KEY

- INTRO PROBLEMS – VIESSMAN & LEWIS; CHAP. 1

1.1 $A_d = 100\ \cancel{km^2}\left(\frac{10^6 m^2}{\cancel{km^2}}\right) = 1\times10^8 m^2$

$A_d = 100 km^2$

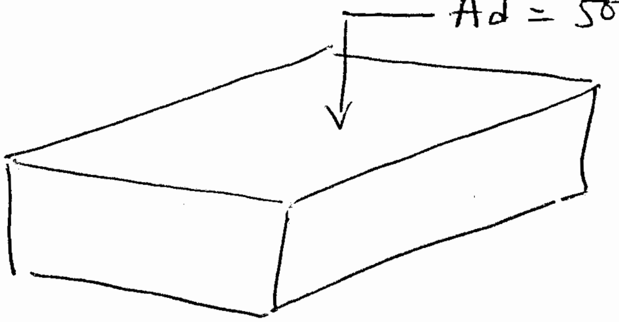
R = RUNOFF = 2 cm depth equivalent $= 2\cancel{cm}\left(\frac{1m}{100\cancel{cm}}\right) = 0.02m$

$Vol = A_d \cdot R = (1\times10^8 m^2)(0.02m) = \boxed{(2\times10^6 m^3)}$ ✱

$Vol = (2\times10^6 \cancel{m^3})\left(\frac{1\ ac\text{-}ft}{1233.5\ \cancel{m^3}}\right) = \boxed{1621.4\ ac\text{-}ft}$ ✱

1.2

$A_d = 500{,}000\ m^2$



INFLOW = $\left(\frac{1 m^3}{\cancel{sec}}\right)\left(\frac{60\cancel{sec}}{\cancel{min}}\right)\left(\frac{60\cancel{min}}{hr}\right) =$

$Q_{INFLOW} = 3600 \frac{m^3}{hr}$ = INFLOW RATE

$Vol = A \cdot d$

$d = 30\cancel{cm}\ \frac{1m}{100\cancel{cm}} = 0.3m$

$Vol = (500{,}000 m^2)(0.3m) = 150{,}000\ m^3$

$t\left(Q_{INFLOW}\right) = \frac{Vol}{\cancel{t}}\ \cancel{t}$

$tQ = Vol$

$t = \frac{Vol}{Q} = \frac{150{,}000\ \cancel{m^3}}{3600\ \cancel{m^3}/hr} = \boxed{41.7\ hr}$

1.3

STORAGE VOLUME = 13 ac-ft

TIME 1
$Q_{INFLOW} = 450 \frac{ft^3}{sec}$
$Q_{OUTFLOW} = 500 \frac{ft^3}{sec}$

↓ 1 hr ↓

TIME 2
$Q_{INFLOW} = 500 \frac{ft^3}{sec}$
$Q_{OUTFLOW} = 530 \frac{ft^3}{sec}$

INFLOW − OUTFLOW = Δ STORAGE

$I - Q = \Delta S$

$450 \frac{ft^3}{sec} - 500 \frac{ft^3}{sec} = -50 \frac{ft^3}{sec}$

$I - Q = \Delta S$

$500 \frac{ft^3}{sec} - 530 \frac{ft^3}{sec} = -30 \frac{ft^3}{sec}$

$$\frac{\Delta S}{1\ hr} = \frac{\Delta S_2 - \Delta S_1}{hr} = -30 \frac{ft^3}{sec} - \left(-50 \frac{ft^3}{sec}\right) =$$

$$-30 \frac{ft^3}{sec} + 50 \frac{ft^3}{sec} = +20 \frac{ft^3}{sec}$$

$$1\ \text{hour NET LOSS} = \left(-30\ \frac{ft^3}{\cancel{sec}}\right)\left(\frac{60\ \cancel{sec}}{\cancel{min}}\right)\left(\frac{60\ \cancel{min}}{1\ hr}\right) = -108{,}000\ ft^3$$

$$1\ \text{hour NET LOSS} = -108{,}000\ \cancel{ft^3}\left(\frac{1\ m^3}{35.31\ \cancel{ft^3}}\right) = \boxed{-3058\ m^3}$$

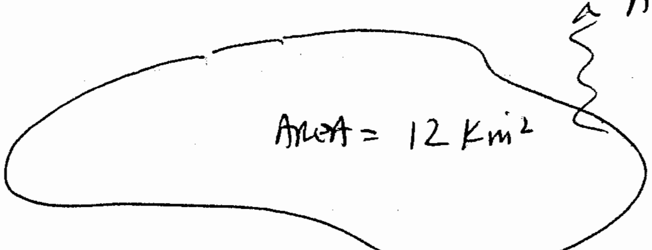
$$1\ \text{hour NET} = \left(-3058\ \cancel{m^3}\right)\left(\frac{1\ ac-ft}{1233.5\ \cancel{m^3}}\right) = \boxed{-2.48\ ac-ft}$$

TOTAL STORAGE VOLUME AFTER 1 hr =

$$13\ ac-ft - 2.48\ ac-ft = \boxed{10.52\ ac-ft}$$

ANNUAL EVAPORATION = 125 cm

1.4



LAKE

$$\text{Area} = 12\,\cancel{Km^2}\left(1\times10^6 \frac{\cancel{m^2}}{\cancel{Km^2}}\right)\left(1\times10^4 \frac{cm^2}{\cancel{m^2}}\right) = 1.2\times10^{11}\,c$$

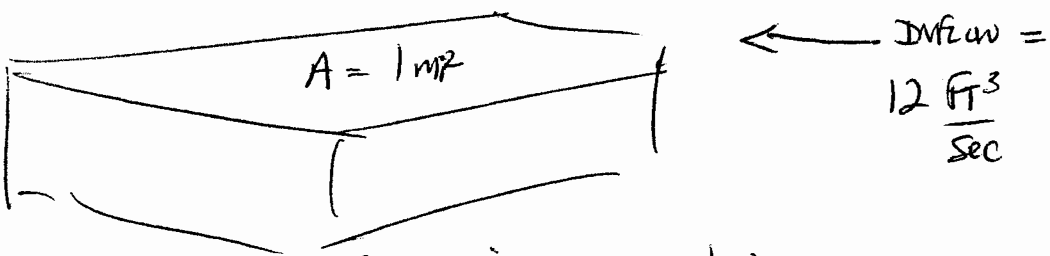
$$\text{Annual EVAP} = 125\ \frac{cm}{yr}$$

$$\text{Daily EVAP} = 125\ \frac{cm}{\cancel{yr}} \cdot \frac{1\,\cancel{yr}}{365\,day} = 0.34\ \frac{cm}{day}$$

$$\text{Daily EVAP.} = 0.34\ \frac{\cancel{cm}}{day}\left(\frac{1\,in}{2.54\,\cancel{cm}}\right) = 0.13\ \frac{in}{day}$$

1.5

86400



Reservoir

depth to RAISE Level = 6 in $\left(\frac{1\,ft}{12\,in}\right)$

$d = 0.5\ ft$

$$A = 1\,\cancel{mi^2}\left(2.79\times10^7 \frac{FT^2}{\cancel{mi^2}}\right) = 2.79\times10^7\ ft^2$$

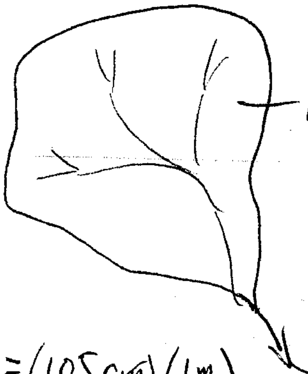
$$A\cdot d = \text{TOTAL VOLUME INCREASE} = (2.79\times10^7 ft^2)(0.5\ ft) = 1.395\times10^7\ f$$

$$Q_{INFLOW} = \frac{VOL}{t} \Rightarrow t = \frac{VOL}{Q_{in}} = \frac{1.395\times10^7\,\cancel{ft^3}}{12\ \cancel{ft^3}/sec} = 1,162,50\ s$$

$$\text{TIME} = 1,162,500\,\cancel{sec}\left(\frac{1\,\cancel{min}}{60\,\cancel{sec}}\right)\left(\frac{1\,\cancel{hr}}{60\,\cancel{min}}\right)\left(\frac{1\,day}{24\,\cancel{hr}}\right) = \boxed{13.45\ day}$$

4 of 6

1.6



$AW = 10{,}000\ \cancel{Km^2}\left(1\times10^6 \frac{m^2}{\cancel{Km2}}\right) = 1\times10^{10}\ m^2$

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INPUT =
$PRECIP = \left(\frac{105\ \cancel{cm}}{yr}\right)\left(\frac{1m}{100\cancel{cm}}\right) = 1.05 \frac{M}{yr}$

$Runoff = \frac{140\ m^3}{yr}$

$INPUT\ VOL = A \cdot d = (1\times10^{10} m^2)\left(1.05 \frac{m}{yr}\right) = 1.05\times10^{10} \frac{m^3}{yr}$

Very Low VALUE NOT REALISTIC!! ⟵ $Runoff = 140 \frac{\cancel{m^3}}{\cancel{yr}}\left(\frac{1\cancel{yr}}{365\cancel{day}}\right)\left(\frac{1\cancel{day}}{24\cancel{hr}}\right)\left(\frac{\cancel{hr}}{60min}\right)\left(\frac{264.17 Gal}{\cancel{m^3}}\right) = 0.07$

$P = I + ET + R$

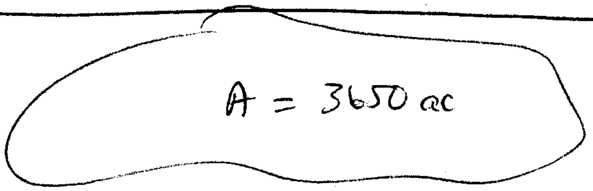
precip = INFILTRATION + EVAPOTRANSP + Runoff

$I + ET = P - R = 1.05\times10^{10} m^3 - 140\ m$

$I + ET = 1.05\times10^{10} M^3$

CAN'T DETERMINE ET WITHOUT AN INFILTRATION FACTOR!

1.7



A = 3650 ac

LAKE

$EVAP = 100 \frac{ac\text{-}ft}{day}$

⟵ $Inflow = 25 \frac{ft^3}{sec}$

TIME = 1 year

$INPUT = Inflow = \frac{25 ft^3}{\cancel{sec}} \frac{60\cancel{sec}}{\cancel{min}} \frac{60\cancel{min}}{\cancel{hr}} \frac{24\cancel{hr}}{\cancel{day}} \frac{365\cancel{day}}{yr} =$

$7.88\times10^8 \frac{\cancel{Ft^3}}{yr}\left(\frac{1\ ac\text{-}ft}{43{,}560\cancel{ft^3}}\right) = 18{,}099 \frac{ac\text{-}ft}{yr}$

$OUTPUT = EVAP = \frac{100\ acft}{\cancel{day}}\left(365 \frac{\cancel{day}}{yr}\right) = 36{,}500 \frac{ac\text{-}ft}{yr}$

$\boxed{-153.7cm}$ ★

$\boxed{DECREASING}$ ★

$I - Q = \Delta S = 18{,}099 \frac{ac\text{-}ft}{yr} - 36{,}500 \frac{ac\text{-}ft}{yr} = -18{,}401 \frac{ac\text{-}ft}{year}$

$d = VOL / AREA = -18401$ ac-ft / yr ... yr CONV 30.48cm ... = -153

1.8 INITIAL STORAGE VOLUME $= 20{,}000\ m^3$

$I =$ INFLOW $= 20\ \frac{m^3}{sec}$

$Q =$ OUTFLOW $= 18\ \frac{m^3}{sec}$

$I - Q = \Delta S = 20\frac{m^3}{sec} - 18\frac{m^3}{sec} = +2\frac{m^3}{sec}$

NET FLUX AFTER 1 hr $= +2\frac{m^3}{\cancel{sec}}\left(\frac{60\cancel{sec}}{\cancel{min}}\right)\left(\frac{60\cancel{min}}{hr}\right) = +7200\ \frac{m^3}{hr}$

FINAL STORAGE $= 20{,}000 m^3 + 7200 m^3 = \boxed{27{,}200\ m^3}$

ALTERNATIVE TO PROBLEM 1.6

1.6 NOTE: THIS QUESTION HAS A TYPO. THE MEAN ANNUAL RUNOFF <u>SHOULD</u> <u>BE</u> 140 m^3/sec

ASSUME THAT GROUNDWATER INFLUX/LOSS = "0"
ASSUME THAT NET CHANGE IN STORAGE ΔS = "0"

$$A = 10{,}000\ km^2 \left(\frac{10^6\ m^2}{1\ km^2}\right) = 10^{10}\ m^2$$

$$\text{OUTPUT} = \text{ANNUAL RUNOFF} = 140\ \frac{m^3}{sec} \cdot \frac{60\ sec}{min} \cdot \frac{60\ min}{hr} \cdot \frac{24\ hr}{day} \cdot \frac{365\ day}{yr} = 4.42 \times 10^9\ \frac{m^3}{yr}$$

$$\text{INPUT} = \text{PRECIP} = 105\ cm = (1.05\ m)(10^{10}\ m^2) = 1.05 \times 10^{10}\ m^3$$

$$ET = \text{PRECIP} - \text{RUNOFF} = 1.05 \times 10^{10}\ \frac{m^3}{yr} - 4.42 \times 10^9\ \frac{m^3}{yr} =$$

$$ET = 6.08 \times 10^9\ m^3 = \frac{6.08 \times 10^9\ m^3}{10^{10}\ m^2} =$$

$$0.61\ m = 610\ cm$$