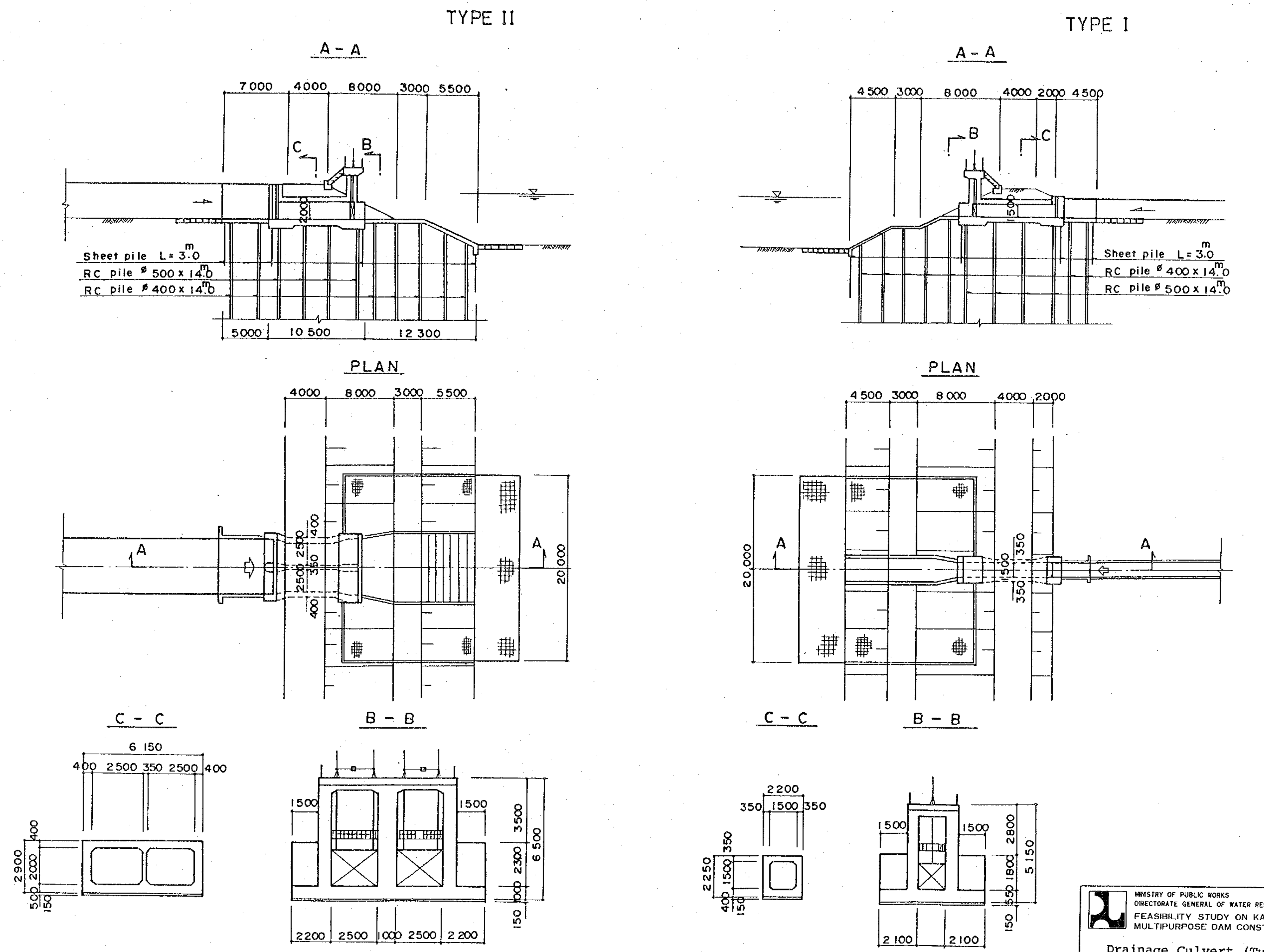
Fig. H-29(1)



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Drainage Culvert (Type-I, II)

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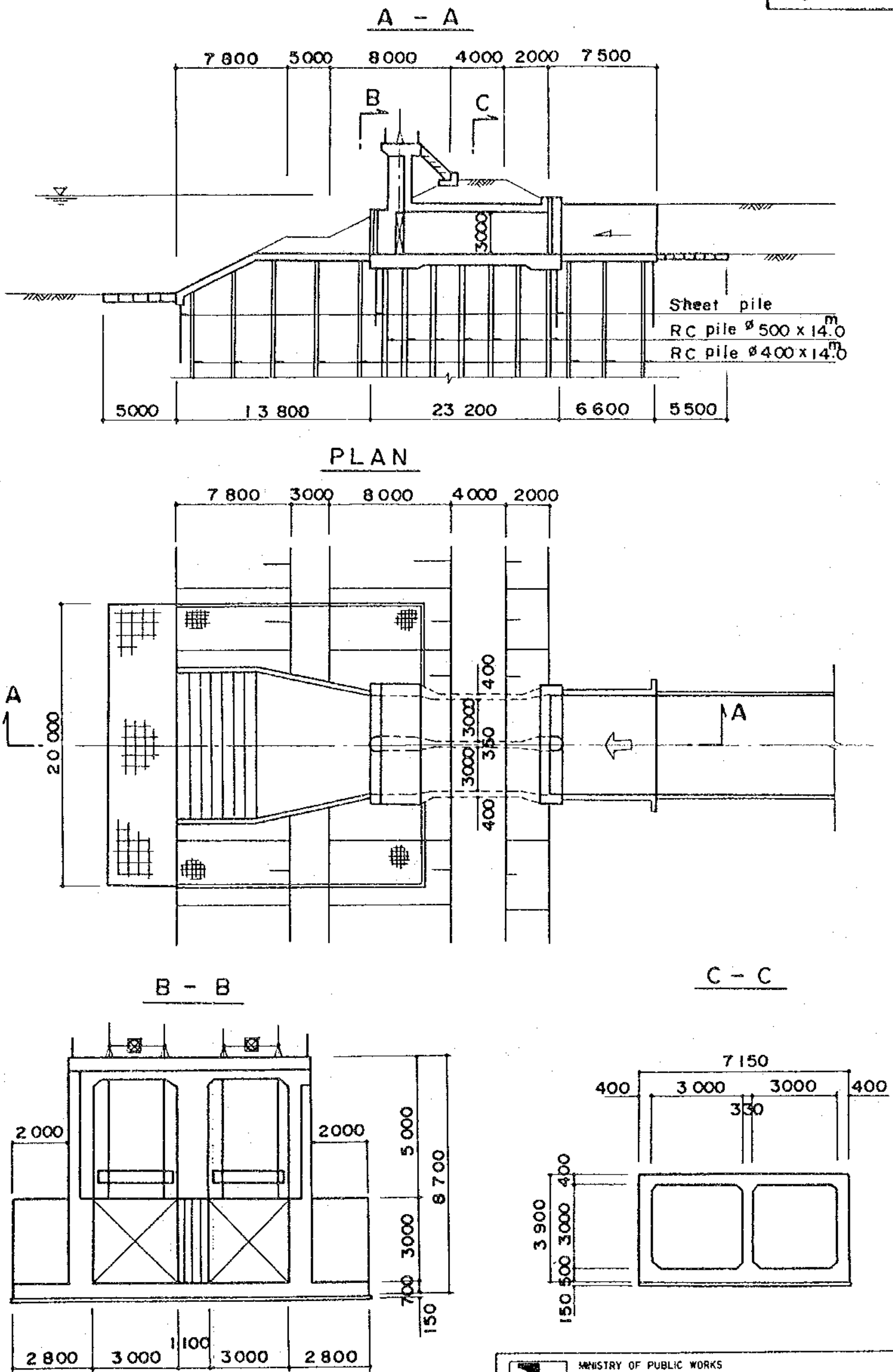
Fig. H-29(2)



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FEASIBILITY STUDY ON KARIAN
MULTIPURPOSE DAM CONSTRUCTION PROJECT

Drainage Culvert (Type-III)

JAPAN INTERNATIONAL COOPERATION AGENCY

APPENDIX - I

CONSTRUCTION MATERIALS

APPENDIX - I

CONSTRUCTION MATERIALS

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APPENDIX - I

CONSTRUCTION MATERIALS

1.1 General

Embankment materials for both the Karian and Cilawang dams, Gadeg intake weir, and concrete aggregates for all the related concrete structures are discussed as construction materials for the Karian Project. This section reports the summary of the study, investigation and laboratory test results.

1.2 Borrow Pits and Quarry Sites

In the Master Plan Report, embankment materials requied for the Karian dam was estimated to be 116,200 m^3 for earth-core materials, 96,600 m^3 for filter, 1,010,200 m^3 for rock and riprap. The Cilawang dam was planned as a concrete gravity dam.

As a result of field geological investigations such as seismic reflaction prospecting and core boring, it was revealed that the subsurface condition at the Cilawang dam site was not so favorable for the foundation for concrete gravity dam as was deemed in the Master Plan stage. Therefore, the Cilawang dam is also planned as a fill type dam in this study. Estimated embankment materials for both the Karian and Cilawang dam including saddle dams are summarized below (Ref. APPENDIX-J).

Karian dam : H.W.L. 67.5 m
Cilawang dam : H.W.L. 76.5 m

Material	Karian dam	Cilawang dam
Earth-core	185,000 m^3	82,000 m^3
Filter	153,000 "	70,000 "
Rock	1,021,000 "	313,000 "
Riprap	132,000 "	69,000 "
Total:	1,491,000 m^3	534,000 m^3

The field reconnaissance was done in the upstream area of the proposed dam sites. Fig. I-1 shows the location of construction material sources. The item of field investigation and laboratory test are briefed below:

(1) Field investigation and material sampling

i) Earth material

Terrace deposits along both the Ciberang river and the Cibeureum river were investigated. At three locations test pitting was made.

ii) Sand and gravel material

Sand and gravel deposits, spreading along the Ciberang river was investigated. At Susakan, Cimenteng and Lebakpicung, there exist abundant river deposits, which are suitable for sand and gravel material.

iii) Rock material

There exist no good quarry sites near the dam sites. Gn. Sendi and Gn. Guradog which are located at 11 - 15 km from the Karian dam site were selected as quarry site. Test boring was made at Gn. Guradog this time.

iv) Gadeg canal

Material sampling was excuted at the three selected points along the proposed route of canal in which a large amount of work quantity is expected.

(2) Laboratory test

The test standard and technical specification of ASTM or the equivalent are applied to the laboratory tests on sampled materials from the test pits and quarry mentioned above.

i) Earth material

Item	Standard	Appellation
a. Specific gravity	ASTM D858-58	SPECIFIC GRAVITY OF SOILS
b. Natural water content	ASTM D2216-66	LABORATORY DETERMINATION OF MOISTURE CONTENT OF SOIL
c. Grain size analysis	ASTM D422-63	GRAIN SIZE ANALYSIS OF SOILS
d. Liquid limit	ASTM D423-66	LIQUID LIMIT OF SOILS
e. Plastic limit	ASTM D424-59	PLASTIC LIMIT AND PLASTICITY INDEX OF SOILS
f. Compaction test	ASTM D698-66&	MOISTURE DENSITY RELATIONS OF SOILS USING 55-LB LAMMER AND 1.2-IN DROP
g. Permeability test	ASTM D2434-65T	PERMEABILITY OF GRANUAL SOILS (CONSTANT HEAD)
h. Triaxial compresion test	BS 1377	TRIAXIAL SHEAR OF SOILS (UU CONDITION)

ii) Sand and gravel material

Item	Standard	Appellation
a. Specific gravity	ASTM C127-59	SPECIFIC GRAVITY OF COARSE AND FINE AGGREGATE
b. Natural water content	ASTM C566-67	TOTAL MOISTURE CONTENT OF AGGREGATE BY DRYING
c. Grain size analysis	ASTM C136-67	SIEVE OR SCREEN ANALYSIS OF FINE AND COARSE AGGREGATE

iii) Rock material

Item	Standard	Appellation
a. Specific gravity and absorption	ASTM C127-59	SPECIFIC GRAVITY AND ABSORPTION OF COARSE AGGREGATES
b. Soundness	ASTM C88-63	SOUNDNESS OF AGGREGATE BY USE OF SODIUM SULFATE OR MAGNESIUM SULFATE
c. Abrasion	ASTM C535-65	RESISTANCE TO ABRASION OF LARGE SIZE COARSE AGGREGATE BY USE OF THE LOS ANGELES MACHINE

iv) Gadeg canal

Test item a. to f. for earth material were applied to the laboratory tests for these samples.

Quantity of each laboratory test is tabulated below:

Quantity of Laboratory Tests

	No.	Gs	Wn	Grain Size	W_L	Wp	Compaction	Triaxial (UU)	Permiability	Absorption	Soundness	Abraision
Earth material	A-1	2	2	2	1	1	1	1	1			
	B-1	2	2	2	1	1						
	C-1	2	2	2	1	1						
	D-1	1	1	1	1	1						
	E-1	2	2	2	1	1	1	1	1			
	E-2	2	2	2	1	1						
	Q-2	1	1	1	1	1						
Sand/ Grovel material	A-a	1	1	1								
	C-a	1	1	1								
Rock material	Q-1	1								1	1	1
	Q-2	1								1	1	1
	Q-3	1								1	1	1
Gadeg Canal	F-1	1	1	1	1	1	1	2				
	F-2	1	1	1	1	1		1				
	F-3	1	1	1	1	1		1				
Total		20	17	17	10	10	3	6	2	3	3	3

1.3 Results of Investigation and Laboratory Test

(1) Test pitting

Test pitting was made at six places, four places at Karian reservoir area and two places at Cilawang dam area to investigate the collectable quantity and qualitative characteristics of the material of each borrow area. Figs. I-2, I-3 and I-4 show the borrow areas for earth material. As a result of test pitting, collectable quantity is roughly estimated as follows:

Collectable Earth Material Volume

Location	Test Pit No.	Block Name	Block Area	Thickness of Stratum	Collectable Volume
Karian	A-1	Cimenteng	105,000 m^2	2.5 m	263,000 m^3
	B-1	Ngancang	110,000 "	3.0 "	330,000 "
	C-1	Susakan	142,000 "	3.0 "	426,000 "
	D-1	Lebakpitung	187,000 "	0.7 "	131,000 "
Cilawang	E-1	Cilawang II	46,000 m^2	3.0 m	138,000 m^3
	E-2	"	57,000 "	0.8 "	46,000 "

In addition, qualitative characteristics of the material of each borrow pit are summarized below:

Qualitative Characteristics of the Materials

Location	Test Pit No.	Excavate depth(m)	Ground water(G.L)	Description
Karian	A-1 (Cimenteng)	2.5	-2.0	soft terrace deposit composed of homogenious clay or sandy clay, the color is dark brownish grey, a small amount of gravel is mixed at the lower part

Location	Test Pit No.	Excavate depth(m)	Ground water(G.L)	Description
Karian	B-1 (Ngancang)	3.0	-0.95	terrace deposit composed of homogenious clay or sandy clay, grand water level is very high
	C-1 (Susakan)	3.0	-1.0	0m to 2.9m in deep: homogenious clay layer lower than 2.9m in deep: sand and gravel layer, a small amount of gravel is mixed at the lower part of the clay layer
	D-1 (Lebak picung)	3.0	-1.0	0m to 0.7m in deep: soft clay layer lower than 0.7m in deep: very stiff sand and gravel layer containing a lot of bolder (ø100 - 400mm)
Cilawang	E-1 (Cilawang II)	3.0	-2.8	soft terrace deposit very homogenious on the whole
	E-2 (Cilawang II)	1.7	-1.2	0m to 0.8m in deep: terrace deposit of sandy clay lower than 0.8m in deep: weathered tuff layer deteriorated into soil, the condition is stiff nevertheless of intensively weathered
Gadeg	F-1 (P.36)	3.0	-	very thick and intensively weathered soft tuff layer deteriorated into soil, the color is reddish brown
	F-2 (P.69)	1.4	-	0m to 0.5m in deep: colluvium in which a small amount of fine gravel is contained lower than 0.5m in deep: weathered tuff layer
	F-3 (T53)	3.0	-	0m to 0.7m in deep: clay layer 0.7m to 2.3m in deep: weathered tuff deteriorated into soil whose color is yellowish grey, lower than 2.3m in deep: weathered tuff deteriorated into soil whose color is brownish grey, the condition of both layers is stiff

Sand and gravel materials were sampled from river deposits widely spreading along the Ciberang river as shown in Fig. I-2. It is estimated that the collectable quantity is large enough.

Samples for rock materials are taken at both the Gn. Sendi and Gn. Guradog site. The sampled materials are andesite and basalt. And the location of three test pittings along Gadeg canal is shown in Fig. I-1. Qualitative characteristics of the material of each borrow pit are summarized in the above table.

(2) Result of laboratory test

Laboratory tests on the sampled material were made by the local consultant (PT. SOILENS). The test results are summarized below:

(Earth material)

Location	Test Pit No.	Depth (G.L.)	Gs	Wn (%)	We (%)	Wp (%)	Ip	Ic	Unified soil classi-fication
Karian	A-1	-1.0	2.66	41.7	55.6	32.0	23.6	0.59	MH
		-2.0	2.64	38.3	-	-	-	-	
	B-1	-1.0	2.65	41.8	49.5	35.0	14.5	0.53	ML
		-2.0	2.60	59.7	-	-	-	-	
	C-1	-1.0	2.62	42.3	58.7	34.5	24.2	0.68	MH
		-2.0	2.67	38.1	-	-	-	-	
	D-1	-1.0	2.66	21.4	39.6	27.0	12.6	1.44	ML
Cilawang	E-1	-1.0	2.59	38.1	89.8	31.4	58.4	0.88	CH
		-2.0	2.56	38.2	-	-	-	-	
	E-2	-1.0	2.50	80.3	126.1	66.0	60.1	0.76	MH
		-1.5	2.38	99.6	-	-	-	-	

(Rock material)

No.	Location	Material	Specific gravity	Absorption (%)	Soundness (%)	Abrasion (%)
Q-1	Gn.Sendi	Andesite	2.54	1.71	3.06	24.49
Q-2	Gn.Guradog	Basalt	2.78	0.26	1.84	12.22
Q-3		Andesite	2.43	2.62	3.72	29.58

As for earth material, compaction test, triaxial compression test and permeability test were also made. The test results are summarized below:

(Compaction test)

Test Pit No.	Soil Classification	Wn (%)	Wpt (%)	pdmax (gf/cm^3)
A-1	MH	41.7	26.55	1,480
E-1	CH	38.1	28.0	1,453

Since the natural moisture content of the material sampled from the borrow area A-1 and E-1 shows rather high value compared with optimum moisture content, it would be needed to consider some improvement by mixing or other means.

(Triaxial compression test)

Test Pit No.	Wf (%)	d (gf/cm^3)	Sr (%)	Cn (kgf/cm^2)	øn (degree)
A-1	30.7	1.41	92.0	0.2	20.5
E-1	32.4	1.38	92.0	1.1	0.0

The result above can be applied to only stability analysis using total stress. Carrying out the analysis for effective stress, it is needed to change the test conditions.

(Permeability test)

A-1 : $K = 2.4 \times 10^{-7}$ cm/sec

E-1 : $K = 1.35 \times 10^{-8}$ cm/sec

Judging from the test result, the material from the forrow area A-1 and E-1 can be utilized as impervious material.

(Gadeg canal)

The test result of the material sampled from the test pit along Gadeg canal is as follows:

Laboratory test result for Gadeg canal

Test pit No.	Sampling point	Wn (%)	Gs	WL (%)	Wp (%)	Wopt (%)	Pdmax (%)	Shearing strength C(kgf/cm^2)	Shearing strength ϕ(°)	Ramark
F-1	P.36	69.5	2.65	112.7	55.2	-	-	0.6	0.5	undisturbed
						42.5	1,155	1.1	6.0	disturbed
F-2	P.69	53.5	2.44	103.8	47.9	-	-	1.13	5.5	
F-3	T.53	54.1	2.48	77.1	40.0	-	-	0.73	1.0	

The natural moisture content of samples from borrow pits F-2 and F-3 is low and the soil conditon is sound. While the moisture content of sample from F-1 is high and the shearing stress is poor because of weathering.

1.4 Conclusions

Judging from the field investigation and laboratory test results, the following tentative conclusion is derived:

i) Earth materials at A-1, C-1 and D-1 are suitable for impervious core materials from the view point of permeability. However, earth materials from A-1 and C-1 are classified to be (MH) and their natural moisture content (Wn) is higher that the optimum moisture content (Wopt). It brings some difficulty in compacting works. Some mixing with coarse material will be needed. On the other hand, earth materials from D-1 are classified to be (ML) and are available as impervious core without any mixing.

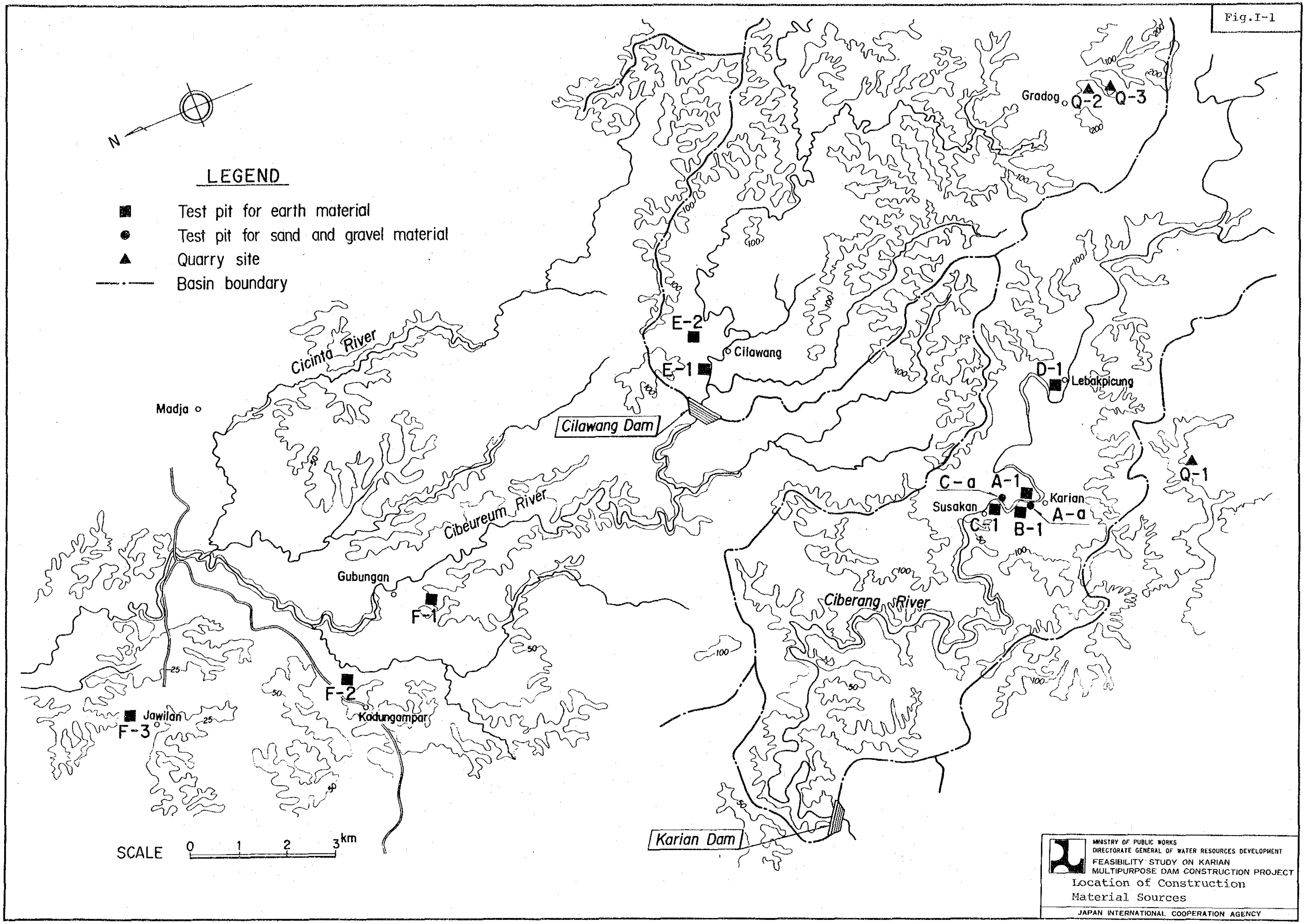
Earth materials exploited from E-1 and E-2 are classified to be (CH) and (MH), respectively. These are also required to be mixed with some coarse material.

ii) Sand and gravel deposits along the Ciberang river are available for filter material and concrete aggregates provided that some screening and mixing are made properly. Sand and gravel layers at D-1 deposit will also be available.

iii) Judging from the field investigation results, it is assumed the available quantity of rock materials (tuff breccia and basalt) are sufficient for the construction of both the Karian and Cilawang dams. However, it is recommended that some additional core boring would be done in the future detailed design stage to grasp the quality and quantity of such rocks more in detail. G. Sendi is recommendable as an alternative quarry site, if necessary.

iv) In this time the investigation for Gadeg canal was carried out at only three points where a large amount of excavation or embankment is expected. At F-1 (excavation) point the base rock is intensively weathered tuff deteriorated into soil. At F-2 and F-3 (embankment) points the base rock is weathered soft rock of tuff. And river gravel deposits around Lebakpicung and Susakan are available as aggregates for canal construction.

Fig.I-1



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Location of Construction Material Sources

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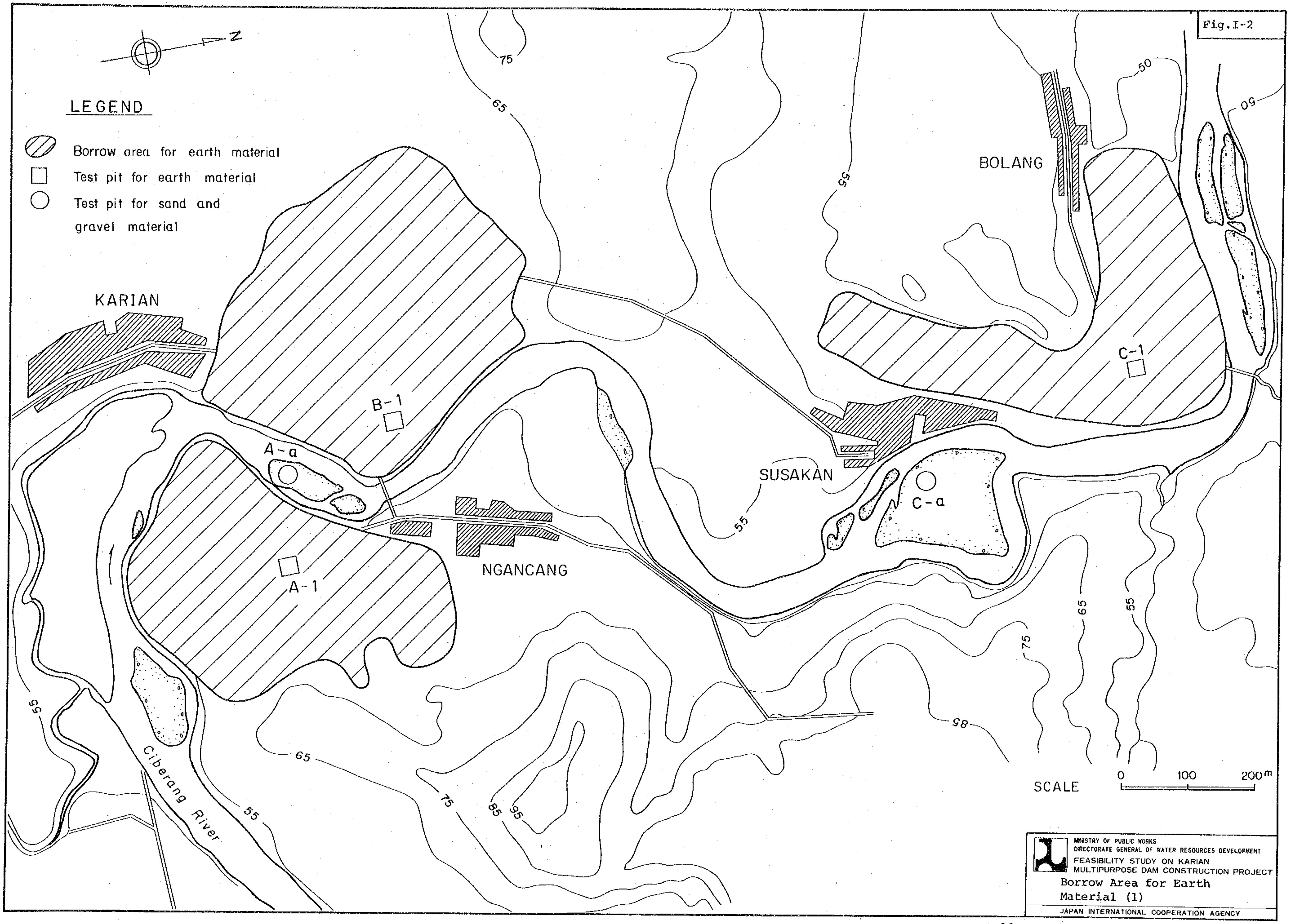
Fig.I-2
N
LEGEND
Borrow area for earth material
Test pit for earth material
Test pit for sand and gravel material
KARIAN
BOLANG
SUSAKAN
NGANCANG
A-a
A-1
B-1
C-a
C-1
Ciberang River
75
65
55
50
85
95
SCALE
0
100
200m
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Borrow Area for Earth Material (1)
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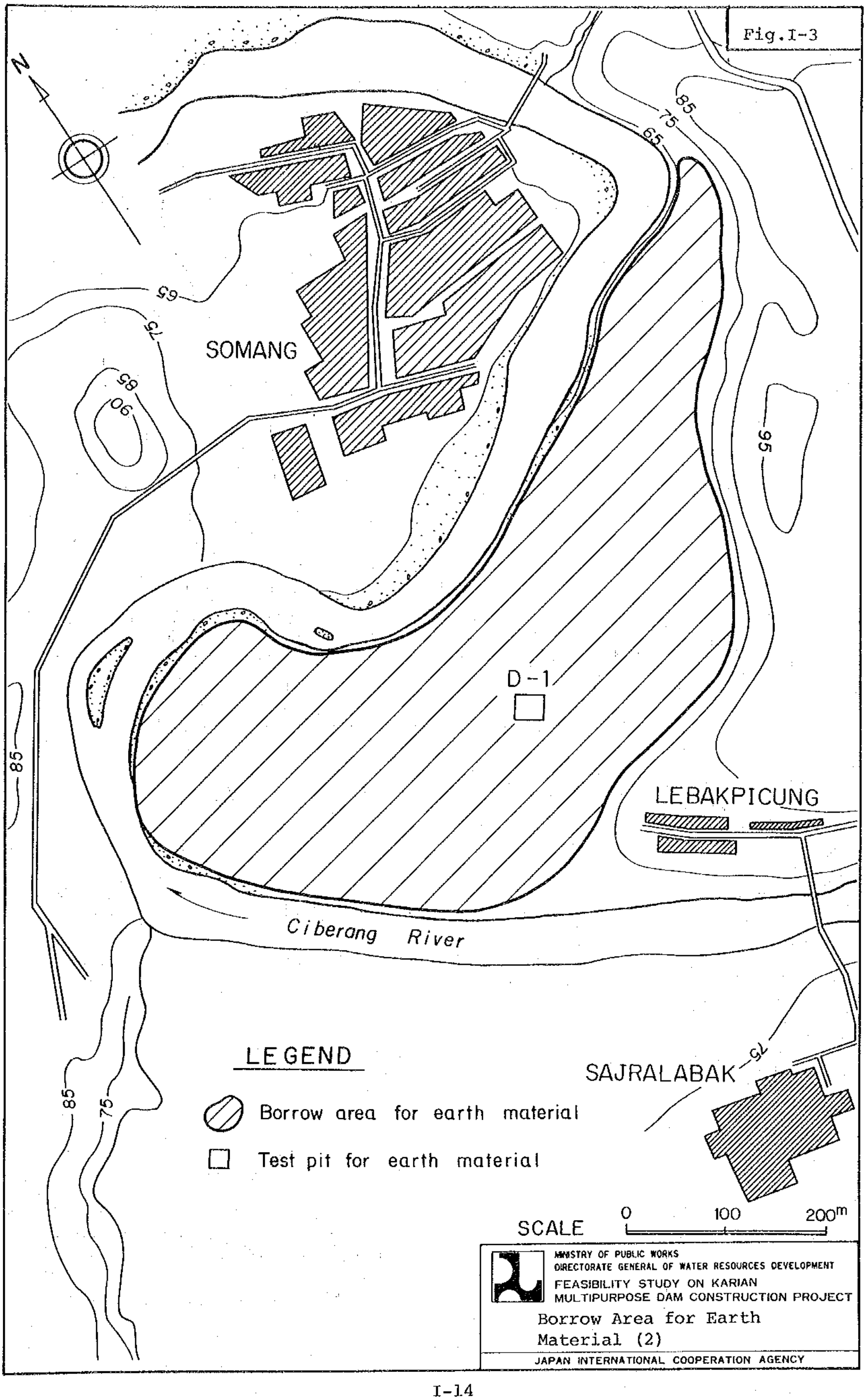

Fig.I-3

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Borrow Area for Earth Material (2)

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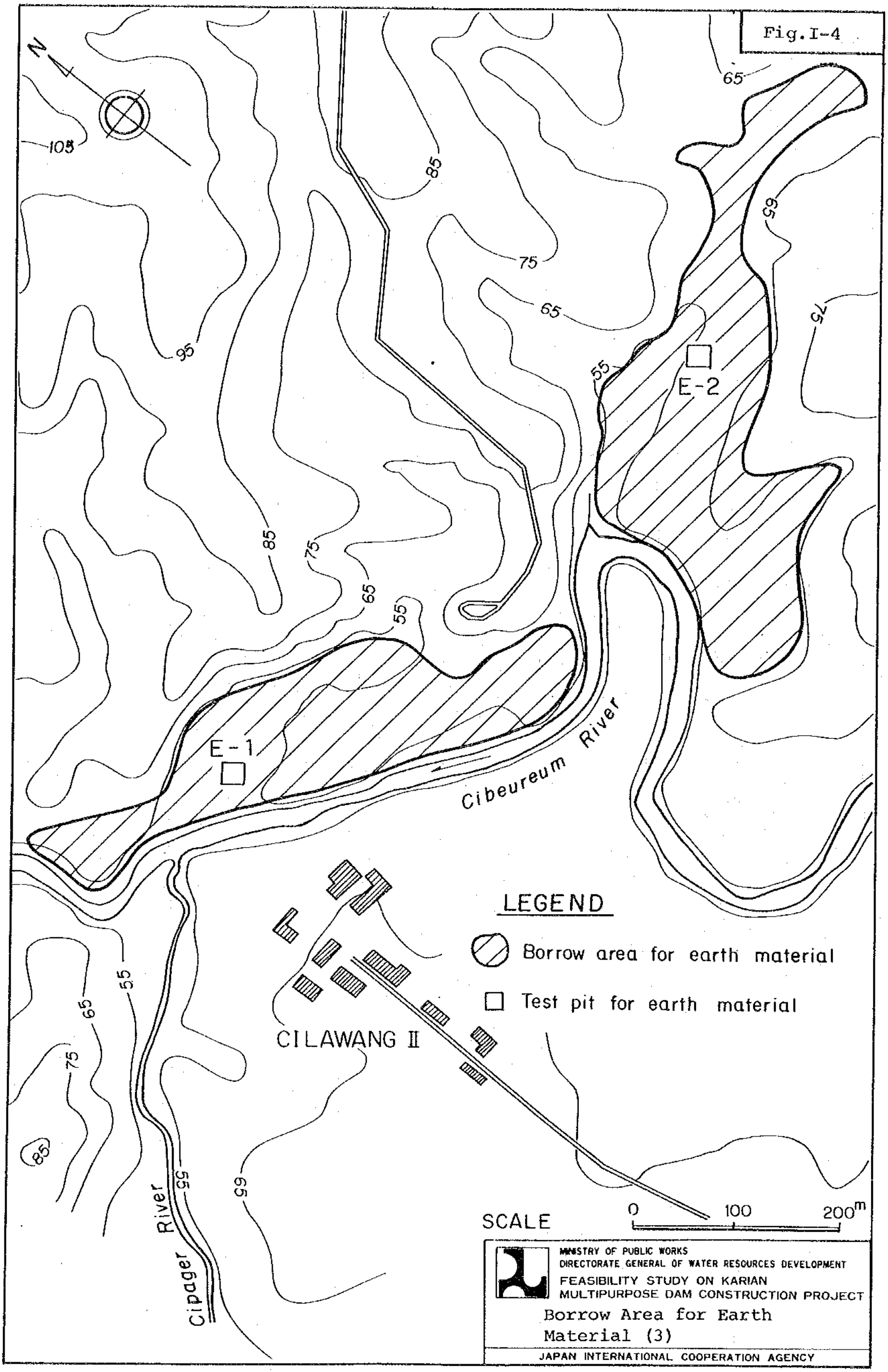
Fig.I-4



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Borrow Area for Earth Material (3)

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APPENDIX - J
DAM AND RESERVOIR

APPENDIX - J

DAM AND RESERVOIR

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1. WATER BALANCE STUDY

1.1 General

Combined water balance study for the Karian and Cilawang reservoirs with two trans-basin tunnels, as shown in Fig. J-1, is made in this chapter. The main objectives of the water balance study of the Karian reservoir and the Cilawang reservoir are as follows:

(1) To estimate the required reservoir capacity of each reservoir for three irrigation schemes, and

(2) To select the best target discharge through the trans-basin tunnel from the Karian reservoir to the K-C-C irrigation scheme.

The above study is carried out on the 10-day basis in accordance with the follwoing procedure:

(1) To generate the long term natural runoff series at the dam and weir sites; Karian dam, Cilawang dam, Pamarayan weir, Buyut weir and Cicinta weir,

(2) To estimate reservoir evaporation loss,

(3) To confirm the surface area and storage capacity curve of each dam,

(4) To estimate the conveyance loss in the river from the proposed dam to the diversion weir site for the irrigation scheme,

(5) To estimate the discharge for the river maintenance flow from each dam and weir,

(6) To estimate the water demand for the irrigation, municipal and industrial use,

(7) To establish a tentative operation rule to release the water from each dam to each irrigation scheme,

(8) To decide the water supply target year,

(9) To simulate the required reservoir capacity in connection with different discharge through the trans-basin tunnel, and

(10) To evaluate the each plan by the construction cost of dam and tunnel.

1.2 Water Balance Study

1.2.1 Study Condition

(1) Natural runoff

The 12 years' natural runoff series from 1972 to 1983 are generated from the observed runoff data at Rangkasbitung station by conversion ratio for each dam and weir site. The observed and estimated mean daily discharge of 10-day basis are tabulated in Appendix-A. The conversion ratios are given below:

Site	Catchment area (km^2)	Conversion ratio
Rangkasbitung	1,383	1.000
Pamarayan weir	1,451	1.025
Karian dam	288	0.299
Cilawang dam	93	0.080
Buyut weir	117	0.096
Cicinta weir	31	0.018

(2) Reservoir evaporation loss

The reservoir evaporation loss is estimated to be 70% of the mean pan evaporation recorded at Cikadu.

(mm/day)

Month	Reservoir evaporation	Month	Reservoir evaporation
Jan.	2.0	Jul.	3.2
Feb.	2.5	Aug.	3.4
Mar.	2.8	Sep.	3.4
Apr.	2.7	Oct.	3.4
May	3.1	Nov.	3.0
Jun.	3.3	Dec.	2.7
Annual total	1,093 mm	Annual average	3.0 mm/day

(3) Reservoir surface area and storage curve

The reservoir surface area of each reservoir is measured on the map of 1/5,000 scale. The storage volume is calculated by the above reservoir surface area. The reservoir surface area and storage volume are shown in Figs. J-2 and J-3.

(4) River conveyance loss

The river conveyance loss consits of percolation from the riverbed into its underground and evaporation from the water surface between the dam site and intake weir site in proportion to the river length and depend on the geology of riverbed.

The diversion efficiency is estimated conservatively taking the river length and gate operation accuracy into consideration as follows:

i) Karian dam-Pamarayan weir (about 25 km)----------------90%

ii) Cilawang dam-Buyut weir (about 7 km)----------------95%
Ciuyah tunnel-Buyut weir (about 4 km)----------------95%
Cilawang dam-Cicinta weir (about 10 km)----------------95%

(5) River maintenance flow

The river maintenance flow from each dam and intake weir is estimated from the runoff record as given in Appendix-A. The adopted discharge is the 10-year average drought runoff of 97% dependability.

Site	Catchment area (km^2)	Maintenance flow (m^3/s)	Specific discharge ($m^3/s/100km^2$)
Pamarayan weir	1451	9.7	0.67
Karian dam	288	3.5	1.2
Cilawang dam	93	1.1	1.2
Buyut weir	117	1.4	1.2
Cicinta weir	31	0.4	1.2

(6) Irrigation water requirement

The irrigation water requirement to be diverted at Pamarayan, Buyut and Cicinta weirs for Ciujung, K-C-C and Cicinta Irrigation Schemes of 24,200 ha, 10,300 ha and 1,430 ha respectively are estimated in Appendix-G for 12 years from 1972 to 1983 on 10-day basis.

(7) Municipal and Industial water demand

The municipal and industial water demand at the target year of 2000 is estimated from the data collected this time.

Water demand for Cilegon including P.T. Krakatau Steel and other industrial estates, and for 17 I.K.K. are estimated to be 1.145 m^3/s and 0.48 m^3/s, respectively. Water demand at Rangkasbitung town is estimated to be 0.14 m^3/s. Such M & I water is released from the Karian reservoir together with irrigation water for Ciujung Irrigation Scheme.

(8) Water supply priority

The priority of water supply from each reservoir is given in following order taking into consideration the principle that the river water resouces will be utilized first for the demand in the same basin:

i) Karian reservoir

- River maintenance flow
- Rangkasbitung municipal water
- Ciujung Irrigation Scheme
- Cilegong M & I water
- K-C-C Irrigation Scheme through Ciuyah tunnel

ii) Cilawang reservoir

- River maintenance flow
- K-C-C Irrigation Scheme
- Cicinta Irrigation Scheme through Cicinta tunnel

(9) Water supply level

The water supply level for the irrigation is selected 5-year probability. The scale of reservoir storage capacity depends upon the irrigation water requirement and the river runoff during the dry season from June to September.

Drought analysis is made on the river runoff of Ciujung at Rangkasbitung for 14 years from 1970 to 1983 as shown in Table J-1 and Fig. J-4. As a result, 5-year drought is estimated to have occurred in 1972, 1976 and 1982. Therefore, the target year for the water supply is selected to be 1977 in the water balance study because of the fourth drought discharge out of 14 years.

1.2.2 Water Balance Calculation

(1) Tentative operation rule

A tentative operation rule is established for the combined operation study of the Karian and the Cilawang reservoirs with the Ciuyah and the Cicinta tunnels. The principle of the tentative operaiton rule is as follows:

Karian reservoir

i) To release the required water through the intake to the Ciujung Irrigation Scheme, Municipal and Industrial water so far as water available when the reservoir water does not spill out through the spillway,

ii) To spill out excess water through the spillway so as to keep the normal high water level (NHWL. 67.50) when the reservoir water level tends to rise higher than NHWL,

iii) To release the river maintenance flow of 3.5 m^3/s through the intake when the water is not required from the Karian reservoir as the result that the runoff of the residual drainage area is large enough to cover the water requirement,

iv) No water release when the water level becomes lower than the low water level (LWL. 46.00), and

v) To release the water through the Ciuyah tunnel to K-C-C Irrigation Scheme so far as water is available.

Cilawang reservoir

i) To separate the required diversion water from the Karian and the Cilawang reservoirs as follows:

- to release the water first from Karian less than the maximum discharge in the Ciuyah tunnel as possible,

- to release the remained water taking the water from Karian from the requirement,

ii) To release the required water through the intake to the K-C-C Irrigation Scheme so far as water is available when the reservoir water does not spill out through the spillway,

iii) To spill out excess water through the spillway so as to keep the normal high water level (NHWL. 76.50) when the reservoir water level tends to rise higher than NHWL,

iv) To release the river maintenance flow of 1.1 m^3/s through the intake when the water is not required from the Cilawang reservoir as the result that the runoff of the residual drainage is large enough to cover the water requirement or the water is available from the Karian reservoir through the Ciuyah tunnel,

v) No water release when the water level becomes lower than low water level (LWL. 66.50), and

vi) To release the water through the Cicinta tunnel to the Cicinta Irrigation Scheme so far as water is available.

Pamarayan weir

i) To release the required water through the intake to the Ciujung Irrigation Scheme, Municipal and Industrial water so far as water is available from the Karian reservoir and the residual drainage area, and

ii) To release the river maintenance flow of 9.70 m^3/s at a first priority through the weir gates.

Buyut weir

i) To release the required water through the intake to the K-C-C Irrigation Scheme so far as water is available from the

Karian and Cilawang reservoirs, and the residual drainage area, and

ii) To release the river maintenance flow of 1.4 m^3/s at a first priority through the weir gates.

Cicinta weir

i) To release the required water through the intake to the Cicinta Irrigation Scheme so far as water is available from the Cilawang reservoir and the residual drainage area, and

ii) To release the river maintenance flow of 0.4 m^3/s at a first priority through the weir gates.

(2) Difinitions of variables

The variables used in the water balance study are defined in Table J-2 and shown in Fig. J-5.

(3) Flow chart of calculation

The general flow chart of calculation is shown in Fig. J-6.

1.3 Water Balance Study Results

1.3.1 Required Storage Volume

The reservoir storage volume varies with the discharge from the Karian reservoir to the Cibeureum river for the K-C-C Irrigation Scheme through the Ciuyah trans-basin tunnel. The required storage capacity of the Karian reservoir increases and the Cilawang reservoir decreases as the diversion water capacity of the tunnel becomes larger.

The combined operation of two reservoirs and the tunnel is simulated for the different maximum discharge in the Ciuyah trans-basin tunnel and the differrent storage capacity of each reservoir.

The average water requirement of 7.8 m^3/s and 0.5 m^3/s for the K-C-C and Cicinta Irrigation Schemes respectively is large as compared with the average inflow of 7.5 m^3/s into the reservoir. Therefore, the water cannot be supplied from the Cilawang reservoir only to the K-C-C and Cicinta Irrigation Schemes even if its storage capacity would be maximized.

The water balance study revealed that the plan without the trans-basin tunnel or with the tunnel of the discharge capacity less than 4 m^3/s cannot be adopted because of inability of water supply from the Cilawang reservoir.

The surplus and shortage of irrigation water from each reservoir for different tunnel discharge are shown in Fig. J-7. The optimum plan is that each reservoir has no surplas or shortage storage for the water requirement. The obtained optimum conbination of two reservoirs are tabulated below:

Tunnel discharge	NHWL (El.m)		Storage volume ($10^6 m^3$)		
(m^3/s)	Karian	Cilawang	Karian	Cilawang	Total
6.0	67.00	77.0	211.5	67.0	278.5
8.0	67.50	76.5	219.0	62.0	281.0
10.0	68.50	74.0	235.7	41.0	276.7
12.0	69.00	73.5	244.3	37.5	281.8

1.3.2 Optimum Plan

(1) Cost comparison

In order to select the optimum combination of reservoirs and tunnel, the cost comparison is made on the above plans for th differrent tunnel discharge. The cost comparison is made on the total cost of dam embankment, tunnel construction and land acquisition (compensation) as shown in Table J-3 and Figs. J-8 to J-11.

From the above cost comparison study, the plan of tunnel discharge of 6.0 m^3/s or 8.0 m^3/s is revealed to be an economical plan. Taking into consideration the flexibility of water diversion, the combination plan of tunnel discharge of 8.0 m^3/s is adopted as a optimum plan for the project.

(2) Final water balance calculation

The water balance calculation for the adopted plan on 10-day basis is shown in Tables J-4 to J-6, in which variables used are shown in Table J-2. The summary of water balance study is given on annual volume basis in Table J-7.

The irrigation water shortage occurred in 1972, 1976 and 1982 in the water balance study. These years are drought year of more than 5-year return period, so the adopted plan with the above drought can be admissible.

The study results are shown about the storage water level, discharge through the intake and the tarans-basin tunnel for each reservoir on 10-day basis on Figs. J-12 and J-13.

(3) Released volume from reservoir

The released volume and percentage from each reservoir to each scheme in 1977 of the water supply target year is tabulated below:

i) Karian reservoir

Scheme	Volume ($10^6 m^3$)	(%)
Ciujung irrigation scheme	202.6	59.6
M & I water for Cilegon and I.K.K.	19.1	5.6
M & I water for Rangkasbitung	2.9	0.9
K-C-C irrigation scheme	115.2	33.9
Total:	339.8	100.0

ii) Cilawang reservoir

Scheme	Volume ($10^6 m^3$)	(%)
K-C-C irrigation scheme	72.5	79.5
Cicinta irrigation scheme	18.7	20.5
Total:	91.2	100.0

(4) Optimum reservoir and tunnel plan

The dimensions of the obtained optimum combination plan of reservoirs and tunnels are given as follows:

Karian reservoir

Normal high water level (NHWL)	67.50 m
Low water level (LWL)	46.00 m
Effective storage volume	219 x 10^6 m^3

Cilawang reservoir

Normal high water level (NHWL)	76.50 m
Low water level (LWL)	66.50 m
Effective storage volume	62 x 10^6 m^3

Ciuyah trans-basin tunnel

Maximum tunnel diversion discharge	8.0 m^3/s
Tunnel diameter	2.6 m

Cicinta trans-basin tunnel

Maximum tunnel diversion discharge	2.7 m^3/s
Tunnel diameter	2.0 m

2. HYDROELECTRIC POWER POTENTIAL

2.1 General Calculation Criteria

The water balance calculation with the power generation at the Karian site is made for the hydroelectric power potential study under the following conditions:

- the first priority of the reservoir water utilization is for the irrigation and M & I water as described in (8) of sub-paragraph 1.2.1.

- the water for the power is released from the intake at the water level higher than El.49.00 m which is three meters higher than LWL of 46.00 m in order not to harm the water releasing pattern for irrigation and M & I water.

- other calculation conditions are the same as those for the irrigation given in sub-paragraphs 1.2.1 and 1.2.2.

The power potential study is made with the following dimensions:

Normal high water level (NHWL)	:	67.50 m
Operational low water level (OLWL)	:	49.00 m
Low water level (LWL)	:	46.00 m
Design water level (DWL)	:	61.00 m
Tail water level (TWL)	:	18.00 m
Combined efficiency of Generator & Turbine	:	0.83

The operation study is carried out in the following different discharge cases as a base load basis:

Maximum plant discharge	:	6.0 m^3/s to 18.0 m^3/s at 2.0 m^3/s intervals
Installed capacity	:	1,950 KW to 5,860 KW at 650 KW intervals

The power is calculated as the following equation:

$P = g*e*Q*He$

Where, P : power (KW)

g : acceleration of gravity ($=9.8\ m/s^2$)

e : combined efficiency of Generator & Turbine (=0.83)

Q : discharge (m^3/s)

He: effective head (m)

The head loss is estimated to be 7% of the gross head.

2.2 Calculation Results

The result of reservoir operation study is shown for 12 years from 1972 to 1983 on the annual energy and dependability in Table J-8 and J-9.

The cases of installed capacity more than 5,200 KW by the maximum plant discharge 16.0 m^3/s cause a water shortage for the concerned irrigation and M & I water schemes under the above calculation criteria. Therefore the plan with the installed capacity more than 5,200 KW as a base load basis connot be adopted.

As for the reliability of power output, the dependability of cases with installed capacity less than 5,900 KW by the maximum plant discharge 16.0 m^3/s is revealed to be 90%.

The average annual energy is estimated to be 15.3 to 35.1 GWh by the installed capacity of 1,950 to 4,600 KW.

3. KARIAN DAM

3.1 General

Preliminary design is executed on main structures for the purpose of estimating the construction cost of the Karian dam as shown in Figs. J-22 to J-26. The design of dam is made in accordance with the basic design requirement by the water balance study made in the preceding Chapter 1.

3.2 Dam Site

The dam site proposed in the Master Plan Study is reviewed from topographical and geological points of view in this study and confirmed as an adequate location for the dam.

3.3 Topography

The Ciberang river flows with a width of around 40 m and riverbed of about EL. 17.5 m at the dam site in the direction from north to south. Terrace deposits of 30 m to 50 m wide and 3 m to 5 m deep exist at the left upstream bank of the dam site. The left bank shapes relatively steep slope of about 30° up to around EL. 30 m and then becomes gentle slope of about 10° up to about EL. 75 m. The right bank is steep slope of about 40° up to EL. 60 m. Hills surrounding the dam and reservoir are about EL. 70 m to 100 m. Specially the right watershed consists of saddles of around EL. 70 m, consequently saddle dams are essential in case that the dam crest is more than EL. 70.0 m.

3.4 Geology

The geology of the dam site belongs to the marine sediments of Pliocene. The tuffaceous sedimentary rocks are composed of mainly Pliocene fine to coarse tuffaceous sandstone, pumice tuff, lapilli tuff, basal conglomerates, weided tuff, and tuffaceous claystone facies. These tuffaceous rock is generally soft rock, especially weak in pumiceous facies.

In the field permeability tests in the bore holes along the dam axis, rather high permiability coefficient of 1.1×10^{-3} to 2×10^{-4} cm/s was observed at some parts in the dam foundation. The compressive strength test was carried out on the core sampled by drilling in the dam foundation. The compressive strength varies in the order of 10 to 30 kg/cm^2.

3.5 Basic Design Conditions

3.5.1 Water Requirement

The required storage volume in the Karian reservoir is 219×10^6 m^3 in effective given in (3) of sub-paragraph 1.3.2. The maximum discharge for the Ciujung Irrigation Scheme and M & I water from the intake is 48 m^3/s. The maximum discharge for the K-C-C Irrigatijn Scheme is 8.0 m^3/s through the Ciuyah trans-basin tunnel.

3.5.2 Sedimentation

The sediment load is estimated to be 1,700 $m^3/km^2/year$ as given in Appendix-B. The sedimentation for the dead storage volume is estimated by the following equation:

$$Vs = S*CA*T$$

Where, S : annual sediment load ($m^3/km^2/year$)

CA : catchment area of reservoir (km^2)

T : sedimentation design year (= 100 year)

$$Vs = 1,700*288*100$$
$$= 49 \times 10^6 \ m^3$$

The reservoir water level for the above sedimentation is at El. 45.0 m.

3.5.3 Water Level and Dam Crest Elevation

The water level for each purpose is set as follows:

The low water level (LWL) is set at the elevation above the top of estimated sedinentation level with the allowance of 1.0 m. The normal high water level (NHWL) is set to store the volume required as active storage above LWL. The flood control water level (FCWL) is set to control the 50-year flood to meet the requirment of the downstream river improvement plan as given in Appendisx-H. The flood water level is set to spill out the design flood safely with enough overflow depth through the spillway (Ref. Sub-paragraph 3.6.2).

The adopted water levels and reservoir storage volume for each purpose are listed below and shown in Fig. J-2. The dam crest elevation is set at the elevation on the flood water level with the freeboard of 2.6 m (Ref. Sub-paragraph 3.6.1).

Dam crest elevation	:	72.50 m
Flood water level (FWL)	:	69.90 m
Flood control water level (FCWL)	:	69.50 m
Normal high water level (NHWL)	:	67.50 m
Low water level (LWL)	:	46.00 m
Dead storage volume	:	54×10^6 m^3
Effective storage volume	:	219×10^6 m^3
Flood control volume	:	33×10^6 m^3

3.6 Design of Main Structures

3.6.1 Main Dam

(1) Dam type

A foundation rock at the proposed dam site consists of soft and weak tuff of which shearing strength is estimated at about 5 kg/cm^2. Some weathered tuff is observed in some places below the riverbed. The dam height required is 60.5 m from the dam foundation. Taking such geology and dam height into consideration, the dam site is not suited for a concrete dam of any kind due to low bearing strength. Therefore, the dam at this site is to be designed as a fill type dam as proposed in the Master Plan.

As the fill dam, four types are conceivable, namely (i) Homogeneous earthfill, (ii) Center core zone rockfill, (iii) Inclined core zone rockfill and (iv) Impervious surface membrane rockfill. Considering the technical difficulties and the availability of fill materials, a standard zoned rockfill dam with the center core is adopted for the Karian dam.

The necessary materials for the fill dam are studied on available volume and their quality. The rock materials of about 1,200 x 10^3 m^3 are recommended to be basalt and fresh tuff breccia from Guradog quarry site (Ref. Appendix-C). This quarry is located at about 15 km south of the Karian dam. The filter material of 153,000 m^3 and the core material of 185,000 m^3 are available from the borrow area at Sajira at about 7 km upstream of the dam.

(2) Dam crest elevation

The dam crest elevation is set at El. 72.50 m, adding free board of 2.60 m above the flood water level of El. 69.90 m.

The wave height (Hw) by the wind is estimated by the S.M.B. and Saville methods from the reservoir length and the dam slope. Since the maximum wind velocity observed is 11 m/s at Serang, the design wind velocity is adopted to be 20 m/s which is commonly used for other projects in Indonesia. The wind wave height of 0.7 m is estimated by the above method from the storage length of 5 km from the dam to the opposite bank.

The wave height by earthquake is estimated by the following equation:

$$He = k*(g*Ho)^{0.5}/(2*3.14)$$

Where, He : wave height by earthquake (m)

k : earthquake coefficient (= 0.15)

g : acceleration of gravity (= 9.8 m/s^2)

Ho : reservoir water depth (= 67.5-18.0=49.5 m)

$$He = 0.15*(9.8*49.5)^{0.5}/(2*3.14)$$
$$= 0.5 \text{ m}$$

The allowance (Ha) for the unforeseeable accident is added on the above freeboard. The pavement is planned to be made by the thickness of 0.40 m (Hp) on the crest of the impervious core.

On comparing the following earthquake and flood cases, the highest is decided as the dam crest elevation:

i) Earthquake condition

EL1=NHWL+Hw+He+Ha+Hp
=67.50+0.70+0.50+1.5+0.40
=70.60 m

ii) Flood condition

EL2=FWL+Hw+Ha+Hp
=69.90+0.70+1.50+0.40
=72.50 m

(3) Zoning

The dam is designed as the center core type having five zones; core, fine and coarse filter, rock and riprap zones. The required embankment volume including the saddle and the main coffer dam is tabulated below:

Zone	Volume (m^3)	Materials
Core	185,000	Earth, sand, grabel
Fine filter	105,000	Sand, gravel
Coarse filter	48,000	Sand, gravel
Rock	1,021,000	Basalt, tuff breccia
Riprap	132,000	Basalt
	1,491,000	

(4) Foundation treatment

Some pervious strata of permeability coefficient of 1.1×10^{-3} to 2×10^{-4} cm/sec are observed in the foundation of the dam. In addition to the above, three faults are observed below the riverbed and at the right and left banks. As foundation treatment, the following grouting works are planned below the core zone.

(i) Blanket grout : at 2 m intervals with 5 m deep and 4 lines

(ii) Curtain grout : at 2 m intervals with 20 to 40 m deep and 2 lines

(5) Dam stability analysis

The dam slope stability is examined by the slide circle and slice method on the following embankment slope as a preliminary study.

Upstream slope = 1 : 3.0
Downstream slope = 1 : 2.5

The analysis is made on the normal and seismic conditions in up- and downstream slope at the normal high water level. The maximum acceleration in a return period of 100-year is estimated to be 0.18*g in Appendix-C. Referring to the design horizontal component of seisimic oceefficient (Kh) used in other project in Java island, Kh of 0.15 is used for the analysis.

The design values of core are estimated from the laboratory that result on earth material (Ref. Appendix-I).

The filter and rock materials were not tested, so the design values are estimated in two cases respectively.

Properties of Embankment Materials

Zone	Wet density (t/m^3)	Saturated density (t/m^3)	Cohesion (t/m^2)	Friction angle (ø)
Core	1.84	1.91	2.00	21
Coarse filter	1.90	2.00, 2.10	0	35
Fine filter	1.80	2.00, 2.10	0	35
Rock	1.80	2.00, 2.10	0	37.5, 40.0

The study results are tabulated below and illustrated with safety factors in Figs. J-14 to J-17.

Safety Factors against Sliding

Friction angle (ø)	37.5°		40.0°	
Saturated density (t/m^3)	2.00	2.10	2.00	2.10
Case	1	2	3	4
i) Normal condition				
Upstream slope	2.62	2.65	2.77	2.67
Downstream slope	2.52	2.47	2.83	2.61
ii) Seismic condition				
Upstream slope	1.21	1.24	1.31	1.35
Downstream slope	1.49	1.47	1.59	1.56

The required minimum values for the safety factor for slopes are more than 1.5 for the condition without seismic force and more than 1.2 with seismic force. The calculated safety factors under the above conditions meet the design criteria in all cases.

(6) Instruments for the dam

The following observation instruments would be provided in the dam:

- pore pressure meters,
- earth pressure meters,
- cross-arm settlement measurement devices,
- earthquake recorders,
- other instruments for displacement of dam surface, and
- leakage water measurement devices.

3.6.2 Spillway

(1) Design condition and concepts

The spillway is aligned toward the right flat river bank where the river turns to the right. Design conditions and concepts are summarized below:

i) A probable maximum flood (PMF) with a peak flow of 3,400 m^3/s is adopted as a design flood inflow for the spillway.

ii) An ungated side spillway with crest of 50 m long and a gated spillway with two radial gates of 12.5 m wide x 12.5 m high are provided.

iii) The effect of reservoir flood routing is considered.

iv) The ungated side spillway is arranged to release a flood smaller than the return period of 50-year without any operation. This controlled 50-year flood is taken into consideration the design-flood for the downstream river improvement.

v) The gated spillway is to be operated in accordance with the reservoir water level rising or falling.

(2) Flood routing and flood water level

The reservoir flood routing effect is calculated for the PMF and 50-year flood.

The 50-year flood is released through the ungated side spillway only. The water level rises up to El. 69.10 m as shown in Fig. J-18, so the flood control water level (FCWL) is set at El. 69.50 m with some allowance of storage capacity.

The gates are opened to release flood discharge more than 50-year flood at the speed of 0.30 m/min when the reservoir water level is over FCWL of El. 69.50 m. The gates are planned to be opened at an interval of 10 minutes depends on the reservoir water level rising speed.

The maximum water level for the design flood (PMF) is at El. 69.90 m as shown in Fig. J-19, so the flood water level (FWL) is set at this level. The relation between peak inflow and outflow are summarized below:

i) 50-year flood : Qip= 800 m^3/s, Qop= 205 m^3/s

ii) PMF : Qip= 3,400 m^3/s, Qop= 2,670 m^3/s

(3) Weir and chute-way

The ungated side spillway is provided at the right bank of gated spillway with 50 m long crest and 9.0 m wide side channel. The crest is set at the normal high water level (NHWL) of El. 67.50 m. The gated spillway has two radial gates of 12.5 m wide x 12.5 m high. The weir crest is set at El. 57.50 m. The side and gated spillway are capable of discharging 370 m^3/s and 2,300 m^3/s respectively at the flood water level of 69.90 m. The chute-way is 39.00 m wide, 116.50 m long and 1:4 slope.

(4) Energy dissipator

As energy dissipator, a stilling basin type or a flip bucket and plunge pool type is applicable for this site. The land downstream of the spillway is flat and broad. A scouring of the riverbed does not cause a special problem at the site. Taking into consideration the circumstances, the flip bucket type is adopted to save the construction cost. The design discharge for the plunge plool is 1,660 m^3/s which is the free overflow discharge through the gated spillway weir at the normal high water level. The required plunge plool length is 70.00 m.

3.6.3 Intake and Discharge Facilities

The maximum discharge for the irrigation and M & I water from the Karian reservoir to the Pamarayan weir and Rangkasbitung is estimated to be 48 m^3/s at the reservoir water level of El. 53.2 m and 17 m^3/s at LWL of El. 46.00 m. To release the required water, the intake and hollow jet valve are provided at the right bank and in the diversion tunnel.

The intake is a shaft type of 10.0 m wide x 11.0 m long x 45.0 m high and connected with the diversion tunnel by a tunnel of 2.0 m in diameter. The intake weir is set at El. 37.0 m with 1.5 m allowance above 50-year sedimentation level. This elevation is decided to release the reservoir water below the low water level in case of emergency and for maintenance of the dam. In case that the sedimentation becomes over the above level, some stoplogs will be put on the intake weir to release the required water without sand and gravel. A gate is provided in the intake for closing at emergency and maintenance.

A hollow jet valve of 2.0 m in diameter is provided in the diversion tunnel of 6.6 m in diameter. A connection tunnel of 2.0 m in diameter between diversion tunnels is planned for the access to the hollow jet valve operation.

3.6.4 River Diversion

Two diversion tunnels are provided to divert the flood discharge during the dam embankment period of about two years. The 25 year probable flood of 700 m^3/s is adopted as the design discharge.

The coffer dam crest elevation is decided taking the possible embankment volume in one dry season into consideration. The estimated embankment volume for three months is 105,000 m^3 and the crest elevation is at El. 39.00 m.

The diversion tunnel is to be 6.6 m in diameter for the design flood at the upstream water level of El. 38.00 m. The tunnel route is selected to minimize the affection to the main dam because the tunnel of large diameter may cause a deflection in the soft rock foundation. The selected routes are 471.2 m and 515.2 m long. These tunnels will be closed at the dam axis by plug concrete after the dam embankment work, and one of two tunnels will be utilized as a permanent facility for discharging the irrigation and M & I water.

4. CILAWANG DAM

4.1 General

Preliminary design is executed on main structures for the purpose of estimating the construction ocst of the Cilawang dam as shown in Figs. J-29 to J-33. The design of dam is made in accordance with the basic design requirement by the water balance study made in the preceding Chapter 1.

4.2 Dam Site

The dam site proposed in the Master Plan Study is reviewed from topographical and geological points of view in this study and confirmed as an adequate location for the dam.

4.3 Topography

The cibeureum river at the Cilawang dam site flows with a width of around 15 m and riverbed of about El. 47 m in the direction from south to north. The left bank shapes a gentle slope of about 10° up to around El. 75 m. The right bank is relatively steep slope of about 25° up to El. 80 m. Hills surrounding the dam and reservoir are about El. 75 m to El. 100 m. The left watershed consists of saddles of around El. 75 m to 80 m, therefore saddle dams are needed in case that the dam crest is more than El. 75.0 m.

4.4 Geology

The main geological formation consists of lapilli tuff of the Genteng Formation Pleiocene. Conglomerate (2 to 3 m thick) of round gravel of andesite appears at the riverbed. No fault has been found so far but there is high possibility that a tectonic fractured line extends northward running across the dam axis diagonally. Quality classification of rock in drilling hole is fairly better than that of the Karian dam site.

In the field permeability tests in the bore holes along the dam axis, rather high permiability coefficient of 2×10^{-3} cm/s was observed at some parts in the dam foundation as same as the Karian dam site. The compressive strength test was carried out on the core sampled by drilling in the dam foundation. The compressive strength varies in the order of 4 to 75 kg/cm^2.

4.5 Basic Design Conditions

4.5.1 Water Requirement

The required storage volume in the Cilawang reservoir is 62×10^6 m^3 in effective given in (3) of Sub-paragraph 1.3.2. The maximum discharge for the K-C-C Irrigation Scheme from the intake is 18 m^3/s. The maximum discharge for the Cicinta Irrigation Scheme is 2.7 m^3/s through the Cicinta trans-basin tunnel.

4.5.2 Sedimentation

The sediment load is estimated to be 1,700 $m^3/km^2/year$ as given in Appendix-B. The sedimentation for the dead storage volume design is calculated by the following equation:

$$Vs = S * CA * T$$

Where, S : annual sediment load ($m^3/km^2/year$)
CA : catchment area of reservoir (km^2)
T : sedimentation design year (= 100 year)

$$Vs = 1,700*93*100$$
$$= 16 \times 10^6 \ m^3$$

The reservoir water level for the above sedimentation is at El. 65.0 m.

4.5.3 Water Level and Dam Crest Elevation

The water level for each purpose is set as follows.

The low water level (LWL) is set at the elevation above the top of estimated sedimentation level with the allowance of 1.5 m. The normal high water level (NHWL) is set to store the volume requied as active storage above LWL. The flood water level is set to spill out the design flood safely with enough overflow depth through the spillway (Ref. Sub-paragraph 4.6.2).

The adopted water levels and reservoir storage volume for each purpose are listed below and shown in Fig. J-3.

The dam crest elevation is set at the elevation on the flood water level with the freeboard of 2.5 m (Ref. Sub-paragraph 4.6.1).

Dam crest elevation	:	81.00 m
Flood water level (FWL)	:	78.50 m
Normal high water level (NHWL)	:	76.50 m
Low water level (LWL)	:	66.50 m
Dead storage volume	:	20×10^6 m^3
Effective storage volume	:	62×10^6 m^3

4.6 Deisgn of Main Structures

4.6.1 Main Dam

(1) Dam type

The standard zoned rockfill dam is adopted as the Cilawang dam because of the same reason of the dam type selection for the Karian dam.

The necessary materials for the fill dam are studied on available volume and their quality. The rock materials of about 382,000 m^3 are recommended to be basalt and fresh tuff breccia from Guradog quarry site as same as for the Karian dam. This quarry is located at about 10 km south of the dam. The filter material of 70,000 m^3 and the core material of 82,000 m^3 are available from the borrow area at Sajila at about 6 km south of the dam.

(2) Dam crest elevation

The dam crest elevation is set at El. 81.00, adding free board of 2.50 m above the flood water level of El. 78.50 m.

The wave height (Hw) by the wind is estimated by the S.M.B. and Saville methods from the reservoir length and the dam slope. Since the maximum wind velocity observed is 11 m/s at Serang, the design wind velocity is adopted to be 20 m/s which is commonly used for other projects in Indonesia. The wind wave height of 0.6 m is estimated by the above method from the storage length of 3.5 km from the dam to the opposite bank.

The wave height by earthquake is estimated by the following equation:

$$He = k*(g*Ho)^{0.5}/(2*3.14)$$

Where, He : wave height by wind (m)

k : earthquake coefficient (= 0.15)

g : acceleration of gravity (= 9.8 m/s^2)

Ho : reservior water depth (= 76.5-47.0=29.5 m)

$$He = 0.15*(9.8*29.5)^{0.5}/(2*3.14)$$
$$= 0.4 \text{ m}$$

The allowance (Ha) for the unforeseeable accident is added on the above freeboard. The pavement is planned to be made by the thickness of 0.40 m (Hp) on the crest of the impervious core.

On comparing the following earthquake and flood cases, the highest is decided as the dam crest elevation:

i) Earthquake conditon

EL1 = NHWL + Hw + He + Ha + Hp

= 76.50 + 0.60 + 0.40 + 1.5 + 0.40

= 79.40 m

ii) Flood condition

$$EL2 = FWL + Hw + Ha + Hp$$
$$= 78.50 + 0.60 + 1.50 + 0.40$$
$$= 81.00 \text{ m}$$

(3) Zoning

The dam is designed as the center core type having five zones; core, find and coarse filter, rock and riprap zones. The required embankment volume including the saddle and the main coffer dam is tabulated below:

Zone	Volume (m^3)	Materials
Core	82,000	Earth, and, grabel
Fine filter	48,000	Sand, gravel
Coarse filter	32,000	Sand, Gravel
Rock	313,000	Basalt, tuff breccia
Riprap	69,000	Basalt
	534,000	

(4) Foundation treatment

Some pervious strata of permeability coefficient of 2×10^{-3} cm/sec are observed in the foundation of the dam.

As foundation treatment, the following grouting works are planned below the core zone.

i) Blanket grout : at 2 m intervals with 5 m deep and 2 lines

ii) Curtain grout : at 2 m intervals with 20 to 35 m deep and 2 lines

(5) Dam stability

The dam stability analisis is refered to that for the Karian dam. Because of the same embankment material, the same dam embankment slope and lower dam height than the Karian dam, the Cilawang dam will have a enough safety factor.

(6) Instruments for the dam

The following observation instruments would be provided in the dam.

- pore pressure meters,
- earth pressure meters,
- cross-arm settlement measurement devices,
- earthquake recorders,
- other instruments for displacement of dam surface, and
- leakage water measurement devices.

4.6.2 Spillway

(1) Design condition and concepts

The spillway is aligned toward the channel center of the river from the right bank hill. Design conditions and concepts are summarized below.

i) A probable maximum flood (PMF) with a peak flow of 1,700 m^3/s is adopted as a design flood inflow for the spillway.

ii) The effect of reservoir flood routing is considered.

iii) An ungated side spillway with crest of 20 m long and a gated spillway with two radial gates of 9.0 m wide x 9.5 m high are provided.

iv) The ungated side spillway is arranged to release a flood smaller than the return period of 50-year without any operation.

v) The gated spillway is to be operated in accordance with the reservoir water level rising or falling.

(2) Flood routing and flood water level

The reservoir flood routing effect is calculated for the PMF and 50-year flood.

The 50-year flood is released through the ungated side spillway only. The water level rises up to El. 77.90 m as shown in Fig. J-19, so the water level to open the gates is set at El. 78.20 m.

The gates are opened to release flood discharge more than 50-year flood at the speed of 0.30 m/min when the reservoir water level is over El. 78.20 m. The gates is planned to be opened at an interval of 10 minutes depends on the reservoir water level rising speed.

The maximum water level for the design flood (PMF) is at El. 78.50 m as shown in Fig. J-20, so the flood water level (FWL) is set at this level. The relation between peak inflow and outflow are summarized below:

i) 50-year flood : Qip = 390 m^3/s, Qop = 74 m^3/s

ii) PMF : Qip = 1,700 m^3/s, Qop = 1,230 m^3/s

(3) Weir and chute-way

The ungated side spillway is provided at the right bank of gated spillway with 25 m long crest and 5.0 m wide side channel. The crest is set at the normal high water level (NHWL) of El. 76.50 m. The gated spillway has two radial gates of 9.0 m wide x 9.5 m high. The weir crest is set at El. 69.00 m. The side and gated spillway are capable of discharging 120 m^3/s and 1,110 m^3/s respectively at the flood water level of 78.50 m. The chute-way is 28.00 m wide, 93.9 m long, 1:10 and 1:2 slope.

(4) Energy dissipator

As for the energy dissipator, a stilling basin type or a flip bucket type is applicable. A flip bucket type needs a large space for a plunge pool and may cause a scouring problem in the riverbed and banks. Since the spillway site is narrow and the foundation of stilling basin consists of tuff which is an erosive soft rock, a stilling basin type is addopted. The design discharge for the plunge plool is 780 m^3/s which is the free overflow discharge through the gated spillway weir at the normal high water level. The requied stilling basin length is 60.00 m long.

4.6.3 Intake and Discharge Facilities

The maximum discharge for the irrigation water from the Cilawang reservoir to the Buyut weir is estimated to be 18 m^3/s at the reservoir water level of El. 75.3 m and 14 m^3/s at LWL of El. 66.50 m. To release the required water, the intake and gate is provided at the right bank along the spillway.

The intake is connected with the outlet in the chuteway by a discharge pipe of 2.0 m in diameter. The intake weir is set at El. 65.0 m below the low water level. Two gates of 2.0 x 2.0 m are provided in the gate operation chamber for normal and maintenance use.

4.6.4 River Diversion

The diversion tunnel is designed against the 25-year probalbe flood of 300 m^3/s for the river diversion during the dam embankment period.

The coffer dam crest elevation is decided taking the possible embankment volume in one dry season into consideration. The estimated embankment volume for three months is 76,000 m^3 and the crest elevation is at El. 61.00 m.

The diversion tunnel is to be 6.6 m in diameter and 346 m long for the design flood at the upstream water level of El. 60.00 m. A emegency river outlet facilities are provided in the diversion tunnel for the emergency case in order to lower the reservoir water level below the low water level.

The intake weir for the river outlet is set at El. 61.50 m of the 50-year sedimentation level. A hollow jet valve and a ring hollow gate of 1.2 m in diameter are provided at the outlet.

5. CIUYAH TRANS-BASIN TUNNEL

5.1 General

The Ciuyah trans-basin tunnel is provided to divert the water from the Karian reservoir to the Cibeureum river for the K-C-C irrigation scehem of 10,300 ha, because the capacity of Cilawang reservoir is not enough for the irrigation water requirement. The released water will be diverted to the K-C-C irrigation scheme at the Buyut diversion weir about 3.5 km downstream from the Cilawang dam.

The intake is planned at the right bank of about 6 km upstream from the Karian dam. The tunnel outlet is located at the left bank of the Cibeureum river at a distance of about 3 km downstream from the Cilawang dam. The maximum tunnel discharge is 8.0 m^3/s. The tunnel is 2.6 m in diameter and 1,540 m long.

Preliminary design is made on main structures for the purpose of estimating the construciton cost of the tunnel as shown in Figs. J-27 and J-28.

5.2 Topography and Geology

The tunnel site is located at a gently sloped hill of El. 40 m to El. 100 m. The general geology in the vicinity of the tunnel site is similar to that of the Karian dam site. The subsurface geology is mainly composed of tuffaceous fine to medium grained sandstone with intercalaction of pumice tuff and claystone. It is estimatbd to include some fractured zone.

5.3 Design of Main Structures

The maximum discharge is 8.0 m^3/s as determined in Sub-paragraph 1.3.2. The intake and valve are designed to release the discharge of 8.0 m^3/s at the water level of El. 48.5 m which is 2.5 m higher than the low water level of the reservoir (LWL). This water level is decided referring to the water level and discharge in the water balance study.

The intake weir is set at El. 45.00 m which is 100-year sedimentation level. The intake is equipped with trash rack and stop log slots.

As for the discharge control facility, a inclined intake with a gate and a vertical shaft intake with a valve are compared on the construction cost. Since the site slope is too gentle to built a inclined intake, it costs more than a shaft type. Therefore, the vertical shaft intake is adopted.

The valve shaft is 2.5 m in diameter and 26.0 m in depth. A hollow jet valve of 1.2 m in diameter as a main valve and a ring hollow gate of 1.2 m in diameter as a guard gate are provided.

The tunnel is designed as a horse-shoe shaped tunnel of 2.6 m in diameter and 1,540 m in length. The tunnel slope is 1/1,500 in order to make stable free flow with velocity less than 2.0 m/s and the water depth of 90% of the tunnel diameter.

The tunnel passes through the gentle hill which earth covering is 13 m to 49 m. Taking into consideration the earth covering and geology, the steel support and consolidation grout may be required for the tunnel construction work. The required parts of consoridation grout and steel support are estimated for 30% and 100% of the total tunnel length respectively for the cost estimation.

The tunnel outlet is located at the left bank of the Cibeureum river. Since the flood water level is estimated to be El. 45.00 m, the tunnel outlet is set so as not to be submerged fully. For the purpose of riverbed protection from the scoring, the baffled apron of 13.0 m long is planned.

6. CICINTA TRANS-BASIN TUNNEL

6.1 General

The Cicinta trans-basin tunnel is provided to divert the water from the Cilawang reservoir to the Cicinta river for the Cicinta irrigation scheme of 1,430 ha to supplement the shortage of irrigation water in the existing irrigation scheme. The released water will be diverted to the Cicinta irrigation scheme at the existing Cicinta diversion weir. The Cicinta irrigation scheme is located at about 10 km downstream of the tunnel outlet.

The intake is planned at the right bank of about 1.5 km upstream from the Cilawang dam. The tunnel outlet is located in the tributary of the Cicinta river. The maximum tunnel discharge is 2.7 m^3/s. The tunnel is 2.0 m in diameter and 1,920 m long.

Preliminary design is executed on main structures for the purpose of estimating the construction cost of the tunnel as shown in Figs. J-34 and J-35.

6.2 Topography and Geology

The tunnel site is located at a gently sloped hill of El. 70 m to El. 115 m. The general geology in the vicinity of the tunnel site is similar to that of the Karian dam site. The subsurface geology is mainly composed of tuffaceous sandstone and claystone. The rocks at the tunnel site are generally soft and partly fractureed with slicken side.

6.3 Design of Main Structures

The maximum discharge is 2.7 m^3/s as determined in Sub-paragraph 1.3.2. The intake and valve are designed to release the discharge of 2.7 m^3/s at the water level of El. 69.0 m which is 2.5 m higher than the low water level of the reservoir (LWL). This water level is decided referring to the water level and discharge in the water balance study.

The intake weir is set at El. 65.00 m which is 100-year sedimentation level. The intake is equipped with trash rack and stop log slots.

As for the discharge control facility, a vertical shaft intake with a valve is adopted because of the same reason for the Ciuyah tunnel.

The valve shaft is 2.0 m in diameter and 14.1 m in depth. A hollow jet valve of 0.7 m in diameter as a main valve and a ring hollow gate of 0.7 m in diameter as a guard gate are provided.

The minimum diameter is 1.8 m in view of the actual construction. Then, the Ciuyah tunnel is designed as a horse-shoe shaped tunnel of 2.0 m in diameter and 1.920 m in length. The tunnel slope is decided to be 1/960 from the elevation of the inlet of El. 65.00 m and the outlet of El. 63.00 m.

The tunnel passes through the gentle hill which earth covering is 8 to 47 m. A paddy field of the covering of about 3.5 m exists near the outlet. The tunnel excavation may be difficult without special construction method, so the open cut method is recommendable for this part of about 100 m long.

Taking into consideration the earth covering and geology, the steel support and consolidation grout may be required for the tunnel construction work. The required parts of consoridation grout and steel support are estimated for 30% and 100% of the total tunnel length respectively for the cost estimation.

The tunnel outlet is located at the left bank of the tributary of the Cicinta river in the paddy field. The river channel improvement and connection channel construction are designed together with the discharge channel.

7. CONSTRUCTION PLAN AND SCHEDULE

7.1 General

The construction plan and schedule are given in this chapter on two groupes; i) the Karian dam and the Ciuyah tunnel group, and ii) the Cilawang dam and the Cicinta tunnel group. This group division is made by the reason that the tunnel work shall be done before filling the reservoir water.

The two dams and two tunnels are different scale and dimensions but same type, so the general descriptions are made commonly for two groupes. The main construction work items and quantities are shown in Table J-10.

7.2 Mode of Construction

The construction work on the project would be carried out by contractors and suppliers on a competitive contract basis, and divided into the following contract:

(1) International contract

(a) Construction of Civil works:

- Dam, spillway, diversion tunnel cofferdam, intake and permanent roads,

- Trans-basin tunnel, intake and outlet.

(b) Supply and installation of metal works:

- Gates, stop logs, valves trash racks and emergency generators.

(2) Local contract

(a) Preparation works at the projects site, especially the construction roads.

(b) Erection of distribution line from the main line to the site.

7.3 Preparatory Works

The preparatory works would include preparation of temporary buildings, the power supply system, the communication system, water supply, etc., in the early stages of construction period.

It is recommended, however, that construction of access roads, excepting the river diversion works, be executed by local contractors prior to the commencement of main civil works to shorten the whole construction period. The river diversion works would be undertaken by a contractor selected by international tender.

7.4 Karian Dam Construction

(1) Civil works

The main civil works consist of construction of diversion tunnels with coffer dams, main and saddle dams, spillway and intake.

(a) Diversion tunnels and coffer dam

Two 6.6 m diameter diversion tunnels with 471 and 515 m long are proposed for river diversion. The work would comprise open and tunnel excavation, steel support erection, concrete lining and grouting. Top heading and bottom bench cut excavation is suggested for tunnel excavation due to the soft rock condition. The concrete lining of arch portion would follow to top heading excavation. River diversion through the tunnel would be effected by closing the river (an upstream initial coffer dam) just downsteram of the diversion tunnel inlet. Another low coffer dam would be constructed at the next riverbed just downstream of the toe of the dam. These coffer dams would be constructed using random materials.

(b) Dam foundation treatment

Dam foundation treatment would comprise foundation excavation, and blanket and curtain grouting. The total drilling lengths would be 10,300 m for blanket grouting and 26,400 m for curtain grouting. The construction of the main coffer dam would be commenced immediately after the completion of river diversion. The coffer dam works would be carried out in parallel with the foundation treatment. This coffer dam would be a rockfill dam with core. Its volume would be approximately 112,400 m^3 and 8.4% of total dam volume. Three months in a dry season will be sufficient for construction of the main coffer dam.

(c) Main dam

The total volume of the main dam is 1,229,000 m^3 consisting of 142,000 m^3 for the core, 128,000 m^3 for the filter and 959,000 m^3 for thr rock.

i) Core material (142,000 m^3 in embankment volume):

For core material, the soil at the borrow pits of Sajira would be mixed with sand and gravel from the same borrow pit. The distance between these borrow pits is about 7 km from the dam.

ii) Filter material (128,000 m^3 in embankment volume):

Sand and gravel materials for filter would be supplied directly from the borrow pits at Sajira after selection for fine and coarse filter.

iii) Rock material (959,000 m^3 in embankment volume):

All rock materials would be supplied from the quarry of Guradog approximately 15 km distant from the dam site. Rock excavation is planned by bench cut.

Two years are allocated for embankment construction, immediately after completion of all necessary foundation treatment. The core embankment with filter can be constructed only in the dry season, but shell zones with rock can be constructed even in the seasons though low work efficiency may be expected due to heavy rainfall. In this study, work periods were assumed to be 6 months a year from May for the core and filter works, and the full year for rock and random materials subject only to suspension in heavy rainfall over 20 m day.

(d) Spillway

The rock quantities for the spillway would be 258,000 m^3 in excavation, 24,000 m^3 in concrete and two gates of 12.5 m high x 12.5 m wide. The construction work would be made separately from the other works.

(e) Intake

The intake would consist of inspection bridge, tower, shaft and connection tunnel with the diversion tunnel. The tunnel shaft excavation would be made with some remaining parts near the diversion tunnel at the same time when the diversion construction work is under going on. The remaining parts of connection tunnel would be made after the closing of diversion tunnel. The tower and inspection gridge work would be made separately from other civil works.

(f) Saddle dam

The saddle dam work quantities would be 102,000 m^3 in excavation and 150,000 m^3 in embankment.

The construction work would be done separately from the other works and in the following procedure: i) stripping and excavation, ii) branket and consolidation grout, and iii) embankment.

(2) Metal works

(a) Spillway gates

Two spillway gates of 12.5 m wide x 12.5 m high, estimated weight of 270 ton would be installed by the Metal contractor. The work would be commenced after the completion of concrete works of the spillway by the civil contractor.

(b) Other metal works

As for the metal works, gates for diversion tunnel inlet, gates, trash racks, follow jet valve for intake, stop logs for intake and spillway would be required, which total weight is estimated to be 285 ton. These works would be made in combination with the civil works.

7.5 Cilawang Dam Construction

(1) Civil works

The main civil works consist of construction of diversion tunnel with coffer dams, main and saddle dams, spillway and intake.

(a) Diversion tunnel and coffer dam

A 6.6 m diameter diversion tunnel with 346 m long is proposed for river diversion. The work would comprise open and tunnel excavation, steel support erection, concrete lining and grouting. Top heading and bottom bench cut excavation is suggested for tunnel excavation due to the soft rock condition. The concrete lining of arch portion would follow to top heading excavation.

The tunnel works shall be completed by the end of May 1989 for river diversion. River diversion through the tunnel would be effected by closing the river (an upstream initial coffer dam) just downstream of the diversion tunnel inlet. Another low coffer dam would be constructed at the next riverbed just downstream of the toe of the dam. These coffer dams would be constructed using random materials.

(b) Dam foundation treatment

Dam foundation treatment would comprise foundation excavation, and blanket and curtain grouting. The total drilling lengths would be 5,800 m for blanket grouting and 14,300 m curtain grouting. The construction of the main coffer dam would be commenced immediately after the completion of river diversion. The coffer dam works would be carried out in parallel with the foundation treatment. This coffer dam would be a rockfill dam with core. Its volume would be approximately 76,000 m^3 and 15% of total dam volume. Three months in a dry season will be sufficient for construction of the main coffer dam.

(c) Main dam

The total volume of the main dam is 419,000 m^3 consisting of 60,000 m^3 for the core, 56,000 m^3 for the filter and 304,000 m^3 for the rock.

i) Core material (60,000 m^3 in embankment volume):

For core material, the soil at the borrow pits of Sajira would be mixed with sand and gravel from the same borrow pit. The distance between these borrow pits is about 6 km from the dam.

ii) Filter material (56,000 m^3 in embankment volume):

Sand and gravel materials for filter would be supplied directly from the borrow pits at Sajira after selection for fine and coarse filter materia.

iii) Rock material (304,000 m^3 in embankment volume):

All rock materials would be supplied from the quarry of approximately 10 km distant from the dam site. Two years are allocated for embankment construction, immediately after completion of all necessary foundation treatment. The core embankment with filter can be constructed only in the dry season, but shell zones with rock can be constructed even in the seasons though low work efficiency may be expected due to heavy rainfall. In this study, work periods were assumed to be 6 months a year from May for the core and filter works, and the full year for rock and random materials subject only to suspension in heavy rainfall over 20 mm a day.

(d) Spillway

The work quantities for the spillway would be 115,000 m^3 in excavation, 29,900 m^3 in concrete and two gates of 9.5 m high x 9.0 m wide. The construction work would be made separately from the other works.

(e) Intake

The intake would be constructed as one of the spillway structures.

(f) Saddle dam

The saddle dam work quantities would be 37,000 m^3 in excavation and 39,000 m^3 in embankment.

The construction work would be done separately from the other works and in the following procedure: i) stripping and excavation, ii) branket and consolidation grout, and iii) embankment.

(2) Metal works

(a) Spillway gates

Two spillway gates of 9.0 m wide x 9.5 m high, estimated weight of 126 ton would be installed by the Metal contractor. The work would be commenced after the completion of concrete works of the spillway by the civil contractor.

(b) Other metal works

As for the metal works, gate for diversion tunnel inlet, gates, trash racks for intake, stop logs for intake and spillway, hollow jet valve and ring hollw gate for the emergency river outlet would be required, which total weight is estimated to be 182 ton. These works would be made in combination with the civil works.

7.6 Ciuyah Tunnel

(1) Civil works

(a) Tunnel

The trans-basin tunnel would be a concrete lined tunnel 1,540 m long with a horse-shoe section of 2.6 m inside diameter. The excavation would be done by a full face cutting method. Steel support erection would be required for most of the tunnel parts. Concrete lining of 7,600 m^3 and grouting work of 7,300 m long would follow the heading excavation.

(b) Intake and outlet

The intake and outlet of 3,400 m^3 in excavation and 250 m^3 in concrete would be done in the open separately from the other works.

(c) Valve shaft

The valve shaft of 2.5 m inside diameter and 26 m deep would be constructed at the hillside. This shaft excavation work would be done from the top to bottom because of the small work quantity and soft rock condition. The concrete lining, plug concrete and grouting work follows excavation work.

(2) Metal works

As for metal works, trash racks at the intake, a hollow jet valve of 1.2 m in diameter and a ring hollow gate would be installed. The total weight of metal works is estimated to be 12 ton. These works would be done mostly after completion of the civil works.

7.7 Cicinta Tunnel

(1) Civil works

(a) Tunnel

The trans-basin tunnel would be a concrete lined tunnel 1,920 m long with a horse-shoe section of 2.0 m inside diameter. The excavation would be done by a full face cutting method. Steel support erection would be required for most of the tunnel parts. Concrete lining of 8,600 m^3 and grouting work of 9,000 m long would follow the heading excavation.

(b) Intake and outlet

The intake and outlet of 7,600 m^3 in excavation and 600 m^3 in concrete would be done in the open separately from the other works.

(c) Valve shaft

The valve shaft of 2.0 m inside diameter and 14 m deep would be constructed at the hillside. This shaft excavation work would be done from the top to bottom because of the small work quantity and soft rock condition. The concrete lining, plug concrete and grouting work follows excavation work.

(2) Metal works

As for metal works, trash racks at the intake, a hollow jet valve of 0.7 m in diameter and a ring hollow gate would be installed. The total weight of metal works is estimated to be 7 ton. These works would be done mostly after completion of the civil works.

7.8 Construction Schedule

Apporoximately five and a half (5.5) years would be required for two dams and two tunnels from the commencement of engineering design to the completion of the work as follows:

(1) Engineering design : 1 year and 6 months

The engineering design including field investigation and preparation of tender document for construction is estimated to be made for one and a half (1.5) years.

(2) Preparatory works : 1 year

The preparatory works including Loan arrangment, Tender is estimated to be done for one year.

(3) Main construction works : 3 years

The main construction works would be commenced from the diversion tunnel excavation and would be completed in the reservoir water filling for three years.

Table J-1 DRYSEASON RUNOFF AT KARIAN DAMSITE

NO.	Year	Runoff (mcum)	(m3/s)	Thomas plot position(%) Fn=(1-n/(N+1))*100
1	1982	47.87	4.54	93.33
2	1972	53.18	5.05	86.67
3	1976	78.89	7.48	80.00
4	1977	110.46	10.48	73.33
5	1979	113.33	10.75	66.67
6	1983	133.39	12.65	60.00
7	1970	182.06	17.27	53.33
8	1980	216.61	20.55	46.67
9	1978	224.75	21.32	40.00
10	1971	225.33	21.38	33.33
11	1975	259.64	24.63	26.67
12	1973	268.13	25.44	20.00
13	1974	312.66	29.66	13.33
14	1981	373.79	35.46	6.67

Note;

(1) The runoff in 1971 is estimated from that of Kopomaja station by the following equation:

Q(Rankasbitung)=3.429*Q(Kopomaja)+18.867

Q(Karian damsite)=0.299*Q(Rankasbitung)

(2) Dryseason is defined as the period from June to September.

Table J-2 VARIABLES FOR WATER BALANCE STUDY (1/2)

(1) GENERAL

HWLK: Normal high water level of Karian reservoir (m)
LWLK: Low water level of Karian reservoir (m)
HWLC: Normal high water level of Cilawang reservoir (m)
LWLC: Low water level of Cilawang reservoir (m)
QMQ2: Maximum diversion discharge from Karian reservoir to K-C-C Irrigation Scheme (m3/s)

(2) KARIAN RESERVOIR

QK : Inflow to Karaian reservoir (m3/s)
QN : Residual river discharge at Pamarayan weir except Karian reservoir catchment area (m3/s)
QE : Evaporation from reservoir water surface (m3/s)
QIR: Irrigation water requirement for the Ciujung Irrigation Scheme at Pamarayan weir (m3/s)
QIK: Required discharge from the intake for the Ciujung Irrigation Scheme (m3/s)
QIS: Irrigation water shortage for the Ciujung Irrigation Scheme at Pamarayan weir (m3/s)
Q1R: Required discharge from the intake for the irrigation and M&I water (m3/s)
Q1 : Discharge from the intake (m3/s)
Q1S: Shortage water from the intake as against requirement (m3/s)
Q2R: Diversion water requirement through Ciuyah tunnel to K-C-C Irrigation Scheme (m3/s)
Q2S: Shortage water as against Q2R (m3/s)
D2 : Supplied municipal water to Rangkasbetung (m3/s)
D1R: Required discharge from the intake for M&I water for Cilegon and 17 I.K.K. (m3/s)
D1 : Supplied M&I water for Cilegon and 17 I.K.K. at Pamayaran weir (m3/s)
SP2: Spill out water from the spillway of Karian dam (m3/s)
SP1: Spill out water from the spillway of Pamarayan weir (m3/s)
H1 : Reservoir water level (m)
S1 : Reservoir storage volume (10x6 m3)
QM : River maintenance flow (m3/s)
RL : River conveyance loss

Table J-2 VARIABLES FOR WATER BALANCE STUDY (2/2)

(4) CILAWANG RESERVOIR

QC : Inflow to Cilawang reservoir (m3/s)
QN : Residual river discharge at Buyut weir except Cilawang reservoir catchment area (m3/s)
QE : Evaporation from reservoir water surface (m3/s)
QIR: Irrigation water requirement for the K-C-C Irrigation Scheme at Buyut weir (m3/s)
QIC: Required discharge from the intake for the K-C-C Irrigation Scheme (m3/s)
QIS: Irrigation water shortage for the K-C-C Irrigation Scheme at Buyut weir (m3/s)
Q2R: Diversion water requirement through Ciuyah tunnel to K-C-C Irrigation Scheme from Karian reservoir (m3/s)
Q2 : Supplied discharge as against Q2R
Q2S: Shortage water as against Q2R
Q3R: Required discharge from the intake for the irrigation and river maintenane flow (m3/s)
Q3 : Discharge from the intake (m3/s)
Q3S: Shortage water as against Q3R
Q4R: Diversion water requirement through Cicinta tunnel to Cicinta Irrigation Scheme (m3/s)
Q4 : Supplied discharge as against Q4R (m3/s)
Q4S: Shortage water as against Q4R (m3/s)
SP3: Spill out water from the spillway of Cilawang dam (m3/s)
SP4: Spill out water from the spillway of Buyut weir (m3/s)
H2 : Reservoir water level (m)
S2 : Reservoir storage volume (10x6 m3)
QM : River maintenance flow (m3/s)
RL : River conveyance loss

(4) CICINTA WEIR

QN : Natural river discharge at Cicinta weir (m3/s)
QIR: Irrigation water requirement for the Cicinta Irrigation Scheme at Cicinta weir (m3/s)
SP5: Spill out water from the spillway of Cicinta weir (m3/s)
Q4R: Diversion water requirement through Cicinta tunnel to the Cicinta Irrigation Scheme (m3/s)
Q4S: Shortage water as against Q4R (m3/s)
QM : River maintenance flow (m3/s)
RL : River conveyance loss

Table J-3 CONSTRUCTION COST COMPARISON OF TUNNEL AND DAM

Tunnel discharge (m^3/sec)	Normal high water level (NHWL)		Flood water level (FWL)		Dam crest elevation (El.m)		Construction cost (US$$10^3$)			Compensation cost (US$$10^3$)		Total (US$$10^6$)
							Ciuyah tunnel cost	Dam embankment cost				
	KA	CI	KA	CI	KA	CI		Karian	Cilawang	Karian	Cilawang	
6.0	67.00	77.00	69.40	79.00	72.00	81.50	2,970	14,550	5,820	9,260	2,580	35,180
8.0	67.50	76.50	69.90	78.50	72.50	81.00	3,500	15,330	5,450	9,450	2,470	36,200
10.0	68.50	74.00	70.90	76.00	73.50	78.50	4,080	16,880	4,020	9,830	1,920	36,730
12.0	69.00	73.50	71.40	75.50	74.00	78.00	5,890	17,650	3,950	10,020	1,810	39,320

Note: KA = Karian dam

CI = Cilawang dam

Table J-4 WATER BALANCE STUDY FOR KARIAN RESERVOIR (1/12)

**** WATER BALANCE STUDY AGAINST C.I. OF 250 % BY PROSIDA ****

KARIAN RESERVOIR

YEAR	HWLK	LWLK	HWLC	LWLC	QMQ2	VHWLK	VLWLC
1972	67.5	46.0	76.5	66.5	8.0	219.3	62.0

MON	DAYS	QK	QN	QE	Q1R	Q1K	Q1S	QTR	Q1	Q1S	Q2R	Q2S	D2	D1R	D1	SP2	SP1	H1	S1
JAN	10	110.28	268.52	0.36	6.05	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	109.92	370.61	67.50	219.3
	10	63.55	154.74	0.36	0.	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	63.19	216.15	67.50	219.3
	11	60.47	147.24	0.36	21.05	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	60.11	184.52	67.50	219.3
FEB	10	54.58	132.89	0.47	27.35	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	54.11	157.88	67.50	219.3
	10	33.49	81.55	0.47	11.37	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	33.03	101.43	67.50	219.3
	9	38.09	92.74	0.47	10.16	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	37.62	118.43	67.50	219.3
MAR	10	69.74	169.82	0.52	7.02	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	69.23	230.25	67.50	219.3
	10	58.63	142.76	0.52	21.54	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	58.11	177.56	67.50	219.3
	11	40.42	98.42	0.52	24.44	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	39.90	112.11	67.50	219.3
APR	10	19.67	47.89	0.49	20.57	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	19.18	44.72	67.50	219.3
	10	14.88	36.23	0.49	29.28	0.	0.	5.02	0.	0.	6.00	0.	0.	0.	1.63	6.39	11.57	67.50	219.3
	10	37.78	91.98	0.49	30.01	0.	0.	3.66	0.	0.	8.00	0.	0.	0.	1.63	29.28	89.48	67.50	219.3
MAY	10	34.76	84.63	0.57	28.80	0.	0.	3.66	0.	0.	8.00	0.	0.	0.	1.63	26.19	80.25	67.50	219.3
	10	26.13	63.63	0.57	25.41	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	25.56	62.01	67.50	219.3
	11	31.70	77.19	0.57	38.48	0.	0.	3.66	0.	0.	8.00	0.	0.	0.	1.63	23.13	60.07	67.50	219.3
JUN	10	8.45	20.57	0.61	25.89	16.70	0.	18.66	18.66	0.	8.00	0.	0.16	1.81	1.63	0.	9.70	66.45	203.0
	10	7.27	17.70	0.59	24.68	18.54	0.	20.51	20.51	0.	8.00	0.	0.16	1.81	1.63	0.	9.70	65.21	184.1
	10	5.90	14.35	0.56	21.30	18.49	0.	20.46	20.46	0.	8.00	0.	0.16	1.81	1.63	0.	9.70	63.87	164.2
JUL	10	5.53	13.45	0.52	25.89	24.60	0.	26.57	26.57	0.	8.00	0.	0.16	1.81	1.63	0.	9.70	62.04	138.6
	10	3.43	8.34	0.48	33.15	36.84	0.	40.31	40.31	0.	8.00	0.	0.16	1.81	1.63	0.	9.70	58.64	99.4
	11	3.21	7.82	0.41	39.20	43.56	0.	47.62	47.62	0.	8.00	0.	0.16	1.81	1.63	0.	9.70	53.23	49.2
AUG	10	4.88	11.89	0.33	38.48	40.32	0.	42.29	42.29	0.	8.00	0.	0.16	1.81	1.63	0.	9.70	47.77	9.7
	10	5.25	12.79	0.22	30.25	16.11	-12.66	32.14	16.27	-15.87	8.00	-8.00	0.16	0.	0.	0.	9.70	46.00	0.
	11	10.26	24.98	0.19	26.86	9.91	-2.66	14.84	10.06	-4.77	8.00	-8.00	0.16	0.	0.	0.	9.70	46.00	0.
SEP	10	2.02	4.91	0.19	20.81	0.	-20.81	30.41	1.82	-28.59	8.00	-8.00	0.	0.	0.	0.	6.55	46.00	0.
	10	2.27	5.52	0.19	18.39	0.	-16.39	27.05	2.07	-24.98	8.00	-8.00	0.	0.	0.	0.	7.38	46.00	0.
	10	1.74	4.24	0.19	15.97	0.00	-15.97	25.78	1.55	-24.24	8.00	-8.00	0.	0.	0.	0.	5.63	46.00	0.
OCT	10	0.93	2.26	0.19	18.15	0.	-18.15	30.40	0.74	-29.66	8.00	-8.00	0.	0.	0.	0.	2.92	46.00	0.
	10	2.35	5.71	0.19	0.	0.	0.	4.59	2.16	-2.43	0.30	-0.30	0.	0.	0.	0.	7.65	46.00	0.
	11	4.85	11.80	0.19	0.	0.	0.	3.66	3.66	0.	0.15	0.	0.16	0.	0.	0.	14.95	46.15	0.8
NOV	10	9.60	23.37	0.17	0.	0.	0.	3.66	3.66	0.	0.	0.	0.16	0.	0.	0.	26.52	47.05	5.8
	10	11.71	28.51	0.19	7.02	0.	0.	3.66	3.66	0.	2.91	0.	0.16	0.	1.63	0.	23.01	47.83	10.1
	10	9.21	22.44	0.20	14.76	2.25	0.	4.22	4.22	0.	6.52	0.	0.16	1.81	1.63	0.	9.70	47.56	8.6
DEC	10	18.41	44.84	0.17	18.39	0.	0.	3.66	3.66	0.	8.00	0.	0.16	0.	1.63	0.	27.96	48.53	14.3
	10	13.48	32.82	0.18	23.96	0.94	0.	3.66	3.66	0.	8.00	0.	0.16	1.81	1.63	0.	10.38	48.75	15.7
	11	24.13	58.76	0.18	19.60	0.	0.	3.66	3.66	0.	8.00	0.	0.16	0.	1.63	0.	40.68	50.47	27.4
VOLUME (MCUM)		745.4	1814.9	11.7	639.6	201.6	-76.8	407.5	245.1	-130.5	149.5	-42.4	2.2	14.2	38.6	573.3	2003.6		

Table J-4 WATER BALANCE STUDY FOR KARIAN RESERVOIR (2/12)

**** WATER BALANCE STUDY AGAINST C.I. OF 250 % BY PROSIDA ****
KARIAN RESERVOIR

YEAR	HWLK	LWLK	HWLC	LWLC	QMQ2	VHWLK	VLWLC
1973	67.5	46.0	76.5	66.5	8.0	219.3	62.0

MON	DAYS	QK	QN	QE	QIR	QIK	QIS	Q1R	Q1	Q1S	Q2R	Q2S	D2	D1R	D1	SP2	SP1	H1	S1
JAN	10	55.58	135.33	0.15	8.95	0.	0.	3.66	3.66	0.	1.27	0.	0.16	0.	1.63	0.	127.90	55.78	71.0
	10	46.30	112.74	0.22	17.67	0.	0.	3.66	3.66	0.	5.71	0.	0.16	0.	1.63	0.	96.60	58.93	102.7
	11	47.33	115.25	0.26	1.21	0.	0.	3.66	3.66	0.	0.	0.	0.16	0.	1.63	0.	115.56	62.43	144.0
FEB	10	33.75	82.17	0.38	0.	0.	0.	3.66	3.66	0.	0.	0.	0.16	0.	1.63	0.	83.69	64.25	169.7
	10	29.19	71.08	0.41	14.04	0.	0.	3.66	3.66	0.	5.05	0.	0.16	0.	1.63	0.	58.57	65.40	187.0
	8	37.10	90.33	0.43	12.34	0.	0.	3.66	3.66	0.	3.85	0.	0.16	0.	1.63	0.	79.51	66.72	207.2
MAR	10	28.44	69.24	0.50	7.02	0.	0.	3.66	0.	0.	1.95	0.	0.	0.	1.63	12.02	72.48	67.50	219.3
	10	52.82	128.60	0.52	21.78	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	52.30	157.35	67.50	219.3
	11	43.02	104.75	0.52	24.44	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	42.50	121.05	67.50	219.3
APR	10	47.49	115.63	0.49	20.57	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	47.00	140.29	67.50	219.3
	10	50.39	122.68	0.49	26.14	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	49.89	144.67	67.50	219.3
	10	56.89	138.53	0.49	25.41	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	56.40	167.75	67.50	219.3
MAY	10	65.34	159.10	0.57	32.43	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	64.77	189.67	67.50	219.3
	10	74.11	180.45	0.57	35.09	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	73.54	217.13	67.50	219.3
	11	32.07	78.09	0.57	27.10	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	31.50	80.71	67.50	219.3
JUN	10	53.99	131.45	0.61	21.78	0.	0.	3.66	0.	0.	8.00	0.	0.	0.	1.63	45.38	153.28	67.50	219.3
	10	24.97	60.80	0.61	20.09	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	24.36	63.31	67.50	219.3
	10	15.92	38.75	0.61	16.46	0.	0.	3.66	0.	0.	6.89	0.	0.	0.	1.63	8.41	28.94	67.50	219.3
JUL	10	16.30	39.70	0.60	24.44	0.	0.	3.66	0.	0.	8.00	0.	0.	0.	1.63	7.71	21.19	67.50	219.3
	10	14.78	35.99	0.60	21.78	0.	0.	3.66	0.	0.	8.00	0.	0.	0.	1.63	6.19	18.63	67.50	219.3
	11	12.55	30.56	0.60	26.14	5.86	0.	7.83	7.83	0.	8.00	0.	0.16	1.81	1.63	0.	9.70	67.26	215.6
AUG	10	16.35	39.80	0.63	21.78	0.	0.	3.66	3.66	0.	8.00	0.	0.16	0.	1.63	0.	19.54	67.49	219.1
	10	25.06	61.02	0.63	22.75	0.	0.	3.66	0.	0.	8.00	0.	0.	0.	1.63	16.23	52.73	67.50	219.3
	11	15.84	38.56	0.64	20.09	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	15.20	31.90	67.50	219.3
SEP	10	34.23	83.33	0.64	18.39	0.	0.	3.66	0.	0.	6.94	0.	0.	0.	1.63	26.65	89.83	67.50	219.3
	10	25.18	61.31	0.64	18.39	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	24.55	65.70	67.50	219.3
	10	52.33	127.41	0.64	6.78	0.	0.	3.66	0.	0.	0.48	0.	0.	0.	1.63	51.21	170.07	67.50	219.3
OCT	10	27.41	66.75	0.62	14.28	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	26.79	77.49	67.50	219.3
	10	20.90	50.89	0.62	0.	0.	0.	3.66	0.	0.	0.	0.	0.	0.	0.	20.28	71.03	67.50	219.3
	11	47.77	116.32	0.62	0.	0.	0.	3.66	0.	0.	0.	0.	0.	0.	0.	47.15	163.34	67.50	219.3
NOV	10	28.68	69.84	0.56	0.	0.	0.	3.66	0.	0.	0.	0.	0.	0.	0.	28.13	97.82	67.50	219.3
	10	12.81	31.18	0.56	7.02	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	12.25	34.64	67.50	219.3
	10	48.92	119.11	0.56	13.07	0.	0.	3.66	0.	0.	3.50	0.	0.	0.	1.63	44.86	149.13	67.50	219.3
DEC	10	34.44	83.86	0.49	20.81	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	33.95	95.22	67.50	219.3
	10	30.22	73.59	0.49	19.60	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	29.73	81.95	67.50	219.3
	11	51.35	125.02	0.49	21.78	0.	0.	3.66	0.	0.	8.00	0.	0.	0.	1.63	42.86	144.33	67.50	219.3
VOLUME (MCUM)		1146.9	2792.5	16.7	535.0	5.6	0.	119.2	29.2	0.	79.9	0.	1.1	1.7	47.0	829.2	3061.5		

Table J-4 WATER BALANCE STUDY FOR KARIAN RESERVOIR (3/12)

**** WATER BALANCE STUDY AGAINST C.I. OF 250 % BY PROSIDA ****

KARIAN RESERVOIR

YEAR	HWLK	LWLK	HWLC	LWLC	QMQ2	VHWLK	VLWLC
1974	67.5	46.0	76.5	66.5	8.0	219.3	62.0

MON	DAYS	QK	QN	QE	QIR	QIK	QIS	Q1R	Q1	Q1S	Q2R	Q2S	D2	D1R	D1	SP2	SP1	H1	S1
JAN	10	102.30	249.07	0.36	0.	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	101.93	349.24	67.50	219.3
	10	56.76	138.19	0.36	18.15	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	56.39	174.67	67.50	219.3
	11	14.85	36.15	0.36	21.05	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	14.48	27.81	67.50	219.3
FEB	10	45.14	109.91	0.47	21.54	0.	0.	3.66	0.	0.	8.00	0.	0.	0.	1.63	36.68	123.28	67.50	219.3
	10	39.41	95.97	0.47	0.	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	38.95	133.14	67.50	219.3
	8	43.98	107.08	0.47	11.13	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	43.51	137.69	67.50	219.3
MAR	10	71.31	173.64	0.52	9.20	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	70.80	233.47	67.50	219.3
	10	29.00	70.62	0.52	23.47	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	28.48	73.86	67.50	219.3
	11	34.76	84.64	0.52	22.51	0.	0.	3.66	0.	0.	8.00	0.	0.	0.	1.63	26.24	86.60	67.50	219.3
APR	10	28.37	69.08	0.49	16.21	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	27.88	78.98	67.50	219.3
	10	53.73	130.82	0.49	23.72	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	53.24	158.58	67.50	219.3
	10	21.20	51.62	0.49	33.88	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	20.71	36.67	67.50	219.3
MAY	10	41.27	100.49	0.57	34.85	0.	0.	3.66	0.	0.	8.00	0.	0.	0.	1.63	32.70	96.57	67.50	219.3
	10	51.40	125.15	0.57	24.20	0.	0.	3.66	0.	0.	8.00	0.	0.	0.	1.63	42.83	142.02	67.50	219.3
	11	22.98	55.96	0.57	35.33	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	22.41	41.27	67.50	219.3
JUN	10	17.13	41.72	0.61	29.28	0.	0.	3.66	0.	0.	8.00	0.	0.	0.	1.63	8.52	19.19	67.50	219.3
	10	13.55	32.99	0.61	20.57	0.	0.	3.66	0.	0.	8.00	0.	0.	0.	1.63	4.94	15.59	67.50	219.3
	10	21.43	52.17	0.61	0.73	0.	0.	3.66	0.	0.	0.73	0.	0.	0.	1.63	20.09	69.76	67.50	219.3
JUL	10	19.82	48.27	0.60	12.10	0.	0.	3.66	0.	0.	4.72	0.	0.	0.	1.63	14.51	48.90	67.50	219.3
	10	26.22	63.85	0.60	29.77	0.	0.	3.66	0.	0.	8.00	0.	0.	0.	1.63	17.63	49.94	67.50	219.3
	11	13.36	32.54	0.60	31.22	9.31	0.	11.28	11.28	0.	8.00	0.	0.16	1.81	1.63	0.	9.70	67.10	213.1
AUG	10	23.91	58.21	0.63	37.75	0.	0.	3.66	0.	0.	8.00	0.	0.	0.	1.63	8.12	26.81	67.50	219.3
	10	28.47	69.33	0.64	30.49	0.	0.	3.66	0.	0.	8.00	0.	0.	0.	1.63	19.84	56.91	67.50	219.3
	11	28.89	70.35	0.64	25.41	0.	0.	3.66	0.	0.	8.00	0.	0.	0.	1.63	20.26	63.43	67.50	219.3
SEP	10	51.67	125.81	0.64	13.79	0.	0.	3.66	0.	0.	3.88	0.	0.	0.	1.63	47.15	157.40	67.50	219.3
	10	69.91	170.22	0.64	7.74	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	69.27	229.98	67.50	219.3
	10	43.28	105.39	0.64	8.47	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	42.65	137.79	67.50	219.3
OCT	10	38.78	94.41	0.62	12.58	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	38.15	118.21	67.50	219.3
	10	27.73	67.51	0.62	0.	0.	0.	3.66	0.	0.	0.	0.	0.	0.	0.	27.11	94.48	67.50	219.3
	11	20.35	49.55	0.62	0.	0.	0.	3.66	0.	0.	0.	0.	0.	0.	0.	19.73	69.14	67.50	219.3
NOV	10	12.38	30.15	0.56	0.	0.	0.	3.66	0.	0.	0.	0.	0.	0.	0.	11.83	41.84	67.50	219.3
	10	36.99	90.07	0.56	7.02	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	36.43	117.71	67.50	219.3
	10	22.29	54.28	0.56	15.97	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	21.74	58.28	67.50	219.3
DEC	10	44.66	108.74	0.49	13.07	0.	0.	3.66	0.	0.	3.74	0.	0.	0.	1.63	40.43	134.33	67.50	219.3
	10	19.78	48.16	0.49	29.04	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	19.29	36.63	67.50	219.3
	11	15.60	37.98	0.49	27.83	0.	0.	3.66	0.	0.	8.00	0.	0.	0.	1.63	7.11	15.49	67.50	219.3
VOLUME (MCUM)		1087.8	2648.5	17.2	572.1	8.8	0.	122.5	10.7	0.	97.0	0.	0.1	1.7	47.0	962.8	2997.4		

Table J-4 WATER BALANCE STUDY FOR KARIAN RESERVOIR (4/12)

**** WATER BALANCE STUDY AGAINST C.I. OF 250 % BY PROSIDA ****
KARIAN RESERVOIR

YEAR	HWLK	LWLK	HWLC	LWLC	QNQ2	VHWLK	VLWLC
1975	67.5	46.0	76.5	66.5	8.0	219.3	62.0

MON	DAYS	QK	QN	QE	QIR	QIK	QIS	Q1R	Q1	Q1S	Q2R	Q2S	D2	D1R	D1	SP2	SP1	H1	S1
JAN	10	30.52	74.31	0.36	7.02	0.	0.	3.66	0.	0.	1.83	0.	0.	0.	1.63	28.32	93.84	67.50	219.3
	10	26.44	64.38	0.36	15.00	0.	0.	3.66	0.	0.	5.64	0.	0.	0.	1.63	20.43	68.04	67.50	219.3
	11	34.63	84.32	0.36	11.13	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	34.27	105.68	67.50	219.3
FEB	10	27.80	67.68	0.47	20.57	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	27.33	72.67	67.50	219.3
	10	79.22	192.89	0.47	1.45	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	78.76	268.43	67.50	219.3
	8	35.75	87.06	0.47	11.13	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	35.29	109.44	67.50	219.3
MAR	10	33.80	82.30	0.52	20.57	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	33.28	93.24	67.50	219.3
	10	23.04	56.09	0.52	21.54	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	22.52	55.31	67.50	219.3
	11	37.37	91.00	0.52	20.33	0.	0.	3.66	0.	0.	8.00	0.	0.	0.	1.63	28.85	97.75	67.50	219.3
APR	10	18.46	44.95	0.49	17.91	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	17.97	43.23	67.50	219.3
	10	20.95	51.00	0.49	28.56	0.	0.	3.66	0.	0.	8.00	0.	0.	0.	1.63	12.45	33.13	67.50	219.3
	10	10.18	24.78	0.49	29.52	16.05	0.	18.02	18.02	0.	8.00	0.	0.16	1.81	1.63	0.	9.70	66.59	205.1
MAY	10	12.60	30.68	0.55	35.82	16.49	0.	18.45	18.45	0.	8.00	0.	0.16	1.81	1.63	0.	9.70	65.78	192.7
	10	17.16	41.79	0.53	38.72	7.37	0.	9.33	9.33	0.	8.00	0.	0.16	1.81	1.63	0.	9.70	65.74	192.1
	11	32.39	78.87	0.53	36.30	0.	0.	3.66	3.66	0.	8.00	0.	0.16	0.	1.63	0.	44.09	66.99	211.3
JUN	10	16.30	39.68	0.60	24.44	0.	0.	3.66	3.66	0.	8.00	0.	0.16	0.	1.63	0.	16.76	67.21	214.8
	10	14.32	34.86	0.60	24.44	0.	0.	3.66	3.66	0.	8.00	0.	0.16	1.02	1.63	0.	11.94	67.33	216.6
	10	7.33	17.84	0.61	20.81	14.08	0.	16.05	16.05	0.	8.00	0.	0.16	1.81	1.63	0.	9.70	66.36	201.6
JUL	10	10.53	25.65	0.57	23.23	8.09	0.	10.06	10.06	0.	8.00	0.	0.16	1.81	1.63	0.	9.70	65.91	194.6
	10	19.85	48.33	0.56	24.93	0.	0.	3.66	3.66	0.	8.00	0.	0.16	0.	1.63	0.	24.93	66.33	201.2
	11	24.56	59.79	0.57	34.85	0.	0.	3.66	3.66	0.	8.00	0.	0.16	0.	1.63	0.	26.47	67.09	212.9
AUG	10	39.42	95.98	0.63	37.27	0.	0.	3.66	0.	0.	8.00	0.	0.	0.	1.63	23.45	80.39	67.50	219.3
	10	16.82	40.95	0.64	30.01	0.	0.	3.66	0.	0.	8.00	0.	0.	0.	1.63	8.18	17.35	67.50	219.3
	11	25.26	61.51	0.64	21.05	0.	0.	3.66	0.	0.	8.00	0.	0.	0.	1.63	16.63	55.31	67.50	219.3
SEP	10	37.62	91.61	0.64	15.00	0.	0.	3.66	0.	0.	5.22	0.	0.	0.	1.63	31.76	106.59	67.50	219.3
	10	46.24	112.58	0.64	16.70	0.	0.	3.66	0.	0.	5.49	0.	0.	0.	1.63	40.11	134.22	67.50	219.3
	10	37.28	90.78	0.64	15.25	0.	0.	3.66	0.	0.	5.35	0.	0.	0.	1.63	31.29	105.06	67.50	219.3
OCT	10	17.96	43.73	0.62	13.55	0.	0.	3.66	0.	0.	5.48	0.	0.	0.	1.63	11.86	40.27	67.50	219.3
	10	18.83	45.84	0.62	0.	0.	0.	3.66	0.	0.	0.	0.	0.	0.	0.	18.20	63.90	67.50	219.3
	11	29.48	71.77	0.62	0.	0.	0.	3.66	0.	0.	0.	0.	0.	0.	0.	28.85	100.49	67.50	219.3
NOV	10	56.99	138.75	0.56	0.	0.	0.	3.66	0.	0.	0.	0.	0.	0.	0.	56.43	195.04	67.50	219.3
	10	35.40	86.20	0.56	7.02	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	34.84	112.26	67.50	219.3
	10	23.59	57.45	0.56	16.70	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	23.04	62.01	67.50	219.3
DEC	10	49.23	119.68	0.49	19.84	0.	0.	3.66	0.	0.	6.52	0.	0.	0.	1.63	42.23	140.49	67.50	219.3
	10	94.83	230.90	0.49	23.47	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	94.34	300.00	67.50	219.3
	11	36.29	88.36	0.49	6.05	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	35.80	116.33	67.50	219.3
VOLUME (MCUM)		961.9	2342.0	17.1	605.6	53.6	0.	161.6	78.6	0.	137.2	0.	1.4	8.7	47.0	729.1	2484.8		

Table J-4 WATER BALANCE STUDY FOR KARIAN RESERVOIR (5/12)

**** WATER BALANCE STUDY AGAINST C.I. OF 250 % BY PROSIDA ****

KARIAN RESERVOIR

YEAR	HWLK	LWLK	HWLC	LWLC	QMQ2	VHWLK	VLWLC
1976	67.5	46.0	76.5	66.5	8.0	219.3	62.0

MON	DAYS	QK	QN	QE	QIR	QIK	QIS	Q1R	Q1	Q1S	Q2R	Q2S	D2	D1R	D1	SP2	SP1	H1	S1
JAN	10	57.68	140.43	0.36	8.47	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	57.31	187.51	67.50	219.3
	10	100.86	245.59	0.36	7.02	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	100.50	337.30	67.50	219.3
	11	94.98	231.25	0.36	1.69	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	94.61	322.40	67.50	219.3
FEB	10	41.00	99.83	0.47	17.91	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	40.53	120.68	67.50	219.3
	10	17.13	41.70	0.47	17.42	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	16.66	39.17	67.50	219.3
	9	31.17	75.90	0.47	3.63	0.	0.	3.66	0.	0.	0.28	0.	0.	0.	1.63	30.43	100.93	67.50	219.3
MAR	10	58.63	142.74	0.52	7.99	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	58.11	191.09	67.50	219.3
	10	29.72	72.37	0.52	20.09	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	29.20	79.71	67.50	219.3
	11	28.97	70.54	0.52	24.68	0.	0.	3.66	0.	0.	8.00	0.	0.	0.	1.63	20.45	64.53	67.50	219.3
APR	10	18.68	45.49	0.49	25.65	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	18.19	36.26	67.50	219.3
	10	28.07	68.35	0.49	19.84	0.	0.	3.66	0.	0.	8.00	0.	0.	0.	1.63	19.58	66.31	67.50	219.3
	10	38.21	93.03	0.49	23.23	0.	0.	3.66	0.	0.	8.00	0.	0.	0.	1.63	29.72	97.74	67.50	219.3
MAY	10	32.46	79.04	0.57	37.99	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	31.89	71.17	67.50	219.3
	10	14.78	35.98	0.57	30.98	5.21	0.	7.18	7.18	0.	8.00	0.	0.16	1.81	1.63	0.	9.70	67.45	218.4
	11	9.12	22.21	0.57	41.87	32.62	0.	34.58	34.58	0.	8.00	0.	0.16	1.81	1.63	0.	9.70	65.34	186.1
JUN	10	18.31	44.58	0.56	29.28	0.	0.	3.66	3.66	0.	8.00	0.	0.16	0.	1.63	0.	16.82	65.69	191.3
	10	10.19	24.81	0.57	21.78	7.42	0.	9.38	9.38	0.	8.00	0.	0.16	1.81	1.63	0.	9.70	65.24	184.6
	10	5.24	12.77	0.56	21.30	20.25	0.	22.22	22.22	0.	8.00	0.	0.16	1.81	1.63	0.	9.70	63.75	162.6
JUL	10	10.55	25.66	0.52	23.23	8.06	0.	10.03	10.03	0.	8.00	0.	0.16	1.81	1.63	0.	9.70	63.26	155.7
	10	4.35	10.58	0.51	33.40	36.13	0.	38.09	38.09	0.	8.00	0.	0.16	1.81	1.63	0.	9.70	60.36	119.1
	11	6.14	14.94	0.45	38.96	37.47	0.	39.43	39.43	0.	8.00	0.	0.16	1.81	1.63	0.	9.70	56.68	79.5
AUG	10	6.85	16.69	0.40	32.91	28.81	0.	30.77	30.77	0.	8.00	0.	0.16	1.81	1.63	0.	9.70	53.54	51.6
	10	5.15	12.54	0.33	28.80	28.85	0.	30.81	30.81	0.	8.00	0.	0.16	1.81	1.63	0.	9.70	49.79	22.2
	11	9.55	23.26	0.25	24.20	11.82	0.	13.79	13.79	0.	8.00	0.	0.16	1.81	1.63	0.	9.70	47.87	10.3
SEP	10	5.03	12.24	0.22	19.84	16.58	-2.39	21.19	16.73	-4.46	8.00	-8.00	0.16	0.	0.	0.	9.70	46.00	0.
	10	3.03	7.38	0.19	18.88	0.27	-18.64	25.51	2.84	-22.67	8.00	-8.00	0.	0.	0.	0.	9.70	46.00	0.
	10	5.36	13.05	0.19	12.58	5.01	-4.72	12.22	5.17	-7.06	5.87	-5.87	0.16	0.	0.	0.	9.70	46.00	0.
OCT	10	16.55	40.29	0.19	11.37	0.	0.	3.66	3.66	0.	4.58	0.	0.16	0.	1.63	0.	30.44	47.28	7.0
	10	17.32	42.18	0.21	0.	0.	0.	3.66	3.66	0.	0.	0.	0.16	0.	0.	0.	45.33	49.22	18.6
	11	6.16	14.99	0.24	0.	0.	0.	3.66	3.66	0.	0.08	0.	0.16	0.	0.	0.	18.14	49.56	20.7
NOV	10	11.24	27.38	0.22	0.	0.	0.	3.66	3.66	0.	0.	0.	0.16	0.	0.	0.	30.53	50.43	27.1
	10	38.80	94.46	0.23	7.02	0.	0.	3.66	3.66	0.	1.36	0.	0.16	0.	1.63	0.	88.96	54.12	56.1
	10	18.05	43.94	0.30	16.70	0.	0.	3.66	3.66	0.	6.88	0.	0.16	0.	1.63	0.	28.76	54.81	62.3
DEC	10	10.99	26.77	0.28	23.47	7.12	0.	9.03	9.08	0.	8.00	0.	0.16	1.81	1.63	0.	9.70	54.20	56.8
	10	20.85	50.76	0.27	14.04	0.	0.	3.66	3.66	0.	5.53	0.	0.16	0.	1.63	0.	38.24	55.29	66.6
	11	13.43	32.70	0.29	16.46	0.	0.	3.66	3.66	0.	8.00	0.	0.16	0.	1.63	0.	17.76	55.45	68.0
VOLUME (MCUM)		741.6	1805.6	12.5	602.3	219.3	-22.2	340.9	270.0	-34.2	149.1	-18.9	3.0	17.7	43.0	480.1	1901.4		

Table J-4 WATER BALANCE STUDY FOR KARIAN RESERVOIR (6/12)

**** WATER BALANCE STUDY AGAINST C.I. OF 250 % BY PROSIDA ****
KARIAN RESERVOIR

YEAR	HWLK	LWLK	HWLC	LWLC	QMQ2	VHWLK	VLWLC
1977	67.5	46.0	76.5	66.5	8.0	219.3	62.0

MON	DAYS	QK	QN	QE	QIR	QIK	QIS	Q1R	Q1	Q1S	Q2R	Q2S	D2	D1R	D1	SP2	SP1	H1	S1
JAN	10	26.28	63.98	0.21	13.07	0.	0.	3.66	3.66	0.	4.79	0.	0.16	0.	1.63	0.	52.43	57.08	83.3
	10	31.42	76.50	0.23	3.15	0.	0.	3.66	3.66	0.	0.05	0.	0.16	0.	1.63	0.	74.88	59.31	107.0
	11	80.78	196.69	0.26	10.16	0.	0.	3.66	3.66	0.	0.38	0.	0.16	0.	1.63	0.	188.04	64.91	179.7
FEB	10	27.70	67.45	0.42	18.88	0.	0.	3.66	3.66	0.	8.00	0.	0.16	0.	1.63	0.	50.09	65.81	193.2
	10	36.06	87.80	0.44	4.36	0.	0.	3.66	0.	0.	0.33	0.	0.	0.	1.63	5.15	86.83	67.50	219.3
	8	36.16	88.05	0.47	1.21	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	35.70	120.77	67.50	219.3
MAR	10	70.98	172.83	0.52	8.95	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	70.46	232.57	67.50	219.3
	10	24.11	58.71	0.52	20.33	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	23.59	60.21	67.50	219.3
	11	44.50	108.34	0.52	24.44	0.	0.	3.66	0.	0.	8.00	0.	0.	0.	1.63	35.98	118.11	67.50	219.3
APR	10	51.63	125.70	0.49	25.17	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	51.13	149.90	67.50	219.3
	10	39.66	96.56	0.49	22.75	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	39.16	111.20	67.50	219.3
	10	38.04	92.63	0.49	22.02	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	37.55	106.39	67.50	219.3
MAY	10	54.25	132.10	0.57	26.38	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	53.68	157.63	67.50	219.3
	10	47.35	115.29	0.57	38.72	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	46.78	121.58	67.50	219.3
	11	20.16	49.10	0.57	27.10	0.	0.	3.66	0.	0.	8.00	0.	0.	0.	1.63	11.59	31.81	67.50	219.3
JUN	10	26.59	64.75	0.61	6.05	0.	0.	3.66	0.	0.	1.62	0.	0.	0.	1.63	24.36	81.29	67.50	219.3
	10	17.96	43.74	0.61	15.73	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	17.35	43.59	67.50	219.3
	10	21.62	52.64	0.61	20.57	0.	0.	3.66	0.	0.	8.00	0.	0.	0.	1.63	13.01	43.31	67.50	219.3
JUL	10	13.29	32.36	0.60	25.89	0.	0.	5.56	0.	0.	0.	0.	0.	0.	1.63	12.69	17.39	67.50	219.3
	10	5.84	14.21	0.60	33.40	32.10	0.	34.06	34.06	0.	8.00	0.	0.16	1.81	1.63	0.	9.70	65.43	187.4
	11	7.70	18.76	0.55	36.06	30.00	0.	31.97	31.97	0.	8.00	0.	0.16	1.81	1.63	0.	9.70	63.30	156.2
AUG	10	4.46	10.85	0.54	39.20	42.28	0.	44.25	44.25	0.	8.00	0.	0.16	1.81	1.63	0.	9.70	59.96	114.5
	10	4.39	10.68	0.47	33.15	35.74	0.	37.71	37.71	0.	8.00	0.	0.16	1.81	1.63	0.	9.70	56.57	78.4
	11	10.33	25.14	0.40	27.59	13.50	0.	15.46	15.46	0.	8.00	0.	0.16	1.81	1.63	0.	9.70	55.17	65.5
SEP	10	2.98	7.26	0.37	20.57	22.86	0.	27.53	27.53	0.	8.00	0.	0.16	1.81	1.63	0.	9.70	51.65	37.1
	10	6.48	15.79	0.29	15.00	9.91	0.	11.88	11.88	0.	6.89	0.	0.16	1.81	1.63	0.	9.70	50.33	26.2
	10	4.41	10.75	0.27	16.21	16.85	0.	18.82	18.82	0.	8.00	0.	0.16	1.81	1.63	0.	9.70	47.21	6.6
OCT	10	6.36	15.48	0.21	15.97	11.32	0.	13.29	13.82	0.	8.00	-8.00	0.16	1.81	1.63	0.	10.18	46.00	0.
	10	7.04	17.15	0.19	0.	0.	0.	3.66	3.66	0.	0.03	0.	0.16	0.	0.	0.	20.30	46.50	2.7
	11	8.50	20.71	0.20	0.	0.	0.	3.66	3.66	0.	0.	0.	0.16	0.	0.	0.	23.86	47.30	7.2
NOV	10	10.95	26.67	0.19	0.	0.	0.	3.66	3.66	0.	0.	0.	0.16	0.	0.	0.	29.82	48.37	13.3
	10	6.33	15.42	0.20	7.02	1.44	0.	3.66	3.66	0.	3.21	0.	0.16	1.81	1.63	0.	9.92	48.27	12.7
	10	7.25	17.65	0.20	16.46	9.45	0.	11.42	11.42	0.	8.00	0.	0.16	1.81	1.63	0.	9.70	46.36	2.0
DEC	10	10.38	25.26	0.16	19.84	4.74	0.	6.71	6.71	0.	6.56	-4.42	0.16	1.81	1.63	0.	9.70	46.00	0.
	10	12.64	30.77	0.15	13.55	0.	0.	3.66	3.66	0.	5.78	0.	0.16	0.	1.63	0.	18.74	46.48	2.6
	11	18.21	44.33	0.16	17.91	0.	0.	3.66	3.66	0.	8.00	0.	0.16	0.	1.63	0.	27.95	47.58	8.7
VOLUME (MCUM)		738.4	1797.8	12.5	571.1	202.6	0.	304.3	255.8	0.	125.9	-10.7	2.9	19.1	47.0	411.1	1816.6		

Table J-4 WATER BALANCE STUDY FOR KARIAN RESERVOIR (7/12)

**** WATER BALANCE STUDY AGAINST C.I. OF 250 % BY PROSIDA ****

KARIAN RESERVOIR

YEAR	HWLK	LWLK	HWLC	LWLC	QMQ2	VHWLK	VLWLC
1978	67.5	46.0	76.5	66.5	8.0	219.3	62.0

MON	DAYS	QK	QN	QE	QIR	QIK	QIS	Q1R	Q1	Q1S	Q2R	Q2S	D2	D1R	D1	SP2	SP1	H1	S1
JAN	10	21.47	52.28	0.13	16.94	0.	0.	3.66	3.66	0.	6.80	0.	0.16	0.	1.63	0.	36.86	49.14	18.1
	10	42.51	103.50	0.14	19.12	0.	0.	3.66	3.66	0.	6.57	0.	0.16	0.	1.63	0.	85.91	52.79	45.9
	11	95.65	232.90	0.18	0.73	0.	0.	3.66	3.66	0.	0.	0.	0.16	0.	1.63	0.	233.70	61.58	133.2
FEB	10	34.96	85.13	0.37	13.07	0.	0.	3.66	3.66	0.	4.29	0.	0.16	0.	1.63	0.	73.58	63.30	156.2
	10	15.19	36.99	0.40	23.96	0.	0.	3.66	3.66	0.	8.00	0.	0.16	0.	1.63	0.	14.56	63.49	158.9
	8	30.67	74.68	0.40	0.48	0.	0.	3.66	3.66	0.	0.	0.	0.16	0.	1.63	0.	75.71	64.75	177.3
MAR	10	42.16	102.65	0.47	17.67	0.	0.	3.66	3.66	0.	5.94	0.	0.16	0.	1.63	0.	86.50	66.58	205.0
	10	42.27	102.92	0.50	14.76	0.	0.	3.66	0.	0.	4.63	0.	0.	0.	1.63	20.67	107.06	67.50	219.3
	11	36.69	89.33	0.52	20.33	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	36.17	103.40	67.50	219.3
APR	10	28.97	70.54	0.49	19.84	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	28.48	77.40	67.50	219.3
	10	13.11	31.93	0.49	29.04	7.57	0.	9.54	9.54	0.	8.00	0.	0.16	1.81	1.63	0.	9.70	67.23	215.0
	10	34.78	84.68	0.49	19.60	0.	0.	3.66	0.	0.	8.00	0.	0.	0.	1.63	21.38	84.68	67.50	219.3
MAY	10	34.00	82.79	0.57	36.30	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	33.43	78.15	67.50	219.3
	10	17.77	43.27	0.57	36.06	0.	0.	4.73	0.	0.	8.00	0.	0.	0.	1.63	9.20	14.65	67.50	219.3
	11	11.84	28.83	0.57	41.87	25.26	0.	27.23	27.23	0.	8.00	0.	0.16	1.81	1.63	0.	9.70	66.03	196.5
JUN	10	15.67	38.16	0.58	22.75	0.	0.	3.66	3.66	0.	8.00	0.	0.16	0.	1.63	0.	16.93	66.22	199.5
	10	19.07	46.44	0.58	15.73	0.	0.	3.66	3.66	0.	6.39	0.	0.16	0.	1.63	0.	32.23	66.69	206.8
	10	27.18	66.17	0.59	7.99	0.	0.	3.66	0.	0.	2.46	0.	0.	0.	1.63	9.66	66.07	67.50	219.3
JUL	10	17.37	42.29	0.60	21.05	0.	0.	3.66	0.	0.	8.00	0.	0.	0.	1.63	8.77	28.23	67.50	219.3
	10	16.42	39.97	0.60	24.20	0.	0.	3.66	0.	0.	8.00	0.	0.	0.	1.63	7.82	21.83	67.50	219.3
	11	20.65	50.27	0.60	30.25	0.	0.	3.66	0.	0.	8.00	0.	0.	0.	1.63	12.05	30.30	67.50	219.3
AUG	10	24.61	59.91	0.64	35.09	0.	0.	3.66	0.	0.	8.00	0.	0.	0.	1.63	15.97	39.02	67.50	219.3
	10	27.78	67.64	0.64	18.39	0.	0.	3.66	0.	0.	8.00	0.	0.	0.	1.63	19.15	66.63	67.50	219.3
	11	22.63	55.10	0.64	15.73	0.	0.	3.66	0.	0.	6.51	0.	0.	0.	1.63	15.48	53.08	67.50	219.3
SEP	10	20.91	50.91	0.64	11.86	0.	0.	3.66	0.	0.	4.77	0.	0.	0.	1.63	15.51	52.79	67.50	219.3
	10	15.63	38.06	0.64	10.89	0.	0.	3.66	0.	0.	4.63	0.	0.	0.	1.63	10.36	35.76	67.50	219.3
	10	27.88	67.88	0.64	13.55	0.	0.	3.66	0.	0.	5.13	0.	0.	0.	1.63	22.11	74.67	67.50	219.3
OCT	10	18.18	44.27	0.62	12.83	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	17.56	47.23	67.50	219.3
	10	19.81	48.24	0.62	0.	0.	0.	3.66	0.	0.	0.	0.	0.	0.	0.	19.19	67.30	67.50	219.3
	11	31.73	77.27	0.62	0.	0.	0.	3.66	0.	0.	0.	0.	0.	0.	0.	31.11	108.24	67.50	219.3
NOV	10	38.89	94.69	0.56	0.	0.	0.	3.66	0.	0.	0.	0.	0.	0.	0.	38.33	132.89	67.50	219.3
	10	34.45	83.87	0.56	7.02	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	33.89	108.97	67.50	219.3
	10	11.36	27.65	0.56	16.21	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	10.80	20.47	67.50	219.3
DEC	10	21.86	53.23	0.49	22.02	0.	0.	3.66	0.	0.	8.00	0.	0.	0.	1.63	13.37	42.81	67.50	219.3
	10	19.38	47.19	0.49	12.83	0.	0.	3.66	0.	0.	5.07	0.	0.	0.	1.63	13.82	46.41	67.50	219.3
	11	39.36	95.83	0.49	16.70	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	38.86	116.23	67.50	219.3
VOLUME (MCUM)		874.9	2130.2	16.4	550.6	30.5	0.	143.7	62.2	0.	139.5	0.	1.5	3.3	47.0	446.3	2030.4		

Table J-4 WATER BALANCE STUDY FOR KARIAN RESERVOIR (8/12)

**** WATER BALANCE STUDY AGAINST C.I. OF 250 % BY PROSIDA ****

KARIAN RESERVOIR

YEAR	HWLK	LWLK	HWLC	LWLC	QMQ2	VHWLK	VLWLC
1979	67.5	46.0	76.5	66.5	8.0	219.3	62.0

MON	DAYS	QK	QN	QE	QIR	QIK	QIS	Q1R	Q1	Q1S	Q2R	Q2S	D2	D1R	D1	SP2	SP1	H1	S1
JAN	10	24.90	60.64	0.36	1.45	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	24.54	81.96	67.50	219.3
	10	51.80	126.13	0.36	0.	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	51.44	175.80	67.50	219.3
	11	41.72	101.57	0.36	15.73	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	41.35	125.42	67.50	219.3
FEB	10	48.24	117.45	0.47	21.54	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	47.77	141.91	67.50	219.3
	10	33.12	80.65	0.47	20.57	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	32.66	90.97	67.50	219.3
	8	55.77	135.80	0.47	0.73	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	55.31	188.60	67.50	219.3
MAR	10	40.38	98.33	0.52	10.89	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	39.87	125.53	67.50	219.3
	10	36.03	87.72	0.52	20.57	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	35.51	100.88	67.50	219.3
	11	34.54	84.10	0.52	25.41	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	34.02	90.94	67.50	219.3
APR	10	60.24	146.67	0.49	26.38	0.	0.	3.66	0.	0.	8.00	0.	0.	0.	1.63	51.74	170.26	67.50	219.3
	10	41.04	99.94	0.49	22.99	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	40.55	115.73	67.50	219.3
	10	46.06	112.15	0.49	20.33	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	45.57	135.61	67.50	219.3
MAY	10	28.03	68.24	0.57	30.73	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	27.46	63.19	67.50	219.3
	10	10.29	25.06	0.57	30.73	17.08	0.	19.05	19.05	0.	8.00	0.	0.16	1.81	1.63	0.	9.70	66.53	204.3
	11	18.66	45.43	0.55	29.28	0.	0.	3.66	3.66	0.	8.00	0.	0.16	0.	1.63	0.	17.66	66.93	210.4
JUN	10	20.17	49.10	0.60	28.31	0.	0.	3.66	3.66	0.	8.00	0.	0.16	0.	1.63	0.	22.31	67.37	217.2
	10	10.72	26.10	0.61	21.30	5.44	0.	7.41	7.41	0.	8.00	0.	0.16	1.81	1.63	0.	9.70	67.08	212.7
	10	5.33	12.97	0.60	21.30	20.03	0.	22.00	22.00	0.	8.00	0.	0.16	1.81	1.63	0.	9.70	65.66	190.8
JUL	10	9.50	23.14	0.56	18.15	5.23	0.	7.20	7.20	0.	8.00	0.	0.16	1.81	1.63	0.	9.70	65.30	185.4
	10	24.01	58.46	0.55	25.65	0.	0.	3.66	3.66	0.	8.00	0.	0.16	0.	1.63	0.	34.33	65.98	195.6
	11	7.04	17.15	0.56	38.96	35.02	0.	36.99	36.99	0.	8.00	0.	0.16	1.81	1.63	0.	9.70	63.50	159.0
AUG	10	6.55	15.94	0.54	32.91	29.64	0.	31.60	31.60	0.	8.00	0.	0.16	1.81	1.63	0.	9.70	61.31	130.0
	10	10.70	26.06	0.50	25.65	10.33	0.	12.30	12.30	0.	8.00	0.	0.16	1.81	1.63	0.	9.70	60.55	121.3
	11	6.57	16.00	0.48	20.81	16.13	0.	18.09	18.09	0.	8.00	0.	0.16	1.81	1.63	0.	9.70	58.89	102.3
SEP	10	7.01	17.08	0.45	12.83	6.05	0.	8.02	8.02	0.	5.99	0.	0.16	1.81	1.63	0.	9.70	58.33	95.8
	10	10.34	25.18	0.44	18.15	2.97	0.	4.94	4.94	0.	8.00	0.	0.16	1.81	1.63	0.	9.70	58.11	93.2
	10	11.88	28.93	0.43	5.32	0.	0.	3.66	3.66	0.	2.14	0.	0.16	0.	1.63	0.	25.13	58.53	98.1
OCT	10	12.59	30.65	0.43	14.04	0.	0.	3.66	3.66	0.	6.00	0.	0.16	0.	1.63	0.	18.13	58.72	100.3
	10	6.21	15.13	0.43	0.	0.	0.	3.66	3.66	0.	0.07	0.	0.16	0.	0.	0.	18.28	58.87	102.1
	11	10.78	26.25	0.44	0.	0.	0.	3.66	3.66	0.	0.	0.	0.16	0.	0.	0.	29.40	59.43	108.4
NOV	10	25.09	61.08	0.40	0.	0.	0.	3.66	3.66	0.	0.	0.	0.16	0.	0.	0.	64.23	61.01	126.6
	10	40.23	97.97	0.43	7.02	0.	0.	3.66	3.66	0.	1.28	0.	0.16	0.	1.63	0.	92.47	63.34	156.7
	10	21.27	51.78	0.48	16.46	0.	0.	3.66	3.66	0.	6.59	0.	0.16	0.	1.63	0.	36.84	63.99	165.8
DEC	10	21.68	52.79	0.43	15.73	0.	0.	3.66	3.66	0.	6.24	0.	0.16	0.	1.63	0.	38.58	64.64	175.6
	10	18.10	44.07	0.44	21.30	0.	0.	3.66	3.66	0.	8.00	0.	0.16	0.	1.63	0.	24.30	64.99	180.8
	11	31.94	77.77	0.45	22.26	0.	0.	3.66	3.66	0.	8.00	0.	0.16	0.	1.63	0.	57.03	66.24	199.7
VOLUME (MCUM)		771.1	1877.6	15.3	569.0	132.2	0.	232.6	191.6	0.	130.9	0.	3.2	16.0	47.0	453.0	1882.5		

Table J-4 WATER BALANCE STUDY FOR KARIAN RESERVOIR (9/12)

**** WATER BALANCE STUDY AGAINST C.I. OF 250 % BY PROSIDA ****
KARIAN RESERVOIR

YEAR	HWLK	LWLK	HWLC	LWLC	QMQ2	VHWLK	VLWLC
1980	67.5	46.0	76.5	66.5	8.0	219.3	62.0

MON	DAYS	QK	QN	QE	QIR	QIK	QIS	Q1R	Q1	Q1S	Q2R	Q2S	D2	D1R	D1	SP2	SP1	H1	S1
JAN	10	36.90	89.85	0.35	14.52	0.	0.	3.66	0.	0.	4.83	0.	0.	0.	1.63	9.06	82.62	67.50	219.3
	10	68.39	166.51	0.36	0.	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	68.02	232.76	67.50	219.3
	11	58.37	142.13	0.36	20.09	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	58.01	178.28	67.50	219.3
FEB	10	41.47	100.97	0.47	16.46	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	41.00	123.74	67.50	219.3
	10	46.05	112.12	0.47	0.	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	45.58	155.94	67.50	219.3
	9	25.73	62.64	0.47	3.15	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	25.26	82.99	67.50	219.3
MAR	10	23.04	56.09	0.52	17.67	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	22.52	59.17	67.50	219.3
	10	21.49	52.34	0.52	20.57	0.	0.	3.66	0.	0.	8.00	0.	0.	0.	1.63	12.98	42.97	67.50	219.3
	11	15.18	36.96	0.52	21.78	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	14.66	28.07	67.50	219.3
APR	10	32.93	80.18	0.49	26.62	0.	0.	3.66	0.	0.	8.00	0.	0.	0.	1.63	24.44	76.23	67.50	219.3
	10	29.54	71.92	0.49	26.38	0.	0.	3.66	0.	0.	8.00	0.	0.	0.	1.63	21.04	64.81	67.50	219.3
	10	27.23	66.31	0.49	13.55	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	26.74	77.72	67.50	219.3
MAY	10	33.30	81.09	0.57	25.65	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	32.73	86.40	67.50	219.3
	10	23.93	58.26	0.57	36.30	0.	0.	3.66	0.	0.	8.00	0.	0.	0.	1.63	15.36	35.55	67.50	219.3
	11	23.45	57.09	0.57	30.49	0.	0.	3.66	0.	0.	8.00	0.	0.	0.	1.63	14.88	39.70	67.50	219.3
JUN	10	19.85	48.33	0.61	22.26	0.	0.	3.66	0.	0.	8.00	0.	0.	0.	1.63	11.24	35.54	67.50	219.3
	10	11.47	27.94	0.61	6.53	0.	0.	3.66	0.	0.	2.70	0.	0.	0.	1.63	8.16	27.80	67.50	219.3
	10	10.64	25.91	0.61	20.81	5.11	0.	7.03	7.08	0.	8.00	0.	0.16	1.81	1.63	0.	9.70	67.22	214.9
JUL	10	11.26	27.41	0.59	22.51	5.32	0.	7.29	7.29	0.	8.00	0.	0.16	1.81	1.63	0.	9.70	66.96	210.9
	10	17.53	42.69	0.58	30.73	0.	0.	3.66	3.66	0.	8.00	0.	0.16	0.	1.63	0.	13.48	67.26	215.5
	11	16.77	40.84	0.59	27.35	0.	0.	3.66	0.	0.	8.00	0.	0.	0.	1.63	4.21	15.93	67.50	219.3
AUG	10	24.05	58.57	0.64	29.28	0.	0.	3.66	0.	0.	8.00	0.	0.	0.	1.63	15.42	42.93	67.50	219.3
	10	46.25	112.61	0.64	13.79	0.	0.	3.66	0.	0.	3.97	0.	0.	0.	1.63	41.64	138.69	67.50	219.3
	11	10.18	24.80	0.64	26.86	13.07	0.	15.04	15.04	0.	0.	0.	0.16	1.81	1.63	0.	9.70	67.16	214.0
SEP	10	25.70	62.58	0.63	16.21	0.	0.	3.66	0.	0.	6.45	0.	0.	0.	1.63	12.59	57.18	67.50	219.3
	10	31.24	76.05	0.64	16.70	0.	0.	3.66	0.	0.	6.35	0.	0.	0.	1.63	24.25	81.84	67.50	219.3
	10	23.07	56.17	0.64	4.84	0.	0.	3.66	0.	0.	1.28	0.	0.	0.	1.63	21.15	70.71	67.50	219.3
OCT	10	15.56	37.90	0.62	15.25	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	14.94	35.82	67.50	219.3
	10	26.09	63.53	0.62	0.	0.	0.	3.66	0.	0.	0.	0.	0.	0.	0.	25.47	88.86	67.50	219.3
	11	20.77	50.58	0.62	0.	0.	0.	3.66	0.	0.	0.	0.	0.	0.	0.	20.15	70.59	67.50	219.3
NOV	10	25.49	62.07	0.56	0.	0.	0.	3.66	0.	0.	0.	0.	0.	0.	0.	24.93	86.86	67.50	219.3
	10	32.83	79.93	0.56	7.02	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	32.27	103.42	67.50	219.3
	10	27.61	67.21	0.56	16.46	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	27.05	76.04	67.50	219.3
DEC	10	22.61	55.06	0.49	20.09	0.	0.	3.66	0.	0.	8.00	0.	0.	0.	1.63	14.12	47.32	67.50	219.3
	10	27.69	67.43	0.49	21.54	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	27.20	71.32	67.50	219.3
	11	59.32	144.44	0.49	8.71	0.	0.	3.66	0.	0.	0.95	0.	0.	0.	1.63	57.87	191.83	67.50	219.3
VOLUME (MCUM)		890.6	2168.6	17.2	530.0	21.4	0.	132.5	29.9	0.	107.3	0.	0.6	4.9	47.2	716.6	2330.5		

Table J-4 WATER BALANCE STUDY FOR KARIAN RESERVOIR (10/12)

**** WATER BALANCE STUDY AGAINST C.I. OF 250 % BY PROSIDA ****

KARIAN RESERVOIR

YEAR	HWLK	LWLK	HWLC	LWLC	QMQ2	VHWLK	VLWLC
1981	67.5	46.0	76.5	66.5	8.0	219.3	62.0

MON	DAYS	QK	QN	QE	QIR	QIK	QIS	Q1R	Q1	Q1S	Q2R	Q2S	D2	D1R	D1	SP2	SP1	H1	S1
JAN	10	44.27	107.80	0.36	7.50	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	43.91	142.44	67.50	219.3
	10	74.00	180.17	0.36	13.07	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	73.64	238.97	67.50	219.3
	11	53.24	129.63	0.36	6.53	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	52.88	174.21	67.50	219.3
FEB	10	43.34	105.53	0.47	13.07	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	42.88	133.57	67.50	219.3
	10	33.79	82.28	0.47	6.29	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	33.33	107.55	67.50	219.3
	8	36.63	89.19	0.47	8.23	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	36.16	115.35	67.50	219.3
MAR	10	31.96	77.81	0.52	14.52	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	31.44	92.96	67.50	219.3
	10	52.29	127.31	0.52	17.67	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	51.77	159.64	67.50	219.3
	11	43.28	105.39	0.52	26.38	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	42.76	120.00	67.50	219.3
APR	10	27.09	65.95	0.49	19.36	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	26.59	71.41	67.50	219.3
	10	34.74	84.58	0.49	24.93	0.	0.	3.66	0.	0.	8.00	0.	0.	0.	1.63	26.25	84.14	67.50	219.3
	10	33.75	82.17	0.49	27.83	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	33.26	85.83	67.50	219.3
MAY	10	33.33	81.16	0.57	26.38	0.	0.	3.66	0.	0.	8.00	0.	0.	0.	1.63	24.76	77.78	67.50	219.3
	10	52.03	126.70	0.57	32.67	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	51.46	143.72	67.50	219.3
	11	26.05	63.43	0.57	30.98	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	25.48	56.16	67.50	219.3
JUN	10	41.70	101.53	0.61	28.31	0.	0.	3.66	0.	0.	8.00	0.	0.	0.	1.63	33.09	104.54	67.50	219.3
	10	63.34	154.23	0.61	14.52	0.	0.	3.66	0.	0.	3.33	0.	0.	0.	1.63	59.41	197.34	67.50	219.3
	10	29.00	70.62	0.61	17.67	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	28.39	79.57	67.50	219.3
JUL	10	16.47	40.10	0.60	22.26	0.	0.	3.66	0.	0.	8.00	0.	0.	0.	1.63	7.87	23.95	67.50	219.3
	10	37.12	90.37	0.60	25.17	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	36.52	99.95	67.50	219.3
	11	58.81	143.19	0.60	22.75	0.	0.	3.66	0.	0.	8.00	0.	0.	0.	1.63	50.21	168.69	67.50	219.3
AUG	10	25.30	61.60	0.64	38.48	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	24.66	46.01	67.50	219.3
	10	22.61	55.06	0.64	6.47	0.	0.	3.66	0.	0.	2.94	0.	0.	0.	1.63	19.04	63.86	67.50	219.3
	11	32.26	78.55	0.64	22.26	0.	0.	3.66	0.	0.	8.00	0.	0.	0.	1.63	23.62	78.13	67.50	219.3
SEP	10	39.32	95.74	0.64	16.15	0.	0.	3.66	0.	0.	6.54	0.	0.	0.	1.63	32.15	107.97	67.50	219.3
	10	31.65	77.07	0.64	9.20	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	31.02	97.12	67.50	219.3
	10	25.95	63.17	0.64	9.68	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	25.31	77.03	67.50	219.3
OCT	10	28.72	69.93	0.62	10.41	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	28.10	85.85	67.50	219.3
	10	18.30	44.55	0.62	0.	0.	0.	3.66	0.	0.	0.	0.	0.	0.	0.	17.67	62.08	67.50	219.3
	11	44.17	107.54	0.62	0.	0.	0.	3.66	0.	0.	0.	0.	0.	0.	0.	43.54	150.94	67.50	219.3
NOV	10	21.41	52.14	0.56	0.	0.	0.	3.66	0.	0.	0.	0.	0.	0.	0.	20.86	72.86	67.50	219.3
	10	79.46	193.48	0.56	7.02	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	78.91	263.60	67.50	219.3
	10	27.39	66.68	0.56	15.49	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	26.83	76.26	67.50	219.3
DEC	10	27.52	67.02	0.49	20.81	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	27.03	71.47	67.50	219.3
	10	23.04	56.10	0.49	28.07	0.	0.	3.66	0.	0.	8.00	0.	0.	0.	1.63	14.55	40.81	67.50	219.3
	11	58.38	142.15	0.49	6.05	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	57.89	192.23	67.50	219.3
VOLUME (MCUM)		1206.2	2936.8	17.2	527.0	0.	0.	115.3	0.	0.	60.8	0.	0.	0.	47.0	1128.1	3486.4		

Table J-4 WATER BALANCE STUDY FOR KARIAN RESERVOIR (11/12)

**** WATER BALANCE STUDY AGAINST C.I. OF 250 % BY PROSIDA ****
KARIAN RESERVOIR

YEAR	HWLK	LWLK	HWLC	LWLC	QNQ2	VHWLK	VLWLC
1982	67.5	46.0	76.5	66.5	8.0	219.3	62.0

MON	DAYS	QK	QN	QE	QIR	QIK	QIS	Q1R	Q1	Q1S	Q2R	Q2S	D2	D1R	D1	SP2	SP1	H1	S1
JAN	10	65.44	159.33	0.36	9.44	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	65.07	213.20	67.50	219.3
	10	91.67	223.21	0.36	0.	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	91.31	312.75	67.50	219.3
	11	56.57	137.74	0.36	12.10	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	56.21	180.07	67.50	219.3
FEB	10	27.52	67.01	0.47	7.02	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	27.06	85.28	67.50	219.3
	10	28.83	70.19	0.47	15.73	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	28.36	81.06	67.50	219.3
	8	21.19	51.60	0.47	6.53	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	20.73	64.03	67.50	219.3
MAR	10	20.45	49.80	0.52	17.18	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	19.93	50.78	67.50	219.3
	10	12.21	29.72	0.52	16.63	0.	0.	3.66	3.34	0.	8.00	0.	0.	0.	1.63	0.32	12.64	67.50	219.3
	11	8.37	20.39	0.52	22.26	12.86	0.	14.83	14.83	0.	8.00	0.	0.16	1.81	1.63	0.	9.70	66.58	205.0
APR	10	18.07	44.00	0.48	23.72	0.	0.	3.66	3.66	0.	8.00	0.	0.16	0.	1.63	0.	21.80	66.91	210.1
	10	33.41	81.34	0.48	26.62	0.	0.	3.66	0.	0.	8.00	0.	0.	0.	1.63	14.39	67.35	67.50	219.3
	10	24.25	59.04	0.49	19.12	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	23.75	61.90	67.50	219.3
MAY	10	24.00	58.43	0.57	37.03	0.	0.	3.66	0.	0.	8.00	0.	0.	0.	1.63	15.43	35.07	67.50	219.3
	10	17.82	43.40	0.57	42.11	9.35	0.	11.31	11.31	0.	8.00	0.	0.16	1.81	1.63	0.	9.70	67.39	217.5
	11	12.24	29.80	0.57	14.28	0.	0.	3.66	3.51	-0.00	6.13	0.	0.	0.	1.63	0.15	17.06	67.50	219.3
JUN	10	7.21	17.54	0.61	22.75	16.56	0.	18.53	18.53	0.	8.00	0.	0.16	1.81	1.63	0.	9.70	66.39	202.0
	10	10.95	26.67	0.58	24.44	8.30	0.	10.26	10.26	0.	8.00	0.	0.16	1.81	1.63	0.	9.70	65.95	195.2
	10	4.90	11.93	0.57	20.81	20.64	0.	22.61	22.61	0.	8.00	0.	0.16	1.81	1.63	0.	9.70	64.43	172.5
JUL	10	3.99	9.72	0.53	25.89	28.75	0.	30.72	30.72	0.	8.00	0.	0.16	1.81	1.63	0.	9.70	62.29	142.0
	10	2.64	6.44	0.49	28.31	31.46	0.	37.05	37.05	0.	8.00	0.	0.16	1.81	1.63	0.	9.70	59.13	105.0
	11	11.89	28.94	0.42	32.19	14.38	0.	16.35	16.35	0.	8.00	0.	0.16	1.81	1.63	0.	9.70	58.06	92.7
AUG	10	3.86	9.40	0.43	36.54	40.60	0.	42.90	42.90	0.	8.00	0.	0.16	1.81	1.63	0.	9.70	53.56	51.7
	10	2.30	5.60	0.33	31.94	35.49	0.	42.01	42.01	0.	8.00	0.	0.16	1.81	1.63	0.	9.70	47.86	10.2
	11	1.84	4.49	0.22	26.86	6.42	-21.09	37.60	12.36	-25.24	8.00	-8.00	0.16	0.	0.	0.	9.70	46.00	0.
SEP	10	1.21	2.96	0.19	20.81	0.	-20.81	32.58	1.02	-31.56	8.00	-8.00	0.	0.	0.	0.	3.88	46.00	0.
	10	2.28	5.56	0.19	18.39	0.	-18.39	27.00	2.09	-24.91	8.00	-8.00	0.	0.	0.	0.	7.44	46.00	0.
	10	1.88	4.58	0.19	15.97	0.00	-15.97	25.40	1.69	-23.72	8.00	-8.00	0.	0.	0.	0.	6.10	46.00	0.
OCT	10	1.70	4.14	0.19	18.63	0.00	-18.63	28.85	1.51	-27.35	8.00	-8.00	0.	0.	0.	0.	5.49	46.00	0.
	10	4.96	12.06	0.19	0.	0.	0.	3.66	3.66	0.	0.15	0.	0.16	0.	0.	0.	15.21	46.15	0.8
	11	7.19	17.50	0.19	0.	0.	0.	3.66	3.66	0.	0.02	0.	0.16	0.	0.	0.	20.65	46.72	4.0
NOV	10	35.40	86.19	0.18	0.	0.	0.	3.66	3.66	0.	0.	0.	0.16	0.	0.	0.	89.34	50.94	31.3
	10	20.70	50.41	0.24	7.02	0.	0.	3.66	3.66	0.	2.59	0.	0.16	0.	1.63	0.	44.91	52.49	43.7
	10	19.83	48.27	0.27	15.25	0.	0.	3.66	3.66	0.	6.13	0.	0.16	0.	1.63	0.	34.55	53.62	52.1
DEC	10	12.25	29.84	0.26	20.09	0.	0.	3.66	3.66	0.	8.00	0.	0.16	1.76	1.63	0.	11.27	53.66	52.4
	10	36.62	89.16	0.26	27.10	0.	0.	3.66	3.66	0.	8.00	0.	0.16	0.	1.63	0.	63.57	56.08	73.8
	11	42.57	103.64	0.30	12.10	0.	0.	3.66	3.66	0.	3.43	0.	0.16	0.	1.63	0.	93.06	59.32	107.2
VOLUME (MCUM)		611.8	1489.5	12.3	594.0	197.2	-63.8	416.8	268.2	-132.8	163.8	-35.3	2.8	17.5	39.9	314.7	1491.6		

Table J-4 WATER BALANCE STUDY FOR KARIAN RESERVOIR (12/12)

**** WATER BALANCE STUDY AGAINST C.I. OF 250 % BY PROSIDA ****
KARIAN RESERVOIR

YEAR	HWLK	LWLK	HWLC	LWLC	QMQ2	VHWLK	VLWLC
1983	67.5	46.0	76.5	66.5	8.0	219.3	62.0

MON	DAYS	QK	QN	QE	QIR	QIK	QIS	Q1R	Q1	Q1S	Q2R	Q2S	D2	D1R	D1	SP2	SP1	H1	S1
JAN	10	40.06	97.54	0.26	8.95	0.	0.	3.66	3.66	0.	2.16	0.	0.16	0.	1.63	0.	90.10	61.88	136.6
	10	49.49	120.50	0.29	23.47	0.	0.	3.66	3.66	0.	8.00	0.	0.16	0.	1.63	0.	98.55	64.20	169.0
	11	26.91	65.51	0.32	3.63	0.	0.	3.66	3.66	0.	0.	0.	0.16	0.	1.63	0.	63.40	65.65	190.8
FEB	10	26.03	63.38	0.43	15.00	0.	0.	3.66	3.66	0.	5.67	0.	0.16	0.	1.63	0.	49.90	66.57	204.9
	10	34.21	83.30	0.45	17.67	0.	0.	3.66	0.	0.	6.40	0.	0.	0.	1.63	10.73	74.59	67.50	219.3
	8	28.57	69.55	0.47	3.63	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	28.10	92.25	67.50	219.3
MAR	10	29.96	72.94	0.52	15.25	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	29.44	85.36	67.50	219.3
	10	23.57	57.38	0.52	23.47	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	23.05	55.18	67.50	219.3
	11	27.43	66.78	0.52	19.60	0.	0.	3.66	0.	0.	8.00	0.	0.	0.	1.63	18.91	64.31	67.50	219.3
APR	10	31.41	76.49	0.49	22.26	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	30.92	83.38	67.50	219.3
	10	19.56	47.63	0.49	26.38	0.	0.	3.66	0.	0.	8.00	0.	0.	0.	1.63	11.07	30.56	67.50	219.3
	10	20.92	50.93	0.49	13.55	0.	0.	3.66	0.	0.	5.31	0.	0.	0.	1.63	15.12	50.73	67.50	219.3
MAY	10	27.17	66.15	0.57	37.03	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	26.60	53.96	67.50	219.3
	10	30.84	75.08	0.57	30.73	0.	0.	3.66	0.	0.	8.00	0.	0.	0.	1.63	22.26	64.64	67.50	219.3
	11	36.72	89.40	0.57	39.45	0.	0.	3.66	0.	0.	8.00	0.	0.	0.	1.63	28.15	76.34	67.50	219.3
JUN	10	22.22	54.10	0.61	15.73	0.	0.	3.66	0.	0.	6.21	0.	0.	0.	1.63	15.40	52.00	67.50	219.3
	10	22.67	55.21	0.61	24.68	0.	0.	3.66	0.	0.	8.00	0.	0.	0.	1.63	14.06	42.82	67.50	219.3
	10	9.39	22.87	0.61	20.81	8.50	0.	10.46	10.46	0.	8.00	0.	0.16	1.81	1.63	0.	9.70	66.96	210.9
JUL	10	11.69	28.47	0.58	14.04	0.	0.	3.66	3.66	0.	6.05	0.	0.16	0.	1.63	0.	15.95	67.04	212.1
	10	10.09	24.57	0.59	24.68	10.90	0.	12.87	12.87	0.	8.00	0.	0.16	1.81	1.63	0.	9.70	66.41	202.3
	11	16.58	40.37	0.57	37.27	7.33	0.	9.29	9.29	0.	8.00	0.	0.16	1.81	1.63	0.	9.70	66.33	201.1
AUG	10	11.08	26.98	0.61	36.78	21.67	0.	23.64	23.64	0.	8.00	0.	0.16	1.81	1.63	0.	9.70	65.12	182.8
	10	12.13	29.52	0.58	29.28	10.51	0.	12.48	12.48	0.	8.00	0.	0.16	1.81	1.63	0.	9.70	64.60	175.1
	11	6.23	15.16	0.57	26.86	23.78	0.	25.75	25.75	0.	8.00	0.	0.16	1.81	1.63	0.	9.70	62.74	148.4
SEP	10	7.94	19.33	0.53	20.57	12.15	0.	14.12	14.12	0.	8.00	0.	0.16	1.81	1.63	0.	9.70	61.80	135.7
	10	9.83	23.94	0.51	18.39	4.61	0.	6.58	6.58	0.	8.00	0.	0.16	1.81	1.63	0.	9.70	61.40	131.1
	10	12.25	29.82	0.50	15.49	0.	0.	3.66	3.66	0.	6.89	0.	0.16	0.	1.63	0.	15.85	61.49	132.2
OCT	10	11.78	28.69	0.49	14.76	0.	0.	3.66	3.66	0.	6.48	0.	0.16	0.	1.63	0.	15.44	61.58	133.2
	10	18.20	44.32	0.49	0.	0.	0.	3.66	3.66	0.	0.	0.	0.16	0.	0.	0.	47.47	62.52	145.3
	11	26.58	64.71	0.51	0.	0.	0.	3.66	3.66	0.	0.	0.	0.16	0.	0.	0.	67.86	64.04	166.6
NOV	10	37.92	92.33	0.49	0.	0.	0.	3.66	3.66	0.	0.	0.	0.16	0.	0.	0.	95.48	65.99	195.8
	10	29.11	70.87	0.53	7.02	0.	0.	3.66	3.66	0.	1.92	0.	0.16	0.	1.63	0.	65.37	67.27	215.7
	10	65.11	158.54	0.55	14.28	0.	0.	3.66	0.	0.	3.12	0.	0.	0.	1.63	57.28	199.77	67.50	219.3
DEC	10	47.93	116.70	0.49	21.05	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	47.43	141.31	67.50	219.3
	10	32.06	78.07	0.49	22.75	0.	0.	3.66	0.	0.	0.	0.	0.	0.	1.63	31.57	85.12	67.50	219.3
	11	35.65	86.81	0.49	15.25	0.	0.	3.66	0.	0.	5.23	0.	0.	0.	1.63	29.93	99.72	67.50	219.3
VOLUME (MCUM)		795.9	1937.9	16.1	599.0	88.6	0.	191.9	137.9	0.	147.9	0.	2.6	12.8	47.0	382.0	1793.6		

Table J-5 WATER BALANCE STUDY FOR CILAWANG RESERVOIR (1/12)

**** WATER BALANCE STUDY AGAINST C.I. OF 250 % BY PROSIDA ****

CILAWANG RESERVOIR

YEAR	HWLK	LWLK	HWLC	LWLC	QMW2	VHWLK	VHWLC
1972	67.50	46.00	76.50	66.50	8.00	219.25	62.00

MON	DAYS	QC	QN	QE	QIR	QIC	QIS	Q2R	Q2S	Q3K	Q3	Q3S	Q4R	Q4S	SP3	SP4	H2	S2
JAN	10	29.59	5.97	0.20	2.57	0.	0.	0.	0.	1.10	0.	0.	0.	0.	29.39	32.78	76.50	62.0
	10	17.05	3.44	0.20	0.	0.	0.	0.	0.	1.10	0.	0.	0.	0.	16.85	20.29	76.50	62.0
	11	16.23	3.27	0.20	8.96	0.	0.	0.	0.	7.46	0.	0.	0.	0.	16.03	10.34	76.50	62.0
FEB	10	14.65	2.95	0.26	11.64	0.	0.	0.	0.	10.62	0.	0.	0.	0.	14.39	5.70	76.50	62.0
	10	8.99	1.81	0.26	4.84	0.	0.	0.	0.	4.66	0.	0.	0.	0.	8.73	5.70	76.50	62.0
	9	10.22	2.06	0.26	4.33	0.	0.	0.	0.	3.86	0.	0.	0.	0.	9.96	7.70	76.50	62.0
MAR	10	18.72	3.77	0.29	2.99	0.	0.	0.	0.	1.10	0.	0.	0.	0.	18.43	19.22	76.50	62.0
	10	15.73	3.17	0.29	9.17	0.	0.	0.	0.	7.78	0.	0.	0.	0.	15.45	9.45	76.50	62.0
	11	10.85	2.19	0.29	10.40	5.75	0.	0.	0.	10.12	5.75	0.	0.	0.	4.37	1.62	76.50	62.0
APR	10	5.28	1.06	0.27	8.75	0.	0.	0.	0.	9.57	9.57	0.	0.44	0.	0.	1.40	76.07	57.7
	10	3.99	0.81	0.26	12.46	5.75	0.	8.00	0.	5.75	5.75	0.	1.29	0.	0.	1.40	75.73	54.8
	10	10.14	2.04	0.26	12.77	4.77	0.	8.00	0.	4.77	4.77	0.	0.	0.	0.	1.40	76.22	59.2
MAY	10	9.33	1.88	0.31	12.26	0.	0.	8.00	0.	4.40	0.	0.	0.	0.	5.82	3.05	76.50	62.0
	10	7.01	1.41	0.32	10.81	11.37	0.	0.	0.	11.37	11.37	0.	0.53	0.	0.	1.40	76.07	57.7
	11	8.51	1.72	0.30	16.38	8.91	0.	8.00	0.	8.91	8.91	0.	0.78	0.	0.	1.40	75.91	56.3
JUN	10	2.27	0.46	0.32	11.02	4.59	0.	8.00	0.	4.59	4.59	0.	1.49	0.	0.	1.40	75.47	52.7
	10	1.95	0.39	0.31	10.51	4.12	0.	8.00	0.	4.12	4.12	0.	1.49	0.	0.	1.40	75.04	49.3
	10	1.56	0.32	0.30	9.06	2.68	0.	8.00	0.	2.68	2.68	0.	1.57	0.	0.	1.40	74.74	46.9
JUL	10	1.48	0.30	0.29	11.02	4.76	0.	8.00	0.	4.76	4.76	0.	1.68	0.	0.	1.40	74.17	42.3
	10	0.92	0.19	0.28	14.21	8.24	0.	8.00	0.	8.24	8.24	0.	2.25	0.	0.	1.40	72.97	33.8
	11	0.86	0.17	0.26	16.89	11.07	0.	8.00	0.	11.07	11.07	0.	2.69	0.	0.	1.40	71.04	21.3
AUG	10	1.31	0.26	0.24	16.69	10.76	0.	8.00	0.	10.76	10.76	0.	2.55	0.	0.	1.40	69.06	10.7
	10	1.41	0.28	0.20	13.08	0.	-1.22	8.00	-8.00	14.94	13.66	-1.29	2.00	-2.00	0.	1.40	66.50	0.
	11	2.75	0.56	0.14	11.74	0.	-10.08	8.00	-8.00	13.25	2.64	-10.61	1.48	-1.48	0.	1.40	66.50	0.
SEP	10	0.54	0.11	0.14	9.06	0.	-9.06	8.00	-8.00	10.90	0.43	-10.47	1.62	-1.62	0.	0.52	66.50	0.
	10	0.61	0.12	0.14	8.03	0.	-8.03	8.00	-8.00	9.80	0.49	-9.31	1.45	-1.45	0.	0.59	66.50	0.
	10	0.47	0.09	0.14	6.90	0.	-6.90	8.00	-8.00	8.64	0.35	-8.29	1.32	-1.32	0.	0.43	66.50	0.
OCT	10	0.25	0.05	0.13	7.73	0.	-7.73	8.00	-8.00	9.55	0.14	-9.41	1.49	-1.49	0.	0.18	66.50	0.
	10	0.63	0.13	0.13	0.	0.	0.	0.30	-0.30	1.34	0.52	-0.82	0.27	-0.27	0.	0.62	66.50	0.
	11	1.30	0.26	0.13	0.	0.	0.	0.15	0.	1.10	1.19	0.	0.11	-0.03	0.	1.54	66.50	0.
NOV	10	2.58	0.52	0.12	0.	0.	0.	0.	0.	1.10	1.10	0.	0.	0.	0.	1.56	66.64	1.2
	10	3.14	0.63	0.13	2.99	1.04	0.	2.91	0.	1.10	1.10	0.	0.11	0.	0.	1.45	67.28	2.7
	10	2.47	0.50	0.14	6.28	1.04	0.	6.52	0.	1.10	1.10	0.	0.75	0.	0.	1.45	67.40	3.2
DEC	10	4.94	1.00	0.12	7.83	0.66	0.	8.00	0.	1.10	1.10	0.	0.38	0.	0.	1.81	68.05	6.0
	10	3.62	0.73	0.13	10.20	3.44	0.	8.00	0.	3.44	3.44	0.	1.05	0.	0.	1.40	67.86	5.2
	11	6.48	1.31	0.13	8.34	0.88	0.	8.00	0.	1.10	1.10	0.	0.09	0.	0.	1.61	68.92	10.1
VOLUME (MCUM)		200.0	40.3	6.9	273.7	79.9	-38.0	149.5	-42.4	192.0	106.9	-50.2	25.1	-6.5	121.4	129.4		

Table J-5 WATER BALANCE STUDY FOR CILAWANG RESERVOIR (2/12)

**** WATER BALANCE STUDY AGAINST C.I. OF 250 % BY PROSIDA ****
CILAWANG RESERVOIR

YEAR	HWLK	LWLK	HWLC	LWLC	GHG2	VHWLK	VHWLC
1973	67.50	46.00	76.50	66.50	8.00	219.25	62.00

MON	DAYS	QC	QN	QE	QIR	QIC	QIS	Q2R	Q2S	Q3R	Q3	Q3S	Q4R	Q4S	SP3	SP4	H2	S2
JAN	10	14.91	3.01	0.11	3.81	1.04	0.	1.27	0.	1.10	1.10	0.	0.	0.	0.	1.45	71.14	21.9
	10	12.43	2.51	0.14	7.52	1.05	0.	5.71	0.	1.10	1.10	0.	0.	0.	0.	1.45	72.65	31.6
	11	12.70	2.56	0.15	0.52	0.	0.	0.	0.	1.10	1.10	0.	0.	0.	0.	3.09	74.18	42.5
FEB	10	9.06	1.83	0.22	0.	0.	0.	0.	0.	1.10	1.10	0.	0.	0.	0.	2.87	75.03	49.1
	10	7.83	1.58	0.23	5.97	1.05	0.	5.05	0.	1.10	1.10	0.	0.	0.	0.	1.45	75.72	54.8
	8	9.96	2.01	0.24	5.25	1.04	0.	3.85	0.	1.10	1.10	0.	0.	0.	0.	1.45	76.37	60.7
MAR	10	7.63	1.54	0.28	2.99	0.	0.	1.95	0.	1.10	0.	0.	0.	0.	5.85	6.26	76.50	62.0
	10	14.17	2.86	0.29	9.27	0.	0.	0.	0.	8.22	0.	0.	0.	0.	13.89	7.47	76.50	62.0
	11	11.54	2.33	0.29	10.40	0.	0.	0.	0.	9.97	0.	0.	0.	0.	11.26	3.18	76.50	62.0
APR	10	12.74	2.57	0.27	8.75	0.	0.	0.	0.	7.98	0.	0.	0.	0.	12.47	6.29	76.50	62.0
	10	13.52	2.73	0.27	11.12	0.	0.	0.	0.	10.31	0.	0.	0.	0.	13.25	4.85	76.50	62.0
	10	15.27	3.08	0.27	10.81	0.	0.	0.	0.	9.62	0.	0.	0.	0.	14.99	7.26	76.50	62.0
MAY	10	17.53	3.54	0.32	13.80	0.	0.	0.	0.	12.28	0.	0.	0.	0.	17.22	6.95	76.50	62.0
	10	19.89	4.01	0.32	14.94	0.	0.	0.	0.	12.97	0.	0.	0.	0.	19.57	8.65	76.50	62.0
	11	8.61	1.74	0.32	11.54	11.79	0.	0.	0.	11.79	11.79	0.	0.05	0.	0.	1.40	76.16	58.6
JUN	10	14.49	2.92	0.33	9.27	0.	0.	8.00	0.	1.10	0.	0.	0.	0.	10.25	11.50	76.50	62.0
	10	6.70	1.35	0.34	8.55	0.	0.	0.	0.	9.05	9.05	0.	0.07	0.	0.	1.40	76.26	59.6
	10	4.27	0.86	0.33	7.00	1.05	0.	6.89	0.	1.10	1.10	0.	0.42	0.	0.	1.45	76.47	61.7
JUL	10	4.38	0.88	0.33	10.40	3.50	0.	8.00	0.	3.50	3.50	0.	0.90	0.	0.	1.40	76.44	61.4
	10	3.97	0.80	0.33	9.27	2.39	0.	8.00	0.	2.39	2.39	0.	0.83	0.	0.	1.40	76.48	61.8
	11	3.37	0.68	0.33	11.12	4.47	0.	9.00	0.	4.47	4.47	0.	1.24	0.	0.	1.40	76.22	59.2
AUG	10	4.39	0.88	0.34	9.27	2.30	0.	8.00	0.	2.30	2.30	0.	0.73	0.	0.	1.40	76.31	60.1
	10	6.73	1.36	0.35	9.99	0.	0.	8.00	0.	2.56	0.	0.	0.27	0.	3.92	2.88	76.50	62.0
	11	4.25	0.86	0.35	8.86	0.	0.	0.	0.	9.90	9.90	0.	0.70	0.	0.	1.40	75.83	55.6
SEP	10	9.18	1.85	0.33	8.03	0.	0.	6.94	0.	1.10	0.	0.	0.	0.	1.48	1.89	76.50	62.0
	10	6.76	1.36	0.35	8.03	0.	0.	0.	0.	8.50	8.50	0.	0.	0.	0.	1.40	76.32	60.2
	10	14.04	2.83	0.35	2.88	0.	0.	0.48	0.	1.10	0.	0.	0.	0.	11.60	12.01	76.50	62.0
OCT	10	7.36	1.48	0.34	6.18	0.47	0.	0.	0.	6.42	0.47	0.	0.	0.	5.95	1.70	76.50	62.0
	10	5.61	1.13	0.34	0.	0.	0.	0.	0.	1.10	0.	0.	0.	0.	5.26	6.40	76.50	62.0
	11	12.82	2.58	0.34	0.	0.	0.	0.	0.	1.10	0.	0.	0.	0.	12.48	15.06	76.50	62.0
NOV	10	7.70	1.55	0.31	0.	0.	0.	0.	0.	1.10	0.	0.	0.	0.	7.39	8.94	76.50	62.0
	10	3.44	0.69	0.31	2.99	0.	0.	0.	0.	3.89	3.89	0.	0.04	0.	0.	1.40	76.43	61.3
	10	13.13	2.65	0.31	5.56	0.	0.	3.50	0.	1.10	0.	0.	0.	0.	12.02	12.43	76.50	62.0
DEC	10	9.24	1.86	0.27	8.86	7.51	0.	0.	0.	8.84	7.51	0.	0.	0.	1.33	1.47	76.50	62.0
	10	8.11	1.64	0.27	8.34	8.53	0.	0.	0.	8.53	8.53	0.	0.	0.	0.	1.40	76.44	61.4
	11	13.78	2.78	0.27	9.27	0.	0.	8.00	0.	1.10	0.	0.	0.	0.	12.87	13.98	76.50	62.0
VOLUME (MCUM)		307.8	62.1	9.2	228.7	41.1	0.	79.9	0.	151.0	71.3	0.	4.7	0.	170.0	146.9		

Table J-5 WATER BALANCE STUDY FOR CILAWANG RESERVOIR (3/12)

**** WATER BALANCE STUDY AGAINST C.I. OF 250 % BY PROSIDA ****

CILAWANG RESERVOIR

YEAR	HWLK	LWLK	HWLC	LWLC	QHQ2	VHWLK	VHWLC
1974	67.50	46.00	76.50	66.50	8.00	219.25	62.00

MON	DAYS	QC	QN	QE	QIR	QIC	QIS	Q2R	Q2S	Q3R	Q3	Q3S	Q4R	Q4S	SP3	SP4	H2	S2
JAN	10	27.45	5.53	0.20	0.	0.	0.	0.	0.	1.10	0.	0.	0.	0.	27.25	32.78	76.50	62.0
	10	15.23	3.07	0.20	7.73	0.	0.	0.	0.	6.37	0.	0.	0.	0.	15.03	10.38	76.50	62.0
	11	3.98	0.80	0.20	8.96	0.	0.	0.	0.	10.06	10.06	0.	0.78	0.	0.	1.40	75.79	55.3
FEB	10	12.11	2.44	0.24	9.17	0.	0.	8.00	0.	1.10	0.	0.	0.	0.	4.11	4.98	76.50	62.0
	10	10.58	2.13	0.26	0.	0.	0.	0.	0.	1.10	0.	0.	0.	0.	10.32	12.45	76.50	62.0
	8	11.80	2.38	0.26	4.74	0.	0.	0.	0.	3.96	0.	0.	0.	0.	11.54	9.18	76.50	62.0
MAR	10	19.14	3.86	0.29	3.91	0.	0.	0.	0.	1.53	0.	0.	0.	0.	16.85	18.79	76.50	62.0
	10	7.78	1.57	0.29	9.99	10.34	0.	0.	0.	10.34	10.34	0.	0.02	0.	0.	1.40	76.25	59.5
	11	9.33	1.88	0.28	9.58	0.	0.	8.00	0.	1.56	0.	0.	0.	0.	6.44	6.34	76.50	62.0
APR	10	7.61	1.54	0.27	6.90	4.93	0.	0.	0.	7.12	4.93	0.	0.	0.	2.19	1.51	76.50	62.0
	10	14.42	2.91	0.27	10.09	0.	0.	0.	0.	9.04	0.	0.	0.	0.	14.15	6.96	76.50	62.0
	10	5.69	1.15	0.27	14.42	0.	0.	0.	0.	15.45	15.45	0.	1.17	0.	0.	1.40	75.42	52.3
MAY	10	11.07	2.23	0.29	14.83	6.74	0.	8.00	0.	6.74	6.74	0.	0.	0.	0.	1.40	75.85	55.8
	10	13.79	2.78	0.30	10.30	0.	0.	8.00	0.	1.39	0.	0.	0.	0.	6.34	6.42	76.50	62.0
	11	6.17	1.24	0.32	15.04	0.	0.	0.	0.	15.99	15.99	0.	1.15	0.	0.	1.40	75.29	51.3
JUN	10	4.60	0.93	0.31	12.46	5.62	0.	8.00	0.	5.62	5.62	0.	1.14	0.	0.	1.40	75.03	49.1
	10	3.64	0.73	0.30	8.75	1.92	0.	8.00	0.	1.92	1.92	0.	0.63	0.	0.	1.40	75.09	49.6
	10	5.75	1.16	0.30	1.44	1.04	0.	0.73	0.	1.10	1.10	0.	0.	0.	0.	1.45	75.56	53.4
JUL	10	5.32	1.07	0.31	5.15	1.04	0.	4.72	0.	1.10	1.10	0.	0.	0.	0.	1.45	75.97	56.8
	10	7.04	1.42	0.32	12.77	5.42	0.	8.00	0.	5.42	5.42	0.	0.61	0.	0.	1.40	76.04	57.4
	11	3.59	0.72	0.32	13.49	6.92	0.	8.00	0.	6.92	6.92	0.	1.54	0.	0.	1.40	75.44	52.4
AUG	10	6.42	1.29	0.32	16.27	9.24	0.	8.00	0.	9.24	9.24	0.	1.27	0.	0.	1.40	74.97	48.6
	10	7.64	1.54	0.31	13.29	5.84	0.	8.00	0.	5.84	5.84	0.	0.54	0.	0.	1.40	75.07	49.5
	11	7.75	1.56	0.32	11.02	3.43	0.	8.00	0.	3.43	3.43	0.	0.18	0.	0.	1.40	75.52	53.1
SEP	10	13.87	2.80	0.33	6.08	0.	0.	3.88	0.	1.10	0.	0.	0.	0.	3.23	5.64	76.50	62.0
	10	18.76	3.78	0.35	3.30	0.	0.	0.	0.	1.10	0.	0.	0.	0.	18.41	18.89	76.50	62.0
	10	11.61	2.34	0.35	3.61	0.	0.	0.	0.	2.80	0.	0.	0.	0.	11.26	10.00	76.50	62.0
OCT	10	10.40	2.10	0.34	5.36	0.	0.	0.	0.	4.90	0.	0.	0.	0.	10.06	6.80	76.50	62.0
	10	7.44	1.50	0.34	0.	0.	0.	0.	0.	1.10	0.	0.	0.	0.	7.10	8.60	76.50	62.0
	11	5.46	1.10	0.34	0.	0.	0.	0.	0.	1.10	0.	0.	0.	0.	5.12	6.22	76.50	62.0
NOV	10	3.32	0.67	0.31	0.	0.	0.	0.	0.	1.10	0.	0.	0.	0.	3.02	3.69	76.50	62.0
	10	9.93	2.00	0.31	2.99	0.	0.	0.	0.	2.51	0.	0.	0.	0.	9.62	8.63	76.50	62.0
	10	5.98	1.21	0.31	6.80	0.	0.	0.	0.	7.36	7.36	0.	0.	0.	0.	1.40	76.35	60.5
DEC	10	11.98	2.42	0.27	5.56	0.	0.	3.74	0.	1.10	0.	0.	0.	0.	10.03	10.44	76.50	62.0
	10	5.31	1.07	0.27	12.36	0.	0.	0.	0.	13.36	13.36	0.	0.96	0.	0.	1.40	75.63	54.0
	11	4.19	0.84	0.25	11.85	5.05	0.	8.00	0.	5.05	5.05	0.	1.15	0.	0.	1.40	75.36	51.8
VOLUME (MCUM)		291.9	58.9	9.2	245.6	59.7	0.	97.0	0.	155.2	115.8	0.	10.2	0.	166.7	182.1		

Table J-5 WATER BALANCE STUDY FOR CILAWANG RESERVOIR (4/12)

**** WATER BALANCE STUDY AGAINST C.I. OF 250 % BY PROSIDA ****

CILAWANG RESERVOIR

YEAR	HWLK	LWLK	HWLC	LWLC	QMQ2	VHWLK	VHULC
1975	67.50	46.00	76.50	66.50	8.00	219.25	62.00

MON	DAYS	QC	QN	QE	QIR	QIC	QIS	Q2R	Q2S	Q3R	Q3	Q3S	Q4R	Q4S	SP3	SP4	H2	S2
JAN	10	8.19	1.65	0.18	2.99	1.05	0.	1.83	0.	1.10	1.10	0.	0.	0.	0.	1.45	76.08	57.8
	10	7.10	1.43	0.19	6.39	0.	0.	5.64	0.	1.10	0.	0.	0.	0.	2.02	2.43	76.50	62.0
	11	9.29	1.87	0.20	4.74	0.	0.	0.	0.	4.49	0.	0.	0.	0.	9.09	6.23	76.50	62.0
FEB	10	7.46	1.50	0.26	8.75	9.11	0.	0.	0.	9.11	9.11	0.	0.	0.	0.	1.40	76.34	60.4
	10	21.26	4.29	0.25	0.62	0.	0.	0.	0.	1.10	0.	0.	0.	0.	19.10	22.77	76.50	62.0
	8	9.59	1.93	0.26	4.74	0.	0.	0.	0.	4.42	0.	0.	0.	0.	9.34	6.53	76.50	62.0
MAR	10	9.07	1.83	0.29	8.75	8.58	0.	0.	0.	8.76	8.58	-0.00	0.	0.	0.18	1.41	76.50	62.0
	10	6.18	1.25	0.29	9.17	0.	0.	0.	0.	9.81	9.81	0.	0.28	0.	0.	1.40	76.14	58.4
	11	10.03	2.02	0.28	8.65	0.	0.	8.00	0.	1.10	0.	0.	0.	0.	5.93	6.90	76.50	62.0
APR	10	4.95	1.00	0.27	7.62	0.	0.	0.	0.	8.45	8.45	0.	0.35	0.	0.	1.40	76.14	58.4
	10	5.62	1.13	0.26	12.15	5.07	0.	8.00	0.	5.07	5.07	0.	0.65	0.	0.	1.40	76.09	57.9
	10	2.73	0.55	0.26	12.57	6.12	0.	8.00	0.	6.12	6.12	0.	1.61	0.	0.	1.40	75.56	53.4
MAY	10	3.38	0.68	0.29	15.24	8.80	0.	8.00	0.	8.80	8.80	0.	1.84	0.	0.	1.40	74.74	46.9
	10	4.61	0.93	0.28	16.48	9.84	0.	8.00	0.	9.84	9.84	0.	1.73	0.	0.	1.40	73.95	40.6
	11	8.69	1.75	0.26	15.45	7.89	0.	8.00	0.	7.89	7.89	0.	0.60	0.	0.	1.40	73.94	40.6
JUN	10	4.37	0.88	0.28	10.40	3.50	0.	8.00	0.	3.50	3.50	0.	0.90	0.	0.	1.40	73.90	40.3
	10	3.84	0.77	0.28	10.40	3.61	0.	8.00	0.	3.61	3.61	0.	1.02	0.	0.	1.40	73.77	39.4
	10	1.97	0.40	0.28	8.86	2.38	0.	8.00	0.	2.38	2.38	0.	1.25	0.	0.	1.40	73.53	37.7
JUL	10	2.83	0.57	0.27	9.89	3.28	0.	8.00	0.	3.28	3.28	0.	1.19	0.	0.	1.40	73.29	36.0
	10	5.33	1.07	0.26	10.61	3.51	0.	8.00	0.	3.51	3.51	0.	0.70	0.	0.	1.40	73.40	36.8
	11	6.59	1.33	0.27	15.14	8.01	0.	8.00	0.	8.01	8.01	0.	1.06	0.	0.	1.40	73.02	34.2
AUG	10	10.58	2.13	0.28	16.17	8.25	0.	8.00	0.	8.25	8.25	0.	0.26	0.	0.	1.40	73.25	35.7
	10	4.51	0.91	0.28	13.08	6.29	0.	8.00	0.	6.29	6.29	0.	1.25	0.	0.	1.40	72.84	32.9
	11	6.78	1.37	0.27	9.17	1.68	0.	8.00	0.	1.68	1.68	0.	0.14	0.	0.	1.40	73.47	37.3
SEP	10	10.10	2.04	0.28	6.59	1.05	0.	5.22	0.	1.10	1.10	0.	0.	0.	0.	1.45	74.49	44.8
	10	12.41	2.50	0.30	7.31	1.05	0.	5.49	0.	1.10	1.10	0.	0.	0.	0.	1.45	75.67	54.3
	10	10.00	2.02	0.33	6.69	1.05	0.	5.35	0.	1.10	1.10	0.	0.	0.	0.	1.45	76.48	61.8
OCT	10	4.82	0.97	0.34	5.77	0.	0.	5.48	0.	1.10	0.	0.	0.11	0.	4.08	4.48	76.50	62.0
	10	5.05	1.02	0.34	0.	0.	0.	0.	0.	1.10	0.	0.	0.	0.	4.71	5.73	76.50	62.0
	11	7.91	1.59	0.34	0.	0.	0.	0.	0.	1.10	0.	0.	0.	0.	7.57	9.16	76.50	62.0
NOV	10	15.29	3.08	0.31	0.	0.	0.	0.	0.	1.10	0.	0.	0.	0.	14.98	18.07	76.50	62.0
	10	9.50	1.92	0.31	2.99	0.	0.	0.	0.	2.60	0.	0.	0.	0.	9.19	8.12	76.50	62.0
	10	6.33	1.28	0.31	7.11	0.	0.	0.	0.	7.61	7.61	0.	0.	0.	0.	1.40	76.36	60.6
DEC	10	13.21	2.66	0.27	8.45	0.	0.	6.52	0.	1.10	0.	0.	0.	0.	11.35	11.76	76.50	62.0
	10	25.45	5.13	0.27	9.99	0.	0.	0.	0.	6.59	0.	0.	0.	0.	25.18	20.32	76.50	62.0
	11	9.74	1.96	0.27	2.57	0.	0.	0.	0.	2.12	0.	0.	0.	0.	9.47	8.85	76.50	62.0
VOLUME (MCUM)		258.1	52.0	8.6	259.3	88.0	0.	137.2	0.	135.8	110.6	-0.0	13.2	0.	115.4	143.4		

Table J-5 WATER BALANCE STUDY FOR CILAWANG RESERVOIR (5/12)

**** WATER BALANCE STUDY AGAINST C.I. OF 250 % BY PROSIDA ****
CILAWANG RESERVOIR

YEAR	HWLK	LWLK	HWLC	LWLC	QHQ2	VHULK	VHULC
1976	67.50	46.00	76.50	66.50	8.00	219.25	62.00

MON	DAYS	QC	QN	QE	QIR	QIC	QIS	Q2R	Q2S	Q3R	Q3	Q3S	Q4R	Q4S	SP3	SP4	H2	S2
JAN	10	15.48	3.12	0.20	3.61	0.	0.	0.	0.	1.98	0.	0.	0.	0.	15.28	14.79	76.50	62.0
	10	27.07	5.46	0.20	2.99	0.	0.	0.	0.	1.10	0.	0.	0.	0.	26.87	29.34	76.50	62.0
	11	25.49	5.14	0.20	0.72	0.	0.	0.	0.	1.10	0.	0.	0.	0.	25.29	29.70	76.50	62.0
FEB	10	11.00	2.22	0.26	7.62	0.	0.	0.	0.	7.16	0.	0.	0.	0.	10.74	5.34	76.50	62.0
	10	4.60	0.93	0.26	7.42	0.	0.	0.	0.	8.30	8.30	0.	0.41	0.	0.	1.40	76.12	58.2
	9	8.36	1.69	0.25	1.55	0.	0.	0.28	0.	1.10	0.	0.	0.	0.	3.26	3.66	76.50	62.0
MAR	10	15.73	3.17	0.29	3.40	0.	0.	0.	0.	1.71	0.	0.	0.	0.	15.44	15.22	76.50	62.0
	10	7.98	1.61	0.29	8.55	8.78	0.	0.	0.	8.78	8.78	0.	0.	0.	0.	1.40	76.41	61.1
	11	7.77	1.57	0.28	10.51	0.	0.	8.00	0.	2.88	0.	0.	0.10	0.	6.40	5.06	76.50	62.0
APR	10	5.01	1.01	0.27	10.92	0.	0.	0.	0.	11.90	11.90	0.	0.62	0.	0.	1.40	75.77	55.1
	10	7.53	1.52	0.26	8.45	0.77	0.	8.00	0.	1.10	1.10	0.	0.	0.	0.	1.72	76.34	60.4
	10	10.25	2.07	0.27	9.89	0.	0.	8.00	0.	1.71	0.	0.	0.	0.	8.18	7.96	76.50	62.0
MAY	10	8.71	1.76	0.32	16.17	16.65	0.	0.	0.	16.65	16.65	0.	0.70	0.	0.	1.40	75.66	54.3
	10	3.97	0.80	0.30	13.18	6.51	0.	8.00	0.	6.51	6.51	0.	1.40	0.	0.	1.40	75.21	50.6
	11	2.45	0.49	0.29	17.82	11.71	0.	8.00	0.	11.71	11.71	0.	2.44	0.	0.	1.40	73.74	39.2
JUN	10	4.91	0.99	0.28	12.46	5.55	0.	8.00	0.	5.55	5.55	0.	1.07	0.	0.	1.40	73.50	37.5
	10	2.73	0.55	0.27	9.27	2.65	0.	8.00	0.	2.65	2.65	0.	1.12	0.	0.	1.40	73.34	36.4
	10	1.41	0.28	0.27	9.06	2.72	0.	8.00	0.	2.72	2.72	0.	1.41	0.	0.	1.40	72.97	33.8
JUL	10	2.83	0.57	0.26	9.89	3.28	0.	8.00	0.	3.28	3.28	0.	1.19	0.	0.	1.40	72.73	32.1
	10	1.17	0.24	0.25	14.21	8.19	0.	8.00	0.	8.19	8.19	0.	2.22	0.	0.	1.40	71.48	23.9
	11	1.65	0.33	0.23	16.89	10.91	0.	8.00	0.	10.91	10.91	0.	2.50	0.	0.	1.40	69.45	12.5
AUG	10	1.84	0.37	0.21	13.49	7.29	0.	8.00	0.	7.29	7.29	0.	1.95	0.	0.	1.40	68.03	6.0
	10	1.38	0.28	0.17	11.95	5.76	0.	8.00	0.	5.76	5.76	0.	1.84	0.	0.	1.40	66.63	0.4
	11	2.56	0.52	0.14	10.09	3.55	-0.61	8.00	0.	3.55	2.91	-0.64	1.28	-1.28	0.	1.40	66.50	0.
SEP	10	1.35	0.27	0.14	9.06	0.	-9.02	8.00	-8.00	10.73	1.24	-9.49	1.42	-1.42	0.	1.40	66.50	0.
	10	0.81	0.16	0.14	8.03	0.	-8.03	8.00	-8.00	9.76	0.70	-9.06	1.40	-1.40	0.	0.83	66.50	0.
	10	1.44	0.29	0.14	5.46	0.	-5.31	5.87	-5.87	6.91	1.33	-5.59	0.88	-0.38	0.	1.40	66.50	0.
OCT	10	4.44	0.90	0.13	4.84	1.05	0.	4.58	0.	1.10	1.10	0.	0.07	0.	0.	1.45	67.28	2.7
	10	4.65	0.94	0.15	0.	0.	0.	0.	0.	1.10	1.10	0.	0.	0.	0.	1.98	67.96	5.6
	11	1.65	0.33	0.17	0.	0.	0.	0.08	0.	1.10	1.10	0.	0.03	0.	0.	1.45	68.04	6.0
NOV	10	3.02	0.61	0.15	0.	0.	0.	0.	0.	1.10	1.10	0.	0.	0.	0.	1.65	68.37	7.5
	10	10.41	2.10	0.16	2.99	1.05	0.	1.36	0.	1.10	1.10	0.	0.	0.	0.	1.45	70.05	15.4
	10	4.84	0.98	0.20	7.11	1.05	0.	6.88	0.	1.10	1.10	0.	0.30	0.	0.	1.45	70.53	18.2
DEC	10	2.95	0.59	0.18	9.99	3.36	0.	8.00	0.	3.36	3.36	0.	1.18	0.	0.	1.40	70.27	16.7
	10	5.59	1.13	0.18	5.97	1.05	0.	5.53	0.	1.10	1.10	0.	0.	0.	0.	1.45	70.90	20.4
	11	3.60	0.73	0.18	7.00	0.08	0.	8.00	0.	1.10	1.10	0.	0.58	0.	0.	2.37	71.17	22.1
VOLUME (MCUM)		199.0	40.1	6.9	256.4	90.3	-19.9	149.1	-18.9	152.3	114.4	-24.8	23.3	-4.4	98.7	134.6		

Table J-5 WATER BALANCE STUDY FOR CILAWANG RESERVOIR (6/12)

**** WATER BALANCE STUDY AGAINST C.I. OF 250 % BY PROSIDA ****
CILAWANG RESERVOIR

YEAR	HWLK	LWLK	HWLC	LWLC	QMQ2	VHWLK	VHWLC
1977	67.50	46.00	76.50	66.50	8.00	219.25	62.00

MON	DAYS	QC	QN	QE	QIR	QIC	QIS	Q2R	Q2S	Q3R	Q3	Q3S	Q4R	Q4S	SP3	SP4	H2	S2
JAN	10	7.05	1.42	0.14	5.56	1.05	0.	4.79	0.	1.10	1.10	0.	0.	0.	0.	1.45	72.01	27.1
	10	8.43	1.70	0.15	1.34	1.05	0.	0.05	0.	1.10	1.10	0.	0.	0.	0.	1.45	72.90	33.3
	11	21.68	4.37	0.16	4.33	1.04	0.	0.38	0.	1.10	1.10	0.	0.	0.	0.	1.45	75.47	52.7
FEB	10	7.43	1.50	0.24	8.03	0.35	0.	8.00	0.	1.10	1.10	0.	0.	0.	0.	2.11	76.10	56.0
	10	9.68	1.95	0.25	1.85	0.	0.	0.33	0.	1.10	0.	0.	0.	0.	4.77	5.18	76.50	62.0
	8	9.70	1.96	0.26	0.52	0.	0.	0.	0.	1.10	0.	0.	0.	0.	9.45	10.89	76.50	62.0
MAR	10	19.05	3.84	0.29	3.81	0.	0.	0.	0.	1.44	0.	0.	0.	0.	18.76	18.79	76.50	62.0
	10	6.47	1.30	0.29	8.65	0.	0.	0.	0.	9.21	9.21	0.	0.14	0.	0.	1.40	76.23	59.3
	11	11.94	2.41	0.28	10.40	0.	0.	8.00	0.	1.89	0.	0.	0.	0.	8.78	8.39	76.50	62.0
APR	10	13.85	2.79	0.27	10.71	0.	0.	0.	0.	9.81	0.	0.	0.	0.	13.58	5.66	76.50	62.0
	10	10.64	2.15	0.27	9.68	0.	0.	0.	0.	9.41	0.	0.	0.	0.	9.62	2.08	76.50	62.0
	10	10.21	2.06	0.27	9.37	1.54	0.	0.	0.	9.17	1.54	0.	0.	0.	7.63	1.78	76.50	62.0
MAY	10	14.56	2.94	0.32	11.23	0.	0.	0.	0.	10.20	0.	0.	0.	0.	14.24	5.95	76.50	62.0
	10	12.71	2.56	0.32	16.48	16.12	0.	0.	0.	16.12	16.12	0.	0.	0.	0.	1.40	76.18	58.8
	11	5.41	1.09	0.31	11.54	4.47	0.	8.00	0.	4.47	4.47	0.	0.31	0.	0.	1.40	76.16	58.6
JUN	10	7.14	1.44	0.33	2.57	0.	0.	1.62	0.	1.10	0.	0.	0.	0.	2.88	3.28	76.50	62.0
	10	4.82	0.97	0.34	6.69	0.	0.	0.	0.	7.50	7.50	0.	0.25	0.	0.	1.40	76.22	59.2
	10	5.80	1.17	0.33	8.75	0.	0.	8.00	0.	1.46	0.	0.	0.31	0.	1.90	1.91	76.50	62.0
JUL	10	3.57	0.72	0.33	11.02	0.	0.	0.	0.	12.32	12.32	0.	1.18	0.	0.	1.40	75.52	53.1
	10	1.57	0.32	0.31	14.21	8.10	0.	8.00	0.	8.10	8.10	0.	2.12	0.	0.	1.40	74.56	45.4
	11	2.07	0.42	0.29	15.45	9.30	0.	8.00	0.	9.30	9.30	0.	2.19	0.	0.	1.40	73.31	36.2
AUG	10	1.20	0.24	0.28	16.69	10.78	0.	8.00	0.	10.78	10.78	0.	2.57	0.	0.	1.40	71.73	25.4
	10	1.18	0.24	0.25	14.11	8.08	0.	8.00	0.	8.08	8.08	0.	2.20	0.	0.	1.40	70.38	17.3
	11	2.77	0.56	0.23	11.74	5.25	0.	8.00	0.	5.25	5.25	0.	1.48	0.	0.	1.40	69.62	13.4
SEP	10	0.80	0.16	0.21	8.65	2.41	0.	8.00	0.	2.41	2.41	0.	1.49	0.	0.	1.40	69.01	10.5
	10	1.74	0.35	0.20	6.49	1.05	0.	6.89	0.	1.10	1.10	0.	0.95	0.	0.	1.45	68.91	10.1
	10	1.16	0.24	0.19	6.90	0.49	0.	8.00	0.	1.10	1.10	0.	1.15	0.	0.	1.98	68.68	9.0
OCT	10	1.71	0.34	0.18	6.80	0.	0.	8.00	-8.00	8.27	8.27	0.	1.01	0.	0.	1.40	67.15	2.3
	10	1.89	0.38	0.15	0.	0.	0.	0.03	0.	1.10	1.10	0.	0.	0.	0.	1.45	67.31	2.8
	11	2.28	0.46	0.15	0.	0.	0.	0.	0.	1.10	1.10	0.	0.	0.	0.	1.51	67.56	3.8
NOV	10	2.94	0.59	0.14	0.	0.	0.	0.	0.	1.10	1.10	0.	0.	0.	0.	1.64	67.86	5.3
	10	1.70	0.34	0.15	2.99	1.04	0.	3.21	0.	1.10	1.10	0.	0.45	0.	0.	1.45	67.88	5.3
	10	1.94	0.39	0.15	7.00	0.43	0.	8.00	0.	1.10	1.10	0.	0.98	0.	0.	2.03	67.83	5.0
DEC	10	2.79	0.56	0.13	6.39	5.46	0.	6.56	-4.42	5.46	5.46	0.	0.69	0.	0.	1.40	67.07	2.0
	10	3.39	0.68	0.12	5.77	1.04	0.	5.78	0.	1.10	1.10	0.	0.45	0.	0.	1.45	67.50	3.5
	11	4.89	0.99	0.12	9.68	2.63	0.	8.00	0.	2.63	2.63	0.	0.67	0.	0.	1.40	67.80	4.9
VOLUME (MCUM)		198.1	39.9	7.3	243.3	72.5	0.	125.9	-10.7	148.7	109.7	0.	18.7	0.	78.3	88.5		

Table J-5 WATER BALANCE STUDY FOR CILAWANG RESERVOIR (7/12)

**** WATER BALANCE STUDY AGAINST C.I. OF 250 % BY PROSIDA ****
CILAWANG RESERVOIR

YEAR	HWLK	LWLK	HWLC	LWLC	QMQ2	VHWLK	VHWLC
1978	67.50	46.00	76.50	66.50	8.00	219.25	62.00

MON	DAYS	QC	QN	QE	QIR	QIC	QIS	Q2R	Q2S	Q3R	Q3	Q3S	Q4R	Q4S	SP3	SP4	H2	S2
JAN	10	5.76	1.16	0.10	7.21	1.04	0.	6.80	0.	1.10	1.10	0.	0.10	0.	0.	1.45	68.63	8.7
	10	11.41	2.30	0.11	8.14	1.05	0.	6.57	0.	1.10	1.10	0.	0.	0.	0.	1.45	70.41	17.6
	11	25.67	5.18	0.13	0.31	0.	0.	0.	0.	1.10	1.10	0.	0.	0.	0.	5.91	73.97	40.8
FEB	10	9.38	1.89	0.22	5.56	1.04	0.	4.29	0.	1.10	1.10	0.	0.	0.	0.	1.45	74.65	47.8
	10	4.08	0.82	0.23	10.20	3.34	0.	8.00	0.	3.34	3.34	0.	0.94	0.	0.	1.40	74.81	47.4
	8	8.23	1.66	0.23	0.21	0.	0.	0.	0.	1.10	1.10	0.	0.	0.	0.	2.50	75.40	52.2
MAR	10	11.31	2.28	0.26	7.52	1.05	0.	5.94	0.	1.10	1.10	0.	0.	0.	0.	1.45	76.37	60.7
	10	11.34	2.29	0.28	6.28	0.	0.	4.63	0.	1.10	0.	0.	0.	0.	9.61	10.02	76.50	62.0
	11	9.85	1.98	0.29	8.65	0.	0.	0.	0.	8.49	0.	0.	0.	0.	9.56	2.89	76.50	62.0
APR	10	7.77	1.57	0.27	8.45	8.71	0.	0.	0.	8.71	8.71	0.	0.	0.	0.	1.40	76.40	61.0
	10	3.52	0.71	0.27	12.36	5.74	0.	8.00	0.	5.74	5.74	0.	1.39	0.	0.	1.40	76.06	57.6
	10	9.33	1.88	0.26	8.34	0.	0.	8.00	0.	1.10	0.	0.	0.	0.	3.98	5.12	76.50	62.0
MAY	10	9.12	1.84	0.32	15.45	15.80	0.	0.	0.	15.80	15.80	0.	0.50	0.	0.	1.40	75.82	55.5
	10	4.77	0.96	0.30	15.35	8.62	0.	8.00	0.	8.62	8.62	0.	1.52	0.	0.	1.40	75.21	50.6
	11	3.18	0.64	0.29	17.82	11.56	0.	8.00	0.	11.56	11.56	0.	2.27	0.	0.	1.40	73.89	40.2
JUN	10	4.21	0.85	0.28	9.68	2.77	0.	8.00	0.	2.77	2.77	0.	0.83	0.	0.	1.40	73.93	40.5
	10	5.12	1.03	0.26	6.69	1.05	0.	6.39	0.	1.10	1.10	0.	0.18	0.	0.	1.45	74.33	43.6
	10	7.29	1.47	0.29	3.40	1.04	0.	2.46	0.	1.10	1.10	0.	0.	0.	0.	1.45	74.97	48.7
JUL	10	4.66	0.94	0.29	8.96	1.92	0.	8.00	0.	1.92	1.92	0.	0.62	0.	0.	1.40	75.17	50.3
	10	4.41	0.89	0.30	10.30	3.36	0.	8.00	0.	3.38	3.38	0.	0.87	0.	0.	1.40	75.15	50.2
	11	5.54	1.12	0.30	13.08	6.07	0.	8.00	0.	6.07	6.07	0.	1.01	0.	0.	1.40	74.94	48.4
AUG	10	6.60	1.33	0.31	15.14	8.01	0.	8.00	0.	8.01	8.01	0.	1.06	0.	0.	1.40	74.63	46.0
	10	7.45	1.50	0.31	8.03	0.35	0.	8.00	0.	1.10	1.10	0.	0.	0.	0.	2.11	75.29	51.2
	11	6.07	1.22	0.32	7.00	1.05	0.	6.51	0.	1.10	1.10	0.	0.	0.	0.	1.45	75.83	55.7
SEP	10	5.61	1.13	0.33	5.25	1.05	0.	4.77	0.	1.10	1.10	0.	0.	0.	0.	1.45	76.23	59.3
	10	4.19	0.85	0.34	4.84	1.05	0.	4.63	0.	1.10	1.10	0.	0.13	0.	0.	1.45	76.45	61.5
	10	7.48	1.51	0.35	5.97	0.	0.	5.13	0.	1.10	0.	0.	0.	0.	6.59	7.00	76.50	62.0
OCT	10	4.88	0.98	0.34	5.56	0.	0.	0.	0.	6.29	6.29	0.	0.07	0.	0.	1.40	76.34	60.4
	10	5.32	1.07	0.34	0.	0.	0.	0.	0.	1.10	0.	0.	0.	0.	3.15	4.22	76.50	62.0
	11	8.52	1.72	0.34	0.	0.	0.	0.	0.	1.10	0.	0.	0.	0.	8.17	9.89	76.50	62.0
NOV	10	10.44	2.10	0.31	0.	0.	0.	0.	0.	1.10	0.	0.	0.	0.	10.13	12.23	76.50	62.0
	10	9.24	1.86	0.31	2.99	0.	0.	0.	0.	2.66	0.	0.	0.	0.	8.94	7.81	76.50	62.0
	10	3.05	0.61	0.31	6.90	0.	0.	0.	0.	8.09	8.09	0.	0.70	0.	0.	1.40	75.97	56.8
DEC	10	5.87	1.18	0.26	9.37	2.09	0.	8.00	0.	2.09	2.09	0.	0.39	0.	0.	1.40	76.25	59.5
	10	5.20	1.05	0.27	5.46	0.	0.	5.07	0.	1.10	0.	0.	0.	0.	2.00	2.41	76.50	62.0
	11	10.56	2.13	0.27	7.11	0.	0.	0.	0.	6.71	0.	0.	0.	0.	10.29	5.31	76.50	62.0
VOLUME (MCUM)		234.8	47.3	8.8	235.8	77.4	0.	139.5	0.	116.2	92.6	0.	11.1	0.	65.0	97.1		

Table J-5 WATER BALANCE STUDY FOR CILAWANG RESERVOIR (8/12)

**** WATER BALANCE STUDY AGAINST C.I. OF 250 % BY PROSIDA ****
CILAWANG RESERVOIR

YEAR	HWLK	LWLK	HWLC	LWLC	QMQ2	VHWLK	VHWLC
1979	67.50	46.00	76.50	66.50	8.00	219.25	62.00

MON	DAYS	QC	QH	QE	QIR	QIC	QIS	Q2R	Q2S	Q3R	Q3	Q3S	Q4R	Q4S	SP3	SP4	H2	S2
JAN	10	6.68	1.35	0.20	0.62	0.	0.	0.	0.	1.10	0.	0.	0.	0.	6.48	7.21	76.50	62.0
	10	13.90	2.80	0.20	0.	0.	0.	0.	0.	1.10	0.	0.	0.	0.	13.70	16.50	76.50	62.0
	11	11.19	2.26	0.20	6.69	0.	0.	0.	0.	6.15	0.	0.	0.	0.	10.99	6.56	76.50	62.0
FEB	10	12.94	2.61	0.26	9.17	0.	0.	0.	0.	8.38	0.	0.	0.	0.	12.69	6.13	76.50	62.0
	10	8.89	1.79	0.26	8.75	8.80	0.	0.	0.	8.80	8.80	0.	0.	0.	0.	1.40	76.49	61.9
	8	14.97	3.02	0.26	0.31	0.	0.	0.	0.	1.10	0.	0.	0.	0.	14.49	17.20	76.50	62.0
MAR	10	10.84	2.18	0.29	4.63	0.	0.	0.	0.	4.05	0.	0.	0.	0.	10.55	8.10	76.50	62.0
	10	9.67	1.95	0.29	8.75	1.21	0.	0.	0.	8.64	1.21	0.	0.	0.	7.43	1.77	76.50	62.0
	11	9.27	1.87	0.29	10.81	10.89	0.	0.	0.	10.89	10.89	0.	0.	0.	0.	1.40	76.32	60.2
APR	10	16.16	3.26	0.27	11.23	0.	0.	8.00	0.	1.86	0.	0.	0.	0.	13.80	13.43	76.50	62.0
	10	11.01	2.22	0.27	9.79	0.	0.	0.	0.	9.44	0.	0.	0.	0.	10.74	3.18	76.50	62.0
	10	12.36	2.49	0.27	8.65	0.	0.	0.	0.	7.96	0.	0.	0.	0.	12.09	5.93	76.50	62.0
MAY	10	7.52	1.52	0.32	13.08	13.65	0.	0.	0.	13.65	13.65	0.	0.54	0.	0.	1.40	75.87	56.0
	10	2.76	0.56	0.30	13.08	6.66	0.	8.00	0.	6.66	6.66	0.	1.67	0.	0.	1.40	75.25	50.9
	11	5.01	1.01	0.29	12.46	5.53	0.	8.00	0.	5.53	5.53	0.	1.05	0.	0.	1.40	75.03	49.1
JUN	10	5.41	1.09	0.30	12.05	5.01	0.	8.00	0.	5.01	5.01	0.	0.89	0.	0.	1.40	74.94	48.5
	10	2.88	0.58	0.30	9.06	2.40	0.	8.00	0.	2.40	2.40	0.	1.06	0.	0.	1.40	74.65	47.7
	10	1.43	0.29	0.30	9.06	2.71	0.	8.00	0.	2.71	2.71	0.	1.40	0.	0.	1.40	74.52	45.1
JUL	10	2.55	0.51	0.29	7.73	1.06	0.	8.00	0.	1.10	1.10	0.	0.94	0.	0.	1.43	74.54	45.3
	10	6.44	1.30	0.29	10.92	3.60	0.	8.00	0.	3.60	3.60	0.	0.48	0.	0.	1.40	74.77	47.1
	11	1.89	0.38	0.29	16.79	10.75	0.	8.00	0.	10.75	10.75	0.	2.42	0.	0.	1.40	73.30	36.1
AUG	10	1.76	0.35	0.28	14.32	8.17	0.	8.00	0.	8.17	8.17	0.	2.09	0.	0.	1.40	72.22	28.5
	10	2.87	0.58	0.26	11.12	4.57	0.	8.00	0.	4.57	4.57	0.	1.36	0.	0.	1.40	71.77	25.6
	11	1.76	0.36	0.25	9.17	2.75	0.	8.00	0.	2.75	2.75	0.	1.34	0.	0.	1.40	71.36	23.2
SEP	10	1.88	0.38	0.25	5.66	1.05	0.	5.99	0.	1.10	1.10	0.	0.80	0.	0.	1.45	71.32	23.0
	10	2.77	0.56	0.25	7.93	1.23	0.	8.00	0.	1.23	1.23	0.	0.92	0.	0.	1.40	71.38	23.3
	10	3.19	0.64	0.25	2.27	1.04	0.	2.14	0.	1.10	1.10	0.	0.	0.	0.	1.45	71.64	24.9
OCT	10	3.38	0.68	0.25	5.97	1.05	0.	6.00	0.	1.10	1.10	0.	0.49	0.	0.	1.45	71.87	26.2
	10	1.67	0.34	0.25	0.	0.	0.	0.07	0.	1.10	1.10	0.	0.02	0.	0.	1.45	71.91	26.5
	11	2.89	0.58	0.25	0.	0.	0.	0.	0.	1.10	1.10	0.	0.	0.	0.	1.63	72.13	27.9
NOV	10	6.73	1.36	0.23	0.	0.	0.	0.	0.	1.10	1.10	0.	0.	0.	0.	2.40	72.80	32.6
	10	10.80	2.18	0.24	2.99	1.04	0.	1.28	0.	1.10	1.10	0.	0.	0.	0.	1.45	73.97	40.8
	10	5.71	1.15	0.26	7.00	1.05	0.	6.59	0.	1.10	1.10	0.	0.08	0.	0.	1.45	74.44	44.5
DEC	10	5.82	1.17	0.23	6.69	1.04	0.	6.24	0.	1.10	1.10	0.	0.01	0.	0.	1.45	74.93	48.3
	10	4.86	0.98	0.24	9.06	1.98	0.	8.00	0.	1.98	1.98	0.	0.59	0.	0.	1.40	75.15	50.1
	11	8.57	1.73	0.25	9.48	1.63	0.	8.00	0.	1.63	1.63	0.	0.	0.	0.	1.40	75.93	56.5
VOLUME (MCUM)		206.9	41.7	8.3	243.5	88.2	0.	130.9	0.	133.7	91.4	0.	16.1	0.	96.0	105.5		

Table J-5 WATER BALANCE STUDY FOR CILAWANG RESERVOIR (9/12)

**** WATER BALANCE STUDY AGAINST C.I. OF 250 % BY RROSIDA ****

CILAWANG RESERVOIR

YEAR	HWLK	LWLK	HWLC	LWLC	QMQ2	VHWLK	VHWLC
1980	67.50	46.00	76.50	66.50	8.00	219.25	62.00

MON	DAYS	QC	QN	QE	QIR	QIC	QIS	Q2R	Q2S	Q3R	Q3	Q3S	Q4R	Q4S	SP3	SP4	H2	S2
JAN	10	9.90	2.00	0.19	6.18	0.	0.	4.83	0.	1.10	0.	0.	0.	0.	3.30	3.70	76.50	62.0
	10	18.35	3.70	0.20	0.	0.	0.	0.	0.	1.10	0.	0.	0.	0.	18.15	21.85	76.50	62.0
	11	15.66	3.16	0.20	8.55	0.	0.	0.	0.	7.15	0.	0.	0.	0.	15.46	10.07	76.50	62.0
FEB	10	11.13	2.24	0.26	7.00	0.	0.	0.	0.	6.48	0.	0.	0.	0.	10.87	6.11	76.50	62.0
	10	12.36	2.49	0.26	0.	0.	0.	0.	0.	1.10	0.	0.	0.	0.	12.10	14.59	76.50	62.0
	9	6.90	1.39	0.26	1.34	0.	0.	0.	0.	1.42	0.	0.	0.	0.	6.65	6.70	76.50	62.0
MAR	10	6.18	1.25	0.29	7.52	0.	0.	0.	0.	8.08	8.08	0.	0.04	0.	0.	1.40	76.31	60.1
	10	5.77	1.16	0.28	8.75	0.	0.	8.00	0.	1.47	0.	0.	0.52	0.	2.94	2.95	76.50	62.0
	11	4.07	0.82	0.29	9.27	0.	0.	0.	0.	10.37	10.37	0.	0.80	0.	0.	1.40	75.75	55.0
APR	10	8.84	1.78	0.26	11.33	3.52	0.	8.00	0.	3.52	3.52	0.	0.	0.	0.	1.40	76.24	59.4
	10	7.93	1.60	0.27	11.23	0.	0.	8.00	0.	3.61	0.	0.	0.17	0.	4.42	2.40	76.50	62.0
	10	7.31	1.47	0.27	5.77	0.	0.	0.	0.	5.99	0.	0.	0.	0.	7.04	2.74	76.50	62.0
MAY	10	8.94	1.80	0.32	10.92	11.07	0.	0.	0.	11.07	11.07	0.	0.	0.	0.	1.40	76.29	59.9
	10	6.42	1.29	0.31	15.45	8.37	0.	8.00	0.	8.37	8.37	0.	1.14	0.	0.	1.40	75.99	56.9
	11	6.29	1.27	0.30	12.98	5.80	0.	8.00	0.	5.80	5.80	0.	0.81	0.	0.	1.40	75.92	56.3
JUN	10	5.33	1.07	0.32	9.48	2.32	0.	8.00	0.	2.32	2.32	0.	0.53	0.	0.	1.40	76.12	58.2
	10	3.08	0.62	0.33	2.78	1.04	0.	2.70	0.	1.10	1.10	0.	0.09	0.	0.	1.45	76.26	59.6
	10	2.86	0.58	0.33	8.86	2.19	0.	8.00	0.	2.19	2.19	0.	1.03	0.	0.	1.40	76.19	58.9
JUL	10	3.02	0.61	0.32	9.68	3.02	0.	8.00	0.	3.02	3.02	0.	1.11	0.	0.	1.40	76.07	57.7
	10	4.71	0.95	0.32	13.18	6.35	0.	8.00	0.	6.35	6.35	0.	1.22	0.	0.	1.40	75.75	55.0
	11	4.50	0.91	0.31	11.64	4.77	0.	8.00	0.	4.77	4.77	0.	1.05	0.	0.	1.40	75.56	53.4
AUG	10	6.45	1.30	0.33	12.67	5.44	0.	8.00	0.	5.44	5.44	0.	0.73	0.	0.	1.40	75.55	53.4
	10	12.41	2.50	0.33	5.87	0.	0.	7.97	0.	1.10	0.	0.	0.	0.	2.09	2.50	76.50	62.0
	11	2.73	0.55	0.35	11.74	0.	0.	0.	0.	13.25	13.25	0.	1.48	0.	0.	1.40	75.17	50.3
SEP	10	6.90	1.39	0.32	7.11	1.04	0.	6.45	0.	1.10	1.10	0.	0.	0.	0.	1.45	75.75	55.0
	10	8.38	1.69	0.33	7.31	1.04	0.	6.35	0.	1.10	1.10	0.	0.	0.	0.	1.45	76.40	61.0
	10	6.19	1.25	0.35	2.06	0.	0.	1.28	0.	1.10	0.	0.	0.	0.	4.68	5.09	76.50	62.0
OCT	10	4.18	0.84	0.34	6.49	0.	0.	0.	0.	7.42	7.42	0.	0.37	0.	0.	1.40	76.16	58.6
	10	7.00	1.41	0.33	0.	0.	0.	0.	0.	1.10	0.	0.	0.	0.	2.71	4.12	76.50	62.0
	11	5.57	1.12	0.34	0.	0.	0.	0.	0.	1.10	0.	0.	0.	0.	5.23	6.35	76.50	62.0
NOV	10	6.84	1.38	0.31	0.	0.	0.	0.	0.	1.10	0.	0.	0.	0.	6.53	7.91	76.50	62.0
	10	8.81	1.78	0.31	2.99	0.	0.	0.	0.	2.75	0.	0.	0.	0.	8.50	7.29	76.50	62.0
	10	7.41	1.49	0.31	7.00	7.27	0.	0.	0.	7.27	7.27	0.	0.	0.	0.	1.40	76.48	61.8
DEC	10	6.07	1.22	0.27	8.55	0.	0.	8.00	0.	1.18	0.	0.	0.22	0.	5.40	5.67	76.50	62.0
	10	7.43	1.50	0.27	9.17	9.55	0.	0.	0.	9.55	9.55	0.	0.	0.	0.	1.40	76.29	59.9
	11	15.92	3.21	0.27	3.71	0.	0.	0.95	0.	1.10	0.	0.	0.	0.	13.48	13.89	76.50	62.0
VOLUME (MCUM)		239.0	48.2	9.4	226.6	63.8	0.	107.3	0.	135.0	99.6	0.	10.0	0.	114.3	132.7		

Table J-5 WATER BALANCE STUDY FOR CILAWANG RESERVOIR (10/12)

**** WATER BALANCE STUDY AGAINST C.I. OF 250 % BY PROSIDA ****
CILAWANG RESERVOIR

YEAR	HWLK	LWLK	HWLC	LWLC	QMQ2	VHWLK	VHWLC
1981	67.50	46.00	76.50	66.50	8.00	219.25	62.00

MON	DAYS	QC	QN	QE	QIR	QIC	QIS	Q2R	Q2S	Q3R	Q3	Q3S	Q4R	Q4S	SP3	SP4	H2	S2
JAN	10	11.88	2.40	0.20	3.19	0.	0.	0.	0.	2.31	0.	0.	0.	0.	11.68	10.88	76.50	62.0
	10	19.86	4.00	0.20	5.56	0.	0.	0.	0.	3.11	0.	0.	0.	0.	19.66	18.10	76.50	62.0
	11	14.29	2.88	0.20	2.78	0.	0.	0.	0.	1.37	0.	0.	0.	0.	14.09	14.19	76.50	62.0
FEB	10	11.63	2.34	0.26	5.56	0.	0.	0.	0.	4.86	0.	0.	0.	0.	11.37	8.16	76.50	62.0
	10	9.07	1.83	0.26	2.68	0.	0.	0.	0.	2.37	0.	0.	0.	0.	8.81	7.96	76.50	62.0
	8	9.83	1.98	0.26	3.50	0.	0.	0.	0.	3.07	0.	0.	0.	0.	9.57	8.05	76.50	62.0
MAR	10	8.58	1.73	0.29	6.18	0.	0.	0.	0.	6.16	0.	0.	0.	0.	8.29	3.84	76.50	62.0
	10	14.03	2.83	0.29	7.52	0.	0.	0.	0.	6.41	0.	0.	0.	0.	13.74	9.05	76.50	62.0
	11	11.61	2.34	0.29	11.23	5.82	0.	0.	0.	10.83	5.82	0.	0.	0.	5.01	1.65	76.50	62.0
APR	10	7.27	1.47	0.27	8.24	8.60	0.	0.	0.	8.60	8.60	0.	0.	0.	0.	1.40	76.36	60.6
	10	9.32	1.88	0.27	10.61	0.	0.	8.00	0.	2.66	0.	0.	0.	0.	7.44	6.31	76.50	62.0
	10	9.06	1.83	0.27	11.85	12.02	0.	0.	0.	12.02	12.02	0.	0.	0.	0.	1.40	76.22	59.2
MAY	10	8.94	1.80	0.31	11.23	0.	0.	8.00	0.	3.39	0.	0.	0.	0.	5.40	3.58	76.50	62.0
	10	13.96	2.82	0.32	13.90	8.14	0.	0.	0.	13.15	8.14	0.	0.	0.	5.00	1.65	76.50	62.0
	11	6.99	1.41	0.32	13.18	13.87	0.	0.	0.	13.87	13.87	0.	0.68	0.	0.	1.40	75.69	54.5
JUN	10	11.19	2.26	0.32	12.05	3.78	0.	8.00	0.	3.78	3.78	0.	0.	0.	0.	1.40	76.36	60.6
	10	17.00	3.43	0.33	6.18	0.	0.	3.33	0.	1.10	0.	0.	0.	0.	15.10	15.50	76.50	62.0
	10	7.78	1.57	0.34	7.52	7.74	0.	0.	0.	7.74	7.74	0.	0.	0.	0.	1.40	76.47	61.7
JUL	10	4.42	0.89	0.33	9.58	0.	0.	8.00	0.	2.62	0.	0.	0.76	0.	3.03	1.95	76.50	62.0
	10	9.96	2.01	0.33	10.71	10.64	0.	0.	0.	10.64	10.64	0.	0.	0.	0.	1.40	76.41	61.1
	11	15.78	3.18	0.33	9.68	0.	0.	8.00	0.	1.10	0.	0.	0.	0.	14.54	15.64	76.50	62.0
AUG	10	6.79	1.37	0.35	16.69	0.	0.	0.	0.	17.60	17.60	0.	1.24	0.	0.	1.40	75.29	51.3
	10	6.07	1.22	0.32	3.61	1.04	0.	2.94	0.	1.10	1.10	0.	0.	0.	0.	1.45	75.79	55.3
	11	8.66	1.75	0.33	9.68	1.83	0.	8.00	0.	1.83	1.83	0.	0.	0.	0.	1.40	76.45	61.5
SEP	10	10.55	2.13	0.35	7.93	0.	0.	6.54	0.	1.10	0.	0.	0.	0.	9.60	10.00	76.50	62.0
	10	8.49	1.71	0.35	4.22	0.	0.	0.	0.	4.12	0.	0.	0.	0.	8.14	5.63	76.50	62.0
	10	6.96	1.40	0.35	4.22	0.	0.	0.	0.	4.44	0.	0.	0.	0.	6.61	3.79	76.50	62.0
OCT	10	7.71	1.55	0.34	4.43	0.	0.	0.	0.	4.50	0.	0.	0.	0.	7.36	4.49	76.50	62.0
	10	4.91	0.99	0.34	0.	0.	0.	0.	0.	1.10	0.	0.	0.	0.	4.57	5.55	76.50	62.0
	11	11.85	2.39	0.34	0.	0.	0.	0.	0.	1.10	0.	0.	0.	0.	11.51	13.90	76.50	62.0
NOV	10	5.75	1.16	0.31	0.	0.	0.	0.	0.	1.10	0.	0.	0.	0.	5.44	6.60	76.50	62.0
	10	21.32	4.30	0.31	2.99	0.	0.	0.	0.	1.10	0.	0.	0.	0.	21.02	22.33	76.50	62.0
	10	7.35	1.48	0.31	6.59	4.97	0.	0.	0.	6.85	4.97	0.	0.	0.	1.88	1.49	76.50	62.0
DEC	10	7.39	1.49	0.27	8.86	9.23	0.	0.	0.	9.23	9.23	0.	0.	0.	0.	1.40	76.32	60.2
	10	6.18	1.25	0.27	11.95	4.74	0.	8.00	0.	4.74	4.74	0.	0.69	0.	0.	1.40	76.36	60.6
	11	15.67	3.16	0.27	2.57	0.	0.	0.	0.	1.10	0.	0.	0.	0.	13.91	14.50	76.50	62.0
VOLUME (MCUM)		323.7	65.3	9.5	225.4	81.7	0.	60.8	0.	159.6	97.0	0.	3.0	0.	213.2	202.9		

Table J-5 WATER BALANCE STUDY FOR CILAWANG RESERVOIR (11/12)

**** WATER BALANCE STUDY AGAINST C.I. OF 250 % BY PROSIDA ****
CILAWANG RESERVOIR

YEAR	HWLK	LWLK	HWLC	LWLC	QHQ2	VHWLK	VHWLC
1982	67.50	46.00	76.50	66.50	8.00	219.25	62.00

MON	DAYS	QC.	QN	QE.	QIR	QIC	QIS	Q2R	Q2S	Q3R	Q3	Q3S	Q4R	Q4S	SP3	SP4	H2	S2
JAN	10	17.56	3.54	0.20	4.02	0.	0.	0.	0.	1.95	0.	0.	0.	0.	17.36	16.88	76.50	62.0
	10	24.60	4.96	0.20	0.	0.	0.	0.	0.	1.10	0.	0.	0.	0.	24.40	29.36	76.50	62.0
	11	15.18	3.06	0.20	5.15	0.	0.	0.	0.	3.67	0.	0.	0.	0.	14.98	12.89	76.50	62.0
FEB	10	7.39	1.49	0.26	2.99	0.	0.	0.	0.	3.05	0.	0.	0.	0.	7.13	5.63	76.50	62.0
	10	7.74	1.56	0.26	6.69	0.89	0.	0.	0.	6.88	0.89	0.	0.	0.	5.99	1.70	76.50	62.0
	8	5.69	1.15	0.26	2.78	0.	0.	0.	0.	3.19	0.	0.	0.	0.	5.43	3.79	76.50	62.0
MAR	10	5.49	1.11	0.29	7.31	0.	0.	0.	0.	8.01	8.01	0.	0.18	0.	0.	1.40	76.24	59.4
	10	3.28	0.66	0.28	7.93	1.13	0.	8.00	0.	1.13	1.13	0.	0.80	0.	0.	1.40	76.33	60.3
	11	2.25	0.45	0.28	9.48	2.97	0.	8.00	0.	2.97	2.97	0.	1.27	0.	0.	1.40	76.12	58.2
APR	10	4.85	0.98	0.26	10.09	3.07	0.	8.00	0.	3.07	3.07	0.	0.74	0.	0.	1.40	76.19	58.9
	10	8.96	1.81	0.27	11.33	0.	0.	8.00	0.	3.50	0.	0.	0.	0.	5.06	3.14	76.50	62.0
	10	6.51	1.31	0.27	8.14	0.	0.	0.	0.	8.66	8.66	0.	0.06	0.	0.	1.40	76.29	59.9
MAY	10	6.44	1.30	0.31	15.76	8.70	0.	8.00	0.	8.70	8.70	0.	1.19	0.	0.	1.40	75.95	56.6
	10	4.78	0.96	0.30	17.92	11.32	0.	8.00	0.	11.32	11.32	0.	1.90	0.	0.	1.40	75.02	49.1
	11	3.28	0.66	0.28	6.08	1.05	0.	6.13	0.	1.10	1.10	0.	0.52	0.	0.	1.45	75.18	50.4
JUN	10	1.93	0.39	0.30	9.68	3.25	0.	8.00	0.	3.25	3.25	0.	1.37	0.	0.	1.40	74.86	47.8
	10	2.94	0.59	0.30	10.40	3.80	0.	8.00	0.	3.80	3.80	0.	1.24	0.	0.	1.40	74.60	45.7
	10	1.32	0.27	0.29	8.86	2.52	0.	8.00	0.	2.52	2.52	0.	1.40	0.	0.	1.40	74.28	43.2
JUL	10	1.07	0.22	0.28	11.02	4.85	0.	8.00	0.	4.85	4.85	0.	1.78	0.	0.	1.40	73.60	38.2
	10	0.71	0.14	0.27	12.15	6.12	0.	8.00	0.	6.12	6.12	0.	2.03	0.	0.	1.40	72.64	31.5
	11	3.19	0.64	0.25	13.90	7.43	0.	8.00	0.	7.43	7.43	0.	1.69	0.	0.	1.40	71.77	25.6
AUG	10	1.04	0.21	0.25	15.76	9.84	0.	8.00	0.	9.84	9.84	0.	2.48	0.	0.	1.40	70.09	15.7
	10	0.62	0.12	0.22	13.90	7.98	0.	8.00	0.	7.98	7.98	0.	2.31	0.	0.	1.40	68.28	7.1
	11	0.50	0.10	0.18	11.74	0.	-5.61	8.00	-8.00	13.73	7.82	-5.91	2.02	-2.02	0.	1.40	66.50	0.
SEP	10	0.33	0.07	0.14	9.06	0.	-9.06	8.00	-8.00	10.95	0.21	-10.73	1.67	-1.67	0.	0.27	66.50	0.
	10	0.61	0.12	0.14	8.03	0.	-8.03	8.00	-8.00	9.80	0.50	-9.30	1.45	-1.45	0.	0.60	66.50	0.
	10	0.50	0.10	0.14	6.90	0.	-6.90	8.00	-8.00	8.63	0.39	-8.24	1.31	-1.31	0.	0.47	66.50	0.
OCT	10	0.46	0.09	0.13	8.03	0.	-8.03	8.00	-8.00	9.83	0.35	-9.49	1.49	-1.49	0.	0.42	66.50	0.
	10	1.33	0.27	0.13	0.	0.	0.	0.15	0.	1.10	1.10	0.	0.10	0.	0.	1.45	66.50	-0.0
	11	1.93	0.39	0.13	0.	0.	0.	0.02	0.	1.10	1.10	0.	0.	0.	0.	1.45	66.69	0.7
NOV	10	9.50	1.92	0.12	0.	0.	0.	0.	0.	1.10	1.10	0.	0.	0.	0.	2.96	68.43	7.8
	10	5.56	1.12	0.16	2.99	1.04	0.	2.39	0.	1.10	1.10	0.	0.	0.	0.	1.45	69.23	11.5
	10	5.32	1.07	0.18	6.49	1.04	0.	6.13	0.	1.10	1.10	0.	0.10	0.	0.	1.45	69.96	14.9
DEC	10	3.29	0.66	0.17	8.55	1.77	0.	8.00	0.	1.77	1.77	0.	0.38	0.	0.	1.40	70.04	15.3
	10	9.83	1.98	0.17	11.54	3.53	0.	8.00	0.	3.53	3.53	0.	0.	0.	0.	1.40	70.93	20.6
	11	11.42	2.30	0.19	5.15	1.04	0.	3.43	0.	1.10	1.10	0.	0.	0.	0.	1.45	72.46	30.2
VOLUME (MCUM)		164.2	33.1	7.1	254.4	73.1	-33.0	163.8	-55.3	156.8	99.3	-43.7	26.4	-7.0	69.8	98.0		

Table J-5 WATER BALANCE STUDY FOR CILAWANG RESERVOIR (12/12)

**** WATER BALANCE STUDY AGAINST C.I. OF 250 % BY PROSIDA ****

CILAWANG RESERVOIR

YEAR	HWLK	LWLK	HWLC	LWLC	QRQ2	VHWLK	VHWLC
1983	67.50	46.00	76.50	66.50	3.00	219.25	62.00

MON	DAYS	QC	QN	QE	QIR	QIC	QIS	Q2R	Q2S	Q3R	Q3	Q3S	Q4R	Q4S	SP3	SP4	H2	S2
JAN	10	10.75	2.17	0.15	3.81	1.04	0.	2.16	0.	1.10	1.10	0.	0.	0.	0.	1.45	73.64	38.4
	10	13.28	2.68	0.16	9.99	1.17	0.	8.00	0.	1.17	1.17	0.	0.	0.	0.	1.40	74.98	48.8
	11	7.22	1.46	0.18	1.03	1.03	0.	0.	0.	1.10	1.10	0.	0.	0.	0.	1.47	75.68	54.4
FEB	10	6.99	1.41	0.24	6.39	1.05	0.	5.67	0.	1.10	1.10	0.	0.	0.	0.	1.45	76.23	59.3
	10	9.18	1.85	0.25	7.52	0.	0.	6.40	0.	1.10	0.	0.	0.	0.	5.79	6.20	76.50	62.0
	8	7.67	1.55	0.26	1.55	0.	0.	0.	0.	1.47	0.	0.	0.	0.	7.41	7.41	76.50	62.0
MAR	10	8.04	1.62	0.29	6.49	0.	0.	0.	0.	6.60	0.	0.	0.	0.	7.75	2.88	76.50	62.0
	10	6.32	1.28	0.29	9.99	0.	0.	0.	0.	10.65	10.65	0.	0.37	0.	0.	1.40	76.07	57.7
	11	7.36	1.48	0.28	8.34	0.	0.	3.00	0.	1.10	0.	0.	0.	0.	2.55	3.29	76.50	62.0
APR	10	8.43	1.70	0.27	9.48	9.66	0.	0.	0.	9.66	9.66	0.	0.	0.	0.	1.40	76.37	60.7
	10	5.25	1.06	0.27	11.23	4.18	0.	8.00	0.	4.18	4.18	0.	0.81	0.	0.	1.40	76.37	60.7
	10	5.61	1.13	0.27	5.77	0.	0.	5.31	0.	1.10	0.	0.	0.	0.	3.84	4.24	76.50	62.0
MAY	10	7.29	1.47	0.32	15.76	16.51	0.	0.	0.	16.51	16.51	0.	0.98	0.	0.	1.40	75.49	52.9
	10	8.27	1.67	0.29	13.08	5.49	0.	8.00	0.	5.49	5.49	0.	0.36	0.	0.	1.40	75.72	54.8
	11	9.85	1.99	0.30	16.79	9.06	0.	8.00	0.	9.06	9.06	0.	0.52	0.	0.	1.40	75.72	54.7
JUN	10	5.96	1.20	0.32	6.69	1.05	0.	6.21	0.	1.10	1.10	0.	0.	0.	0.	1.45	76.17	58.7
	10	6.08	1.23	0.33	10.51	3.24	0.	8.00	0.	3.24	3.24	0.	0.50	0.	0.	1.40	76.34	60.4
	10	2.52	0.51	0.33	8.86	2.26	0.	8.00	0.	2.26	2.26	0.	1.11	0.	0.	1.40	76.24	59.4
JUL	10	3.14	0.63	0.32	5.97	1.05	0.	6.05	0.	1.10	1.10	0.	0.54	0.	0.	1.45	76.34	60.4
	10	2.71	0.55	0.33	10.51	3.96	0.	8.00	0.	3.96	3.96	0.	1.31	0.	0.	1.40	76.09	57.9
	11	4.45	0.90	0.32	16.07	9.44	0.	8.00	0.	9.44	9.44	0.	1.71	0.	0.	1.40	75.29	51.2
AUG	10	2.97	0.60	0.32	15.96	9.65	0.	8.00	0.	9.65	9.65	0.	2.04	0.	0.	1.40	74.31	43.4
	10	3.25	0.66	0.30	12.77	6.23	0.	8.00	0.	6.23	6.23	0.	1.51	0.	0.	1.40	73.75	39.3
	11	1.67	0.34	0.29	11.74	5.48	0.	8.00	0.	5.48	5.48	0.	1.74	0.	0.	1.40	72.96	33.7
SEP	10	2.13	0.43	0.28	8.96	2.45	0.	8.00	0.	2.45	2.45	0.	1.22	0.	0.	1.40	72.74	32.2
	10	2.64	0.53	0.27	8.03	1.37	0.	8.00	0.	1.37	1.37	0.	0.96	0.	0.	1.40	72.74	32.2
	10	3.29	0.66	0.27	6.80	1.04	0.	6.89	0.	1.10	1.10	0.	0.63	0.	0.	1.45	72.90	33.3
OCT	10	3.16	0.64	0.27	6.39	1.05	0.	6.48	0.	1.10	1.10	0.	0.60	0.	0.	1.45	73.05	34.3
	10	4.88	0.98	0.27	0.	0.	0.	0.	0.	1.10	1.10	0.	0.	0.	0.	2.03	73.48	37.4
	11	7.13	1.44	0.28	0.	0.	0.	0.	0.	1.10	1.10	0.	0.	0.	0.	2.48	74.23	42.8
NOV	10	10.18	2.05	0.26	0.	0.	0.	0.	0.	1.10	1.10	0.	0.	0.	0.	3.10	75.19	50.5
	10	7.81	1.57	0.28	2.99	1.04	0.	1.92	0.	1.10	1.10	0.	0.	0.	0.	1.45	75.88	56.0
	10	17.47	3.52	0.29	6.08	0.	0.	3.12	0.	1.10	0.	0.	0.	0.	10.24	10.65	76.50	62.0
DEC	10	12.86	2.59	0.27	8.96	0.	0.	0.	0.	8.18	0.	0.	0.	0.	12.59	6.22	76.50	62.0
	10	8.60	1.73	0.27	9.68	9.84	0.	0.	0.	9.84	9.84	0.	0.	0.	0.	1.40	76.37	60.7
	11	9.57	1.93	0.27	6.49	0.	0.	5.23	0.	1.10	0.	0.	0.	0.	7.93	8.33	76.50	62.0
VOLUME (MCUM)		213.6	43.1	8.7	256.1	95.8	0.	147.9	0.	127.0	108.3	0.	15.0	0.	49.8	80.2		

Table J-6 WATER BALANCE STUDY AT CICINTA WEIR (1/4)

**** WATER BALANCE STUDY AGAINST C.I. OF 250 % B
CICINTA IRRIGATION SCHEME

YEAR	HWLK	LWLK	HWLC	LWLC	QMQ2
1972	67.50	46.00	76.50	66.50	8.00

MON	DAYS	QN	QIR	SPS	Q4R	Q4S
JAN	10	6.72	0.36	6.36	0.	0.
	10	3.87	0.	3.87	0.	0.
	11	3.68	1.24	2.44	0.	0.
FEB	10	3.32	1.62	1.71	0.	0.
	10	2.04	0.67	1.37	0.	0.
	9	2.32	0.60	1.72	0.	0.
MAR	10	4.25	0.41	3.63	0.	0.
	10	3.57	1.27	2.30	0.	0.
	11	2.46	1.44	1.02	0.	0.
APR	10	1.20	1.22	0.40	0.44	0.
	10	0.91	1.73	0.40	1.29	0.
	10	2.30	1.77	0.53	0.	0.
MAY	10	2.12	1.70	0.42	0.	0.
	10	1.59	1.50	0.40	0.33	0.
	11	1.93	2.27	0.40	0.78	0.
JUN	10	0.51	1.53	0.40	1.49	0.
	10	0.44	1.46	0.40	1.49	0.
	10	0.36	1.26	0.40	1.37	0.
JUL	10	0.34	1.53	0.40	1.68	0.
	10	0.21	1.97	0.40	2.28	0.
	11	0.20	2.35	0.40	2.68	0.
AUG	10	0.30	2.32	0.40	2.55	0.
	10	0.32	1.82	0.40	2.00	-2.00
	11	0.62	1.63	0.40	1.48	-1.48
SEP	10	0.12	1.26	0.40	1.62	-1.62
	10	0.14	1.12	0.40	1.45	-1.45
	10	0.11	0.96	0.40	1.32	-1.32
OCT	10	0.06	1.07	0.40	1.49	-1.49
	10	0.14	0.	0.40	0.27	-0.27
	11	0.30	0.	0.40	0.11	-0.03
NOV	10	0.58	0.	0.58	0.	0.
	10	0.71	0.41	0.40	0.11	0.
	10	0.56	0.87	0.40	0.75	0.
DEC	10	1.12	1.09	0.40	0.38	0.
	10	0.82	1.42	0.40	1.05	0.
	11	1.47	1.16	0.40	0.09	0.
VOLUME (MCUM)		45.4	38.0	31.2	25.1	-8.5

**** WATER BALANCE STUDY AGAINST C.I. OF 250 % B
CICINTA IRRIGATION SCHEME

YEAR	HWLK	LWLK	HWLC	LWLC	QMQ2
1973	67.50	46.00	76.50	66.50	8.00

MON	DAYS	QN	QIR	SPS	Q4R	Q4S
JAN	10	3.39	0.53	2.86	0.	0.
	10	2.82	1.04	1.78	0.	0.
	11	2.88	0.07	2.81	0.	0.
FEB	10	2.06	0.	2.06	0.	0.
	10	1.78	0.83	0.95	0.	0.
	8	2.26	0.73	1.53	0.	0.
MAR	10	1.73	0.41	1.32	0.	0.
	10	3.22	1.29	1.93	0.	0.
	11	2.62	1.44	1.18	0.	0.
APR	10	2.89	1.22	1.68	0.	0.
	10	3.07	1.54	1.52	0.	0.
	10	3.47	1.50	1.96	0.	0.
MAY	10	3.98	1.92	2.06	0.	0.
	10	4.51	2.07	2.44	0.	0.
	11	1.95	1.60	0.40	0.05	0.
JUN	10	3.29	1.29	2.00	0.	0.
	10	1.52	1.19	0.40	0.07	0.
	10	0.97	0.97	0.40	0.42	0.
JUL	10	0.99	1.44	0.40	0.90	0.
	10	0.90	1.29	0.40	0.83	0.
	11	0.76	1.54	0.40	1.24	0.
AUG	10	1.00	1.29	0.40	0.73	0.
	10	1.53	1.39	0.40	0.27	0.
	11	0.96	1.23	0.40	0.70	0.
SEP	10	2.08	1.12	0.97	0.	0.
	10	1.53	1.12	0.42	0.	0.
	10	3.19	0.40	2.79	0.	0.
OCT	10	1.67	0.86	0.81	0.	0.
	10	1.27	0.	1.27	0.	0.
	11	2.91	0.	2.91	0.	0.
NOV	10	1.75	0.	1.75	0.	0.
	10	0.78	0.41	0.40	0.04	0.
	10	2.98	0.77	2.21	0.	0.
DEC	10	2.10	1.23	0.87	0.	0.
	10	1.84	1.16	0.68	0.	0.
	11	3.13	1.29	1.84	0.	0.
VOLUME (MCUM)		69.9	31.8	42.6	4.7	0.

**** WATER BALANCE STUDY AGAINST C.I. OF 250 % B
CICINTA IRRIGATION SCHEME

YEAR	HWLK	LWLK	HWLC	LWLC	QMQ2
1974	67.50	46.00	76.50	66.50	8.00

MON	DAYS	QN	QIR	SPS	Q4R	Q4S
JAN	10	6.23	0.	6.23	0.	0.
	10	3.46	1.07	2.38	0.	0.
	11	0.90	1.24	0.40	0.78	0.
FEB	10	2.75	1.27	1.48	0.	0.
	10	2.40	0.	2.40	0.	0.
	8	2.68	0.66	2.02	0.	0.
MAR	10	4.34	0.54	3.80	0.	0.
	10	1.77	1.39	0.40	0.02	0.
	11	2.12	1.33	0.79	0.	0.
APR	10	1.73	0.96	0.77	0.	0.
	10	3.27	1.40	1.87	0.	0.
	10	1.29	2.00	0.40	1.17	0.
MAY	10	2.51	2.06	0.45	0.	0.
	10	3.13	1.43	1.70	0.	0.
	11	1.40	2.09	0.40	1.15	0.
JUN	10	1.04	1.73	0.40	1.14	0.
	10	0.83	1.22	0.40	0.63	0.
	10	1.30	0.20	1.10	0.	0.
JUL	10	1.21	0.72	0.49	0.	0.
	10	1.60	1.77	0.40	0.61	0.
	11	0.81	1.87	0.40	1.54	0.
AUG	10	1.46	2.26	0.40	1.27	0.
	10	1.73	1.84	0.40	0.54	0.
	11	1.76	1.53	0.40	0.18	0.
SEP	10	3.15	0.84	2.30	0.	0.
	10	4.26	0.46	3.80	0.	0.
	10	2.64	0.50	2.14	0.	0.
OCT	10	2.36	0.74	1.62	0.	0.
	10	1.69	0.	1.69	0.	0.
	11	1.24	0.	1.24	0.	0.
NOV	10	0.75	0.	0.75	0.	0.
	10	2.25	0.41	1.84	0.	0.
	10	1.36	0.94	0.41	0.	0.
DEC	10	2.72	0.77	1.95	0.	0.
	10	1.20	1.72	0.40	0.96	0.
	11	0.95	1.64	0.40	1.15	0.
VOLUME (MCUM)		66.2	34.1	41.8	10.2	0.

Table J-6 WATER BALANCE STUDY AT CICINTA WEIR (2/4)

**** WATER BALANCE STUDY AGAINST C.I. OF 250 % B
CICINTA IRRIGATION SCHEME

YEAR	HWLK	LWLK	HWLC	LWLC	QNQ2
1975	67.50	46.00	76.50	66.50	8.00

MON	DAYS	QN	QIR	SP5	Q4R	Q4S
JAN	10	1.86	0.41	1.44	0.	0.
	10	1.61	0.89	0.72	0.	0.
	11	2.11	0.66	1.45	0.	0.
FEB	10	1.69	1.22	0.48	0.	0.
	10	4.82	0.09	4.74	0.	0.
	8	2.18	0.66	1.52	0.	0.
MAR	10	2.06	1.22	0.84	0.	0.
	10	1.40	1.27	0.40	0.28	0.
	11	2.28	1.20	1.07	0.	0.
APR	10	1.12	1.06	0.40	0.35	0.
	10	1.28	1.69	0.40	0.85	0.
	10	0.62	1.74	0.40	1.61	0.
MAY	10	0.77	2.12	0.40	1.84	0.
	10	1.05	2.29	0.40	1.73	0.
	11	1.97	2.15	0.40	0.60	0.
JUN	10	0.99	1.44	0.40	0.90	0.
	10	0.87	1.44	0.40	1.02	0.
	10	0.45	1.23	0.40	1.25	0.
JUL	10	0.64	1.37	0.40	1.19	0.
	10	1.21	1.47	0.40	0.70	0.
	11	1.50	2.10	0.40	1.06	0.
AUG	10	2.40	2.25	0.40	0.26	0.
	10	1.02	1.82	0.40	1.25	0.
	11	1.54	1.27	0.40	0.14	0.
SEP	10	2.29	0.92	1.38	0.	0.
	10	2.82	1.02	1.80	0.	0.
	10	2.27	0.93	1.34	0.	0.
OCT	10	1.09	0.80	0.40	0.11	0.
	10	1.15	0.	1.15	0.	0.
	11	1.80	0.	1.80	0.	0.
NOV	10	3.47	0.	3.47	0.	0.
	10	2.16	0.41	1.74	0.	0.
	10	1.44	0.99	0.45	0.	0.
DEC	10	3.00	1.17	1.83	0.	0.
	10	5.78	1.39	4.39	0.	0.
	11	2.21	0.36	1.85	0.	0.
VOLUME (MCUM)		58.6	36.0	35.2	13.2	0.

**** WATER BALANCE STUDY AGAINST C.I. OF 250 % B
CICINTA IRRIGATION SCHEME

YEAR	HWLK	LWLK	HWLC	LWLC	QNQ2
1976	67.50	46.00	76.50	66.50	8.00

MON	DAYS	QN	QIR	SP5	Q4R	Q4S
JAN	10	3.51	0.50	3.01	0.	0.
	10	6.14	0.41	5.73	0.	0.
	11	5.78	0.10	5.68	0.	0.
FEB	10	2.50	1.06	1.44	0.	0.
	10	1.04	1.03	0.40	0.41	0.
	9	1.90	0.21	1.68	0.	0.
MAR	10	3.57	0.47	3.10	0.	0.
	10	1.81	1.19	0.62	0.	0.
	11	1.76	1.46	0.40	0.10	0.
APR	10	1.14	1.52	0.40	0.82	0.
	10	1.71	1.17	0.54	0.	0.
	10	2.33	1.37	0.95	0.	0.
MAY	10	1.98	2.25	0.40	0.70	0.
	10	0.90	1.83	0.40	1.40	0.
	11	0.56	2.47	0.40	2.44	0.
JUN	10	1.12	1.73	0.40	1.07	0.
	10	0.62	1.29	0.40	1.12	0.
	10	0.32	1.26	0.40	1.41	0.
JUL	10	0.64	1.37	0.40	1.19	0.
	10	0.26	1.97	0.40	2.22	0.
	11	0.37	2.35	0.40	2.50	0.
AUG	10	0.42	1.87	0.40	1.95	0.
	10	0.31	1.66	0.40	1.84	0.
	11	0.58	1.40	0.40	1.28	-1.28
SEP	10	0.31	1.26	0.40	1.42	-1.42
	10	0.18	1.12	0.40	1.40	-1.40
	10	0.33	0.76	0.40	0.88	-0.88
OCT	10	1.01	0.67	0.40	0.07	0.
	10	1.06	0.	1.06	0.	0.
	11	0.38	0.	0.40	0.03	0.
NOV	10	0.68	0.	0.68	0.	0.
	10	2.36	0.41	1.95	0.	0.
	10	1.10	0.99	0.40	0.30	0.
DEC	10	0.67	1.39	0.40	1.18	0.
	10	1.27	0.83	0.44	0.	0.
	11	0.82	0.97	0.40	0.58	0.
VOLUME (MCUM)		45.2	35.6	31.7	23.3	-4.4

**** WATER BALANCE STUDY AGAINST C.I. OF 250 % B
CICINTA IRRIGATION SCHEME

YEAR	HWLK	LWLK	HWLC	LWLC	QNQ2
1977	67.50	46.00	76.50	66.50	8.00

MON	DAYS	QN	QIR	SP5	Q4R	Q4S
JAN	10	1.60	0.77	0.83	0.	0.
	10	1.91	0.19	1.73	0.	0.
	11	4.92	0.60	4.32	0.	0.
FEB	10	1.69	1.12	0.57	0.	0.
	10	2.20	0.26	1.94	0.	0.
	8	2.20	0.07	2.13	0.	0.
MAR	10	4.32	0.53	3.79	0.	0.
	10	1.47	1.20	0.40	0.14	0.
	11	2.71	1.44	1.27	0.	0.
APR	10	3.14	1.49	1.66	0.	0.
	10	2.42	1.34	1.07	0.	0.
	10	2.32	1.30	1.02	0.	0.
MAY	10	3.30	1.56	1.75	0.	0.
	10	2.88	2.29	0.60	0.	0.
	11	1.23	1.60	0.40	0.81	0.
JUN	10	1.62	0.36	1.26	0.	0.
	10	1.09	0.93	0.40	0.25	0.
	10	1.32	1.22	0.40	0.31	0.
JUL	10	0.81	1.53	0.40	1.18	0.
	10	0.36	1.97	0.40	2.12	0.
	11	0.47	2.15	0.40	2.19	0.
AUG	10	0.27	2.32	0.40	2.57	0.
	10	0.27	1.96	0.40	2.20	0.
	11	0.63	1.63	0.40	1.48	0.
SEP	10	0.18	1.20	0.40	1.49	0.
	10	0.39	0.90	0.40	0.95	0.
	10	0.27	0.96	0.40	1.15	0.
OCT	10	0.39	0.94	0.40	1.01	0.
	10	0.43	0.	0.43	0.	0.
	11	0.52	0.	0.52	0.	0.
NOV	10	0.67	0.	0.67	0.	0.
	10	0.39	0.41	0.40	0.45	0.
	10	0.44	0.97	0.40	0.98	0.
DEC	10	0.63	0.89	0.40	0.69	0.
	10	0.77	0.80	0.40	0.45	0.
	11	1.11	1.34	0.40	0.67	0.
VOLUME (MCUM)		45.0	33.8	28.9	18.7	0.

Table J-6 WATER BALANCE STUDY AT CICINTA WEIR (3/4)

**** WATER BALANCE STUDY AGAINST C.I. OF 250 % B
CICINTA IRRIGATION SCHEME

YEAR	HWLK	LWLK	HWLC	LWLC	QNQ2
1978	67.50	46.00	76.50	66.50	8.00

MON	DAYS	QN	QIR	SP5	Q4R	Q4S
JAN	10	1.31	1.00	0.40	0.10	0.
	10	2.59	1.13	1.46	0.	0.
	11	5.83	0.04	5.78	0.	0.
FEB	10	2.13	0.77	1.36	0.	0.
	10	0.93	1.42	0.40	0.94	0.
	8	1.87	0.03	1.84	0.	0.
MAR	10	2.57	1.04	1.52	0.	0.
	10	2.57	0.87	1.70	0.	0.
	11	2.23	1.20	1.03	0.	0.
APR	10	1.76	1.17	0.59	0.	0.
	10	0.80	1.72	0.40	1.39	0.
	10	2.12	1.16	0.96	0.	0.
MAY	10	2.07	2.15	0.40	0.50	0.
	10	1.08	2.13	0.40	1.52	0.
	11	0.72	2.47	0.40	2.27	0.
JUN	10	0.95	1.34	0.40	0.83	0.
	10	1.16	0.93	0.40	0.18	0.
	10	1.66	0.47	1.18	0.	0.
JUL	10	1.06	1.24	0.40	0.62	0.
	10	1.00	1.43	0.40	0.87	0.
	11	1.26	1.82	0.40	1.01	0.
AUG	10	1.50	2.10	0.40	1.06	0.
	10	1.69	1.12	0.58	0.	0.
	11	1.38	0.97	0.41	0.	0.
SEP	10	1.27	0.73	0.54	0.	0.
	10	0.95	0.67	0.40	0.13	0.
	10	1.70	0.83	0.87	0.	0.
OCT	10	1.11	0.77	0.40	0.07	0.
	10	1.21	0.	1.21	0.	0.
	11	1.93	0.	1.93	0.	0.
NOV	10	2.37	0.	2.37	0.	0.
	10	2.10	0.41	1.68	0.	0.
	10	0.69	0.96	0.40	0.70	0.
DEC	10	1.33	1.30	0.40	0.39	0.
	10	1.18	0.76	0.42	0.	0.
	11	2.40	0.99	1.41	0.	0.
VOLUME (MCUM)		53.3	32.7	31.1	11.1	0.

**** WATER BALANCE STUDY AGAINST C.I. OF 250 % B
CICINTA IRRIGATION SCHEME

YEAR	HWLK	LWLK	HWLC	LWLC	QNQ2
1979	67.50	46.00	76.50	66.50	8.00

MON	DAYS	QN	QIR	SP5	Q4R	Q4S
JAN	10	1.52	0.09	1.43	0.	0.
	10	3.15	0.	3.15	0.	0.
	11	2.54	0.93	1.61	0.	0.
FEB	10	2.94	1.27	1.67	0.	0.
	10	2.02	1.22	0.80	0.	0.
	8	3.40	0.04	3.35	0.	0.
MAR	10	2.46	0.64	1.82	0.	0.
	10	2.19	1.22	0.98	0.	0.
	11	2.10	1.50	0.60	0.	0.
APR	10	3.67	1.56	2.11	0.	0.
	10	2.50	1.36	1.14	0.	0.
	10	2.81	1.20	1.60	0.	0.
MAY	10	1.71	1.82	0.40	0.54	0.
	10	0.63	1.82	0.40	1.67	0.
	11	1.14	1.73	0.40	1.05	0.
JUN	10	1.23	1.67	0.40	0.89	0.
	10	0.65	1.26	0.40	1.06	0.
	10	0.32	1.26	0.40	1.40	0.
JUL	10	0.58	1.07	0.40	0.94	0.
	10	1.46	1.52	0.40	0.48	0.
	11	0.43	2.33	0.40	2.42	0.
AUG	10	0.40	1.99	0.40	2.09	0.
	10	0.65	1.54	0.40	1.36	0.
	11	0.40	1.27	0.40	1.34	0.
SEP	10	0.43	0.79	0.40	0.80	0.
	10	0.63	1.10	0.40	0.92	0.
	10	0.72	0.31	0.41	0.	0.
OCT	10	0.77	0.83	0.40	0.49	0.
	10	0.38	0.	0.40	0.02	0.
	11	0.66	0.	0.66	0.	0.
NOV	10	1.53	0.	1.53	0.	0.
	10	2.45	0.41	2.04	0.	0.
	10	1.30	0.97	0.40	0.08	0.
DEC	10	1.32	0.93	0.40	0.01	0.
	10	1.10	1.26	0.40	0.59	0.
	11	1.95	1.32	0.63	0.	0.
VOLUME (MCUM)		47.0	33.8	28.5	16.1	0.

**** WATER BALANCE STUDY AGAINST C.I. OF 250 % B
CICINTA IRRIGATION SCHEME

YEAR	HWLK	LWLK	HWLC	LWLC	QNQ2
1980	67.50	46.00	76.50	66.50	8.00

MON	DAYS	QN	QIR	SP5	Q4R	Q4S
JAN	10	2.25	0.86	1.39	0.	0.
	10	4.17	0.	4.17	0.	0.
	11	3.56	1.19	2.37	0.	0.
FEB	10	2.53	0.97	1.55	0.	0.
	10	2.80	0.	2.80	0.	0.
	9	1.57	0.19	1.38	0.	0.
MAR	10	1.40	1.04	0.40	0.04	0.
	10	1.31	1.22	0.40	0.32	0.
	11	0.92	1.29	0.40	0.80	0.
APR	10	2.01	1.57	0.43	0.	0.
	10	1.80	1.56	0.40	0.17	0.
	10	1.66	0.80	0.86	0.	0.
MAY	10	2.03	1.52	0.51	0.	0.
	10	1.46	2.15	0.40	1.14	0.
	11	1.43	1.80	0.40	0.81	0.
JUN	10	1.21	1.32	0.40	0.53	0.
	10	0.70	0.39	0.40	0.09	0.
	10	0.65	1.23	0.40	1.03	0.
JUL	10	0.69	1.34	0.40	1.11	0.
	10	1.07	1.83	0.40	1.22	0.
	11	1.02	1.62	0.40	1.05	0.
AUG	10	1.46	1.76	0.40	0.73	0.
	10	2.82	0.62	2.00	0.	0.
	11	0.62	1.63	0.40	1.48	0.
SEP	10	1.57	0.99	0.58	0.	0.
	10	1.90	1.02	0.89	0.	0.
	10	1.40	0.29	1.12	0.	0.
OCT	10	0.95	0.90	0.40	0.37	0.
	10	1.59	0.	1.59	0.	0.
	11	1.27	0.	1.27	0.	0.
NOV	10	1.55	0.	1.55	0.	0.
	10	2.00	0.41	1.58	0.	0.
	10	1.68	0.97	0.71	0.	0.
DEC	10	1.38	1.19	0.40	0.22	0.
	10	1.69	1.27	0.41	0.	0.
	11	3.61	0.51	3.10	0.	0.
VOLUME (MCUM)		54.2	31.5	32.3	10.0	0.

Table J-6 WATER BALANCE STUDY AT CICINTA WEIR (4/4)

**** WATER BALANCE STUDY AGAINST C.I. OF 250 % B
CICINTA IRRIGATION SCHEME

YEAR	HWLK	LWLK	HWLC	LWLC	QMQ2
1981	67.50	46.00	76.50	66.50	8.00

MON	DAYS	QN	QIR	SPS	Q4R	Q4S
JAN	10	2.70	0.44	2.25	0.	0.
	10	4.51	0.77	3.73	0.	0.
	11	3.24	0.39	2.86	0.	0.
FEB	10	2.64	0.77	1.87	0.	0.
	10	2.06	0.37	1.69	0.	0.
	8	2.23	0.49	1.74	0.	0.
MAR	10	1.95	0.86	1.09	0.	0.
	10	3.18	1.04	2.14	0.	0.
	11	2.64	1.56	1.08	0.	0.
APR	10	1.65	1.14	0.51	0.	0.
	10	2.12	1.47	0.64	0.	0.
	10	2.06	1.64	0.41	0.	0.
MAY	10	2.03	1.56	0.47	0.	0.
	10	3.17	1.93	1.24	0.	0.
	11	1.59	1.83	0.40	0.68	0.
JUN	10	2.54	1.67	0.87	0.	0.
	10	3.86	0.86	3.00	0.	0.
	10	1.77	1.04	0.72	0.	0.
JUL	10	1.00	1.33	0.40	0.76	0.
	10	2.26	1.49	0.77	0.	0.
	11	3.58	1.34	2.24	0.	0.
AUG	10	1.54	2.32	0.40	1.24	0.
	10	1.38	0.50	0.88	0.	0.
	11	1.96	1.34	0.62	0.	0.
SEP	10	2.39	1.10	1.29	0.	0.
	10	1.93	0.59	1.34	0.	0.
	10	1.58	0.59	0.99	0.	0.
OCT	10	1.75	0.61	1.13	0.	0.
	10	1.11	0.	1.11	0.	0.
	11	2.69	0.	2.69	0.	0.
NOV	10	1.30	0.	1.30	0.	0.
	10	4.84	0.41	4.42	0.	0.
	10	1.67	0.92	0.75	0.	0.
DEC	10	1.68	1.23	0.45	0.	0.
	10	1.40	1.66	0.40	0.69	0.
	11	3.56	0.36	3.20	0.	0.
VOLUME (MCUM)		73.5	31.3	45.0	3.0	0.

**** WATER BALANCE STUDY AGAINST C.I. OF 250 % B
CICINTA IRRIGATION SCHEME

YEAR	HWLK	LWLK	HWLC	LWLC	QMQ2
1982	67.50	46.00	76.50	66.50	8.00

MON	DAYS	QN	QIR	SPS	Q4R	Q4S
JAN	10	3.99	0.56	3.43	0.	0.
	10	5.58	0.	5.58	0.	0.
	11	3.45	0.72	2.73	0.	0.
FEB	10	1.68	0.41	1.26	0.	0.
	10	1.76	0.93	0.83	0.	0.
	8	1.29	0.39	0.90	0.	0.
MAR	10	1.25	1.02	0.40	0.18	0.
	10	0.74	1.10	0.40	0.80	0.
	11	0.51	1.32	0.40	1.27	0.
APR	10	1.10	1.40	0.40	0.74	0.
	10	2.03	1.57	0.46	0.	0.
	10	1.48	1.13	0.40	0.06	0.
MAY	10	1.46	2.19	0.40	1.19	0.
	10	1.09	2.49	0.40	1.90	0.
	11	0.75	0.84	0.40	0.52	0.
JUN	10	0.44	1.34	0.40	1.37	0.
	10	0.67	1.44	0.40	1.24	0.
	10	0.30	1.23	0.40	1.40	0.
JUL	10	0.24	1.53	0.40	1.78	0.
	10	0.16	1.69	0.40	2.03	0.
	11	0.72	1.93	0.40	1.69	0.
AUG	10	0.24	2.19	0.40	2.48	0.
	10	0.14	1.93	0.40	2.31	0.
	11	0.11	1.63	0.40	2.02	-2.02
SEP	10	0.07	1.26	0.40	1.67	-1.67
	10	0.14	1.12	0.40	1.45	-1.45
	10	0.11	0.96	0.40	1.31	-1.31
OCT	10	0.10	1.12	0.40	1.49	-1.49
	10	0.30	0.	0.40	0.10	0.
	11	0.44	0.	0.44	0.	0.
NOV	10	2.16	0.	2.16	0.	0.
	10	1.26	0.41	0.85	0.	0.
	10	1.21	0.90	0.40	0.10	0.
DEC	10	0.75	1.19	0.40	0.88	0.
	10	2.23	1.60	0.63	0.	0.
	11	2.59	0.72	1.88	0.	0.
VOLUME (MCUM)		37.3	35.3	27.0	26.4	-7.0

**** WATER BALANCE STUDY AGAINST C.I. OF 250 % B
CICINTA IRRIGATION SCHEME

YEAR	HWLK	LWLK	HWLC	LWLC	QMQ2
1983	67.50	46.00	76.50	66.50	8.00

MON	DAYS	QN	QIR	SPS	Q4R	Q4S
JAN	10	2.44	0.53	1.91	0.	0.
	10	3.01	1.39	1.63	0.	0.
	11	1.64	0.14	1.50	0.	0.
FEB	10	1.59	0.89	0.70	0.	0.
	10	2.08	1.04	1.04	0.	0.
	8	1.74	0.21	1.53	0.	0.
MAR	10	1.82	0.90	0.92	0.	0.
	10	1.44	1.39	0.40	0.37	0.
	11	1.67	1.16	0.51	0.	0.
APR	10	1.91	1.32	0.60	0.	0.
	10	1.19	1.56	0.40	0.81	0.
	10	1.27	0.80	0.47	0.	0.
MAY	10	1.65	2.19	0.40	0.98	0.
	10	1.88	1.82	0.40	0.36	0.
	11	2.24	2.33	0.40	0.52	0.
JUN	10	1.35	0.93	0.42	0.	0.
	10	1.38	1.46	0.40	0.50	0.
	10	0.57	1.23	0.40	1.11	0.
JUL	10	0.71	0.83	0.40	0.54	0.
	10	0.61	1.46	0.40	1.31	0.
	11	1.01	2.23	0.40	1.71	0.
AUG	10	0.67	2.22	0.40	2.04	0.
	10	0.74	1.77	0.40	1.51	0.
	11	0.38	1.63	0.40	1.74	0.
SEP	10	0.48	1.24	0.40	1.22	0.
	10	0.60	1.12	0.40	0.96	0.
	10	0.75	0.94	0.40	0.63	0.
OCT	10	0.72	0.89	0.40	0.60	0.
	10	1.11	0.	1.11	0.	0.
	11	1.62	0.	1.62	0.	0.
NOV	10	2.31	0.	2.31	0.	0.
	10	1.77	0.41	1.36	0.	0.
	10	3.97	0.84	3.12	0.	0.
DEC	10	2.92	1.24	1.67	0.	0.
	10	1.95	1.34	0.61	0.	0.
	11	2.17	0.90	1.27	0.	0.
VOLUME (MCUM)		48.5	35.6	27.1	15.0	0.

Table J-7 SUMMARY OF WATER BALANCE STUDY (1/2)

**** WATER BALANCE STUDY AGAINST C.I. OF 250 % BY PROSIDA ****
KARIAN RESERVOIR ANNUAL VOLUME(MCUM)

HWLK	LWLK	HWLC	LWLC	QMQ2	VHWLK	VHWLC
67.50	46.00	76.50	66.50	8.00	219.3	62.0

YEAR	QK	QN	QE	QIR	QIK	QIS	Q1R	Q1	Q1S	Q2R	Q2S	D2	D1R	D1	SP2	SP1	MINH1	MINS1
1972	745.4	1814.9	11.7	639.6	201.8	-76.8	407.5	245.1	-130.5	149.5	-42.4	2.2	14.2	38.6	573.3	2003.6	46.00	0.
1973	1146.9	2792.5	16.7	535.0	5.6	0.	119.2	29.2	0.	79.9	0.	1.1	1.7	47.0	829.2	3061.5	67.26	215.6
1974	1087.8	2648.5	17.2	572.1	8.8	0.	122.5	10.7	0.	97.0	0.	0.1	1.7	47.0	962.8	2997.4	67.10	213.1
1975	961.9	2342.0	17.1	605.6	53.6	0.	161.6	78.6	0.	137.2	0.	1.4	8.7	47.0	729.1	2484.8	65.74	192.1
1976	741.6	1805.6	12.5	602.3	219.3	-22.2	340.9	270.0	-34.2	149.1	-18.9	3.0	17.7	43.0	480.1	1901.4	46.00	0.
1977	738.4	1797.8	12.5	571.1	202.6	0.	304.3	255.8	0.	125.9	-10.7	2.9	19.1	47.0	411.1	1816.6	46.00	0.
1978	874.9	2130.2	16.4	550.6	30.5	0.	143.7	62.2	0.	139.5	0.	1.5	3.3	47.0	446.3	2030.4	66.03	196.5
1979	771.1	1877.6	15.3	569.0	132.2	0.	232.6	191.6	0.	130.9	0.	3.2	16.0	47.0	453.0	1882.5	58.11	93.2
1980	890.6	2168.6	17.2	530.0	21.4	0.	132.5	29.9	0.	107.3	0.	0.6	4.9	47.2	716.6	2330.5	66.96	210.9
1981	1206.2	2936.8	17.2	527.0	0.	0.	115.3	0.	0.	60.8	0.	0.	0.	47.0	1128.1	3486.4	67.50	219.3
1982	611.8	1489.5	12.3	594.0	197.2	-83.8	416.8	268.2	-132.8	163.8	-35.3	2.8	17.5	39.9	314.7	1491.6	46.00	0.
1983	795.9	1937.9	16.1	599.0	88.6	0.	191.9	137.9	0.	147.9	0.	2.6	12.8	47.0	362.0	1793.6	61.40	131.1

**** WATER BALANCE STUDY AGAINST C.I. OF 250 % BY PROSIDA ****
CILAWANG RESERVOIR ANNUAL VOLUME(MCUM)

HWLK	LWLK	HWLC	LWLC	QMQ2	VHWLK	VHWLC
67.50	46.00	76.50	66.50	8.00	219.25	62.00

YEAR	QC	QN	QE	QIR	QIC	QIS	Q2R	Q2S	Q3R	Q3	Q3S	Q4R	Q4S	SP3	SP4	MINH2	MINS2
1972	200.0	40.3	6.9	273.7	79.9	-38.0	149.5	-42.4	192.0	106.9	-50.2	25.1	-8.5	121.4	129.4	66.50	0.
1973	307.8	62.1	9.2	228.7	41.1	0.	79.9	0.	151.0	71.3	0.	4.7	0.	170.0	146.9	75.83	55.6
1974	291.9	58.9	9.2	245.6	59.7	0.	97.0	0.	155.2	115.8	0.	10.2	0.	166.7	182.1	74.97	48.6
1975	258.1	52.0	8.8	259.3	88.0	0.	137.2	0.	135.8	110.6	-0.0	13.2	0.	115.4	143.4	72.84	32.9
1976	199.0	40.1	6.9	256.4	90.3	-19.9	149.1	-18.9	152.3	114.4	-24.8	23.3	-4.4	98.7	134.8	66.50	0.
1977	198.1	39.9	7.3	243.3	72.5	0.	125.9	-10.7	148.7	109.7	0.	18.7	0.	78.3	88.5	67.07	2.0
1978	234.8	47.3	8.8	235.8	77.4	0.	139.5	0.	116.2	92.8	0.	11.1	0.	65.0	97.1	73.89	40.2
1979	206.9	41.7	8.3	243.5	88.2	0.	130.9	0.	133.7	91.4	0.	16.1	0.	96.0	105.5	71.32	23.0
1980	239.0	48.2	9.4	226.6	63.8	0.	107.3	0.	135.0	99.8	0.	10.0	0.	114.3	132.7	75.17	50.3
1981	323.7	65.3	9.5	225.4	81.7	0.	60.8	0.	159.6	97.0	0.	3.0	0.	213.2	202.9	75.29	51.3
1982	164.2	33.1	7.1	254.4	73.1	-33.0	163.8	-35.3	156.8	99.3	-43.7	26.4	-7.0	69.8	98.0	66.50	-0.0
1983	213.6	43.1	8.7	256.1	95.8	0.	147.9	0.	127.0	108.3	0.	15.0	0.	49.8	80.2	72.74	32.2