SUMP PIT OPERATING VOLUME

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Definition of variables:

q = ground water flow rate (gpm)

p = pumping rate (gpm)

t_1 = time pump is off (minutes)

t_2 = time pump is on (minutes)

$t_1 + t_2$ = pump cycle time (minutes)

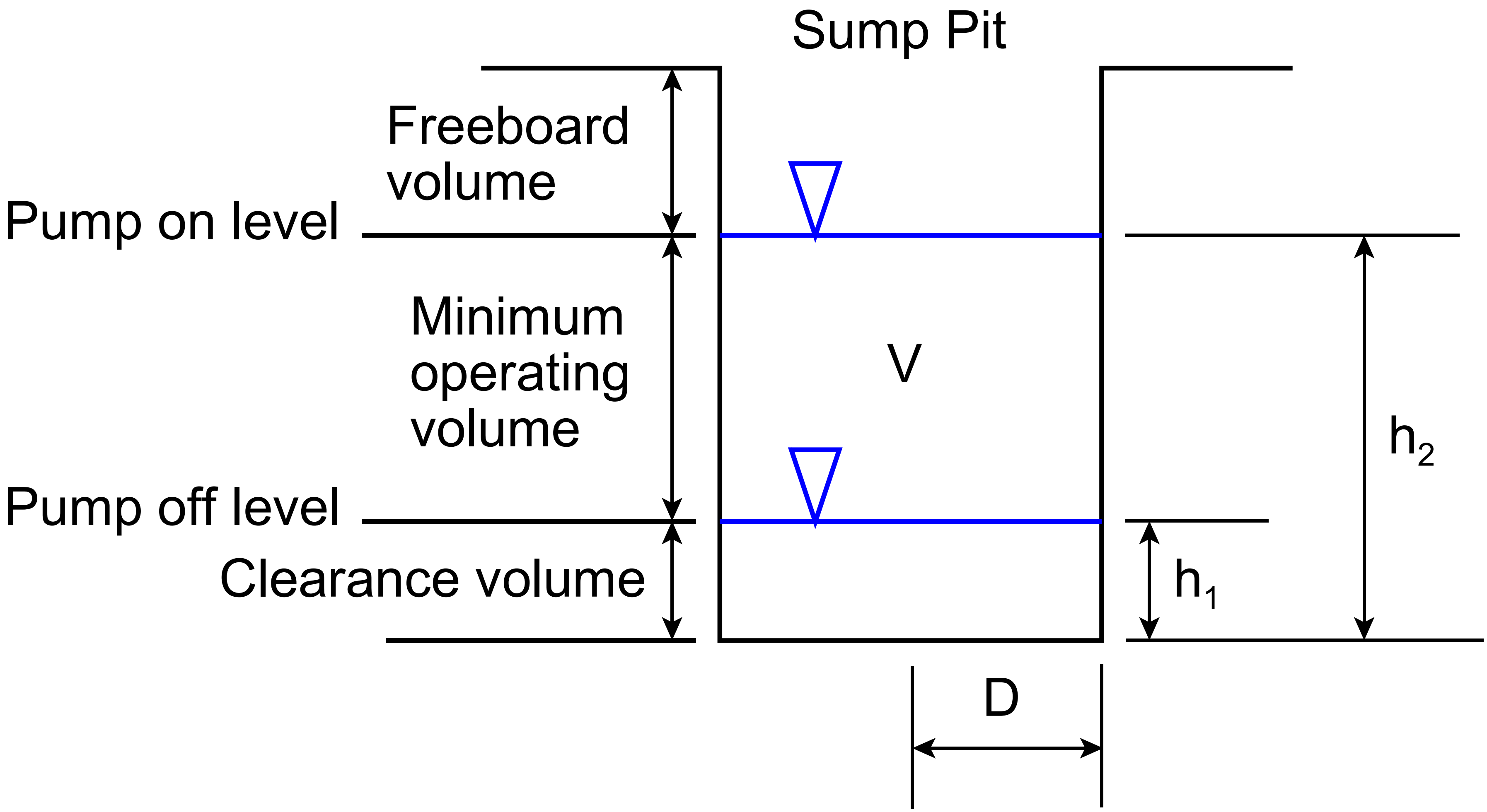
h_1 = pump shut off depth (inches)

h_2 = pump start depth (inches)

D = diameter of the sump pit (inches)

V = minimum required sump pit operating volume (cubic inches)

Cross section view of the sump pit



OVERVIEW

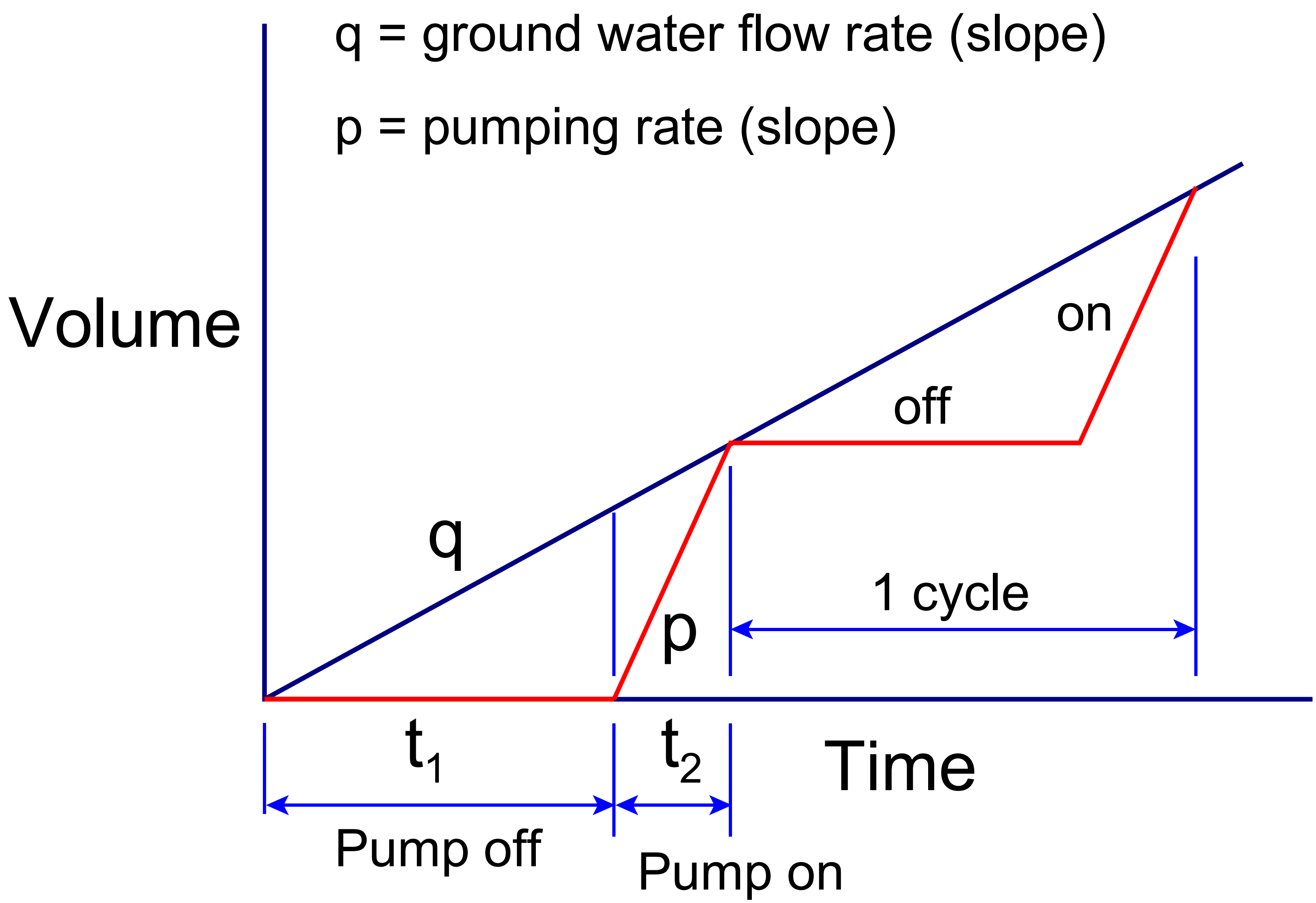
1) The expected flow rate of the ground water into the sump pit is determined by the analysis of the ground water conditions.

2) The configuration of the discharge pipe from the sump pump is determined from the basement depth and the location of the discharge.

3) A sump pump is selected which is capable of pumping the anticipated ground water flow rate within the limits specified by the pump manufacturer for the number of pump starts per hour. Note that the number of pump starts per hour is the reciprocal of the pump cycle time. A recommended 6 starts per hour is equivalent to a pump cycle time of 1/6 of an hour or 10 minutes.

4) A sump pit volume is determined to satisfy the time requirements for the recommended pump cycle time.

Pump cycle time analysis:



Provided by the pump manufacturer:

$t_1 + t_2$ = minimum pump cycle time

t_2 = mimimum time that the pump should be on during each cycle

Determined from analysis:

q is determined from the groundwater flow analysis

p is determined from the specifics of the discharge pipe and the pump characteristics.

Equation relating the pump cycle time, ground water flow rate, pumping rate, and minimum operating volume of the sump pit.

$$V = (t_1 + t_2) * q = t_2 * p$$

Example:

Ground water flow rate q = 2 gallons per minute (gpm)

Pumping flow rate p = 22 gallons per minute (gpm)

Minimum time for pump to be on t_2 = 1 minute

Minimum pump cycle time $t_1 + t_2$ = 10 minutes

Water level to turn off pump h_1 = 3 inches

Water level to turn on pump h_2 = 9 inches

Unit conversions needed for the example:

1 gallon = 231 cubic inches

1 cubic foot = 1728 cubic inches

Calculate the minimum operating volume of the sump pit:

$$V = t_2 * p = (1\,\text{min})\left(22\,\frac{gallons}{\text{min}}\right) = 22\,gallons$$

$$(22\,gallons)\left(\frac{231\,in^3}{gallon}\right) = 5082\,in^3$$

$$(5082\,in^3)\left(\frac{1\,ft^3}{1728\,in^3}\right) = 2.94\,ft^3$$

Calculate the time that the pump will be off during each cycle.

$$V = (t_1 + t_2) * q$$

$$22\,gal = (t_1 + 1\min)(2\,gpm)$$

$$t_1 = 10\min$$

Compare the actual conditions to the recommendations:

Actual pump on time during each cycle = 1 minute
Recommended pump on time during each cycle = 1 minute

Actual pump off time during each cycle = 10 minutes
Recommended pump off time during each cycle = 9 minutes

The actual conditions are consistent with the pump manufacturer recommendations.

Determine the diameter of the sump pit:

$$V = \frac{\pi}{4} D^2 (h_2 - h_1)$$

$$5082\, in^3 = \frac{\pi}{4} D^2 (9\, in - 3\, in)$$

$$D = 32.84\, inches$$ Say 33 inches

$$D = 2.74\ ft$$ Say 2.75 feet

The standard sump pit is 18 inches in diameter with an operational volume of 1527 cubic inches (assumes h_2 -h_1 = 6 inches. More than 3 three standard sump pits are needed to meet the operating conditions recommended by the pump manufacturer. The standard size sump pit is too small.