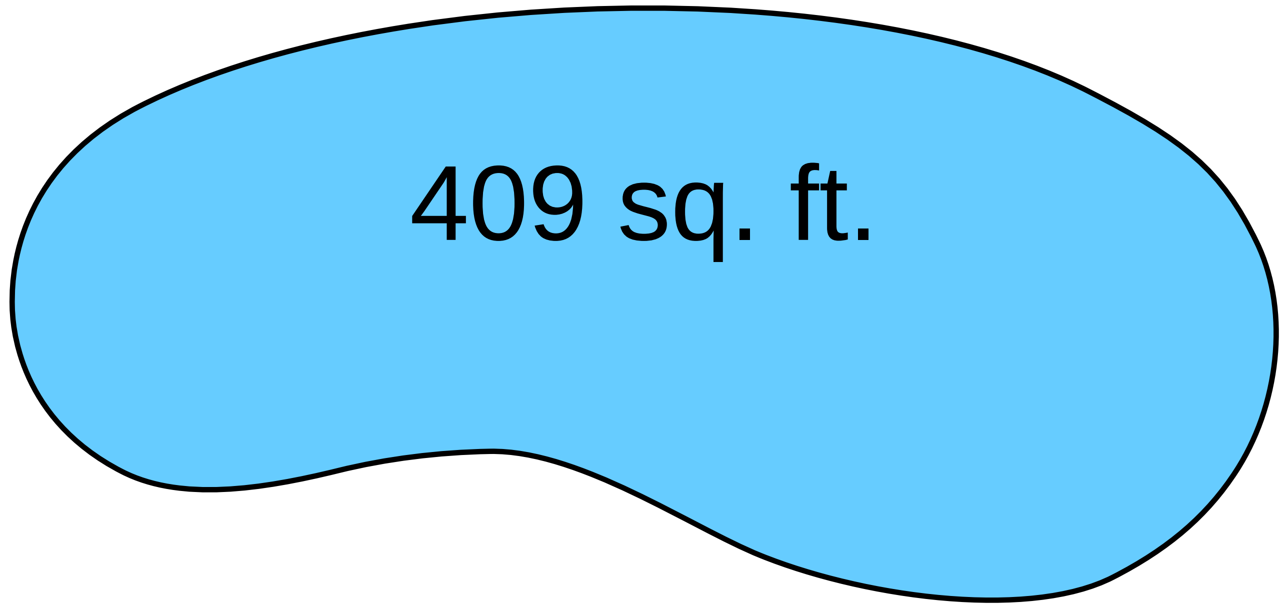


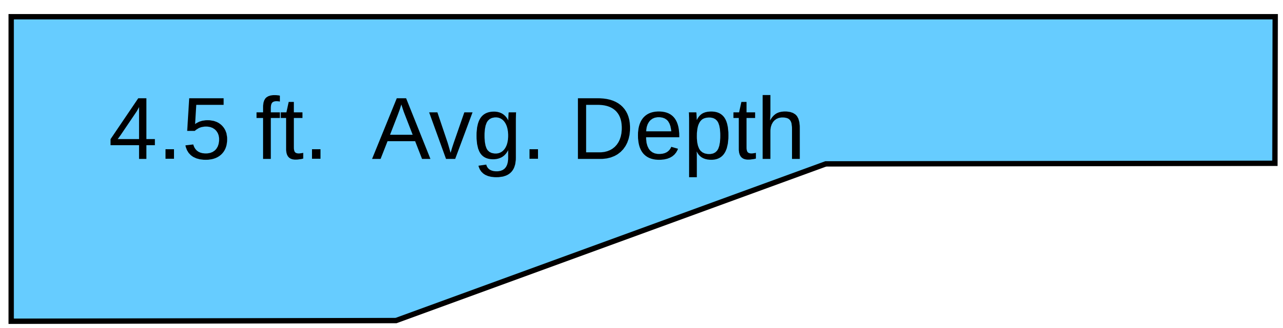
Then Average Depth



6 ft. + 3 ft. = 9 ft. ÷ 2 = 4.5 ft. Avg. Depth

Then Volume & Turnover





381 x 4.5 = 1,714 cubic feet

1,714 cu. ft. x 7.48 = 12,820 gallons

12,820 ÷ 360 = 35.6 (36 gpm)

Consider this Example

- Most in the industry size for a single turnover in 8 hours - even though 12 hours (the ANSI-5 minimum) would be more efficient.
- 15,000 ÷ 12 ÷ 60 = 21 gpm. – at 8 hours only 31 gpm is needed.
- For a 15,000 gallon pool, common practice was to install at least a one h.p. pump and run it 8 hours.

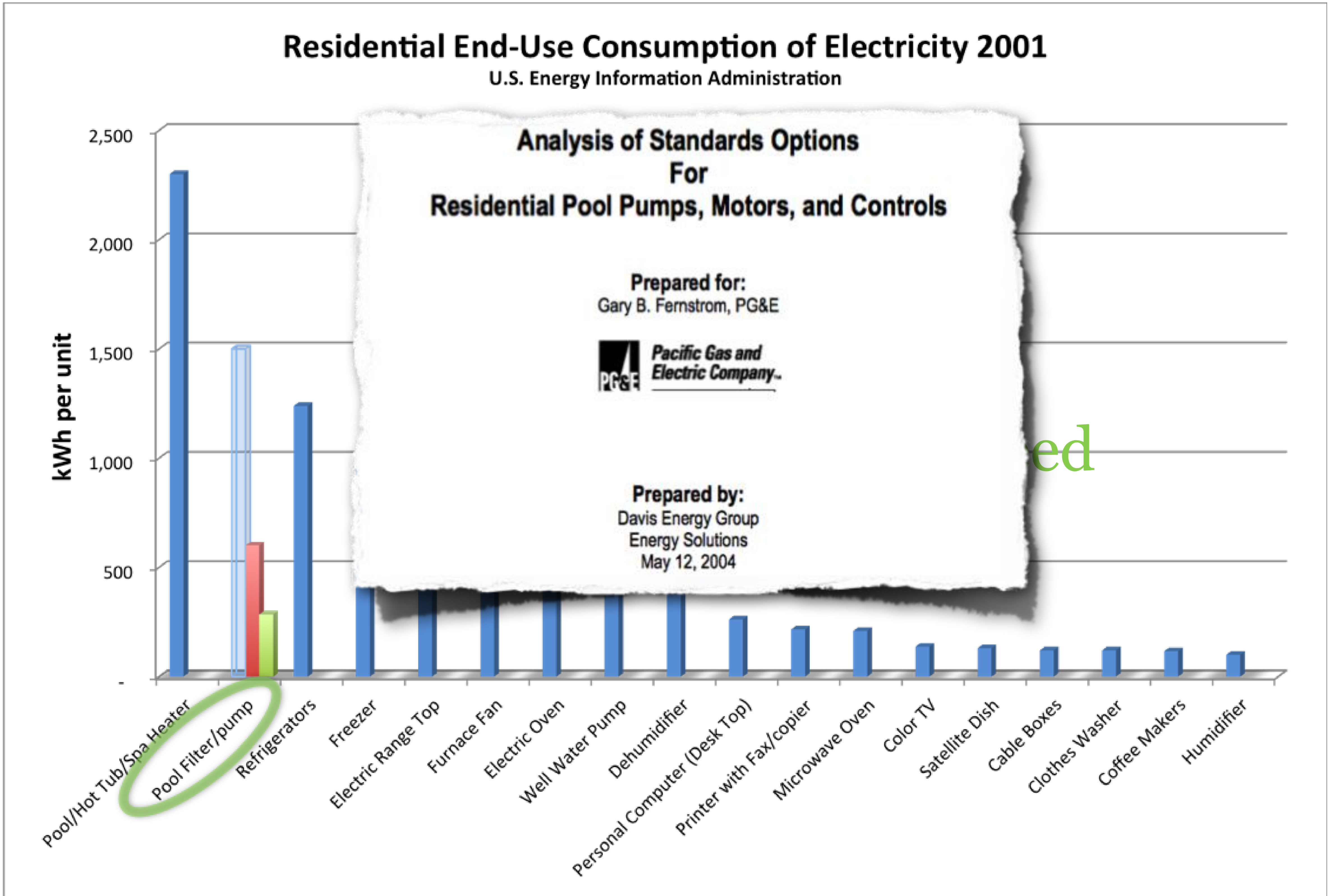
Popular 1 h.p. pump draws 7.8 amps
230volts x 7.8 amps = 1794 watts = 1.8 kwh
1.8 x 8 hours x 365 days = 5,256 kwh
@ .13¢ per kwh = $683.28 per year

Popular 1 h.p. 2-speed pump draws 2.3 amps (low speed)
230 volts x 2.3 amps = 529 watts = .529 kwh
.529 x 12 hours hours x 365 days = 2,317 kwh
@ .13¢ per kwh = $301.21 per year

Installing the 1 h.p. single speed was a complete waste of nearly $ 32.00 a month

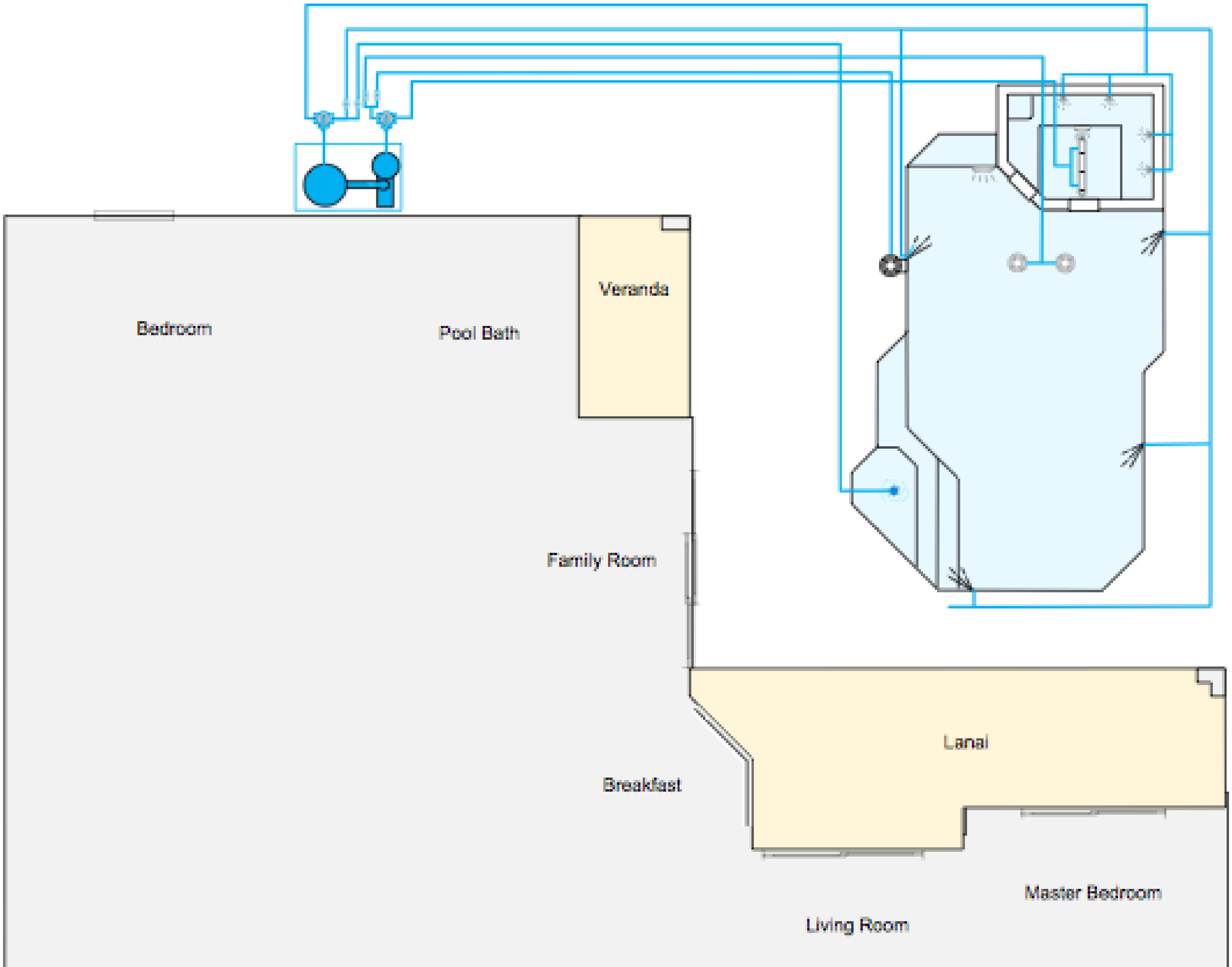
Here's Why

ANSI-15

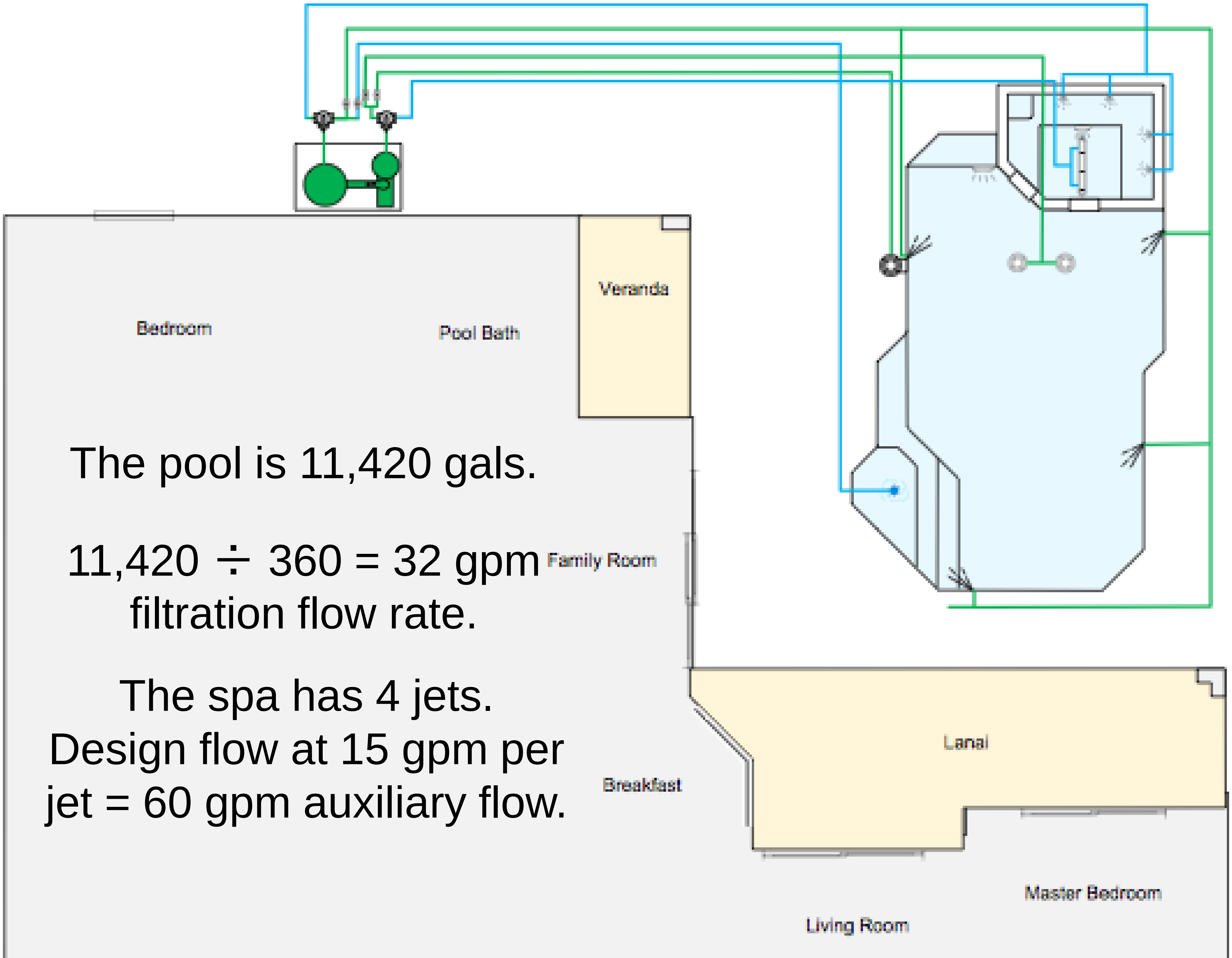


Step 1: Design

Sample pool w/piping illustrated



Sizing for ANSI-15 Compliance



The pool is 11,420 gals.

11,420 ÷ 360 = 32 gpm filtration flow rate.

The spa has 4 jets.
Design flow at 15 gpm per jet = 60 gpm auxiliary flow.

First, select the pump

Sample pool filtration flow rate: 32 gpm

For multi-speed and variable-speed filter pumps, at least one speed shall have the flow listed for Curve (A or C) that is equal to or less than the maximum filtration flow rate.

For filtration flow rates up to 17,000 gals. Select pump from Curve A

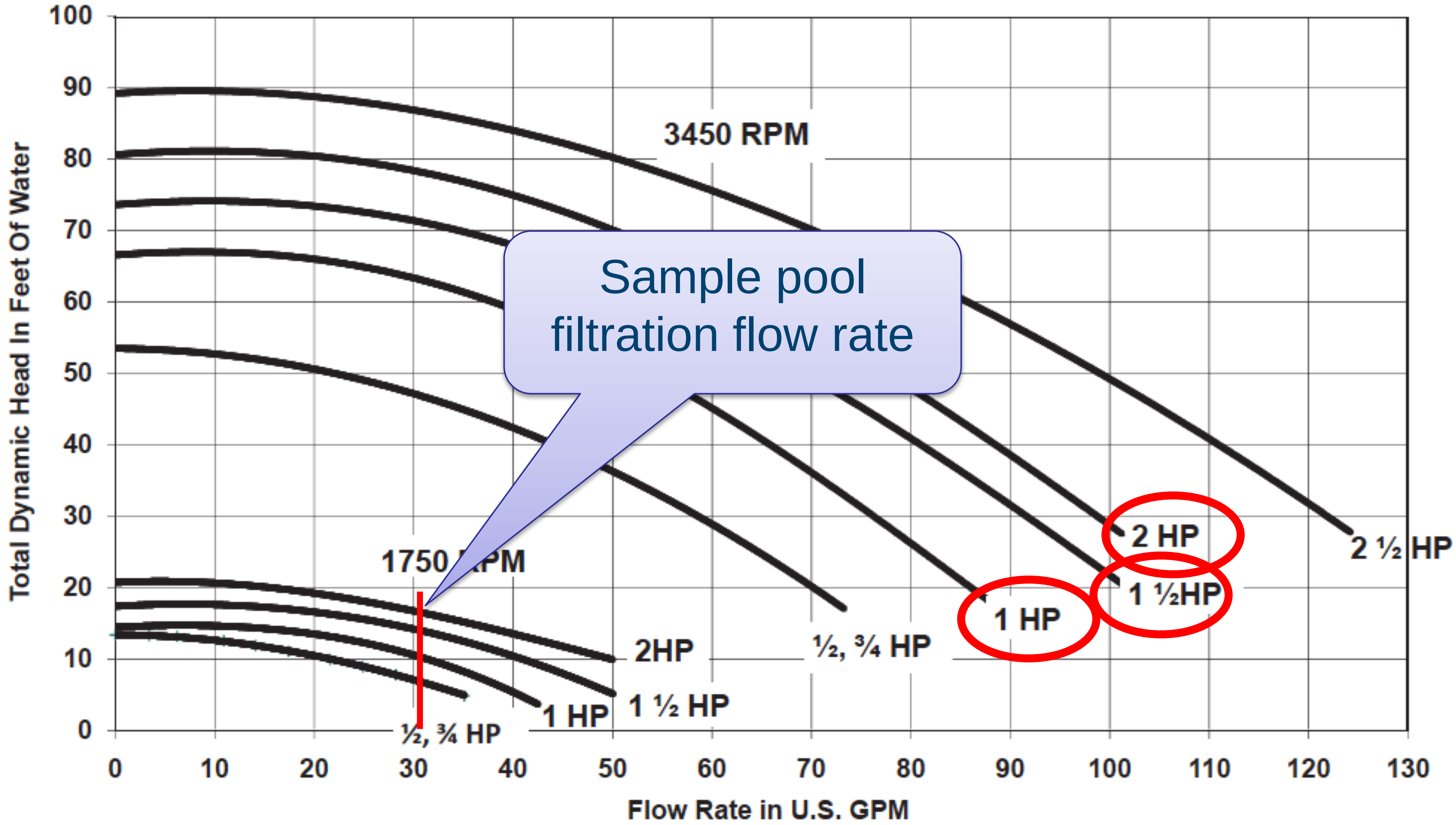
For filtration flow rates greater than 17,000 gals. Select pump from Curve C

ANSI-15

Appliance Database

	B	C	D	E	F	G	H	I	J	K	L
1	APSP Appliance Efficiency Pool Pump Database (Last Revised: May 14, 2012)										
2	Brand Name	Model Number	Speed RPM	Motor Design	Curve-A gpm Flow	Curve-A Power Watts	Curve-A Energy Factor	Curve-C gpm Flow	Curve-C Power Watts	Curve-C Energy Factor	Motor Construction
105	Sta-Rite	MPEAA6YG-168L (HIGH SPEED)	3450	Dual-Speed	67	2004	2.01	91	2256	2.42	Capacitor Start - Capacitor Run
106	Sta-Rite	MPEAA6YG-168L (LOW SPEED)	1725	Dual-Speed	33	418	4.74	55	454	7.27	Capacitor Start - Capacitor Run
107	Sta-Rite	MPEAA6YG-208L (HIGH SPEED)	3450	Dual-Speed	68	1995	2.05	82	2272	2.17	Capacitor Start - Capacitor Run
108	Sta-Rite	MPEAA6YG-208L (LOW SPEED)	1725	Dual-Speed	35	368	5.71	49	410	7.17	Capacitor Start - Capacitor Run
109	Sta-Rite	P2RA5YG-183L (HIGH SPEED)	3450	Dual-Speed	65	1619	2.41	82	1916	2.57	Capacitor Start - Capacitor Run
110	Sta-Rite	P2RA5YG-183L (HIGH SPEED)	1725	Dual-Speed	33	376	5.27	41	398	6.18	Capacitor Start - Capacitor Run
111	Sta-Rite	P2RA5YG-183LC (HIGH SPEED)	3450	Dual-Speed	65	1619	2.41	82	1916	2.57	Capacitor Start - Capacitor Run
112	Sta-Rite	P2RA5YG-183LC (LOW SPEED)	1725	Dual-Speed	33	386	5.13	41	398	6.18	Capacitor Start - Capacitor Run
113	Sta-Rite	P6RA6YF-206LM (HIGH SPEED)	3450	Dual-Speed	62	1711	2.17	76	1806	2.52	Permanent-split capacitor motor
114	Sta-Rite	P6RA6YF-206LM (LOW SPEED)	1725	Dual-Speed	31	381	4.88	38	395	5.77	Permanent-split capacitor motor
115	Sta-Rite	P6RA6YG-207L (HIGH SPEED)	3450	Dual-Speed	63	1941	1.95	83	2146	2.32	Capacitor Start - Capacitor Run
116	Sta-Rite	P6RA6YG-207L (LOW SPEED)	1725	Dual-Speed	35	415	5.06	45	443	6.09	Capacitor Start - Capacitor Run
117	Pentair	PFII-P2-1A (HIGH SPEED)	3450	Dual-Speed	55	1341	2.46	70	1418	2.96	Permanent-split capacitor motor
118	Pentair	PFII-P2-1A (LOW SPEED)	1725	Dual-Speed	31	310	6.00	39	320	7.31	Permanent-split capacitor motor
119	Sta-Rite	PHK2RAY6D-101L (HIGH SPEED)	3450	Dual-Speed	47	1114	2.53	59	1130	3.13	Permanent-split capacitor motor
120	Sta-Rite	PHK2RAY6D-101L (LOW SPEED)	1725	Dual-Speed	24	280	5.14	30	280	6.43	Permanent-split capacitor motor
121	Sta-Rite	PHK2RAY6E-102L (HIGH SPEED)	3450	Dual-Speed	56	1373	2.45	70	1436	2.92	Permanent-split capacitor motor
122	Sta-Rite	PHK2RAY6E-102L (LOW SPEED)	1725	Dual-Speed	31	309	6.02	38	320	7.13	Permanent-split capacitor motor
123	Sta-Rite	PHK2RAY6F-103L (HIGH SPEED)	3450	Dual-Speed	61	1680	2.18	83	2130	2.34	Permanent-split capacitor motor
124	Sta-Rite	PHK2RAY6F-103L (LOW SPEED)	1725	Dual-Speed	33	386	5.13	43	400	6.45	Permanent-split capacitor motor
125	Sta-Rite	PHK2RAY6G-104L (HIGH SPEED)	3450	Dual-Speed	64	1970	1.95	83	2130	2.34	Permanent-split capacitor motor
126	Sta-Rite	PHK2RAY6G-104L (HIGH SPEED)	1725	Dual-Speed	34	428	4.77	45	446	6.05	Permanent-split capacitor motor
127	Pentair	RSP10C (HIGH SPEED)	3450	Dual-Speed	55	1420	2.32	69	1432	2.89	Permanent-split capacitor motor
128	Pentair	RSP10C (LOW SPEED)	1725	Dual-Speed	28	291	5.77	35	293	7.17	Permanent-split capacitor motor
129	Pentair	RSP15C (HIGH SPEED)	3450	Dual-Speed	59	1558	2.27	76	1558	2.93	Permanent-split capacitor motor
130	Pentair	RSP15C (LOW SPEED)	1725	Dual-Speed	31	343	5.42	39	353	6.63	Permanent-split capacitor motor
131	Pentair	SF-N2-1-1/2A (HIGH SPEED)	3450	Dual-Speed	59	1738	2.04	76	1857	2.46	Permanent-split capacitor motor
132	Pentair	SF-N2-1-1/2A (LOW SPEED)	1725	Dual-Speed	29	369	4.72	39	385	6.08	Permanent-split capacitor motor
133	Pentair	SF-N2-1A (HIGH SPEED)	3450	Dual-Speed	56	1378	2.44	70	1450	2.90	Permanent-split capacitor motor
134	Pentair	SF-N2-1A (LOW SPEED)	1725	Dual-Speed	31	322	5.78	38	330	6.91	Permanent-split capacitor motor
135	Pentair	SF-N2-2A (HIGH SPEED)	3450	Dual-Speed	62	1960	1.90	82	2140	2.30	Permanent-split capacitor motor
136	Pentair	SF-N2-2A (LOW SPEED)	1725	Dual-Speed	31	403	4.62	41	424	5.80	Permanent-split capacitor motor
137	Pentair	SF-N2-3/4A HIGH SPEED	3450	Dual-Speed	47	1114	2.53	59	1130	3.13	Permanent-split capacitor motor
138	Pentair	SF-N2-3/4A LOW SPEED	1725	Dual-Speed	24	280	5.14	30	280	6.43	Permanent-split capacitor motor
139	Pentair	WFDS-24 (HIGH SPEED)	3450	Dual-Speed	61	1571	2.33	78	1592	2.94	Permanent-split capacitor motor
140	Pentair	WFDS-24 (LOW SPEED)	1725	Dual-Speed	34	370	5.51	42	380	6.63	Permanent-split capacitor motor
141	Pentair	SPEED)	3450	Dual-Speed	61	1571	2.33	78	1592	2.94	Permanent-split capacitor motor
142	Pentair	SPEED)	1725	Dual-Speed	34	370	5.51	42	380	6.63	Permanent-split capacitor motor
143	Pentair	WFDS-26 (HIGH SPEED)	3450	Dual-Speed	64	1795	2.14	82	1880	2.62	Permanent-split capacitor motor
144	Pentair	WFDS-26 (LOW SPEED)	1725	Dual-Speed	35	428	4.91	45	440	6.14	Permanent-split capacitor motor
145	Pentair	WFDS-26 WO SWITCH AQUATE (HIGH	3450	Dual-Speed	64	1795	2.14	82	1880	2.62	Permanent-split capacitor motor
146	Pentair	WFDS-26 WO SWITCH AQUATE (LOW	1725	Dual-Speed	35	428	4.91	45	440	6.14	Permanent-split capacitor motor
147	Pentair	WFDS-28 (HIGH SPEED)	3450	Dual-Speed	68	2055	1.99	90	2195	2.46	Permanent-split capacitor motor

Pump Performance Curve



1 ½ h.p. 2-speed pump

Selecting the pump - recap

Pool gallons
(to determine Curve A or C)

Calculate filtration flow rate
(pool gallons ÷ 360 minutes)

Select pump from database with Curve A or C listed flow rate equal to or less than calculated filtration flow rate

Residential pool pumps and motors:

- Applies only to Residential Pool Filtration Pumps.
- Florida code does not regulate pumps used for other features; booster pumps for cleaners, waterfall pumps, etc. Only pumps that operate the main filtration system are regulated.
- Spa jet pumps are excluded per ANSI-15
- Excludes auxiliary filters not used to maintain water quality, example: fountains, waterfalls...

Residential pool pumps and motors:

- Prohibits split-phase, shaded-pole or capacitor start-induction run type pump motors.
- Requires pool pumps and pump motors with a total horsepower of 1 h.p. or greater to have the capability of operating at two or more speeds.
- Pool pump motor controls for use with a two-speed or greater pump shall have the capability of operating the pool pump at a minimum of two speeds.

Filter Sizing

ANSI-15

- Filter shall be sized for 6 hour turnover (pool gallons ÷ 360) - sample pool = 32 gpm, or maximum flow rate, whichever is greater.
- Sample pool – the spa therapy jet flow rate is 60 gpm (4 jets @ 15 gpm each). This is the maximum flow rate.
- Sample pool filter shall be sized, using the "filter factor" for 60 gpm - the maximum flow rate.

Filter Factors

ANSI-15

Cartridge	.375 gpm per sq. ft.
Sand	15 gpm per sq. ft.
Diatomaceous Earth	2 gpm per sq. ft.

Cartridge Filter: (filtration area)

150 sq. ft. x .375 = 56.25 gpm – Too small

200 sq. ft. x .375 = 75 gpm - Compliant @ 60 gpm

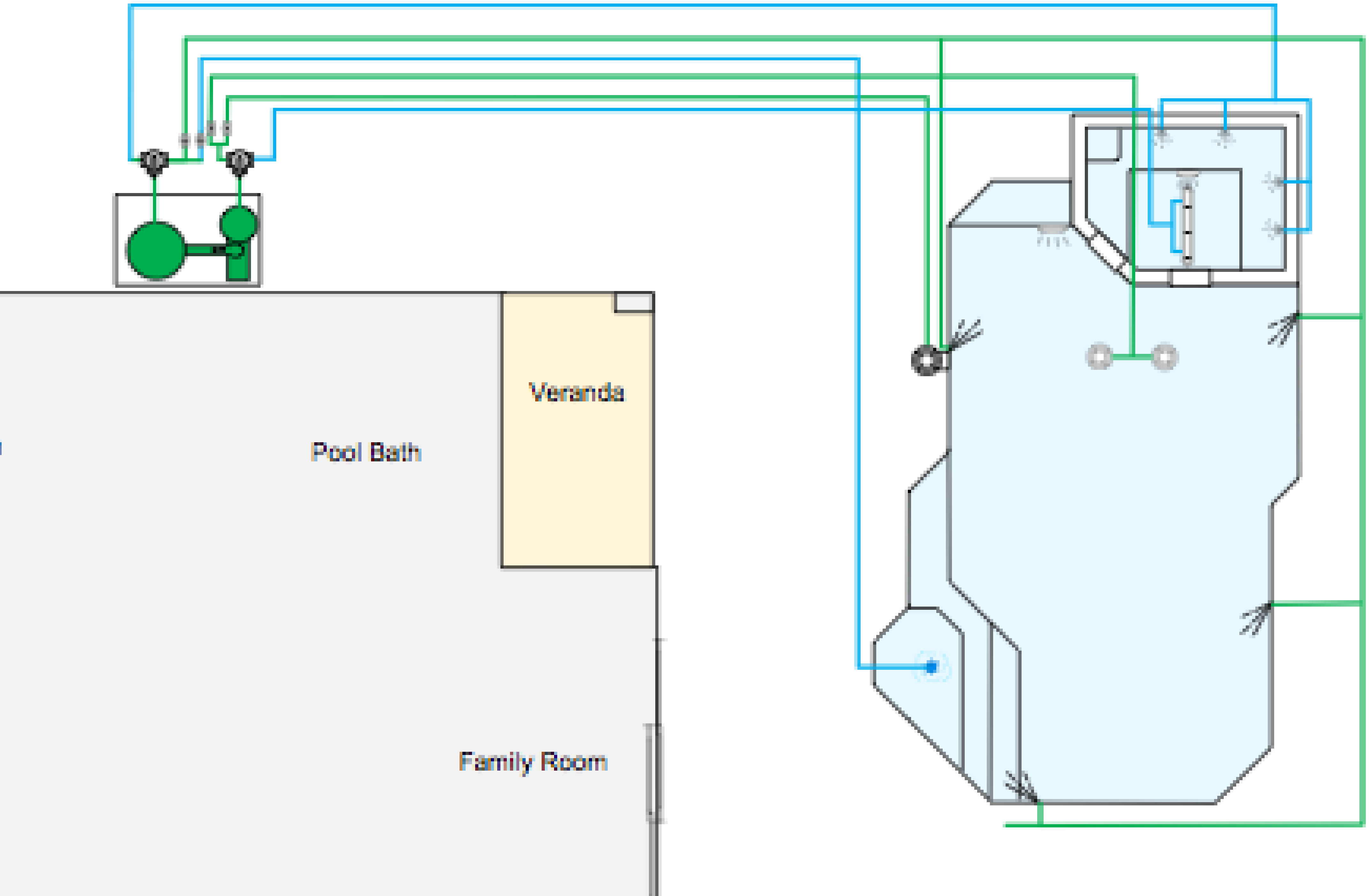
Diatomaceous Earth Filter: (filtration area)

27 sq. ft. x 2 = 54 gpm - Too small

36 sq. ft. x 2 = 72 gpm – Compliant @ 60 gpm

Filtration Pipe Sizing

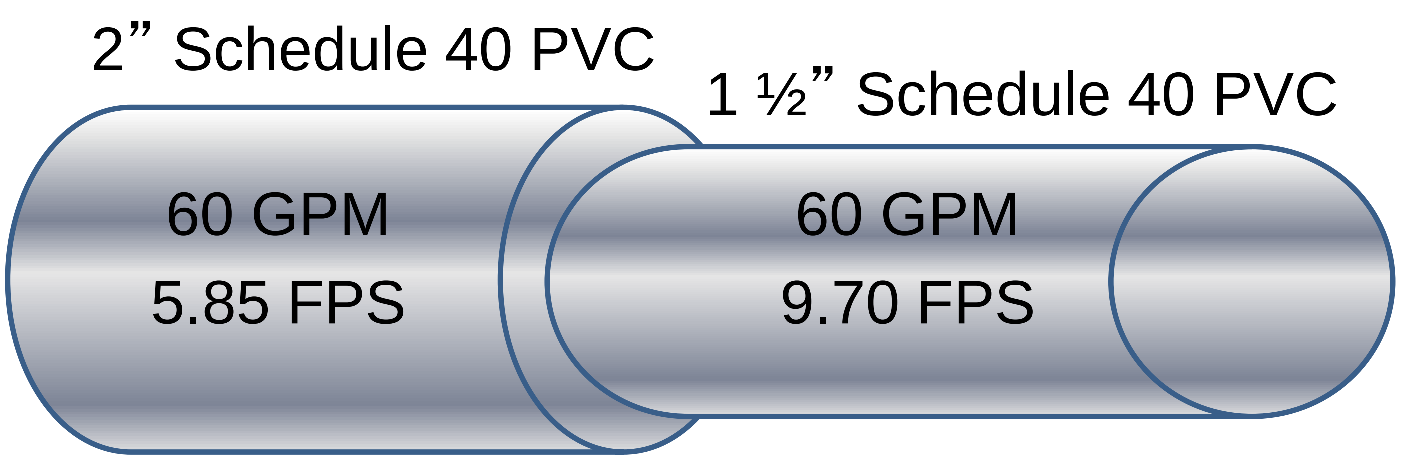
6 fps – suction side 8 fps – return side



Sizing is based on Velocity

Velocity is a measurement of how fast a liquid moves through pipe. Velocity is expressed in Feet Per Second (FPS)

Velocity changes as pipe size changes



Filtration Pipe Sizing ANSI-15

Pool piping & fittings shall be sized per table 1

Suction side maximum 6 fps (all suction piping)

Return side maximum 8 fps

Pipe Size	1.5"	2"	2.5"	3"	3.5"	4"	5"	6"
Nominal GPM @ 6fps	38	63	90	138	185	238	374	540
Nominal GPM @ 8fps	51	84	119	184	247	317	499	720

Pipe and fittings do not include equipment connections or internal equipment piping of, but not limited to, suction safety systems, pumps, heaters, and sanitizing devices

Final steps for compliance

- Multi-speed pumps shall have a controller that defaults to filtration flow rate when no auxiliary load is operating and/or within 24 hours.
- Filtration pump shall have a straight length of pipe at least 4 pipe diameters in front of the intake.
- 18 inches of straight pipe between the filter and heater or connections installed for future solar.
- The pool shall have directional inlets that adequately mix the pool water.

ANSI-15

Design Process

1st APSP-5 Residential Pools ✔

2nd APSP-15 Energy Efficiency ✔

3rd APSP-7 Suction Safety

ANSI-7 – The Hazards

Hair Entrapment

Body Suction Entrapment

Evisceration (Disembowelment)

Mechanical Entrapment

ANSI-7 – Root Causes

FLOW – Hair Entrapment

Suction – Body Entrapment & Evisceration

Mechanical – Limb Entrapment (jewelry, etc.)

Evisceration – Get drains out of wading pools!

General Requirements

There is no backup for a missing or damaged suction outlet cover/grate. If any cover/grate is found to be damaged or missing, the pool or spa shall be immediately closed to bathers.

Requirements

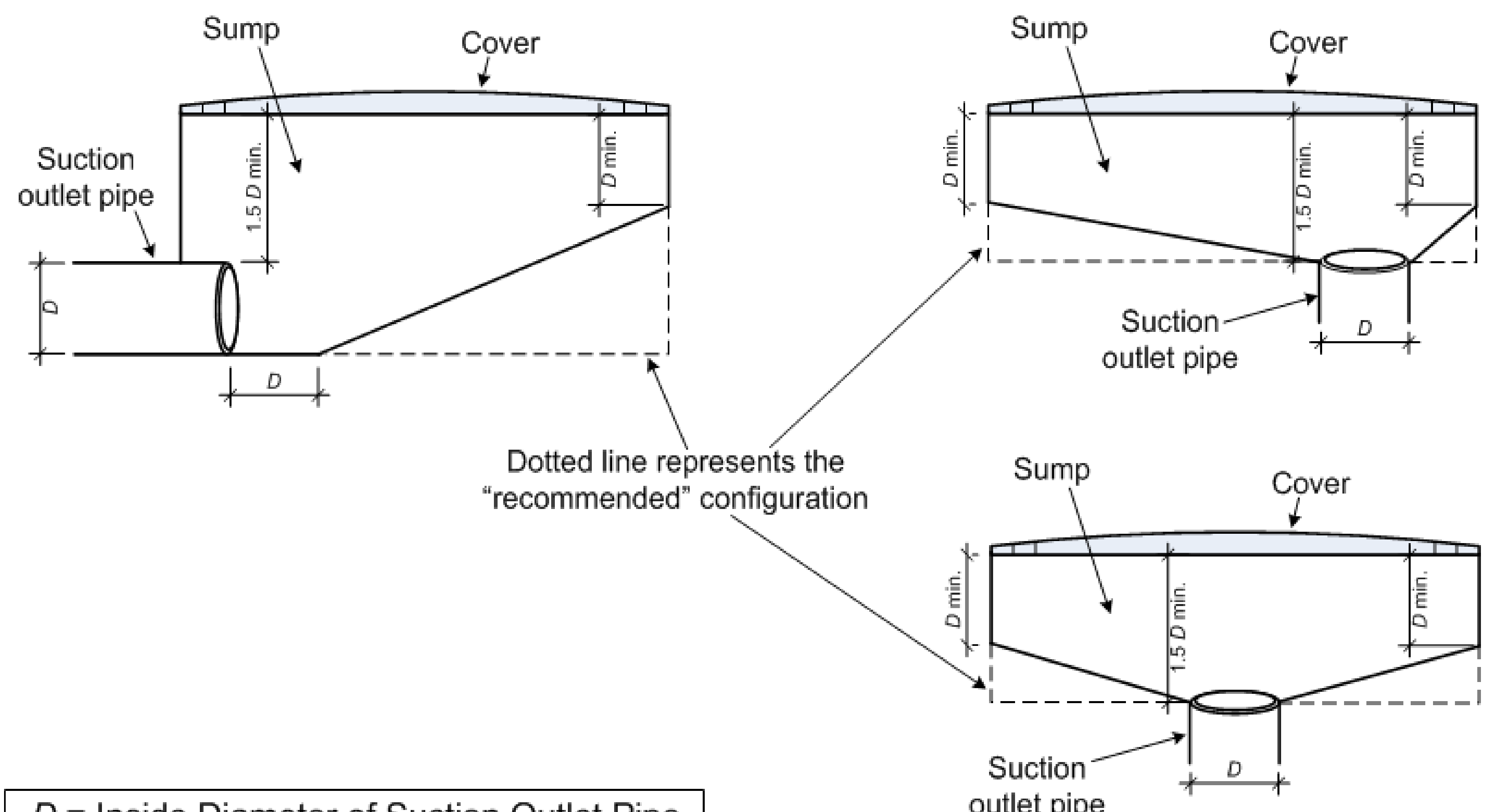
ANSI-7

Listed suction outlet(s). Suction outlet covers/grates shall be tested and certified by a nationally recognized testing laboratory as conforming to the most recent edition of APSP/ANSI-16

A suction fitting is defined in this standard as the *cover, attachments and sump*

(Suction Outlet Fitting Assembly – SOFA)

Field Built Sumps



D = Inside Diameter of Suction Outlet Pipe

Requirements of the Standard

- Listed Safety Covers – what's required & how to comply
- Water Velocity – what's required & how to comply
- Placement of Submerged Suction Outlets (Drains) – what's required & how to comply

Certified Covers?

- ASME A112.19.8 – 1987
  - No test for Finger, Body, or Cover Pull-off
  - UV inhibitors, no UV testing
  - Lock of hair
- ASME A112.19.8 – 2007 (ANSI/APSP-16)
  - Finger & Limb Entrapment Test
  - Body Entrapment Test
  - Shear Load & Pull Load Tests
  - UV Weathering before structural test
  - Fastener Test
  - Full Head of Hair Test
  - Pony Tail Test
  - No Size Limit

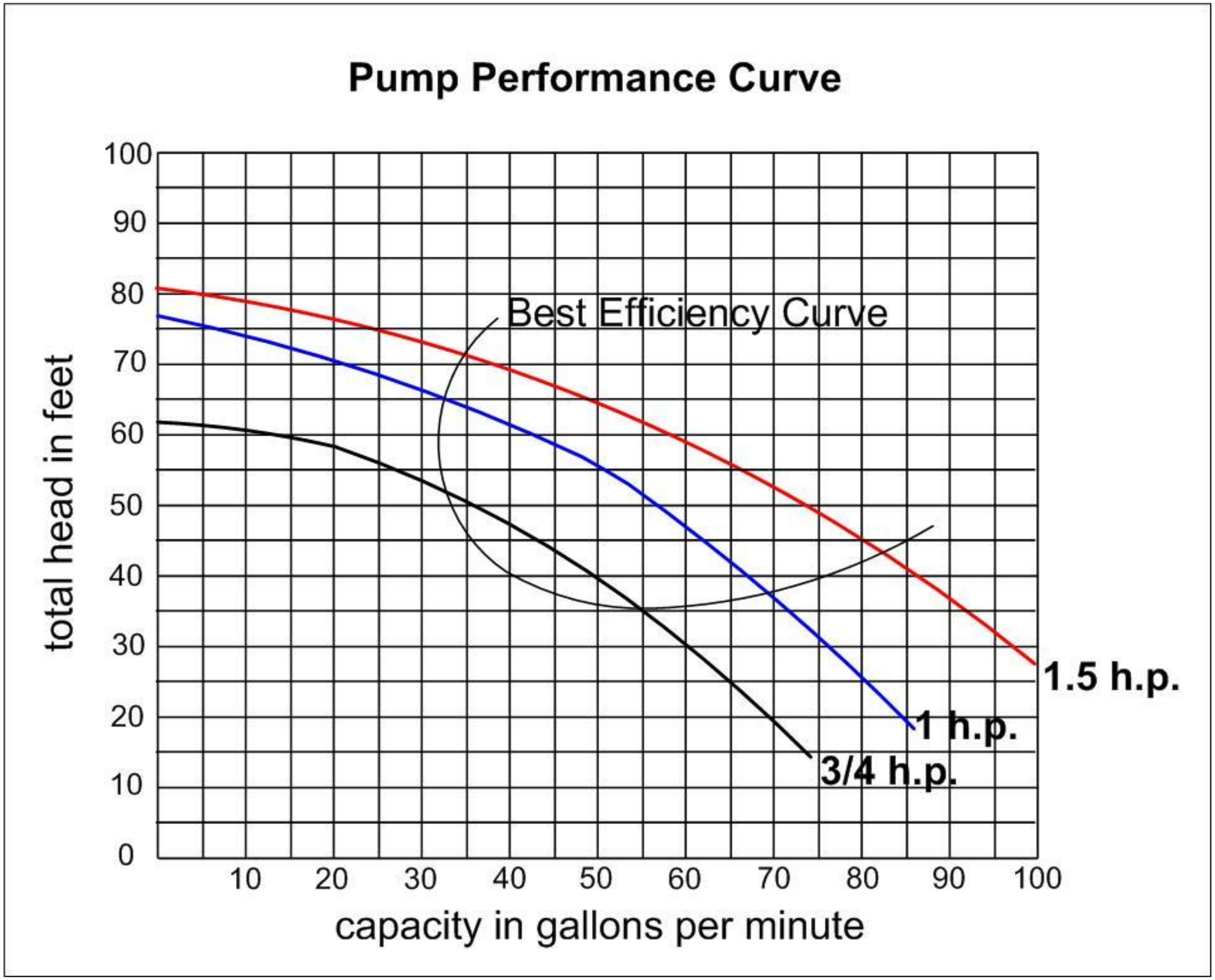
ANSI-7 Requirements

- Water velocity in field fabricated piping is based on the maximum system flow rate
- Water velocity in branch suction piping is based on maximum system flow rate and shall be limited to 6 feet per second when one of a pair of drains is blocked. In normal operation then, the branch suction piping velocity is 3 feet per second. 8 fps in header piping to the pump.

Lets Start the Process

- Determine Maximum flow rate
- Calculate resistance (TDH)
- Size the piping system & select a compliant cover

Pump Efficiency Curve



Outside the Curve – Not good for the Pump

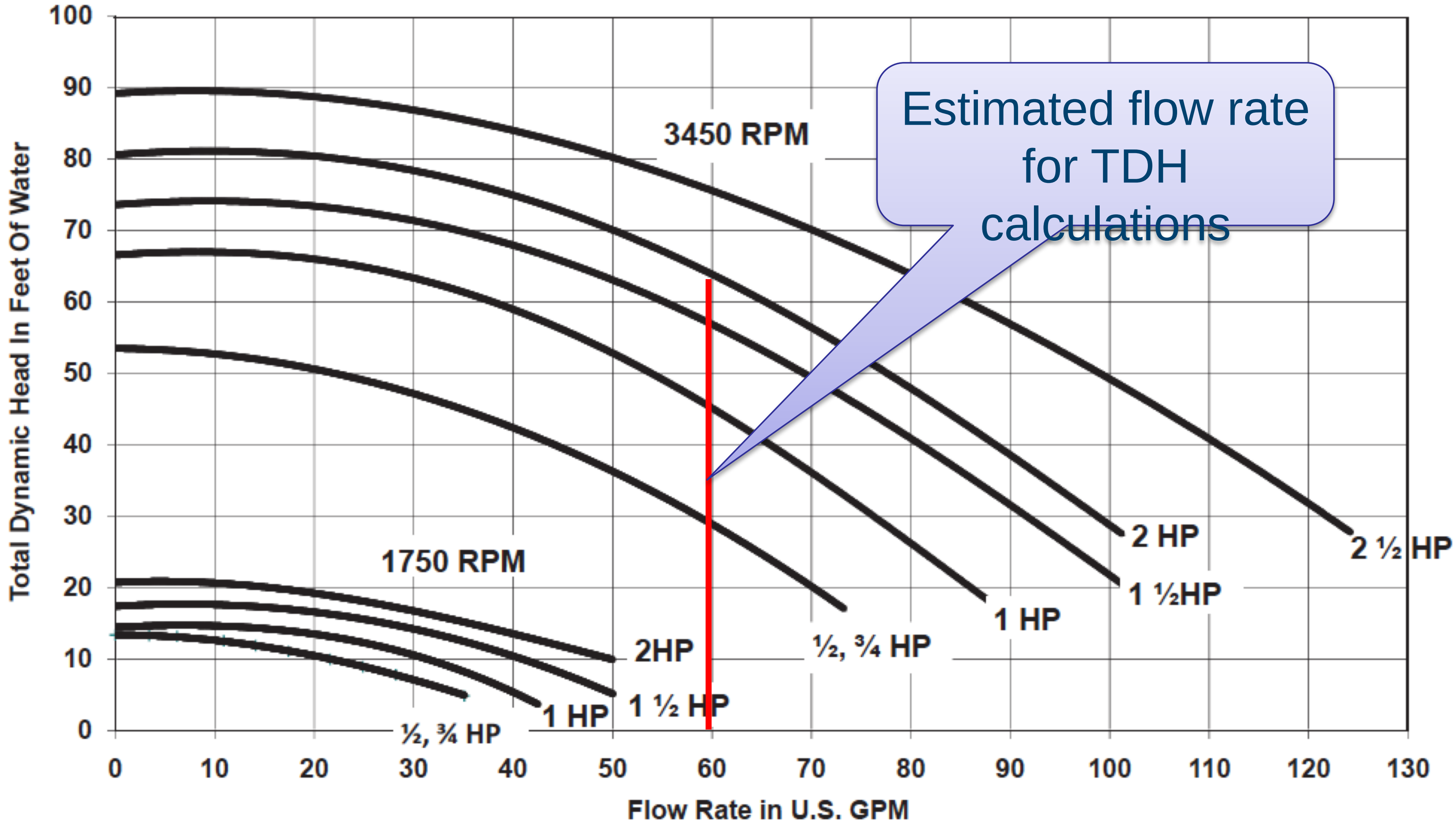
The Calculations for

Maximum pump flow: From the manufacturer's pump curve.
(Large piping system & flow typically outside pump's efficiency curve)

Total dynamic head (TDH): Sum of all resistances in a complete operating system (pipe, fittings, valves, filter, heater, etc.).
(Estimate maximum flow - then perform TDH calculations at estimated
flow, this may lead to a smaller piping system than if you use Maximum pump flow - and pump performance closer to it's efficiency curve)

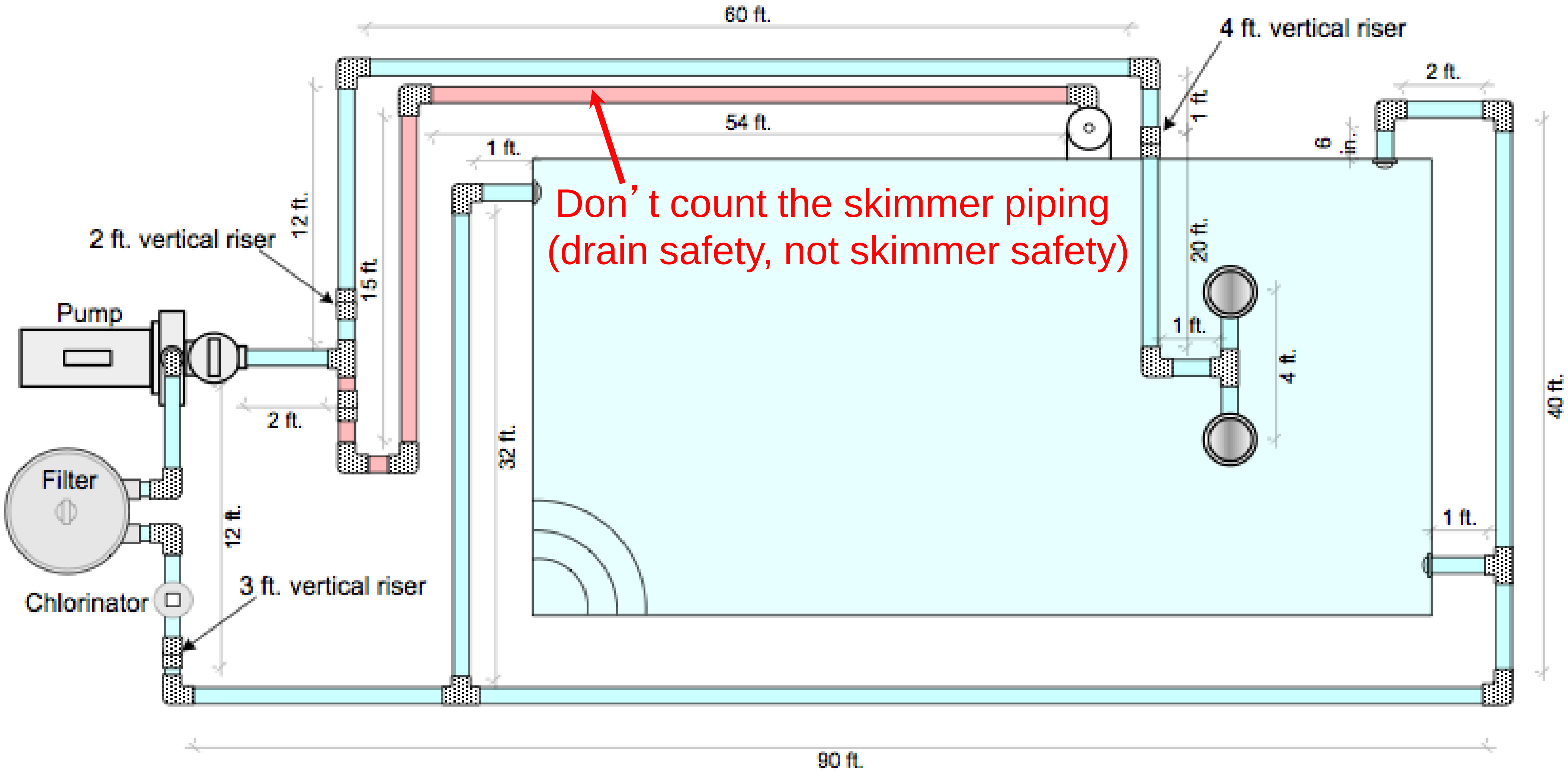
Simplified TDH calculation: Hydraulic calculations using the shortest distance between the pool and the pump, omitting the calculations for fittings/valves, and using the best performance ratings for filters and heaters. (likely won't help)

Pump Performance Curve



Spa design flow rate at 60 gpm

Here’s how TDH is Calculated



Measure the pipe, count the fittings, valves, equipment, return & drain fittings

FRICTION LOSS - WATER

Flow Velocity & Friction Loss — Schedule 40 Pipe

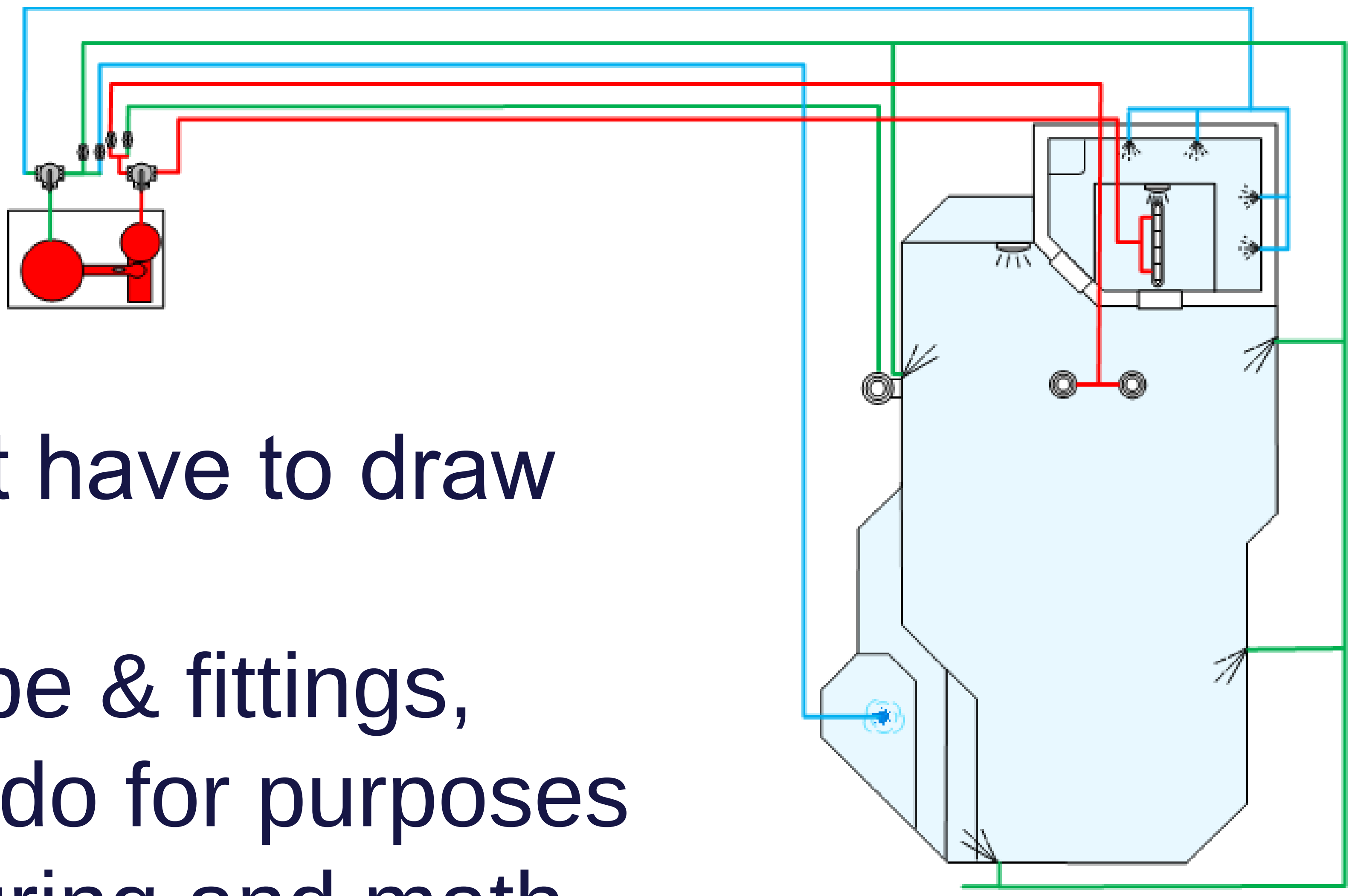
Gallons/Minute	Velocity Ft./Second	Friction Loss Ft. Water/100 Ft.	Friction Loss PSI/100 Ft.	Velocity Ft./Second	Friction Loss Ft. Water/100 Ft.	Friction Loss PSI/100 Ft.	Velocity Ft./Second	Friction Loss Ft. Water/100 Ft.	Friction Loss PSI/100 Ft.	Velocity Ft./Second	Friction Loss Ft. Water/100 Ft.	Friction Loss PSI/100 Ft.	Velocity Ft./Second	Friction Loss Ft. Water/100 Ft.	Friction Loss PSI/100 Ft.	Velocity Ft./Second	Friction Loss Ft. Water/100 Ft.	Friction Loss PSI/100 Ft.	Velocity Ft./Second	Friction Loss Ft. Water/100 Ft.	Friction Loss PSI/100 Ft.	Velocity Ft./Second	Friction Loss Ft. Water/100 Ft.	Friction Loss PSI/100 Ft.
	½ in.			¾ in.																				
1	1.13	2.08	0.90	0.63	0.51	0.22	1 in.			1¼ in.			1½ in.											
2	2.26	4.16	1.80	1.26	1.02	0.44	0.77	0.55	0.24	0.44	0.14	0.06	0.33	0.07	0.03	2 in.			2½ in			3 in.		
5	5.64	23.44	10.15	3.16	5.73	2.48	1.93	1.72	0.75	1.11	0.44	0.19	0.81	0.22	0.09	0.49	0.066	0.029	0.30	0.038	0.016	0.22	0.015	0.007
7	7.90	43.06	18.64	4.43	10.52	4.56	2.72	3.17	1.37	1.55	0.81	0.35	1.13	0.38	0.17	0.69	0.11	0.048	0.49	0.051	0.023	0.31	0.021	0.009
10	11.28	82.02	35.51	6.32	20.04	8.68	3.86	6.02	2.61	2.21	1.55	0.67	1.62	0.72	0.31	0.98	0.21	0.091	0.68	0.09	0.039	0.44	0.03	0.013
15	4 in.			9.48	42.46	18.39	5.79	12.77	5.53	3.31	3.28	1.42	2.42	1.53	0.66	1.46	0.45	0.19	1.03	0.19	0.082	0.66	0.07	0.030
20	0.51	0.03	0.013	12.65	72.34	31.32	7.72	21.75	9.42	4.42	5.59	2.42	3.23	2.61	1.13	1.95	0.76	0.33	1.37	0.32	0.14	0.88	0.11	0.048
25	0.64	0.04	0.017	5 in.			9.65	32.88	14.22	5.52	8.45	3.66	4.04	3.95	1.71	2.44	1.15	0.50	1.71	0.49	0.21	1.10	0.17	0.074
30	0.77	0.06	0.026	0.49	0.02	0.009	11.58	46.08	19.95	6.63	11.85	5.13	4.85	5.53	2.39	2.93	1.62	0.70	2.05	0.68	0.29	1.33	0.23	0.10
35	0.89	0.08	0.035	0.57	0.03	0.013				7.73	15.76	6.82	5.66	7.36	3.19	3.41	2.15	0.93	2.39	0.91	0.39	1.55	0.31	0.13
40	1.02	0.11	0.048	0.65	0.03	0.013				8.84	20.18	8.74	6.47	9.43	4.08	3.90	2.75	1.19	2.73	1.16	0.50	1.77	0.40	0.17
45	1.15	0.13	0.056	0.73	0.04	0.017	6 in.			9.94	25.10	10.87	7.27	11.73	5.08	4.39	3.43	1.49	3.08	1.44	0.62	1.99	0.50	0.22
50	1.28	0.16	0.069	0.81	0.05	0.022	0.56	0.02	0.009	11.05	30.51	13.21	8.08	14.25	6.17	4.88	4.16	1.80	3.42	1.75	0.76	2.21	0.60	0.26
60	1.53	0.22	0.095	0.97	0.07	0.030	0.67	0.03	0.013				9.70	19.98	8.65	5.85	5.84	2.53	4.10	2.46	1.07	2.65	0.85	0.37
70	1.79	0.30	0.13	1.14	0.10	0.043	0.79	0.04	0.017							6.83	7.76	3.36	4.79	3.27	1.42	3.09	1.13	0.49
75	1.92	0.34	0.15	1.22	0.11	0.048	0.84	0.05	0.022							7.32	8.82	3.82	5.13	3.71	1.61	3.31	1.28	0.55
80	2.05	0.38	0.16	1.30	0.13	0.056	0.90	0.05	0.022							7.80	9.94	4.30	5.47	4.19	1.81	3.53	1.44	0.62
90	2.30	0.47	0.20	1.46	0.16	0.069	1.01	0.06	0.026	8 in.						8.78	12.37	5.36	6.15	5.21	2.26	3.98	1.80	0.78
100	2.56	0.58	0.25	1.62	0.19	0.082	1.12	0.08	0.035	0.65	0.03	0.012				9 75	15.03	6.51	6.84	6.33	2.74	4.42	2.18	0.94
125	3.20	0.88	0.38	2.03	0.29	0.125	1.41	0.12	0.052	0.81	0.035	0.015							8.55	9.58	4.15	5.52	3.31	1.43
150	3.84	1.22	0.53	2.44	0.40	0.17	1.69	0.16	0.069	0.97	0.04	0.017							10.26	13.41	5.81	6.63	4.63	2.00
175	4.48	1.63	0.71	2.84	0.54	0.235	1.97	0.22	0.096	1.14	0.055	0.024	10 in.									7.73	6.16	2.67
200	5.11	2.08	0.90	3.25	0.69	0.30	2.25	0.28	0.12	1.30	0.07	0.030	0.82	0.027	0.012							8.83	7.88	3.41
250	6.40	3.15	1.36	4.06	1.05	0.45	2.81	0.43	0.19	1.63	0.11	0.048	1.03	0.035	0.015							11.04	11.93	5.17
300	7.67	4.41	1.91	4.87	1.46	0.63	3.37	0.60	0.26	1.94	0.16	0.069	1.23	0.05	0.022	12 in.								
350	8.95	5.87	2.55	5.69	1.95	0.85	3.94	0.79	0.34	2.27	0.21	0.091	1.44	0.065	0.028	1.01	0.027	0.012						
400	10.23	7.52	3.26	6.50	2.49	1.08	4.49	1.01	0.44	2.59	0.27	0.12	1.64	0.09	0.039	1.16	0.04	0.017						
450				7.31	3.09	1.34	5.06	1.26	0.55	2.92	0.33	0.14	1.85	0.11	0.048	1.30	0.05	0.022						
500				8.12	3.76	1.63	5.62	1.53	0.66	3.24	0.40	0.17	2.05	0.13	0.056	1.45	0.06	0.026						
750										4.86	0.85	0.37	3.08	0.28	0.12	2.17	0.12	0.052						
1000										6.48	1.45	0.63	4.11	0.48	0.21	2.89	0.20	0.087						
1250													5.14	0.73	0.32	3.62	0.31	0.13						
1500													6.16	1.01	0.44	4.34	0.43	0.19						
2000																5.78	0.73	0.32						
2500																7.23	1.11	0.49						

Friction loss through fittings

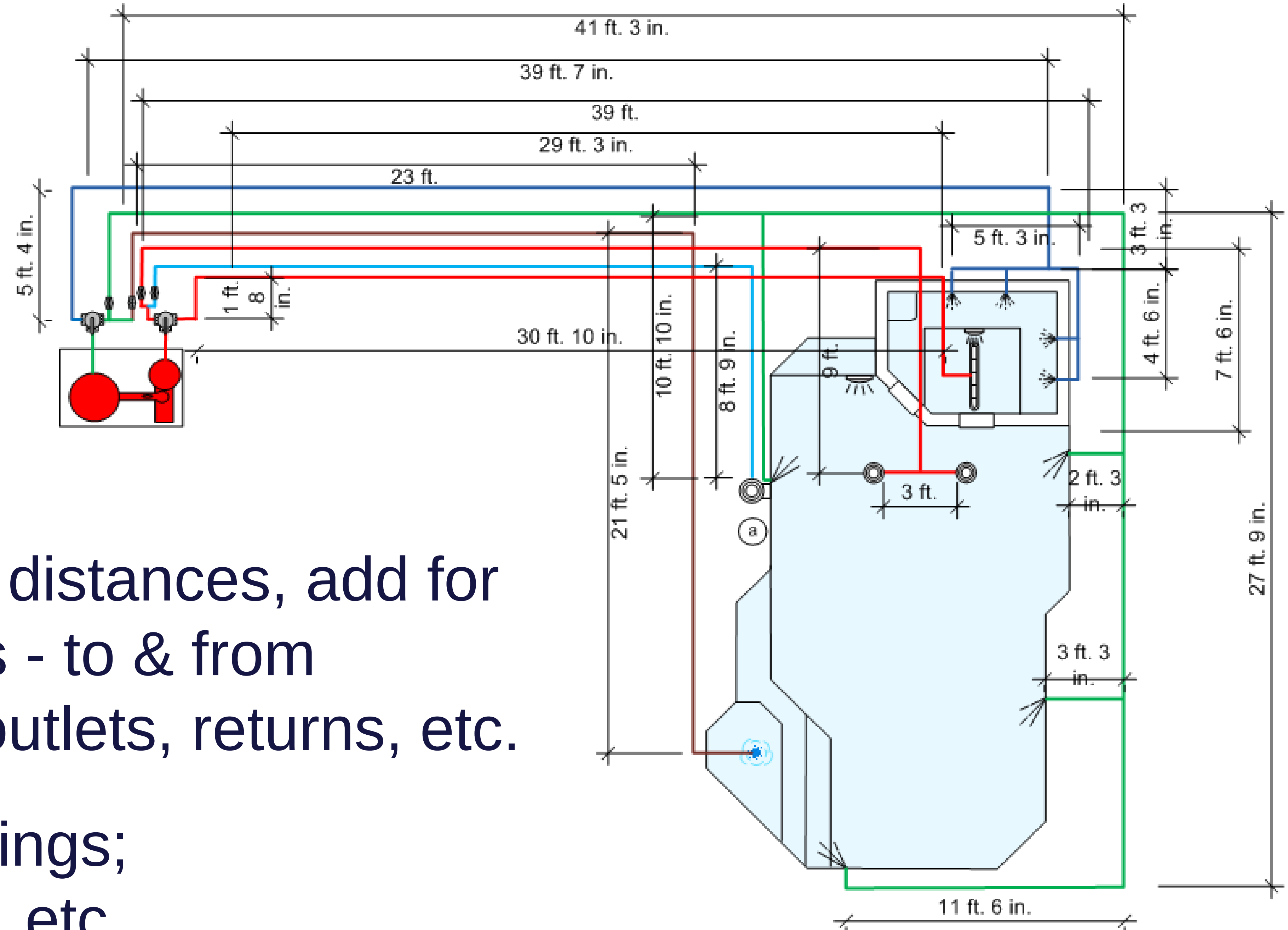
Equivalent length of straight pipe in feet

Pipe Size	1”	1.5”	2”	2.5”	3”	4”	5”	6”	8”
90º elbow	2.5	4.0	5.7	6.9	7.9	11.4	14.5	16.7	21.0
45º elbow	1.4	2.1	2.6	3.1	4.0	5.1	7.0	8.0	10.6
Tee through	1.7	2.7	4.0	4.9	6.1	7.9	9.7	12.3	14.0
Tee branch	6.0	8.4	12.0	14.7	16.4	22.0	26.2	32.7	49.0
Swing Check Valve	11.2	15.2	19.1	22.0	27.0	38.0			

The Complete Piping System



You don’t have to draw the
actual pipe & fittings,
lines will do for purposes
of measuring and math.

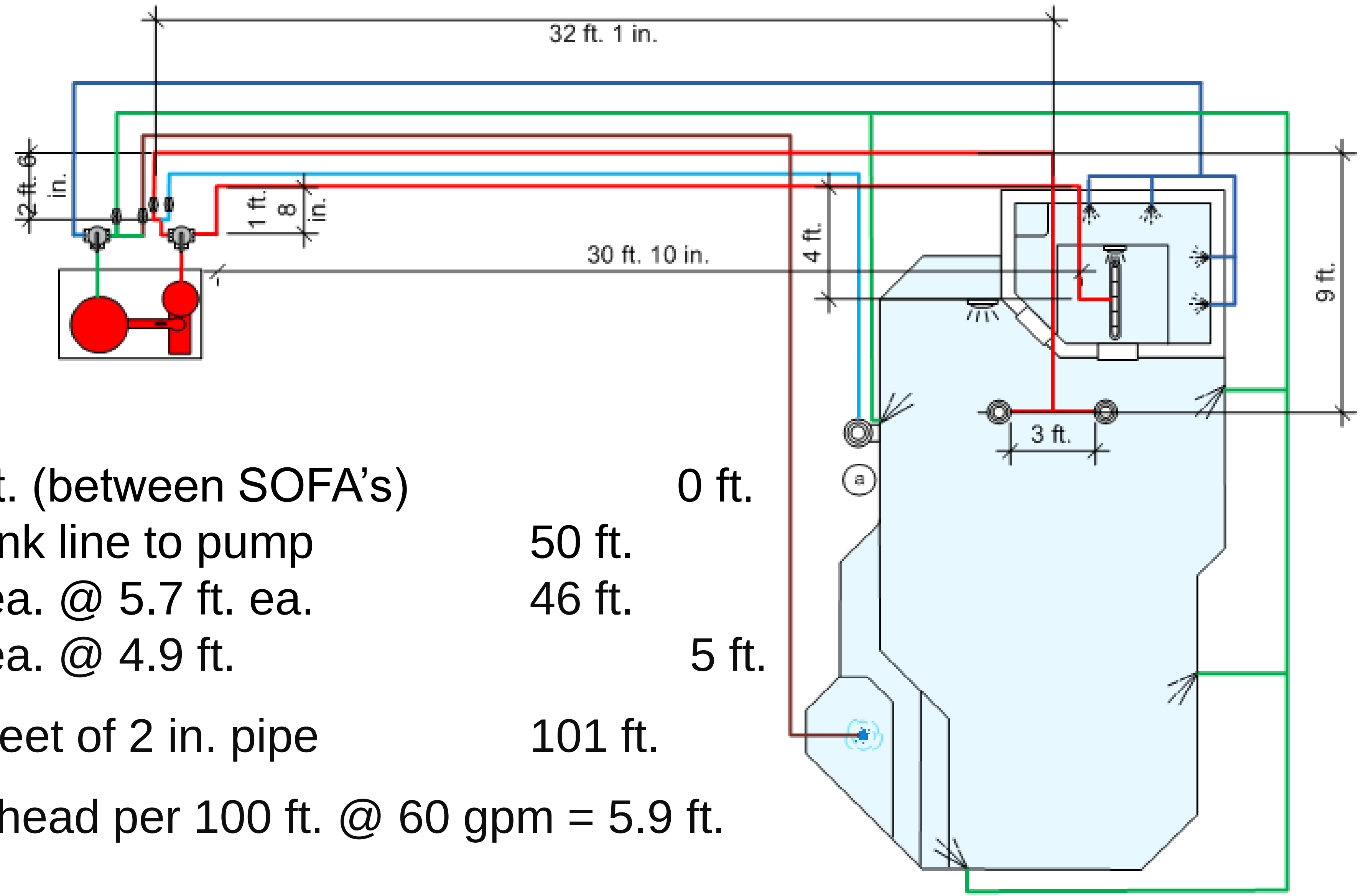


Measure the distances, add for vertical pipes - to & from submerged outlets, returns, etc.

Count the fittings; elbows, tees, etc.

Calculate suction side first to get pipe & fitting size correct – return piping is typically smaller.

Suction Side – the Pool



POOL:

2 ½ " pipe 3 ft. (between SOFA's) 0 ft.
2" pipe trunk line to pump 50 ft.
2" 90's 8 ea. @ 5.7 ft. ea. 46 ft.
2 1/2" Tee 1 ea. @ 4.9 ft. 5 ft.

Total equivalent feet of 2 in. pipe 101 ft.

1.01 x 5.84 ft. of head per 100 ft. @ 60 gpm = 5.9 ft. head

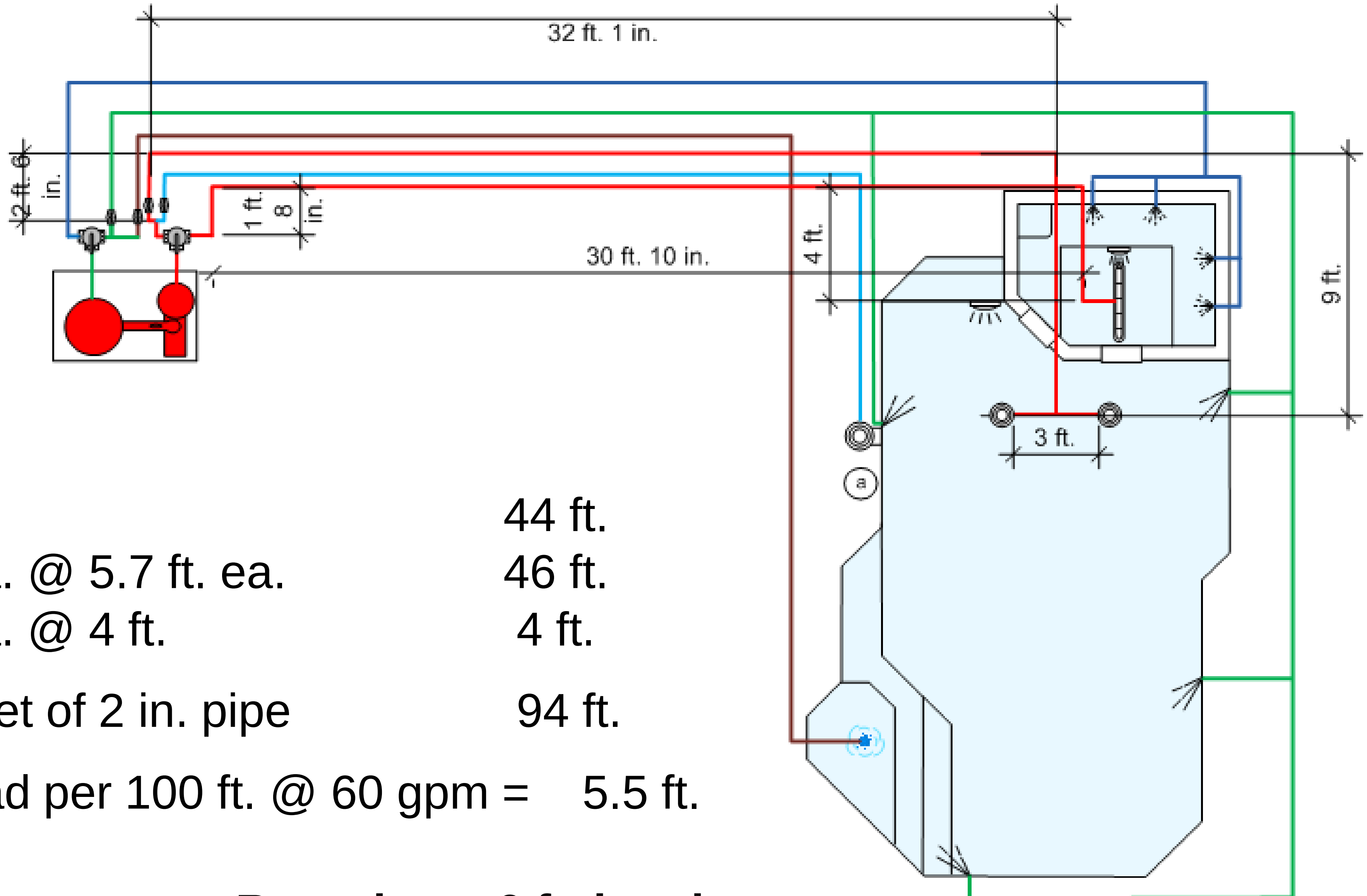
Round to 6 ft. head

3 way valve 1 ea. @ 2 ft. 2 ft. head
2" ball valve 1 ea. @ 1 ft. 1 ft. head
SOFA's 2 ea. @ 2 ft. 4 ft. head

Total Dynamic Head – Pool Suction Side = 13 ft. TDH

ANSI-7

Suction Side – the Spa



SPA:

2" pipe		44 ft.
2" 90's	8 ea. @ 5.7 ft. ea.	46 ft.
2 " Tee's	1 ea. @ 4 ft.	4 ft.

Total equivalent feet of 2 in. pipe 94 ft.

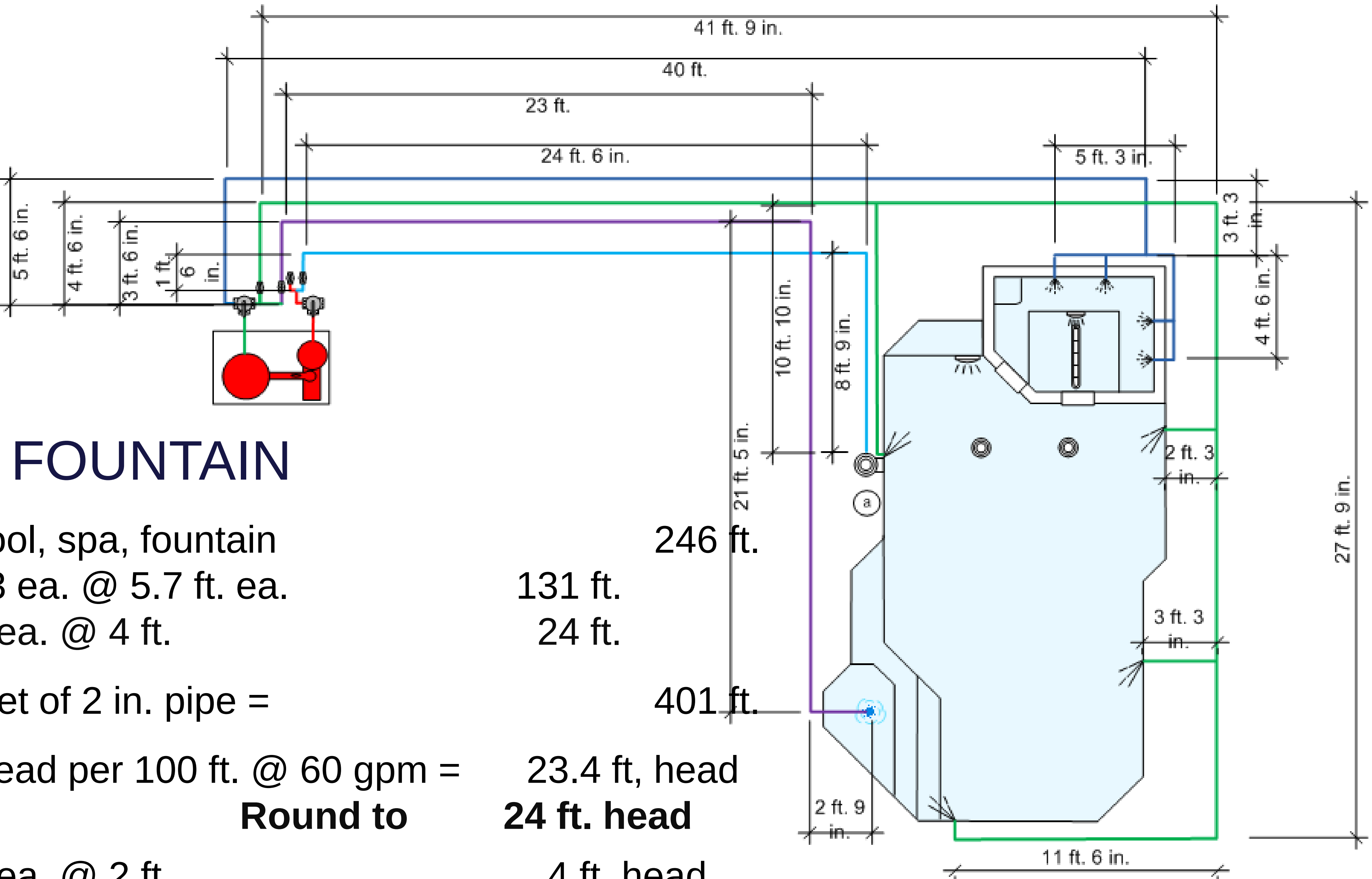
94 x 5.84 ft. of head per 100 ft. @ 60 gpm = 5.5 ft. Head

Round to 6 ft. head

3 way valve	1 ea. @ 2 ft.	2 ft. head
SOFA	1 ea. @ 1 ft.	1 ft. head

Total Dynamic Head – Spa Suction Side = 9 ft. TDH

Return Side Calculations



POOL, SPA, FOUNTAIN

2" pipe	pool, spa, fountain		246 ft.
2" 90's	23 ea. @ 5.7 ft. ea.	131 ft.	
2" Tee	6 ea. @ 4 ft.	24 ft.	

Total equivalent feet of 2 in. pipe = 401 ft.

4.01 x 5.84 ft. of head per 100 ft. @ 60 gpm = 23.4 ft, head

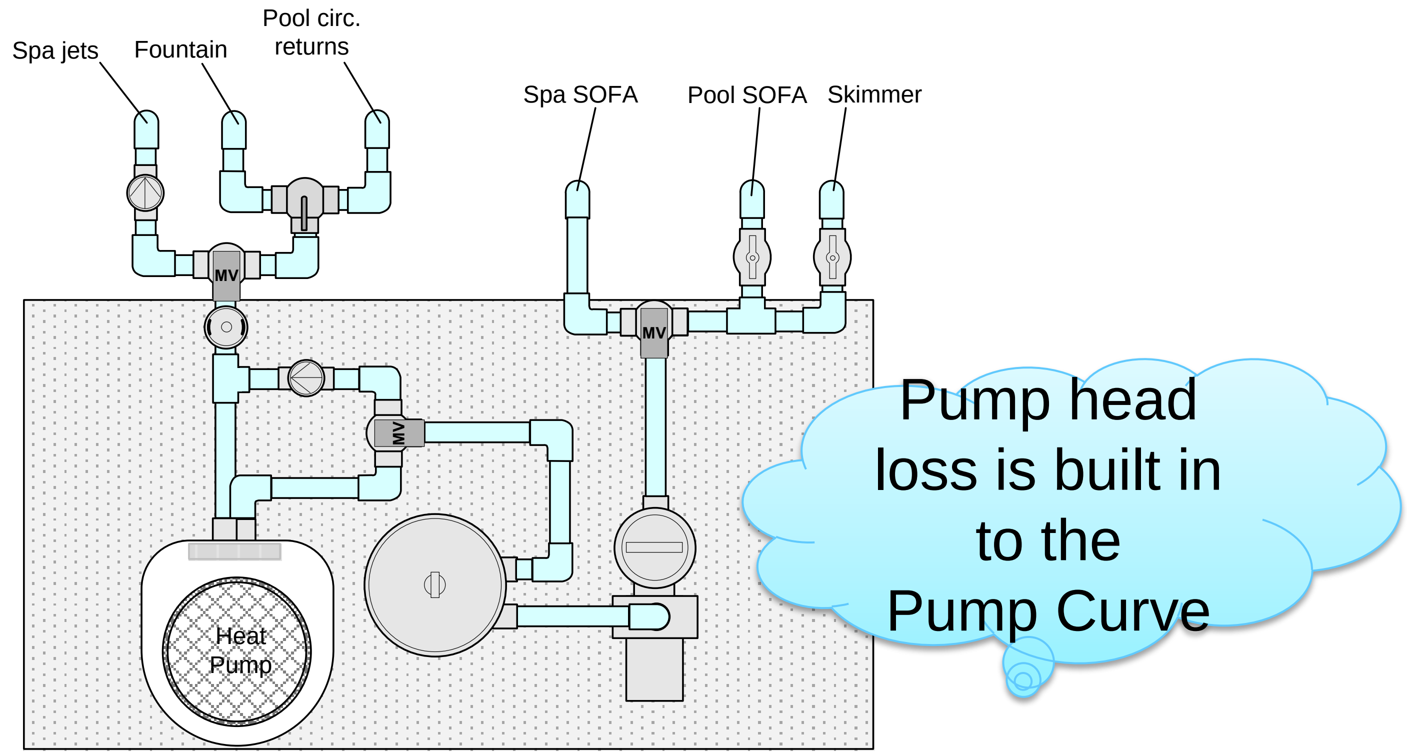
Round to **24 ft. head**

3 way valve	2 ea. @ 2 ft.	4 ft. head
2" check valve	1 ea @ 2 ft.	2 ft. head
Chlorinator		1 ft. head
1 in. pool inlet fittings		1 ft. head
¼ in. spa jet fittings		4 ft. head

Total Dynamic Head – Return Side = 36ft. TDH

ANSI-7

Equipment Loss



Pool/Spa Equipment

Total feet - 2 in. pipe	10 ft.
2 in. 90 degree elbows 10 @ 5.7 ft. ea. =	57 ft.
Total equivalent feet of 2 in. pipe =	67
.67 x 5.84 =	3.9 ft. head
Filter =	3.7 ft. head
Total TDH loss at Equipment =	7.6 ft. head
	Round to 8 ft. head

TDH Calculations

SPA Side TDH

Total Dynamic Head – Spa Suction Side =	9 ft. TDH
Total Dynamic Head – Return Side =	36 ft. TDH
Total Dynamic Head – Equipment =	8 ft. TDH

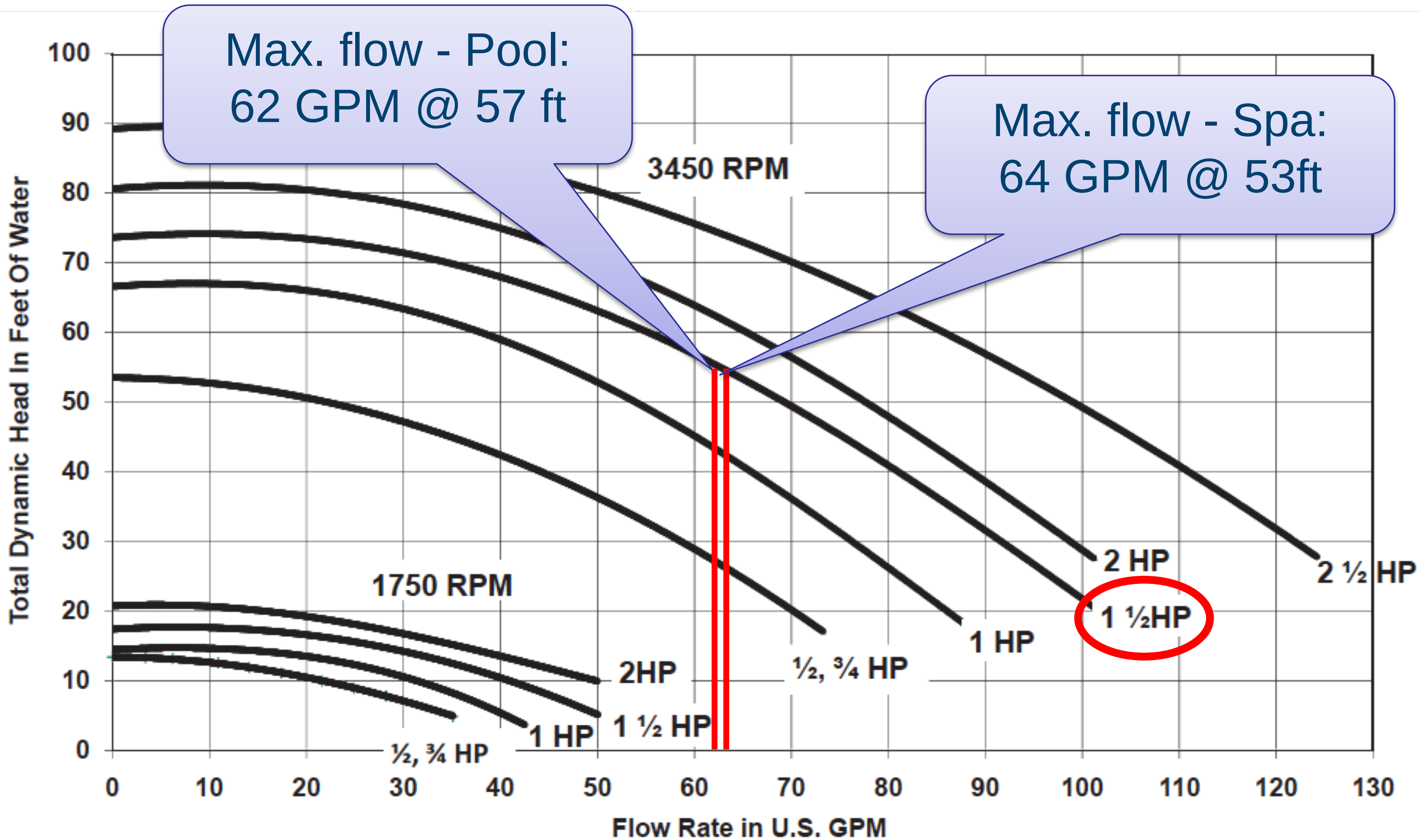
Spa System TDH = 53 ft. Head

POOL Side TDH

Total Dynamic Head – Pool Scution Side =	13 ft. TDH
Total Dynamic Head – Return Side =	36 ft. TDH
Total Dynamic Head – Equipment =	8 ft. TDH

Spa System TDH = 57 ft. Head

Pump Performance Curve



Pipe Size	1.5"	2"	2.5"	3"	3.5"	4"	5"	6"
Nominal GPM @ 6fps	38	63	90	138	185	238	374	540
Nominal GPM @ 8fps	51	84	119	184	247	317	499	720

Simplified TDH

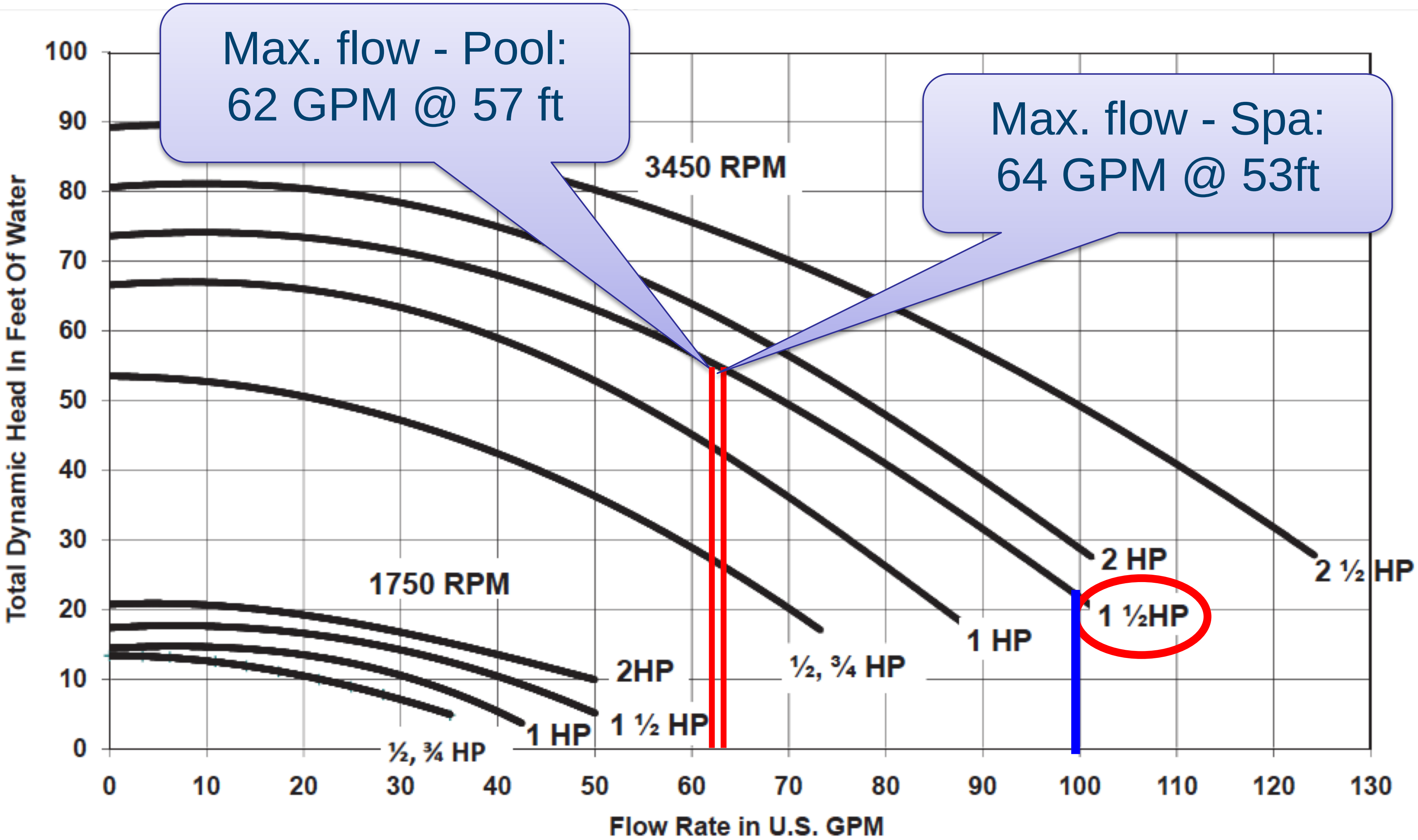
296 ft. of pipe to & from the pool, spa, etc.

2.96 x 5.84 = 17.3 ft. head

Filter loss = 3.7 ft. head

Total = 21 ft. head

Simplified TDH



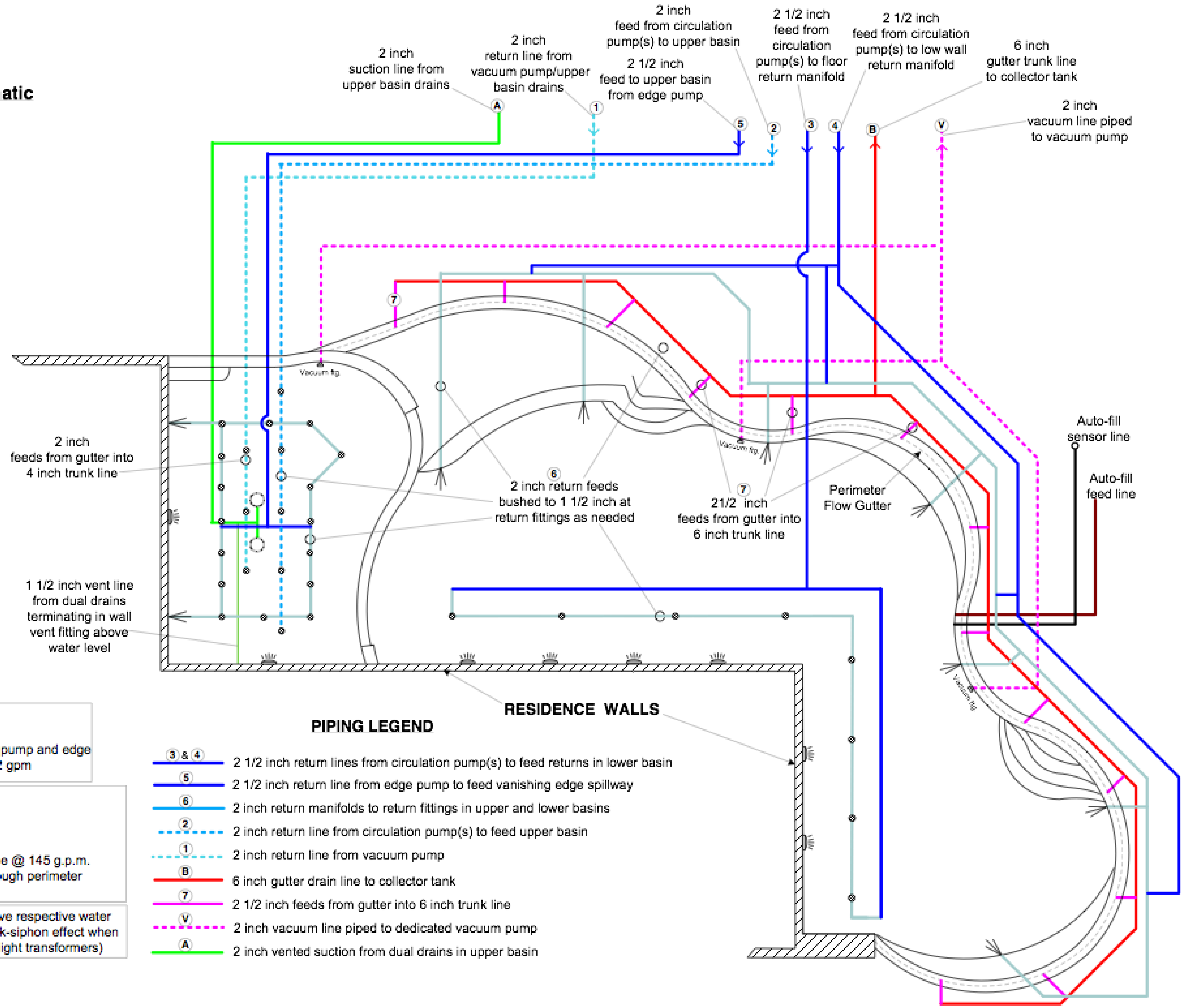
Pipe Size	1.5"	2"	2.5"	3"	3.5"	4"	5"	6"
Nominal GPM @ 6fps	38	63	90	138	185	238	374	540
Nominal GPM @ 8fps	51	84	119	184	247	317	499	720

You can Calculate Big Pools also

2,355 sq.ft. - Split level - Perimeter flow

Pool Piping Schematic

1/8 in. = 1 ft.

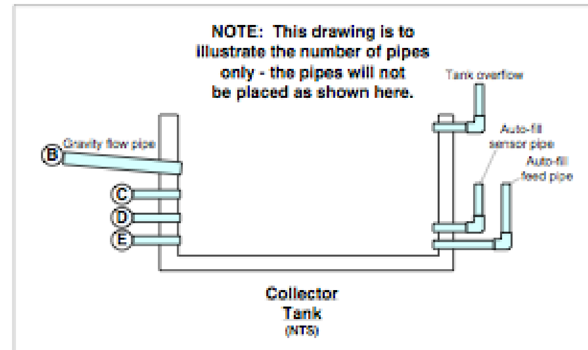


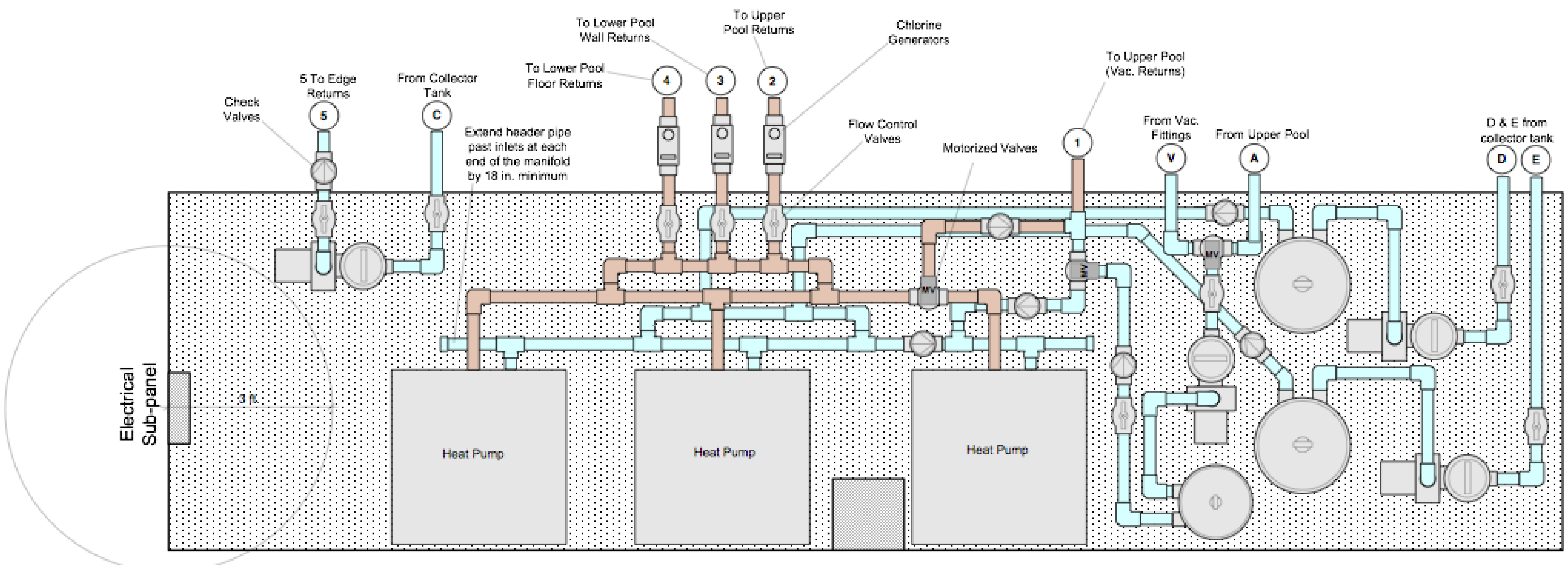
Pool circulation at approx. 250 gpm
Edge pump at aaprox. 132 gpm
Total maximum flow with circulation pump and edge pump running full flow approx. = 382 gpm

VOLUME / FLOW CALCULATIONS
Upper level = approx. 6,800 gal.
Lower level = approx. 45,100 gal.
Total volume in gallons = approx. 51,900
System flow to achieve 6 hour turnover cycle @ 145 g.p.m.
Actual system flow @ approx. 250 gpm through perimeter system

NOTE: All return lines to be looped up above respective water levels with vacuum breakers to prevent back-siphon effect when pump is off. (Loops are behind wall next to light transformers)

Equipment Layout





Equipment room layout is a piping guideline - precise placement of equipment may be adjusted to accommodate field conditions.

NOTE: All equipment room piping is 2 1/2 in. sch. 40 PVC (except vacuum/upper pool low flow pump may be 2 inch).

Size the Pipe for ANSI-7

Pool drain branch suction piping:
TDH = 62 gpm = 2" @ 6 fps

Pool drain header piping from branch to pump:
TDH = 62 gpm = 2" @ 8 fps

Spa drain header piping from drain to pump (Spa has a channel drain – there is no "branch" piping):
TDH = 64 gpm = 2" @ 8 fps

Total Dynamic Head

Calculated TDH is the most accurate, least costly method to achieve compliance with ANSI-7

For our sample pool, max. flow or simplified TDH would require 3 inch PVC for all suction piping and 2 ½ inch for all return side piping.

More costly to build. Resulting in flow outside the pump's efficiency curve, shortening pump life dramatically and creating a very noisy system.

How do we Pipe our Sample Pool?

ANSI-15

Filtration flow rate at 32 gpm

Spa design flow rate at 60 gpm

2 inch piping will be compliant

ANSI-7 (using TDH)

Potential pool drain flow rate at 62 gpm requires 2"

Spa drain header flow rate at 64 gpm requires 2"

If the spa had one more therapy jet (now needing 75 gpm) the suction piping would have to be 2 ½ inch. ANSI-7 flow restrictions trump ANSI-15 restrictions.

Safety over Energy Efficiency

Design Process

1st APSP-5 Residential Pools ✔

2nd APSP-15 Energy Efficiency ✔

3rd APSP-7 Suction Safety ✔

Demonstrate Compliance

APSP *The Association of Pool & Spa Professionals®*

ANSI/APSP/ICC 15 ENERGY EFFICIENCY COMPLIANCE INFORMATION FOR RESIDENTIAL SWIMMING POOLS

PROJECT NAME: AND ADDRESS		CONTRACTOR NAME AND ADDRESS:		
OWNER:		CONTRACTOR PHONE:		DATE:

This information sheet was prepared by the APSP-15 Residential Swimming Pool and Spa Energy Efficiency Standard Writing Committee of the Association of Pool and Spa Professionals (APSP). It is not part of the American National Standard ANSI/APSP/ICC-15 2011 but is included for information only. Contractors should acquire and comply with the ANSI/APSP/ICC-15 2011 standard which can be purchased at www.apsp.org.

1. §5.2.1: Calculated pool volume
a. Gallons: ___________ ; or
b. *Calculated Gallons: ________(surface area) X ________ (average depth) X 7.48 (gal/ft^3) = _________*

1. _________ gallons ____

2. §5.2.1: Calculated maximum filtration flow rate
(Pool volume ÷ 360 or 36gpm whichever is larger)

2. _________ gpm ____

3. §5.2.2: Auxiliary Pool Load: ____Yes, ____No?
(Enter the highest "auxiliary pool load" to be powered by the swimming pool filtration pump. Do not add auxiliary pool load flow rates together, only the highest is used.)

3. _________ gpm ____

4. Calculated maximum flow rate
(Item 2 or item 3, whichever is larger.)

4. _________ gpm ____

5. §5.5.1: Pipe sizing:

a. Minimum suction pipe diameter
(Enter the smallest pipe size from Table 1 with a 6 fps flow capacity the same or more than item 4.)

5a. _________ inches ____

b. Minimum suction branch pipe diameter
(Calculate: Item 4. ______(gpm) ÷ Branch Pipes ______(quantity) = branch flow rate _______(gpm). Enter the smallest pipe size from Table 1 with a 6 fps flow capacity the same or more than the calculated suction branch flow rate.)

5b. _________ inches ____

c. Minimum return pipe diameter
(Enter the smallest pipe size from Table 1 with a 8 fps flow capacity the same or more than item 4.)

5c. _________ inches ____

d. Minimum return branch pipe diameter
(Calculate: Item 4. ______(gpm) ÷ Branch Pipes ______(quantity) = branch flow rate _______(gpm). Enter the smallest pipe size from Table 1 with a 8 fps flow capacity the same or more than the calculated return branch flow rate.)

5d. _________ inches ____

6. §5.4.1: Filter type and size:

a. Filter type: *(Cartridge, DE, Sand)*

6a. _________________ ____

b. Minimum filter area
(Calculate: item 4. _______(gpm) ÷ filter factor _______)
Filter factors: Cartridge=0.375, Sand=15, Diatomaceous Earth=2

6b. _________ sq. ft. ____

7. §5.4.2: Backwash valve: ____Yes, ____No?
(When using a backwash valve, enter result of item 5c or 2 inches whichever is larger)

7. _________ inches ____

Table 1

Pipe Size:	1.5"	2"	2.5"	3"	3.5"	4"	5"	6"
Nominal GPM @ 6 fps	38	63	90	138	185	238	374	540
Nominal GPM @ 8 fps	51	84	119	184	247	317	499	720

8. Pump selection:
§5.3.2.1: Pools 17,000 gallons or less, select pump from the database with a Curve-A gpm flow equal to item 2 or less.*
§5.3.2.2: Pools 17,001 gallons or more, select pump from the database with a Curve-C gpm flow equal to item 2 or less. *Multi-speed pumps must have one speed listed that satisfies this requirement.*

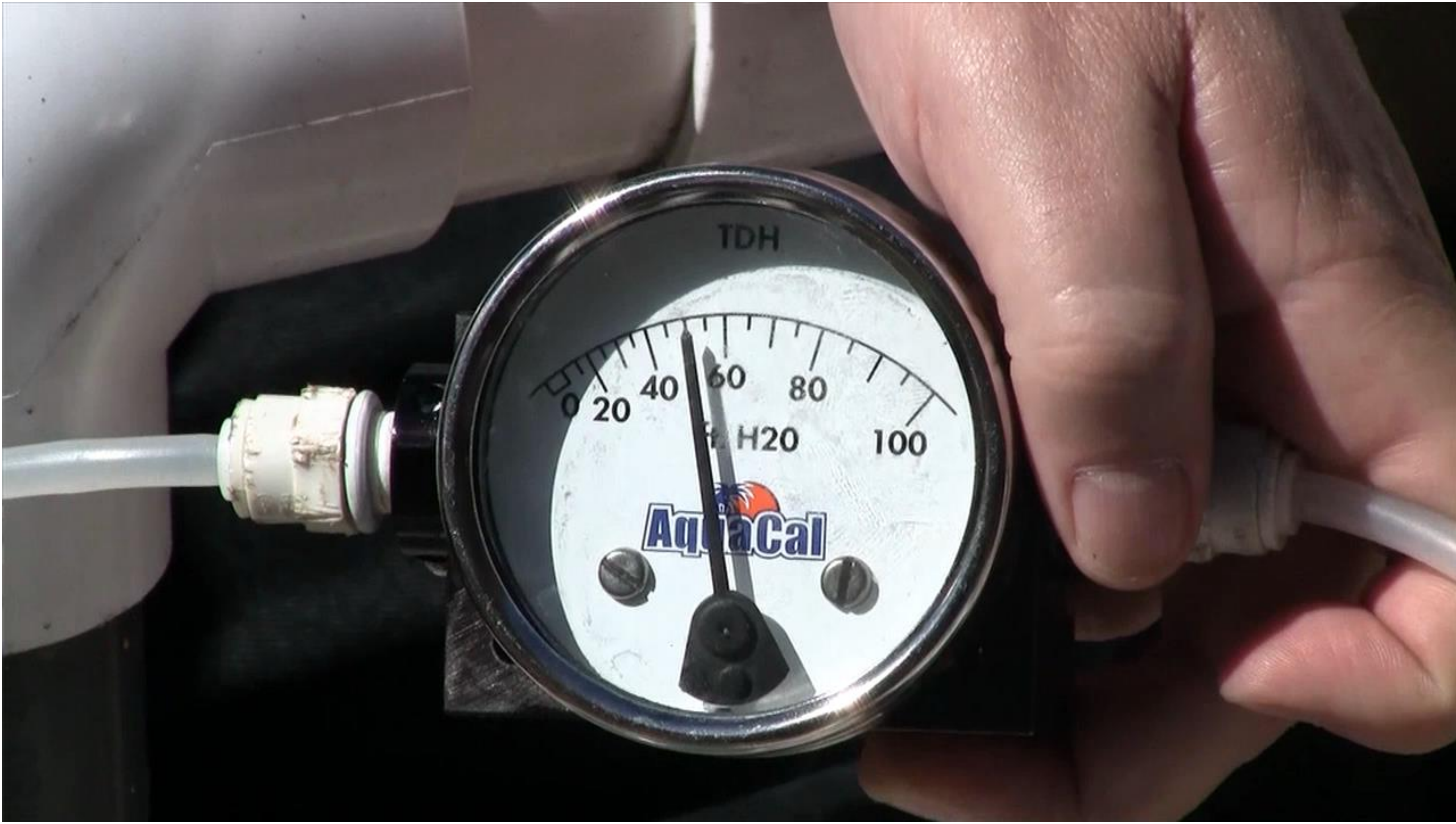
a. Pump model

8a. _________________ ____

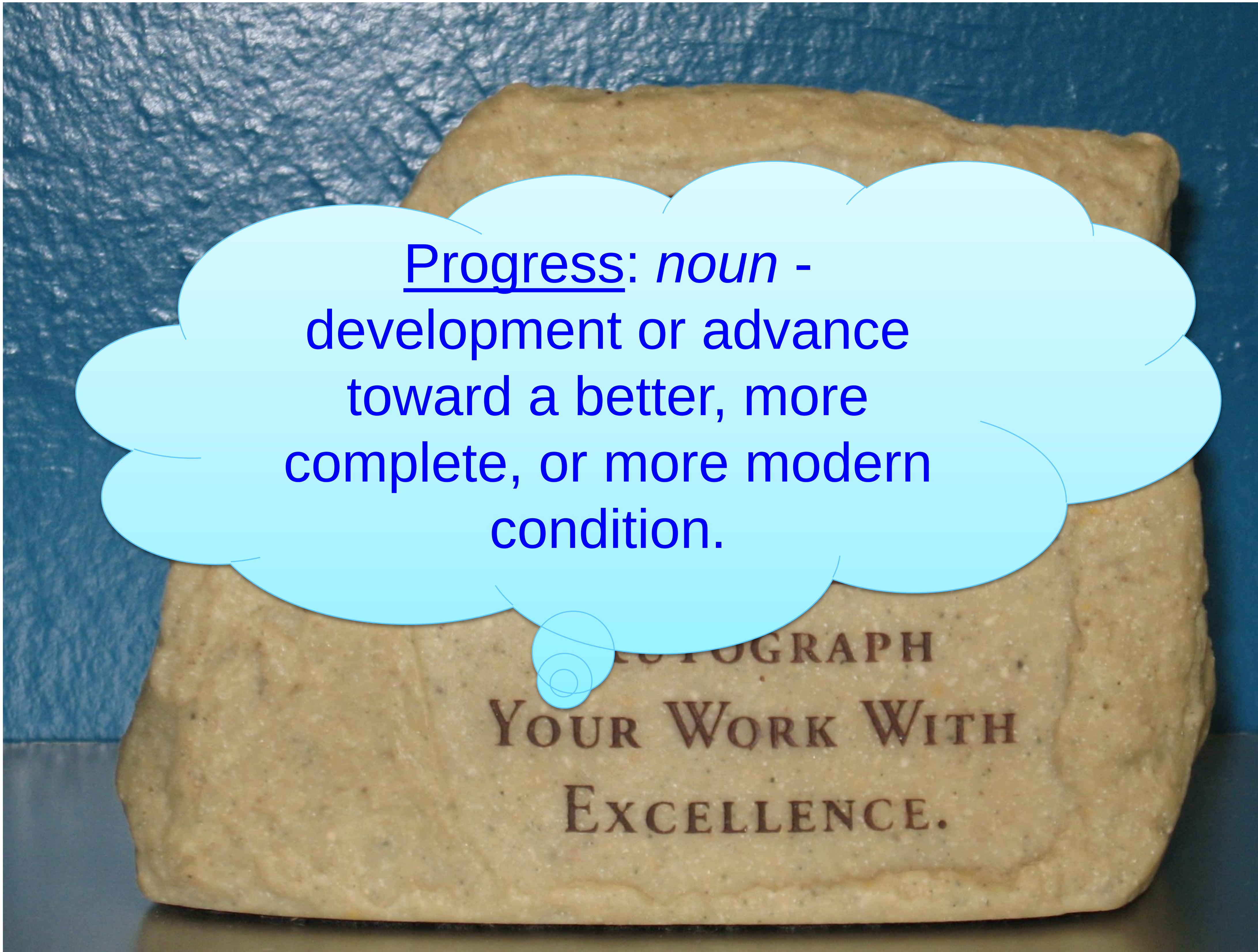
b. Pump flow
(§5.3.2.1, 5.3.2.2: Applicable Curve A or C gpm flow listed in database)

8b. _________ gpm ____

Verify System Flow



PROGRESS



<u>Progress</u>: *noun* - development or advance toward a better, more complete, or more modern condition.

Questions?