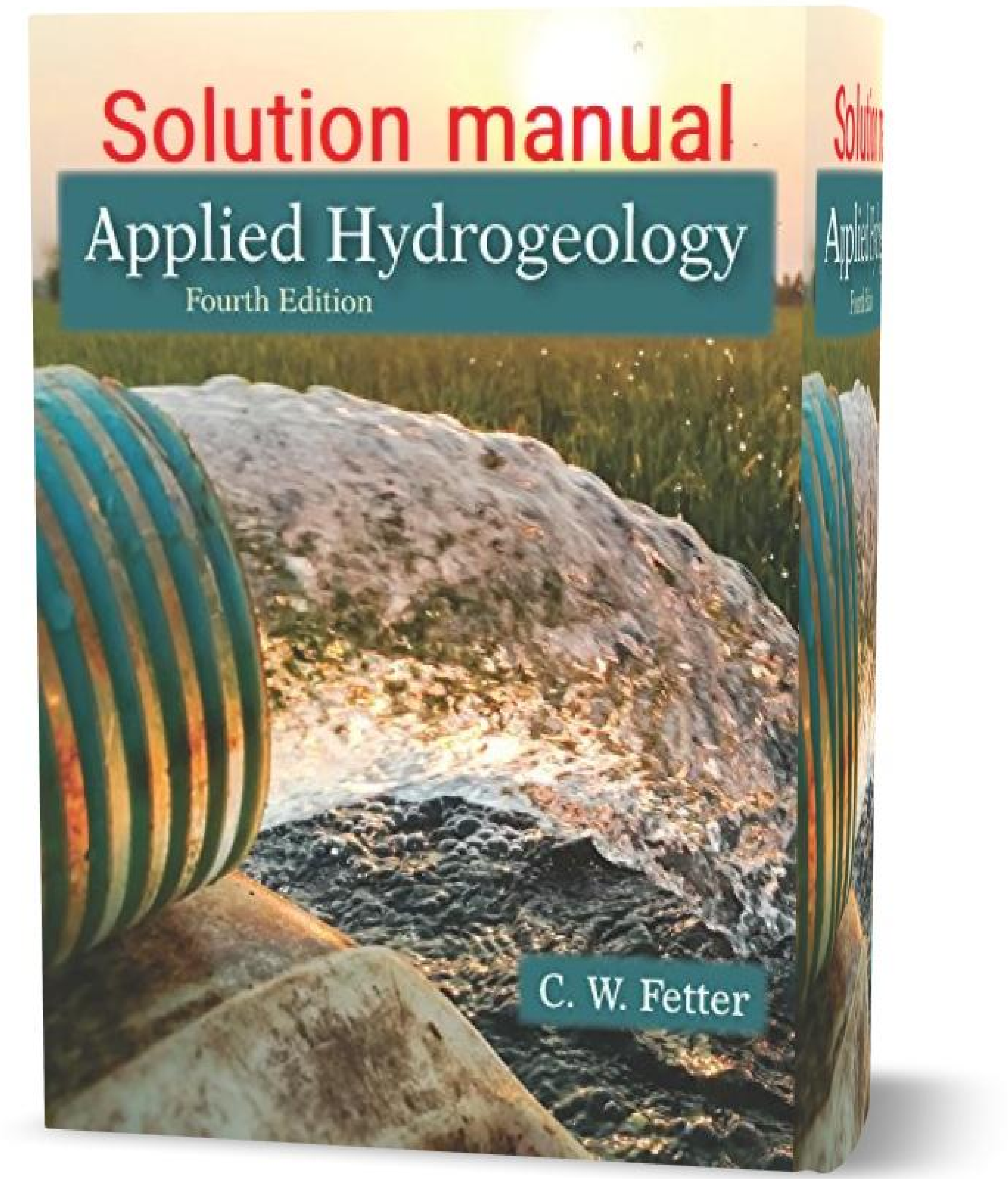
Solution manual
Applied Hydrogeology
Fourth Edition
C. W. Fetter

Problem

Note that the answers to odd-numbered problems are at the end of the book and step-by-step solutions to the odd- numbered problems can be found on the *Applied Hydrogeology* home page: http://www.appliedhydrogeology.com.

A vertical water tank is 15 ft in diameter and 60 ft high. What is the volume of the tank in cubic feet?

Step-by-step solution

Step 1 of 2

Determine the area *A* of the vertical water tank using the formula;

$$A = \frac{\pi}{4} \times d^2$$

Here, *d* is the diameter of the vertical water tank.

Substitute 15 ft for *d*.

$$A = \frac{\pi}{4} \times (15)^2$$
$$= 176.71 \text{ ft}^2$$

Comment

Step 2 of 2

Determine the volume *V* of the tank in cubic feet using the formula;

$$V = A \times h$$

Here, *h* is the height of the vertical water tank.

Substitute 176.71 ft^2 for *A* and 60 ft for *h*.

$$V = 176.71 \times 60$$
$$= 1.10 \times 10^4 \text{ ft}^3$$

Therefore, the volume of the vertical water tank is $\boxed{1.10 \times 10^4 \text{ ft}^3}$.

Problem

Note that the answers to odd-numbered problems are at the end of the book and step-by-step solutions to the odd- numbered problems can be found on the *Applied Hydrogeology* home page: http://www.appliedhydrogeology.com.

What is the volume of the above tank in cubic meters?

Step-by-step solution

Step 1 of 3

Convert the unit of diameter *d* of water tank from feet to meter;

$$1.0\,\text{ft} = 0.3048\,\text{m}$$
$$d = 15 \times 0.3048$$
$$= 4.572\,\text{m}$$

Convert he unit of height *h* of water tank from feet to meter;
Convert he unit of height *h* of water tank from feet to meter;

$$1.0\,\text{ft} = 0.3048\,\text{m}$$
$$h = 60 \times 0.3048$$
$$= 18.288\,\text{m}$$

Comment

Step 2 of 3

Determine the area *A* of the vertical water tank using the formula;

$$A = \frac{\pi}{4} \times d^2$$

Substitute 4.572 m for *d*.

$$A = \frac{\pi}{4} \times (4.572)^2$$
$$= 16.417\,\text{m}^2$$

Comment

Step 3 of 3

Determine the volume *V* of the tank in cubic meter using the formula;

$$V = A \times h$$

Substitute $16.417\,\text{m}^2$ for *A* and 18.288 m for *h*.

$$V = 16.417 \times 18.288$$
$$= 300.23\,\text{m}^3$$

Therefore, the volume of the vertical water tank is $\boxed{300.23\,\text{m}^3}$.

Comment

Problem

Note that the answers to odd-numbered problems are at the end of the book and step-by-step solutions to the odd- numbered problems can be found on the *Applied Hydrogeology* home page: http://www.appliedhydrogeology.com.

If the above tank were measured and found to have an inside diameter of exactly 15.00 ft and a height of 60.00 ft, what would be the volume in cubic feet?

Step-by-step solution

Step 1 of 2

Determine the area *A* of the vertical water tank using the formula;

$$A = \frac{\pi}{4} \times d^2$$

Here, *d* is the diameter of the vertical water tank.

Substitute 15 ft for *d*.

$$A = \frac{\pi}{4} \times (15)^2$$
$$= 176.71\,\text{ft}^2$$

Comment

Step 2 of 2

Determine the volume *V* of the tank in cubic feet using the formula;

$$V = A \times h$$

Here, *h* is the height of the vertical water tank.

Substitute $176.71\,\text{ft}^2$ for *A* and 60 ft for *h*.

$$V = 176.71 \times 60$$
$$= 10,600\,\text{ft}^3$$

Therefore, the volume of the vertical water tank is $\boxed{10,600\,\text{ft}^3}$.

Comment

Problem

Note that the answers to odd-numbered problems are at the end of the book and step-by-step solutions to the odd- numbered problems can be found on the *Applied Hydrogeology* home page: http://www.appliedhydrogeology.com.

What would be the above tank's volume in cubic meters?

Step-by-step solution

Step 1 of 3

Convert the unit of diameter *d* of water tank from feet to meter;

$$1.0\,\text{ft} = 0.3048\,\text{m}$$

$$d = 15 \times 0.3048$$
$$d = 15 \times 0.3048$$
$$= 4.572\,\text{m}$$

Convert he unit of height *h* of water tank from feet to meter;

$$1.0\,\text{ft} = 0.3048\,\text{m}$$

$$h = 60 \times 0.3048$$
$$= 18.288\,\text{m}$$

Comment

Step 2 of 3

Determine the area *A* of the vertical water tank using the formula;

$$A = \frac{\pi}{4} \times d^2$$

Substitute 4.572 m for *d*.

$$A = \frac{\pi}{4} \times (4.572)^2$$
$$= 16.417\,\text{m}^2$$

Comment

Step 3 of 3

Determine the volume *V* of the tank in cubic meter using the formula;

$$V = A \times h$$

Substitute $16.417\,\text{m}^2$ for *A* and 18.288 m for *h*.

$$V = 16.417 \times 18.288$$
$$= 300.23\,\text{m}^3$$

Therefore, the volume of the vertical water tank is $\boxed{300.23\,\text{m}^3}$.

Comment

Problem

Note that the answers to odd-numbered problems are at the end of the book and step-by-step solutions to the odd- numbered problems can be found on the *Applied Hydrogeology* home page: *http://www.appliedhydrogeology.com*.

If a well pumps at a rate of 8.4 gal per minute, how long would it take to fill the tank described above?

Step-by-step solution

Step 1 of 4

Determine the area *A* of the vertical water tank using the formula;

$$A = \frac{\pi}{4} \times d^2$$

Here, *d* is the diameter of the vertical water tank.

Substitute 15 ft for *d*.

$$A = \frac{\pi}{4} \times (15)^2$$
$$= 176.71\,\text{ft}^2$$

Comment

Step 2 of 4

Determine the volume *V* of the tank in cubic feet using the formula;

$$V = A \times h$$

Here, *h* is the height of the vertical water tank.

Substitute $176.71\,\text{ft}^2$ for *A* and 60 ft for *h*.

Comment

Step 3 of 4

Convert the unit of pumping rate *Q* from galloon per minute to ft^3/s;

$$1.0\,\text{gpm} = 0.002228\,\text{ft}^3/\text{s}$$
$$Q = 8.6 \times 0.002228$$
$$= 0.01916\,\text{ft}^3/\text{s}$$

Comments (1)

Step 4 of 4

Determine the time *t* take fill the vertical water tank using the formula;

$$t = \frac{V}{Q}$$

Substitute $1.10 \times 10^4\,\text{ft}^3$ for *V* and $0.01916\,\text{ft}^3/\text{s}$ for *Q*.

$$t = \frac{1.10 \times 10^4}{0.01916}$$
$$= 574{,}112.73\,\text{sec}$$
$$= 574{,}112.73 \times 0.000277778\,\text{hrs}$$
$$= 160\,\text{hrs}$$

Therefore, the time take fill the vertical water tank is $\boxed{160\,\text{hrs}}$.

Comment

Problem

Note that the answers to odd-numbered problems are at the end of the book and step-by-step solutions to the odd- numbered problems can be found on the *Applied Hydrogeology* home page: http://www.appliedhydrogeology.com.

The only swimming pool at the El Cheapo Motel is outdoors. It is 5.0 m wide and 12.0 m long. If the weekly evaporation is 2.35 in., how many gallons of water must be added to the pool if it does not rain?

Step-by-step solution

Step 1 of 3

Convert the dimensions (width and length) of swimming pool from meter to inches;

$$1.0\,\text{m} = 39.3701\,\text{in.}$$

$$\begin{aligned}\text{Width} &= 5.0 \times 39.3701 \\ &= 196.85\,\text{in.}\end{aligned}$$

$$\begin{aligned}\text{Length} &= 12 \times 39.3701 \\ &= 472.44\,\text{in.}\end{aligned}$$

Comment

Step 2 of 3

Determine the volume *V* of the swimming pool using the formula;

$$V = \text{Width} \times \text{Length} \times \text{Depth of evaporation}$$

Substitute 196.85 inches for width, 472.44 inches for length, and 2.35 inches for depth evaporation.

$$\begin{aligned}V &= 196.85 \times 472.44 \times 2.35 \\ &= 218{,}550\,\text{in.}^3\end{aligned}$$

Comment

Step 3 of 3

There are 231 cubic inches in a gallon.

Determine the gallons of water must be added to the pool if it does not rain using the relation;

$$\text{Quantity of water required} = \frac{V}{\text{Number of cubic inches in a gallon}}$$

Substitute $218{,}550\,\text{in.}^3$ for V and $231\,\text{in.}^3$ for number of cubic inches in a gallon.

$$\begin{aligned}\text{Quantity of water required} &= \frac{218{,}550}{231} \\ &= 946.1\,\text{gallons}\end{aligned}$$

Therefore, the gallons of water must be added to the pool if it does not rain is $\boxed{946.1\,\text{gallons}}$.

Problem

Note that the answers to odd-numbered problems are at the end of the book and step-by-step solutions to the odd- numbered problems can be found on the *Applied Hydrogeology* home page: http://www.appliedhydrogeology.com.

If during the next week the pool still loses 2.35 in. of water to evaporation, even with 29 mm of rainfall, how many liters of water must be added?

Step-by-step solution

Step 1 of 3

Convert the unit of evaporation per week from inches to millimeter;

$$1.0\,\text{in.} = 25.4\,\text{mm}$$
$$1.0\,\text{in.} = 25.4\,\text{mm}$$

$$\begin{aligned}\text{Evaporation} &= 2.35 \times 25.4 \\ &= 59.69\,\text{mm/week}\end{aligned}$$

Comment

Step 2 of 3

Determine the area *A* of the swimming pool using the formula;

$$A = \text{Width} \times \text{Length}$$

Substitute 5.0 m for width and 12 m for length.

$$\begin{aligned}A &= 5.0 \times \left(\frac{1000\,\text{mm}}{1.0\,\text{m}}\right) \times 12 \times \left(\frac{1000\,\text{mm}}{1.0\,\text{m}}\right) \\ &= 60 \times 10^6\,\text{mm}^2\end{aligned}$$

Comment

Step 3 of 3

Determine the quantity of water must be added using the formula;

$$\text{Quantity of water} = (\text{Rate of evaporation} - \text{Rate of precipitation}) \times A$$

Substitute $59.69\,\text{mm/week}$ for rate of evaporation, $29\,\text{mm/week}$ for rate of precipitation, and $60 \times 10^6\,\text{mm}^2$ for *A*.

$$\begin{aligned}\text{Quantity of water} &= (59.69 - 29) \times 60 \times 10^6 \\ &= 1.8414 \times 10^9\,\text{mm}^3 \\ &= 1.800\,\text{m}^3 \times 1000\,\text{L} \\ &= 1{,}800\,\text{L}\end{aligned}$$

Therefore, the quantity of water must be added is $\boxed{1{,}800\,\text{L}}$.

Comment

Problem

Note that the answers to odd-numbered problems are at the end of the book and step-by-step solutions to the odd- numbered problems can be found on the *Applied Hydrogeology* home page: http://www.appliedhydrogeology.com.

A ground-water basin has a surface area of 125 km^2. The following long-term annual averages have been measured:

Precipitation 60.6 cm

Evapotranspiration 46.3 cm

Overland flow 3.4 cm

Baseflow 10.6 cm

There is no streamflow into the basin and no groundwater flow either into or out of the basin.

(A) Prepare an annual water budget for the basin as a whole, listing inputs in one column and outputs in another. Make sure that the two columns balance as these are long-term values and we assume no change in the volume of water stored in the basin.

we assume no change in the volume of water stored in the basin.

(B) Prepare an annual water budget for the streams.

(C) Prepare an annual water budget for the groundwater basin.

(D) What is the annual runoff from the basin expressed in centimeters?

(E) What is the annual runoff from the basin expressed as an average rate in cubic meters per second?

Step-by-step solution

Step 1 of 12

Convert the unit of area from square kilometer to square meter;

$$1.0\,\text{km}^2 = 1{,}000{,}000\,\text{m}^2$$
$$A = 125 \times 1{,}000{,}000 = 125{,}000{,}000\,\text{m}^2$$

Convert the unit of precipitation of centimeter to meter;

$$1.0\,\text{cm} = 0.01\,\text{m}$$
$$\text{Precipitation} = 60.6 \times 0.01 = 0.606\,\text{m}$$

Comments (1)

Anonymous
Error in given precipitation value, it should be 60.3

Submit

Step 2 of 12

Determine the input using the formula;

$$\text{Input} = \text{Precipitation} \times \text{Area}$$

Substitute 0.606 m for precipitation and $125{,}000{,}000\,\text{m}^2$ for area.

$$\text{Input} = 0.606 \times 125{,}000{,}000 = 75{,}750{,}000\,\text{m}^3$$

Comment

Step 3 of 12

Convert the unit of evapotranspiration of centimeter to meter;

$$1.0\,\text{cm} = 0.01\,\text{m}$$
$$\text{Evapotranspiration} = 46.3 \times 0.01 = 0.463\,\text{m}$$

Convert the unit of overland flow from centimeter to meter;

$$1.0\,\text{cm} = 0.01\,\text{m}$$
$$\text{Overland flow} = 3.4 \times 0.01 = 0.034\,\text{m}$$

Convert the unit of base flow from centimeter to meter;

$$1.0\,\text{cm} = 0.01\,\text{m}$$
$$\text{Base flow} = 10.6 \times 0.01 = 0.106\,\text{m}$$

Comment

Step 4 of 12

Determine the evapotranspiration using the formula;

$$\text{Evapotranspiration} = \text{Evapotranspiration} \times \text{Area}$$

Substitute 0.463 for evapotranspiration and $125{,}000{,}000\,\text{m}^2$ for area.

$$\text{Evapotranspiration} = 0.463 \times 125{,}000{,}000 = 57{,}875{,}000\,\text{m}^3$$

Comment

Step 5 of 12

Determine the overland flow using the formula;

$$\text{Overland flow} = \text{Overland flow} \times \text{Area}$$

Substitute 0.034 m for overland flow and $125{,}000{,}000\,\text{m}^2$ for area.

$$\text{Overland flow} = 0.034 \times 125{,}000{,}000 = 4{,}250{,}000\,\text{m}^3$$

Comment

Step 6 of 12

Determine the base flow using the formula;

$$\text{Base flow} = \text{Base flow} \times \text{Area}$$

Substitute 0.106 m for base flow and $125{,}000{,}000\,\text{m}^2$ for area.

$$\text{Base flow} = 0.106 \times 125{,}000{,}000 = 13{,}250{,}000\,\text{m}^3$$

Comment

Step 7 of 12

Determine the output using the formula;

$$\text{Output} = \text{Evapotranspiration} + \text{overland flow} + \text{base flow}$$

Substitute $57{,}875{,}000\,\text{m}^3$ for evapotranspiration, $4{,}250{,}000\,\text{m}^3$ for overland flow, and $13{,}250{,}000\,\text{m}^3$ for base flow.

$$\text{Output} = 57{,}875{,}000 + 4{,}250{,}000 + 13{,}250{,}000 = 75{,}375{,}000\,\text{m}^3$$

Comment

Step 8 of 12

A)

Show the input and output as in Table (1).

Input (m^3)	Output (m^3)		
Precipitation	75,750,000	Evapotranspiration	57,875,000
		Overland flow	4,200,000
		Base flow	13,250,000
Total	75,750,000	Total	75,375,000

From the above Table (1) input value is almost close to output.

Therefore, the input value balances the output value.

Comments (2)

Step 9 of 12

B)

Prepare annual water budget for the streams:

Determine the overland flow using the formula;

$$\text{Overland flow} = \text{Overland flow} \times \text{Area}$$

Substitute 0.034 m for overland flow and $125{,}000{,}000\,\text{m}^2$ for area.

$$\text{Overland flow} = 0.034 \times 125{,}000{,}000 = 4{,}250{,}000\,\text{m}^3$$

Therefore, the annual water budget for the streams is $\boxed{4{,}250{,}000\,\text{m}^3}$.

Comment

Step 10 of 12

C)

Prepare the annual water budget for the ground water basin:

Determine the base flow using the formula;

$$\text{Base flow} = \text{Base flow} \times \text{Area}$$

Substitute 0.106 m for base flow and $125{,}000{,}000\,\text{m}^2$ for area.

$$\text{Base flow} = 0.106 \times 125{,}000{,}000 = 13{,}250{,}000\,\text{m}^3$$

Therefore, the annual water budget for the ground water basin is $\boxed{13{,}250{,}000\,\text{m}^3}$.

Comment

Step 11 of 12

D)

Prepare annual runoff from the basin:

Determine the overland flow using the formula;

$$\text{Annual runoff from the basin} = \text{Overland flow}$$

Substitute 0.034 m for overland flow.

$$\text{Annual runoff from the basin} = 0.034\,\text{m} = 3.4\,\text{cm}$$

Therefore, the annual runoff from the basin is $\boxed{3.4\,\text{cm}}$.

Comments (1)

Anonymous
The book's glossary says runoff = Base flow plus overland flow not just overland flow

Submit

Step 12 of 12

E)

Determine the annual runoff from the basin expressed as an average rate in cubic meters per second using the relation;

$$\text{Annual runoff from the basin} = \frac{\text{Annual runoff from the basin}}{(60 \times 60 \times 24 \times 365)}$$

Substitute $4{,}250{,}000\,\text{m}^3$ for annual runoff from the basin.

$$\text{Annual runoff from the basin} = \frac{4{,}250{,}000}{(60 \times 60 \times 24 \times 365)} = 0.1348\,\text{m}^3/\text{s}$$

Therefore, the annual runoff from the basin expressed as an average rate in cubic meters per second is $\boxed{0.1348\,\text{m}^3/\text{s}}$.

Comments (2)