Sidney's Big Book of Water and Wastewater Math

Indigo Water Group

Unit Conversions to Know by Heart

1 inch = 2.54 centimeters
1 meter = 3.28 feet
1 mile = 5280 feet

1 acre = 43,560 ft^2
1 m^2 = 10.76 ft^2

1 gallon = 3.785 liters
1 ft^3 = 7.48 gallons
1 m^3 = 35.31 ft^3

1 ft water = 0.433 psi

1 gallon = 8.34 lbs when specific gravity is 1.0
1 kg = 2.2 lbs

1% = 10,000 mg/L
1 mg/L = 1 ppm
1 µg/L = 1 ppb

1 day = 1440 minutes
1 hp = 0.746 kW

1 gram = 15.43 grains
1 grain per gallon = 17.1 mg/L

Water Formulas

pounds per day = (concentration in mg/L)*(flow rate in mgd)*(8.34)

chlorine dose = demand + residual

$$\text{velocity} = \frac{\text{flow}}{\text{area}} \qquad V = \frac{Q}{A}$$

$$\text{flow rate} = \frac{\text{volume}}{\text{time}} \qquad Q = \frac{V}{t}$$

$$\text{overflow rate} = \frac{\text{flow rate}}{\text{area}}$$

$$\text{weir loading rate} = \frac{\text{flow rate}}{\text{feet of weir}}$$

(concentration 1)*(volume 1) = (concentration 2)*(volume 2) $\qquad C_1V_1 = C_2V_2$

(conc. 1)*(volume 1) + (conc. 2)*(volume 2) = (conc. 3)*(volume 3)

$$C_1V_1 + C_2V_2 = C_3V_3$$

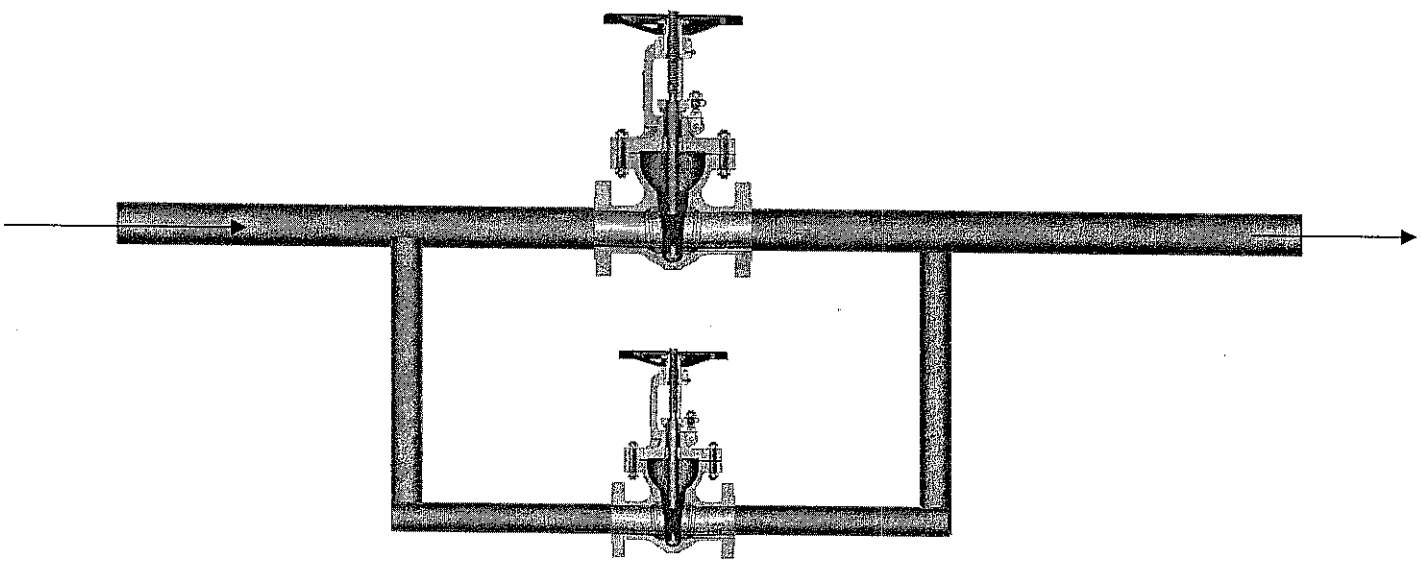
$$\text{horsepower} = \frac{(\text{flow in gpm})*(\text{lift in feet})}{3960}$$

Force

Numbers in **RED** can be changed. Numbers in **BLUE** are calculated by the spreadsheet.

$$FORCE = (PRESSURE)(AREA)$$

Bypass diameter	**10**	inches	Force on Main line	**83126.4**	pounds
Bypass area	**78.54**	square inches		**41.6**	tons
Main line diameter	**42**	inches			
Main line area	**1385.44**	square inches	Force on Bypass	**4712.4**	pounds
				2.4	tons
System Pressure	**60**	psi (pounds per square inch)			



Wells
Drawdown, Specific Yield, and Yield

Numbers in **RED** can be changed. Numbers in **BLUE** are calculated by the spreadsheet.

Static Water Level	**80**	feet
Pumped Water Level	**110**	feet
Drawdown	**30**	feet
Pumping Rate or Yield	**300**	gpm
Specific Yield	**10**	gpm/ft

Problem 1: A well is drilled through an unconfined aquifer. The top of the aquifer is 80 feet below grade. After the well was in service for a year, the water level in the well stabilized at 110 feet below grade. Calculate the well drawdown..

30 feet

Problem 2: A well produces 300 gpm. If the drawdown is 30 feet, find the specific yield of the well.

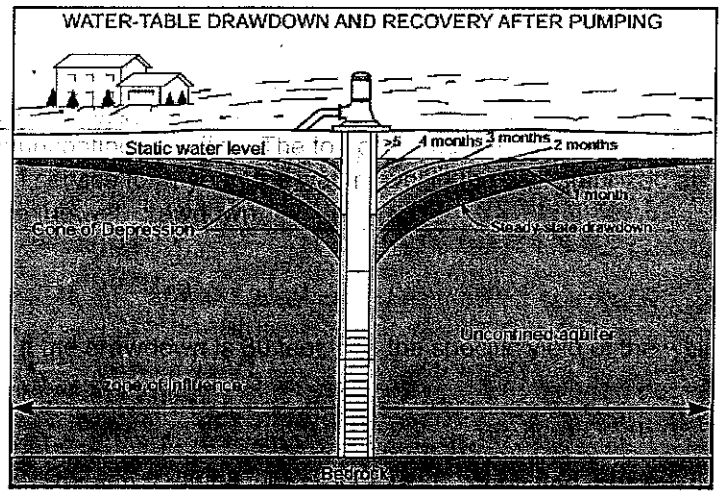
10 gpm/ft

Problem 3: The specific yield for a well is 10 gpm/ft. If the well produces 300 gpm, find the drawdown.

30 feet

Problem 4: The pumped water level of a well is 110 feet below the surface. The well produces 300 gpm. If the specific yield of the well is 10 gpm/ft, find the original water level in the aquifer. Express your answer as feet below grade.

80 feet



80

JOB _____ JOB NO. _____

SHEET NO. _____ OF _____

CALCULATED BY _____ DATE _____

CHECKED BY _____ DATE _____

SUBJECT _____

Wells

1. Drawdown is the difference

$$\begin{array}{r} 110 \text{ ft} \\ -\ 80 \text{ ft} \\ \hline 30 \text{ ft} \end{array}$$

2. Specific yield = $\frac{\text{yield, gpm}}{\text{drawdown}}$

Specific yield = $\frac{300 \text{ gpm}}{30 \text{ ft}}$

specific yield = 10 gpm/ft

3. specific yield = $\frac{\text{yield, gpm}}{\text{drawdown}}$

$10 \text{ gpm/sf} = \frac{300 \text{ gpm}}{\text{drawdown}}$

$(10 \times \text{drawdown}) = 300$

drawdown = 30 ft

4. from #3 we know that the drawdown is 30ft

$$\begin{array}{r} 110 \\ -30 \\ \hline 80 \text{ ft} \end{array}$$

Distribution by Sidney

Name: _____

Date: _____ Period: _____

1. What is the motor horsepower (mhp) for a pump with the following parameters? Motor efficiency: 87%, Total Head (TH): 107 ft, Pump efficiency: 79%, Flow: 2.544 mgd
   (A) 87 mph
   (B) 79 mph
   (C) 25 mph
   (D) 69 mph

2. W6. This term describes the amount of water that a particular well can produce in a specified amount of time.
   (A) Cone of Depression
   (B) Well Yield
   (C) Specific Capacity
   (D) Pumping Water Level
   (E) Zone of Influence
   (F) Static Water Level
   (G) Drawdown

3. A well produces 365 gpm with a drawdown of 22.5 ft. What is the specific yield in gallons per minute per foot?
   (A) 32.4
   (B) 16.2
   (C) 36.5
   (D) 22.5

4. Given the following data, calculate the total kilowatts needed to operate the following small facility when everything is running: Raw water pump=300 hp, Flocculators=60 hp, Filter pump for backwashing=100 hp, Chlorination=25 hp, Clear water pump=100 hp, Lighting=11 hp, Instrumentation=4 hp
   (A) 600 kW
   (B) 448 kW
   (C) 1,386 kW
   (D) 260 kW

5. W3. After a well has been operating for some time, the water level in the well will be lower than the water level in the surrounding aquifer. The new water level is the
   (A) Specific Capacity
   (B) Drawdown
   (C) Static Water Level
   (D) Pumping Water Level
   (E) Cone of Depression
   (F) Zone of Influence
   (G) Well Yield

6. A well produces 162 gpm. The drawdown for the well is 16 ft. Calculate the specific yield in gallons per minute per foot.
   (A) 2 gpm/ft
   (B) 5 gpm/ft
   (C) 10 gpm/ft
   (D) 16 gpm/ft

7. W2. The distance from ground level to the top of an aquifer is called the
   (A) Static Water Level
   (B) Well Yield
   (C) Drawdown
   (D) Specific Capacity
   (E) Pumping Water Level
   (F) Cone of Depression
   (G) Zone of Influence

82

8. W5. Pumping water out of wells lowers the water level of the aquifer around the well. This term is used to describe the three dimensional shape that begins at the pumping water level and extends up and out towards the ground surface.
   (A) Pumping Water Level
   (B) Cone of Depression
   (C) Static Water Level
   (D) Specific Capacity
   (E) Zone of Influence
   (F) Drawdown
   (G) Well Yield

9. W1. This term is used to describe the area at ground level that is affected by a particular well.
   (A) Well Yield
   (B) Pumping Water Level
   (C) Static Water Level
   (D) Cone of Depression
   (E) Drawdown
   (F) Specific Capacity
   (G) Zone of Influence

10. W7. The _____ is calculated by dividing the amount of water produced by a specific well by the foot of drawdown.
   (A) Cone of Depression
   (B) Drawdown
   (C) Zone of Influence
   (D) Specific Capacity
   (E) Well Yield
   (F) Pumping Water Level
   (G) Static Water Level

11. Find the drawdown of a well, if the well yields 265 gpm and the specific yield is 11.7 gpm/ft
   (A) 10.3 ft
   (B) 11.7 ft
   (C) 22.7 ft
   (D) 17.6 ft

12. W4. The difference between the static water level and the pumping water level in a well is the
   (A) Drawdown
   (B) Specific Capacity
   (C) Static Water Level
   (D) Pumping Water Level
   (E) Well Yield
   (F) Cone of Depression
   (G) Zone of Influence

13. The static level in the well is 79.12 ft and the drawdown is 26.08 ft. Calculate the pumping water level in the well.
   (A) 11.3 ft
   (B) 53.0 ft
   (C) 34.3 ft
   (D) 105.2 ft

14. Find the total head, in feet, for a pump with a total static head of 19 ft and a head loss of 3.7 ft.
   (A) 15.3 ft
   (B) 5.1 ft
   (C) 70.3 ft
   (D) 22.7 ft

15. The static water level (non-pumping well) in a well is 84.5 ft. The pumping level is 104.2 ft. What is the drawdown?
   (A) 36.6 ft
   (B) 188.7 ft
   (C) 45.1 ft
   (D) 19.7 ft

Distribution by Sidney

Answer Key

1. D
2. B
3. B
4. B
5. D
6. C
7. A
8. B
9. G
10. D
11. C
12. A
13. ~~B~~ D
14. D
15. D

84

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1. $\frac{2.544\ mg}{day} \left| \frac{1{,}000{,}000\ gal}{1\ mg} \right| \frac{1\ day}{1440\ min} = 1766.67\ \frac{gal}{min}$

$$HP = \frac{(gpm \times TDH, ft)}{(3960 \times E_p \times E_m)}$$

$$HP = \frac{(1766.67\ gpm \times 107\ ft)}{(3960 \times 0.79 \times 0.87)}$$

$$HP = 69$$

3. Specific Yield = $\frac{Yield}{Drawdown}$

$$= \frac{365\ gpm}{22.5\ ft}$$

$$= 16.2\ gpm/ft$$

4.
300 HP
60 HP
100 HP
25 HP
100 HP
11 HP
+ 4 HP
600 HP

$600\ HP \left| \frac{0.745\ kw}{1\ HP} \right| = 447\ kW$

6. Specific Yield = $\frac{Yield}{Drawdown}$

$$= \frac{162\ gpm}{16\ ft}$$

$$= 10.1\ gpm/ft$$

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11. Specific Yield = $\frac{\text{Yield}}{\text{Drawdown}}$

$\frac{11.7 \text{ gpm}}{\text{ft}} = \frac{265 \text{ gpm}}{D}$

$11.7 D = 265$

$D = 22.6$ ft

13.
$$\begin{array}{r} 79.12 \\ +\ 26.08 \\ \hline 105.2 \text{ ft} \end{array}$$

14. TOTAL HEAD = STATIC HEAD + LOSSES

= 19 ft + 3.7 ft

= 22.7 ft

15.
$$\begin{array}{r} 104.2 \\ -\ 84.5 \\ \hline 19.7 \text{ ft} \end{array}$$