Applied Hydrology 622 U2600

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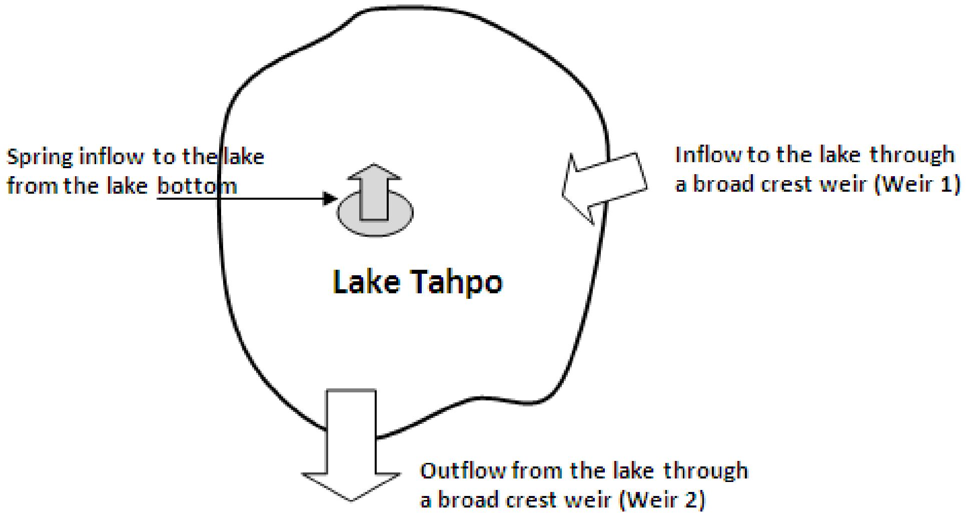
Homework 3 [Due May 11, 2016]

1. The Lake Tahpo as shown in the following figure is located in Chih-Shang, Taidong County. The lake is surrounded by a peripheral channel and water in the channel can flow into the lake only through a broad crest weir (Weir 1). Lake water can only be discharged through another outfall weir (Weir 2). It has been observed that there are spring inflows (湧泉) to the lake from the lake bottom. The length of weir 1 and weir 2 are 5 m and 13 m, respectively. The crest of weir 2 is at an elevation 4.1 m above the lake bottom. The spring inflow is assumed be constant.
An engineer was assigned to estimate the spring inflow rate. During a 30-day of no rain period, he measured daily flow depths at the crests of weir 1 and weir 2 (see Table 1).
Weir flow can be calculated by the following equation:
Q (cms) $= cLH^{1.5}$
[c=2.066, L=length of the weir (in meter), H: flow depth at crest (in meter)]
The stage-storage relationship of the lake is shown in Table 2.
If you were the engineer, what would be your estimate of the spring inflow rate? [Ignore the losses such as evaporation, infiltration and seepage from the lake.]



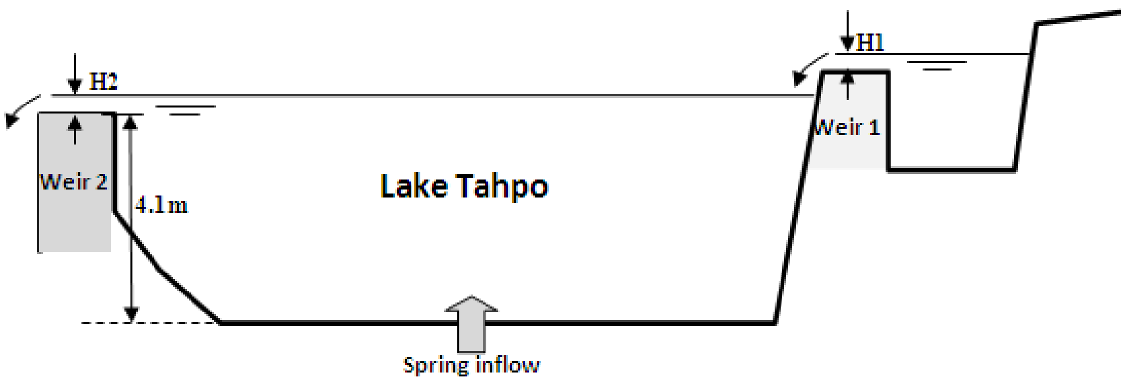


Table 1 Daily flow depths of weirs 1 and 2

Weir 1				Weir 2			
Day	H1 (cm)	Day	H1 (cm)	Day	H2 (cm)	Day	H2 (cm)
1	35	16	29	1	41.1	16	37.9
2	35	17	30	2	39.2	17	38.8
3	35	18	32	3	40.8	18	39.1
4	32	19	33	4	38.8	19	39.8
5	31	20	32	5	39.4	20	39.2
6	38	21	32	6	40.7	21	39.4
7	31	22	34	7	39.6	22	39.6
8	26	23	32	8	39.0	23	39.4
9	29	24	32	9	36.8	24	39.2
10	28	25	31	10	37.3	25	39.0
11	31	26	29	11	39.2	26	38.2
12	37	27	29	12	40.4	27	38.2
13	34	28	28	13	40.1	28	37.8
14	35	29	28	14	39.6	29	37.8
15	33	30	38	15	40.1	30	39.8

Table 2

Stage above the lake bottom (m)	Storage volume (1000 m^3)
0	0
0.5	0.327778
1	2.202419
1.5	6.711995
2	14.7986
2.5	27.3249
3	45.09956
3.5	68.89096
4	99.4355
4.1	106.4177
4.5	137.4434
5	183.6028
5.5	238.5826
6	303.0352

2. A detention pond has the following elevation–area relationship.

Elevation (ft)	Area (acre)	Elevation (ft)	Area (acre)
100.00	0.158	104.00	0.263
100.50	0.170	104.50	0.278
101.00	0.182	105.00	0.293
101.50	0.194	105.50	0.309
102.00	0.207	106.00	0.325
102.50	0.221	106.50	0.342
103.00	0.234	107.00	0.359
103.50	0.248		

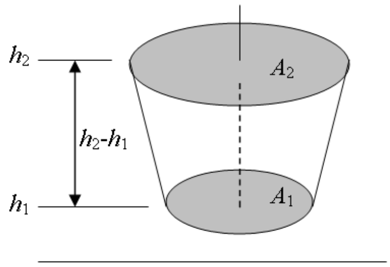
A composite outlet structure is being designed with an orifice and a weir operating in parallel. The orifice is a 6-inch diameter orifice plate with an invert elevation of 100.00 ft and an orifice coefficient of C=0.60. The orifice discharges into the top section of a large culvert; under the maximum head conditions in the pond, the water within the culvert will not rise above the orifice invert (i.e., inlet control condition). The concrete rectangular suppressed weir has a weir coefficient approximated as 2.6 for the entire range of headwaters, a weir length of 15 ft, and a crest elevation at 105.00 ft. It operates under free outfall conditions.

Orifice flow: $Q = CA\sqrt{2gh}$;

Weir flow: $Q = CLH^{3/2}$

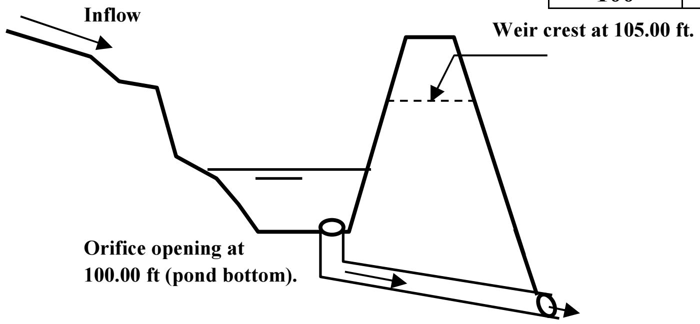
Route the following inflow hydrograph through the pond. Determine the maximum storage volume, maximum outflow rate, and peak lag resulting from the detention.

Note: ***Conic method*** for storage volume calculation



$$\Delta S = \left(\frac{h_2 - h_1}{3}\right)\cdot\left(A_1 + A_2 + \sqrt{A_1 A_2}\right)$$

Time (minutes)	**Inflow (cfs)**	**Time (minutes)**	**Inflow (cfs)**
0	**0**	**110**	**7.27**
10	**0.58**	**120**	**6.61**
20	**5.94**	**130**	**5.49**
30	**15.44**	**140**	**3.32**
40	**20.75**	**150**	**1.52**
50	**20.27**	**160**	**0.66**
60	**17.44**	**170**	**0.29**
70	**14.19**	**180**	**0.12**
80	**11.42**	**190**	**0.05**
90	**9.44**	**200**	**0.02**
100	**8.12**	**210**	**0.00**



3. For a small watershed the effective rainfall hyetograph of a storm event and the corresponding direct runoff hydrograph are shown in the following table.

Time (h)	ERH (cm/s)	Time (h)	DRH (cms)	Time (h)	DRH (cms)
0 – 1	4.3	0	0	9	32.7
1 – 2	3.2	1	6.5	10	23.8
2 – 3	2.4	2	15.4	11	16.4
3 – 4	1.8	3	43.1	12	9.6
		4	58.1	13	6.8
		5	68.2	14	3.2
		6	63.1	15	1.5
		7	52.7	16	0
		8	41.9		

Determine the coefficient *n* and *k* of the Nash *n-LR* model IUH.