(d) Water demand for Cilegon industrial estate

The unit industrial water demand of Cilegon Industrial Estate is considered to be constant to 1.25 lit/sec/ha on the assumption that the common machinery industries are to be introduced and the unit industrial water demand by each industrial category to be similar to that in Japan.

The water demands thus estimated and the water supply from the Cidanau river through existing pipeline are compared as follows:

(Unit: lit/sec)

	1985	1990	1995	2000
- Raw water supply from the Cidanan	2,500	2,500	2,500	2,500
- Raw water demand				
• PT. Krakatau Steel Works	594	1,340	1,709	2,530
• Anyer-Merak Area	8	9	9	10
• Suralaya Power Station	35	46	46	58
• Cilegon Industrial Estate	122	190	580	831
• Others	27	55	82	123
Total	786	1,640	2,426	3,522
- Balance	+1,714	+860	+74	-1,052

4.3.4 Flood Control

(1) Requirement for flood control

Three main tributaries, the Upper Ciujung, the Ciberang and the Cisimeut rivers, join all together at Rangkasbitung in the upstream Ciujung basin. Their catchments total to 1,383 km^2 or correspond to about 75% of the whole Ciujung basin area. Thus concentrated flood outflows have afflicted the area in and around Rangkasbitung with frequent damage.

From Rangkasbitung to the Java Sea for about 54 km, the Ciujung river flows down with a gentle gradient embracing extensive flat land on both river banks. Accordingly the lower reaches have experienced almost routine flooding due to poor flow capacity of the river.

In the preceding Master Plan Study, firstly the whole section of the Ciujung river from the river mouth to Rangkasbitung was subject to the study of river improvement, with a design scale of 50-year return period as the overall master plan level and on several alternative plans in combination with flood regulation by proposed dams. However, the study revealed that every alternative plan would require an excessively heavy investment so far as the present socio-economic level in the basin was concerned.

Whereas, after the flood control and drainage study for several years on the lower Ciujung river, the section from the river mouth to Kragilan has recently been improved by PROSIDA with the design flood discharge of 1,100 m^3/sec. However, the section from Kragilan to the Pamarayan weir has been left unimproved because the embankments of irrigation canals on both river banks form the boundaries of flooded area stretching along the Ciujung river.

Accordingly, considering the above and the pressing requirement for flood mitigation in and around Rangkasbitung, the first stage plan was introduced with a lesser scale of 10-year return period and in a shortened river section focussing on Rangkasbitung. The section from the Pamarayan weir to Rangkasbitung was subject to the river improvement study, taking account of its improvement effect of lowering the flood water level at Rangkasbitung by dredging and shortcuts.

After the comparative study on four alternative plans of river improvement in combination with proposed upstream dams, the first stage plan F-2, which consists of the flood regulation by Karian dam and the river improvement of 1/10 design scale in the upstream section from the Pamarayan weir, was proposed as the flood control plan in the Master Plan.

Thus, in the present study, a flood control plan will be formulated mainly focussing on the flood damage mitigation in and around Rangkasbitung and also considering the good correspondence with the design flood discharge of the lower Ciujung reaches.

(2) Floods in the past

According to available data at Regional Offices DPUP, the Ciujung river has experienced flood events in January 1977, February 1978, January 1979, January and November 1981, November 1983 and April 1984 during the period from 1977 through 1984. Among them the flood in November 1981 is reported to be the largest.

(3) Flood damage

The present flow capacity of the Ciujung river is estimated mostly at 400 m^3/sec to 500 m^3/sec, by means of non-uniform flow calculation, in the objective river section from the Pamarayan weir to Rangkasbitung as shown in Fig. 4-1. The non-damage flood discharge around Rangkasbitung is estimated at about 500 m^3/sec.

A flood damage survey around the objective river section was conducted by the Study Team assisted by P3SA staff. The result of the survey was as follows.

The flood in November 1981 inundated an area of 1,250 ha on the section from the Pamarayan weir to Rangkasbitung, of which 1,180 ha was farmland (Ref. Fig. 4-2). The number of inundated houses and buildings was about 2,500. The flood damage is estimated at about Rp. 7.5 billion at the 1984 current price.

Whereas the flood in November 1983 inundated an area of 505 ha on the same section. The number of inundated houses and buildings was about 1,050. The flood damage is estimated at about Rp. 2.2 billion at the 1984 current price.

The flood discharge in November 1981 and November 1983 are estimated at 1,150 m^3/sec and 670 m^3/sec respectively, based on flood marks of each flood event and the discharge rating curve at Rangkasbitung gauging station (Ref. Fig. 4-3).

Under the present river condition with natural flooding, above-mentioned flood discharges will correspond to the probability of about 1/8 and about 1/2 respectively.

4.3.5 Water Balance

Water balance study at both the Karian and Cilawang dam sites is made on the basis of the following conditions.

(1) The 10-day mean discharge at the selected dam sites, i.e. Karian and Cilawang, and at the weir sites, i.e. Pamarayan, Gadeg and Cicinta is estimated by analysing the discharge record observed at Rangkasbitung for 12 years from 1972 to 1983 (Ref. Appendix-B).

(2) Evaporation loss from the reservoir surface is estimated to be 70% of the mean pan-evaporation observed at Cikadu (1978 - 1983).

Month	Oversed pan record (mm/day)	Evaporation loss from reservoir (mm/day)
Jan.	2.8	2.0
Feb.	3.6	2.5
Mar.	4.0	2.8
Apr.	3.8	2.7
May	4.4	3.1
Jun.	4.7	3.3
Jul.	4.6	3.2
Aug.	4.9	3.4
Sep.	4.9	3.4
Oct.	4.8	3.4
Nov.	4.3	3.0
Dec.	3.8	2.7

(3) Diversion efficiency from the Karian reservoir is estimated to be 90% at the Pamarayan intake weir, and 95% at the Gadeg intake weir, judging from the distance between the reservoir and each intake weir. In a same manner, the diversion efficiency from the Cilawang reservoir is estimated to be 95% at both the Gadeg intake weir and the Cicinta intake weir.

(4) River maintenance flow at both the Karian and the Cilawang dam sites, and the intake weir sites at Pamarayan, Gadeg and Cicinta is estimated from the discharge record observed at Rangkasbitung and Kragilan. The adopted discharge is the 10-year average drought runoff of 97% dependability.

Location	Catchment Area (km^2)	River Maintenance Flow (m^3/sec)
Pamarayan	1,451	9.7
Karian	288	3.5
Cilawang	93	1.1
Gadeg	117	1.4
Cicinta	31	0.4

(5) Municipal and industrial water demand at the target years of 2000 is estimated from the data collected this time. Water demand for Cilegon including PT. Krakatau Steel and other industrial estates, and for 17 I.K.K. are estimated to be 1,145 m^3/sec 0.48 m^3/sec respectively. Municipal water demand at Rangkasbitung town is estimated to be 0.14 m^3/sec. Such M & I water is released from the Karian reservoir together with irrigation water for Ciujung irrigation area.

(6) Irrigation water demand is estimated for the cropping intensity, 250% for each Ciujung irrigation area, K-C-C irrigation area and Cicinta irrigation area. Details are shown in Subsection 4.3.2 and Tables G-1, G-2 and G-3 of Appendix-G.

(7) Required effective storage capacity is defined as the storage capacity which enables full irrigation for each schemes unless otherwise low water flows exceeding 5-year return period occur.

Water balance study is made to find required storage capacities of two reservoirs with two trans-basin tunnels from the Karian reservoir to the Cibeureum river and from the Cilawang reservoir to the Cicinta river, which supplement the irrigation water supply for the K-C-C irrigation area and the Cicinta irrigation area. Under the conditions, storage capacity of the reservoirs and maximum tunnel discharge are selected as parameters for the case study. As a result, it is calculated the following four cases can satisfy the required conditions (Ref. Appendix-J).

Case No.	Max. tunnel Discharge (m^3/sec)	Karian Reservoir		Cilawang Rservoir	
		HWL (El.m)	Storage ($10^6 m^3$)	HWL (El.m)	Storage ($10^6 m^3$)
1	6.0	67.0	211.5	77.0	67.0
2	8.0	67.5	219.0	76.5	62.0
3	10.0	68.5	235.7	74.0	41.0
4	12.0	69.0	244.3	73.5	37.5

As an extreme case, it is studied that the tunnel discharge from the Karian reservoir to the Cibeureum river is omitted. It comes from the fact that the bigger reservoir capacity at the Cilawang dam is conveivable judging from the newly obtained topographical maps is scale of 1 : 5,000. The study reveals that the Cilawang reservoir itself cannot supply required irrigation water for both the K-C-C irrigation area and the Cicinta irrigation area without receiving supplemental water from the Karian reservoir through the Ciuyah trans-basin tunnel.

4.3.6 Hydroelectric Power Potential

The possibility of hydroelectric power generation at the Karian dam site is studied referring to the results of water balance study described in Subsection 4.3.5. As was already discussed in the Master Plan Report, it was deemed the Karian dam site has some hydroelectric power potentials even though its maximum output and energy generated are rather small (Max. Output: 2,800 kW, Energy: 19,000 MWh/yr).

Without harming the water releasing pattern for irrigation and M & I water use, optimum reservoir operation method is studied under the following conditions:

Normal high water level (El.m)	:	67.50
Low water level (El.m)	:	49.00
Rated water level (El.m)	:	61.00
Tail water level (El.m)	:	18.00
Combined efficiency of turbine and generator	:	0.83
Max. plant discharge	:	6.0 m^3/sec to 18 m^3/sec at 2.0 m^3/sec interval

The power is calculated by the following equation:

$$P = g \times Q \times He \times \eta$$

where, P : power generated (kW)

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

Q : plant discharge (m^3/sec)

He : effective head (m)

η : combined efficiency of turbine and generator (0.83)

The results of reservoir operation study for 12 years from 1972 to 1983 is summarized below. The case of installed capacity more than 5,200 kW with maximum plant discharge 16.0 m^3/sec causes a water shortage for the concerned irrigation and M & I water use. Then, the case with the installed capacity more than 5,200 kW is not adoptable as a base load basis.

Dependability of Power Generation

Max. plant discharge (m^3/sec)	Installed capacity (MW)	Power output duration			
		75%	90%	92.5%	95%
6.00	1.95	1.95	1.31	0.0	0.0
8.00	2.60	2.60	1.74	0.0	0.0
10.00	3.25	3.25	2.18	0.0	0.0
12.00	3.90	3.90	2.62	0.0	0.0
14.00	4.55	4.55	2.99	0.0	0.0
16.00	5.20	5.10	3.22	0.0	0.0
18.00	5.86	5.56	0.0	0.0	0.0

Annual Energy

(Unit: GWh)

	Installed capacity and Max. plant discharge						
P (kW)	1.95	2.60	3.25	3.90	4.55	5.20	5.86
Q (m^3/sec)	6.00	8.00	10.00	12.00	14.00	16.00	18.00
1972	10.28	13.71	17.14	20.57	23.99	27.42	30.85
1973	16.81	22.40	27.99	33.57	39.13	44.68	50.20
1974	17.10	22.80	28.49	34.19	39.89	45.59	51.29
1975	17.10	22.80	28.49	34.19	39.89	45.59	51.29
1976	13.41	17.79	21.18	25.27	29.31	33.30	36.58
1977	12.06	16.01	19.95	23.82	27.60	31.23	34.08
1978	16.31	21.74	27.16	32.58	37.99	43.37	48.71
1979	16.72	22.12	27.17	31.94	36.37	39.93	43.27
1980	17.14	22.86	28.57	34.19	39.72	45.21	50.64
1981	17.10	22.80	28.49	34.19	39.89	45.59	51.29
1982	12.42	16.51	20.58	24.62	28.60	32.39	35.23
1983	17.06	22.70	28.29	33.81	39.16	43.50	44.95
Ave.	15.29	20.35	25.29	30.25	35.13	39.82	44.03

As is seen in the above tables, maximum output as a based load basis is rather small ranging 1,950 kW to 4,550 kW. To increase maximum output, peaking operation is considerable. In this case, however, it is required to construct a afterbay to regulated the discharge. Anyway, it is concluded that the Karian dam has a hydroelectric power potential which enables the electrification of the towns and villages existing nearby.

4.4 Development Plan

4.4.1 Agricultural Development

(1) Basic Concept of Agricultural Development

Agricultural development plans are formulated for the study area taking the economic utilization of natural resources such as lands and water and of human resources into consideration in order to improve the living standard of the people in the study area, to supply the staple food for the consumers and to save the foreign exchange spent for imported rice.

The limitation of the full utilization of agricultural potential of land due to the shortage of irrigation water is observed in the Ciujung irrigation scheme, K-C-C area and Cicinta irrigation scheme. In Ciujung and Cicinta irrigation schemes, as many as 34% (8,590 ha) of paddy fields are left fallow in the dry season because of lack of irrigation water in spite of plentiful water resources. In K-C-C area, 8,960 ha (87%) out of potential irrigable area of 10,300 ha are not planted in the dry season, also due to lack of water. Unreliable irrigation water supply in the rainy season and the shortage of the water in the dry season restricts rice yield resulting in low yield, 3.7 ton/ha in with-irrigation, and 2.7 ton/ha without-irrigation conditions. Unreliable water supply constrains the increase in the amount of fertilizer application. At present, no more than 124 kg/ha of urea is given to the paddy.

A large amount of red onion, about 9,000 ton, is imported to Serang from outside majorly from Brebes in Central Java, even though there is some potential to produce onion in the Project area.

The high unemployment rate, i.e. 17% of the economically active population in the area shows a waste of human resources and social unstability.

In the above-mentioned context, the following principles for agricultural development plans are formulated.

i) Introduction of year-round irrigated rice cultivation in K-C-C area, Ciujung and Cicinta irrigation schemes.

ii) Introduction of onion cultivationto K-C-C and Cicinta areas which have more suitable soil condition having better drain-ability than Ciujung area.

iii) Increase in cropping intensity up to 250% from the 110% to 170% in present conditions.

iv) Increase in amount of fertilizer applications to paddy production from 124 kg to 200 kg urea per ha and from 73 kg to 100 kg T.S.P. per ha.

v) Intensification of agricultural support services such as agricultural extension, agricultural credit, and supply of improved seeds.

(2) Proposed land use

In line with the above-mentioned concept, land irrigable by gravity is selected from the K-C-C area to the possible maximum extent for irrigated rice cultivation leaving existing residential areas, orchards and area for infrastructure. The land use of Ciujung (24,200 ha) and Cicinta (1,430 ha) irrigation schemes are not changed. The difference in land use in K-C-C area by the Project is summarized in the following table.

Land Use Change in K-C-C Area by the Project

(Unit: ha)

Land Use	Without-Project	With-Project
Paddy field		
Irrigated	240	10,300
Rainfed	10,260	-
Upland	530	-
Grasslands	140	-
Roads, Canal, Paddy Field Bands	950	1,820
Total:	12,120	12,120

(3) Proposed cropping patterns

The future cropping patterns are formulated in due consideration of the following conditions.

(a) Cropping patterns should assure farmers and Project of as larger and more stable benefit as possible.

(b) Farming labour requirement should be within the limit of available labour forces.

(c) Cropping patterns should be acceptable to farmers as well as government authorities.

As paddy is the most suitable crop, economically and physically to irrigation farming in lawlands where drainage is much restricted, and BUPATI recommends paddy or onion growing in areas where irrigation water is available and farmers prefer paddy growing where irrigable, paddy is introduced as much as possible leaving 10% of areas for palawija or onion. The ten percents for palawija in Ciujung area is nearly the existing portion allocated to palawija crops in paddy fields. The canal drainage period is set for canal maintenance from middle of October to middle of November. This period is same as that of Ciujung irrigation scheme. A cropping intensity of 250% is proposed in due consideration of BUPATI recommendation in which 250% intensity is proposed where irrigable, and of introduction of locally improved late growing varieties which limit higher intensity.

The proposed cropping pattern is given in Fig. 4-4. The water requirement in a canal drainage period is met by supplying water stored in paddy fields in advance of canal drainage.

(4) Proposed farming practices

The present farming practices for the paddy cultivation in the Project area have already reached to the satisfactory technical level except in the amounts of dosage of fertilizers. With the year-round irrigation water supplied by the Project, the amounts of fertilizers to be applied can be increased with less risk to 200 kg/ha for urea, 100 kg/ha for T.S.P. and 50 kg/ha for potassium chloride. With the increase in fertilizer dosage, pest and disease controls must be intensified. Insecticides and rodenticide have to be applied at a rate of 2 litres/ha and 0.2 kg/ha respectively. Because most of the irrigated areas in the beneficial areas are now under the World Bank Project, the technical level of the farming in without-project condition is anticipated as that of with-project condition. No major improvements in farming is anticipated for rainfed paddy growing. The farming labour balance study is made for the most labour intensive pattern (250% cropping intensity in K-C-C area) to check the adaptability of this pattern to the present labour availability. As illustrated in Fig. E-3 in Appendix-E, the pattern of 250% cropping intensity is adaptable in terms of farm labour requirement. The less labour intensive cropping patterns can of course be adaptable from viewpoints of farm family labour requirement.

The draft animal labour requirements is estimated at 45 animal-day/ha for the land preparation. The carabao population density is calculated at 1.1 head/ha of paddy field for 14 related Kecamatans. Therefore the proposed 2 months for land preparation will be enough in terms of animal labour availability.

(5) Anticipated crop production

As stated in preceding sections with the introduction of irrigation water supplied by the Project, farmers can diminish the dependence on the unreliable rainfall or river flow for paddy growing and can increase the farm inputs to the optimum level with less risk. The anticipated paddy yields are estimated at 5.0 ton/ha for both wet and dry seasons in full development stage of the Project. This unit yield corresponds to 75% of the yield attained in the demonstration fields of the agricultural extension offices. The unit yield of paddy in without-project condition is estimated at 5.0 ton/ha for irrigated paddy and 2.9 ton/ha for rainfed paddy. The unit yield of palawija crops is expected to increase by 15% with irrigation. Groundnut yield, for example, is anticipated at 0.87 ton/ha at the full development stage of the Project. No major improvement in unit yield is expected for palawija crop irrigated in without-project condition. Onion yield is expected to increase to 8.0 ton/ha by doubling the planting density. The summary of change in unit yields of crops are shown below.

Change in Unit Yields

(Unit: ton/ha)

Crops	Present	Future	
		Without-Project	With-Project
Irrigated Paddy	3.7	5.0	5.0
Rainfed Paddy	2.7	2.9	-
Onion	4.6	5.0	8.0
Irrigated Palawija Crops	0.84	0.87	0.87
Rainfed Palawija Crops	0.73	0.76	-

Remark: Yield of palawija crops is estimated in terms of groundnuts

Following the proposed land use, and the cropping patterns, land use, cropping ratio, planted area, and crop production in the future for each area are summarized in Table 4-1.

Paddy production of 431,150 tons is expected to be produced annually by the Project with the incremental production of 193,260 tons compared with without-project condition. Onion production is also expected to be increased by 9,360 tons annually, which correspond to imported amounts from outside of West Java to Serang. Palawija crop production will decrease by 1,350 tons annually, but this amount might be covered by growing these crops in unirrigable areas in K-C-C areas.

(6) Marketing of agricultural products

Indonesia has not been self-sufficient in rice. In 1983, 1,169 thousands tons of rice was imported as shown below.

Rice Import by Indonesia

(x 1,000 tons)

Year	1974	1975	1976	1977	1978
Volume	1,132.1	692.6	1,301.2	1,973.4	1,841.6

Year	1979	1980	1981	1982	1983
Volume	1,922.0	2,011.7	538.3	309.6	1,168.8

The import would continue so long as the high growth rates of population and income per-capita prevails. Surplus paddy production in the net beneficial area in 1997 when the Project will be at the full development stage is estimated at about 331,500 tons subtracting self-consumption, feed, waste and seeds from the total production of 431,150 tons. This amount corresponds to only 19% of the rice imported in 1983. In consideration of population and per-capita consumption increases, the surplus rice could be consumed in Java Island where rice is most deficient. Onion of 9,360 tons/year produced by the Project at the full development stage could substitute onion of about 9,000 tons brought in to Serang from Central Java. Area allocated to palawija crops in Ciujung area almost corresponds to the existing allocation of 11%. The existing demand for palawija crops in K-C-C area, 6% of the area, will be filled by palawija crop planted in non-irrigable areas.

For the financial and economic analysis of the Project, prices of agricultural products and inputs are determined. As to the financial analysis, prices are valued at 1984 constant market prices. The economic prices of rice and fertilizers are derived applying economic parity prices of imported ones. These are valued at Rp. 218,360/ton for rice, Rp. 341,500/ton for urea, Rp. 263,800/ton for TSP and Rp. 177,700/ton for Kcl. Bases of the calculation are shown in Tables 4-2 and 4-3. Economic labour charge is valued at 60% (Rp. 1,200/man-day) of current wage. Other economic prices are valued at local market prices.

(7) Agricultural support services

Agricultural support services such as agricultural extension including agricultural research, agricultural credit, agricultural cooperative and transportation of agricultural produce and input are indispensable for the success of the Project. The present agricultural package programs, BIMAS/INMAS programs for example, have showed outstanding success providing irrigated farmers with fertilizers, insecticides and improved high-yielding seeds through credit. The present agricultural development plan will attain the target crop yields with the recommended farming practices as long as activities of the present agricultural support services will be kept alive in the future. However, there are several points to be improved to accelerate further development of the Project.

(a) The present coverage of 2,000 farm households or 1,200 ha of farm land by an extension worker (PPL) is too large. The desirable areal coverage should be 600 - 800 ha per an extension worker. A number of necessary additional extension workers for the Project is estimated at 30 persons.

(b) The existing transportation means for an extension worker is very limited. About 15% of the extension workers use motorcycles. Every extension worker should be equipped with a motorcycle through Government credit.

(c) Farmers in the study area have not been well organized into groups such as Kotompok Tani through which extension services have been provided to farmers. All the beneficial farmers should be organized into the groups.

(d) Technical knowledge on crop husbandry of an extension worker (PPL) is not sufficient as in the case of Kcl application. The extension office of Kab. Serang should make some manuals on crop husbandry for PPLs.

(8) Irrigation benefit

Financial crop production costs for paddy, palawija and onion are estimated based on the recommended or projected farming practices for future with- and without-project conditions. For economic analysis, economic crop production costs are also calculated excluding tax and interests from the financial costs. Financial and economic prices are applied in the financial and economic cost estimations. The total costs are summarized in the following table.

Total Production Costs

(Unit: Rp./ha)

	Financial		Economic	
	Without-Project	With-Project	Without-Project	With-Project
Paddy				
Irrigated	448,260	448,260	358,380	358,380
Rainfed	385,990	-	275,040	-
Palawija				
Irrigated	299,900	299,900	223,490	223,490
Rainfed	299,900	-	223,490	-
Onion				
Irrigaged	-	1,545,580	-	1,390,420

Remark: Palawija is represented by groundnuts

Details of the financial and economic production costs are shown in Tables 4-3 to 4-9. Irrigation benefits of the Project are derived majorly from the increase in crop production due to the irrigation water supply by the dams. The benefits are defined as a difference in net income between with-project and without-project conditions of the total concerned area of 37,750 ha; 24,200 ha for Ciujung area, 1,430 ha for Cicinta area and 12,120 ha for K-C-C area. The construction of the Project facilities will be started in 1986 and be completed in 1993. In 1997, after 6 years of a built-up period, crop production will attain the target yields. The irrigation benefit at the full development stage is estimated at Rp. 7,320 millions applying financial prices and Rp. 33,610 millions applying economic prices. Detailed calculation basis of the benefits are presented in Tables 4-10 and 4-11. The Project must secure attractive benefits for farmers involved. Economic viability of the Project from farmer's viewpoint is evaluated based on the typical farm budgets. Most of farmers benefited by the Project are paddy farmers, whose landholding is estimated at 0.6 ha on an average. As irrigated paddy fields is a predominant land use in the beneficial area, an irrigated farm is selected as a typical farm. Based on the present and future cropping patterns the following farm budget is envisaged for the typical farm. The incremental income of the typical farm is estimated at Rp. 160,400/year. Incremental income of other type of farm is larger than that of this typical farm because the typical farm has the least opportunity to increase farm income, already having irrigated fields.

Farm Budget of A Typical Farm (0.6 ha)

		Without-Project		With-Project	
		Paddy Irrigated	Upland Crops Irrigated	Paddy Irrigated	Upland Crops Irrigated
A.	Cropping Ratio (%)	162	11	240	10
B.	Planted Area (ha)	0.97	0.07	1.44	0.06
C.	Net Disposable Income including Family labour Cost (Rp./ha)	349,340	378,900	349,340	378,900
D.	Total Net Disposable Income (Rp.)	338,860	26,520	503,050	22,730
E.	Incremental Income (Rp.)		(160,400)		

Remark: Family labour cost spent for farming practices is estimated at 80% of the total labour costs.

4.4.2 Irrigation and Drainage Development Plans

(1) Irrigation water requirements

Irrigation water requirements are calculated for the recommended cropping pattern with an intensity of 250% consisting of 100% of locally improved paddy, 140% of high yield varieties of paddy and 10% of palawija or red onion. The calculation is made against the rainfall with an 80% probability of exceedence of the drought year to obtain the design irrigation water requirements.

In the calculation the effective rainfall is estimated using the effective rainfall chart developed on the basis of the results obtained through the daily balance calculation between the rainfall and consumptive use of water which was made for the similar irrigation project in Indonesia. For the estimation, the rainfall data at the Serang meteorological station are used for all the Ciujung, K-C-C and Cicinta areas.

The potential evapotranspiration (ETP) is calculated using the Penman formula modified by PROSIDA. Since the meteorological data required for the calculation are available only at the Serang station in the Project area, the ETP value calculated using these data (1972 - 1983) is applied to the calculation of consumptive use of water for all the scheme areas.

The percolation losses in paddy fields, canal conveyance losses and puddling water requirement are estimated based on the results measured by the expert of the Team in this study period. The other basic data required for the calculation, such as canal operation losses and farm application losses are assumed taking into account the soil characteristics, topography, climate, irrigation practices and experiences in the Project area.

The following table shows the calculated results of the unit design water requirement and the diversion requirements for the respective scheme areas (Ref. Appendix-G).

Scheme	Irrigation Area (ha)	Unit Design Water Requirement (lit/sec/ha)	Diversion Requirements (m^3/sec)
Ciujung	24,200	1.60	38.72
Cicinta	1,430	1.60	2.29
K-C-C	10,300	1.60	16.48

(2) Drainage water requirement

For the establishment of suitable drainage improvement plan within a feasible range, the study is made to estimate the drainage water requirement for the K-C-C area, where the drainage improvement could be practiced economically by gravity. The study is made taking into account the various factors such as topographic conditions, present drainage conditions, soil characteristics, etc. which vary from area to area.

The design drainage requirements are calculated for 3-day consecutive rainfall with a 5-year return period for main and secondary drains, 3-day consecutive rainfall with a 20-year return period for the related structures and 2-day consecutive rainfall with a 25-year return period for tertiary drains, using the rainfall data observed at the Serang station (1972 - 1983). The design drainage requirements thus calculated are as follows:

- for main and secondary drains : 4.2 lit/sec/ha
- for related structures : 6.3 lit/sec/ha
- for tertiary drains : 6.9 lit/sec/ha

(3) Improvement of Ciujung irrigation scheme area

The Ciujung irrigation scheme, 24,200 ha in net, was completed in 1918. Since the completion, the facilities have effectively been used, but its performance has not been satisfactory because of water shortage in the Ciujung river particularly in the dry season. According to the estimation of irrigated area based on the discharge data collected at the Pamarayan intake gates, the irrigated area in the dry season has been limited to 13,000 - 17,000 ha averaging 14,800 ha in the recent 5 years.

Other limiting factors in the full irrigation development in this scheme area are insufficient discharge capacities of the existing Right and Left Primary Canals. The shortage of these canal capacities would become more serious, when the recommended cropping pattern with an intensity of 250% is introduced to the scheme area and when, especially for the Left Primary Canal, the canal is used for the conveyance of M & I water to the Cilegon area. In this context, the assessment of the Primary Canal capacities is made and improvement plan is briefed as follows (Ref. Appendix-G).

Right Primary Canal

In almost all the parts of the canal reaches, the present canal capacity would not be enough, when the recommended cropping pattern with 250% intensity is introduced to the scheme area. To cope with such future situation, it would be necessary to increase the canal capacity by raising the canal banks for 20 cm throughtout the length and by providing concrete lining for 5.4 km in total length, where the capacities are not enough even after raising the canal banks for 20 cm.

Left Primary Canal

In all the canal reaches, the present canal capacity would not be sufficient for introducing the recommended cropping pattern with 250% intensity to the scheme area. Moreover, when the canal is used for the conveyance of M & I water supply of 1.47 m^3/sec to the Cilegon area, the canal capacity would be far less than the required. In order to meet the future increased requirement for the canal capacity, the length and the wet perimeter of the canal will be lined with concrete at the places where the canal capacities are not enough even after raising the canal banks for 30 cm.

Central Primary Canal

The existing discharge capacity of this canal will be sufficient for the full irrigation of its command area under the recommended cropping pattern.

In addition to the above improvement works, some rehabilitation works such as dredging of main, secondary and tertiary canals and repairing of the canal structures, and the tertiary development in the flooded area of about 1,200 ha will be required for the attainment of the full irrigation development in the scheme area.

(4) Improvement of Cicinta irrigation scheme area

The Cicinta scheme area of 1,430 ha is located between the Cidurian and Cibeureum rivers. The water source of this scheme is the Cicinta river; a tributary of the Cibeureum river. The catchment area is 30 km^2 at the existing Cicinta diversion weir. The available discharge of the Cicinta river during the dry season can only secure the dry season paddy cultivation of about 100 ha. For the full irrigation development of the area under the recommended cropping pattern of 250% intensity, therefore, it is planned to augment the Cicinta river discharge particularly in the dry season from the Cilawang reservoir through the construction of a 1.9-km long trans-basin tunnel.

For the efficient and equitable distribution of the irrigation water over the scheme area, it would be necessary to rehabilitate the existing canal system. The rehabilitation works would include the replacement of gates at check gates and turnouts, reshaping main and tertiary canals, repair of diversion weir and provision of new structures such as check gates, drops and culverts on the main canal. In addition to the above rehabilitation works, drainage improvement would be required particularly in the northern part of the scheme area.

(5) New irrigation development in K-C-C scheme area

(a) Delineation of development area

In delineation of the irrigation area, the following factors are taken into consideration (Ref. Appendix-G).

Land capability

The total surveyed area of 21,870 ha is graded into four classes of land capability as follows:

Capability Class	Area (ha)
I	8,360
II	12,220
III	1,250
IV	40
Total	21,870

In the above areas, the lands graded in Class-I, -II and -III are taken as an irrigable area (Ref. Appendix-D).

Area distribution by elevation

The K-C-C area lies on the elevations between 0 m and 55 m having an average ground slope of 1/655 northward, but its area distribution is not proportionate to elevation: lower altitude occupies more area. The study on area distribution by elevation shows that the area increase above El. 35 m is only 1,240 ha in gross (740 ha in net), while the area below El. 35.0 m is 16,910 ha, and it would not be economical to include the area above El. 35.0 m, because the irrigation of this high land requires a much raised canal system including diversion works, resulting in unreasonably high construction cost. Thus, the maximum gross irrigable area would be 12,760 ha (10,300 ha in net) after deducting 1,930 ha of village area, 930 ha of forest and plantation areas, 770 ha of military area and 520 ha of swamp areas from 16,910 ha lying below El. 35 m.

Water resources and water demands

The Project intends to supply irrigation water to the three schemes area; the Ciujung, Cicinta and K-C-C areas, in addition to supply of municipal water to the major towns in the Project area and industrial water to the Cilegon area. The water resources of these water demands will depend on three rivers; the Ciujung, Cibeureum and Cicinta. The runoffs of these rivers particularly in the dry season are limited as compared with the above-mentioned water demands. The water resources endowed in these rivers would, therefore, be exploited by construction of storage dams. For the exploitation of such water resources, it is proposed to construct two dams; the Karian dam on the Ciberang river and the Cilawang dam on the Cibeureum river. The water thus exploited on the two rivers is planned to be used combinedly for the following purposes:

i) Supplementary water supply to the Ciujung irrigation scheme area of 24,200 ha under the cropping pattern with a 250% intensity.

ii) Supplementary water supply to the Cicinta irrigation scheme area of 1,430 ha under the cropping pattern with a 250% intensity.

iii) Water supply to the K-C-C irrigation scheme area of 10,300 ha under the cropping pattern with 250% intensity.

iv) Municipal water supply of 0.62 m^3/sec to major towns (IKKs) in the Project area.

v) Industrial water supply of 1.145 m^3/sec to Cilegon area.

In order to check whether or not the exploited water resources can suffice the above-mentioned water demands, the water balance studies are made between the various combinations of the storage capacities of the Karian and Cilawang reservoirs and the water demands. As the results, it is clarified that the storage of 219.0 MCM for the Karian reservoir and 62.0 MCM for the Cilawang reservoir can most economically suffice the above-mentioned water demands.

(b) Alternative study on diversion method for irrigation water

In the feasibility study conducted by JICA in 1983, a diversion dam was proposed on the Cibeureum river near Gadeg village to take water for the irrigation of 3,500 ha in the southern half of K-C-C area under the run-off-river type system. In the present study, however, it is planned to develop 10,300 ha of whole K-C-C area as one package by augmenting the river discharge particularly in the dry season through construction of a storage dam (Cilawang dam) on the upstream reach of the Cibeureum river and a trans-basin tunnel between the Karian reservoir and the Cibeureum river. This alteration of development plan would require restudy on the diversion method of irrigation water.

In order to find out the possible sites for the construction of diversion works, a series of desk study and field reconnaissance had been made using the 1/5,000 map and concluded that the following three alternative cases should further be examined from the technical and economical viewpoints and the most attractive method should be selected among the three cases (Fig. 4-5).

Alternative-1 : Construction of a diversion dam at the Gadeg site following the recommendation made in the feasibility study conducted by JICA in 1983.

Alternative-2 : Construction of a diversion weir at the Gadeg site applying the Coupure system, which which was proposed and designed by a local consultant in 1983.

Alternative-3 : Construction of a diversion weir at the Buyut site; 3-km upstream of the Gadeg site, applying the Coupure system.

The advantages and disadvantages of each alternative case are compared as follows:

i) Alternative-3 site provides more narrow river width and higher topography than those of the others, which would result in less embankment volume for the construction of river closure dam.

ii) Rock foundation is observed at 3.0 - 3.5 m below the riverbed at the dam site of Alternative-1, 5.0 - 6.0 m below ground surface along the diversion channel of Alternative-2 and 2.0 - 3.0 m below ground surface along the diversion channel of Alternative-3.

iii) The hydrological conditions are almost the same at all the sites.

iv) A long and deep-cut headreach; 1.7 km in length and 20 m in the deepest cutting, is required in case of Alternative-3, while Alternative-1 and -2 require only 0.1 km and 0.2 km in total length, and their cutting depths are 18 m and 7 m in the deepest portion respectively.

v) In both cases of Alternative-1 and -2, 83 houses and more than 30 ha of farm lands will be submerged due to construction of diversion works, which may induce social problems to the area.

vi) Alternative-1 requires more cost for the provision of access.

vii) In Alternative-1, a gated spillway, which will also have a function of maintaining the reservoir water level at the designed one, will be constructed 650 m away from the intake due to topographical reason. This configuration would give some difficulties for a compatible operation between these two structures.

Considering the above-mentioned advantages and disadvantages, the cost comparison is made among the three cases. The estimated construction cost for each alternative is as follows:

(Unit: Rp. 10^6)

Alternative Case	Construction Cost
1	4,627
2	4,094
3	4,008

From the above comparative study, it can be concluded that there is no significant difference in the construction costs between Alternative-2 and -3, and both are given equal priority from the economical viewpoint. However, if it is considered that Alternative-2 would bring about social problems to the riparian villages due to submergence of houses and farm lands, the first priority would be given to Alternative-3.

(c) Irrigation and drainage systems

The scheme area of 10,300 ha in net, with a general land slope from south to north, is characterized by the undulated topography, and crisscrossing rivers and streams divide the irrigation area into many natural self-contained irrigation blocks particularly in the southern half of the scheme area, which makes the canal arrangement complicated and canal construction cost high. On the other hand, the northern half of the scheme suffers from maldrainage due to its depressed and lowlying topography. Rain water stagnates throughout the year in deeply depressed lands of about 520 ha and for 7 - 8 months in shallowly depressed lands of 320 ha. These adverse natural conditions to the agricultural development would require an elaborate irrigation and drainage plans.

Irrigation canal system

The irrigation water diverted from the Cibeureum river will be conveyed to the head of irrigation area by a 2.1 km long headreach which will pass through the skirt of the hilly ranges on the left bank of the Cibeureum river, and distributed to the scheme area through a main canal. The main canal will run for around 30 km in south-north direction bisecting the scheme area (Fig. 4-6). From this main canal, 8 secondary canals will be branched off to distribute water to the secondary units, of which size will vary from 265 ha to 2,360 ha depending on the topography, and further 8 sub-secondary canals will be branched off from the secondary canals in some secondary units where the topography is complicated. About 84 km of the secondary canals including the sub-secondary canals will be constructed in the scheme area. About 160 tertiary canals totalling 285-km are branched off from the main, secondary and sub-secondary canals to supply water to tertiary blocks.

Drainage canal system

The location of main drain is dominated by natural streams and rivers crisscrossing the scheme area. Out of these rivers, 9 rivers totalling 82 km will be used as the main drains and 6 rivers totalling 27 km will be used as the secondary drains with some modifications. In addition, 5.2 km long main drain and 1.7 km long secondary drain will newly be excavated along the depressed areas. The secondary drains will be planned to collect water from quaternary and tertiary drains and to transport them to main drains or rivers. Depressed areas or old stream beds will be used for locating tertiary drains. In the scheme area, 190 tertiary drains with a total length of 163 km will be excavated for the drainage improvement of the area. Particularly in the swamp areas located in the northern part of the scheme area, about 320 ha out of 840 ha will become cultivable by providing a properly planned drainage system.

Tertiary development

The teritary development program will be prepared for every tertiary block to be irrigated by tertiary system. The tertiary system will consist of tertiary canal, sub-tertiary canals and quaternary canals which will respectively cover the tertiary block (50 - 150 ha), sub-tertiary blocks and quaternary blocks (10 - 15 ha). In tertiary blocks, tertiary drains and quaternary drains will also be required to evacuate excess rainwater from the blocks. Fig. 4-7 shows sample layouts of tertiary systems which are prepared for three predominate topographies; steep, gently sloped and flat topographies.

4.4.3 Municipal and Industrial Water Supply

(1) General

The water sources for the most of minicipalities in the Project area are springs and/or deep wells. The policy of obtaining water sources from springs and/or deep wells is recommendable so long as stable and sufficient yields are available. The supply-demand study made in Subsection 4.3.3 hereof has concluded that Rangkasbitung, Cilegon and 17 I.K.K. towns would require the water supplies from the proposed Karian reservoir. The said supply-demand study has also concluded that the shortage of industrial water supply in the Cilegon area would occur in the year of 2000 and this shortage would also be supplied by the proposed Karian reservoir.

The present study concerns to estimate the future demand for the municipal and industrial water supply and reflects such demand in the planning of capacity of the Karian reservoir. Proper water supply facilities for each demand area are to be planned separately by the concerned organization, accordingly the costs for such facilities are to be borne by such organizations.

(2) Municipal water supply to Rangkasbitung

The municipal water supply for Rangkasbitung depends on deep wells with sufficient yields at present. However, the water levels of these deep wells have become lower year by year and they may dry up in near future. Expecting this crucial situation, the CIPTA KARYA, with an aid of Netherlands, has taken up the construction of deep wells as a part of 15 cities water supply project. Under this Project, Rangkasbitung will be provided with three deep wells with a total yield of 40 lit/sec. However, this total yield of the wells will not suffice the future demand of municipal water in the town and require another development of groundwater or surface water. In the time of Master Plan Study in 1983, the geohydrological study was made on the possibility of further groundwater development and it is suggested that it would be better to take water from the proposed Karian reservoir than the groundwater development because of less potentials of groundwater.

For the conveyance of surface water from the Karian reservoir to Rangkasbitung, a comparative study is made between two alternatives: one is a direct conveyance of raw water from the Karian reservoir through a pipeline system and the other is an intake pumping system from the Ciujung river.

The direct conveyance of raw water from the reservoir will require the construction of water intake tower of the low water level of El. 46.0 m of the reservoir, a gravity pipeline with a diameter of 600 mm and a total length of 9.10 km and a receiving well with a high water level of El. 40.3 m in treatment plant.

The intake pumping system consists of a water intake tower on the left bank of the Ciujung river near Rangkasbitung, a grid chamber, intake pump facilities, ø 450-mm unlined ductile cast iron pipe with a total length of 300 m and stop and control valves to a receiving well.

The comparative study shows that the intake pumping system from the Ciujung river would be preferable to the direct conveyance pipe system from the economical viewpoints.

(3) Municipal and industrial water supply to Cilegon area

The water demands in the Cilegon area would amount to 1,145 lit/sec of raw water in the year 2000 comprising of 93 lit/sec of the municipal water for Cilegon town and 1,052 lit/sec of the industrial water in the Cilegon area. These water demands will be supplied from the Karian reservoir through the Ciujung Left Primary Canal. For the use of the Ciujung Left Primary Canal for the conveyance of such water, the canal capacity is assessed as shown in Appendix-G. The assessed result shows that the canal capacity can easily be increased in the portion from the head to 41.8 km point (BPB-36) of the canal by providing concrete lining for 9.8 km where the capacity is not enough even after raising the canal banks by 30 cm which is required for the conveyance of irrigation water for the Ciujung irrigation scheme area.

The municipal and industrial water carried by the Ciujung Left Primary Canal will be boosted by pump facilities at the BPB-36 of the canal and conveyed to the Krenceng reservoir through a 1,100 mm ø D.C.I. pipeline with a total length of 4.9 km. The pump station is equipped with 3 sets of double suction volute pumps with an each capacity of 40.9 m^3/min. Each pump unit will be driven by a 260 kW wound rotor induction motor.

(4) Municipal water supply to I.K.K. towns

Among 17 I.K.K. towns in the Project area, 8 I.K.K. towns (because of their locations) will receive raw water from the Karian reservoir through the Ciujung Left Primary Canal and 9 I.K.K. towns will receive raw water from the Ciujung river. When the stable and sufficient water becomes available with construction of the Karian dam, the water supply system for the 17 I.K.K. towns will depend on the Karian reservoir for its water source.

4.4.4 Flood Control Plan

(1) Flood runoff analysis

Dividing the Ciujung catchment into 12 sub-basin, the runoff system of the Ciujung river will be illustrated as shown in Figs. 4-8 and 4-9. The storage function method will be employed for the flood runoff analysis in this study, of which the details will be given in Appendix-H.

Hydrologic data on the flood in November 1981 will be employed for the verification of coefficients of the storage function, because it is the only flood event of which hourly data of rainfall and river discharge are available within the basin.

Coefficients of storage function for sub-basins, river channels and flooding will be obtained by the verification as shown in Table 4-12. The computed hydrograph of the November 1981 flood at Rangkasbitung, Pamarayan and Kragilan and the observed flood hydrograph at Kragilan are shown in Fig. 4-10.

(2) Probable flood discharge under present river condition

Thus, the probable flood discharge of the Ciujung river basin will be obtained from the storm rainfall in each sub-basin (Ref. Table 4-13) and by employing the storage function of verified equation coefficients. Table 4-14 shows the computed probable flood discharge of the Ciujung river in the present river condition, corresponding to specific return periods. They will be summarized as follows:

Return period (year)	Q_{pro}	
	10 years	50 years
Kragilan gauge	1,070	1,440
Pamarayan weir	1,120	1,590
Rangkasbitung	1,220	1,730

Where, Q_{pro} denotes the probable flood discharge corresponding to specific return periods in the present river condition.

(3) Flood control plan

As is mentioned in Subsection 4.3.4 "Flood Control", the flood control plan in this study will be focussed on flood mitigation in and around Rangkasbitung.

The proposed Karian reservoir is located at no great distance from Rangkasbitung, which will be very effective to regulate the flood outflow from the Ciberang river. However, it has a relatively small catchment of 288 km^2, occupying only about 20% of the whole catchment area at Rangkasbitung.

Considering the unregulated flood outflow from the Cisimeut and the Upper Ciujung rivers, a river improvement plan will be set up to protect the objective flood-prone area together with the flood regulation by the proposed Karian reservoir.

The level of flood control plan in Indonesia has generally been set up for the return period ranging from 20 to 50 years, sometimes with lesser period for the first stage.

Although the Project area remains in its rather depressed situation at present, it has a prospective advantage as follows. It has a favourable location on the main route linking Jakarta and Sumatra. The construction of new Jakarta-Merak highway is well under way. The land use will be promoted by proposed improvement and development of Ciujung, Cicinta and K-C-C irrigation schemes. Further industrial development is expected in the Project area. All of these will accrue the increase of population and enhancement of economic activities in the Project area.

Accordingly, the proposed Karian dam will be planned to have a flood control storage for the design flood inflow of 50-year return period, considering the importance of the area and possible improvement of its socio-economic condition as mentioned above.

Whereas, the level of river improvement will be planned with lesser return period of 10 years, taking account of the present socio-economic condition of the area and other instances of river improvement in Indonesia.

The lower reaches of the Ciujung river was recently improved with the flood discharge of 1,100 m^3/sec, which will be reestimated to correspond to around 15-year return period at Kragilan gauge if derived from its flood flow data from 1970 through 1983 as shown in Table 4-15.

Thus the river improvement for the objective section will be planned with the design flood discharge of 10-year return period, taking account of flood regulation by the proposed Karian reservoir and also good correspondence with the design flood discharge of lower reaches.

(4) Basic high water

Considering the river-channel condition without flooding, the basic high water at main points along the Ciujung; the Ciberang and the Upper Ciujung rivers will be computed by employing the verified storage function. The computed basic high water will be shown in Table 4-16 by specific return periods. They are summarized as follows:

Basic High Water

(Unit: m^3/sec)

Return period (years)		10 years	50 years
Kragilan gauge	(Ciujung)	1,500	2,100
Pamarayan weir	(Ciujung)	1,300	1,900
Rangkasbitung	(Ciujung)	1,300	1,900
Karian dam site	(Ciujung)	550	800

The computed basic high water will be used as the basis for flood control planning. The flood control plan of the Ciujung river will be set up by distributing the projected flood discharge into flood regulation by the proposed Karian reservoir and the river improvement.

(5) Flood regulation by Karian dam

The flood regulation at the proposed Karian dam will be planned by an ungated overflow-type spillway with its overflow crest positioned at the full supply level of the reservoir.

The required storage volume for flood control is estimated at 33 million m^3 above the ungated overflow crest, which will regulate the flood inflow of 800 m^3/sec, corresponding to the basic high water of 50-year return period, to the outflow of 210 m^3/sec at the dam site (Ref. Figs. 4-11 and 5-5).

For the basic high water of 10-year return period, the inflow of 550 m^3/sec will be regulated to the outflow of 160 m^3/sec at the dam site (Ref. Fig. 4-11).

(6) Design flood discharge distribution

Based upon the basic high water of 10-year return period and taking account of the effect of flood regulation by the Karian reservoir, the distribution of design flood discharge along the river will be estimated as presented in Table 4-16 and Figs. 4-12 and 4-13. They are summarized as follows:

		Basic high water (m^3/sec)	Design flood discharge (m^3/sec)
Kragilan	(Ciujung)	1,500	1,100/1
Pamarayan	(Ciujung)	1,300	1,100
Rangkasbitung	(Ciujung)	1,300	1,100
Rangkasbitung	(Upper Ciujung)	700	700
Rangkasbitung	(Ciberang)	900	700

Note: /1 : Under the present river condition from Kragilan to Pamarayan

The above table Shows that the design flood discharge, after flood regulation by the Karian dam, will be estimated at 1,100 m^3/sec for the river section between Rangkasbitung and Pamarayan, and also the same at Kragilan coinciding with the PROSIDA's design flood discharge if the river section between Pamarayan and Kragilan remains unimproved as it is at present.

However, if the river section between Pamarayan and Kragilan is subject to improvement sometime in the future, a careful study will be necessary beforehand of its influence on the lower reaches downstream from Kragilan and the countermeasures to be taken, with additional data of river survey and riverbed-material analysis.

Some suggestions are given on the provision of shortcut and retarding basin along the objective river section in Appendix-H. However, judging from the difference of basic high water peaks at Pamarayan and Kragilan in the above table, the flood discharge at Kragilan will be increased by about 200 m^3/sec after improvement of the objective section. Perhaps this discharge increment will not be covered by above suggestions and an additional river improvement might be necessary on the river section downstream from Kragilan.

(7) River improvement plan

As described in (3) "Flood control plan" hereinabove, a river improvement plan will be set up in the objective river section from the Pamarayan weir to Rangkasbitung for about 18 km on the Ciujung river, about 3 km on the Ciberang river and about 4 km on the Upper Ciujung river.

Main items of river improvement in the objective section are the diking to protect the flood-prone area, the dredging of riverbed upstream from the Pamarayan weir, a series of shortcut on meanderings near Rangkasbitung, groynes and revetments to prevent bank erosion on developed river bends and meanderings, and the treatment of small tributary confluences. Among them, the dredging and shortcut will be effective to reduce the high water level at Rangkasbitung by about 0.90 m for the design flood discharge of 1,100 m^3/sec. The details of river improvement works will be given in Section 5.5 "River Improvement Works".

4.4.5 Dam Plan and Optimum Scale of Dams

(1) Dam plan

In the Master Plan study, the Karian dam was planned as a rockfill type dam and the Cilawang dam as a concrete gravity type one judging from the topographical and geological conditions. However, it has been revealed by the additional geological investigation of this time that the subsurface condition at the Cilawang dam site is not so favorable as was deemed in the last study (Ref. Appendix-C). Therefore the Cilawang dam is planned as a rockfill type one. The Karian dam is also a rockfill type one as was planned before.

As for the Karian dam, the alignment of spillway is shifted and shortened to minimize the work quantities. Water permeability tests at the dam site show a rather high permeability coefficient in excess of $K = 3 \times 10^{-4}$ cm/sec. At the Cilawang dam site, right abutment forms a steep slope compared with that of left abutment. Spillway is designed on the right abutment to minimize the work quantities. Geological conditions at the site is mostly similar to that of the Karian dam site. Then, the allowable height of dam will be limited and also careful founda- foundation treatments will be necessary.

Main features of main dams, saddle dams and related facilities are explained in Sections 5.1, 5.2, 5.3 and 5.4.

(2) Optimum scale of dams

Following to the result of water balance study, optimum scale of the Karian dam and the Cilawang dam is studied by comparing the costs required for the construction of dams and for the land acquisition of the reservoir area. As was described in Subsection 4.3.5, maximum discharge of Ciuyah trans-basin tunnel which connects the Karian reservoir and the Cibeureum river, is a key parameter to determine the scale of both dams. From the above cost comparison study, the case of tunnel discharge of 6.0 or 8.0 m^3/sec is revealed to be most economical. Difference of total cost between the two is little. Then, the case of tunnel discharge of 8.0 m^3/sec is adopted as an optimum plan for the Project taking the flexibility of water diversion into consideration. Details of comparative study is shown in Appendix-J.

Main features of dams and related structures thus determined are as as shown below.

KARIAN DAM

Crest level	(El.m)	72.50
Flood high water level	(El.m)	69.90
Normal high water level	(El.m)	67.50
Low water level	(El.m)	46.00
Dam height from foundation	(m)	60.50
Effective storage volume	(10^6 m^3)	219
Embankment volume	(10^3 m^3)	1,490
Spillway design flood inflow	(m^3/sec)	3,400
outflow	(m^3/sec)	2,670
Spillway gates	(m)	2 nos x 12.5(B) x 12.5(H)
Gated spillway weir	(El.m)	57.50
Side channel spillway weir	(El.m)	67.50
weir length	(m)	50.00

Intake max. discharge	(m^3/sec)	48.00
Flood control (50-year flood)		
Flood control water level	(El.m)	69.50
Storage volume	(10^6 m^3)	33.50

CILAWANG DAM

Crest level	(El.m)	81.00
Flood high water level	(El.m)	78.50
Normal high water level	(El.m)	76.50
Low water level	(El.m)	66.50
Dam height from foundation	(m)	36.00
Effective storage volume	(10^6 m^3)	62
Embankment volume	(10^3 m^3)	532
Spillway design flood inflow	(m^3/sec)	1,700
outflow	(m^3/sec)	1,230
Spillway gates	(m)	2 nos x 9.0(B) x 9.5(H)
Gated spillway weir	(El.m)	69.00
Side channel spillway weir	(El.m)	76.50
weir length	(m)	20.00
Intake max. discharge	(10^6 m^3)	18.00

KARIAN-CIBEUREUM TRANS-BASIN TUNNEL

Design discharge	(m^3/sec)	8.00
Tunnel diameter	(m)	2.60
Tunnel length	(m)	1,540
Hollow jet valve diameter	(mm)	1,200

CILAWANG-CICINTA TRANS-BASIN TUNNEL

Design discharge	(m^3/sec)	2.70
Tunnel diameter	(m)	2.00
Tunnel length	(m)	1,920
Hollow jet valve diameter	(mm)	700

V PRELIMINARY DESIGN OF STRUCTURES

5.1 Karian Dam

5.1.1 General

The Karian dam of 60.5 m high and the catchment area of 288 km^2 is proposed for the Project in combination with the Cilawang dam and two trans-basin tunnels as shown in Fig. 5-1.

Preliminary design is made on main structures for the purpose of estimating the construction cost of the Karian dam as shown in Figs. 5-8 to 5-12. The design of dam is made in accordance with the basic design requirement in the water balance study.

5.1.2 Dam Site

The Karian dam site on the Ciberang river, tributary of the Ciujung river, is located about 10 km upstream from Rangkasbitung. The dam site proposed in the M/P Study is reviewed from topographical and geological points of view in this study and confirmed as an adequate location for the dam. The Ciberang river flows with a width of around 40 m and riverbed of about El. 17.5 m at 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 about 40° up to El. 60 m. Hills surrounding the dam and reservoir are about El. 70 m to El. 100m.

5.1.3 Geology

The geology of the dam site consists of tuffaceous sedimentary rocks which are generally soft rock, especially weak in pumiceous facies. Three faults exist in and around the dam site.

In the field permeability tests, permeability coefficient of 1.1×10^{-3} to 2×10^{-4} cm/sec was observed at some parts in the dam foundation. The compressive strength test on the core samples shows the strength in the order of 10 to 30 kg/cm^2.

5.1.4 Basic Design Conditions

(1) Water requirement

The required storage volume in the Karian reservoir is 219×10^6 m^3 in effective. The maximum discharge for the Ciujung irrigation scheme and M & I water from the intake is 48 m^3/sec. The maximum discharge for the K-C-C irrigation scheme is 8.0 m^3/sec through the Ciuyah trans-basin tunnel.

(2) Sedimentation

The sediment load is estimated to be 1,700 m^3/km^2/year. The sedimentation is estimated to be 49×10^6 m^3 for 100-year design period and its elevation is at El. 45.0 m.

(3) Water level and dam crest elevation

The water level and storage volume for each purpose is set as follows and shown on the storage volume curve of Fig. 5-2.

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
Flood control storage volume	:	33×10^6 m^3
Effective storage volume	:	219×10^6 m^3
Dead storage volume	:	54×10^6 m^3

5.1.5 Design of Main Structures

(1) Dam

The dam crest elevation is set at El. 72.50 m above the flood water level of El. 69.90 m with free board of 2.6 m.

Taking into consideration the soft rock foundation and the dam height of 60.5 m, the standard zoned rockfill dam with the center core proposed in the M/P study is adopted as the Karian dam. The required embankment volume including the main, coffer and saddle dams are tabulated below:

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

The rock materials of about 1,200,000 m^3 are available from Gradog quarry site about 15 km south. The filter materials 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 south of the dam.

To improve the dam foundation including high permeable strata and faults, the following grouting works are planned below the core zone;
i) blanket grouting of 5 m deep and 4 lines at 2 m intervals, and
ii) curtain grouting of 20 to 40 m deep and 2 lines at 2 m intervals.

The dam stability analysis is made by the slide circle and slice method on the adopted embankment slope; upstream slope of 1 : 3.0, and downstream of 1 : 2.5. The analysis is done under the normal and seismic conditions in up- and downstream slope. The design horizontal component of seismic coefficient of 0.15 is used for the seismic condition analysis. The calculated minimum values are more than required values, which are more than 1.5 for the normal condition and more than 1.2 for the seismic condition.

(2) Spillway

The spillway is aligned on the right flat bank under the following design conditions and concepts:

- a probable maximum flood (PMF) with a peak flow of 3,400 m^3/sec is adopted as a design flood inflow for the spillway.
- the effect of reservoir flood routing is considered.
- an ungated side spillway and a gated spillway are provided.
- the ungated side spillway is arranged to release a flood smaller than the return period of 50-year without any operation.
- the gated spillway is to be operated in accordance with the reservoir water level rising or falling.

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. 57.50 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 dis-discharging 370 m^3/sec and 2,300 m^3/sec respectively at the flood water level of 69.90 m.

The reservoir flood routing effect is calculated for the PMF and 50-year flood and shown in Figs. 5-4 and 5-5. The relation between peak inflow and outflow, and the maximum water level are summarized below:

50-year flood :	Qi = 800 m^3/sec,	Qo = 205 m^3/sec,	W.L. = 69.10 m
PMF :	Qi = 3,400 m^3/sec,	Qo = 2,670 m^3/sec,	W.L. = 69.90 m

The chute-way is 39.00 m wide, 116.50 m long and 1 : 4 slope.

A flip bucket and plunge pool is adopted as a energy dissipator because of the low construction cost. The design discharge for the plunge pool is 1,160 m^3/sec which is the free overflow discharge through the gated spillway weir at the normal high water level. The required plunge pool is 70.00 m long.

(3) Intake and discharge facilities

The maximum discharge for the Ciujung irrigation scheme and M & I water from the Karian reservoir is estimated to be 48 m^3/sec. To release the required water, the intake and discharge facilities are provided at the right bank and in the diversion tunnel.

The intake with trash racks, stoplogs and a gate is a shaft type of 10.0 m wide, 11.0 m long and 45.0 m high. The shaft is connected with the diversion tunnel by a tunnel of 2.0 m inside 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 lower the reservoir water level below the low water level in case of an emergency and for the maintenance of the dam.

A hollow jet valve of 2.0 m in diameter is provided in the diversion tunnel of 6.6 m inside diameter. A connection tunnel of 2.0 m high is planned from another diversion tunnel to the valve chamber.

(4) River diversion

Two diversion tunnels of 6.6 m inside diameter and 462 m and 506 m long are provided to divert the flood discharge during the dam embankment period of about two years. The 25-year flood of 700 m^3/sec is adopted as a design discharge.

The estimated embankment volume of the coffer dam is 112,000 m^3 and the crest elevation is at El. 39.00 m.

5.2 Cilawang Dam

5.2.1 General

The Cilawang dam of 36.0 m high and the catchment area of 93 km^2 is proposed for the Project in combination with the Karian dam and two trans-basin tunnels as shown in Fig. 5-1.

Preliminary design is executed on main structures for the purpose of estimating the construction cost of the Cilawang dam as shown in Figs. 5-15 to 5-19. The design of dam is made in accordance with the basic design requirement in the water balance study.

5.2.2 Dam Site

The Cilawang dam site on the Cibeureum river, tributary of the Cidurian river, is located about 15 km to the southeast of Rangkasbitung. 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.

The Cibeureum river flows with a width of around 15 m and riverbed of about El. 47 m at the dam site. The left bank shapes a gentle slope of about 10° up to around El. 75 m and the right bank is relatively steep slope about 25° up to El. 80 m. Hills surrounding the dam and reservoir are about El. 75 m to El. 100 m.

5.2.3 Geology

The main geological formation consists of lapilli tuff and conglomerate (2 to 3 m thick) of round gravel of andesite appears at the riverbed. No fault has been found so far. Quality classification of rock in drilling hole is fairly better than that of the Karian dam.

In the field permeability tests, permeability coefficient of 2×10^{-3} cm/sec was observed at some parts in the dam foundation as same as the Karian dam site. The compressive strength test on the core samples shows the strength in the order of 4 to 75 kg/cm^2.

5.2.4 Basic Design Conditions

(1) Water requirement

The required storage volume in the Cilawang reservoir is 62×10^6 m^3 in effective. The maximum discharge for the K-C-C irrigation scheme from the intake is 18 m^3/sec. The maximum discharge for the Cicinta irrigation scheme is 2.7 m^3/sec through the Cicinta trans-basin tunnel.

(2) Sedimentation

The sediment load is estimated to be 1,700 m^3/km^2/year. The sedimentation is estimated to be 16×10^6 m^3 for 100-year design period and its elevation is at El. 65.0 m.

(3) Water level and dam crest elevation

The water level and storage volume for each purpose is set as follows and shown in the storage volume curve of Fig. 5-3:

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
Effective storage volume	:	62×10^6 m^3
Dead storage volume	:	20×10^6 m^3

5.2.5 Design of Main Structures

(1) Dam

The dam crest elevation is set at El. 81.00 m above the flood water level of El. 78.50 m with free board of 2.5 m.

The standard zoned rockfill dam instead of a concrete gravity dam proposed in the M/P study is adopted as the Cilawang dam because of the same reason of the dam type selection for the Karian dam. The required embankment volume including the main, coffer and saddle dams are tabulated below:

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

The rock materials of about 382,000 m^3 are available from Gradog quarry site about 10 km south as same as for the Karian 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 Sajira at about 6 km south of the dam.

To improve the dam foundation including high permeable strata, the following grouting works are planned below the core zone; i) blanket grouting of 5 m deep and 4 lines at 2 m intervals, and ii) curtain grouting of 20 to 40 m deep and 2 lines at 2 m intervals.

The dam stability analysis is referred 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 an enough safety factor.

(2) Spillway

The spillway is aligned toward the channel center of the river from the right bank hill under the following design condition and concepts:

- a probable maximum flood (PMF) with a peak flow of 1,700 m^3/sec is adopted as a design flood inflow for the spillway.
- the effect of reservoir flood routing is considered.
- an ungated side spillway and a gated spillway are provided.

- the ungated side spillway is arranged to release a flood smaller than the return period of 50-year without any operation.
- the gated spillway is to be operated in accordance with the reservoir water level rising or falling.

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 110 m^3/sec and 1,110 m^3/sec respectively at the flood water level of 78.50 m.

The reservoir flood routing effect is calculated for the PMF and 50-year flood and shown in Figs. 5-6 and 5-7. The relation between peak inflow and outflow, and the maximum water level are summarized below:

50-year flood	: Qi = 390 m^3/sec,	Qo = 74 m^3/sec,	W.L. = 77.90 m
PMF	: Qi = 1,700 m^3/sec,	Qo = 1,220 m^3/sec,	W.L. = 78.50 m

The chute-way is 28.00 m wide, 93.9 m long, 1 : 10 and 1 : 2 slope.

A stilling basin is adopted as a energy dissipator because of the narrow space and erosive soft rock foundation. The design discharge for the stilling basin is 780 m^3/sec which is the free overflow discharge through the gated spillway weir at the normal high water level. The required stilling basin is 60.00 m long.

(3) Intake and discharge facilities

The maximum discharge for the K-C-C irrigation scheme from the Cilawang reservoir is estimated to be 18 m^3/sec. 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 chute-way by a discharge pipe of 2.0 m in diameter through the gate operation chamber.

(4) River diversion

A diversion tunnel of 6.6 m inside diameter and 351 m long is provided to divert the flood discharge during the dam embankment period of about two years. The 25-year flood of 300 m^3/sec is adopted as a design discharge.

The estimated embankment volume of the coffer dam is 76,000 m^3 and the crest elevation is at El. 61.00 m.

A emergency river outlet facilities are provided in the diversion tunnel for the emergency case in order to release the reservoir water 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 follower gate of 1.2 m in diameter are provided at the outlet.

5.3 Trans-basin Tunnels

5.3.1 Ciuyah Trans-basin Tunnel

(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 scheme of 10,300 ha. The released water will be diverted to the K-C-C irrigation scheme at the Buyut diversion weir about 3.5 km downstream.

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/sec. The tunnel is 2.6 m in diameter and 1,540 m long.

Preliminary design is executed on main structures for the purpose of estimating the construction cost of the Ciuyah trans-basin tunnel as shown in Figs. 5-13 and 5-14.

(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 intercalation of pumice tuff and claystone. It is estimated to include some fractured zone.

(3) Design of main structures

The intake and valves are designed to release the maximum discharge of 8.0 m^3/sec at the water level of El. 48.5 m which is 2.5 m higher than the low water level of the reservoir. The intake weir is set at El. 45.00 m which is the 100-year sedimentation level. The intake is equipped with trash rack and stoplog slots.

Since the intake site slope is too gentle to built a inclined intake and it costs more than a shaft type, the vertical shaft intake is adopted. The value shaft is 2.5 m in diameter and 26.0 m in depth. A hollow jet valve and a ring follower gate of 1.2 m in diameter are provided.

The tunnel is designed as a horseshoe shaped tunnel of 2.6 m inside diameter, 1,540 m long and slope of 1/1,500 in order to make stable free flow with velocity less than 2.0 m/sec 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 most parts of the tunnel construction work.

The tunnel outlet is located at the left bank of the Cibeureum river. As the flood water level is estimated to be El. 45.00 m, the tunnel outlet is planned not to be submerged. For the purpose of river-bed protection from the scouring, the baffled apron of 13.0 m long is planned.

5.3.2 Cicinta Trans-basin Tunnel

(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. The rleased water will be diverted to the Cicinta irrigation scheme locating about 10 km downstream of the existing Cicinta weir.

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/sec. 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. 5-20 and 5-21.

(2) Topography and geology

The tunnel site is located at a gently sloped hill of El. 78 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 fractured with slicken side.

(3) Design of main structures

The intake and valve is designed to release the maximum discharge of 2.7 m^3/sec at the water level of El. 69.0 m which is 2.5 m higher than the low water level of the reservoir. The intake weir is set at El. 65.00 m which is the top level of 100-year sedimentation. The intake is equipped with trash rack and stoplog slots.

As for the discharge control facility, a vertical shaft intake with a valve is adopted because of the same reason for the Ciuyah trans-basin tunnel. The valve shaft is 2.0 m in diameter and 14.1 m in depth. A hollow jet valve and a ring follower gate of 0.7 m in diameter are provided.

The minimum diameter is 1.8 m in view of the actual construction. Then, the Cicinta trans-basin tunnel is designed as a horseshoe 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, the earth covering of which 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 most parts of tunnel.

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.

5.4 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 trans-basin tunnels. The principle of the tentative operation 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/sec 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/sec 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/sec 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/sec 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/sec at a first priority through the weir gates.

5.5 Irrigation Facilities

5.5.1 Diversion Works

(1) General condition of the site

A diversion weir is planned on the Cibeureum river to take water for the irrigation of the K-C-C scheme area. The proposed site (Alternative-3) is located near Buyut village, about 9 km (river distance) from the head of irrigation area. The river course at the site largely meanders and provides a convenience for the construction of diversion weir under the Coupure system. The catchment area is 116 km^2 at the weir site and its flood discharge is estimated at 455 m^3/sec in a 100-year return period. The riverbed elevation is about EL. 28.0 m at the head of diversion channel and EL. 27.0 m at the tail of diversion channel. Rock foundation mainly consisting of tuffaceous sandstone is found at 2.0 m below the riverbed at the river closure dam and 2.0 - 3.0 m below the ground surface along the route of diversion channel.

(2) Design conditions

(a) Design flood discharge

The flood with a 100-year return period; 455 m^3/sec is taken as the design flood discharge. The structures designed for the above design flood discharge should stand against the probable maximum flood (PMF) of 1,220 m^3/sec (after regulation by the Cilawang dam).

(b) Design flood water level

The design flood water level should preferably be lower than the elevation of riparian house yards, farmlands and bridges in the upstream reaches of the diversion weir.

(c) Design intake discharge

The sum of peak diversion requirement of 16.48 m^3/sec is taken as a design intake discharge.

(d) Design intake water level

The design intake water level is determined to be EL. 38.0 m taking the minimum required water level of EL. 35.0 m at the head of irrigation area and the headreach gradient of 1/10,000.

(3) Preliminary Design

The diversion works broadly consist of a river closure dam, diversion channel, gated weir and intake structure. For the well functioning as the diversion works, each component should be combined with and fully compatible with each other. The following are brief descriptions of the designed results for major components (Ref. Table 5-2).

(a) River closure dam

A river closure dam is required on the Cibeureum river immediately downstream of the entrance of the diversion channel to divert the river flow to the diversion channel (Ref. Fig. 5-22). The type of dam is proposed to be homogeneous earthfill with toe drain. The dam will have a height of 19.0 m and a crest length of 150.0 m, and will be formed with an upstream slope of 1 : 3 and a downstream slope of 1 : 2.5.

(b) Diversion channel

A 260 m long diversion channel will be excavated on the left bank of the Cibeureum river to lead the river flow to the diversion weir. The channel will have a trapezoidal section with a bottom width of 25.0 m and inside slope of 1 : 1.0 in case of rock excavation and 1 : 1.5 in case of earth excavation. The channel should be safe against the PMF of 1,220 m^3/sec.

(c) Diversion weir

A gated diversion weir with two bays; 11.5 m wide for each, will be constructed on the diversion channel. The structure is designed for super-critical flow in order to flush out the bed loads. The top elevation of gates has an allowance of 10 cm above the design intake water level. The gate width is determined to be 11.5 m after economic comparison and further taking into account the passing of drift woods between the piers. A 5.4 m high drop combined with a 1.6 m deep stilling basin will be provided immediately after the gated weir to kill the flow energy. The gates will be operated by motor considering the weight of gates and frequency of operation.

(d) Intake structure

An intake structure will be constructed on the left bank of the civersion channel, immediately upstream of the weir. The net width of the intake structure is determined to be 10 meters for the design intake discharge of 16.48 m^3/sec and the design flow velocity of 0.82 m/sec in the structure. The structure will be equipped with four steel slide gates; 2.5 m high and 2.5 m wide, which can be operated manually. The bottom floor of the intake structure will be raised for 2.0 m from the floor level of the upstream apron of the diversion weir to prevent the riverbed loads from flowing into the structure.

5.5.2 Irrigation Canal System

Irrigation canal system to be provided under this Project includes all the headreach, main, secondary, sub-secondary and tertiary canals in the K-C-C scheme area. In the design of these canals including their related structures, the following design standards are established and the designed results are shown in Table 5-2.

(a) Canal

Design discharge: The design discharges for the main and secondary canals are obtained by multiplying the respective command areas by the unit design irrigation water requirement of 1.60 lit/sec/ha, and those for the tertiary canals and quaternary canals are obtained by using the Tegal curve.

Canal lining: All the raised portions of the main and secondary canals will be lined with 7 cm thick plain concrete for the main canal and 5 cm thick plain concrete for the secondary canals to check seepage through the canal banks and bottom and to protect the inside slope of the canal from erosion.

Velocity: The maximum and minimum permissible velocities are as follows:

	Maximum velocity (m/sec)	Minimum velocity (m/sec)
- Concrete lining	1.50	-
- Earth	0.80	0.30
- Tuffaceous sandstone	2.00	-

Roughness coefficient: The following roughness coefficient (after the Manning's formula) is used in the calculation of required canal section.

	Roughness coefficient
- Concrete lining	0.015
- Earth ($Q \geqq 3$ m^3/sec)	0.0225
- Earth ($Q < 3$ m^3/sec)	0.025

Inside slope of canal: The canal inside slope of 1 : 1.5 for earthcut and concrete-lined portions and 1 : 1.0 for sandstone-cut portions are adopted in the design.

(b) Related structures

A large number of structures are essential for the full function of canal system, for which the following structures are proposed:

i) Structures for distribution of irrigation water such as turnouts and division boxes,

ii) Structures for regulation of water level such as check gates and drops,

iii) Structures for conveyance of irrigation water over or under roads, rivers, streams, etc. such as syphons, aqueducts, culverts and bridges,

iv) Structures for protection of canal such as canal spillways and cross drains, and

v) Structures for measuring canal discharge such as Cipoletti weirs, Parshall flumes, Romijin gates and gauging staffs.

5.5.3 Drainage Canal System

The unit design drainage requirements are determined to be 4.2 lit/sec/ha for the main and secondary drains, 6.3 lit/sec/ha for the drainage structures, and 6.9 lit/sec/ha for the tertiary drains. The design discharges of the respective drains are calculated on the based of the said unit design requirements. In the design, the existing drains and natural streams are incorporated into the proposed drainage canal network as much as possible.

The related structures to the drainage canals include cross drains, culverts, drops and flap gates. They are planned and designed with the same principles as those of the related structures for the irrigation canals.

The designed results are shown in Table 5-2.

5.5.4 Inspection Road

For the operation and maintenance of the irrigation canals and their related structures, the inspection roads are proposed along the canals. Since these roads will also be used as village roads and farm roads, the layout planning is prepared considering the existing farm and village road networks so as to attain the smooth and efficient connection between them.

In the K-C-C scheme area, the following three types of inspection roads will be provided:

i) gravel-metalled main inspection road along the main canal; 7.0 meters in total width and 5.0 meters in effective width,

ii) gravel-metalled secondary inspection road along the secondary canal; 5.0 meters in total width and 3.5 meters in effective width; and

iii) non-metalled tertiary inspection road along the tertiary canal; 3.0 meters in total width.

5.5.5 Office and Quarters

For the project engineering operation in both project construction and operation and maintenance periods, a main office and quarters (for the construction stage) will be built preferably at Rangkasbitung. In addition, six branch offices consisting of office, quarters, garage and store would be required at the two dam sites, diversion weir site and major towns in the K-C-C area such as Kopo, Cikande and Carenang. The required housing spaces for these offices and quarters are as follows:

(1)	Main office	700 m^2
(2)	Branch offices	1,200 m^2
(3)	Repair shops	300 m^2
(4)	Storehouses	1,500 m^2
(5)	Quarters	1,000 m^2
(6)	Motor pools	3,000 m^2

5.6 River Improvement Works

5.6.1 Basic Consideration

Main problems of the river improvement in the objective section of the Ciujung river will be enumerated such as the aggravation of high water level due to heavy sediment on the riverbed upstream from the Pamarayan weir, the developed meanderings in the river section upstream thereof, and severe bank erosion liable to cause collapse around Rangkasbitung near the confluence of the Ciberang and the Upper Ciujung rivers.

Their countermeasures wlll be contemplated as follows:

- Dredging of riverbed in the upstream reaches from the Pamarayan weir,
- A series of short cut in the section of meanderings between 8.3 km point and 15.0 km point upstream from the Pamarayan weir,
- Improvement of the confluence of the Ciberang and the Upper Ciujung rivers by short cut, and
- Provision of groynes and revetments on river bends and meanderings confronting with flood flow.

Three alternative plans are studied to find out the most reasonable plan, with consideration on the stabilization of river channel, execution and economic aspects, as shown in Table 5-3 and Fig. 5-23.

In Table 5-3, Case-1 includes the improvement of the confluence of the Ciberang and the Upper Ciujung rivers by short cut, whereas no improvement of the above confluence will be planned in Case-2 and Case-3. Case-1 and Case-2 include the short cuts on developed meanderings between 8.3 km and 15.0 km, whereas no short cut will be planned in Case-2.

From the technical viewpoints on river improvement and maintenance, the most desirable plan will be Case-1 followed by Case-2. However, considering the economic aspects as well, Case-2 will be proposed to be subject to the preliminary design and economic analysis in this Report.

5.6.2 Design Principle

Based upon the basic consideration as described in Subsection 5.5.1 hereinabove, the river improvement works for the Ciujung river will be designed as follows:

(1) Plane arrangement (Ref. Fig. 5-24)

Generally, the plane arrangement of the dyke and the river channel will be designed to be in smooth accommodation with expected flood flow, however, a series of short cut will be designed on developed meanderings in the river section between 8.3 km and 15.0 km upstream from the Pamarayan weir, to increase the flow capacity and to stabilize the river channel.

The length of the present river channel of 18.3 km, between the Pamarayan weir and Rangkasbitung, will be reduced to 15.2 km by designed short cuts.

(2) Cross-sectional arrangement (Ref. Fig. 5-25)

For the river section with ample space at present, the double cross section will be designed. Considering the required flow capacity and topography of the objective section, the improved river width and the low-water channel will be designed mostly as follows:

		Ciujung	Ciberang	Upper Ciujung
- Improved river width	(m)	100	85	70
- Improved riverbed width	(m)	60	50	50

(3) Longitudinal profile arrangement (Ref. Fig. 5-26)

The riverbed elevation upstream from the Pamarayan weir has risen to around EL. 8.0 m at present, which is about 3 m higher above the sill of the weir. The heavy sedimentation has raised the flood water stage which has resulted in aggravation of flood condition along the river.

The longitudinal river profile will be designed with an improved riverbed slope, starting from around the sill elevation of the weir and linking to the present riverbed elevation near the lower end of the shortcut section. Lowering of the riverbed will be done by dredging.

The design high water level will be decided starting from the design HWL EL. 11.0 m at the Pamarayan weir and according to the design river cross section. The present riverbed slope of about 1/3,000 in the shortcut section will be increased to about 1/2,300 by designed short cuts.

(4) Manning's roughness coefficient "n"

The improved cross section of the river will be designed with the Manning's roughness coefficient "n" of 0.030, taking account of the result of analyses on riverbed materials and considering river meanderings, bank erosion and planning safety.

(5) Typical cross section of dyke (Ref. Fig. 5-25)

The typical cross section of dyke will be designed with crown width of 4 m at minimum and both side-slopes of 1 : 2, considering the stability of dyke and a function of inspection road. A freeboard of 1 m will be provided above the design high water level.

The berm of 3 m width will be provided in 3 to 5 m height from the crown on the riverside slope of the dyke, and in 2 to 3 m height from the crown on the land-side slope, considering the possible seepage within the embankment.

(6) Groyne and revetment

To deal with local channel scouring and bank erosion, piled groynes and gabion revetments will be designed on river bends and meanderings confronting with flood flow.

(7) Treatment of small tributary confluence

The treatment of small tributary confluence will be designed by the open levee, if the interior ground lies above the high water level of the Ciujung river. However, the sluice will be designed if the high water levee of the Ciujung river exceeds the interior ground level. The sluice will be designed by three types, type-I (H 1.5 m x B 1.5 m x 1), type-II (H 2.0 m x B 2.5 m x 2) and type-III (H 3.0 m x B 3.0 m x 2), according to dimension of the tributary.

(8) Other facilities

The inspection road will be designed on the crown of the dyke with gravel surface. In the section of open level, some connection with the existing road will be provided.

The drain ditch will be designed at the land-side toe of the dyke according to the topography, if necessary.

5.6.3 Benefit

The amount of flood damage decrement, by flood regulation at the Karian dam and river improvement on the objective river section, will be given as the flood control benefit.

The total benefit by flood control will be evaluated as the average annual decrement of flood damage on the probability of 1/10. The estimated value is Rp. 2,570 million (Ref. Appendix-H, Table H-12).

VI PROJECT ORGANIZATION AND MANAGEMENT

6.1 Organization for Project Implementation

The water resources development projects in Indonesia are implemented under the responsibility of the Directorate General of Water Resources Development (DGWRD) of the Ministry of Public Works (PU). In most cases, big projects are implemented by DGWRD through the project construction offices and transferred to Provincial Government for their operation and maintenance. For the Karian Multipurpose Dam Construction Project also, it is proposed to establish the project construction office under DGWRD (Appendix-K).

The main functions of the project office are summarized below.

(1) Financial arrangement for the construction of the project works,

(2) Design and construction supervision of all the project works down to tertiary canals,

(3) Assistance to farmers in construction of quaternary system, and

(4) Accounting and management of construction works.

The project construction office will consist of one main office and six branch offices. It is proposed to establish the main office at Rangkasbitung before getting into the major construction works for the Project. The branch offices will be constructed at the two dam sites, diversion weir site and major towns in the K-C-C area such as Kopo, Cikande and Carenang in keeping with the progress of the project construction works.

The main office will have two working divisions; Technical and Administrative Divisions. The Technical Division will be responsible for all the engineering matters relating to construction of the project facilities. This division will consist of three Subdivisions of Design, Construction and Equipment. The Administrative Division will be responsible for financing, accounting, administrative affairs and procurement for the implementation, operation and maintenance of the Project. This Division will consist of four Subdivisions; Finance, Personnel, Administrative and Security. Total number of the staff required for the project office would be 174.

6.2 Operation and Maintenance of the Project

6.2.1 Existing Organization for Operation and Maintenance

Operation and maintenance of irrigation systems in Indonesia are conducted under the responsibility of the Provincial Governments. As the executing agency of operation and maintenance works, an irrigation section (Seksi Pengairan) has been established under the Provincial Public Works at Kabupaten level. Most of the project area is covered by the Serang Irrigation Section and some parts; Karian and Cilawang dams, diversion weir and about 200 ha of irrigation area, are covered by the Pandeglang/Rangkasbitung Irrigation Section.

Under the chief of Irrigation Section, there are three divisions, i.e. Operation, Maintenance and Rehabilitation Division, Construction Division and Administrative Division, the Subsections and an Institute of Research and Study.

The major works of the Irrigation Section consist of planning of irrigation schedule, control of irrigation water delivery, maintenance and repair, assistance to water users' associations in technical and administrative matters. In addition, the Irrigation Section has a function of executing office for small scale irrigation projects such as tertiary system developments and simple irrigation developments. Actual field works of operation and maintenance are carried out by Subsection.

For the purpose to coordinate all irrigation activities in Kabupaten, Irrigation Board has been established according to President Instruction No.1/1969. The Irrigation Board is composed of a chairman, a secretary and six members who are the representatives of the organizations relating to village development, agriculture, police, land use, forestry and fishery. The Board is in charge of coordination in plan, design, execution of operation and maintenance works.

6.2.2 Proposed Organization and Management

(1) Proposed organization

After completion of the construction works, all the project facilities will be transferred to the Serang Irrigation Section for their operation and maintenance. In order to control the water management including the reservoir operation of two dams, Dam Operation Subdivision will newly be organized in the existing Operation, Maintenance and Rehabilitation Division. For the operation and maintenance works of the Karian and Cilawang dams and the diversion weir, three Subsections will additionally be established under the chief of the Serang Irrigation Section, i.e. Subsection XI for the Karian dam, Subsection XII for the Cilawang dam and Subsection XIII for the diversion weir.

The irrigation and drainage facilities of the K-C-C scheme and flood control facilities will be operated and maintained by the present Subsections as follows:

(i) K-C-C Irrigation Scheme

- Kopo Area	Subsection IV
- Cikande Area	Subsection II
- Carenang Area	Subsection III

(ii) Flood Control Facilities Subsection IV

(2) Management plan of operation and Maintenance

All the present operation and maintenance works of the Serang Irrigation Section will be expanded to cover the Project. Among the major management works to be done by this Section, the present procedure particularly in planning for irrigation schedule and control of irrigation water delivery will be improved to establish the proper water management system. In this context, the provision of a radio telephone system and the establishment of operation rule are recommended. The system will be established for the connection of main office of the Serang Irrigation Section to the dam operation offices (Subsections XI and XII), diversion weir operation offices at Pamarayan, Buyut and Cicinta and to several major field offices.

(3) Staffing

The staff required for the Serang Irrigation Section would amount to 545 persons after completion of the Project, which is compared with the present staffing of 448 persons.

(4) Operation and maintenance facilities

In order to operate and maintain the project facilities effectively, 22 items of operation and maintenance equipment amounting to about 60 nos. would be required for the Project.

6.3 Water Users' Association

The water users' association (Perkumpulan Petani Pemakai Air; P3A) will be established based on the President Instruction No.1/1969. The village office, together with the water users' association, would be responsible for operation and maintenance of irrigation facilities below the tertiary level.

The ULU-ULU (water master) is posted in the village office and is in charge of water management and maintenance of the tertiary system within the village. The works of ULU-ULU are very wide and cover all the irrigation services within the village consisting of water distribution, maintenance, monitoring, advisory services to the water users' association.

The water users' association has a board which consists of a chief, secretary, treasurer, assistants to ULU-ULU, etc. The chief of the board elected from and by the members will manage the association. The treasurer is responsible for financial administration. Assistants to ULU-ULU are engaged in water management and maintenance of irrigation facilities under the guidance of ULU-ULU. The assistant to ULU-ULU is in charge of the quaternary canal which usually covers 10 to 25 ha of irrigation area.

Before completion of the construction works of the Project, the water users' association would be established under the initiation of each village chief, Camat and Bupati with a guidance of and consultation with the Serang Irrigation Section and Agricultural Office.

Since the staff of water users' association are required to have a certain technical knowledge for water supply management of the Project as well as farm level, they will be trained by the staff of the Serang Irrigation Section.

6.4 Expatriate Assistance Works

Large civil engineering works on the water resources development projects require experienced professional manpower at all levels of the responsible organization as a whole. For the successful prosecution of the Project, appropriate expatriate assistance is proposed to be introduced.

A vital part of the functions of expatriate assistance would be the training of the local professional and sub-professional manpower on management of supervision on the construction works and the provision of substantial experience and techniques to the Project..

VII CONSTRUCTION PLAN AND COST ESTIMATE

7.1 Construction Plan and Method

7.1.1 General

Construction plan and method for the works such as construction of Karian and Cilawang dams, two trans-basin tunnels, K-C-C irrigation facilities, and river improvement works are described in this Chapter. Major construction work items and quantities for each work category are shown in Tables 7-1, 7-2 and 7-3.

7.1.2 Mode of Construction

The construction works of the Project will be carried under the following international competitive contracts and local contracts judging from a scale of the Project.

International competative contracts

- construction of the Karian dam and related structures including Karian-Cibeureum trans-basin tunnel,
- construction of the Cilawang dam and related structures including Cilawang-Cicinta trans-basin tunnel, and
- supply and installation of metal works for dams and tunnels.

Local contracts

- river improvement works such as dredging, shortcut and construction of levees,
- construction of K-C-C irrigation facilities including Buyut diversion works and on-farm development works,
- preparatory works at each site to be prepared by the Government, and
- construction of permanent access roads and relocation work of the existing roads in the Project area.

7.1.3 Construction Plan and Method

(1) Karian dam and Karian-Cibeureum trans-basin tunnel

Main civil works including metal works consist of construction of diversion tunnel with coffer dams, main and saddle dams, spillway, intake and trans-basin tunnel.

(a) Diversion tunnels and coffer dam

Two 6.6 m diameter diversion tunnels with 462 m and 506 m long are planned 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 tunnels 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) Main dam and saddle dam

Dam foundation treatment would comprise foundation excavation, and blanket and curtain grouting. The total drilling lengths would be 10,300 m for blanket gourting 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.

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 the rock. For core material, the soil at the borrow pits of Sajila 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. Sand and gravel materials for filter would be supplied directly from the borrow pits at Sajira after selection for fine and coarse filter. All rock materials would be supplied from the quarry of Gradog approximately 15 km distant from the dam site. Rock excavation is planned by bench cut.

Work quantities for the saddle dam 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 in three stages, i.e. i) stripping and excavation, ii) blanket and consolidation grout, and iii) embankment.

(c) Spillway

Work 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. Two spillway gates of 12.5 m wide x 12.5 m high each, estimated weight of 270 ton would be installed. Installation of gates would be commenced after the completion of concrete works of the spillway structure.

(d) 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 tunnels 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.

(e) Karian-Cibeureum trans-basin tunnel

The trans-basin tunnel would be a concrete lined tunnel, 1,540 m long with a horseshoe 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. The intake and outlet of 3,400 m^3 in excavation and 250 m^3 in concrete would be done in the open air separately from the other works. The valve shaft of 2.5 m inside diameter and 26 m deep would be construction 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 to excavation work.

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

(2) Cilawang dam and Cilawang-Cicinta trans-basin tunnel

Main civil works including metal works consist of construction of diversion tunnel with coffer dams, main dam and saddle dam, spillway, intake and trans-basin tunnel.

(a) Diversion tunnel and coffer dam

A 6.6 m diameter diversion tunnel with 351 m long is planned 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 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) Main dam and saddle dam

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 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 cofferdam would be a rockfill dam with core. 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. 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 5 km from the dam. Sand and gravel materials for filter would be supplied directly from the borrow pits at Sajira after selection for fine and coarse filter material.

Work quantities for the saddle dam 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 in three stages, i.e. i) stripping and excavation, ii) branket and consolidation grout, and iii) embankment.

(c) Spillway

Work quantities for the spillway would be 115,000 m^3 in excavation, 29,000 m^3 in concrete and two gates of 9.5 m high and 9.0 m wide. The construction work would be made separately from the other works. Two spillway gates of 9.0 m wide x 9.5 m high each, estimated weight of 126 ton would be installed. Installation of gates would be commenced after the completion of concrete works of the spillway structure.

(d) Intake

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

(e) Cilawang-Cicinta trans-basin tunnel

The trans-basin tunnel would be a concrete lined tunnel 1,920 m long with a horseshoe 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. 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. 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 to excavation work.

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

(3) River improvement works

Main items of river improvement works consist of dredging, excavation and embankment, and their work volumes are estimated as follows:

- Dredging	560 x 10^3 m^3
- Excavation	1,404 x 10^3 m^3
- Embankment	521 x 10^3 m^3

Dredging will be carried out in the river section for about 8.3 km upstream from the Pamarayan weir. According to the result of field survey, this section has the water depth from 2 m to 6 m and riverbed materials are mostly of sandy nature on the surface. A 1,000 Hp diesel dredger will be employed with an average dredging capacity of about 25,000 m^3 per month. Spoil from dredging will be deposited into spoil-banks nearby the river.

Excavated soil will be conveyed by dump trucks and partly be utilized for embankment. The rest of them will be deposited into the old channel, which has an enough capacity of about 2.1 million m^3 to receive the soil from dredging and excavation.

Embankment will be carried out with materials from borrow pits nearby and partly with excavated soils. The embankment height will be mostly from 2 m to 3 m in the lower section and mostly from 1 m to 2 m around the city of Rangkasbitung.

(4) K-C-C irrigation facilities

Construction works of K-C-C irrigation facilities mainly consist of i) Buyut diversion works, ii) irrigation and drainage facilities, and iii) on-farm development works.

(a) Buyut diversion works

The Buyut diversion works comprise the diversion channel, weir, intake and closure dam. The construction of the Buyut diversion works would be mostly executed by heavy construction machinery. Through geological investigation and test boring, there found soft rock at 2 - 3 meters below the ground surface at the diversion works site. Stripping and common soil excavation would be mainly made by bulldozer, while soft rock would be excavated by bulldozer with ripper. The excavated common soil would be used as embankment material of the closure dam. In case of the shortage the materials would be supplemented from borrow area near the diversion works site (Ref. Appendix-I).

After completion of the diversion channel, weir and intake facilities, the coffer dam would be mounded up to EL. 35 m to close the river and to divert the river flow into the diversion channel mentioned above. Prior to embankment of main portion of the closure dam, curtain grouting would be executed. After completion of grout holes drilled by hydraulic boring machines, cement milk mixed by mortal mixer would be poured into the holes by grouting pump. For making sure the grouting condition, test hole would be drilled and grouting effect would be checked by observing the lifted core and Lugeon test.

Embankment works would be mainly executed by bulldozer and vibrating roller under the strict control by the D-value, and also the water contents ratio would be checked throughout the construction period. In case of a low natural water contents, proper amount of water should be added by tank lorry so as to maintain the optimum water content of the soil.

(b) Irrigation and drainage facilities

The irrigation facilities consist of headreach, main canal, secondary canals, tertiary canals and their related structures. Stripping and surface excavation of the headreach, main canal and secondary canals would be mainly made by bulldozer, and subsurface and deep excavation, would be done by back-hoe shovel depending on the soil condition at the working site. Soft rock (Tuffaceous sandstone or claystone), which are hard and beyond capacity of back-hoe shovel, would be excavated by bulldozer with ripper. Manpower would much contribute to the tertiary canals construction, face smoothing, compacting of canal invert and minor works.

The excavated materials excessive of filling requirement would be transported to a spoil area.

In case of shortage of materials for filling, the materials would be supplemented from borrow area selected along the canal route. As a result of the soil mechanical and geological investigation, the earth materials along the canals are generally suitable for the embankment (Ref. Appendix-I). The raised and sharply curved portions of the headreach, main canal and secondary canals would be lined with 7 cm thick concrete. After completion of earth works, concrete lining works would be started. Concrete would be produced by portable concrete mixer, at site and placed by manpower. Simple sliding form would be used for the lining.

Earth work for canal related structures would be done by manpower. The structures are mainly made of rainforced concrete or wet stone masonry. The concrete would be mixed by portable mixer at site and placed by manpower.

The drainage facilities consist of main drains,secondary drains, tertiary drains and their related structures. Excavation of drainage canals would be executed by back-hoe shovel and excavated materials be directly used as filling, materials for the construction of irrigation canals and remaining materials would be hauled to spoil areas. Concrete and wet stone masonry works would be constructed in the same manner as that for the irrigation facilities.

(c) On-farm development works

On-farm development works consist of the construction of quaternary system and land grading. The works would be carried out by manpower of farmer themselves under the supervision of the Project office. In order to obtain the irrigation benefit as soon as possible, the construction of on-farm development works would be executed by each tertiary block in parallel with the construction of its tertiary canal.

7.2 Implementation Schedule

The Project implementation schedule is prepared for the following three work categories referring to the construction plan and method mentioned hereinabove, and also required period for engineering design works.

(1) Construction of Karian and Cilawang dams and their related structures

Approximately 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 construction works. Out of which one and a half (1.5) years would be required for the engineering design including field investigation and preparation of tender documents, one year for the preparatory works including loan agreement and tendering, and three (3) years for the main construction works (Ref. Figs. 7-1 and 7-2).

(2) River improvement works

It would also require five and a half (5.5) years for the river improvement works. Major civil works would be commenced from the beginning of 1988.

Construction work is to be executed in the order considering the effect of decreasing water level on Rangkasbitung. Dredging up to No.85 Point upstream from the Pamarayan weir will be started at first and will be completed in 3 years. Next shortcut work will be executed in the section from No.85 Point to No.64 Point in 2 years, which is most effective to lower the flood stage of Rangkasbitung, and Embankment will be carried out from the Pamarayan weir to No.64 Point in parallel with dredging and shortcut. Finally, construction work centers around embankment upstream from No.64 Point including upper Ciujung and Ciberang rivers (Ref. Fig. 7-3).

(3) K-C-C irrigation facilities

Before getting into the actual construction works of the Project, two and a half years (2.5) from the beginning of 1986 would be required for the engineering design and preparatory works. The actual construction works would be commenced in the middle of 1988 and completed by the middle of 1993. The total period for the project implementation will be about seven and a half (7.5) years (Ref. Fig. 7-4).

7.3 Cost Estimate

7.3.1 General Conditions

The project cost is estimated based on the following conditions:

(1) The exchange rate used in the estimate is US$1 = Rp. 1,050 = ¥240.

(2) All the civil engineering works are to be carried on the contract basis using contractor's own machinery.

(3) All the unit rates for civil work items are estimated using the current prices as of November 1984

(4) The project cost comprises foreign and local currency portions. Each currency portion includes the following items:

Local currency component

- labor force
- sand, gravel and wooden materials
- fuel, oil, etc.
- reinforcement bar and other structural steel
- steel slide gates
- cost of land acquisition
- inland transportation costs
- government's administration expenses during the period of the project implementation

- contractor's general expenses and profit
- expenses of engineering services for local consultant
- minor works

Foreign currency portion

- spillway gates, and hollow jet valves
- roller gates for the diversion weir, diesel generators, and motor
- depreciation costs for construction machinery
- vehicles to be required for the construction supervision and O & M equipment
- foreign contractors' general expenses and profit
- expenses and fees of engineering services for foreign consultant

(5) The physical contingency of around 15% of direct cost and the price contingency of 5% per annum for the foreign currency portion and 12% per annum for the local currency portion are included in the estimate.

(6) The associated cost to be financed by the Government, such as the cost for strengthening the extension services, facilities of the water users' association, and improvement of the social infrastructures are not included in the estimate.

7.3.2 The Project Cost

The project cost comprises direct construction costs, land acquisition cost, procurement cost of O & M equipment, administration expenses, engineering services cost and contingencies. The project cost is estimated based on the detail unit cost analysis and quantity calculation of the project works. The total project costs are estimated at Rp. 296,147 million as summarized in Table 7-4. The summary of the direct construction costs for the Karian dam, the Cilawang dam, the river improvement works, and the irrigation facilities of the K-C-C area are shown in Tables 7-5, 7-6, 7-7 and 7-8 respectively.

7.3.3 Annual Disbursement Schedule

The annual disbursement schedule is worked out based on the construction time schedule for each work category (Ref. Figs. 7-1 to 7-4). The summary of the disbursement schedule is shown in Table 7-9.

7.3.4 Annual Operation and Maintenance Costs

The annual operation and maintenance costs include the salaries of project administration staff, the materials and labour costs for repair and maintenance of project facilities, the cost for operation and maintenance of O & M equipment, and the running costs of project facilities including diesel generators. The estimated costs at the full stage of the Project are Rp. 715 million per annum as shown below:

(Unit: Rp. 10^6)

Facilities	Annual O & M Costs
1. Karian Dam	254
2. Cilawang Dam	135
3. Irrigation Facilities for K-C-C Area	275
4. Facilities for Flood Control	51
Total:	715

7.3.5 Replacement Costs

Some of the project facilities, especially mechanical and electrical works have shorter useful life than the civil works, and required replacement at a certain time within the Project useful life. The replacement costs and the useful lives of these facilities are shown below:

Equipment & Facilities	Useful (year)	Replacement Cost (Rp. 10^6)
1. O & M Equipment	10	1,570
2. Project Facilities		
2.1 Karian dam, gate	25	3,252
2.2 Cilawang dam, gate	25	1,732
2.3 Buyut diversion works, gate	25	486
2.4 Irrigation facilities, gate	25	570
2.5 Facilities of flood control works, gate	25	175

VIII PROJECT EVALUATION

8.1 Economic Analysis

8.1.1 General

The Project evaluation is carried out in order to ascertain the feasibility of the project in view of economic, financial and socio-economic aspects. This section is to cover principally the economic analysis by calculating the economic internal rate of return (EIRR) on the foregoing study of the Project.

For the economic evaluation, the following basic assumptions are established.

(1) The economic useful life of the Project is taken as 50 years from 1986.

(2) At the beginning of the above project life, a period of 8 years in total are required consisting of 2 years for detail design and preparation procedure, and 6 years for construction.

(3) The current prices as of November 1984 are used in this evaluation.

(4) The exchange rate of Indonesian Rupiah is taken to be Rp. 1,050 equivalent to US$1 based on the foreign exchange middle rate of the Bank Indonesia at the end of November 1984.

(5) Only direct benefits of irrigation, flood control, and municipal and industrial (M & I) water supply are counted in the evaluation. Indirect and/or intangible benefits are excluded and any other benefits to be derived from the fishery and hydropower generation are not counted.

(6) As to the prospective demands of municipal and industrial water, the most probable mean enforcement of such supply will be made:

municipal water for Rangkasbitung
140 lit/sec effective 1994;

municipal water for 17 IKKs
488 lit/sec effective 1997; and

municipal and industrial water for Cilegon
1,145 lit/sec effective 2000.

Whereas no additional cost is born out of the circumstances mentioned in Subsection 4.4.3.

8.1.2 Economic Prices

For evaluation of economic resources, the assumption of the economic price out of the market price is made provided with the criteria mentioned hereunder.

(1) Standard conversion factor (SCF)

Tariff and trade restrictions introduce a distortion in the price relationships between traded goods and non-traded goods. In order to evaluate the project cost and benefit comparable to the world market price, a SCF is applied to the price of non-traded goods and services. In the absence of trade restrictions, SCF is estimated at 0.85, according to the actual trend of the foreign trade, taxation and surcharges in Indonesia for the last 5 years.

(2) Transfer payment

From the viewpoint of international economy, the transfer payment such as tax, duty, subsidy, interest and contractor's profit is merely a domestic monetary movement without direct productivity. Hence, it is excluded in the economic price of the goods and services.

(3) Economic prices for agricultural outputs and inputs

The economic prices of the farm products such as rice, groundnuts and vegetables and of the farm inputs such as fertilizers and plant protection are estimated based on the projected international market prices of 1984 forecasted by IBRD in the long term range at 1984 constant price. The domestic components are adjusted by the aforesaid SCF of 0.85.

(4) Economic opportunity cost of farm labour

At present, a large part of farming works are generally operated by family labours except for transplanting and harvesting of paddy. Seasonal labours required for the transplanting and harvesting of paddy are mainly hired from small-hold farmers and tenant farmers at the rate of Rp. 1,200/man-day, corresponding to one half of the financial wage, with some food or crop. From such point of view, 60% of the actual market wage is deemed to be economic opportunity cost of farm labour. While, in the estimation of the aforesaid SCF, the conversion factor for consumer goods is also calculated at 0.71. Since it is understood that farmers' revenues is to be disbursed for their daily living consumption except some reimbursement or saving by about 15%, such opportunity cost can be corroborated supplementally as $0.71 \times (1 - 0.15) \doteqdot 0.6$.

(5) Economic opportunity cost of unskilled construction labour

Unskilled construction labour for the Project would likely come from farm households, for which the opportunity to be sacrified by the project is agricultural activities. In addition, due consideration would be required to the extent of some extra premium owing to rather severe temporary work despite the existing majority of underemployment in rural area. Thus, the wages paid to seasonal farm workers are more indicative of the opportunity costs of unskilled construction labour. Consequently, the economic opportunity cost of unskilled construction labour is determined to be 60% of the financial wage rate for such labour with reference to the studies of similar projects.

(6) Construction conversion factor (CCF)

The construction of project facilities is carried out by equipment, materials, skilled and unskilled labours. For the economic analysis, the construction conversion factor is estimated as follows:

(a) Traded component

This component includes imported materials. Since it is traded, the conversion factor is 1.00. This category occupies 54% of the capital cost.

(b) Non-traded component

This component includes skilled labour and locally manufactured materials. The SCF of 0.85 is used as the conversion factor, and 41% of the capital cost belongs to this category.

(c) Unskilled labour

As estimated in the above (5) hereof, the conversion factor of 0.6 is applied to this item, and 5% of the capital cost belongs to this category.

Thus, the CCF (the weighted average of the above components) is calculated at 0.92.

8.1.3 Economic Costs

The capital cost broadly comprises:

i) Cost for preparatory works,

ii) Construction cost for project facilities including the contractor's overhead costs, profit and contract tax,

iii) Cost for land acquisition and compensation,

iv) Procurement cost of operation and maintenance (O & M) equipment, first procurement only,

v) Administration expenses,

vi) Engineering services,

vii) Physical contingencies, and

viii) Price contingencies.

Among the costs mentioned above, all the costs except the contractor's profit, contract tax and price contingencies are counted as the net capital cost to be considered in the economic evaluation. Whereas, the subjected breakdown of land acquisition and compensation at reservoir areas is shown on Table 8-1, and the loss by "production foregone" attended on the possession transfer is properly born as a cost of the project. This net capital cost is further converted into the economic capital cost by applying the CCF estimated in (6) of Subsection 8.1.2.

The economic capital cost thus estimated and its annual disbursement for each feature are as shown below:

(Unit: Rp. 10^6)

Year	Karian Dam	Cilawang Dam	K-C-C Irrigation Scheme	River Improvement	Administration & Engineering Service
1986	-	-	158	-	4,213
1987	2,559	731	-	196	2,272
1988	14,542	5,819	2,237	1,658	3,467
1989	17,086	8,978	8,233	3,654	2,930
1990	17,157	9,616	11,537	4,011	2,608
1991	9,867	4,991	11,151	1,203	868
1992	-	-	6,488	-	653
1993	-	-	1,783	-	330
Total	61,211	30,135	41,587	10,722	17,341

(2) Sunk cost

In view of mutual coordination with the existing Ciujung and Cicinta irrigation schemes, no sunk cost is economically born in this project. Instead, the costs for improvement of canal system and total costs for on-farm development are taken into account as mentioned in (3) of Subsection 8.1.3.

(3) Other construction cost

As mentioned in Section 5.4, increment of agricultural products in both of the Ciujung and Cicinta irrigation scheme areas can be made available with the accomplishment of irrigation water supply in this project. Whereas, it is necessary to invest further costs in addition to the above capital cost for the improvement and rehabilitation of the existing systems. However, since these Ciujung and Cicinta irrigation schemes themselves are out of present "Scope of Work" predetermined by the authorities, such Other Construction Cost is not born financially, but is to be counted as an economic cost corresponding to the projected benefit.

The economic costs for the following improvement and rehabilitation are estimated at Rp. 7.61 billion for (a) Ciujung, Rp. 2.41 billion for (b) Cicinta and Rp. 10.02 billion in total.

(a) Ciujung irrigation scheme area

The existing Right and Left Primary Canals are to be improved to meet future increasing requirement on the canal capacity mainly by raising the canal banks and partly by proving concrete lining. And some rehabilitation works such as dredging of main, secondary and tertiary canals and repairing of the canal structures, and the tertiary development in inundation suffering area of about 1,200 ha will be required for the attainment of the full irrigation development in the scheme area.

(b) Cicinta irrigation scheme area

For the efficient and equitable distribution of the irrigation water over the scheme area, it will be necessary to rehabilitate the existing canal system. The rehabilitation works would include the replacement of gates at check gates and turnouts, reshaping of main and tertiary canals, repair of diversion weir and provision of new structures. In addition to the above rehabilitation works, drainage improvement would be required particularly in the northern part of the scheme area.

(4) Annual operation and maintenance cost

The annual operation and maintenance (O & M) costs by each feature are converted into the economic costs using the CCF of 0.92 as shown below:

(Unit: Rp. 10^6)

Feature	Annual O & M Cost (Economic)
Karian dam	233
Cilawang dam	125
K-C-C irrigation scheme	253
Ciujung irrigation scheme	595
Cicinta irrigation scheme	35
River improvement	47

(5) Replacement cost

The replacement costs are converted into the economic costs using the conversion factor of 1.0 for the gates and O & M equipment mentioned in Section 7.3.

8.1.4 Economic Benefits

(1) Agricultural benefit

The agricultural benefit is evaluated as the difference of net income from crops in future between "without-project" and "with-project" conditions. The benefit will come out immediately after the completion of dam construction, even before the completion of the total canal works. The benefit is expected to increase year by year after start of irrigation and reach to the maximum level 4 to 6 years after the start of irrigation.

(2) Flood control benefit

The flood control benefit is evaluated as an economic counter-effect involved by flood damages on houses, household articles, stock assets of offices and shops, agricultural crops, public facilities and business activities. Immediate realization of this benefit will be expected even before the completion of the river improvement work and succeedingly expanded to the maximum level. As described in Subsection 5.5.3 and Appendix-H, the aforesaid flood control benefit thereof is so estimated on the basis of international boarder price or so bearable against economic evaluation that such assumption can be applied commonly to this economic benefit.

(3) Municipal and industrial water supply benefit

The benefit by the municipal and industrial water is evaluated at the nominal economic rate of Rp. 10 per m^3 under the raw water delivery basis at the dam or canal sites. The economic rate is given by the P3SA as a value currently in practice. The benefit will become due in accordance with the estimated time and corresponding quantitative schedule in (6) of Subsection 8.1.1.

(4) Total benefits

All the above economic benefits per annum through the project life after completion of the built-up are listed as below:

(Unit: Rp. 10^6)

Feature	Economic benefit	Distribution (%)
Agriculture:		
K-C-C irrigation scheme area	16,677	48.7
Cicinta irrigation scheme area	1,841	5.4
Ciujung irrigation scheme area	12,451	36.4
Flood control	2,570	7.5
M & I water supply	699	2.0
Total	34,238	100.0

8.1.5 Economic Internal Rate of Return (EIRR)

Thus and so, the economic cost and benefit with their disbursement and built-up periods are obtained as per the summary below:

Feature	Capital cost	(%)	Construction period (year)	Target annual benefit	(%)	Built-up period (year)
Karian dam	61,211	35.8	5			
Cilawang dam	30,135	17.6	5			
Agriculture:						
K-C-C irrigation scheme area	41,587	24.3	8	16,677	48.7	6
Ciujung irrigation scheme area	7,610*	4.5	4	12,451	36.4	4
Cicinta irrigation scheme area	2,410*	1.4	3	1,841	5.4	4
River improvement	10,722	6.3	5	2,570	7.5	1
M & I water supply	-			699	2.0	6
Adm. and engineering services	17,124	10.1	8			
Total	170,799	100.0	8	34,238	100.0	-

Note: The items marked with "*" belong to other construction cost, (3) of Subsection 8.1.3.

The economic cost and benefit stream is prepared (Ref. 8-2). Then the economic analysis is made which results in EIRR of 14.3%.

Reference is made to the staged development of the Project. Namely the EIRRs for assumptive case 1 (Karian dam precedes Cilawang dam in commencement of the construction with an interval of two years) and assumptive case 2 (The reverse in the order of the above case 1) are calculated at 14.1% and 14.4% respectively. Reference is also made to the cases of the Ciujung river features (Karian dam with irrigation for Ciujung scheme area, river improvement and M & I water supply) and the Cibeureum river features (Cilawang dam with irrigation for K-C-C and Cicinta scheme areas), and the results become 17.3% and 12.5% on calculation basis.

8.1.6 Sensitivity Analysis

In order to evaluate further the soundness of the Project to possible changes of economic situations in future, the economic sensitivity analyses are made for the following critical conditions in terms of EIRR:

(1) Paddy price is decreased by 5% or paddy production cost is increased by 15.2%.

(2) Paddy price is decreased by 10% or paddy production cost is increased by 30.4%.

(3) Compound variations

Project cost is increased by 0, 5 & 10% and project benefit is decreased by 0, 5 & 10% in combination.

EIRRs : (1) 13.8%

(2) 13.2%

(3)

Cost up / Benefit down	(0%)	(5%)	(10%)
(0%)	14.3%	13.8%	13.2%
(5%)	13.7%	13.2%	12.6%
(10%)	13.1%	12.5%	12.0%

8.2 Financial Analysis

8.2.1 General

The financial feasibility of the project is evaluated principally from the viewpoint of farmer's economy. In this connection, the assessment of the amount of water charge to be born by water users is made on preliminary basis. The study on the capability of foreign capital cost repayment is also made on the project level by preparing the cash flow table.

8.2.2 Financial Cost

Based on the current market prices and costs as of November 1984, the financial construction cost of the Project is estimated as shown in Table 8-3 and summarized as follows:

(Unit: Rp. 10^6)

Description	Foreign currency	Local currency	Total
Direct Construction Cost:			
Karian Dam	27,709	23,005	50,714
Cilawang Dam	13,154	13,918	27,072
K-C-C irrigation	19,031	17,691	36,722
River improvement	6,320	3,973	10,293
Office and quarter	-	1,100	1,100
Land acquisition	-	18,149	18,149
Procurement cost of O & M equipment	1,490	80	1,570
Administration and engineering service	10,156	6,233	16,389
Physical contingency	11,678	12,623	24,301
Sub-total	89,538	96,772	186,310
Price contingency	28,622	81,215	109,837
Total	118,160	177,987	296,147

In this estimate, the physical contingencies of 15% of the capital cost, and the price contingencies of 5% per annum for the foreign currency portion and 12% per annum for the local currency portion are considered to be the direct cost.

8.2.3 Capacity to Pay

For evaluation of the Project feasibility from the financial aspect of farmers, typical farm budget analyses are made under both "with-project" and "without-project" conditions as shown in Subsection 4.4.1 and Appendix-F. Therefore the capacity to pay in terms of farm household incremental income by the proposed agriculture is assessed as shown below:

(Unit: Rp./household/year)

Area	Without-project	With-project	Capacity to pay incremental income
K-C-C and Cicinta	152,600	695,800	543,300
Ciujung	365,400	525,800	160,400
Project area	295,900	581,300	285,400

Note: Project area means the relevant 14 Kecamatans which encompass the above irrigation areas.

8.2.4 Water Charge

When the project facilities are completed and water is released to farm, but if the water charge is not collected as usual, all the cost of the Project will have to be financed by the Government, and such expenditure will become a heavy burden to the country. It is generally understood that the water charge is imposed to the water users, and the water charges thus collected is spent for payment of O & M and replacement expenditures incurred to the Project and/or for repayment of the capital cost of the Project. In Indonesia, however, the farmers traditionally are used to not pay any water charge directly.

The annual O & M and replacement costs per farm household are estimated at Rp. 24,750 for K-C-C and Cicinata area, Rp. 11,770 for Ciujung area and Rp. 16,010 for the Project area, corresponding to 4.6%, 7.3% and 5.6% of the respective capacity to pay. On the other hand, the annual scale of amount for the repayment of foreign currency portion of the capital cost with an interest of 3.5% per annum is estimated to be so much as Rp. 250,200 per household in K-C-C and Cicinta area, likewise Rp. 43,520 in Ciujung area and Rp. 110,990 in the Project area. These repayments would be scarcely covered obviously by the capacity to pay from the viewpoint of the farmer's economy.

8.2.5 Repayment of Project Cost

The financial evaluation of the Project is made by examining the repayment capability for the capital cost of the project. For the examination, a financial cash flow statement for the proposed development plan using the anticipated project revenue and fund requirement is prepared as shown in Table 8-4.

In the examination of repayment capability, it is assumed that the capital required for the project implementation will be arranged under the following conditions:

(1) For the foreign currency portion, the capital is financed by bilateral or international organizations with an interest rate of 3.5% per annum for a repayment period of 30 years including a grace period of 10 years.

(2) For the local currency portion, the capital is financed by the budget allocation of the Government without interest and repayment.

8.3 Indirect Benefit and Socio-economic Impact

8.3.1 General

In addition to the direct benefits mentioned in the economic and financial analyses, this paragraph describes the positive or negative indirect and/or intangible benefits and socio-economic impacts to be induced by the implementation of the Project.

The study is made principally in two directions; on the project site from the angle of community well-being and on its surroundings in view of national and regional development aspects. Whereas, the former is made by reconnaissances and also covered in parallel with the land acquisition and compensation survey for submergence in the projected reservoir and weir sites.

8.3.2 The Project Site

(1) Inhabitants

At present, there are 27 Kampungs (substructure of village) with 3007 households in the dam, weir and reservoir sites of Karian, Cilawang and Gadeg. Among them, interviews are made to 149 households with the following occupations.

Area	Nos. of Kampung	Nos. of house-hold	Nos. of sample house-hold	Occupation					
				Farmer	La-bourer	Trader	Officer	Re-tailer	No specific choice
Karian	22	2,487	119	84	13	8	10	3	1
Cilawang	4	437	21	14	2	2	2	1	
Gadeg	1	83	9	7	1			1	
Total	27	3,007	149	105	16	10	12	5	1

Generally, inhabitants show reluctance to be displaced from the land where they have been living for many years and complain about fears caused by the implementation.

Problem	Proportion
Vegitation destruction	42%
Misgiving for land possession	28%
Inundation by reservoir	12%
Disruption of income source	11%
No idea	7%

However, the field survey eventually reveals that the inhabitants agree to the construction by a majority and insist on maintaining same occupations at the neighbouring villages as follows:

Responses to the construction	Proportion	Preferred location for resettlement	Proportion
Agree	58%	Neighbouring village	82%
Disagree	17%	Existing village	6%
No idea	25%	No idea	12%

During the construction, probable negative effect to the inhabitants may be environmental pollution and damages. Nevertheless, it is noted that they are rather looking for their working opportunities out of the construction than these disadvantages.

The results of the study suggest apparently in general that almost no adverse socio-environmental effects can be anticipated at the project sites if the administrative arrangement on displacement to neighbouring areas is feliciously conducted.

(2) Employment and income level

As obviously proved, the largest beneficiary of this Project will be the farmers, but the relevant incremental manpower will be wholly furnished by their household labours and neighbouring tenants with intensification of their operation efficiency. Meanwhile, owing to such activation of agricultural sector and stabilization of livelihood by flood control, employment opportunity will be created locally in the field of these construction works; trading and transportation of the agricultural inputs and outputs; home-industry and labour incentive food-processing industry; and other service industrial sectors.

Through these opportunities, the industrial structures in North Banten area will be reinforced and the inhabitants' income level will also be improved significantly. The agricultural incomes of typical farm households in the project area will grow considerably i.e. 4.6 times as much as the "without-project" condition in K-C-C and Cicinta, the poorest rural area, and twice over whole of irrigation area (Ref. Subsection 8.2.3). Therefore additional earning from these other industrial sectors will contribute efficiently to their well-being.

(3) Infrastructure

In the study area, other than national and provincial trunk roads, the current feeder roads are poor in alignment and maintenance. Hence, they are functioning not well as an overall transportation network (Ref. Subsection 3.3.3). In this connection, improvement and rehabilitation of the feeder roads are expected for the relevant construction work, together with the one between Cikande and Rangkasbitung committed in REPELITA IV.

As a part of this Project, the following facilities will improve remarkably the local traffic.

(a) Inspection roads with gravel metalling in K-C-C irrigation scheme area:

for main canal, 5 m wide, 27 km long; and
for secondary and tertiary canal, 3 m wide, 343 km long in total

(b) Bank road with gravel metalling of the Ciujung river:

both sides of the river between Rangkasbitung and Pamarayan, 3 m wide, 15 km long each

(c) Probable improvement of inspection roads with gravel metalling in Ciujung irrigation scheme area:

for left and right main canal, 5 m wide, 76 km long in total

Furthermore, by the effects of the river improvement work and securing of the river maintenance flow by the dams, river transportation in the Ciujung river especially between Rangkasbitung and Pamarayan would be activated. Also, the transportation on the surface of two reservoirs would stimulate the development of these remote areas. Such water surface will create new tourism resources.

Municipal and industrial water supply will be helpful for modernization of home life and industrialization in the area as well as health and welfare of the people.

As the whole, the convenient access to big markets and public utilities will be so improved that economic growth including manufacturing industries and tourism will be accordingly accelerated.

8.3.3 Project Site Surroundings

(1) Foreign trade balance

After completion of the Project, paddy production is expected to increase remarkably from 237,890 ton in "without-project" condition to 431,150 ton in "with-project" condition every year, this increment corresponds to 131,400 ton of rice per annum. Comparing with rice import record (1,168,800 ton, CIF US$387 million in 1983), such import has a share of 2% among Indonesian total import (US$19,120 million in 1983) and the above increment by this Project corresponds to 11% of the rice total import in quantity and to an import substitute by US$43.5 million.

(2) National and regional development plans

The conceptual approach of this Project has been based on rural development for well-being of the people by optimization of a use of water resources. Coincidentally, the implementation exactly conforms with the principles of the national and regional development plans in all respects (Ref. Section 2.2 and Sections 1.1 & 1.2 of Appendix-A). As already referred, the Project envisages that a predominant number of rural inhabitants could enjoy their impartial and steady lives centering around agriculture and through such course, the country and other regions would be fairly affected for further development.

8.4 Environmental Impact Assessment

Among the several probable adverse effects of the Project on inland fishery listed in Subsection 3.9.2, the effects of the destruction of the sprawling grounds is conjectured negligible since no concrete lining will be applied in the Project thus permitting fish to sprawl on hydrophytes at the waterside, on soils, gravel and sand. Hampering of migration and sprawling by dam construction or by fluctuation in water surface by dam operation will be anticipated. These effects are very difficult to quantity. However, considering the existing small economic value from susceptible river fishing, i.e. 20.25 ton/year (0.15 ton/km of river x 135 km), the effects are considered negligible.

Salt water intrusion to paddy fields by excessive water taking in upstreams by weir or dam will not occur since elevations of paddy field are higher than the river water table. In fact no damage on paddy by salt water has been reported even when at lowest river water table. For safety, maintenance flow of 12.1 m^3/sec at Kragilan gauging station will be discharged.

Salt water intrusion the fishponds or oxygen shortage in fishponds by the excessive water taking in the upstreams by irrigation has been experienced in the downstreams of Ciujung river and Ciujung canals in dry season. This problem will be alliviated by increase in return flow from irrigated paddy fields.

Pollution of fishpond water by insecticide or herbicide sprayed to rice fields is a serious problem to inland fishery. With the intensified irrigated rice cultivation by the Project, this problem will become more serious, communications between fishpond operators and rice growers near fishponds are indispensable for the prevention of the pollution. Unanimous spraying and prompt notice of the spray to fishpond operators guided by extension workers should be assured.

There are no serious problems of soil erosion in the watersheds of dams planned in the present study. The watersheds have high potentiality of soil erosion due to intense rainfall in wet season and locally due to steepness in topography. Misuse of the land such as cultivation of annual crops in steep land will cause serious soil erosion. Proper guidance in land use in the watershed by extension workers will be necessary to conserve watershed through such as contour cultivation, reforestation and stripe cultivation of soil conserving plants.

8.5 Project Evaluation

The results of analysis show that the Project is economically feasible (Ref. Subsection 8.1.4). The Project is also financially viable (Ref. Section 8.2).

During the course of the study, the international market price forecast of rice, projected by IBRD, has dropped drastically all of a sudden. Thus taking this fact into consideration, it is found that the viability of the Project is rather sensitive to changes in paddy production or price. However, in all cases considered, the EIRRs are larger than 12.2% even in the most critical case, which means the Project still remain sound against such changes (Ref. Subsection 8.1.5).

Besides the above nature of the Project, staged development programs are also referred from economic point of view. The EIRRs for time delayed combinations of the structures indicate almost no difference (Ref. Subsection 8.1.4).

The socio-economic and environment studies in Sections 8.3 and 8.4 result the following:

- the negative effects in the case of displacement of inhabitants can be solved if an appropriate administrative arrangement for resettlement to neighbouring villages could be conducted felicitously;

- the adverse effect that may arise from the probable change of natural environment is difficult to quantify, but would not be significant; and

- remarkable contribution to the regional and national economic development is expected.

Hence, from economic, financial and socio-environmental viewpoints, the Project is qualifiable for launching.

IX CONCLUSION AND RECOMMENDATION

9.1 Conclusion

This Project has been formulated as a sole project in the North Banten area purposed to level up the income standard of the area to the level of the West Java Province, and also to level the income depressions which exist in the area. Current feasibility study on the Project is made in conformity with this concept.

The Project consists of many structural components and works as the integral parts such as dams, tunnels, irrigation facilities, river improvement works and minor items. All of these components have to be implemented without any missing components for the purpose to achieve the concept.

As the results of the current feasibility study, it is clarified; that each of the Project components is technically possible; that the whole Project is economically feasible having EIRR of 14.3%; that the economic viability is sound even under recent severe condition of drastic drop of international rice price; and that the Project is financially sound. Because the concept aims at levelling the income standard of the Project area and accordingly of the North Banten area, the Project is socially and socio-economically desirable.

It is, therefore, concluded that the Project is worthy of early implementation.

9.2 Recommendations

As the conclusion of the present feasibility study is as aforementioned, it is recommended that necessary steps for the implementation of the Project are to be taken. Such steps will be composed of administrative matters and technical matters.

Main factors of the administrative matters to be taken up will be the determination of executing agency, the procurement of necessary fund in foreign currency and the preparation of budget in domestic currency as a counterparts fund.

Necessary technical matters to be made by the Government are composed of the hydrologic observation and the geological investigations. Such works are recommended to be commenced earliest.

Existing and available hydrologic data and records concerning the Project planning are not satisfactorily ample. Especially, the flow data of the Ciberang river near the Karian dam site and of the Cibeureum river at Gadeg are extremely important for the Project in many view angles. Automatic gauges have been installed at said sites, but available data therefrom at present cover only less than one year. Hence, it is recommended to continue the observation and maintain high accuracy so that future available data before the implementation start will cover more than one or plural number of hydrologic years.

Both of the Karian and Cilawang dam sites are located in the tuffaceous zone which required special consideration of foundation treatment of high dams. At present, the geological information by drilling and seismic exploration are available to the least extent. Hence, it is recommended to make more geological investigations on two dam sites, especially on the Karian dam site. It is desired that ample data are available before the start of the detailed design works.

TABLES

Table 1-1 **ASSIGNMENT SCHEDULE**

EXPERT			1984							1985			
NO.	SPECIALITY	NAME	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	COUNTERPART
1.	Team Leader	T. ICHIMIYA											M. Yusuf Kardi, M.Sc.
2.	Dam Planner	K. INOUE											Ir. Budi Santoso
3.	Dam/Tunnel Design Engineer	I. SHIKAE											Ir. Agni Handoyoputro &
		S. SAKODA											Muzni Zakarie, B.E.
4.	Hydrologist	T. OHTA											Drs. Agus Praptomo
5.	River Planner	K. WAKAYAMA											I Gusti Made Putera, B.E.
6.	River Design Engineer	S. ISOWAKI											Ir. Susilo Sutrisno
7.	Geologist	M. FUJINAMI											Harry Witanto, B.E.
8.	Soil Mechanic Engineer	K. NAKAMORI											Muzni Zakarie, B.E.
9.	Seismic Exploratory Engineer	K. TERAZONO											Zulkifli E.S., B.E.
10.	Pedologist	K. SAKURAI											Wahyudi
11.	Agronomist/Environmental Assessment Expert	H. IKEWADA											Drs. Hisbullah Rachman
12.	Agro-Economist	M. SHIBATA											Drs. Hisbullah Rachman
13.	Irrigation/Drainage Planner	T. TOMITA											Drs. Sunardi
14.	Irrigation/Drainage Design Engineer	N. NAGAWARA											Poniman Suyono, B.E.
15.	Industrial/Municipal Water Supply Planner	M. KAWAGUCHI											Drs. Hisbullah Rachman
16.	Socio-Economist	R. KUBOTA											Drs. Sumarno Kadarusman
17.	Survey Engineer	H. KOSHIKAWA											Subandi
	Submitting of Report				▲ Inc.R.				▲ Int.R.			▲	D.F.R.

Liaison Officer: Drs. Bambang Trenggono

Remarks: Inc.R. : Inception Report
Int.R. : Interim Report
D.F.R. : Draft Final Report

Table 2-1 POPULATION CENSUSES IN 1961, 1971 & 1980 BY REGION AND AREA

Region	Area (km^2)	Population Censuses			Annual Average Growth Rate of Population (%)			Population Density per km^2 in 1980
		Oct. 31 1961	Sep. 24 1971	Oct. 31 1980	61/71	71/80	61/80	
Indonesia	1,919,443	97,085,348	119,208,229	147,490,298	2.07	2.39	2.23	77
Java	132,187	63,059,575	76,086,327	91,269,528	1.90	2.04	1.97	690
West Java	46,300	17,614,555	21,623,529	27,453,525	2.07	2.69	2.36	593
Banten :	7,607	1,588,184	1,978,459	2,486,813	2.22	2.57	2.39	327
Kab. Serang	1,876	720,169	859,467	1,109,186	1.78	2.87	2.30	591
Kab. Lebak	3,120	427,802	546,364	682,868	2.48	2.51	2.49	219
Kab. Pandegland	2,611	440,213	572,628	694,759	2.66	2.17	2.43	266
Study area :	3,623	1,077,271	1,295,200	1,653,604	1.86	2.75	2.28	456
Kab. Serang	1,876	720,169	859.467	1,109,186	1.78	2.87	2.30	591
Kab. Lebak	1,573	270,749	333,003	411,825	2.09	2.39	2.23	262
Kab. Pandeglang	175	86,353	102,730	132,593	1.75	2.88	2.28	758

Source: Statistical Yearbook of Indonesia 1983, Biro Pusat Statistik, Jakarta and Penduduk Propinsi Jawa Barat 1961, 1971 & 1980, Kantor Statistik Propinsi Jawa Barat

Table 2-2 SUMMARY OF THE FOURTH FIVE YEARS DEVELOPMENT PLAN OF INDONESIA

Description	PELITA III	REPELITA IV		
		Average annual growth rate (%)		
	1983/84	1984/85	1988/89	1983/1988
Population (10^6)	158.1	161.6	175.6	
Annual growth rate to previous year (= 100)	-	2.2	2.0	2.1
GNP (Rp. 10^9) /1	73,692	84,465	138,127	13.2
Per Capita GNP (Rp. 10^3) /1	446	553	787	12.0
Composition of GDP /2 : (%)		100.0	100.0	5.0
Agriculture		29.2	26.4	3.0
Mining		7.4	6.6	2.4
Manufacturing		15.8	19.4	9.5
Construction		6.3	6.3	5.0
Transportation & communication		6.0	6.0	5.2
Others		35.3	35.3	5.0
Inflation rate (%)				
Trade current balance (US$$10^6$)	-4,711	-4,669	-3,231	
Export	19,310	19,875	31,116	10.0
Import	-17,103	-17,287	24,799	7.7
Services	-6,918	-7,257	-9,548	
Government finance /1 (Rp. 10^9)				
National revenue		16,149	35,660	21.9
Current expenditure		10,101	21,520	20.8
Government saving		6,048	14,140	23.7
Foreign aid		4,411	7,203	13.0
Fiscal resource for development		10,459	21,343	19.5
Other investment /1 (Rp. 10^9)	7,482	8,657	18,684	20.1
Total investment /1 (Rp. 10^9)	16,678	19,116	40,027	19.1
Total investment/GNP (%)	22.6	22.6	29.0	

Remarks: /1 : At current price
/2 : At 1975 constant price

Source : Rencana Pembangunan Lima Tahun 1984/85-1988/89

Table 3-1 STRATIGRAPHY OF NORTH BANTEN AREA

		Stratigraphy	Composition	Thickness
QUARTERNARY	Holocene	Alluvial deposits Holocene volcanoes		
	Pleistocene			
	Upper	Terrace deposits		
	Middle	Volcanoes formed after block-faulting and collapse of the Danau comples		
	Lower	Bojong Formation (upper part of the Banten tuffs)	Clauconite, tuffaceous, more or less Sandy marls, with Limestone lenses. Pumice tuffs, Basal conglomerates	200
TERTIARY	Pliocene			
	Upper	Cilegon Formation (Pumice tuff with marine intercalla- tions) and part of the Cikeusik Formation	Pumice tuffs	50
			Pumice tuffs, rich in hornblende	60
			Pumice tuffs	40
			Pumice tuffs, rich in biotite	50
	Middle	Cipacar Formation	Upper part; tuffaceous glauconitic marls, clay, sandstones, andesitic breccia. Lower part; pumice tuffs	400
	Lower	Genteng Formation	Pumice tuffs, rich in plant remains and silicified wood	730
	Miocene			
	Upper		Instruction of hornblende andesite	
	Upper part of the Middle Miocene	Bojongmanik Formation	Marls and clays with browncoal, tuff sandstone andesitic gravels. In the upper part also pumice tuffs.	
	Lower to Middle Miocene	Badui Formation and Lower Bojongmanik Formation	Limestone, marls, clay-shales, Basal andesitic conglomerates and sand stones	
	Lower	Sareweh Formation Cimadag Formation Citarate Formation		

Table 3-2 EXISTING CONDITION OF MONTHLY RAINFALL DATA

BANTEN

NO	NAME	1942	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
8	MAJAU								△	△																																		
9	BOJONG DATAR										○	○					△		○							○						○	○	○	○	○	○	○				○	○		
10	SANGIANG DAMAR											△	○	○	○	△	○	△			△	○	○	○		△	○			○	○	○	○	△	○	○	○	○	△		△			
10 a	BOJONG	○	○	○							○	○	△	○	○	△		△	○	○	△									○	○	△	○	○	○	○	○	○	○	○	△	△	△	
10 b	KADUMLATI											△	△	○	○	○	△							○		△	△																	
11 b	RANGKAS	○	○	○	○	△				○	○	△	○	○	△			△	○	○	○	△	○	△	○	△	○	○	○	○	○	○	○	○	○	○	○	○	○	○	△	△	○	
12	CIBALIUNG	○	○	△	△	△					○	△	○	○	○	△	○	○	○	△	△	△								△	△	△	○	○	○	△	○	○	○		△	△	○	
13	CIMANGGU	○	○	○	△						○	○	○	○	○	△	△	△		△			△	△									△		○	○	△				△	○	○	
14	CILEGON	△	○	○							○		△	○	△	○	○	○	○	○	○	○	○	△	○	△	△						△					△	○	△	○	△	○	
14 a	BAJANEGARA	△	○	○	△						○	○	○	○	○		○	△	△	○	○	○	○	○	○	△	△		△				△				△	△	○	△	△	○		
14 c	KRAMATWATU	△	○	○	△																									△			△	○	△	△	△	△	△	△	△	△	△	
14 d	CILEGON B.P.M.D.																△	○	△	△																					△	△	△	
17	GUNUNG KUPAK																																					○					
18	CIOMAS	○	○	○	△																			○	○	△	△	○	○	○	○	○	○	△	○									
19	PABUARAN	○	○	○	△							△	○	○	○	○	△	○	○	○	○	○	○	○	○	△	△			△		△	○	△	△	○	△			△	△	△	○	
20 a	GUNUNG KARANG	○	○	△	△												△	△	△												△	○	△	△	○		△	△		△	△	△	△	
21	MANDALAWANGI	○	○	○	○	○					○	○	○	○	○	○	△	○	○	○	○	○	△	○	○	○	○	○			△										△			
22	CIMAUK	○	○	○	△	○	△		△	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	△		○	△	△	○		○	○	○	○	○	△	△	△	△	
23	SERANG		○	△	△				△	○	○	○	○	○	○	○	○		○	○	○	○	△	△	○			○	△				△	○	○	○	○	○	○	○	○	△	△	
23 a	SERANG (IRR)	△	○	○	△				△												○	△	△	○			○	△					△		○	○	○	△	○	○	○	△		
23 b	CIMIOENG	○	○	△	○																						○	△					△	○	○	○	△	○	○	○	△			
23 c	KRAMATWETAN	△	○	○	△				△	○	○	○	○	○	○	△	○	○	○	○	○	○	○	○	△	△	○	○	○	○	○	△	○		○	△		○	○	△	△	△		
23 d	SOEKALILA	○	○	△										○	○	○	○	○	○	○	○	○	△																					
23 e	SINGAMERTA (K.P)	○	○	○	△								△	○							△	○	○		△			○		○	△	○	○	○	△	○								
23 f	CIRUAS										○	○	○	○	○	○	○	△	○	○	○	○	○	○	○	△	△	○		△	○	○										△	○	
23 g	KALENPENTUNG										○	○	○	○	○	○	○	○	○		○	○	○	○	△	△	○				△	○	○									△	△	
24	BAROS	○	○	△	△						○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	△		△	○	○	○	△		○	○	○	○	○	△	○		
24 a	NYAPAH																○	△	○	○	○	○	○	○	○	○	△	○			△	○	○						△	△	△	△	○	
24 b	PETIR																															△	○	○				○	○	△				
26	PANDEGLANG	○	○	○			△			△	○	○	○	○	○	△	△	△	△	△	△	○	△	○	○		△	○	○	○	○	○	○	○	△	○	△	○	○	○	△	○		
26 a	CIKAREO																○	△	○	○	△			○									○	△	△	△								
26 b	CILELES	○	△	△	△						△	○	△	△	○	○	△	○			△	△	○	△								△	○	△		△	○					○		
26 c	WARUNGGUNUNG	○	○	○	○						△	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○			△	△	○	△	△	○	△	△	○	○	○	△				
27	GUNUNG KENCANG	○	○	△	△						△	○	○	○	○	○	○	○	△	△	○	△	○	△	△	△				△	△	○	○	○	○	△	○	○			△			
28	MUNJUL	○	○	○	○						○	○	○	○	○	○	○	△	○	△	△	○	○	○	△							△												
29	GUNUNG KENDENG	○	○	○	△						○	○	○	○																														
30	CIKEUSIK	△	△								○	○	○	○	○	△	△	○	○	○	△		○	△	△			○	○	△							△							
31	MALINGPING	○	○	○	△					△	○	△	○	○	○	○	○	○	○	○	○	○	○	○	△			○		△	○	○	△	△	○	△	○	○	○	△		○		
31 a	KANDANG SAPI	○	○	○	△																																							
32	TANARA											○	○	△																							△							
32 a	JEUNGJING	○	○	○	○	○			○	○	○	○	○	○	○	○	○	○	△	○	○	○	△	○	△	△	○				△	○	○	△										
32 b	KEMAJUNGAN	○	○	△	△						○	△	○	△																														
32 c	RAGASILIR											○	○	○	○	○	○	○	○	○	△	○	○	○	○	○	△	△	○		△	○	○	○										
33	PARIGI / CIKANDE	△	△	○							○	○	○	○	○	△	○	○	○	○	○	○	○	○	△	△	○			△	○	○	○							△	○			
35	PAMARAYAN	△	○	○	△				○	○	○	○	○	○	△	○	○	△	○	○	△	○	○	○	○	○	○	○		○	○		○	○	○	○	○	○	○					
36 a	MAJA								○	○	○	○	○	○	○	○	○	△	○	○	○	○	△	○	○	○	○	○		○	△		○					△	△	○	△			
37	RANGKASBITUNG	○	○	△	○	○	△				○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	△		△	○	○	○	○	○	○	○	○	○	○	○	○		○		
37 b	CIKADU										○	○	○	○	○	○	○	○	○	○	△		○	○	○	△		○			○	○	○	○	○	○	○	△	△			○		
37 c	CIMARGA					○					○																					○					△							
37 e	CIMARGA	△	△								△		○	△	○	○	○	△	△												△	△	○	○	○	△	△	△	○	△				
37 f	CISALAK BARU										○	△	○		○	△	△	○	○	○	○	○	○	○	○	○	△	○	○	○	○	○	○	○	○	○	△	○	○	○	△			
37 g	JINTHNIH											○	○	△	○	△	△	○	○		○	○	○	△																				
37 h	PANANCANGAN											○	○	○	○	○	△		○	△	○	○	○	○	△	○	△		○	△	○	○	△											
38	LEUWIDAMAR	○	○	○		△					○	○	○	△	○	○	○	△	○	△									○			△					△							
38 a	SAMPANG PEUNDEUY																△	△	○	○	△	△	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	△			
38 b	WANTI			△																															△									
38 c	CIKOPEK (PASIR KOPPO)																○	○		○	△	△	○	○	△	○																		
38 d	GUNUNG RUNGGAL											○	○	○	○	○	△	△	○	○	○	○	△				△	○	○	△	○						△							
38 e	BANTAR JAYA																												○		△	○	○		○	○								
39	CICARUNGEUN		○	○	△																																							
40	BOJONG MANIK	○	○	○	△	△					△	○	○	○	△		△	△			△			○	△	○				△		○	△	△	○	△	○	○	△					
41	PASIR AJUNAN																○	○	○	○	○	○	○	○	△	○	○	△	○															
42 a	SAJIRA	○	○	△	○	○					○	○	○	△	○	△	△	△	△	○	△				○	○					△	○	○				△	○	△	△				
43	MUNCANG	○	○	○	△	○					○	△																			△	○					○							
43 a	PANGGARANGAN	○	○	○						○	△	○	○	○	○			○	△	○	○	○	○	△	○	△	△	○	○	○	○	△	○	○	○	○	○	○	○	○	○	△	○	
43 b	CILAKI											○	○	○	○	○	○	○	△	○	○	○	△			○		△			○	○	○	○	○	○	○	○	○	○		○		
44	CIPANAS	○	○	△	△						○	○	○	○	○	△	○	○	○	○	○	○	△	△	△	△	△		△						△	△	△	△				○		
44 a	BANJAR IRIGASI											○	○		○	△				○	△	○	○	○	△		○		△	△		○		○	○	○	○			△				
45	LEBAK PARAY																												△															
45 a	CIROTAN																																			○						○		
	BAYAH (EAST)																																									○		

JAKARTA

NO	NAME	1942	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
2	JASINGA								○	○	○	○	○	○	○	○	○	○	○	○	△				△	○		○	○	△	○	○	△	○	○	○	○	△	○	○	△	△	△		
2 a	PERK. CIKOPO MAJAK										△	○	○	○		○	△	○	○	△	△	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	△	○	
2 b	PINTU AIR JENGKIL																																											
3	KEC. PABUARAN																																											
5	KARANG BOJONG																																											
5 a	CURUG									○																																		
6 a	CIMARACA				△					○	△	○	○	○	○	○	○	○	○	○					△																	△	△	
11	CISARUA																																										△	
12	CIPEUNDEUY KIARAPANDA																																											
14	TOGE																																○	○	○	○					△	△	
15	CIRANGSAD	△								○	○	△	○	○	○	○	○	○	○	○	○	△	△		○	△	△	△		○	△	△	△	○	○	○	△		△	△		△		
16	CIKASUNGKA (CIGUDEG)									○	○	○	○	○	○	○	○	○	○	○	○	○	○	△	○	○	△		△		△		○											
21	PROY. KELAPA CIHUNI	△		△	△																																					△		
21 a	PERKEBUNAN CIANTEN									○	○		○	○	○	○	○	○	○	○	○	○	○	○	○	○	△		○	△	○	○	△	○	○	○	○				△			
21 b	PLTA KRACAK	○			△			○	○	○		○	○	○	○	○	○	○	○	○	○	○	○	○	○	△	○	△	○	○	○	○	○	○	○	○	○	○			○			
25	KOMP. KEC. MAUK		△	△	○							△	△	○	○	○	○	○	○	○	○	○	△	△	△	○																		
25 a	KRESEK		○	△	○																										○	△	○	○	○	○	○	○	○	○	△	△	△	
25 b	BALARAJA		○	○	○					○	○	○	○	○	○	○	○	○	○	○	○	○	○	○							○	○	△	○	○	○	○	○	○	○	△	△	△	
25 e	BUMIAYU									○	△	○	○	○	○	△	○	○	○	○	△	○	○	○	○	△	△	○	○	○	○	△	○	○	○	○	○	○	○	○	○	△	△	
25 f	HAL. KANTOR PS. KEMIS																																○	○	○	○	○		○	△				
25 g	SPATAN																																○	○	○	△			△		△			
25 h	LONTAR BENYAWAKAN																																○	○	○	○	△		○	△	△			
25 i	KARANG KOMBONG																																○	○	○	○			○	○	△			
25 j	CIBOJONG																																		○	○	△		○	△	△			
25 k	BOJONG JAKARTA																																		○	△	△			△	△			
30 a	CURUG (BPMD)	○	○	△	△			△	○	○	○	△	△			△	△	○		○	○	△	○	△	△	○				△	○	△	○	○		○	△	○						
30 b	TIGA RAKSA	○	○	△	△					△	○				△	○	△	△	△	○							△	○	○	△			△											
30 c	PARUNG PANJANG	○	○	△	○		△			△	○				○	○	△	○	△				△	○	○	△	○	△	○	○	○	○			○	○	○	○		△	△	△	△	
31 a	PONDOK JAGUNG									○	○				○	○	○	△	○	○	△		○	○	△	○															△			

Remarks; ○ Available Data

△ Partially Available Data

Table 3-3 LIST OF METEOROLOGIC STATIONS

Station	Installed by	Period of Observation
Serang	PMG	1972 - 1983
Padarincang	P3SA	1978 - 1983
Cikadu	P3SA	1978 - 1983
Cadasari	P3SA	1978 - 1983
Cileles	P3SA	1978 - 1983

River	Location	Catchment Area (Km2)	Type	Installed by	Established Date	Water Level Data
Ciberang	Cileuksa	58	A	T.A	1929	1929,1934
Ciberang	Sajira	233	S	P3SA	1977	1978-1983
Ciberang	Sabagi	233	S	DPMA	1984	-
Cisimeut	Leuwidamar	183	A & S	P3SA	1979	1980-1983
Cisimeut	Pariuk	458	S	P3SA	1977	1978-1979
Ciujung	Cileles	216	A & S	P3SA	1978	1978-1983
Ciujung	Rangkasbitung	1.383	A & S	DPMA	1969/1970	1972-1983
Ciujung	Pamarayan	1.451	S	DPU	-	1975-1983
Ciujung	Kragilan	1.812	A & S	DPMA	1969	1970,1972-1975,1978-1983
Cibeureum	Gadeg	117	A & S	DPMA(A) & P3SA(S)	1982 (S), 1984 (A)	1983 (S)-(A)
Cidurian	Tanjung	265	S	P3SA	1978	1978-1983
Cidurian	Kopomaja	304	S	DPMA	1969	1970-1983
Cidurian	Rancasumur	-	A & S	P3SA	1978	1979-1983
Cidurian	Parigi	649	A	DPMA	1969	1970-1975

Remarks ;

A; Automatic recorder

S; Staff gauge

Table 3-5 RECORDED MONTHLY MEAN DISCHARGE (1/2)

Unit: m^3/s

(1) Kragilan Station (Catchment Area = 1.812km2)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Average	Annu Run- (10^6m
1969	-	-	-	-	-	-	-	-	-	40.6	38.2	42.7	-	-
1970	78.1	204.3	132.4	164.7	193.6	133.8	40.0	18.4	40.9	48.1	115.7	225.5	116.3	3,667
1971	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1972	308.0	159.4	184.9	90.2	127.6	24.2	87.9	15.8	17.1	7.4	25.6	34.1	90.2	2,844
1973	196.6	146.8	165.7	183.9	71.1	111.8	43.8	61.1	123.0	124.0	135.4	136.2	133.3	4,203
1974	276.9	196.0	64.6	101.1	155.4	59.0	84.9	110.7	271.5	100.6	112.5	79.7	134.4	4,238
1975	73.5	169.3	150.4	134.0	120.8	32.4	56.3	48.0	145.5	74.6	91.9	191.9	107.4	3,386
1976	398.4	120.9	144.0	80.6	37.0	19.6	10.2	10.9	4.5	26.4	64.5	28.6	78.8	2,485
1977	186.1	146.0	198.3	150.4	125.2	78.7	15.0	5.0	5.1	5.0	11.0	38.4	80.4	2,535
1978	190.7	91.5	163.5	111.5	68.5	49.0	51.3	65.6	85.8	92.5	116.9	93.6	98.4	3,103
1979	236.7	160.6	45.2	129.4	62.1	30.2	28.5	14.5	21.1	21.2	95.4	-	(76.8)	(2,422)
1980	290.2	147.3	79.2	98.2	84.4	24.0	29.5	90.7	63.3	47.6	87.9	123.3	97.1	3,063
1981	275.5	166.6	149.6	103.6	119.1	-	120.5	60.1	87.1	93.5	175.0	131.5	(134.7)	(4,248)
1982	314.5	118.6	56.0	118.6	39.6	26.4	7.9	5.0	7.8	5.0	-	-	(69.9)	(2,205)
1983	-	55.6	64.4	64.2	52.3	25.0	15.3	4.5	1.3	-	-	102.5	-	-
1984	158.2	167.5	165.6	-	-	-	-	-	-	-	-	-	-	-
Average	229.5	146.5	126.0	117.7	104.4	51.2	45.5	41.6	67.2	52.8	89.2	102.3	97.8	3,084

(2) Pamarayan weir station (catchment Area = 1.451 km^2)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Average	Annu Run- (10^6m
1975	90.1	75.4	67.8	162.6	148.8	88.7	122.8	178.8	370.0	120.6	157.0	489.5	172.7	5,446
1976	959.0	376.5	268.9	114.9	70.2	45.1	21.5	21.9	15.0	38.3	72.7	54.5	171.5	5,408
1977	157.3	110.1	164.6	191.6	129.7	83.7	31.9	14.4	15.2	13.0	34.8	29.5	80.5	2,539
1978	158.1	83.3	151.4	97.6	77.0	51.7	41.9	76.3	81.0	29.2	-	72.4	83.6	2,636
1979	124.9	-	102.7	151.2	21.9	28.0	41.9	18.8	37.7	30.9	-	53.6	61.1	1,927
1980	287.1	196.4	58.5	76.3	121.5	100.2	78.8	95.0	93.5	77.0	61.7	148.5	116.2	3,665
1981	162.4	178.9	136.7	116.0	140.8	139.0	161.8	101.5	98.5	99.9	123.7	104.7	130.4	4,051
1982	277.4	112.0	59.2	122.3	67.6	49.8	24.6	10.5	-	-	80.0	62.5	86.6	2,693
1983	94.8	57.9	54.2	47.6	74.3	26.8	14.3	12.8	15.5	-	-	-	-	-
Average	256.8	148.8	118.2	120.0	94.6	68.2	539.5	58.9	90.8	58.4	86.7	126.9	112.8	-

(3) Rangkasbitung Station (Catchment Area = 1.383 km^2)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Average	Annu Run- (10^6m
1969	-	-	-	-	-	-	-	-	-	-	52.8	63.4	-	-
1970	73.6	201.1	211.1	223.2	143.9	132.2	90.2	30.5	(72.0)	51.7	113.5	208.5	129.3	4,078
1971	177.7	263.9	166.1	91.2	-	-	-	-	-	-	120.7	90.2	-	-
1972	260.0	141.3	187.0	80.8	103.5	24.2	13.5	23.7	6.7	9.3	34.1	63.2	78.9	2,488
1973	166.4	110.8	139.0	172.8	188.8	105.9	48.5	63.6	124.8	109.0	101.0	130.9	121.9	3,844
1974	189.5	143.3	149.7	115.4	127.5	58.2	65.6	91.0	184.1	96.1	80.0	88.2	115.7	3,649
1975	102.8	162.3	105.8	55.4	70.7	42.4	62.0	90.8	135.3	74.8	129.5	198.8	102.6	3,236
1976	281.0	99.6	129.9	94.9	61.9	37.7	23.4	24.3	15.0	43.9	76.0	50.4	78.2	2,466
1977	(158.4)	110.9	155.7	144.4	(133.8)	73.9	29.8	21.8	15.5	(24.6)	27.4	46.5	(78.6)	2,479
1978	182.9	89.4	134.9	85.8	(70.0)	(69.1)	61.1	83.5	71.9	78.8	94.6	91.4	(92.8)	2,927
1979	132.5	150.7	123.6	164.5	63.6	40.4	44.6	26.4	32.7	33.1	96.7	81.0	82.5	2,602
1980	183.2	127.8	66.2	100.2	89.7	46.9	51.2	88.1	89.3	69.7	96.0	124.9	94.4	2,977
1981	191.1	127.3	142.5	106.7	123.2	149.7	127.8	90.1	108.2	103.3	(143.2)	(124.0)	(128.1)	4,033
1982	237.0	87.7	45.2	84.6	59.8	25.8	21.3	8.9	6.0	15.7	84.8	103.4	65.0	2,047
1983	128.6	99.4	90.4	80.3	106.3	60.6	43.3	32.5	33.5	64.0	147.6	(128.8)	84.6	2,668
1984	162.4	167.2	-	-	-	-	-	-	-	-	-	-	-	-
Average	175.2	138.8	142.1	114.3	103.3	74.4	52.5	51.9	68.8	59.5	93.2	99.3	96.4	3,038