G.10.8 Review of Earlier Study on Prek Toek Sap Reservoir

Site-1 (Upper Prek Toek Sap Reservoir) is originally proposed by pre-feasibility study (Fraser Thomas, 1994). In this1994 study, the optimum location of the proposed dam site was roughly determined from studies of old contour maps of the catchment and from visual, airborne appraisals of the area. The proposed potential site for a dam is at a location downstream of the confluence of the main channel and its major tributary. There is a waterfall at the confluence that called “Kabl Chay” waterfall. In 1999 study by the SWSA that financed by Word Bank (Parsons ES) conducted field topographic survey at around the Site-1 in the above map. Dam site locations were refined using the prepared 1:2,500 scale map. Optimum dam location has been slightly changed based on improved topographic information but the general area of the proposed dam is the same as before. The results of reservoir water balance calculation at Site-1 by 1999 Study are shown in the table below.

Table G-45 Required Dam Height at Site-1 (SWSA, 1999 Study, Parsons ES)

Demand (m^3/day)	Minimum Dam Height to Meet Demand	Construction Cost (mil.US$)	Note
20,000	Less than 20 m		
40,000	20 m	12.0	
60,000	30 m	25.0	
80,000	40 m		Maximum water level will over crest of Kabal Chay waterfall
100,000	40 m		

Source : Cambodia Urban Water Supply Project, SWSA, (WB Credit), Report on Long-term Water Supply, Parsons, (1999)

Above calculation is assumed drought return period of at least 20 years (1967-68 rainfall used) and maintenance flow for the down stream in dry season is not considered.

Kabl Chay (photo below) is presently a popular tourist area, with many visitors coming to see the waterfalls. Some or all of the scenic beauty of this area would be inundated in the event of constructing a proposed dam at Site-1.

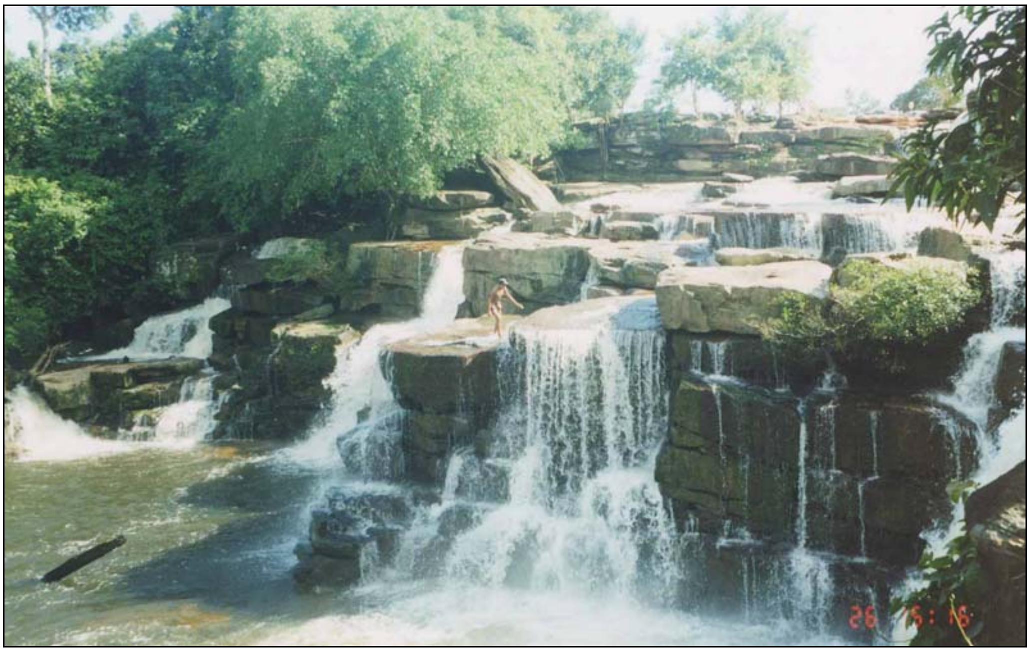

Photo G.10-1 Kbal Chay Waterfall at Upper Prek Toek Sap River

G.10.9 Preliminary Development Plan of Toek Sap Reservoir

(1) Introduction

Reservoir operation studies by several case of dam height and water demand (water requirement for water supply and maintenance flow to downstream) for each alternative sites (site-1, 2 and 3) are conducted in this study.

Observed water level data in the Prek Toek Sap River was only available 2 years (2001-2002) at present. Therefore, the long-term inflow sequence for reservoir operation was formulated by using available monthly rainfall records of total 35 years (1957-63, 65-69, 71-73 and 83-2002) at Sihanoukville and Tank model. The model parameters are calibrated by using calculated daily discharge at Kbal Chay W.L. Station of the period of 2001 to 2002.

(2) Rainfall

The project site is located in a tropical area, which is characterized by a well-defined dry season in the winter and a rainy southwestern monsoon in the summer months. The meteorology of the project area is influenced by the southwestern monsoon (the rainy season) from April to October and the northeast monsoon (the dry season) from November to March. Isohyetal map of annual rainfall in Cambodia is shown in **Figure G-24**.

Annual rainfall in Sihanoukville varies between 2,291 mm - 4,870 mm, with an average of 3,439 mm (average in available 35 years;1957-63, 65-69, 71-73 and 83-2002). About 90% of annual rainfall (3,105 mm) falls during the rainy season from April to October. The peak rainfall occurs in August with 650 mm. On the contrary, only 10% of annual rainfall (335 mm) are produced during dry season from November to March as shown in **Figure G-42**. The available monthly rainfall record at Sihanoukville is shown in **Table G-46**. A long-term annual rainfall change in Sihanoukville seems decreasing as shown in **Figure G-43**.

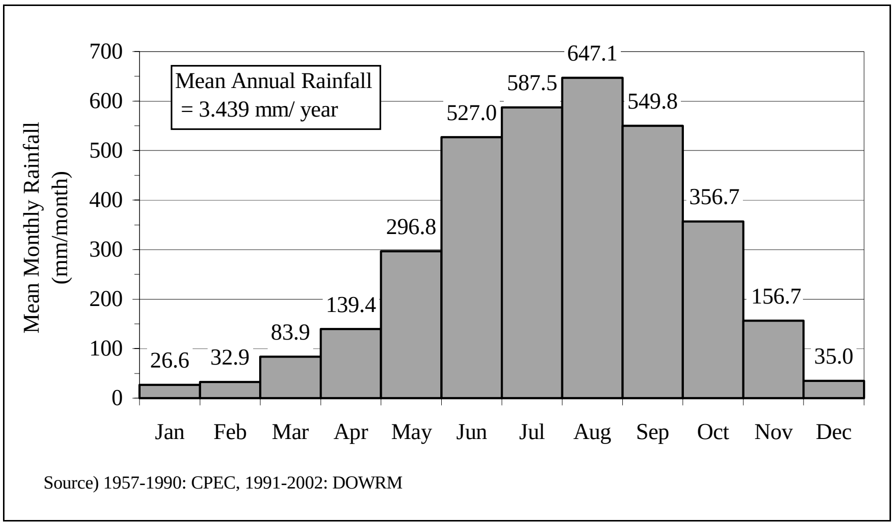

Figure G-42 Mean Monthly Rainfall at Sihanoukville

Table G-46 Historical Rainfall Record at Sihanoukville (Kampong Som)

Station : Sihanoukville (Kampong Som)

Latitude : 10° 38' **Longitud : 103° 29'** **Elevation : 13 m.s.n.m**

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1957	23.0	24.1	219.3	141.3	198.0	406.6	538.2	475.2	827.0	472.3	231.2	17.7	3,574
1958	38.5	5.2	22.5	98.0	476.6	310.9	704.3	836.1	507.7	420.2	20.3	17.5	3,458
1959	0.0	55.0	388.9	104.1	185.8	481.0	937.8	876.1	541.8	249.7	180.9	109.8	4,111
1960	160.3	16.5	21.6	164.4	479.5	705.0	642.2	526.8	683.6	270.1	212.7	13.6	3,896
1961	7.6	24.8	87.0	124.1	51.8	435.6	408.1	971.1	693.1	458.8	40.0	67.2	3,369
1962	34.3	6.0	44.7	278.7	7.9	405.4	917.2	515.1	835.3	122.6	140.9	0.9	3,309
1963	0.0	61.9	85.5	28.2	196.8	498.8	525.5	1094.3	686.3	328.2	354.5	49.6	3,910
1964	*	*	*	*	*	*	*	*	*	*	*	*	*
1965	0.0	98.2	81.5	218.3	452.5	674.6	619.5	453.5	972.5	451.5	123.0	16.5	4,162
1966	28.5	5.5	113.0	101.0	644.0	451.5	1477.5	572.5	386.5	614.5	323.5	152.0	4,870
1967	10.5	19.0	0.0	159.5	602.3	1028.5	882.1	1033.5	280.3	508.2	41.5	0.7	4,566
1968	36.5	7.7	16.4	18.4	232.8	34.3	805.3	537.8	728.7	197.5	37.3	30.2	2,683
1969	76.4	98.1	63.5	30.9	354.2	68.9	88.7	261.6	1160.2	290.3	238.5	2.5	2,734
1970	*	*	*	*	*	*	*	*	*	*	*	*	*
1971	9.2	35.1	61.2	61.8	387.6	468.5	357.1	573.3	481.4	738.7	39.4	73.8	3,287
1972	3.4	72.4	262.9	200.1	176.6	590.5	392.0	500.1	506.9	176.7	180.7	57.9	3,120
1973	6.4	17.2	96.0	85.1	146.4	808.7	762.0	789.2	395.3	364.0	426.5	39.9	3,937
1974	*	*	*	*	*	*	*	*	*	*	*	*	*
1975	*	*	*	*	*	*	*	*	*	*	*	*	*
1976	*	*	*	*	*	*	*	*	*	*	*	*	*
1977	*	*	*	*	*	*	*	*	*	*	*	*	*
1978	*	*	*	*	*	*	*	*	*	*	*	*	*
1979	*	*	*	*	*	*	*	*	*	*	*	*	*
1980	*	*	*	*	*	*	*	*	*	*	*	*	*
1981	*	*	*	*	*	*	*	*	*	*	*	*	*
1982	*	*	*	*	*	*	*	*	*	*	*	*	*
1983	0.0	0.0	65.5	0.0	390.6	934.4	465.7	677.1	509.9	679.3	260.6	94.6	4,078
1984	27.4	98.0	24.5	175.8	242.8	806.1	482.6	453.6	222.6	209.3	33.7	79.5	2,856
1985	4.6	48.6	74.0	263.5	343.6	551.9	217.3	609.3	660.1	340.9	40.0	8.0	3,162
1986	6.8	3.2	35.6	251.1	300.5	811.5	398.3	654.0	596.8	311.8	152.0	5.2	3,527
1987	4.5	0.0	0.4	216.3	216.1	778.1	221.1	363.1	555.4	318.3	409.4	0.0	3,083
1988	14.2	70.5	23.7	127.6	454.2	600.4	799.1	338.7	555.9	447.7	122.6	0.0	3,555
1989	30.4	22.8	120.3	83.8	613.2	388.2	540.6	864.7	224.5	380.1	53.4	8.9	3,331
1990	35.2	21.1	109.6	81.9	209.5	683.9	309.3	625.7	590.7	261.8	111.9	2.0	3,043
1991	37.2	23.5	2.6	223.1	224.1	505.4	1315.7	720.7	775.2	402.2	4.2	1.0	4,235
1992	1.0	58.5	14.9	80.0	179.6	670.9	483.7	717.9	393.3	324.3	9.4	2.6	2,936
1993	40.0	10.0	129.7	158.9	196.6	654.7	741.9	504.1	607.8	256.3	100.6	42.4	3,443
1994	62.5	16.4	221.2	199.2	352.6	612.9	408.0	560.7	760.4	208.1	23.3	83.4	3,509
1995	24.8	0.6	53.6	63.2	299.3	363.6	544.4	941.1	540.2	286.7	42.9	24.2	3,185
1996	19.8	2.6	24.4	119.5	82.6	60.0	390.6	422.5	497.3	175.7	492.3	11.8	2,299
1997	3.4	75.0	6.4	84.3	146.6	90.6	841.6	435.0	253.1	168.5	185.0	1.6	2,291
1998	0.8	6.7	0.0	34.6	65.9	449.0	691.1	692.0	337.5	721.4	249.6	87.6	3,336
1999	0.0	0.0	150.6	275.2	363.3	527.7	673.7	313.8	515.9	425.6	325.3	48.6	3,620
2000	70.8	79.9	64.5	289.1	286.2	577.5	430.9	962.8	135.9	500.2	53.9	25.5	3,477
2001	104.6	62.2	166.4	156.0	423.7	579.6	293.8	841.2	305.1	333.7	32.5	26.0	3,325
2002	7.4	6.8	84.9	183.2	403.9	431.0	256.2	932.7	518.4	70.5	190.3	22.6	3,108
Ave.	26.6	32.9	83.9	139.4	296.8	527.0	587.5	647.1	549.8	356.7	156.7	35.0	3,439
Max	160.3	98.2	388.9	289.1	644.0	1028.5	1477.5	1094.3	1160.2	738.7	492.3	152.0	4,870
Min.	0.0	0.0	0.0	0.0	7.9	34.3	88.7	261.6	135.9	70.5	4.2	0.0	2,291

Note: "*" missing data.

Source: Data from 1991 to 2002 : CPEC, 1995.
Data from 1957 to 1990 : Dept. of Water Resource and Meteorology, Sihanoukville.

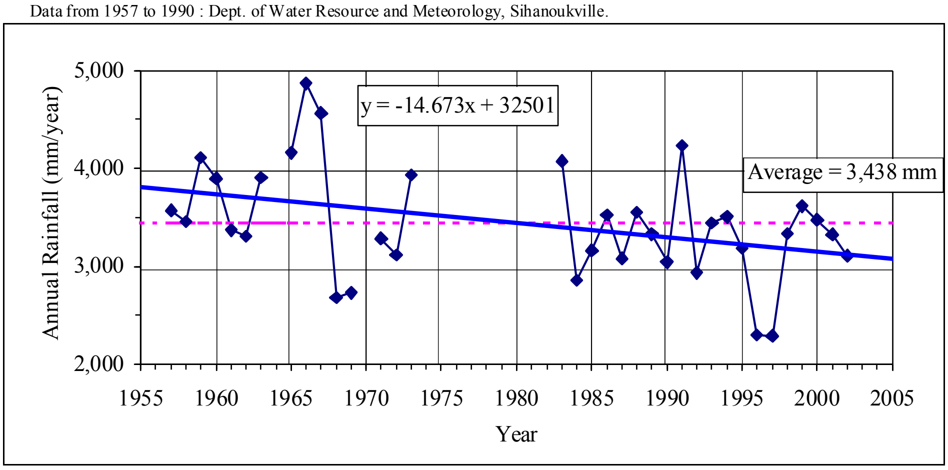

Figure G-43 Long-term Annual Rainfall Changes in Sihanoukville

(3) Evaporation

Mean annual pan evaporation in Sihanoukville is 1,173 mm. To estimate potential evapotranspiration from catchment area, a coefficient of 0.7 is used for the Tank model. To estimate of evaporation from reservoir water surface, pan evaporation rate is used as 0.85 (referred Kamchay HEP Study, 2002). The mean monthly pan evaporation in Sihanoukville is shown in the table below.

Table G-47 Pan Evaporation at Sihanoukville (Kampong Som)

Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Evaporation	137	112	115	108	87	95	73	75	70	73	105	123	1,173

Source: National Capacity Development Project Case Study, TF-4, 2002. MOWRAM.

(4) Estimation of Long-term Discharge at Kbal Chay W.L. Staion

To evaluate the optimum development scale of projects, through computation of reservoir water balance, the long-term runoff data for a time period of more than 20 years at the proposed dam site is normally needed. Further, the runoff data should be of high accuracy, because estimation of the economic viability of the project is highly sensitive to the runoff records. However, it is often that long-term runoff records are not available. It is therefore important to extend the available records using a rainfall-runoff model from available rainfall records.

As described above, the runoff records at Kbal Chay water level gauging station in Prek Toek Sap River are only available for 2 years between 2001 to 2002. This data observation period does not seem to be sufficient for reliable planning of the project. Considering that the rainfall records are available at Sihanoukville stations in the period of 35 years in total (1957-63, 65-69, 71-73 and 83-2002), it should be possible to estimate the discharge data for the period of 35 years by using a rainfall-runoff model. In this study, the Tank Model is applied as the rainfall-runoff model.

The basic concept of the Tank model (Sugawara, 1956) is a simple tank with holes to let out water. The outflow from each hole is proportionate to the height between the hole and water surface. Provided that a tank is accommodated with one bottom hole and two side holes, the rule for outflow computation is as follows;

[Concept of Tank Model]

$$y_n = 0 \qquad (X_n \leqq h_1)$$
$$y_n = \alpha_1(X_n - h_1) \qquad (h_1 < X_n \leqq h_2)$$
$$y_n = \alpha_2(X_n - h_2) + \alpha_1(X_n - h_1) \qquad (h_2 < X_n),$$
$$z_n = \beta Xn,$$
$$X_n' = X_n - y_n - z_n,$$
$$Z_n+1 = X_n' + x_n + 1 \qquad \text{-----------------} (1)$$

where, X_n : water depth of stage *n*,

y_n : outflow from side holes of stage 4,

z_n : outflow from bottom hole of stage 4,

x_n : inflow of stage *n*,

α_1, α_2 : coefficient of side holes, and

β : coefficient of bottom hole.

Normally, a tank model combining several tanks in a series makes a better simulation result. In Japan, the tank model consisting of four tanks in a series successfully analyzes a number of river basins. In such models, each tank interacts in the manner described in the above equation (1). The top tank receives the rainfall as inflow to the tank, while the tanks below get the supply from the bottom holes of the tank directory above. The last or the bottom tank only has a side hole. The aggregated outflow from all the side holes of the tanks constitutes the inflow into the river course. Trial-and-error is needed to determine the tank parameters that minimize the difference between the observed and estimated runoff.

The calibrated model parameters for the Kbal Chay gauging station is shown in the figure below.

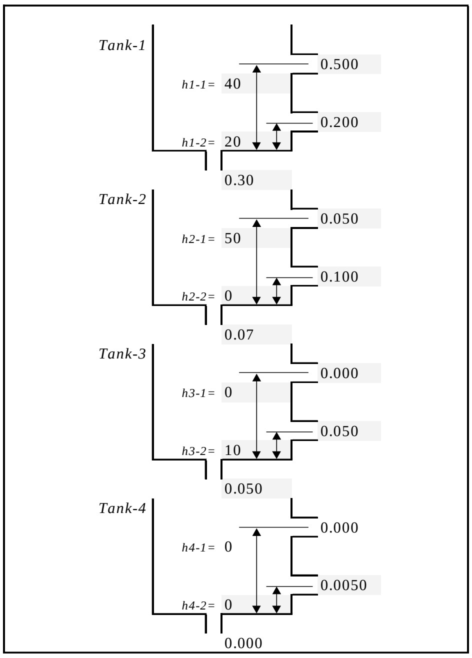

Figure G-44 Calibrated Tank Model Parameters for Kbal Chaty W.L. Station

The model parameter values are calibrated based on the observed discharge (calculated discharge by observed water level records) at the Kbal Chay gauging station. The calculation was conducted by monthly time step. Result of calibration of the model is shown in **Figure G-45**. Estimated monthly discharge at Kbal Chay Station is shown in **Table G-48**.

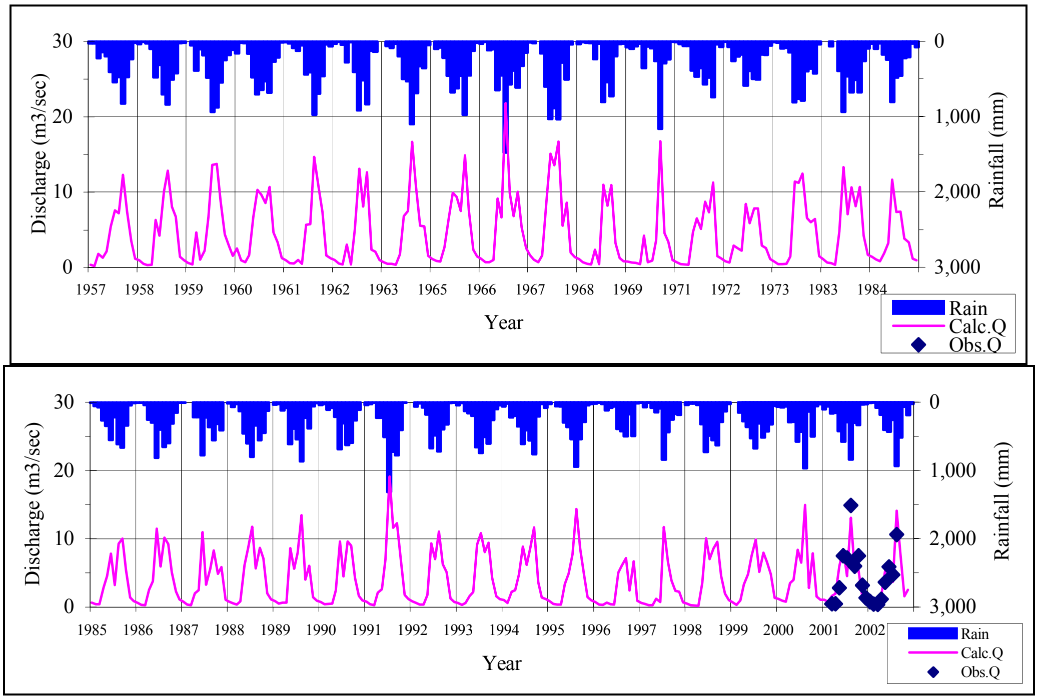

Figure G-45 Monthly Discharge Hydrograph at Kbal Chay Station

(5) Estimation of Long-term Inflow Data at Proposed Reservoir

Using the estimated monthly discharge at Kbal Chay gauging station (Q_k) (catchment area =52.52 km^2), the monthly stream flow sequences at the proposed dam sites for the period of 35 years are estimated by ratio of the catchment area as follows.

$$Q_{site1} = Q_k \times A_{site1} / A_k = Q_k \times 64.15 / 52.52 = Q_k \times 1.22$$

$$Q_{site2} = Q_k \times A_{site2} / A_k = Q_k \times 73.37 / 52.52 = Q_k \times 1.40$$

$$Q_{site3} = Q_k \times A_{site3} / A_k = Q_k \times 87.58 / 52.52 = Q_k \times 1.67$$

The estimated monthly discharge at the proposed reservoir (dam) site-3 is shown in **Table G-49**.

The mean annual runoff (MAR) at the proposed site-3 (catchment area of 87.58 km^2) is 7.16 m^3/sec (= specific yield of 8.18 m^3/sec/100km^2 or 2,579 mm/year), with the runoff coefficient of 0.75 (= MAR/MAP = 2,579 / 3,439 = 0.75).

Table G-48 Estimated Monthly Discharge at Kbal Chay W.L. Station (35 Years)

Station: Kbal Chay WL St. C.A.(km2)= 52.52 Unit: m3/sec

Year	Month	1 Jan.	2 Feb.	3 Mar.	4 Apr.	5 May	6 Jun.	7 Jul.	8 Aug.	9 Sep.	10 Oct.	11 Nov.	12 Dec.	Annual
1957	1	0.33	0.15	1.79	1.25	2.13	5.42	7.55	7.19	12.25	7.36	3.46	1.15	4.17
1958	2	0.92	0.47	0.29	0.34	6.29	4.20	10.06	12.85	8.00	6.70	1.40	0.92	4.37
1959	3	0.59	0.38	4.60	1.04	2.20	6.70	13.62	13.73	8.75	4.37	2.86	1.50	5.03
1960	4	2.48	0.94	0.66	1.60	6.68	10.24	9.66	8.55	10.66	4.63	3.32	1.24	5.06
1961	5	0.92	0.53	0.50	1.00	0.46	5.64	5.71	14.64	10.64	7.37	1.56	1.20	4.18
1962	6	0.97	0.51	0.37	3.03	0.37	5.02	13.07	8.07	12.62	2.32	2.09	1.00	4.12
1963	7	0.68	0.47	0.43	0.32	1.77	6.78	7.46	16.63	10.72	5.53	5.44	1.50	4.81
1965	8	1.11	0.86	0.77	2.65	6.41	9.88	9.38	7.48	14.86	7.59	2.31	1.44	5.40
1966	9	1.16	0.66	0.70	0.98	9.13	6.63	21.79	9.79	6.78	10.03	5.33	2.52	6.29
1967	10	1.60	1.02	0.67	1.54	8.56	15.10	13.52	16.69	5.51	8.57	1.96	1.34	6.34
1968	11	1.12	0.65	0.44	0.35	2.31	0.40	10.97	8.17	10.91	3.24	1.23	0.83	3.39
1969	12	0.77	0.62	0.56	0.39	4.22	0.67	0.90	3.58	16.70	4.52	3.39	0.98	3.11
1971	13	0.69	0.41	0.35	0.32	4.65	6.48	5.09	8.69	7.30	11.24	1.49	1.17	3.99
1972	14	0.83	0.62	2.90	2.53	2.21	8.43	5.83	7.82	7.81	2.89	2.52	1.09	3.79
1973	15	0.78	0.41	0.42	0.47	1.45	11.36	11.19	12.42	6.55	5.96	6.43	1.48	4.91
1983	16	1.10	0.60	0.52	0.32	4.68	13.28	7.01	10.64	8.09	10.68	4.21	1.65	5.23
1984	17	1.38	1.08	0.81	1.90	3.23	11.66	7.37	7.38	3.81	3.31	1.15	0.92	3.67
1985	18	0.63	0.42	0.40	2.83	4.55	7.83	3.22	9.30	10.00	5.44	1.36	0.88	3.91
1986	19	0.59	0.31	0.27	2.51	3.76	11.50	5.94	10.17	9.24	5.10	2.32	1.09	4.40
1987	20	0.78	0.38	0.27	2.00	2.46	10.93	3.25	5.56	8.27	4.86	5.83	1.05	3.80
1988	21	0.77	0.57	0.37	0.83	6.09	8.53	11.75	5.65	8.62	7.10	1.96	1.11	4.45
1989	22	0.88	0.50	0.66	0.66	8.59	5.62	7.97	13.42	4.00	6.02	1.43	0.93	4.22
1990	23	0.74	0.41	0.48	0.51	2.42	9.60	4.51	9.58	9.01	4.22	1.61	0.95	3.67
1991	24	0.76	0.43	0.29	2.12	2.61	6.97	19.10	11.64	12.27	6.94	1.75	1.17	5.50
1992	25	0.83	0.59	0.39	0.36	1.75	9.34	7.01	11.04	6.26	5.12	1.22	0.74	3.72
1993	26	0.58	0.32	0.62	1.60	2.21	9.14	10.81	8.03	9.41	4.26	1.56	1.15	4.14
1994	27	1.01	0.59	2.26	2.48	4.84	8.87	6.17	8.83	11.65	3.64	1.40	1.13	4.41
1995	28	0.88	0.45	0.39	0.35	3.36	4.91	7.73	14.33	8.49	4.74	1.43	0.98	4.00
1996	29	0.73	0.37	0.30	0.64	0.40	0.37	5.06	6.06	7.15	2.42	6.73	0.90	2.59
1997	30	0.59	0.46	0.27	0.28	1.19	0.73	11.72	6.60	3.85	2.37	2.27	0.68	2.58
1998	31	0.50	0.27	0.21	0.17	3.50	10.07	7.05	8.55	9.55	4.54	1.92	1.03	3.95
1999	32	0.70	0.33	0.96	3.33	4.84	7.50	9.88	5.16	7.93	6.63	4.81	1.31	4.45
2000	33	1.19	0.90	0.77	3.51	3.95	8.37	6.50	14.94	2.80	7.86	1.53	1.06	4.45
2001	34	1.06	0.79	1.59	1.93	5.96	8.46	4.54	13.03	5.15	5.35	1.36	0.93	4.18
2002	35	0.64	0.35	0.35	1.70	5.34	6.03	3.67	14.12	8.10	1.58	2.54		4.04
Average		0.89	0.54	0.79	1.37	3.84	7.50	8.46	10.01	8.68	5.56	2.66	1.15	4.30
Max.		2.48	1.08	4.60	3.51	9.13	15.10	21.79	16.69	16.70	11.24	6.73	2.52	21.79
Min.		0.33	0.15	0.21	0.17	0.37	0.37	0.90	3.58	2.80	1.58	1.15	0.68	0.15

Source: JICA JICA Study Team

Table G-49 Estimated Monthly Inflow at Proposed Reservoir Site-3 (35 Years)

Site: Proposed Site-3 C.A.(km2)= 87.58 Unit: m3/sec

Year	Month	1 Jan.	2 Feb.	3 Mar.	4 Apr.	5 May	6 Jun.	7 Jul.	8 Aug.	9 Sep.	10 Oct.	11 Nov.	12 Dec.	Annual
1957	1	0.55	0.25	2.98	2.08	3.55	9.04	12.59	11.99	20.43	12.27	5.77	1.92	6.95
1958	2	1.53	0.78	0.48	0.57	10.49	7.00	16.78	21.43	13.34	11.17	2.33	1.53	7.29
1959	3	0.98	0.63	7.67	1.73	3.67	11.17	22.71	22.90	14.59	7.29	4.77	2.50	8.39
1960	4	4.14	1.57	1.10	2.67	11.14	17.08	16.11	14.26	17.78	7.72	5.54	2.07	8.43
1961	5	1.53	0.88	0.83	1.67	0.77	9.41	9.52	24.41	17.74	12.29	2.60	2.00	6.97
1962	6	1.62	0.85	0.62	5.05	0.62	8.37	21.79	13.46	21.04	3.87	3.49	1.67	6.87
1963	7	1.13	0.78	0.72	0.53	2.95	11.31	12.44	27.73	17.88	9.22	9.07	2.50	8.02
1965	8	1.85	1.43	1.28	4.42	10.69	16.48	15.64	12.47	24.78	12.66	3.85	2.40	9.00
1966	9	1.93	1.10	1.17	1.63	15.22	11.06	36.34	16.33	11.31	16.73	8.89	4.20	10.49
1967	10	2.67	1.70	1.12	2.57	14.27	25.18	22.55	27.83	9.19	14.29	3.27	2.23	10.57
1968	11	1.87	1.08	0.73	0.58	3.85	0.67	18.29	13.62	18.19	5.40	2.05	1.38	5.64
1969	12	1.28	1.03	0.93	0.65	7.04	1.12	1.50	5.97	27.85	7.54	5.65	1.63	5.18
1971	13	1.15	0.68	0.58	0.53	7.75	10.81	8.49	14.49	12.17	18.74	2.48	1.95	6.65
1972	14	1.38	1.03	4.84	4.22	3.69	14.06	9.72	13.04	13.02	4.82	4.20	1.82	6.32
1973	15	1.30	0.68	0.70	0.78	2.42	18.94	18.66	20.71	10.92	9.94	10.72	2.47	8.19
1983	16	1.83	1.00	0.87	0.53	7.80	22.15	11.69	17.74	13.49	17.81	7.02	2.75	8.72
1984	17	2.30	1.80	1.35	3.17	5.39	19.44	12.29	12.31	6.35	5.52	1.92	1.53	6.11
1985	18	1.05	0.70	0.67	4.72	7.59	13.06	5.37	15.51	16.68	9.07	2.27	1.47	6.51
1986	19	0.98	0.52	0.45	4.19	6.27	19.18	9.91	16.96	15.41	8.50	3.87	1.82	7.34
1987	20	1.30	0.63	0.45	3.34	4.10	18.23	5.42	9.27	13.79	8.10	9.72	1.75	6.34
1988	21	1.28	0.95	0.62	1.38	10.16	14.22	19.59	9.42	14.37	11.84	3.27	1.85	7.41
1989	22	1.47	0.83	1.10	1.10	14.32	9.37	13.29	22.38	6.67	10.04	2.38	1.55	7.04
1990	23	1.23	0.68	0.80	0.85	4.04	16.01	7.52	15.98	15.02	7.04	2.68	1.58	6.12
1991	24	1.27	0.72	0.48	3.54	4.35	11.62	31.85	19.41	20.46	11.57	2.92	1.95	9.18
1992	25	1.38	0.98	0.65	0.60	2.92	15.57	11.69	18.41	10.44	8.54	2.03	1.23	6.20
1993	26	0.97	0.53	1.03	2.67	3.69	15.24	18.03	13.39	15.69	7.10	2.60	1.92	6.91
1994	27	1.68	0.98	3.77	4.14	8.07	14.79	10.29	14.72	19.43	6.07	2.33	1.88	7.35
1995	28	1.47	0.75	0.65	0.58	5.60	8.19	12.89	23.90	14.16	7.90	2.38	1.63	6.68
1996	29	1.22	0.62	0.50	1.07	0.67	0.62	8.44	10.11	11.92	4.04	11.22	1.50	4.33
1997	30	0.98	0.77	0.45	0.47	1.98	1.22	19.54	11.01	6.42	3.95	3.79	1.13	4.31
1998	31	0.83	0.45	0.35	0.28	5.84	16.79	11.76	14.26	15.93	7.57	3.20	1.72	6.58
1999	32	1.17	0.55	1.60	5.55	8.07	12.51	16.48	8.60	13.22	11.06	8.02	2.18	7.42
2000	33	1.98	1.50	1.28	5.85	6.59	13.96	10.84	24.91	4.67	13.11	2.55	1.77	7.42
2001	34	1.77	1.32	2.65	3.22	9.94	14.11	7.57	21.73	8.59	8.92	2.27	1.55	6.97
2002	35	1.07	0.58	0.58	2.83	8.90	10.06	6.12	23.55	13.51	2.63	4.24		6.73
Average		1.49	0.90	1.32	2.28	6.41	12.51	14.11	16.69	14.47	9.27	4.44	1.91	7.16
Max.		4.14	1.80	7.67	5.85	15.22	25.18	36.34	27.83	27.85	18.74	11.22	4.20	10.57
Min.		0.55	0.25	0.35	0.28	0.62	0.62	1.50	5.97	4.67	2.63	1.92	1.13	4.31

Source: JICA JICA Study Team

(6) Elevation-Storage Capacity

The elevation-storage and elevation-area curves of the proposed reservoirs are developed based on the 1:50,000 scale map. The elevation-storage and elevation-area curves of the proposed reservoirs are shown below.

H-V-A

FSL Elev. (m)	Reservoir Surface Area (km^2) Site-1 WB*1)	Site-2 Alt.-2	Site-3 Alt.-3	Res. Volume (MCM) Site-1 WB*1)	Site-2 Alt.-2	Site-3 Alt.-3
5	0.000	0.123	0.442	0.00	0.00	0.00
10	*0.100*	0.638	1.595	0.00	1.90	5.09
20	*0.210*	1.742	4.000	*1.35*	13.80	33.07
30	0.321	2.761	6.356	3.86	36.32	84.85
40	0.502	3.779	8.712	8.10	69.02	160.18
50	0.999	5.828	12.147	16.64	117.06	264.48
60	3.437	7.877	15.583	45.98	185.58	403.13

Dam Crest Length (m)

DCL Elev. (m)	Dam Height Site-1 WB*1)	Site-2 Alt.-2	Site-3 Alt.-3	Dam Crest Length (m) Site-1 WB*1)	Site-2 Alt.-2	Site-3 Alt.-3
5	-	0	0	0	*120*	*150*
10	0	5	5	64	320	340
20	10	15	15	152	620	680
30	20	25	25	264	810	890
40	30	35	35	372	1,000	1,100
50	40	45	45	496	1,080	1,150
60	50	55	55	648	1,160	1,200

Source *1): "Cambodia Urban Water Supply Project" SWSA, IDA Credit No.3041-KH (WB), DF/R on Long-Term Water Supply, PARSONS, Jul. 1999.

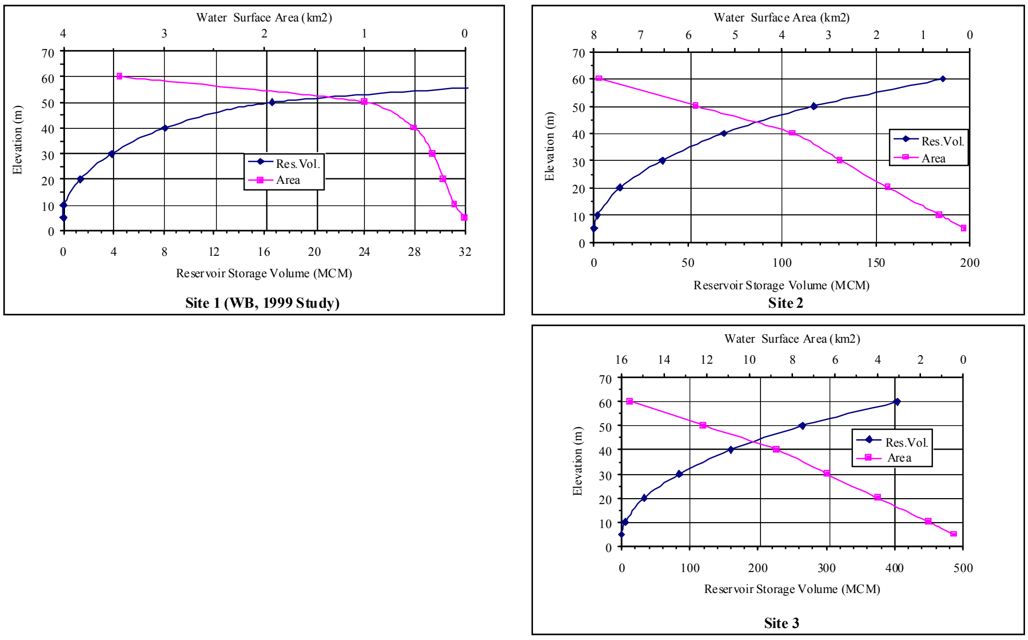

Figure G-46 Elevation-Storage-Area Curves of Proposed Reservoir Sites

(7) Water Balance Model

The water balance model is formulated based on the topographic conditions at three (3) proposed reservoir sites. The computation of the water balance is performed on a monthly basis for a period of 35 years from 1957 to 2002. The water demand is assumed as 80,000 m^3/day in the year of 2020.

The operation of the proposed reservoir is simulated using a water balance model whereby the change in reservoir storage is equal to inflow minus outflow and loss equals change in storage. It is expressed by the following mass balance equations:

[Reservoir Water Balance]

$$V_t = V_{t-1} + I_t + R_t - E_t - (Spill_t + Release_t)$$

Where, V_t : reservoir storage at the end of month t, [MCM=10^6 m^3]
V_{t-1} : reservoir storage at the end of previous month t-1, [MCM]
I_t : reservoir inflow from upstream during the month t, [MCM]

R_t	: rainfall at reservoir water surface during the month *t*,	[MCM]
E_t	: evaporation losses from the reservoir during month *t*,	[MCM]
$Spill_t$	: spill out from the reservoir during the month *t*,	[MCM]
$Release_t$	: normal outflow from the reservoir during the month *t*, (outflow through the hydropower turbine)	[MCM]

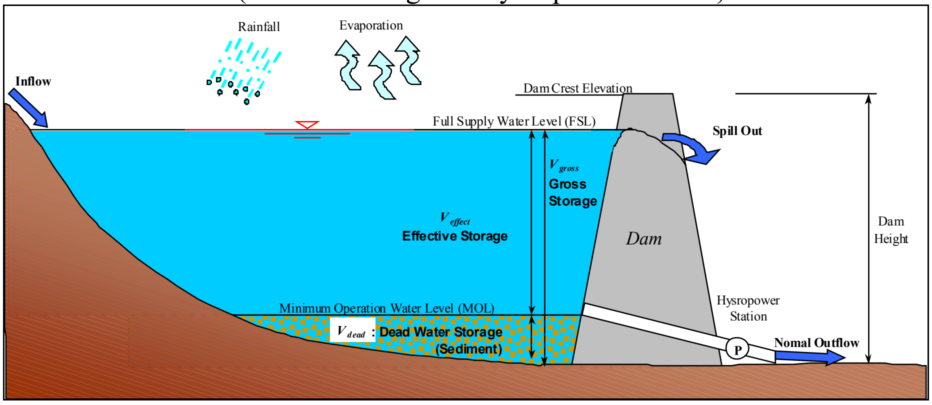

Figure G-47 Concept of Reservoir Operation Model

(8) Case of River Maintenance Flow for Downstream

River flow will be changed after construction of proposed reservoir. The elevation of riverbed at proposed sites are very low at only around 5 to 10 m by topographic map. During dry season, there is a possibility of occurrence of blackish (salinity) water problems in downstream river channels, paddy fields and existing shallow wells, because of seawater rise in the channel, if the water release from reservoir is nothing. In this study, several cases of river maintenance flow for the downstream are discussed. The following cases of target discharge for the river maintenance flow were evaluated.

- Case-A : minimum release = average discharge of February for a period of 35 years from 1957 to 2002
- Case-B : minimum release = minimum discharge of February for a period of 35 years from 1957 to 2002
- Case-C : minimum release = 0 (not considered)

Table G-50 Case of River Maintenance Flow for Downstream

Reservoir Site	C.A. (km^2)	Case of Target River Maintenance Flow Qm (m^3/sec)		
		A: $Q_m = Q_{ave(Feb.)}$	B: $Q_m = Q_{min.(Feb.)}$	C: $Q_m = 0$
Site-1	64.15	0.66	0.18	0
Site-2	73.37	0.75	0.21	0
Site-3	87.58	0.90	0.25	0

(10) Reservoir Sedimentation

Since no measurement data related to sediments in the Prek Toek Sap River are available, the following approach was taken to estimate of reservoir sedimentation for this study.

- Denudation Rate is assumed as 1.0 mm/year[14] for Prek Toek Sap River basin.
- Sediment Bulk Density in the reservoir is assumed as 1,150 kg/m^3 by using a results of Murthy[15] (1977) study that the sediment samples from the bed of reservoirs have densities varying from 500-1,800 kg/m^3.
- Specific Sediment Yield is calculated by using above sediment bulk density and denudation rate. 1.0 mm/year x 1,150 kg/m^3 = 1,150 tons/km^2/year.
- Deposition Rate (t/year) is able to calculate by using specific sediment yield and catchment area.
- Trap efficiency will be 95% using the value of capacity-inflow ratio (= gross storage volume / annual mean inflow volume) and the Brune curves (U.S. Bureau of Reclamation, 1974).
- Life of reservoir for sedimentation is assumed at 50 yeas.

Estimated reservoir sedimentation volume (dead storage volume) for 50 years life is shown blow:

Table G-51 Estimated Reservoir Sedimentation Volume

Reservoir Site:	Site-1	Site-2	Site-3
Denudation Rate (mm/year) of Sediment	**1.00**	**1.00**	**1.00**
Sediment Bulk Dencity (kg/m^3)	1,150	1,150	1,150
Specific Sediment Yield (tons/km^2/year)	1,150	1,150	1,150
Deposition Rate (t/year)	74,000	84,000	101,000
Mean Annual Inflow (m^3/sec) at Kbal Chay WL St.	4.30	4.30	4.30
Mean Annual Inflow (m^3/sec) at Dam Site	5.25	6.00	7.16
Capacity-Inflow Ratio	2.85	3.34	2.41
Trap Efficiency (%)	95%	95%	95%
Annual Sediment Inflow Vol. (m^3/year)	61,130	69,391	83,435
Life (year) of Reservoir for Sedimentation	**50**	**50**	**50**
Dead Storage Vol. for Sediment ($x10^6$ m^3)	**3.06**	**3.47**	**4.17**

(11) Type of Dam

In this study, type of dam is selected as the “earth fill-type” due to scale of dam height and unknown of the geophysical condition of riverbed, foundation and embankment materials at present. A general geological description of the Upper Prek Toek Sap region was developed in the 1994 report (Pre-F/S) from available relevant information on the region, and is summarized below (referred SWSA-WB report, 1999, Parsons).

The peninsula of Sihanoukville forms an extension of the foothills of the Cardamoms Mountains, which extend along the whole of the shore of the Gulf of

14 Refereed "Kamchay HEP F/S", MIME, CIDA (2002).
15 Source: Murthy, B. N., 1977. "Reservoir sedimentation, life and remedial measures", Symposium on Silting Reservoirs. India, Cent. Board Irrig. Power, Publ. No. 126; Vol.1, pp.123 -134.

Thailand. Landforms are gently to steeply incised. The predominant rock type is "sandstone", identified as the Upper Indosinian formation, of the upper Cretaceous period. This formation consists of a thick (of the order of 1,000 meters) sequence of sandstone, shale, clay, marl and conglomerates. In some horizons the sandstone is fissured, giving it a high hydraulic conductivity except in situations where the fissures have been infilled with clay. The Indosinian snadstone rocks are overlain by residual clay soil due to weathering of the sandstone. On the evidence of groundwater investigation drilling carried out in 1993, as well as borehole-log information provide from UNICEF records, and the geological data presented in the Soviet report on the Kamchay Hydro-electric power investigation, thickness of the clay soils veneer varies from zero in area of sandstone outcrops, to 15 meters and more.

(12) Spillway

According to the design criteria of dam construction in Japan, to design of the spillway must accommodate an extreme flood with at least return period of 1/200 (x 1.2 times for fill-type dam), in general. However, this criteria is for the basin where available long-term and reliable hydrological and meteorological data. If height of dam is high or important dam, the probable maximum flood (PMF) is used for the design flood in general in the world. In this study, the return period of design flood is selected at 1/1000 year.

Analysis of historical data and supported by anecdotal records of flows in Kamchay River enable estimates to be made in the earlier study of flood peak specific discharges for flood of various probabilities of exceedence. Resulting values for specific discharge, taken from the Soviet repot, are presented in **Table G-52**. Adjustments were made to recognize several differences between the two catchment by SWSA report (Parsons, 1999).

- The Prek Toek Sap catchment (60-88 km^2) is rather smaller than the Kamchay catchment (770 km^2), therefore it is necessary to compensate for the effects of the time of concentration for the respective catchments.
- The ground cover of the Kamchay catchment at the time of Soviet study was predominantly jungle whereas the vegetation cover of the Prek Toek Sap catchment, has largely been destoroyed.

Peak design flows for the Prek Toek Sap were estimated by 1999 study for various probabilities of exceedence by multiplying the specific discharge values for Kamchay by a factor to compensate for the effect of higher intensity stomes and reduced catchment cover and then multiplying the modified value by the Prek Toek Sap catchment area (60 - 88 km^2). Results of these calculations are included in **Table G-52**.

Table G-52 Design Flood Peak Design in Prek Toek Sap River

Probability of exceedence / Return Period	(%) / (year)	5% / 20	3% / 30	2% / 50	1% / 100	**0.1% / 1000**	PMF 3)
Peak Discharge in Kamchay River (CA=770 km^2) *1)	(m^3/s)						10,000
Maximum Specific Q at Kamchay (CA=770 km^2) *1)	(m^3/s/km^2)	4.7	5.2	5.8	6.5	**9.7**	14.1
Assumed coefficient for Prek Toek Sap River Basin *2)	x times	**2.3**	**2.3**	**2.3**	**2.3**	**2.3**	**2.3**
Estimated Maximum Specific Q in Prek Toek Sap *2)	(m^3/s/km^2)	10.8	12.0	13.3	15.0	**22.3**	32.4
Estimated peak discharge at Site-1 (60 km^2)	(m^3/sec)	700	720	800	900	**1,400**	2,000
Estimated peak discharge at Site-2 (73 km^2)	(m^3/sec)	788	876	971	1,095	**1,628**	2,364
Estimated peak discharge at Site-3 (88 km^2)	(m^3/sec)	950	1,056	1,170	1,320	**1,962**	2,849

Source *1) : Kamchay HEPP (URSS, soviet report, 1965).
Source *2) : SWSA - WB, Parsons, (1999)
Source *3) : Kamchay HEP F/S, Experco, (2002). (CA=710 km^2)

After allowance was made for the relative areas of the Prek Toek Sap and Kamchay river catchments, it was considered that the spillway should be designed to accommodate a flow of up to 1,400 m^3/sec at Site-1 and 1,962 m^3/sec at Site-3 in 1/1,000 years of return period.

Calculation of spillway width and maximum water level of reservoir is conducted by using the formula of *Broadcrested* weir type as shown below.

$$Q = m \cdot b \cdot h_0 \cdot \sqrt{2gh_0}$$

where, m : coefficient (0.35 is used)

b : width of spillway (m)

h_0 : water height (m)

The maximum height (h_0) of water increasing in reservoir during design flood is design of 2.5 m. Required spillway crest length (or width) for the design flood at site-1, site-2 and site-3 are 235 m, 268 m and 320 m, respectively. Considering of the topographic condition of each site and construction cost, a side-channel type of spillway used is recommended. The side-channel spillway is a spillway in which the flow, after passing over the crest, is carried away in a channel running parallel to the crest. The crest is usually a concrete gravity section, but it may consist of pavement laid on an earth embankment or the natural ground surface. This type of spillway is a used in narrow canyon where sufficient crest length is not available for overflow or chute spillway. For easy operation, non-gate-type spillway is recommended.

(13) Embankment Volume

To evaluate of optimum development scale of the dams, several cases of the reservoir full supply level (FSL) or dam height are established for each proposed site.

- The dam height of the proposed dam on each case of the FSL is calculated by following equation.

Dam height [m] = FSL [El.m] - Riverbed elevation[El.m] + Freeboard [m]

Where, freeboard is assumed as 5.0 m (include maximum water level of design flood at 2.5 m) for all proposed dams. The full supply level (FSL) is calculated by required reservoir gross storage volume and elevation-storage capacity curve.

- After decide of the dam height, dam crest length (DCL) is also calculated by topographic conditions of the dam site.
- Other assumptions and features on the dam sites for estimation of the dam embankment volume are summarized in **Table G-53**.
- Using above assumptions and features on the dam sites, volumes of the dam embankment are estimated based on following typical surface dam embankment features.

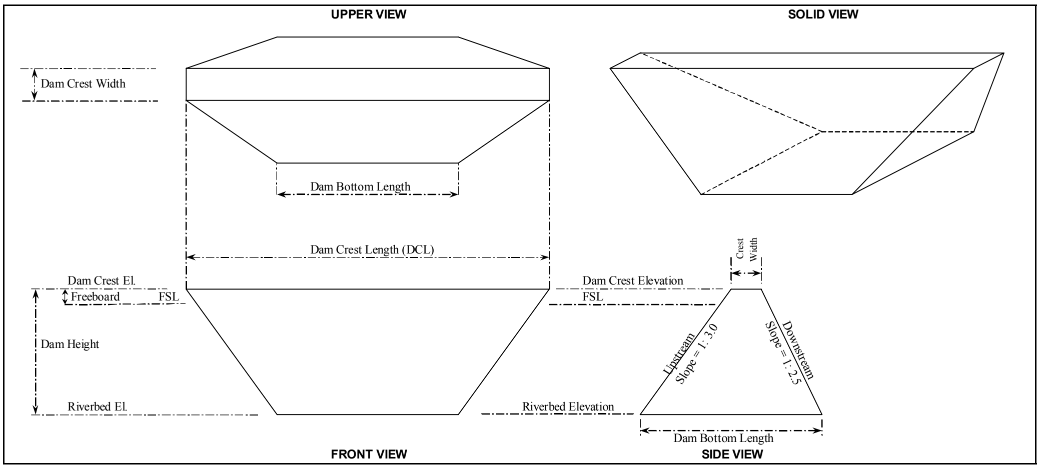

Figure G-48 Typical Surface Dam Embankment Features

Table G-53 Designed Dam Embankment Features

Name of Proposed Dam		Site-1	Site-2	Site-3
Full Supply Water Level	FSL	Case Study for Optimization by Water Demand and Maintenance Flow		
Gross Storage Volume	-	From H-V-A curve by FSL case		
Dead Storage Volume	-	3.06 MCM	3,47 MCM	4.17 MCM
Freeboard (include Flood Max.WL 2.5 m)		5.0 m (2.5 + 2.5 m, assumed)		
Dam Crest Elevation	DCL	FSL + Freeboard		
Riverbed Elevation	RBE	10 m	5 m	5 m
Dam Height	H_{dam}	DCE – RBE		
Dam Crest Length	DCL	From elevation-DCL curve and DCE		
Dam Crest Width	DCW	15 m (for increasing of dam height in future)		
Dam Bottom Length	DBL	64 m	120 m	150 m
Slope of Upstream-side Embankment	SU	1: 3.0 (earth fill type)		
Slope of Downstream-side Embankment	SD	1: 2.5 (earth fill type)		

(14) Construction Cost

Initial cost of the proposed reservoir construction is estimated based on above embankment volume and other quantity of necessary facilities. In this county, there is no recent dam construction experience. In this study, unit prices of dam construction are refereed the unit price of hydropower project in the Lao P.D.R[16]. and Kamchay HEPP in Cambodia[17] for estimation of construction cost of dam.

(15) Project Cost

Other additional costs for the project of the proposed dam are assumed by using following percentages to estimated construction cost that is generally used in the pre-F/S study.

- Environmental cost : 5% of construction cost
- Engineering service cost : 5% of construction cost + Environmental cost
- Administration cost : 5% of above total cost
- Contingency : 0% of above total cost

Hence, total project cost is estimated as construction cost plus above additional casts. In these costs not included the costs for feasibility study or detail design.

(16) Optimum Development Scale

Generally, the development cost varies with the magnitude of development yield. Optimum development scale for surface dams are analysed on the basis of the simulated discharge for 35 years from 1957 to 2002 (**Figure G-49**). The dam construction cost was initially estimated preliminary based on the embankment volume and adjusted to the price level in February 2003. The figure below shows the development cost by each dam development scheme.

The each scheme shows fairly high dam construction cost for producing a unit yield. The unit construction costs over around 70,000 m^3/day of development yield are almost same at each site. The development cost includes preparation works, river diversion, excavation and foundation, dam embankment, intake facilities, spillway, bottom outlet, electrical facilities, access road and land compensation costs but not included hydropower facilities, environmental, engineering services, administration costs and contingency. The development yields are not included river maintenance flow for downstream.

16 Nam Ngiep-I HEPP F/S, JICA, (2000). Price escalation of +5% is used for 2000 to 2003.
17 Kamchay HEP F/S, Experco, (2002).

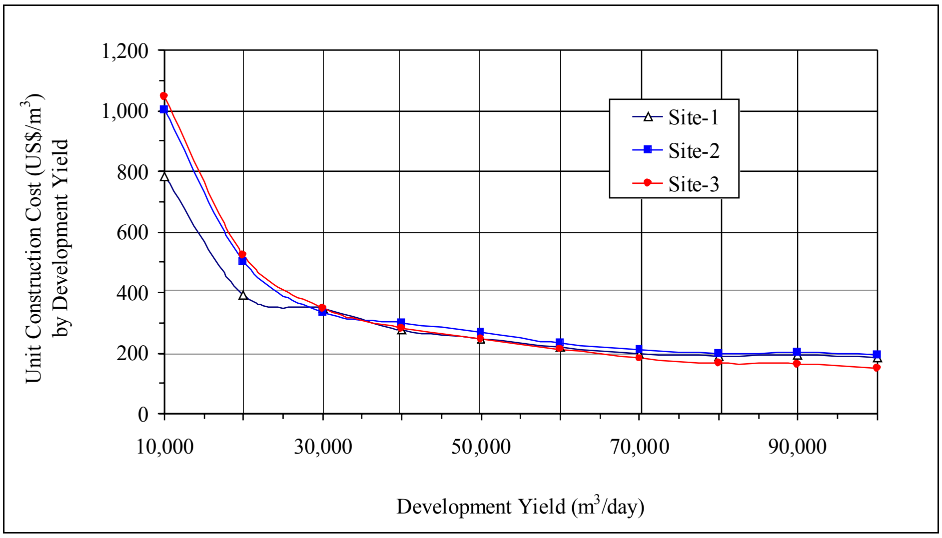

Figure G-49 Unit Construction Cost by Development Yield at Each Site

(17) Results of Reservoir Operation Study by Case

Results of reservoir water balance calculation by each case of maintenance flow for downstream are summarized in **Table G-54**. Water demand is assumed 80,000 m^3/sec at year of 2020. This includes water demand of proposed two-(2) sites of industrial area (IA). Probable drought year is designed as 1/10 years (around 4 times of supply deficit will occur in the period of 35 years).

As shown in the table below, site-3 is best place for the construction of reservoir. Considering of environmental impact of downstream stretch, the river maintenance flow is required at least average of dry season's natural flow (case-A).

Table G-54 Results of Reservoir Operation Study by Each Site and Case of River Maintenance Flow

Case : Daily Demand (m^3/d) = **80,000**
Water Intake from Reservoir
w/o Micro-Hydro Power

Site			Case of Maintenance Flow for Downstream		
			Case-A	Case-B	Case-C
			Qm = Ave.Q (Feb.)	Qm = Min.Q (Feb.)	Qm = 0
Site-1	Required Minimum Dam Height	(m)	43.0	36.0	33.0
	Embankment Vol.	(m^3)	1,734,968	1,047,341	825,675
	Dam Construction Cost	(mil.US$)	25.1	19.5	17.6
Site-2	Required Minimum Dam Height	(m)	21.0	16.0	15.0
	Embankment Vol.	(m^3)	652,349	358,248	312,188
	Dam Construction Cost	(mil.US$)	18.4	15.6	15.1
Site-3	Required Minimum Dam Height	(m)	**14.0**	12.0	11.0
	Embankment Vol.	(m^3)	**298,102**	209,664	172,719
	Dam Construction Cost	(mil.US$)	**15.4**	14.3	13.8

Therefore, construction of 14 m height of dam at site-3 is the most optimal size of project. The construction cost and the project cost are estimated at 15.4 million US$ and 17.8 million US$, respectively.

The calculation sheets of reservoir operation (water balance) of optimal case of reservoir are shown in **Tables G-55 and G-56 and Figure G-50**. Estimated construction cost of proposed Toek Sap Reservoir at Site-3 is shown in **Table G-57**. The preliminary layout plan of proposed Toek Sap Reservoir at Site-3 is shown in **Figure G-51**.

Table G-55 Case and Results of Reservoir Operation of Proposed Reservoir at Site-3

Case of Dam and Reservoir Fuatures

Site	**Site-3**	
River	**Prek Toek Sap River (Sihanoukville)**	
C.A.	**87.58**	**km2**

Case of Dam Height	**14.0 m**	
Water Demand (m3/day) for W.Supply	**80,000**	
Design Intake (m3/sec) for W.Supply	**0.93**	
Min.Q (m3/s) at Dam Site (1957-2002)	**0.25**	Min.Release
Ave.Q (m3/s) in Feb. at Dam Site (1957-2002)	**0.90**	0.25
Design Release (m3/s) for Maintenance flow	**0.90**	**OK**

(1) Reservoir Storage Curve (H-V-A)

	Elevation (El.m)	Volume (MCM)	Area (km2)	D.C.L * (m)
1	5	0.00	0.442	150
2	10	5.09	1.595	340
3	20	33.07	4.000	680
4	30	84.85	6.356	890
5	40	160.18	8.712	1,100
6	50	264.48	12.147	1,150
7	60	403.13	15.583	1,200

(2) Features of Dam Embankment

Dam Height (m)		14.0 m
Riverbed Elevation (El.m)		5.0 El.m
Dam Bottom Length (DBL) (m)		150.0 m
Freeboard + Flood Control Height (m)		**5.0** m
Dam Crest Elevation (El.m)		19.0 m
Dam Crest Length (DCL) (m)	2	646.0 m
Dam Crest Width (m)		15.0 m
Upstream Slope		3.0
Downstream Slope		2.5
Embankment Volume (Fill Type)		**298,102 m3**
Dam Construction Cost		**15.40 mill.US$**
Total Project Cost		**17.79 mill.US$**
Unit Construction Cost		**51.68 US$/m3**

(3) Reservoir Sedimentation

Denudation Rate (mm/year) of Sediment	**1.00**	assumed. Refferd "Kamchay HEP F/S", MIME, CIDA (2002).
Sediment Bulk Dencity (kg/m3)	1,150	Source *2) : Murthy, B. N., (1977). "Res. Sedimentation", C.B.I.P., No. 126) 500 - 1,800 kg/m3
Specific Sediment Yield (tons/km2/year)	1,150	
Deposition Rate (t/year)	101,000	
Mean Annual Inflow (m3/sec) at Kbal Chay WL St.	4.30	Ave. 35 years, from Tank model results
Mean Annual Inflow (m3/sec) at Dam Site	7.16	Q(dam) = Q(KC) * A(dam) / A(KC)
Capacity-Inflow Ratio	2.27	(Gross Res. Capacity) / (Annual Inflow)
Trap Efficiency (%)	95%	According to the Brune curves (U.S. Bureau of Reclamation, 1974)
Annual Sediment Inflow Vol. (m3/year)	83,435	
Life (year) of Reservoir for Sedimentation	**50**	assumed
Dead Storage Vol. for Sediment (x106 m3)	**4.17**	

(4) Features of Reservoir

Gross Storage Vol.(x106 m3)	**16.28**	from H-V-A
Dead Storage (x106 m3)	**4.17**	1
Effective (Net) Storage Vol.(x106 m3)	**12.1**	
Full Supply Level (FSL) (m)	**14.00**	2
Minimum Operation Level (MOL) (m)	**9.10**	from H-V-A
Riverbed Elevation (m)	**5.00**	
Pan Evaporation Rate for Res.W.Surface	**0.85**	

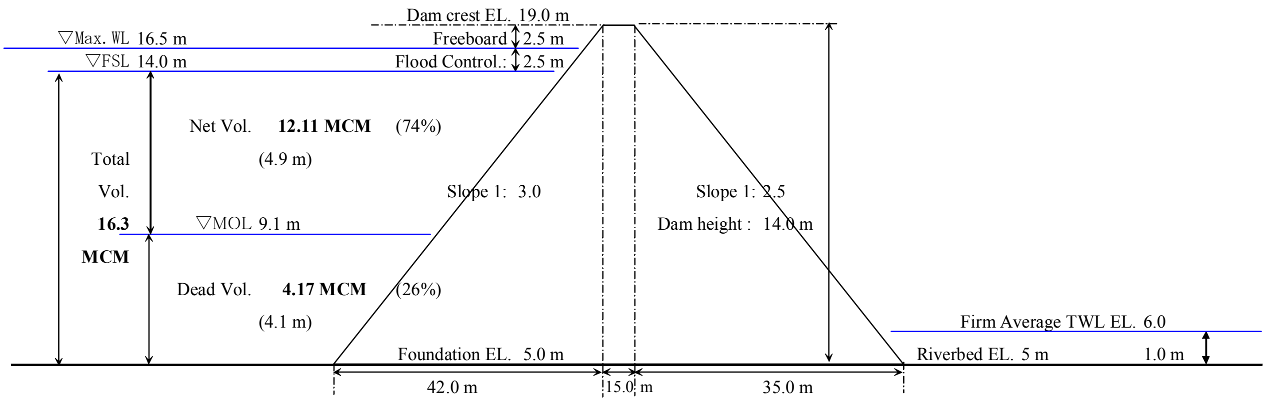

Table G-56 Reservoir Water Balance Calculation of Proposed Toek Sap Reservoir (Site-3) (1/8)
[Dam Height = 14m, Water Demand =80,000 m^3/day, Release = $Q_{ave(Feb)}$, without Hydropower]

Max.	-	-	-	36.34	97.32	16.28	2.56	1,477.5	3.78	116.5	0.30	0.93	2.49	0.90	2.40	0.93	2.49	35.86	96.05	0.90	2.40	36.76	98.45
Min.	-	-	-	0.00	0.00	4.17	1.39	0.0	0.00	59.5	0.09	0.93	2.25	0.90	2.17	**0.00**	0.00	0.01	0.02	0.25	0.66	0.25	0.66
Average	-	-	-	7.15	18.88	14.46	2.40	286.5	0.70	83.1	0.20	0.93	2.45	0.90	2.36	0.92	2.42	8.93	23.61	0.89	2.35	6.42	16.97

Year	Year	Month	Month	Days of Month	Inflow		Res.Stor.	W.Surface	Rainfall at W.Surface		Evaporation		Intake Requir.		Min. Release		Act.Intake Res.		Spill Out		Outflow (Gene.)		Total Outflow	
					Disch.	Vol.	(t-1)	Area	mm	Vol.	mm	Vol.	Dis.	Vol.	Dis.	Vol.	Dis.	Vol.	Dis.	Vol.	Dis.	Vol.	Dis.	Vol.
					(m3/sec)	(x106 m3)	(x106 m3)	(km2)	(mm/mon.)	(x106 m3)	(mm/mon.)	(x106 m3)	(m3/s)	(x106 m3)	(m3/s)	(x106 m3)	(m3/s)	(x106 m3)	(m3/s)	(x106 m3)	(m3/s)	(x106 m3)	(m3/s)	(x106 m3)
1957	1	1	Jan.	31	0.55	1.47	16.28	2.56	23.0	0.06	116.5	0.30	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**
		2	Feb.	28	0.25	0.61	12.62	2.24	24.1	0.05	95.2	0.21	0.93	2.25	0.90	2.17	0.93	2.25			0.90	2.17	**0.90**	**2.17**
		3	Mar.	31	2.98	7.99	8.65	1.90	219.3	0.42	97.8	0.19	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**
		4	Apr.	30	2.08	5.40	11.98	2.19	141.3	0.31	91.8	0.20	0.93	2.41	0.90	2.32	0.93	2.41			0.90	2.32	**0.90**	**2.32**
		5	May	31	3.55	9.51	12.76	2.25	198.0	0.45	74.0	0.17	0.93	2.49	0.90	2.40	0.93	2.49	0.51	1.38	0.90	2.40	**1.41**	**3.78**
		6	Jun.	30	9.04	23.43	16.28	2.56	406.6	1.04	80.8	0.21	0.93	2.41	0.90	2.32	0.93	2.41	7.53	19.53	0.90	2.32	**8.43**	**21.85**
		7	Jul.	31	12.59	33.72	16.28	2.56	538.2	1.38	62.1	0.16	0.93	2.49	0.90	2.40	0.93	2.49	11.22	30.05	0.90	2.40	**12.11**	**32.45**
		8	Aug.	31	11.99	32.11	16.28	2.56	475.2	1.22	63.8	0.16	0.93	2.49	0.90	2.40	0.93	2.49	10.56	28.27	0.90	2.40	**11.45**	**30.67**
		9	Sep.	30	20.43	52.95	16.28	2.56	827.0	2.11	59.5	0.15	0.93	2.41	0.90	2.32	0.93	2.41	19.36	50.18	0.90	2.32	**20.25**	**52.50**
		10	Oct.	31	12.27	32.87	16.28	2.56	472.3	1.21	62.1	0.16	0.93	2.49	0.90	2.40	0.93	2.49	10.84	29.03	0.90	2.40	**11.73**	**31.43**
		11	Nov.	30	5.77	14.96	16.28	2.56	231.2	0.59	89.3	0.23	0.93	2.41	0.90	2.32	0.93	2.41	4.08	10.58	0.90	2.32	**4.98**	**12.91**
		12	Dec.	31	1.92	5.14	16.28	2.56	17.7	0.05	104.6	0.27	0.93	2.49	0.90	2.40	0.93	2.49	0.01	0.02	0.90	2.40	**0.90**	**2.42**
1958	2	1	Jan.	31	1.53	4.11	16.28	2.56	38.5	0.10	116.45	0.30	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**
		2	Feb.	28	0.78	1.90	15.30	2.47	5.2	0.01	95.20	0.24	0.93	2.25	0.90	2.17	0.93	2.25			0.90	2.17	**0.90**	**2.17**
		3	Mar.	31	0.48	1.30	12.55	2.24	22.5	0.05	97.75	0.22	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**
		4	Apr.	30	0.57	1.47	8.79	1.91	98.0	0.19	91.80	0.18	0.93	2.41	0.90	2.32	0.93	2.41			0.90	2.32	**0.90**	**2.32**
		5	May	31	10.49	28.09	5.53	1.63	476.6	0.78	73.95	0.12	0.93	2.49	0.90	2.40	0.93	2.49	4.90	13.11	0.90	2.40	**5.79**	**15.51**
		6	Jun.	30	7.00	18.15	16.28	2.56	310.9	0.79	80.75	0.21	0.93	2.41	0.90	2.32	0.93	2.41	5.40	14.01	0.90	2.32	**6.30**	**16.33**
		7	Jul.	31	16.78	44.93	16.28	2.56	704.3	1.80	62.05	0.16	0.93	2.49	0.90	2.40	0.93	2.49	15.56	41.68	0.90	2.40	**16.46**	**44.08**
		8	Aug.	31	21.43	57.39	16.28	2.56	836.1	2.14	63.75	0.16	0.93	2.49	0.90	2.40	0.93	2.49	20.34	54.48	0.90	2.40	**21.24**	**56.88**
		9	Sep.	30	13.34	34.58	16.28	2.56	507.7	1.30	59.50	0.15	0.93	2.41	0.90	2.32	0.93	2.41	11.96	30.99	0.90	2.32	**12.85**	**33.31**
		10	Oct.	31	11.17	29.92	16.28	2.56	420.2	1.07	62.05	0.16	0.93	2.49	0.90	2.40	0.93	2.49	9.69	25.95	0.90	2.40	**10.58**	**28.35**
		11	Nov.	30	2.33	6.05	16.28	2.56	20.3	0.05	89.25	0.23	0.93	2.41	0.90	2.32	0.93	2.41	0.44	1.14	0.90	2.32	**1.34**	**3.46**
		12	Dec.	31	1.53	4.11	16.28	2.56	17.5	0.04	104.55	0.27	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**
1959	3	1	Jan.	31	0.98	2.64	15.28	2.47	0.0	0.00	116.45	0.29	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**
		2	Feb.	28	0.63	1.53	12.73	2.25	55.0	0.12	95.20	0.21	0.93	2.25	0.90	2.17	0.93	2.25			0.90	2.17	**0.90**	**2.17**
		3	Mar.	31	7.67	20.55	9.75	2.00	388.9	0.78	97.75	0.20	0.93	2.49	0.90	2.40	0.93	2.49	3.62	9.71	0.90	2.40	**4.52**	**12.11**
		4	Apr.	30	1.73	4.50	16.28	2.56	104.1	0.27	91.80	0.23	0.93	2.41	0.90	2.32	0.93	2.41			0.90	2.32	**0.90**	**2.32**
		5	May	31	3.67	9.83	16.07	2.54	185.8	0.47	73.95	0.19	0.93	2.49	0.90	2.40	0.93	2.49	1.87	5.01	0.90	2.40	**2.77**	**7.41**
		6	Jun.	30	11.17	28.96	16.28	2.56	481.0	1.23	80.75	0.21	0.93	2.41	0.90	2.32	0.93	2.41	9.74	25.25	0.90	2.32	**10.64**	**27.57**
		7	Jul.	31	22.71	60.83	16.28	2.56	937.8	2.40	62.05	0.16	0.93	2.49	0.90	2.40	0.93	2.49	21.72	58.18	0.90	2.40	**22.62**	**60.58**
		8	Aug.	31	22.90	61.32	16.28	2.56	876.1	2.24	63.75	0.16	0.93	2.49	0.90	2.40	0.93	2.49	21.84	58.51	0.90	2.40	**22.74**	**60.91**
		9	Sep.	30	14.59	37.82	16.28	2.56	541.8	1.39	59.50	0.15	0.93	2.41	0.90	2.32	0.93	2.41	13.24	34.32	0.90	2.32	**14.14**	**36.64**
		10	Oct.	31	7.29	19.52	16.28	2.56	249.7	0.64	62.05	0.16	0.93	2.49	0.90	2.40	0.93	2.49	5.64	15.11	0.90	2.40	**6.54**	**17.51**
		11	Nov.	30	4.77	12.36	16.28	2.56	180.9	0.46	89.25	0.23	0.93	2.41	0.90	2.32	0.93	2.41	3.03	7.86	0.90	2.32	**3.93**	**10.19**
		12	Dec.	31	2.50	6.70	16.28	2.56	109.8	0.28	104.55	0.27	0.93	2.49	0.90	2.40	0.93	2.49	0.68	1.82	0.90	2.40	**1.58**	**4.22**
1960	4	1	Jan.	31	4.14	11.08	16.28	2.56	160.3	0.41	116.45	0.30	0.93	2.49	0.90	2.40	0.93	2.49	2.35	6.30	0.90	2.40	**3.25**	**8.70**
		2	Feb.	29	1.57	3.93	16.28	2.56	16.5	0.04	95.20	0.24	0.93	2.33	0.90	2.25	0.93	2.33			0.90	2.25	**0.90**	**2.25**
		3	Mar.	31	1.10	2.95	15.43	2.48	21.6	0.05	97.75	0.24	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**
		4	Apr.	30	2.67	6.92	13.30	2.30	164.4	0.38	91.80	0.21	0.93	2.41	0.90	2.32	0.93	2.41			0.90	2.32	**0.90**	**2.32**
		5	May	31	11.14	29.84	15.65	2.50	479.5	1.20	73.95	0.19	0.93	2.49	0.90	2.40	0.93	2.49	9.45	25.32	0.90	2.40	**10.35**	**27.72**
		6	Jun.	30	17.08	44.26	16.28	2.56	705.0	1.80	80.75	0.21	0.93	2.41	0.90	2.32	0.93	2.41	15.86	41.12	0.90	2.32	**16.76**	**43.45**
		7	Jul.	31	16.11	43.15	16.28	2.56	642.2	1.64	62.05	0.16	0.93	2.49	0.90	2.40	0.93	2.49	14.84	39.74	0.90	2.40	**15.73**	**42.14**
		8	Aug.	31	14.26	38.19	16.28	2.56	526.8	1.35	63.75	0.16	0.93	2.49	0.90	2.40	0.93	2.49	12.87	34.48	0.90	2.40	**13.77**	**36.88**
		9	Sep.	30	17.78	46.08	16.28	2.56	683.6	1.75	59.50	0.15	0.93	2.41	0.90	2.32	0.93	2.41	16.57	42.94	0.90	2.32	**17.46**	**45.26**
		10	Oct.	31	7.72	20.68	16.28	2.56	270.1	0.69	62.05	0.16	0.93	2.49	0.90	2.40	0.93	2.49	6.09	16.32	0.90	2.40	**6.99**	**18.72**
		11	Nov.	30	5.54	14.35	16.28	2.56	212.7	0.54	89.25	0.23	0.93	2.41	0.90	2.32	0.93	2.41	3.83	9.93	0.90	2.32	**4.73**	**12.26**
		12	Dec.	31	2.07	5.54	16.28	2.56	13.6	0.03	104.55	0.27	0.93	2.49	0.90	2.40	0.93	2.49	0.15	0.41	0.90	2.40	**1.05**	**2.81**

Table G-56 Reservoir Water Balance Calculation of Proposed Toek Sap Reservoir (Site-3) (2/8)
[Dam Height = 14 m, Water Demand =80,000 m3/day, Release = Qave(Feb), without Hydropower]

1961	5	1	Jan.	31	1.53	4.11	16.28	2.56	7.6	0.02	116.45	0.30	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**
		2	Feb.	28	0.88	2.14	15.22	2.47	24.8	0.06	95.20	0.23	0.93	2.25	0.90	2.17	0.93	2.25			0.90	2.17	**0.90**	**2.17**
		3	Mar.	31	0.83	2.23	12.77	2.25	87.0	0.20	97.75	0.22	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**
		4	Apr.	30	1.67	4.32	10.08	2.02	124.1	0.25	91.80	0.19	0.93	2.41	0.90	2.32	0.93	2.41			0.90	2.32	**0.90**	**2.32**
		5	May	31	0.77	2.05	9.74	1.99	51.8	0.10	73.95	0.15	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**
		6	Jun.	30	9.41	24.38	6.85	1.75	435.6	0.76	80.75	0.14	0.93	2.41	0.90	2.32	0.93	2.41	4.18	10.83	0.90	2.32	**5.08**	**13.16**
		7	Jul.	31	9.52	25.50	16.28	2.56	408.1	1.04	62.05	0.16	0.93	2.49	0.90	2.40	0.93	2.49	8.03	21.50	0.90	2.40	**8.92**	**23.90**
		8	Aug.	31	24.41	65.39	16.28	2.56	971.1	2.48	63.75	0.16	0.93	2.49	0.90	2.40	0.93	2.49	23.45	62.82	0.90	2.40	**24.35**	**65.22**
		9	Sep.	30	17.74	45.99	16.28	2.56	693.1	1.77	59.50	0.15	0.93	2.41	0.90	2.32	0.93	2.41	16.54	42.87	0.90	2.32	**17.44**	**45.20**
		10	Oct.	31	12.29	32.92	16.28	2.56	458.8	1.17	62.05	0.16	0.93	2.49	0.90	2.40	0.93	2.49	10.84	29.04	0.90	2.40	**11.74**	**31.44**
		11	Nov.	30	2.60	6.74	16.28	2.56	40.0	0.10	89.25	0.23	0.93	2.41	0.90	2.32	0.93	2.41	0.73	1.88	0.90	2.32	**1.62**	**4.21**
		12	Dec.	31	2.00	5.36	16.28	2.56	67.2	0.17	104.55	0.27	0.93	2.49	0.90	2.40	0.93	2.49	0.14	0.37	0.90	2.40	**1.04**	**2.77**
1962	6	1	Jan.	31	1.62	4.33	16.28	2.56	34.3	0.09	116.45	0.30	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**
		2	Feb.	28	0.85	2.06	15.51	2.49	6.0	0.01	95.20	0.24	0.93	2.25	0.90	2.17	0.93	2.25			0.90	2.17	**0.90**	**2.17**
		3	Mar.	31	0.62	1.65	12.93	2.27	44.7	0.10	97.75	0.22	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**
		4	Apr.	30	5.05	13.10	9.57	1.98	278.7	0.55	91.80	0.18	0.93	2.41	0.90	2.32	0.93	2.41	0.78	2.02	0.90	2.32	**1.68**	**4.34**
		5	May	31	0.62	1.65	16.28	2.56	7.9	0.02	73.95	0.19	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**
		6	Jun.	30	8.37	21.70	12.87	2.26	405.4	0.92	80.75	0.18	0.93	2.41	0.90	2.32	0.93	2.41	5.51	14.29	0.90	2.32	**6.41**	**16.61**
		7	Jul.	31	21.79	58.38	16.28	2.56	917.2	2.35	62.05	0.16	0.93	2.49	0.90	2.40	0.93	2.49	20.78	55.67	0.90	2.40	**21.68**	**58.07**
		8	Aug.	31	13.46	36.04	16.28	2.56	515.1	1.32	63.75	0.16	0.93	2.49	0.90	2.40	0.93	2.49	12.06	32.31	0.90	2.40	**12.96**	**34.71**
		9	Sep.	30	21.04	54.55	16.28	2.56	835.3	2.14	59.50	0.15	0.93	2.41	0.90	2.32	0.93	2.41	19.98	51.80	0.90	2.32	**20.88**	**54.12**
		10	Oct.	31	3.87	10.36	16.28	2.56	122.6	0.31	62.05	0.16	0.93	2.49	0.90	2.40	0.93	2.49	2.10	5.62	0.90	2.40	**3.00**	**8.03**
		11	Nov.	30	3.49	9.03	16.28	2.56	140.9	0.36	89.25	0.23	0.93	2.41	0.90	2.32	0.93	2.41	1.71	4.43	0.90	2.32	**2.61**	**6.76**
		12	Dec.	31	1.67	4.47	16.28	2.56	0.9	0.00	104.55	0.27	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**
1963	7	1	Jan.	31	1.13	3.04	15.59	2.50	0.0	0.00	116.45	0.29	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**
		2	Feb.	28	0.78	1.90	13.44	2.31	61.9	0.14	95.20	0.22	0.93	2.25	0.90	2.17	0.93	2.25			0.90	2.17	**0.90**	**2.17**
		3	Mar.	31	0.72	1.92	10.84	2.09	85.5	0.18	97.75	0.20	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**
		4	Apr.	30	0.53	1.38	7.85	1.83	28.2	0.05	91.80	0.17	0.93	2.41	0.90	2.32	0.93	2.41			0.90	2.32	**0.90**	**2.32**
		5	May	31	2.95	7.91	4.38	1.43	196.8	0.28	73.95	0.11	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**
		6	Jun.	30	11.31	29.31	7.57	1.81	498.8	0.90	80.75	0.15	0.93	2.41	0.90	2.32	0.93	2.41	6.41	16.61	0.90	2.32	**7.31**	**18.94**
		7	Jul.	31	12.44	33.32	16.28	2.56	525.5	1.34	62.05	0.16	0.93	2.49	0.90	2.40	0.93	2.49	11.06	29.61	0.90	2.40	**11.95**	**32.01**
		8	Aug.	31	27.73	74.28	16.28	2.56	1,094.3	2.80	63.75	0.16	0.93	2.49	0.90	2.40	0.93	2.49	26.89	72.02	0.90	2.40	**27.79**	**74.42**
		9	Sep.	30	17.88	46.34	16.28	2.56	686.3	1.75	59.50	0.15	0.93	2.41	0.90	2.32	0.93	2.41	16.67	43.20	0.90	2.32	**17.56**	**45.53**
		10	Oct.	31	9.22	24.70	16.28	2.56	328.2	0.84	62.05	0.16	0.93	2.49	0.90	2.40	0.93	2.49	7.65	20.49	0.90	2.40	**8.55**	**22.89**
		11	Nov.	30	9.07	23.51	16.28	2.56	354.5	0.91	89.25	0.23	0.93	2.41	0.90	2.32	0.93	2.41	7.51	19.46	0.90	2.32	**8.40**	**21.78**
		12	Dec.	31	2.50	6.70	16.28	2.56	49.6	0.13	104.55	0.27	0.93	2.49	0.90	2.40	0.93	2.49	0.62	1.67	0.90	2.40	**1.52**	**4.07**
1965	8	1	Jan.	31	1.85	4.96	16.28	2.56	0.0	0.00	116.45	0.30	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**
		2	Feb.	28	1.43	3.47	16.05	2.54	98.2	0.25	95.20	0.24	0.93	2.25	0.90	2.17	0.93	2.25			0.90	2.17	**0.90**	**2.17**
		3	Mar.	31	1.28	3.44	15.11	2.46	81.5	0.20	97.75	0.24	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**
		4	Apr.	30	4.42	11.45	13.61	2.33	218.3	0.51	91.80	0.21	0.93	2.41	0.90	2.32	0.93	2.41	1.68	4.35	0.90	2.32	**2.57**	**6.67**
		5	May	31	10.69	28.63	16.28	2.56	452.5	1.16	73.95	0.19	0.93	2.49	0.90	2.40	0.93	2.49	9.22	24.70	0.90	2.40	**10.12**	**27.11**
		6	Jun.	30	16.48	42.70	16.28	2.56	674.6	1.72	80.75	0.21	0.93	2.41	0.90	2.32	0.93	2.41	15.23	39.49	0.90	2.32	**16.13**	**41.81**
		7	Jul.	31	15.64	41.89	16.28	2.56	619.5	1.58	62.05	0.16	0.93	2.49	0.90	2.40	0.93	2.49	14.35	38.43	0.90	2.40	**15.24**	**40.83**
		8	Aug.	31	12.47	33.41	16.28	2.56	453.5	1.16	63.75	0.16	0.93	2.49	0.90	2.40	0.93	2.49	11.02	29.51	0.90	2.40	**11.92**	**31.91**
		9	Sep.	30	24.78	64.23	16.28	2.56	972.5	2.49	59.50	0.15	0.93	2.41	0.90	2.32	0.93	2.41	23.85	61.83	0.90	2.32	**24.75**	**64.15**
		10	Oct.	31	12.66	33.90	16.28	2.56	451.5	1.15	62.05	0.16	0.93	2.49	0.90	2.40	0.93	2.49	11.20	30.00	0.90	2.40	**12.10**	**32.40**
		11	Nov.	30	3.85	9.98	16.28	2.56	123.0	0.31	89.25	0.23	0.93	2.41	0.90	2.32	0.93	2.41	2.06	5.34	0.90	2.32	**2.96**	**7.66**
		12	Dec.	31	2.40	6.43	16.28	2.56	16.5	0.04	104.55	0.27	0.93	2.49	0.90	2.40	0.93	2.49	0.49	1.31	0.90	2.40	**1.39**	**3.72**

Table G-56 Reservoir Water Balance Calculation of Proposed Toek Sap Reservoir (Site-3) (3/8)
[Dam Height = 14 m, Water Demand =80,000 m3/day, Release = Qave(Feb), without Hydropower]

1966	9	1	Jan.	31	1.93	5.18	16.28	2.56	28.5	0.07	116.45	0.30	0.93	2.49	0.90	2.40	0.93	2.49	0.02	0.06	0.90	2.40	**0.92**	**2.47**
		2	Feb.	28	1.10	2.66	16.28	2.56	5.5	0.01	95.20	0.24	0.93	2.25	0.90	2.17	0.93	2.25			0.90	2.17	**0.90**	**2.17**
		3	Mar.	31	1.17	3.13	14.30	2.39	113.0	0.27	97.75	0.23	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**
		4	Apr.	30	1.63	4.24	12.57	2.24	101.0	0.23	91.80	0.21	0.93	2.41	0.90	2.32	0.93	2.41			0.90	2.32	**0.90**	**2.32**
		5	May	31	15.22	40.78	12.09	2.20	644.0	1.41	73.95	0.16	0.93	2.49	0.90	2.40	0.93	2.49	12.30	32.94	0.90	2.40	**13.20**	**35.35**
		6	Jun.	30	11.06	28.66	16.28	2.56	451.5	1.15	80.75	0.21	0.93	2.41	0.90	2.32	0.93	2.41	9.59	24.87	0.90	2.32	**10.49**	**27.19**
		7	Jul.	31	36.34	97.32	16.28	2.56	1,477.5	3.78	62.05	0.16	0.93	2.49	0.90	2.40	0.93	2.49	35.86	96.05	0.90	2.40	**36.76**	**98.45**
		8	Aug.	31	16.33	43.73	16.28	2.56	572.5	1.46	63.75	0.16	0.93	2.49	0.90	2.40	0.93	2.49	14.98	40.13	0.90	2.40	**15.88**	**42.54**
		9	Sep.	30	11.31	29.31	16.28	2.56	386.5	0.99	59.50	0.15	0.93	2.41	0.90	2.32	0.93	2.41	9.80	25.41	0.90	2.32	**10.70**	**27.73**
		10	Oct.	31	16.73	44.80	16.28	2.56	614.5	1.57	62.05	0.16	0.93	2.49	0.90	2.40	0.93	2.49	15.43	41.32	0.90	2.40	**16.32**	**43.72**
		11	Nov.	30	8.89	23.04	16.28	2.56	323.5	0.83	89.25	0.23	0.93	2.41	0.90	2.32	0.93	2.41	7.29	18.90	0.90	2.32	**8.19**	**21.23**
		12	Dec.	31	4.20	11.26	16.28	2.56	152.0	0.39	104.55	0.27	0.93	2.49	0.90	2.40	0.93	2.49	2.42	6.48	0.90	2.40	**3.32**	**8.89**
1967	10	1	Jan.	31	2.67	7.15	16.28	2.56	10.5	0.03	116.45	0.30	0.93	2.49	0.90	2.40	0.93	2.49	0.74	1.98	0.90	2.40	**1.64**	**4.38**
		2	Feb.	28	1.70	4.11	16.28	2.56	19.0	0.05	95.20	0.24	0.93	2.25	0.90	2.17	0.93	2.25			0.90	2.17	**0.90**	**2.17**
		3	Mar.	31	1.12	2.99	15.78	2.51	0.0	0.00	97.75	0.25	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**
		4	Apr.	30	2.57	6.66	13.64	2.33	159.5	0.37	91.80	0.21	0.93	2.41	0.90	2.32	0.93	2.41			0.90	2.32	**0.90**	**2.32**
		5	May	31	14.27	38.23	15.72	2.51	602.3	1.51	73.95	0.19	0.93	2.49	0.90	2.40	0.93	2.49	12.73	34.10	0.90	2.40	**13.63**	**36.50**
		6	Jun.	30	25.18	65.27	16.28	2.56	1,028.5	2.63	80.75	0.21	0.93	2.41	0.90	2.32	0.93	2.41	24.29	62.96	0.90	2.32	**25.19**	**65.28**
		7	Jul.	31	22.55	60.39	16.28	2.56	882.1	2.26	62.05	0.16	0.93	2.49	0.90	2.40	0.93	2.49	21.50	57.59	0.90	2.40	**22.40**	**59.99**
		8	Aug.	31	27.83	74.54	16.28	2.56	1,033.5	2.64	63.75	0.16	0.93	2.49	0.90	2.40	0.93	2.49	26.93	72.13	0.90	2.40	**27.83**	**74.53**
		9	Sep.	30	9.19	23.82	16.28	2.56	280.3	0.72	59.50	0.15	0.93	2.41	0.90	2.32	0.93	2.41	7.58	19.65	0.90	2.32	**8.48**	**21.97**
		10	Oct.	31	14.29	38.28	16.28	2.56	508.2	1.30	62.05	0.16	0.93	2.49	0.90	2.40	0.93	2.49	12.89	34.53	0.90	2.40	**13.79**	**36.93**
		11	Nov.	30	3.27	8.47	16.28	2.56	41.5	0.11	89.25	0.23	0.93	2.41	0.90	2.32	0.93	2.41	1.39	3.61	0.90	2.32	**2.29**	**5.94**
		12	Dec.	31	2.23	5.98	16.28	2.56	0.7	0.00	104.55	0.27	0.93	2.49	0.90	2.40	0.93	2.49	0.31	0.83	0.90	2.40	**1.21**	**3.23**
1968	11	1	Jan.	31	1.87	5.00	16.28	2.56	36.5	0.09	116.45	0.30	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**
		2	Feb.	29	1.08	2.72	16.19	2.55	7.7	0.02	95.20	0.24	0.93	2.33	0.90	2.25	0.93	2.33			0.90	2.25	**0.90**	**2.25**
		3	Mar.	31	0.73	1.97	14.10	2.37	16.4	0.04	97.75	0.23	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**
		4	Apr.	30	0.58	1.51	10.98	2.10	18.4	0.04	91.80	0.19	0.93	2.41	0.90	2.32	0.93	2.41			0.90	2.32	**0.90**	**2.32**
		5	May	31	3.85	10.32	7.61	1.81	232.8	0.42	73.95	0.13	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**
		6	Jun.	30	0.67	1.73	13.32	2.30	34.3	0.08	80.75	0.19	0.93	2.41	0.90	2.32	0.93	2.41			0.90	2.32	**0.90**	**2.32**
		7	Jul.	31	18.29	49.00	10.21	2.03	805.3	1.64	62.05	0.13	0.93	2.49	0.90	2.40	0.93	2.49	14.76	39.54	0.90	2.40	**15.66**	**41.94**
		8	Aug.	31	13.62	36.49	16.28	2.56	537.8	1.38	63.75	0.16	0.93	2.49	0.90	2.40	0.93	2.49	12.25	32.81	0.90	2.40	**13.15**	**35.21**
		9	Sep.	30	18.19	47.16	16.28	2.56	728.7	1.86	59.50	0.15	0.93	2.41	0.90	2.32	0.93	2.41	17.03	44.13	0.90	2.32	**17.92**	**46.46**
		10	Oct.	31	5.40	14.47	16.28	2.56	197.5	0.51	62.05	0.16	0.93	2.49	0.90	2.40	0.93	2.49	3.71	9.92	0.90	2.40	**4.60**	**12.33**
		11	Nov.	30	2.05	5.32	16.28	2.56	37.3	0.10	89.25	0.23	0.93	2.41	0.90	2.32	0.93	2.41	0.17	0.45	0.90	2.32	**1.07**	**2.77**
		12	Dec.	31	1.38	3.71	16.28	2.56	30.2	0.08	104.55	0.27	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**
1969	12	1	Jan.	31	1.28	3.44	14.91	2.44	76.4	0.19	116.45	0.28	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**
		2	Feb.	28	1.03	2.50	13.36	2.31	98.1	0.23	95.20	0.22	0.93	2.25	0.90	2.17	0.93	2.25			0.90	2.17	**0.90**	**2.17**
		3	Mar.	31	0.93	2.50	11.44	2.14	63.5	0.14	97.75	0.21	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**
		4	Apr.	30	0.65	1.69	8.98	1.93	30.9	0.06	91.80	0.18	0.93	2.41	0.90	2.32	0.93	2.41			0.90	2.32	**0.90**	**2.32**
		5	May	31	7.04	18.85	5.81	1.66	354.2	0.59	73.95	0.12	0.93	2.49	0.90	2.40	0.93	2.49	1.48	3.95	0.90	2.40	**2.37**	**6.35**
		6	Jun.	30	1.12	2.90	16.28	2.56	68.9	0.18	80.75	0.21	0.93	2.41	0.90	2.32	0.93	2.41			0.90	2.32	**0.90**	**2.32**
		7	Jul.	31	1.50	4.02	14.41	2.40	88.7	0.21	62.05	0.15	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**
		8	Aug.	31	5.97	15.99	13.60	2.33	261.6	0.61	63.75	0.15	0.93	2.49	0.90	2.40	0.93	2.49	3.32	8.88	0.90	2.40	**4.21**	**11.28**
		9	Sep.	30	27.85	72.18	16.28	2.56	1,160.2	2.97	59.50	0.15	0.93	2.41	0.90	2.32	0.93	2.41	27.11	70.26	0.90	2.32	**28.00**	**72.59**
		10	Oct.	31	7.54	20.19	16.28	2.56	290.3	0.74	62.05	0.16	0.93	2.49	0.90	2.40	0.93	2.49	5.93	15.88	0.90	2.40	**6.83**	**18.28**
		11	Nov.	30	5.65	14.65	16.28	2.56	238.5	0.61	89.25	0.23	0.93	2.41	0.90	2.32	0.93	2.41	3.97	10.30	0.90	2.32	**4.87**	**12.62**
		12	Dec.	31	1.63	4.38	16.28	2.56	2.5	0.01	104.55	0.27	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**
1971	13	1	Jan.	31	1.15	3.08	15.51	2.49	9.2	0.02	116.45	0.29	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**
		2	Feb.	28	0.68	1.65	13.43	2.31	35.1	0.08	95.20	0.22	0.93	2.25	0.90	2.17	0.93	2.25			0.90	2.17	**0.90**	**2.17**
		3	Mar.	31	0.58	1.56	10.52	2.06	61.2	0.13	97.75	0.20	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**
		4	Apr.	30	0.53	1.38	7.12	1.77	61.8	0.11	91.80	0.16	0.93	2.41	0.90	2.32	0.75	1.95			0.90	2.32	**0.90**	**2.32**
		5	May	31	7.75	20.77	4.17	1.39	387.6	0.54	73.95	0.10	0.93	2.49	0.90	2.40	0.93	2.49	1.57	4.20	0.90	2.40	**2.46**	**6.60**
		6	Jun.	30	10.81	28.01	16.28	2.56	468.5	1.20	80.75	0.21	0.93	2.41	0.90	2.32	0.93	2.41	9.36	24.27	0.90	2.32	**10.26**	**26.59**
		7	Jul.	31	8.49	22.73	16.28	2.56	357.1	0.91	62.05	0.16	0.93	2.49	0.90	2.40	0.93	2.49	6.94	18.60	0.90	2.40	**7.84**	**21.00**
		8	Aug.	31	14.49	38.81	16.28	2.56	573.3	1.47	63.75	0.16	0.93	2.49	0.90	2.40	0.93	2.49	13.15	35.22	0.90	2.40	**14.05**	**37.62**
		9	Sep.	30	12.17	31.55	16.28	2.56	481.4	1.23	59.50	0.15	0.93	2.41	0.90	2.32	0.93	2.41	10.76	27.90	0.90	2.32	**11.66**	**30.22**
		10	Oct.	31	18.74	50.20	16.28	2.56	738.7	1.89	62.05	0.16	0.93	2.49	0.90	2.40	0.93	2.49	17.56	47.04	0.90	2.40	**18.46**	**49.44**
		11	Nov.	30	2.48	6.44	16.28	2.56	39.4	0.10	89.25	0.23	0.93	2.41	0.90	2.32	0.93	2.41	0.61	1.58	0.90	2.32	**1.51**	**3.90**
		12	Dec.	31	1.95	5.23	16.28	2.56	73.8	0.19	104.55	0.27	0.93	2.49	0.90	2.40	0.93	2.49	0.10	0.25	0.90	2.40	**0.99**	**2.66**

Table G-56 Reservoir Water Balance Calculation of Proposed Toek Sap Reservoir (Site-3) (4/8)
[Dam Height = 14 m, Water Demand =80,000 m3/day, Release = Qave(Feb), without Hydropower]

1972	14	1	Jan.	31	1.38	3.71	16.28	2.56	3.4	0.01	116.45	0.30	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**
		2	Feb.	29	1.03	2.59	14.81	2.43	72.4	0.18	95.20	0.23	0.93	2.33	0.90	2.25	0.93	2.33			0.90	2.25	**0.90**	**2.25**
		3	Mar.	31	4.84	12.95	12.77	2.25	262.9	0.59	97.75	0.22	0.93	2.49	0.90	2.40	0.93	2.49	1.84	4.92	0.90	2.40	**2.73**	**7.32**
		4	Apr.	30	4.22	10.94	16.28	2.56	200.1	0.51	91.80	0.23	0.93	2.41	0.90	2.32	0.93	2.41	2.50	6.48	0.90	2.32	**3.40**	**8.80**
		5	May	31	3.69	9.87	16.28	2.56	176.6	0.45	73.95	0.19	0.93	2.49	0.90	2.40	0.93	2.49	1.96	5.24	0.90	2.40	**2.85**	**7.64**
		6	Jun.	30	14.06	36.44	16.28	2.56	590.5	1.51	80.75	0.21	0.93	2.41	0.90	2.32	0.93	2.41	12.73	33.01	0.90	2.32	**13.63**	**35.33**
		7	Jul.	31	9.72	26.04	16.28	2.56	392.0	1.00	62.05	0.16	0.93	2.49	0.90	2.40	0.93	2.49	8.21	21.99	0.90	2.40	**9.11**	**24.39**
		8	Aug.	31	13.04	34.93	16.28	2.56	500.1	1.28	63.75	0.16	0.93	2.49	0.90	2.40	0.93	2.49	11.63	31.15	0.90	2.40	**12.53**	**33.55**
		9	Sep.	30	13.02	33.76	16.28	2.56	506.9	1.30	59.50	0.15	0.93	2.41	0.90	2.32	0.93	2.41	11.64	30.17	0.90	2.32	**12.53**	**32.49**
		10	Oct.	31	4.82	12.91	16.28	2.56	176.7	0.45	62.05	0.16	0.93	2.49	0.90	2.40	0.93	2.49	3.10	8.31	0.90	2.40	**4.00**	**10.71**
		11	Nov.	30	4.20	10.89	16.28	2.56	180.7	0.46	89.25	0.23	0.93	2.41	0.90	2.32	0.93	2.41	2.47	6.39	0.90	2.32	**3.36**	**8.72**
		12	Dec.	31	1.82	4.87	16.28	2.56	57.9	0.15	104.55	0.27	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**
1973	15	1	Jan.	31	1.30	3.48	16.14	2.54	6.4	0.02	116.45	0.30	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**
		2	Feb.	28	0.68	1.65	14.45	2.40	17.2	0.04	95.20	0.23	0.93	2.25	0.90	2.17	0.93	2.25			0.90	2.17	**0.90**	**2.17**
		3	Mar.	31	0.70	1.88	11.50	2.15	96.0	0.21	97.75	0.21	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**
		4	Apr.	30	0.78	2.03	8.48	1.89	85.1	0.16	91.80	0.17	0.93	2.41	0.90	2.32	0.93	2.41			0.90	2.32	**0.90**	**2.32**
		5	May	31	2.42	6.48	5.76	1.65	146.4	0.24	73.95	0.12	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**
		6	Jun.	30	18.94	49.10	7.46	1.80	808.7	1.45	80.75	0.15	0.93	2.41	0.90	2.32	0.93	2.41	14.22	36.86	0.90	2.32	**15.12**	**39.18**
		7	Jul.	31	18.66	49.98	16.28	2.56	762.0	1.95	62.05	0.16	0.93	2.49	0.90	2.40	0.93	2.49	17.50	46.88	0.90	2.40	**18.40**	**49.28**
		8	Aug.	31	20.71	55.47	16.28	2.56	789.2	2.02	63.75	0.16	0.93	2.49	0.90	2.40	0.93	2.49	19.58	52.43	0.90	2.40	**20.47**	**54.84**
		9	Sep.	30	10.92	28.31	16.28	2.56	395.3	1.01	59.50	0.15	0.93	2.41	0.90	2.32	0.93	2.41	9.43	24.44	0.90	2.32	**10.32**	**26.76**
		10	Oct.	31	9.94	26.62	16.28	2.56	364.0	0.93	62.05	0.16	0.93	2.49	0.90	2.40	0.93	2.49	8.40	22.50	0.90	2.40	**9.30**	**24.90**
		11	Nov.	30	10.72	27.79	16.28	2.56	426.5	1.09	89.25	0.23	0.93	2.41	0.90	2.32	0.93	2.41	9.23	23.92	0.90	2.32	**10.13**	**26.24**
		12	Dec.	31	2.47	6.61	16.28	2.56	39.9	0.10	104.55	0.27	0.93	2.49	0.90	2.40	0.93	2.49	0.58	1.55	0.90	2.40	**1.48**	**3.95**
1983	16	1	Jan.	31	1.83	4.91	16.28	2.56	0.0	0.00	116.45	0.30	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**
		2	Feb.	28	1.00	2.42	16.00	2.53	0.0	0.00	95.20	0.24	0.93	2.25	0.90	2.17	0.93	2.25			0.90	2.17	**0.90**	**2.17**
		3	Mar.	31	0.87	2.32	13.77	2.34	65.5	0.15	97.75	0.23	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**
		4	Apr.	30	0.53	1.38	11.12	2.11	0.0	0.00	91.80	0.19	0.93	2.41	0.90	2.32	0.93	2.41			0.90	2.32	**0.90**	**2.32**
		5	May	31	7.80	20.90	7.57	1.81	390.6	0.71	73.95	0.13	0.93	2.49	0.90	2.40	0.93	2.49	2.94	7.87	0.90	2.40	**3.84**	**10.28**
		6	Jun.	30	22.15	57.40	16.28	2.56	934.4	2.39	80.75	0.21	0.93	2.41	0.90	2.32	0.93	2.41	21.16	54.85	0.90	2.32	**22.06**	**57.17**
		7	Jul.	31	11.69	31.31	16.28	2.56	465.7	1.19	62.05	0.16	0.93	2.49	0.90	2.40	0.93	2.49	10.25	27.45	0.90	2.40	**11.14**	**29.85**
		8	Aug.	31	17.74	47.52	16.28	2.56	677.1	1.73	63.75	0.16	0.93	2.49	0.90	2.40	0.93	2.49	16.50	44.20	0.90	2.40	**17.40**	**46.60**
		9	Sep.	30	13.49	34.97	16.28	2.56	509.9	1.30	59.50	0.15	0.93	2.41	0.90	2.32	0.93	2.41	12.11	31.38	0.90	2.32	**13.00**	**33.71**
		10	Oct.	31	17.81	47.70	16.28	2.56	679.3	1.74	62.05	0.16	0.93	2.49	0.90	2.40	0.93	2.49	16.57	44.39	0.90	2.40	**17.47**	**46.79**
		11	Nov.	30	7.02	18.20	16.28	2.56	260.6	0.67	89.25	0.23	0.93	2.41	0.90	2.32	0.93	2.41	5.36	13.90	0.90	2.32	**6.26**	**16.22**
		12	Dec.	31	2.75	7.37	16.28	2.56	94.6	0.24	104.55	0.27	0.93	2.49	0.90	2.40	0.93	2.49	0.92	2.45	0.90	2.40	**1.81**	**4.85**
1984	17	1	Jan.	31	2.30	6.16	16.28	2.56	27.4	0.07	116.45	0.30	0.93	2.49	0.90	2.40	0.93	2.49	0.39	1.04	0.90	2.40	**1.29**	**3.44**
		2	Feb.	29	1.80	4.51	16.28	2.56	98.0	0.25	95.20	0.24	0.93	2.33	0.90	2.25	0.93	2.33			0.90	2.25	**0.90**	**2.25**
		3	Mar.	31	1.35	3.62	16.22	2.55	24.5	0.06	97.75	0.25	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**
		4	Apr.	30	3.17	8.21	14.76	2.43	175.8	0.43	91.80	0.22	0.93	2.41	0.90	2.32	0.93	2.41	0.83	2.16	0.90	2.32	**1.73**	**4.49**
		5	May	31	5.39	14.43	16.28	2.56	242.8	0.62	73.95	0.19	0.93	2.49	0.90	2.40	0.93	2.49	3.72	9.97	0.90	2.40	**4.62**	**12.37**
		6	Jun.	30	19.44	50.40	16.28	2.56	806.1	2.06	80.75	0.21	0.93	2.41	0.90	2.32	0.93	2.41	18.33	47.52	0.90	2.32	**19.23**	**49.84**
		7	Jul.	31	12.29	32.92	16.28	2.56	482.6	1.23	62.05	0.16	0.93	2.49	0.90	2.40	0.93	2.49	10.86	29.10	0.90	2.40	**11.76**	**31.50**
		8	Aug.	31	12.31	32.96	16.28	2.56	453.6	1.16	63.75	0.16	0.93	2.49	0.90	2.40	0.93	2.49	10.85	29.07	0.90	2.40	**11.75**	**31.47**
		9	Sep.	30	6.35	16.47	16.28	2.56	222.6	0.57	59.50	0.15	0.93	2.41	0.90	2.32	0.93	2.41	4.69	12.15	0.90	2.32	**5.58**	**14.47**
		10	Oct.	31	5.52	14.78	16.28	2.56	209.3	0.54	62.05	0.16	0.93	2.49	0.90	2.40	0.93	2.49	3.83	10.27	0.90	2.40	**4.73**	**12.67**
		11	Nov.	30	1.92	4.97	16.28	2.56	33.7	0.09	89.25	0.23	0.93	2.41	0.90	2.32	0.93	2.41	0.04	0.09	0.90	2.32	**0.93**	**2.42**
		12	Dec.	31	1.53	4.11	16.28	2.56	79.5	0.20	104.55	0.27	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**
1985	18	1	Jan.	31	1.05	2.81	15.43	2.48	4.6	0.01	116.45	0.29	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**
		2	Feb.	28	0.70	1.69	13.08	2.28	48.6	0.11	95.20	0.22	0.93	2.25	0.90	2.17	0.93	2.25			0.90	2.17	**0.90**	**2.17**
		3	Mar.	31	0.67	1.79	10.25	2.04	74.0	0.15	97.75	0.20	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**
		4	Apr.	30	4.72	12.23	7.09	1.77	263.5	0.47	91.80	0.16	0.93	2.41	0.90	2.32	0.93	2.41			0.90	2.32	**0.90**	**2.32**
		5	May	31	7.59	20.32	14.89	2.44	343.6	0.84	73.95	0.18	0.93	2.49	0.90	2.40	0.93	2.49	5.49	14.70	0.90	2.40	**6.38**	**17.10**
		6	Jun.	30	13.06	33.84	16.28	2.56	551.9	1.41	80.75	0.21	0.93	2.41	0.90	2.32	0.93	2.41	11.70	30.31	0.90	2.32	**12.59**	**32.64**
		7	Jul.	31	5.37	14.38	16.28	2.56	217.3	0.56	62.05	0.16	0.93	2.49	0.90	2.40	0.93	2.49	3.69	9.89	0.90	2.40	**4.59**	**12.29**
		8	Aug.	31	15.51	41.54	16.28	2.56	609.3	1.56	63.75	0.16	0.93	2.49	0.90	2.40	0.93	2.49	14.20	38.04	0.90	2.40	**15.10**	**40.44**
		9	Sep.	30	16.68	43.22	16.28	2.56	660.1	1.69	59.50	0.15	0.93	2.41	0.90	2.32	0.93	2.41	15.44	40.02	0.90	2.32	**16.34**	**42.35**
		10	Oct.	31	9.07	24.30	16.28	2.56	340.9	0.87	62.05	0.16	0.93	2.49	0.90	2.40	0.93	2.49	7.51	20.12	0.90	2.40	**8.41**	**22.52**
		11	Nov.	30	2.27	5.88	16.28	2.56	40.0	0.10	89.25	0.23	0.93	2.41	0.90	2.32	0.93	2.41	0.39	1.02	0.90	2.32	**1.29**	**3.34**
		12	Dec.	31	1.47	3.93	16.28	2.56	8.0	0.02	104.55	0.27	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**

Table G-56 Reservoir Water Balance Calculation of Proposed Toek Sap Reservoir (Site-3) (5/8)
[Dam Height = 14 m, Water Demand =80,000 m3/day, Release = Qave(Feb), without Hydropower]

1986	19	1	Jan.	31	0.98	2.64	15.07	2.45	6.8	0.02	116.45	0.29	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**
		2	Feb.	28	0.52	1.25	12.55	2.24	3.2	0.01	95.20	0.21	0.93	2.25	0.90	2.17	0.93	2.25			0.90	2.17	**0.90**	**2.17**
		3	Mar.	31	0.45	1.21	9.17	1.95	35.6	0.07	97.75	0.19	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**
		4	Apr.	30	4.19	10.85	5.37	1.62	251.1	0.41	91.80	0.15	0.93	2.41	0.90	2.32	0.93	2.41			0.90	2.32	**0.90**	**2.32**
		5	May	31	6.27	16.79	11.74	2.17	300.5	0.65	73.95	0.16	0.93	2.49	0.90	2.40	0.93	2.49	2.93	7.85	0.90	2.40	**3.83**	**10.25**
		6	Jun.	30	19.18	49.71	16.28	2.56	811.5	2.08	80.75	0.21	0.93	2.41	0.90	2.32	0.93	2.41	18.07	46.84	0.90	2.32	**18.97**	**49.16**
		7	Jul.	31	9.91	26.53	16.28	2.56	398.3	1.02	62.05	0.16	0.93	2.49	0.90	2.40	0.93	2.49	8.40	22.50	0.90	2.40	**9.30**	**24.90**
		8	Aug.	31	16.96	45.42	16.28	2.56	654.0	1.67	63.75	0.16	0.93	2.49	0.90	2.40	0.93	2.49	15.70	42.04	0.90	2.40	**16.59**	**44.44**
		9	Sep.	30	15.41	39.94	16.28	2.56	596.8	1.53	59.50	0.15	0.93	2.41	0.90	2.32	0.93	2.41	14.11	36.58	0.90	2.32	**15.01**	**38.90**
		10	Oct.	31	8.50	22.78	16.28	2.56	311.8	0.80	62.05	0.16	0.93	2.49	0.90	2.40	0.93	2.49	6.92	18.52	0.90	2.40	**7.81**	**20.93**
		11	Nov.	30	3.87	10.03	16.28	2.56	152.0	0.39	89.25	0.23	0.93	2.41	0.90	2.32	0.93	2.41	2.10	5.45	0.90	2.32	**3.00**	**7.78**
		12	Dec.	31	1.82	4.87	16.28	2.56	5.2	0.01	104.55	0.27	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**
1987	20	1	Jan.	31	1.30	3.48	16.00	2.53	4.5	0.01	116.45	0.29	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**
		2	Feb.	28	0.63	1.53	14.31	2.39	0.0	0.00	95.20	0.23	0.93	2.25	0.90	2.17	0.93	2.25			0.90	2.17	**0.90**	**2.17**
		3	Mar.	31	0.45	1.21	11.20	2.12	0.4	0.00	97.75	0.21	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**
		4	Apr.	30	3.34	8.64	7.31	1.79	216.3	0.39	91.80	0.16	0.93	2.41	0.90	2.32	0.93	2.41			0.90	2.32	**0.90**	**2.32**
		5	May	31	4.10	10.99	11.44	2.14	216.1	0.46	73.95	0.16	0.93	2.49	0.90	2.40	0.93	2.49	0.58	1.55	0.90	2.40	**1.48**	**3.96**
		6	Jun.	30	18.23	47.24	16.28	2.56	778.1	1.99	80.75	0.21	0.93	2.41	0.90	2.32	0.93	2.41	17.09	44.29	0.90	2.32	**17.98**	**46.62**
		7	Jul.	31	5.42	14.52	16.28	2.56	221.1	0.57	62.05	0.16	0.93	2.49	0.90	2.40	0.93	2.49	3.74	10.03	0.90	2.40	**4.64**	**12.43**
		8	Aug.	31	9.27	24.83	16.28	2.56	363.1	0.93	63.75	0.16	0.93	2.49	0.90	2.40	0.93	2.49	7.73	20.71	0.90	2.40	**8.63**	**23.11**
		9	Sep.	30	13.79	35.75	16.28	2.56	555.4	1.42	59.50	0.15	0.93	2.41	0.90	2.32	0.93	2.41	12.45	32.28	0.90	2.32	**13.35**	**34.60**
		10	Oct.	31	8.10	21.71	16.28	2.56	318.3	0.81	62.05	0.16	0.93	2.49	0.90	2.40	0.93	2.49	6.52	17.47	0.90	2.40	**7.42**	**19.87**
		11	Nov.	30	9.72	25.20	16.28	2.56	409.4	1.05	89.25	0.23	0.93	2.41	0.90	2.32	0.93	2.41	8.21	21.28	0.90	2.32	**9.11**	**23.61**
		12	Dec.	31	1.75	4.69	16.28	2.56	0.0	0.00	104.55	0.27	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**
1988	21	1	Jan.	31	1.28	3.44	15.81	2.52	14.2	0.04	116.45	0.29	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**
		2	Feb.	29	0.95	2.38	14.10	2.37	70.5	0.17	95.20	0.23	0.93	2.33	0.90	2.25	0.93	2.33			0.90	2.25	**0.90**	**2.25**
		3	Mar.	31	0.62	1.65	11.85	2.18	23.7	0.05	97.75	0.21	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**
		4	Apr.	30	1.38	3.59	8.45	1.88	127.6	0.24	91.80	0.17	0.93	2.41	0.90	2.32	0.93	2.41			0.90	2.32	**0.90**	**2.32**
		5	May	31	10.16	27.20	7.37	1.79	454.2	0.81	73.95	0.13	0.93	2.49	0.90	2.40	0.93	2.49	5.25	14.07	0.90	2.40	**6.15**	**16.47**
		6	Jun.	30	14.22	36.87	16.28	2.56	600.4	1.54	80.75	0.21	0.93	2.41	0.90	2.32	0.93	2.41	12.91	33.46	0.90	2.32	**13.81**	**35.79**
		7	Jul.	31	19.59	52.48	16.28	2.56	799.1	2.04	62.05	0.16	0.93	2.49	0.90	2.40	0.93	2.49	18.47	49.47	0.90	2.40	**19.37**	**51.87**
		8	Aug.	31	9.42	25.24	16.28	2.56	338.7	0.87	63.75	0.16	0.93	2.49	0.90	2.40	0.93	2.49	7.86	21.05	0.90	2.40	**8.75**	**23.45**
		9	Sep.	30	14.37	37.26	16.28	2.56	555.9	1.42	59.50	0.15	0.93	2.41	0.90	2.32	0.93	2.41	13.04	33.79	0.90	2.32	**13.93**	**36.12**
		10	Oct.	31	11.84	31.71	16.28	2.56	447.7	1.14	62.05	0.16	0.93	2.49	0.90	2.40	0.93	2.49	10.38	27.80	0.90	2.40	**11.28**	**30.21**
		11	Nov.	30	3.27	8.47	16.28	2.56	122.6	0.31	89.25	0.23	0.93	2.41	0.90	2.32	0.93	2.41	1.47	3.82	0.90	2.32	**2.37**	**6.15**
		12	Dec.	31	1.85	4.96	16.28	2.56	0.0	0.00	104.55	0.27	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**
1989	22	1	Jan.	31	1.47	3.93	16.08	2.54	30.4	0.08	116.45	0.30	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**
		2	Feb.	28	0.83	2.02	14.90	2.44	22.8	0.06	95.20	0.23	0.93	2.25	0.90	2.17	0.93	2.25			0.90	2.17	**0.90**	**2.17**
		3	Mar.	31	1.10	2.95	12.32	2.22	120.3	0.27	97.75	0.22	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**
		4	Apr.	30	1.10	2.85	10.43	2.05	83.8	0.17	91.80	0.19	0.93	2.41	0.90	2.32	0.93	2.41			0.90	2.32	**0.90**	**2.32**
		5	May	31	14.32	38.37	8.53	1.89	613.2	1.16	73.95	0.14	0.93	2.49	0.90	2.40	0.93	2.49	9.98	26.74	0.90	2.40	**10.88**	**29.14**
		6	Jun.	30	9.37	24.29	16.28	2.56	388.2	0.99	80.75	0.21	0.93	2.41	0.90	2.32	0.93	2.41	7.85	20.34	0.90	2.32	**8.74**	**22.67**
		7	Jul.	31	13.29	35.60	16.28	2.56	540.6	1.38	62.05	0.16	0.93	2.49	0.90	2.40	0.93	2.49	11.92	31.93	0.90	2.40	**12.82**	**34.33**
		8	Aug.	31	22.38	59.94	16.28	2.56	864.7	2.21	63.75	0.16	0.93	2.49	0.90	2.40	0.93	2.49	21.32	57.09	0.90	2.40	**22.21**	**59.50**
		9	Sep.	30	6.67	17.29	16.28	2.56	224.5	0.57	59.50	0.15	0.93	2.41	0.90	2.32	0.93	2.41	5.01	12.98	0.90	2.32	**5.90**	**15.30**
		10	Oct.	31	10.04	26.89	16.28	2.56	380.1	0.97	62.05	0.16	0.93	2.49	0.90	2.40	0.93	2.49	8.52	22.81	0.90	2.40	**9.41**	**25.21**
		11	Nov.	30	2.38	6.18	16.28	2.56	53.4	0.14	89.25	0.23	0.93	2.41	0.90	2.32	0.93	2.41	0.52	1.35	0.90	2.32	**1.42**	**3.68**
		12	Dec.	31	1.55	4.15	16.28	2.56	8.9	0.02	104.55	0.27	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**
1990	23	1	Jan.	31	1.23	3.31	15.30	2.47	35.2	0.09	116.45	0.29	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**
		2	Feb.	28	0.68	1.65	13.51	2.32	21.1	0.05	95.20	0.22	0.93	2.25	0.90	2.17	0.93	2.25			0.90	2.17	**0.90**	**2.17**
		3	Mar.	31	0.80	2.14	10.57	2.07	109.6	0.23	97.75	0.20	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**
		4	Apr.	30	0.85	2.20	7.85	1.83	81.9	0.15	91.80	0.17	0.93	2.41	0.90	2.32	0.93	2.41			0.90	2.32	**0.90**	**2.32**
		5	May	31	4.04	10.81	5.30	1.61	209.5	0.34	73.95	0.12	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**
		6	Jun.	30	16.01	41.49	11.44	2.14	683.9	1.46	80.75	0.17	0.93	2.41	0.90	2.32	0.93	2.41	12.81	33.20	0.90	2.32	**13.71**	**35.53**
		7	Jul.	31	7.52	20.14	16.28	2.56	309.3	0.79	62.05	0.16	0.93	2.49	0.90	2.40	0.93	2.49	5.93	15.88	0.90	2.40	**6.83**	**18.28**
		8	Aug.	31	15.98	42.79	16.28	2.56	625.7	1.60	63.75	0.16	0.93	2.49	0.90	2.40	0.93	2.49	14.69	39.33	0.90	2.40	**15.58**	**41.73**
		9	Sep.	30	15.02	38.94	16.28	2.56	590.7	1.51	59.50	0.15	0.93	2.41	0.90	2.32	0.93	2.41	13.72	35.57	0.90	2.32	**14.62**	**37.89**
		10	Oct.	31	7.04	18.85	16.28	2.56	261.8	0.67	62.05	0.16	0.93	2.49	0.90	2.40	0.93	2.49	5.40	14.47	0.90	2.40	**6.30**	**16.87**
		11	Nov.	30	2.68	6.96	16.28	2.56	111.9	0.29	89.25	0.23	0.93	2.41	0.90	2.32	0.93	2.41	0.88	2.28	0.90	2.32	**1.78**	**4.61**
		12	Dec.	31	1.58	4.24	16.28	2.56	2.0	0.01	104.55	0.27	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**

Table G-56 Reservoir Water Balance Calculation of Proposed Toek Sap Reservoir (Site-3) (6/8)
[Dam Height = 14 m, Water Demand =80,000 m3/day, Release = Qave(Feb), without Hydropower]

1991	24	1	Jan.	31	1.27	3.39	15.37	2.48	37.2	0.09	116.45	0.29	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**
		2	Feb.	28	0.72	1.73	13.68	2.33	23.5	0.05	95.20	0.22	0.93	2.25	0.90	2.17	0.93	2.25			0.90	2.17	**0.90**	**2.17**
		3	Mar.	31	0.48	1.30	10.82	2.09	2.6	0.01	97.75	0.20	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**
		4	Apr.	30	3.54	9.16	7.03	1.76	223.1	0.39	91.80	0.16	0.93	2.41	0.90	2.32	0.93	2.41			0.90	2.32	**0.90**	**2.32**
		5	May	31	4.35	11.66	11.69	2.16	224.1	0.48	73.95	0.16	0.93	2.49	0.90	2.40	0.93	2.49	0.93	2.50	0.90	2.40	**1.83**	**4.90**
		6	Jun.	30	11.62	30.13	16.28	2.56	505.4	1.29	80.75	0.21	0.93	2.41	0.90	2.32	0.93	2.41	10.22	26.48	0.90	2.32	**11.11**	**28.80**
		7	Jul.	31	31.85	85.31	16.28	2.56	1,315.7	3.36	62.05	0.16	0.93	2.49	0.90	2.40	0.93	2.49	31.22	83.62	0.90	2.40	**32.12**	**86.02**
		8	Aug.	31	19.41	51.99	16.28	2.56	720.7	1.84	63.75	0.16	0.93	2.49	0.90	2.40	0.93	2.49	18.21	48.78	0.90	2.40	**19.11**	**51.18**
		9	Sep.	30	20.46	53.03	16.28	2.56	775.2	1.98	59.50	0.15	0.93	2.41	0.90	2.32	0.93	2.41	19.34	50.13	0.90	2.32	**20.24**	**52.45**
		10	Oct.	31	11.57	31.00	16.28	2.56	402.2	1.03	62.05	0.16	0.93	2.49	0.90	2.40	0.93	2.49	10.07	26.97	0.90	2.40	**10.97**	**29.38**
		11	Nov.	30	2.92	7.56	16.28	2.56	4.2	0.01	89.25	0.23	0.93	2.41	0.90	2.32	0.93	2.41	1.01	2.61	0.90	2.32	**1.90**	**4.94**
		12	Dec.	31	1.95	5.23	16.28	2.56	1.0	0.00	104.55	0.27	0.93	2.49	0.90	2.40	0.93	2.49	0.03	0.07	0.90	2.40	**0.92**	**2.47**
1992	25	1	Jan.	31	1.38	3.71	16.28	2.56	1.0	0.00	116.45	0.30	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**
		2	Feb.	29	0.98	2.47	14.80	2.43	58.5	0.14	95.20	0.23	0.93	2.33	0.90	2.25	0.93	2.33			0.90	2.25	**0.90**	**2.25**
		3	Mar.	31	0.65	1.74	12.60	2.24	14.9	0.03	97.75	0.22	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**
		4	Apr.	30	0.60	1.56	9.26	1.95	80.0	0.16	91.80	0.18	0.93	2.41	0.90	2.32	0.93	2.41			0.90	2.32	**0.90**	**2.32**
		5	May	31	2.92	7.82	6.06	1.68	179.6	0.30	73.95	0.12	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**
		6	Jun.	30	15.57	40.37	9.16	1.95	670.9	1.30	80.75	0.16	0.93	2.41	0.90	2.32	0.93	2.41	11.44	29.66	0.90	2.32	**12.34**	**31.99**
		7	Jul.	31	11.69	31.31	16.28	2.56	483.7	1.24	62.05	0.16	0.93	2.49	0.90	2.40	0.93	2.49	10.27	27.49	0.90	2.40	**11.16**	**29.90**
		8	Aug.	31	18.41	49.31	16.28	2.56	717.9	1.84	63.75	0.16	0.93	2.49	0.90	2.40	0.93	2.49	17.21	46.09	0.90	2.40	**18.10**	**48.49**
		9	Sep.	30	10.44	27.06	16.28	2.56	393.3	1.01	59.50	0.15	0.93	2.41	0.90	2.32	0.93	2.41	8.94	23.18	0.90	2.32	**9.84**	**25.50**
		10	Oct.	31	8.54	22.87	16.28	2.56	324.3	0.83	62.05	0.16	0.93	2.49	0.90	2.40	0.93	2.49	6.96	18.65	0.90	2.40	**7.86**	**21.05**
		11	Nov.	30	2.03	5.27	16.28	2.56	9.4	0.02	89.25	0.23	0.93	2.41	0.90	2.32	0.93	2.41	0.13	0.33	0.90	2.32	**1.03**	**2.66**
		12	Dec.	31	1.23	3.31	16.28	2.56	2.6	0.01	104.55	0.27	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**
1993	26	1	Jan.	31	0.97	2.59	14.43	2.40	40.0	0.10	116.45	0.28	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**
		2	Feb.	28	0.53	1.29	11.95	2.18	10.0	0.02	95.20	0.21	0.93	2.25	0.90	2.17	0.93	2.25			0.90	2.17	**0.90**	**2.17**
		3	Mar.	31	1.03	2.77	8.63	1.90	129.7	0.25	97.75	0.19	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**
		4	Apr.	30	2.67	6.92	6.57	1.72	158.9	0.27	91.80	0.16	0.93	2.41	0.90	2.32	0.93	2.41			0.90	2.32	**0.90**	**2.32**
		5	May	31	3.69	9.87	8.87	1.92	196.6	0.38	73.95	0.14	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**
		6	Jun.	30	15.24	39.51	14.08	2.37	654.7	1.55	80.75	0.19	0.93	2.41	0.90	2.32	0.93	2.41	13.09	33.93	0.90	2.32	**13.99**	**36.25**
		7	Jul.	31	18.03	48.28	16.28	2.56	741.9	1.90	62.05	0.16	0.93	2.49	0.90	2.40	0.93	2.49	16.85	45.13	0.90	2.40	**17.75**	**47.53**
		8	Aug.	31	13.39	35.87	16.28	2.56	504.1	1.29	63.75	0.16	0.93	2.49	0.90	2.40	0.93	2.49	11.98	32.10	0.90	2.40	**12.88**	**34.50**
		9	Sep.	30	15.69	40.67	16.28	2.56	607.8	1.55	59.50	0.15	0.93	2.41	0.90	2.32	0.93	2.41	14.41	37.34	0.90	2.32	**15.30**	**39.66**
		10	Oct.	31	7.10	19.03	16.28	2.56	256.3	0.66	62.05	0.16	0.93	2.49	0.90	2.40	0.93	2.49	5.46	14.63	0.90	2.40	**6.36**	**17.03**
		11	Nov.	30	2.60	6.74	16.28	2.56	100.6	0.26	89.25	0.23	0.93	2.41	0.90	2.32	0.93	2.41	0.79	2.04	0.90	2.32	**1.68**	**4.36**
		12	Dec.	31	1.92	5.14	16.28	2.56	42.4	0.11	104.55	0.27	0.93	2.49	0.90	2.40	0.93	2.49	0.03	0.08	0.90	2.40	**0.93**	**2.49**
1994	27	1	Jan.	31	1.68	4.51	16.28	2.56	62.5	0.16	116.45	0.30	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**
		2	Feb.	28	0.98	2.38	15.76	2.51	16.4	0.04	95.20	0.24	0.93	2.25	0.90	2.17	0.93	2.25			0.90	2.17	**0.90**	**2.17**
		3	Mar.	31	3.77	10.09	13.53	2.32	221.2	0.51	97.75	0.23	0.93	2.49	0.90	2.40	0.93	2.49	1.02	2.73	0.90	2.40	**1.92**	**5.13**
		4	Apr.	30	4.14	10.72	16.28	2.56	199.2	0.51	91.80	0.23	0.93	2.41	0.90	2.32	0.93	2.41	2.41	6.26	0.90	2.32	**3.31**	**8.58**
		5	May	31	8.07	21.62	16.28	2.56	352.6	0.90	73.95	0.19	0.93	2.49	0.90	2.40	0.93	2.49	6.51	17.44	0.90	2.40	**7.41**	**19.84**
		6	Jun.	30	14.79	38.34	16.28	2.56	612.9	1.57	80.75	0.21	0.93	2.41	0.90	2.32	0.93	2.41	13.49	34.96	0.90	2.32	**14.39**	**37.29**
		7	Jul.	31	10.29	27.56	16.28	2.56	408.0	1.04	62.05	0.16	0.93	2.49	0.90	2.40	0.93	2.49	8.79	23.55	0.90	2.40	**9.69**	**25.95**
		8	Aug.	31	14.72	39.44	16.28	2.56	560.7	1.43	63.75	0.16	0.93	2.49	0.90	2.40	0.93	2.49	13.37	35.82	0.90	2.40	**14.27**	**38.22**
		9	Sep.	30	19.43	50.35	16.28	2.56	760.4	1.94	59.50	0.15	0.93	2.41	0.90	2.32	0.93	2.41	18.29	47.41	0.90	2.32	**19.19**	**49.74**
		10	Oct.	31	6.07	16.26	16.28	2.56	208.1	0.53	62.05	0.16	0.93	2.49	0.90	2.40	0.93	2.49	4.38	11.74	0.90	2.40	**5.28**	**14.14**
		11	Nov.	30	2.33	6.05	16.28	2.56	23.3	0.06	89.25	0.23	0.93	2.41	0.90	2.32	0.93	2.41	0.44	1.15	0.90	2.32	**1.34**	**3.47**
		12	Dec.	31	1.88	5.05	16.28	2.56	83.4	0.21	104.55	0.27	0.93	2.49	0.90	2.40	0.93	2.49	0.04	0.10	0.90	2.40	**0.93**	**2.50**

Table G-56 Reservoir Water Balance Calculation of Proposed Toek Sap Reservoir (Site-3) (7/8)
[Dam Height = 14 m, Water Demand =80,000 m3/day, Release = Qave(Feb), without Hydropower]

1995	28	1	Jan.	31	1.47	3.93	16.28	2.56	24.8	0.06	116.45	0.30	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**
		2	Feb.	28	0.75	1.82	15.09	2.45	0.6	0.00	95.20	0.23	0.93	2.25	0.90	2.17	0.93	2.25			0.90	2.17	**0.90**	**2.17**
		3	Mar.	31	0.65	1.74	12.25	2.21	53.6	0.12	97.75	0.22	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**
		4	Apr.	30	0.58	1.51	9.00	1.93	63.2	0.12	91.80	0.18	0.93	2.41	0.90	2.32	0.93	2.41			0.90	2.32	**0.90**	**2.32**
		5	May	31	5.60	15.01	5.72	1.65	299.3	0.49	73.95	0.12	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**
		6	Jun.	30	8.19	21.22	16.21	2.55	363.6	0.93	80.75	0.21	0.93	2.41	0.90	2.32	0.93	2.41	6.61	17.14	0.90	2.32	**7.51**	**19.46**
		7	Jul.	31	12.89	34.53	16.28	2.56	544.4	1.39	62.05	0.16	0.93	2.49	0.90	2.40	0.93	2.49	11.52	30.87	0.90	2.40	**12.42**	**33.27**
		8	Aug.	31	23.90	64.00	16.28	2.56	941.1	2.41	63.75	0.16	0.93	2.49	0.90	2.40	0.93	2.49	22.91	61.35	0.90	2.40	**23.80**	**63.76**
		9	Sep.	30	14.16	36.70	16.28	2.56	540.2	1.38	59.50	0.15	0.93	2.41	0.90	2.32	0.93	2.41	12.81	33.19	0.90	2.32	**13.70**	**35.51**
		10	Oct.	31	7.90	21.17	16.28	2.56	286.7	0.73	62.05	0.16	0.93	2.49	0.90	2.40	0.93	2.49	6.29	16.85	0.90	2.40	**7.19**	**19.25**
		11	Nov.	30	2.38	6.18	16.28	2.56	42.9	0.11	89.25	0.23	0.93	2.41	0.90	2.32	0.93	2.41	0.51	1.33	0.90	2.32	**1.41**	**3.65**
		12	Dec.	31	1.63	4.38	16.28	2.56	24.2	0.06	104.55	0.27	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**
1996	29	1	Jan.	31	1.22	3.26	14.43	2.40	19.8	0.05	116.45	0.28	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**
		2	Feb.	29	0.62	1.55	12.57	2.24	2.6	0.01	95.20	0.21	0.93	2.33	0.90	2.25	0.93	2.33			0.90	2.25	**0.90**	**2.25**
		3	Mar.	31	0.50	1.34	9.33	1.96	24.4	0.05	97.75	0.19	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**
		4	Apr.	30	1.07	2.77	5.64	1.64	119.5	0.20	91.80	0.15	0.93	2.41	0.90	2.32	0.75	1.95			0.90	2.32	**0.90**	**2.32**
		5	May	31	0.67	1.79	4.17	1.39	82.6	0.11	73.95	0.10	0.93	2.49	0.90	2.40	0.00	0.00			0.67	1.80	**0.67**	**1.80**
		6	Jun.	30	0.62	1.60	4.17	1.39	60.0	0.08	80.75	0.11	0.93	2.41	0.90	2.32	0.00	0.00			0.61	1.57	**0.61**	**1.57**
		7	Jul.	31	8.44	22.60	4.17	1.39	390.6	0.54	62.05	0.09	0.93	2.49	0.90	2.40	0.93	2.49	2.26	6.05	0.90	2.40	**3.16**	**8.45**
		8	Aug.	31	10.11	27.07	16.28	2.56	422.5	1.08	63.75	0.16	0.93	2.49	0.90	2.40	0.93	2.49	8.62	23.09	0.90	2.40	**9.52**	**25.49**
		9	Sep.	30	11.92	30.90	16.28	2.56	497.3	1.27	59.50	0.15	0.93	2.41	0.90	2.32	0.93	2.41	10.53	27.29	0.90	2.32	**11.42**	**29.61**
		10	Oct.	31	4.04	10.81	16.28	2.56	175.7	0.45	62.05	0.16	0.93	2.49	0.90	2.40	0.93	2.49	2.32	6.21	0.90	2.40	**3.21**	**8.61**
		11	Nov.	30	11.22	29.09	16.28	2.56	492.3	1.26	89.25	0.23	0.93	2.41	0.90	2.32	0.93	2.41	9.79	25.38	0.90	2.32	**10.69**	**27.71**
		12	Dec.	31	1.50	4.02	16.28	2.56	11.8	0.03	104.55	0.27	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**
1997	30	1	Jan.	31	0.98	2.64	15.17	2.46	3.4	0.01	116.45	0.29	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**
		2	Feb.	28	0.77	1.86	12.64	2.24	75.0	0.17	95.20	0.21	0.93	2.25	0.90	2.17	0.93	2.25			0.90	2.17	**0.90**	**2.17**
		3	Mar.	31	0.45	1.21	10.03	2.02	6.4	0.01	97.75	0.20	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**
		4	Apr.	30	0.47	1.21	6.16	1.69	84.3	0.14	91.80	0.15	0.93	2.41	0.90	2.32	0.33	0.86			0.90	2.32	**0.90**	**2.32**
		5	May	31	1.98	5.31	4.17	1.39	146.6	0.20	73.95	0.10	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**
		6	Jun.	30	1.22	3.16	4.69	1.51	90.6	0.14	80.75	0.12	0.93	2.41	0.90	2.32	0.53	1.37			0.90	2.32	**0.90**	**2.32**
		7	Jul.	31	19.54	52.35	4.17	1.39	841.6	1.17	62.05	0.09	0.93	2.49	0.90	2.40	0.93	2.49	13.60	36.42	0.90	2.40	**14.50**	**38.83**
		8	Aug.	31	11.01	29.48	16.28	2.56	435.0	1.11	63.75	0.16	0.93	2.49	0.90	2.40	0.93	2.49	9.53	25.53	0.90	2.40	**10.43**	**27.94**
		9	Sep.	30	6.42	16.64	16.28	2.56	253.1	0.65	59.50	0.15	0.93	2.41	0.90	2.32	0.93	2.41	4.78	12.40	0.90	2.32	**5.68**	**14.73**
		10	Oct.	31	3.95	10.59	16.28	2.56	168.5	0.43	62.05	0.16	0.93	2.49	0.90	2.40	0.93	2.49	2.23	5.96	0.90	2.40	**3.12**	**8.37**
		11	Nov.	30	3.79	9.81	16.28	2.56	185.0	0.47	89.25	0.23	0.93	2.41	0.90	2.32	0.93	2.41	2.05	5.32	0.90	2.32	**2.95**	**7.65**
		12	Dec.	31	1.13	3.04	16.28	2.56	1.6	0.00	104.55	0.27	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**
1998	31	1	Jan.	31	0.83	2.23	14.16	2.37	35.6	0.08	116.45	0.28	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**
		2	Feb.	28	0.45	1.09	11.31	2.13	20.0	0.04	95.20	0.20	0.93	2.25	0.90	2.17	0.93	2.25			0.90	2.17	**0.90**	**2.17**
		3	Mar.	31	0.35	0.94	7.82	1.83	18.4	0.03	97.75	0.18	0.93	2.49	0.90	2.40	0.76	2.04			0.90	2.40	**0.90**	**2.40**
		4	Apr.	30	0.28	0.73	4.17	1.39	34.6	0.05	91.80	0.13	0.93	2.41	0.90	2.32	0.00	0.00			0.25	0.66	**0.25**	**0.66**
		5	May	31	5.84	15.63	4.17	1.39	321.9	0.45	73.95	0.10	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**
		6	Jun.	30	16.79	43.53	15.26	2.47	726.6	1.79	80.75	0.20	0.93	2.41	0.90	2.32	0.93	2.41	15.18	39.36	0.90	2.32	**16.08**	**41.68**
		7	Jul.	31	11.76	31.49	16.28	2.56	489.2	1.25	62.05	0.16	0.93	2.49	0.90	2.40	0.93	2.49	10.34	27.69	0.90	2.40	**11.23**	**30.09**
		8	Aug.	31	14.26	38.19	16.28	2.56	554.2	1.42	63.75	0.16	0.93	2.49	0.90	2.40	0.93	2.49	12.90	34.55	0.90	2.40	**13.80**	**36.95**
		9	Sep.	30	15.93	41.28	16.28	2.56	629.5	1.61	59.50	0.15	0.93	2.41	0.90	2.32	0.93	2.41	14.66	38.00	0.90	2.32	**15.56**	**40.32**
		10	Oct.	31	7.57	20.28	16.28	2.56	283.5	0.72	62.05	0.16	0.93	2.49	0.90	2.40	0.93	2.49	5.96	15.95	0.90	2.40	**6.85**	**18.35**
		11	Nov.	30	3.20	8.30	16.28	2.56	132.8	0.34	89.25	0.23	0.93	2.41	0.90	2.32	0.93	2.41	1.42	3.68	0.90	2.32	**2.31**	**6.00**
		12	Dec.	31	1.72	4.60	16.28	2.56	23.0	0.06	104.55	0.27	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**

Table G-56 Reservoir Water Balance Calculation of Proposed Toek Sap Reservoir (Site-3) (8/8)
[Dam Height = 14 m, Water Demand =80,000 m3/day, Release = Qave(Feb), without Hydropower]

1999	32	1	Jan.	31	1.17	3.13	15.56	2.50	0.0	0.00	116.45	0.29	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**
		2	Feb.	28	0.55	1.33	13.50	2.32	0.0	0.00	95.20	0.22	0.93	2.25	0.90	2.17	0.93	2.25			0.90	2.17	**0.90**	**2.17**
		3	Mar.	31	1.60	4.29	10.20	2.03	150.6	0.31	97.75	0.20	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**
		4	Apr.	30	5.55	14.39	9.70	1.99	275.2	0.55	91.80	0.18	0.93	2.41	0.90	2.32	0.93	2.41	1.33	3.44	0.90	2.32	**2.22**	**5.76**
		5	May	31	8.07	21.62	16.28	2.56	363.3	0.93	73.95	0.19	0.93	2.49	0.90	2.40	0.93	2.49	6.52	17.46	0.90	2.40	**7.42**	**19.87**
		6	Jun.	30	12.51	32.42	16.28	2.56	527.7	1.35	80.75	0.21	0.93	2.41	0.90	2.32	0.93	2.41	11.12	28.83	0.90	2.32	**12.02**	**31.15**
		7	Jul.	31	16.48	44.13	16.28	2.56	673.7	1.72	62.05	0.16	0.93	2.49	0.90	2.40	0.93	2.49	15.23	40.80	0.90	2.40	**16.13**	**43.20**
		8	Aug.	31	8.60	23.05	16.28	2.56	313.8	0.80	63.75	0.16	0.93	2.49	0.90	2.40	0.93	2.49	7.02	18.79	0.90	2.40	**7.91**	**21.19**
		9	Sep.	30	13.22	34.28	16.28	2.56	515.9	1.32	59.50	0.15	0.93	2.41	0.90	2.32	0.93	2.41	11.85	30.71	0.90	2.32	**12.74**	**33.03**
		10	Oct.	31	11.06	29.61	16.28	2.56	425.6	1.09	62.05	0.16	0.93	2.49	0.90	2.40	0.93	2.49	9.58	25.65	0.90	2.40	**10.47**	**28.05**
		11	Nov.	30	8.02	20.79	16.28	2.56	325.3	0.83	89.25	0.23	0.93	2.41	0.90	2.32	0.93	2.41	6.43	16.66	0.90	2.32	**7.32**	**18.98**
		12	Dec.	31	2.18	5.85	16.28	2.56	48.6	0.12	104.55	0.27	0.93	2.49	0.90	2.40	0.93	2.49	0.30	0.82	0.90	2.40	**1.20**	**3.22**
2000	33	1	Jan.	31	1.98	5.31	16.28	2.56	70.8	0.18	116.45	0.30	0.93	2.49	0.90	2.40	0.93	2.49	0.11	0.31	0.90	2.40	**1.01**	**2.71**
		2	Feb.	29	1.50	3.76	16.28	2.56	79.9	0.20	95.20	0.24	0.93	2.33	0.90	2.25	0.93	2.33			0.90	2.25	**0.90**	**2.25**
		3	Mar.	31	1.28	3.44	15.43	2.48	64.5	0.16	97.75	0.24	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**
		4	Apr.	30	5.85	15.17	13.89	2.35	289.1	0.68	91.80	0.22	0.93	2.41	0.90	2.32	0.93	2.41	3.28	8.51	0.90	2.32	**4.18**	**10.83**
		5	May	31	6.59	17.64	16.28	2.56	286.2	0.73	73.95	0.19	0.93	2.49	0.90	2.40	0.93	2.49	4.96	13.29	0.90	2.40	**5.86**	**15.69**
		6	Jun.	30	13.96	36.18	16.28	2.56	577.5	1.48	80.75	0.21	0.93	2.41	0.90	2.32	0.93	2.41	12.62	32.71	0.90	2.32	**13.52**	**35.04**
		7	Jul.	31	10.84	29.03	16.28	2.56	430.9	1.10	62.05	0.16	0.93	2.49	0.90	2.40	0.93	2.49	9.36	25.08	0.90	2.40	**10.26**	**27.48**
		8	Aug.	31	24.91	66.73	16.28	2.56	962.8	2.46	63.75	0.16	0.93	2.49	0.90	2.40	0.93	2.49	23.94	64.13	0.90	2.40	**24.84**	**66.54**
		9	Sep.	30	4.67	12.10	16.28	2.56	135.9	0.35	59.50	0.15	0.93	2.41	0.90	2.32	0.93	2.41	2.92	7.56	0.90	2.32	**3.81**	**9.89**
		10	Oct.	31	13.11	35.11	16.28	2.56	500.2	1.28	62.05	0.16	0.93	2.49	0.90	2.40	0.93	2.49	11.70	31.33	0.90	2.40	**12.60**	**33.74**
		11	Nov.	30	2.55	6.61	16.28	2.56	53.9	0.14	89.25	0.23	0.93	2.41	0.90	2.32	0.93	2.41	0.69	1.79	0.90	2.32	**1.59**	**4.11**
		12	Dec.	31	1.77	4.73	16.28	2.56	25.5	0.07	104.55	0.27	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**
2001	34	1	Jan.	31	1.77	4.73	15.92	2.53	104.6	0.26	116.45	0.29	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**
		2	Feb.	28	1.32	3.19	15.73	2.51	62.2	0.16	95.20	0.24	0.93	2.25	0.90	2.17	0.93	2.25			0.90	2.17	**0.90**	**2.17**
		3	Mar.	31	2.65	7.10	14.42	2.40	166.4	0.40	97.75	0.23	0.93	2.49	0.90	2.40	0.93	2.49	0.19	0.51	0.90	2.40	**1.09**	**2.91**
		4	Apr.	30	3.22	8.34	16.28	2.56	156.0	0.40	91.80	0.23	0.93	2.41	0.90	2.32	0.93	2.41	1.46	3.77	0.90	2.32	**2.35**	**6.10**
		5	May	31	9.94	26.62	16.28	2.56	423.7	1.08	73.95	0.19	0.93	2.49	0.90	2.40	0.93	2.49	8.45	22.62	0.90	2.40	**9.34**	**25.02**
		6	Jun.	30	14.11	36.57	16.28	2.56	579.6	1.48	80.75	0.21	0.93	2.41	0.90	2.32	0.93	2.41	12.77	33.11	0.90	2.32	**13.67**	**35.43**
		7	Jul.	31	7.57	20.28	16.28	2.56	293.8	0.75	62.05	0.16	0.93	2.49	0.90	2.40	0.93	2.49	5.97	15.98	0.90	2.40	**6.86**	**18.38**
		8	Aug.	31	21.73	58.20	16.28	2.56	841.2	2.15	63.75	0.16	0.93	2.49	0.90	2.40	0.93	2.49	20.64	55.29	0.90	2.40	**21.54**	**57.69**
		9	Sep.	30	8.59	22.26	16.28	2.56	305.1	0.78	59.50	0.15	0.93	2.41	0.90	2.32	0.93	2.41	7.00	18.15	0.90	2.32	**7.90**	**20.48**
		10	Oct.	31	8.92	23.90	16.28	2.56	333.7	0.85	62.05	0.16	0.93	2.49	0.90	2.40	0.93	2.49	7.35	19.70	0.90	2.40	**8.25**	**22.10**
		11	Nov.	30	2.27	5.88	16.28	2.56	32.5	0.08	89.25	0.23	0.93	2.41	0.90	2.32	0.93	2.41	0.39	1.00	0.90	2.32	**1.28**	**3.32**
		12	Dec.	31	1.55	4.15	16.28	2.56	26.0	0.07	104.55	0.27	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**
2002	35	1	Jan.	31	1.07	2.86	15.34	2.48	7.4	0.02	116.45	0.29	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**
		2	Feb.	28	0.58	1.41	13.04	2.28	6.8	0.02	95.20	0.22	0.93	2.25	0.90	2.17	0.93	2.25			0.90	2.17	**0.90**	**2.17**
		3	Mar.	31	0.58	1.56	9.83	2.00	84.9	0.17	97.75	0.20	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**
		4	Apr.	30	2.83	7.35	6.47	1.71	183.2	0.31	91.80	0.16	0.93	2.41	0.90	2.32	0.93	2.41			0.90	2.32	**0.90**	**2.32**
		5	May	31	8.90	23.85	9.24	1.95	403.9	0.79	73.95	0.14	0.93	2.49	0.90	2.40	0.93	2.49	4.69	12.56	0.90	2.40	**5.59**	**14.97**
		6	Jun.	30	10.06	26.06	16.28	2.56	431.0	1.10	80.75	0.21	0.93	2.41	0.90	2.32	0.93	2.41	8.57	22.22	0.90	2.32	**9.47**	**24.55**
		7	Jul.	31	6.12	16.39	16.28	2.56	256.2	0.66	62.05	0.16	0.93	2.49	0.90	2.40	0.93	2.49	4.48	12.00	0.90	2.40	**5.38**	**14.40**
		8	Aug.	31	23.55	63.07	16.28	2.56	932.7	2.38	63.75	0.16	0.93	2.49	0.90	2.40	0.93	2.49	22.55	60.39	0.90	2.40	**23.45**	**62.80**
		9	Sep.	30	13.51	35.01	16.28	2.56	518.4	1.33	59.50	0.15	0.93	2.41	0.90	2.32	0.93	2.41	12.13	31.45	0.90	2.32	**13.03**	**33.77**
		10	Oct.	31	2.63	7.06	16.28	2.56	70.5	0.18	62.05	0.16	0.93	2.49	0.90	2.40	0.93	2.49	0.82	2.19	0.90	2.40	**1.71**	**4.59**
		11	Nov.	30	4.24	10.98	16.28	2.56	190.3	0.49	89.25	0.23	0.93	2.41	0.90	2.32	0.93	2.41	2.51	6.50	0.90	2.32	**3.41**	**8.83**
		12	Dec.	31	0.00	0.00	16.28	2.56	22.6	0.06	104.55	0.27	0.93	2.49	0.90	2.40	0.93	2.49			0.90	2.40	**0.90**	**2.40**

Table G-57 Construction Cost of Proposed Toek Sap Reservoir (Site-3) [H = 14 m, Demand =80,000 m^3/d, Release = $Q_{ave(Feb)}$, wo.HEP]

A. Direct Construction Cost (1,000US$)

Particular	Unit Price		Q'ty		Cost
	Unit	(US$)	Unit		(x 1,000 US$)
(1) River Diversion Scheme					**704.8**
Open excavation	m3	5.8	103 m3	5.70	33.3
Tunnel excavation	m3	40.7	103 m3	7.12	290.1
Lining concrete	m3	147.5	103 m3	0.91	134.9
Curtain grouting	m	119.8	103 m	0.16	19.7
Consolidation grouting	m	119.8	103 m	0.75	90.3
Re-bar	ton	836.9	ton	36.58	30.6
Cofferdam embankment	m3	5.3	103 m3	20.00	105.8
(2) Dam					**4,755.4**
Main dam embankment	m3	6.6	103 m3	298.10	1,971.9
Foundation excavation	m3	5.8	103 m3	116.42	680.9
Curtain grouting	m	119.8	103 m	3.32	397.8
Consolidation grouting	m	119.8	103 m	14.23	1,704.8
Open concrete works	m3	97.5	103 m3	0.00	0.0
Re-bar	ton	836.9	ton	0.00	0.0
(3) Spillway					**2,267.8**
Open excavation	m3	5.8	103 m3	151.82	887.9
Open concrete works	m3	97.5	103 m3	11.25	1,097.4
Re-bar	ton	836.9	ton	337.50	282.4
(4) Bottom Outlet					**39.3**
Open excavation	m3	5.8	103 m3	1.08	6.3
Tunnel excavation	m3	40.7	103 m3	0.31	12.6
Lining concrete	m3	147.5	103 m3	0.06	9.3
Curtain grouting	m	119.8	103 m	0.04	5.2
Consolidation grouting	m	119.8	103 m	0.03	3.6
Re-bar	ton	836.9	ton	2.53	2.1
(5) Intake					**16.2**
Open excavation	m3	5.8	103 m3	0.28	1.6
Open concrete works	m3	97.5	103 m3	0.12	11.5
Re-bar	ton	836.9	ton	3.55	3.0
(6) Headrace Tunnel					**5.2**
Tunnel excavation	m3	40.7	103 m3	0.01	0.5
Lining concrete	m3	147.5	103 m3	0.00	0.0
Re-bar	ton	836.9	ton	0.01	0.0
Consolidation grouting	m	119.8	103 m3	0.04	4.7
(7) Penstock Line					**6.0**
Open excavataion	m3	5.8	103 m3	0.62	3.6
Open concrete works	m3	97.5	103 m3	0.02	2.1
Re-bar	ton	836.9	ton	0.42	0.4
(8) Powerhouse					**0.0**
Open excavation	m3	5.8	103 m3	0.00	0.0
Open concrete works	m3	97.5	103 m3	0.00	0.0
Re-bar	ton	836.9	ton	0.00	0.0
(9) Intake Weir (at Downstream)					**0.0**
Open excavation	m3	6.6	103 m3	0.00	0.0
Open concrete works	m3	97.5	103 m3	0.00	0.0
Re-bar	ton	836.9	ton	0.00	0.0
(10) Pump house	**3**	**sites**			**19.0**
Open excavation	m3	6.6	103 m3	0.06	0.4
Open concrete works	m3	97.5	103 m3	0.13	13.0
Re-bar	ton	836.9	ton	6.66	5.6
(11) Miscellaneous Cost for Civil					
Civil Works (No.1 to No.10)	-	1.0%			**77.9**

Particular	Unit Price		Q'ty	
	Unit	(US$)	Unit	
(12) Metal Works				
Diversion tunnel stoplogs	ton	4,000	ton	37.23
Spillway stoplogs	ton	4,000	ton	58.80
Spillway gate	ton	7,350	ton	0.00
Bottom outlet valves	ton	6,000	ton	10.74
Intake screen and gate (U/S)	ton	6,000	ton	1.45
Penstock pipe	ton	6,000	ton	5.36
Tailrace gates	ton	6,000	ton	30.45
Intake screen and gate (D/S.)	ton	6,000	ton	0.48
Intake pipe (to pump)	ton	6,000	ton	0.85
(13) Generating Equipment				
Water turbine	kW	593	kW	0.0
Generator	kW	incl.Turb.	kW	incl.Turb
Transforner	kVA	8.0	MVA	0.0
Indoor switchgear	kVA	31.5		
Ancillary equip. and others	kVA	16.0		
(14) Transmission Line and Substation				
Transmission line	km	189,000	km	15.00
Substation	MVA	12.6		
(15) Pump Facility				
Pump (28 m3/min, H=50 m, 200kW)	unit	411,000	unit	6
(16) Miscellaneous M & E Works				
M & E Works (No.10 to No.12)	-	1.0%		

B. Preparatory Works Cost (1,000US$)

B-1 Construction of Temporary Facilities

Particular	Unit Price		Q'ty	
	Unit	(US$)	Unit	
New road construction	US$/km	315,000	km	2.0
Existing road betterment	US$/km	105,000	km	3.0
Telecommunication line	US$/km	10,500	km	15.0
Power distribution line	US$/km	21,000	km	2.0
Employer's site facilities	US$/m2	11	m2	2,500
Total cost				

B-2 Land compensation

Access road (W=30m)			m2	60,000
Dam site			m2	42,100
Power Generation & Pump station			m2	625
Others (30% of the abobe 3 items)			m2	30,900
Total area to be compensated	2.5	US$/m2	m2	133,625
B-3 Relocation of Road				
Relocation road (=FSL Area / 5km2)	US$/km	157,500	km	0
	Total cost	(1,000US$)		

C. Total Project Cost

Particular
Direct Construction Cost of Civil (1-11)
Direct Construction Cost of M&E (12-16)
Preparatory Works Cost (B-1 to B-3)
Total Construction Cost

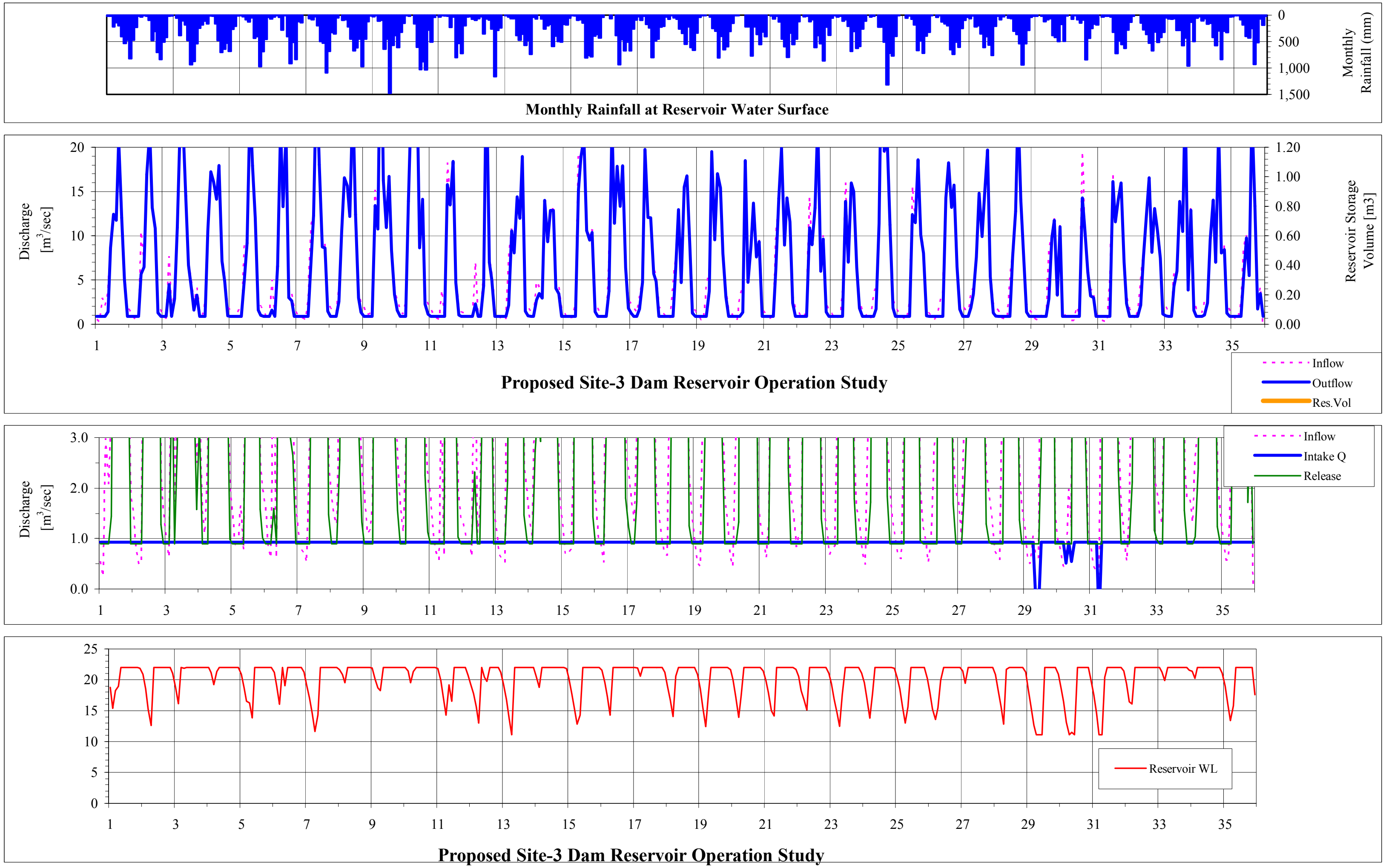

Figure G-50 Results of Reservoir Operation of Proposed Toek Sap Reservoir (Site-3)
[Dam Height = 14 m, Water Demand =80,000 m^3/day, Release = $Q_{ave(Feb)}$, without Hydropower]

The Study on Regional Development of The Phnom Penh - Sihanoukville Growth Corridor in The Kingdom of Cambodia	**Figure G-51** **Layout Plan of Proposed Toek Sap Reservoir**
Japan International Cooperation Agency (JICA)	

G.11 INVESTMENT ENVIRONMENT OF CAMBODIA

G.11.1 Comparison study of investment cost

Table G-58 shows the comparative analysis concerning the investment cost in the neighboring countries and Cambodia. Problems of Cambodian investment cost is summarized in **Table G-59**.

Table G-58 Necessary Cost for FDI in Asian Countries

Country		Cambodia		Thailand	China		Vietnam		Philippine	Malaysia	Myanmar	Sri Lanka
City		Phnom Penh	Sihanouk ville	BKK	Shenzhen	Shanghai	Hanoi	HCMN	Manila	KL	Yangon	Colombo
Date of source		Nov. 2001	Nov. 2001	Nov. 2001	Nov. 2001	Nov. 2001	Nov. 2001	Nov. 2001	Mar. 2001	Oct. 2001	Nov. 2001	Nov. 2001
Monthly salary	Worker (incl. of fringe benefit)	60-70	60-70	140	40-110	190-280	75-115	95-140	90-145	200	17-35	47-90
	Engineer/Supervisor	100-500	100-300	300	120-250	280-460	190-310	155-290	170-380	710	80-140	95-150
	Manager	500-2,500	n.a.	620	340-720	430-910	470-540	470-620	350-790	1,500	130-240	150-420
	Minimum wage by law	45	45	3.71/day	69.35	59.2	41.6	41.6	4.55/day	undefined	undefined	37
Land/office price	Factory lot sale in IE ($/m^2)	20 – 40 (outside IE)	n.a.	30-70	14 (50 years)	25 (50 years)	80 (30 years)	100 (40-50 years)	60-70 (50 years)	50-100	50 (46 years)	6 (50 years)
	Factory lot lease in IE ($/m^2/month)	0.1 – 0.2	n.a.	unknown	0.24	unavailable	0.22	0.23	unknown	unknown	0.11	0.06
	Office floor ($/m^2/month)	10-20	10-20	10	12-14.5	30	22	16	10-12	11-14	15	12
	Apartment ($/month)	1,000-2,000	800-1,500	1,350-1,460	360-970	2,150-4,000	1,700	1,800	1,300-1,600	1,300	1,800	750-1,100
Utility	Electricity ($/kWh)	0.21	0.21	0.04	0.09-0.12	0.07	0.07	0.07	0.037	0.05	0.08	0.05
	Water ($/cum)	0.20	0.25	0.21-0.36	0.23-0.29	0.15	0.23	0.23	0.17	0.50	0.95	0.27
	Telephone (3 min. to Japan)	4.8	4.8	2.3	2.9	2.9	6.9	6.9	1.2	2.6	8.1	2.0
Transport (40 ft container to Yokohama port Japan)		1,800	1,600	1,450	1,250	700	1,500	1,500	1,100	700	1,600 (20 feet)	950

Source: Result of factory interview survey for Cambodia, JETRO data for the others

Note: Advantageous (green) Disadvantageous (magenta)

Table G-59 Problems in Cambodian Investment Cost

Labor Cost	Worker	Although the worker cost of Cambodia has advantages comparing with Thailand, China coastal area and Vietnam, inland of China area provides cheaper cost. Comparing with Sri Lanka, that has three folds per capita GDP, Cambodian worker cost is disadvantageous. Minimum wage applied for the garment and shoes industry legally, which is required for GSP treatment by USA and EU and inevitable for preferential export, is the reason of the disadvantageous labor cost. Considering that Cambodia is planning to enter the WTO, where the free trade is the principles, discussion for the balance between industrial promotion and minimum labor wage preference will be necessary.
	Engineer/ Supervisor	Supervisors from mainland China are employed in the garment and shoes factory in Cambodia paying approximately US$ 500 for the monthly salary. In the competing countries, US$ 150 – 300 is paid to the supervisor. Program of education and nourishment of supervisors and engineers are carried out in the Cambodian Garment Training Center by the cooperation of Japanese Government for the garment industry. Factory owners are corporative for the program and the gradual replacement of Chinese supervisors by cheaper Cambodian trainees will be done.
	Manager	The shortage of human resources for managing works is the reason of the high wage of the managers of the FDI enterprises in Cambodia. On the basis of the interview results, foreigners from the original countries of FDI and Chinese Cambodian who have the experience of study abroad are the managers of FDI factories. Wage level of the managers become consequently higher. Number of graduates from the universities and institutes should be enlarged and professional education and training should be done.
Price of factory land		Land price of factory site is estimated at 20 - 40$/m^2 in the suburb of Phnom Penh City. This price is cheaper than 100$/m^2 of EPZ located in Ho Chi Minh, Vietnam. However, Thailand provides only 30-70$/m^2 for the industrial estates in the Eastern Seaboard and price of 14$/m^2 in China and 6$/m^2 in Sri Lanka are the overwhelmingly cheap. To compete with these countries, Cambodia should lower the price of factory land by mitigation of the development cost and the public support for the basic infrastructure.

Table G-59 Problems in Cambodian Investment Cost (con.t)

Cost of utility and services	In the course of the factory interview, almost all factories pointed out the high prices of electricity and telecommunication services. China and Vietnam, strong competitors, provide half or one third for the electric tariff. Furthermore, factories in Cambodia should facilitate own generators to cope with frequent black out. If the electric tariff becomes same level of China and Vietnam, factories can depend on the public electric supply to save the generator cost. Telecommunication cost become sharply lower thanks to the open market policy for the private company. However, the tariff is still two folds of Thailand. Telecommunication quality such as high-speed data transmission is still disadvantageous for the factories located in the suburb area. Note: Telecommunication prices in Vietnam are higher than Cambodia due to the firewall problem and Cambodia has advantage in this point.
Transportation cost	Transportation cost of 40 feet container from Sihanoukville to Yokohama Port in Japan is estimated at approximately US$ 1,600, while US$ 700 is from Shanghai Port or Ports in Malaysia. This higher cost for the cargo handling in Sihanoukville Port is understandable due to the scale demerit and inefficient port operation to be tackled with by the port authority. However approximately US$ 700 additionally necessary for custom clearance and relevant procedure should be rationalized referring to the fact that US$ 200 for custom clearance is normal in the neighboring countries. The reduction of total transportation cost by means of the modernization of cargo transportation method and transparency of import and export custom procedure should be urgently realized.

G.11.2 Comparison analysis of investment incentives

Table G-60 shows comparison summary of investment incentives of neighboring countries.

(1) Problem of current Investment Law

The current Investment Law of Cambodia needs several amendments due to the lack of detailed definition. However, from the investment incentive points of view, the current Investment Law of Cambodia seems to be competing with laws of the neighboring countries. For instance;

- Same or preferential treatment can applied to FDI in Cambodia in corporate income tax and import/export taxes. Exemption and reduction treatment for the tax is same or preferable than the neighboring counties,[23]
- 100 % owned by the FDI investors and 70 years limit for land lease period are competing with the neighboring countries,

[23] VAT exemption is possible in EPZ of the neighboring country, while no definition can be seen in Cambodia. This point should be improved for the FDI promotion.

- A one-stop service organization for the investment application and permission procedure is developed as same as the neighboring countries. Moreover, evaluation period of 28 days for investment approval is same as 1 month of Thailand.

Despite of the above, there are a lot of problems in the arbitrary understanding and application by relevant organizations concerned as described below.

1) As many FDI investors indicated, Council for the Development of Cambodia (CDC) and custom interfere the import and export activities. For instance, CDC improperly examined application submitted by factory for the material import in order to receive the preferential tax rate for import good. A FDI enterprise witnessed that three months was necessary to get permission from CDC and one third of applied volume was only permitted to import.
2) There are many document procedures for the export works. The export-oriented enterprises consume a lot of time and cost to clear the complicated procedure.
3) Application for the export permission attached with samples should be done to the central government in Phnom Penh. This should be done by each export business. The time and cost for commuting the capital from the local area hazards the production efficiency. If the product is to be examined by the authorized organization for the guarantee of the quality, a systematic and effective examination should be taken.
4) Pre-shipment Document Investigation (PSI) by SGS (Society General of Surveillance makes the import and export procedure complicated in Cambodia. Originally PSI is designed to supervise the illegal trade and simplification of traffic supervision by the pre-shipment documentation. When the PSI is introduced, the procedure in custom should be simplified. However, nevertheless the PSI started in 2002 in Cambodia, the custom procedure is unchanged and the enterprises are obliged to do double document works presently.[24]
5) When the actual production amount is different from the annual production plan submitted by factory, CDC claimed for CDC status. They do not understand the actual production activity in the market economy.
6) The investors with much acknowledgement about investment promotion organization in the neighboring countries do not think that CDC is well developed as the one-stop service center. One-stop service center should be upgraded with sophisticated facility and empowered staffs.

[24] Vietnam does not adopt the PSI.

7) Cambodia as well as Thailand has the centralized investment promotion organization, while Vietnam developed local absolute authorities such as Ho Chi Minh City EPZ and IZ Authority (HEPZA) at Ho Chi Minh City. Cambodia should analyze whether the local authority system is suitable or not for the efficient and effective promotion of FDI in Cambodian.

(2) Problems of Revised Investment Law

The revision of the Investment Law, being deliberated in the National Council, has some problems as cited below.

1) New Investment Law does not design the specific investment incentives for the Industrial Zone (IZ) and EPZ and same incentives are applied wherever project is developed. Without specific incentives for enterprises established in IZ and EPZ, attractiveness of IZ and EPZ is reduced. Considering that the development of IZ and EPZ is strong measure for the industrial development in the developing countries with poor infrastructure, attractiveness of IZ and EPZ should be strengthened.[25]

2) New Investment Law does not mention about the reduction of corporate tax rate after the expiration of the tax holiday, although the current Investment law defines the preferential corporate tax rate of 9% for infinite period instead of the normal rate of 20%.

3) The idea that the less preferential treatment is desirable for both the domestic and overseas enterprises for the free trade seems to support the revisions of the Investment Law. However, the unattractive investment environment in Cambodia caused by the detrimental revision of the Investment Law will reduce the FDI and consequently constraints the industrial development in Cambodia.

[25] Ministry of Industry is now preparing the Law on IZ to support the atstractiveness of the IZ.

Table G-60 Comparison of Investment Incentives

Item	Cambodia	Chinese ESZ	Thai EPZ/IE	Philippine Eco-zone	Vietnam EPZ/IE
Preferential Corporate Profit Tax	• 1 - 8 year tax holiday is applicable in accordance with the criteria defined by Sub-decree for the CDC licensed projects/enterprises • 3 years+ n(by new investment law)	2 years tax holiday (1 year for service industry)	3-8 years tax holiday (3years in IE of Zone I, 3-5 years in Zone II (5 years in IE), 8 years in Zone III & Laem Chabang IE) *Laem Chabang IE will be categorized in Zone II after 2005.	4 years tax holiday for non-pioneer projects, 6-8 years for pioneer projects. (Those projects outside Eco-zone can also receive tax holiday)	4 years tax holiday in EPZ 1-2 years tax holiday for outside EPZ (4 years tax holiday for enterprises with 80 % export or over) 8 years tax holiday for high-tech industry
	Reduction to 9% for the CDC licensed projects/enterprises (except for exploration and exploitation of natural resources including timber, oil and gas, gold and precious stones) Note：New Investment Law does not indicate any concession of profit tax instead of ordinary tax rate of 20%	Reduction to 7.5% for three years after termination of tax holiday (2 years for service industry) Then reduction to 15% (10% to enterprises with 70% export or over) Note: normal rate outside ESZ is 33%. However, rate of 25% will be applied to all enterprises due of the entry into WTO on Dec. 11, 2001.	50% reduction for 5 years after tax holiday in Zone III & Laem Chabang IE. Note: normal tax is 30% Until the end of 2004 for Laem Chabang IE.	Enterprises in Eco-zone can enjoy a special tax rate of 5% of gross income (sales – cost) exempting the other taxes after the termination of tax holiday. Note: normal rate is 32%.	Reduction to 10% for manufacturer in EPZ, enterprise with 80% export or over, and high-tech industries (15 years). Reduction to 15% for service industries in EPZ & enterprises with 50% - 80% export (12 years). Reduction to 20% for enterprises with less than 50% export (10 years). Note: normal rate is 25%.
Other Tax	Exemption of remittance tax. 5 years carry over of loss VAT exemption by new law (presently 10% levied)	Exemption of remittance tax	Free remittance 5 years carry over of loss VAT exemption for EPZ	Remittance of earnings without prior approval from the Philippine Central Bank	Reduction of remittance tax to 3% for EPZ/IE (normal rate is 7%) VAT exemption for EPZ
Land Leasing	70 years land lease Building ownership by foreigner is not clearly defined by the law.	30-50 years land lease (3 years free and half rate of lease charge for succeeding 3 years for high-tech industry)	The land ownership by foreign enterprises (more than 50% foreign share) can be approved.	50-75 years land lease	Duration of land lease shall conform to the duration of operation as specified in investment license (less than 50 years, maximum 70 years).
Organization for investment license	CDC (Council for the Development of Cambodia)	Provincial Government	BOI & IEAT (Industrial Estate of Thailand)	PEZA (Philippine Economic Zone Authority) OSAC (The One Stop Action Center for Investment)	Each province/city authority can independently work as the one-stop service center.
Others	Approval of 100% foreign capital enterprises in almost sectors.	Approval of 100% foreign capital enterprises except for negative list category	Approval of 100% foreign capital for manufacturing industry enterprises	Approval of 100% foreign capital enterprises except for negative list category	Approval of 100% foreign capital enterprises except for negative list category