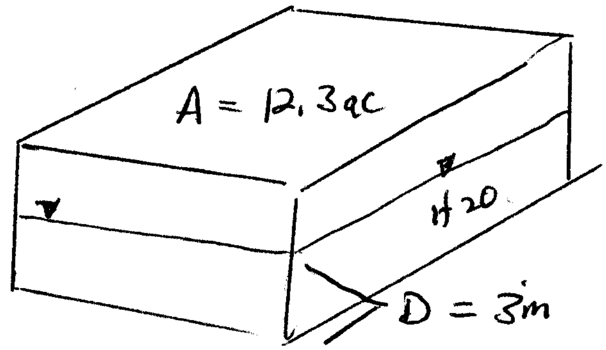
Hydrology HW #2 Key – Intro to Applied Problems in Hydrology

1. Reservoir



AT END OF RAINY SEASON:

$$\text{TOTAL VOL.}_{H_2O} = A \cdot D =$$

$$A = (12.3\,ac)\left(\frac{0.4047\,Ha}{1\,ac}\right)\left(\frac{1\times10^4\,m^2}{Ha}\right) = 497{,}781\,m^2$$

$$D = 3\,m$$

$$\text{ORIGINAL VOL}_{H_2O} = A \cdot D = (497781\,m^2)(3\,m) = 1{,}493{,}343\,m^3$$

DRY SEASON...

$$\text{EVAPORATION RATE} = \left(\frac{3.5\,in}{WK}\right)\left(\frac{1\,m}{39.37\,in}\right) = 8.89\times10^{-2}\,m/WK$$

$$\text{PUMP RATE} = \left(\frac{100\,GAL}{DAY}\right)\left(\frac{7\,DAY}{WK}\right)\left(\frac{1\,m^3}{264.17\,GAL}\right) = 2.65\,m^3/WK$$

$$\text{EVAPORATION VOLUME} = \left(\frac{8.89\,m}{WK}\right)(497{,}781\,m^2) = 4.42\times10^6\,\frac{m^3}{WK}$$

$$\text{WEEKLY LOSS} = \text{PUMP RATE} + \text{EVAP RATE} = 2.65\,\frac{m^3}{WK} + 4.42\times10^6\,\frac{m^3}{WK} \cong 4.42\times10^6\,\frac{m^3}{WK}$$

$$\text{TOTAL LOSS} \left(4.42\times10^6\,\frac{m^3}{WK}\right)(3\,WK) = 1.33\times10^7\,m^3$$

TOTAL STORAGE AFTER 3 WKS = $0\,m^3$ = 0 GAL.

2.

$$\text{Pump Rate} = 25 \frac{\text{gal}}{\text{min}} \left(\frac{1\,\text{m}^3}{264.17\,\text{gal}} \right) = 9.46 \times 10^{-2} \frac{\text{m}^3}{\text{min}}$$

$$\text{Tank Vol.} = 60\,\text{m}^3$$

$$Q = \frac{\text{Vol}}{t} \; ; \quad t = \frac{\text{Vol}}{Q} \left(\frac{\text{m}^3}{\text{m}^3/\text{min}} = \text{min} \right)$$

$$t = \frac{60\,\text{m}^3}{9.46 \times 10^{-2} \frac{\text{m}^3}{\text{min}}} = 634.25\,\text{min}$$

3.

$$\text{Watershed Area} = (20.5\,\text{mi}^2)\left(\frac{4.01 \times 10^9\,\text{in}^2}{\text{mi}^2} \right) = 8.22 \times 10^{10}\,\text{in}^2$$

$$\text{Summer Storm Vol} = \text{Area} \times \text{Depth} = (8.22 \times 10^{10}\,\text{in}^2)(2.5\,\text{in}) = 2.06 \times 10^{11}\,\text{in}^3$$

A. $$\text{Runoff} = (0.65)(\text{Storm Vol.}) = (0.65)(2.06 \times 10^{11}\,\text{in}^3) = 1.34 \times 10^{11}\,\text{in}^3$$

B. $$\text{Runoff} = (1.34 \times 10^{11}\,\text{in}^3)\left(\frac{1\,\text{ft}^3}{1728\,\text{in}^3} \right) = 7.75 \times 10^7\,\text{ft}^3$$

C. $$\text{Runoff} = 1.34 \times 10^{11}\,\text{in}^3 \left(\frac{1\,\text{m}^3}{61{,}023\,\text{in}^3} \right) = 2.19 \times 10^6\,\text{m}^3$$

4. RUNOFF

Q LEE VINING CREEK $87.3\ ft^3/sec \left(\frac{1\ m^3}{35.31\ ft^3}\right) = 2.70\ m^3/sec$

Q RUSH CREEK $44.8\ ft^3/sec \left(\frac{1\ m^3}{35.31\ ft^3}\right) = 1.27\ m^3/sec$

Q MILL CREEK $37.0\ ft^3/sec \left(\frac{1\ m^3}{35.31\ ft^3}\right) = 1.05\ m^3/sec$

TOTAL ~~RUNOFF~~ Q = $5.02\ m^3/sec$

TOTAL ANNUAL RUNOFF =

$$\frac{5.02\ m^3}{sec}\ \frac{60\ sec}{min}\ \frac{60\ min}{hr}\ \frac{24\ hr}{day}\ \frac{365.25\ day}{year} =$$

$$1.58 \times 10^8\ m^3/yr$$

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5. TOTAL DIVERSIONS = $\left(105,305\ \frac{ac\text{-}ft}{yr}\right)\left(\frac{1233.5\ m^3}{1\ ac\text{-}ft}\right) =$

$$1.30 \times 10^8\ m^3/yr$$

EFFECTIVE ANNUAL FLOW INTO MONO LAKE =

TOTAL RUNOFF − TOTAL DIVERSIONS =

$$1.58 \times 10^8\ m^3/yr - 1.30 \times 10^8\ m^3/yr = 2.8 \times 10^7\ m^3/yr$$

6\. ANDY THOMPSON CREEK

EMPIRICAL WEIR CALCULATION: $Q = 2.54\, h^{5/2}$ (UNITS cfs & ft)

$$h = 6.9\,in \left(\frac{1\,ft}{12\,in}\right) = 0.58\,ft$$

$$Q = 2.54\,(0.58\,ft)^{5/2} = 2.54\,(0.58\,ft)^{2.5} = 0.65\,\frac{ft^3}{sec}$$

$$Q = \left(0.65\,\frac{ft^3}{sec}\right)\left(\frac{1\,m^3}{35.31\,ft^3}\right) = 0.018\,\frac{m^3}{sec}$$

ANNUAL RUNOFF THROUGH WEIR:

$$\left(0.018\,\frac{m^3}{sec}\right)\left(\frac{60\,sec}{min}\right)\left(\frac{60\,min}{hr}\right)\left(\frac{24\,hr}{day}\right)\left(\frac{365.25\,day}{yr}\right) =$$

$$5.8 \times 10^5\, m^3/yr$$

7\. $Q = 3.33(L - 0.2h)\,h^{3/2}$ $L = 3\,ft$ $h = 3.5\,in\left(\frac{1\,ft}{12\,in}\right) = 0.29\,ft$

$$Q = 3.33\,(3\,ft - 0.2(0.29\,ft))(0.29)^{3/2} = (3.33)(2.94)(0.16) = 1.57\,\frac{ft^3}{sec}$$

$$\text{Annual } Q = \left(1.57\,\frac{ft^3}{sec}\right)\left(\frac{1\,m^3}{35.31\,ft^3}\right)\left(\frac{3.15 \times 10^7\,sec}{yr}\right) = 1.4 \times 10^6\,\frac{m^3}{yr}$$

8. SPRING RUNOFF = 5530 $\frac{GAL}{MIN}$

ANNUAL SPRING DISCHARGE =

$$\left(5530 \frac{GAL}{MIN}\right)\left(5.256 \times 10^{5} \frac{MIN}{YR}\right)\left(\frac{1 m^3}{264.17 GAL}\right) = 1.1 \times 10^{7} \frac{m^3}{YR}$$

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9 TOTAL MONO LAKE RUNOFF BUDGET (ANNUAL)
(FROM Q.4, Q5, Q6, Q7, Q8)

TOTAL RUNOFF-INPUT:

LEE VINING CK, RUSH CK, MILL CK	$1.58 \times 10^{8} m^3/yr$	(Q.4)
THOMPSON CK	$5.8 \times 10^{5} m^3/yr$	(Q.6)
LARGE STREAM	$1.4 \times 10^{6} m^3/yr$	(Q.7)
SPRINGS	$1.1 \times 10^{7} m^3/yr$	(Q.8)
TOTAL INPUT	$1.71 \times 10^{8} m^3/yr$	
(Q.5) TOTAL DIVERSION	$- 2.8 \times 10^{7} m^3/yr$	

TOTAL INPUT: $1.43 \times 10^{8} m^3/yr$

10.

$$VOL = \frac{1}{3}\pi h (r_1^2 + r_1 r_2 + r_2^2)$$

$$h = (6406.9\,ft - 6391.2\,ft) = 15.7\,ft$$

AREA OF CIRCLE $= \pi r^2$

$$r^2 = \frac{A}{\pi}$$

$$r = \sqrt{\frac{A}{\pi}}$$

1954 AREA $= 89.4\,mi^2$

1964 AREA $= 77.0\,mi^2$

$$r_1 = r_{1954} = \sqrt{\frac{89.4\,mi^2}{3.14}} = 5.34\,mi = 28,195.2\,ft$$

$$r_2 = r_{1964} = \sqrt{\frac{77.0\,mi^2}{3.14}} = 4.95\,mi = 26,136\,ft$$

$$VOL = \frac{1}{3}\pi\ 15.7\,ft\left((28195.2\,ft)^2 + [28195\,ft \times 26,136\,ft] + (26136\,ft)^2\right)$$

$$= 16.3\,ft\left[7.94\times10^8\,ft^2 + 7.37\times10^8\,ft^2 + 6.8\times10^8\,ft^2\right]$$

$$= 3.60 \times 10^{10}\,FT^3$$

VOLUME LOSS 1954→1964 =
$3.6\times10^{10}\,FT^3$