APPENDIX F

ENVIRONMENT

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1. INTRODUCTION

The discussion in this Appendix is directed mainly towards water-related problems, i.e. inland fishery, Ranca Danau Nature Reserve and watershed management, taking into consideration their relevance to the water resources development study.

The data and informations are mainly obtained from the government authorities concerned as follows; Agricultural Office, Fishery Office, and Plantation and Estate Office of the Kabupatens of Serang, Lebak and Pandeglang; Agrarian Office of the Province of West Java; Botanical Gardens in Bogor, Soil Research Institute, Directorate of Nature Conservation and Wild-life Management, and Directorate of Reforestation and Land Rehabilitation in Bogor.

2. WATER USAGE FOR INLAND FISHERY

2.1 General

In Indonesia, the policies, programs and priorities for fishery development have been set forth in the Third Five Year Development Plan (REPELITA III). As for the fishery, REPELITA III emphasizes the improvement of living standard and export promotion through increase in fish production. For this purpose, intensification, extensification and diversification of fishery are envisaged in practice.

Inland fishery comprising fresh water and brackish water fishery is playing an important role in Indonesia. According to the National Statistics in 1978, inland fishery produced 420,000 tons in the whole country. Out of them, 130,000 tons were caught in Java and 74,000 tons in the Province of West Java. In the Study Area, however, a very few freshwater fish catch is landed at present, although there are numerous brackish water ponds in Serang. In this view, it is expected that the new water impoundment under the proposed water-related projects will become the new fishing ground for inland fishery. In addition, expansion of year-round irrigation area is expected to accelerate fish culture on wet paddy fields.

2.2 Present Condition of Inland Fishery

2.2.1 Fishing ground

In the Study Area, there are several kinds of fishing ground such as freshwater ponds, wet paddy fields, cages, rivers, swamps, reservoir and brackish water ponds. These are classified into two groups according to fisheries activities. One is fish catching in natural water, the other is fish culturing in artifically impounded water. As of 1981, areal extent by fishing ground in the Study Area is estimated as shown in Table F-1.

Freshwater ponds are scattered in the Study Area and used for the fish culture ponds in combination with rice field fish culture. Wet paddy fields are, however, used for the fish culture to very limited extent which is estimated to be 1.2% of the total wet paddy fields of 93,000 ha. Fish culture in cage in the Study Area has been recently introduced from such advanced districts as the Kabupatens of Majalaya, Sukabumi, Cianjur and Bogor, but it is still under experimental stage. Fishing in river is mainly carried out in the two river systems, Ciujung and Cidurian. Fish culture in the brackish water ponds distributing in the coastal area along Banten Bay is most active in five Kecamatans, i.e. Bojonagara, Kramatwatu, Kasemen, Pontang and Tirtayasa, in the Kabupaten of Serang.

2.2.2 Fishing methods and gears

The most intensive fish culture method is to place bamboo fence partitions or bamboo cages in streams and ponds, to plant seeds in these partitions or cages and to grow fry by feeding. Though this method has been recently introduced into the Study Area and its scale is still very limited, high potentiality can be expected in future. On the other hand, no traditional fishing method and gear peculiar to the inland fishery in the Study Area have been developed due to lack of broad water surface suitable for undertaking a large-scale inland fishery.

2.2.3 Fish production

Table F-2 shows the recent fish production by fishing ground and fish catch per unit area in 1981. As seen in Table F-2, there is a wide range of fish catch per unit area. The rice field fish culture shows very low yield, though it is promoted by the Government. The fish catch in the freshwater ponds is estimated to be Rp 315,000 based on the fish market price of Rp 1,500/kg in 1982, which is equivalent to gross income obtained from wetland paddy yield of 2.3 ton/ha based on the market price of Rp 135/kg as dry paddy. Ikan Mas (Ciprinus carpio) is the mainstay of freshwater pond culture, although Nila (Tillapia nilotica) and Mujair (Tillapia mozambica) also contribute to some extent. In brackish water pond culture, more than half of the fish catch consists of Mujair and Bandeng (Chanos chanos or Milk fish).

2.3 Water-related Project and Inland Fishery

2.3.1 New fishing potential expected from new water impoundment

In the Study Area, 16 possible dam sites on seven rivers are found. From them, seven dam sites are selected in the present study. If these dams are fully constructed, a total of 47.7 km^2 in reservoir area will be created. Out of seven dams, it is proposed that two dams, Karian and Cilawang, are constructed by 2000.

The proposed Karian and Cilawang dams will form a reservoir of 1,040 ha on the Ciujung river and 500 ha on the Cibeureum river, when these two reservoirs are operated to keep the normal water level. In general, deep reservoirs have less fishery productivity compared with shallow reservoirs. Further, construction of dam has an adverse effect on fish fauna in the downstream reaches of the Ciujung and Cibeureum rivers resulting in decrease in fish catch to some extent. On the contrary, the fishery production in the proposed reservoirs is expected to surpass thoroughly the said production loss because the fish catch in the river is quite low as shown in Table F-2. The freshwater fish production expected by the construction of these two dams is estimated to be 410 ton/y at the Karian reservoir and 100 ton/y at the Cilawang reservoir, based on the fish catch per unit area of 0.21 ton/ha/y at freshwater ponds in the Study Area in 1981.

2.3.2 Irrigation farming and rice field fish culture

The Government promotes the spread of rice field fish culture to the whole country. At present, rice field fish culture extends over 1,100 ha being equivalent to 1.2% of the total wet paddy fields in the Study Area. The land in the Study Area is fully developed for agriculture, especially for wet paddy fields. Under such condition, the intensive use of land through the provision of new irrigation facilities and the rehabilitation of existing irrigation facilities is envisaged in the agricultural sector. The stable irrigation water supply to wet paddy fields will also make certain of the expansion of rice field fish culture. On the other hand, with intensification of farming practices, water quality will be declining due to the application of agro-chemicals supported by BIMAS and INMAS program. In addition, there are some constraints for fish culture as follows:

(1) To move fry grown on wet paddy fields to freshwater fish pond is required for the maturation of fry. In the Study Area, however, there is no additional land suitable for constructing freshwater fish pond.

(2) Lack of hatchery or spawning ground causes provision of seeds in high cost to developer.

Therefore, the rice field fish culture under the intensive agriculture seems to have less potentiality in future.

2.3.3 Fish culture in brackish water pond

Although the brackish water ponds distributed along Banten Bay are using water taken from estuaries of rivers, the pond water is strongly influenced by the sea water, especially in the dry season. The salinity contents may come to a same level with sea water when river flow becomes minimum. In the wet season, the ponds are sometimes damaged by flood which is main constraint for the fish culture in the brackish water pond. The proposed flood control plan will protect the brackish water fish pond area.

New delta has been developed at the estuaries of main rivers, Ciujung and Cidurian, under the balanced siltation between ocean current and river flow discharge. On such fresh land, numerous fish ponds have been newly constructed at the risk of developer. Hence, the further investigation to clarify the mechanism of delta formation will be required prior to the detailed planning for dam construction.

2.4 Water Demand for Inland Fishery

At present, fish culturing on wet paddy fields, fresh water ponds and cages and fish catching in rivers and swamps in the Study Area depend on freshwater surface. Out of these fishing grounds, freshwater ponds with the water surface of 665 ha mainly distributing along the

Ciujung river have year-round water demand individually. According to the interviews, fisheries offices concerned have the following development strategy for inland fishery:

(1) to increase yield per unit area;

(2) to furnish technical advice or training to the fishermen;

(3) to rehabilitate fish market facilities;

(4) to establish the hatchery and spawning ground; and

(5) to rehabilitate irrigation canal.

This strategy means that development priority will be given over intensive use of fishing grounds and new water demand will not be created.

In view of the trend of intensification in agriculture, the development of new freshwater fish ponds will be confined to the uplands southward of the Study Area rather than lowlands which are fully developed for wet paddy fields. In this case, it is required that the top of the cultivated land in the valleys are usually allotted to new freshwater fish ponds.

The Kabupaten Office of Pandeglang has a plan to increase the hectareage of freshwater fish ponds from 19 ha in 1984 to 95 ha in 1988 within the Study Area under the Fourth Five Year Development Plan (REPELITA IV) in addition to the existing hectareage. However, this trend cannot be applied to other areas due to less room for the development of new freshwater fish ponds.

In general, the water depth of 1 m should be retained for intensive fish culture. Assuming that the hectareage of fish ponds in the Kabupatens of Serang and Lebak in 1981 and Pandeglang in 1988 is maintained in 2000, the total freshwater demand estimated for fish pond culture in the Study Area will increase from 7×10^6 m^3 in 1981 to 8×10^6 m^3 in 2000. This demand could be met by surplus runoff in the wet season. For the limitation of land and water resources, it is recommended that inland fishery in the Study Area is promoted depending on the intensification of present fish culture through establishment of hatchery or spawning ground and strengthening of seeding and feeding which will ensure success to increase the unit yield.

3. RANCA DANAU NATURE RESERVE

3.1 Background

The Government of Indonesia plans to increase its natural parks and reserves in face of accelerating disruption of forests due to commercial logging and transmigration projects from overpopulated Java to less populated islands. The existing protected area totals 284 units and 11 x 10^6 ha, comprising game reserve, nature reserve, conservation forest and national park. Out of these, 44 units with the total area of 119,000 ha are distributed in West Java.

In the North Banten area, there are three protected areas, i.e. Ranca Danau, Pulau Dua and Tukung Gede. The Ranca Danau Reserve has been authorized since 1921, the Pulau Dua Reserve since 1937 and the Tukung Gede Reserve since 1979. All of them occur in the Kabupaten of Serang and occupy 4,208 ha in total.

The Ranca Danau Reserve is the most attractive among the three in terms of size and unique of freshwater swamp, which is located in a caldera formed in the upper part of the Cidanau river basin. This Reserve, covered 3,791 ha in 1921, has been destroyed by illegal farming. According to the list of reserve/park published in 1981, the Ranca Danau Reserve has an extent of 2,500 ha. The Directorate of Nature Conservation and Wildlife Management (PPA) delineated the boundary of the Ranca Danau Reserve on the map without any kind of field investigation. According to the map provided by PPA, the total area is estimated to be 4,600 ha comprising swamp portion of 3,300 ha and mountain portion of 1,300 ha. Species names of flora and fauna reported by Mr. J. Wind under FAO National Parks Development Project in 1977 are summarized in Table F-3. However, these reserved areas are still in jeopardy by man-made invasion activities.

3.2 Present Status of Ranca Danau Reserve

Based on the interpretation of aerial photographs of 1/20,000 in scale, taken in March 1980, and the present field survey, the present status of the Ranca Danau Reserve are examined and its result is shown in Table F-4 and illustrated in Fig. F-1. Out of six land use categories which are identified within the area delineated by PPA under the present study, the main one in the Ranca Danau Reserve is the freshwater swamp forest occupying 1,230 ha followed by swamp of 830 ha. It is observed that 1,260 ha are still kept under natural condition of freshwater swamp forest, swamp grown with aquatic plants and montane forest in the swamp portion of PPA's delineated area. On the contrary, 830 ha in total of these three land use categories have been disturbed by cropping and logging activities.

Freshwater swamp forests develop on the natural levees along the old river courses and the present river trails, and slightly heightened lands surrounding the swamp. Timber trees in these swamp forests are primarily evergreen and of two to three storeys; the emergent storey of 20 to 30 m in tree height, the main storey of 15 to 20 m and the under storey of 10 to 15 m. The ground surface and swamp are deeply submerged for the period of the wet season. The perennial open water area is confined to the present river trails to limited extent. No facilities or marks to protect the man-made invasion activities are found, because deep inundation in the wet season guards against such invasion as extension of land use for the cropping and logging purposes to the swamp and the freshwater swamp forests.

The montane forests which have developed at the escarpment northward of the caldera were investigated by FAO expert in 1977 and have been proposed to be included into the Ranca Danau Reserve in order to maintain the whole watershed of swamp and to accomplish conservation of the vergin tropical rain forests. According to the map provided by PPA, the mountain area delineated totals 1,300 ha including forests of 930 ha. Among these forests, 600 ha are kept under natural condition of montane forest, freshwater swamp forest and swamp in the mountain portion of PPA's delineated area. The lands after logging are used for shifting cultivation of upland rice, maize and groundnuts, and then they gradually change to plantation area growing coffee, clove and coconut.

3.3 Recommendations to Reestablish Boundary of Ranca Danau Reserve

Insofar as the boundary established by PPA is concerned, the conservation of the Ranca Danau Reserve will be accomplished effectively taking into account the fact that the whole Reserve necessary to protect are included into the protected areas. However, it is the minimum requirement for realizing PPA's plan that an agreement is made between the Government and local people to set up a new boundary based on the present land use situation of the Ranca Danau Reserve.

In the caldera, at present, about 4,100 ha are cultivated for wetland paddy. Out of these wet paddy fields, 1,410 ha are taken in PPA's delineated area. Most of the wet paddy fields are under the rainfed condition. The growing season starts from November and ends in July. Average unit yield of dry paddy is estimated to be 1.5 to 2 ton/ha. The paddy yield is low in the wet paddy fields nearby the swamp by the effect of deeply inundated water during the growing period. The expected annual paddy production from PPA's delineated area is estimated to be about 2,500 tons which can meet the annual demand for about 10,000 persons.

The ecosystem of swamp and freshwater swamp forests depends largely on the water balance between outflow from and inflow into the caldera. The water balance in the caldera is totally controlled at the outlet of the caldera from which the Cidanau river flows downward. Unless the discharge of the Cidanau river is stored or diverted at a place where the water balance in the caldera is adversely affected, swamp and freshwater swamp forests will be kept under natural condition. Therefore, man's activities for the cropping and felling purposes will become harmful to the conservation of the Ranca Danau Reserve.

From the discussion mentioned in the above, several alternatives for reestablishing the boundary of the Ranca Danau Reserve are proposed as follows:

Case 1 The new reserve consists of the whole of PPA's delineated area of 4,600 ha. This area includes wet paddy fields of 1,410 ha, coconut and other tree crop areas of 170 ha, and cleared land of 240 ha in addition to montane forest, freshwater swamp forest and swamp of 2,780 ha in total.

Case 2 The new reserve of 2,780 ha comprises swamp of 860 ha, freshwater swamp forest of 1,310 ha and montane forest of 610 ha which are presently kept under undisturbed and disturbed conditions. The new reserve has no wet paddy fields.

Case 3 The new reserve is 2,880 ha including the Case 2 area and wet paddy fields of 100 ha distributed at the inlet of the swamp into which the upper reaches of the Cidanau river flows.

It is clear that the Ranca Danau swamp has land resources potential for agricultural development to large extent. In the Case 1, it is required to compensate production loss which will occur in the existing wet paddy fields included in the new reserve area, even though illegally cultivated. To transmigrate farmers who cultivate these wet paddy fields is considered not to be practical. The possible way to solve the compensation problem is to increase unit yield in the wet paddy fields outside of the new reserve area. For this, input supply such as fertilizers and agro-chemicals and irrigation water supply must be improved within the limitation that the present water balance, quality and quantity, in the caldera should be maintain at the present level.

In the Case 2, it is required to protect the existing undisturbed swamp, freshwater swamp forest and montane forest totaling 1,260 ha in the swamp portion and 600 ha in the mountain portion from man-made activities for the cropping and logging purposes. In the Case 3 aiming at more effective conservation, it is proposed that the existing wet paddy fields of 100 ha are afresh converted to the swamp because the location plays very important role to protect the freshwater swamp forest and swamp from the invasion of human activities. In conclusion, if the financial support is expected, the Case 1 is most recommendable plan, while the Case 3 is the second choice without any fund.

4. SOIL CONSERVATION AND WATERSHED MANAGEMENT

4.1 *General*

Water resources development is effectively attained by the comprehensive watershed management which is carried out for the following purposes:

(1) water storage;

(2) prevention of flush floods and sedimentation in the drainage system;

(3) recharge of groundwater resources, springs and river flow;

(4) control of soil erosion and soil degradation; and

(5) establishment of the ecological balance between man and his environment.

Soil conservation is an integral and highly important part of the watershed management practices. The present study has its objective to clarify the existing condition, especially the soil erosion hazard for watershed in the Study Area, and to prepare a recommendation on the measures for land conservation in each watershed from the viewpoint of watershed management and proper land use for agriculture.

4.2 *Assessment of Soil Erosion Hazard*

4.2.1 Soil erosion

At present, there is no severe soil erosion in the Study Area, but sheet and gully erosions occur on the steep hillside in the bottom of valley. It is considered that undulating hilly area in the southern part of the Study Area is vulnerable to soil erosion due to unsuitable cultivation techniques, improper choice of crops and extension of cultivation area to marginal lands.

Bank erosion caused by meandering action of rivers is common in the Ciujung river, but it is not a serious problem in general.

4.2.2 Method of assessment

Out of several kinds of soil degradation processes, there is a very fair possibility of sheet, rill and gully erosions and mass movements in the Study Area. In order to assess the soil erosion hazard, such environmental factors as rainfall, soils, topography and land use or vegetation are taken up from each existing thematic map with 1/250,000 scale prepared in 1978 and meteorological statistics. All map informations with a resolution of 500 m x 500 m or 25 ha and statistics are digitized, stored in computor, processed and automatically replotted for the Study Area. The procedure is based on a Provisional Methodology for Soil Degradation Assessment presented by FAO in 1979. The basic equation is as follows:

$$A = RKTC$$

where, A: Computed soil loss per unit area

R: Rainfall factor based on the index which is modified by FAO as follows:

$$R = f\left(\sum_{1}^{12} \frac{Pi}{P}\right)$$

where; Pi = average monthly precipitation
P = average annual precipitation

K: Soil erodibility factor according to the erodibility classes of FAO Soil Units

T: Topographic factor based on slope class

C: Cropping-management factor including natural vegetation factor

The rates of each factor which is considered for the assessment of water erosion are summarized in Table F-5. Thematic maps showing areal distribution of each factor are illustrated in Fig. B-2 of annual iso-hyetal map, Fig. G-3 of soil map, Fig. F-2 of slope classification map and Fig. G-1 of present land use map.

4.2.3 Assessment of the risk of water erosion

The results of assessment, as shown in Figs. F-3 and F-4, indicate soil loss per unit area under the condition of with and without land cover. In other words, these correspond to the potential and existing soil erosion hazards, respectively, and the risk of soil erosion will be considerably enhanced by clearing the existing forests.

Under the present condition of vegetation or land use, as shown in Fig. F-3, the result in evaluating soil loss points out the upstream basin of the Ciujung river as a problem area having a high degree of existing soil erosion hazards. The present situation of soil erosion is mainly caused by the extension of crop cultivation to marginal lands and improper choice of crops such as upland rice and maize which are usually grown with little undergrowth.

With disappearance of land cover as a result of logging, overgrazing, shifting cultivation and disturbing, soil erosion risk becomes more serious in the upstream basin of the Ciujung river and in the mountain area in the western part of the Study Area. The degree of soil erosion under this condition depends on the topography with steep slopes.

4.3 Watershed Management

4.3.1 Present situation of watershed

To formulate a watershed management plan, the Study Area is broadly divided into seven watersheds named Cibeureum, Ciujung, Cibanten, Cidanau, Kali Anyer, Kali Kedungingas and Gunung Gede in Peninsula. The Ciujung watershed is further divided into four watersheds, i.e. Ciberang, Cisimeut, upper Ciujung and lower Ciujung at the confluence of three upper tributaries of the Ciujung river. The areal extent of each watershed is shown in Table F-6 and illustrated in Fig. F-5. The present status of land use in each watershed is summarized in Table F-7.

The each basin is almost fully developed for the agricultural purpose, especially in the lower Ciujung watershed where 57% of the watershed area is wet paddy fields. Though forests play an important role in soil conservation, the forest cover in the Study Area is only 22,100 ha corresponding to 6% of the whole watershed of 355,100 ha. About 12,500 ha or 57% of the forest lands are concentrated in two watersheds, the Ciberang and the Cidanau. It is considered that plantations growing coffee, coconuts, rubber and clove as well as shrub have also important function in soil and watershed conservation. The land covered with these extends over 54,700 ha or 15% of the whole watersheds. This land is mainly distributed in the upper Ciujung, Cisimeut, Ciberang and Kali Anyer watersheds.

4.3.2 Management practice and forestry

Except for the forest in the Ranca Danau Reserve, there are no significant forests for conservation, reserve and commercial exploitation of timber in the Study Area. It means that no measures for environmental conservation have been undeveloped till now. From the viewpoint of watershed management, expansion of plantation such as coconuts and rubber is effective in terms of reforestation and afforestation in cleared land. The watershed management, especially on the gently sloping to undulating hills in the southern part of the Study Area, depends on agricultural practices in upland cropping area occupying 178,000 ha or 50% of the Study Area. Thus, effective countermeasures to prevent and reduce soil loss from upland crop fields are also indispensable for watershed management.

4.3.3 Watershed management plan

The present land use in the catchment area of each possible dam site is summarized in Table F-8. Although topography is undulating to steep, half of the catchment area has been developed for cultivating such upland crops as upland rice, maize, beans and cassava. Prevailing farming practices on such undulating to steep fields are dangerously apt to expose ground surface to the pelting rain occurring frequently during the wet season and cause severe surface soil loss in the catchment area.

Under the tropical monsoon and densely populated conditions, it can be considered as a fairly realistic plan that crop diversification is introduced to upland crop fields in the catchment area with a technical guidance and financial support aiming at provision of countermeasures for soil conservation. The recommended crop diversification for hilly to steep upland crop fields in the catchment area is to intercrop fast-growing trees having two functions, erosion prevention and shade, and perennial and biennial crops like coffee, banana, pineapple and cassava. For gently undulating to hilly upland crop fields, it is needed to adopt contour cultivation method for planting annual crops with a strip of trees or pastures grown for reducing surface soil loss.

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Table F-1 AREAL EXTENT BY FISHING GROUND

Fishing Ground	Unit	Kabupaten			Total
		Serang	Lebak	Pandeglang	
Freshwater pond	ha	110	466	89	665
Wet Paddy Field	ha	143	183	787	1,113
Cage	No.	-	134	7	141
River	km	463	1,249	50	1,762
Swamp	ha	346	55	-	401
Brackish Water Pond	ha	5,527	-	-	5,527

Table F-2 FISH PRODUCTION BY FISHING GROUND

Unit: ton/y

Fishing Ground	Fish Production				Unit Fish Catch
	1978	1979	1980	1981	
Freshwater Pond	39	93	75	141	0.21 ton/ha
Wet Paddy Field	61	57	58	129	0.12 ton/ha
Cage	1	2	2	3	0.02 ton/unit
River	58	53	56	56	0.03 ton/km
Swamp	24	31	23	19	0.05 ton/ha
Brackish Water Pond	2,817	2,743	2,886	3,265	1.69 ton/ha

Source: Dinas Perikanan in the Kabupatens of Serang, Lebak and Pandeglang

Table F-3 FAUNA AND FLORA IN THE RANCA DANAU RESERVE

	Fauna			Flora		
	Zoological Name	Local Name	Popular Name	Botanical Name	Popular or Local Name	Characteristics, Usage
Vertebrates				Moraceae		
Fishes	Monopterus albus		beluga	Artocarpus elasticus	Teureup	food, fiber, timber, gum, paper
	Ciarias batrachus		catfish			
	Purttius binotatus			Olacaceae		
	Ophiocephalus melanopterus			Strombosia javanica	Kikacang	forest tree food (leaves)
Reptiles	Varanus sps.	Blawak	iguana	Euphorbiaceae		
	Trionyx cartilagineus		turtle	Glochidion sp.	Unknown	small tree
	(Crocodylus sp.)		crocodile	Meliaceae		
Birds	Anhinga melanogaster	Pecuk ular		Dysoxylum sp.	Kibawang	
	Egretta sp.	Kuntur		Ancardiaceae		
	Bubulcus ibis	Kuntur kerbau		Manojifera sp.	Unknown	
	Nycticorax sp.	Kowak malam				
	Duptor faivicollis	Kokkokan hitam		Icacinaceae		
	Ixobrychus cinnomomeus			Stemonurus secundiflorus	Unknown	forest tree in swamp food (fruits)
	Dendrocygna javania					
	Halcyon chloris	Raja udang, Cekakak	king fisher			
	Pelargopsis capensis	Raja udang	king fisher	Elaeocarpaceae		
	Alcedo sps.		king fisher	Elaeocarpus sps.	Unknown	common food (fruits)
	Dicrurus paradiseus		drongo	Sterculiaceae		
Mammals	(Hylobates moloch)	Owa	pimata	Pterospermum sps.	Bajur	forest tree
	Presbytis aygula	Surili	primata	Apocynaceae		
	Presbytis sp.	Lutung	primata	Alstonia sps.	Gabus	
	Macaca sp.	Bokoi	primata	Araceae		
	Panthera pardus	Macan tutul	panther	Alocasia sps.	Unknown	
	(Nycticebus coucang)	Kukang	sloth			
	(Tragulus javanicus)	Kancil	chevrotain			
	(Muntiacus muntjak)	Kidang, Muncak	chevrotain			
	Aonyx sp.		otter			
Invertebrates						
	Unknown					

Remarks: Species in parentheses indicate those according to local information.

Source: FAO, 1977

Table F-4 PRESENT STATUS OF RANCA DANAU NATURE RESERVE

Unit: ha

Land Use Category	Situation	Ranca Danau Reserve: Swamp Area (Caldera)	Ranca Danau Reserve: Mountain Area (Somma)	Ranca Danau Reserve: Sub-total	Study Area
Montane Forest	Undisturbed	20	520	540	760
	Disturbed	10	60	70	200
	Sub-total	30	580	610	960
Freshwater Swamp Forest	Undisturbed	540	50	590	590
	Disturbed	690	30	720	720
	Sub-total	1,230	80	1,310	1,310
Swamp	Undisturbed	700	30	730	740
	Disturbed	130	-	130	130
	Sub-total	830	30	860	870
Cleared Land		-	240	240	500
Wet Paddy Field		1,200	210	1,410	6,160
Coconuts and Others		10	160	170	5,600
Total		3,300	1,300	4,600	15,400

Table F-5 RATE OF EACH FACTOR FOR WATER EROSION ASSESSMENT

Rainfall factor (R)

Annual precipitation:

1,000 to 1,500 mm	(152)	3,000 to 3,500 mm	(294)
1,500 to 2,000 mm	(189)	3,500 to 4,000 mm	(338)
2,000 to 2,500 mm	(204)	4,000 to 5,000 mm	(402)
2,500 to 3,000 mm	(247)	more than 5,000 mm	(498)

Soil erodibility factor (K)

Gleysols	(1.0)	Fluvisols	(1.0)	Nitosols	(0.5)	Acrisols	(2.0)
Rendzinas	(0.5)	Regosols	(1.0)	Vertisols	(2.0)	Andosols	(0.5)
Luvisols	(0.5)						

Topographic factor (T)

Dominant slope:

0 to 2%	(0.15)	2 to 15%	(2.0)
15 to 40%	(8.0)	more than 40%	(11.0)

Area covered with soils of Fluvisols and Gleysols: Any sloping class (0.15)

Cropping-management factor (C)

Land use:

Wet paddy field, double cropping	(0.561)*
Wet paddy field, single cropping	(0.561)*
Mixed cropping field	(0.195)*
Upland crop field	(0.195)*
Plantation	(0.01)
Shrub	(0.07)
Pure forest	(0.006)
Dense forest	(0.006)
Grass land	(0.12)
Swamp	(0)
Fish pond	(0)
Fallow land	(0.32)
Cleared land	(0.45)

Soil degradation classes expressed as soil loss (ton/ha/y)

None to slight	(10)	Moderate	(10 to 50)	High	(50 to 200)
Very high	(200)				

Remarks: * = Data according to the Soil Research Institute in Bogor

Source: FAO, 1979

Table F-6 AREAL EXTENT OF WATERSHED

Main River System	Watershed	Area (ha)
Cidurian	Cibeureum	25,500
Ciujung	Ciberang/1	33,100
	Cisimeut/1	45,800
	Upper Ciujung/1	59,400
	Lower Ciujung	94,100
Cibanten	Cibanten	18,500
Cidanau	Cidanau/2	31,600
Kali Kedungingas	Kali Kedungingas	14,900
Kali Anyer	Kali Anyer/3	19,800
—	Gunung Gede in Peninsula/4	12,400
Total		355,100

Remarks: /1 = Each catchment area is measured at the confluence of these three tributaries of the Ciujung river.

/2 = The area includes 10,300 ha of the Cipasauran river basin adjacent to the Cidanau river basin.

/3 = The area includes several minor river basins draining into the Sunda Strait.

/4 = The area has no major river system.

Table F-7 PRESENT LAND USE BY WATERSHED IN THE STUDY AREA

Unit: ha

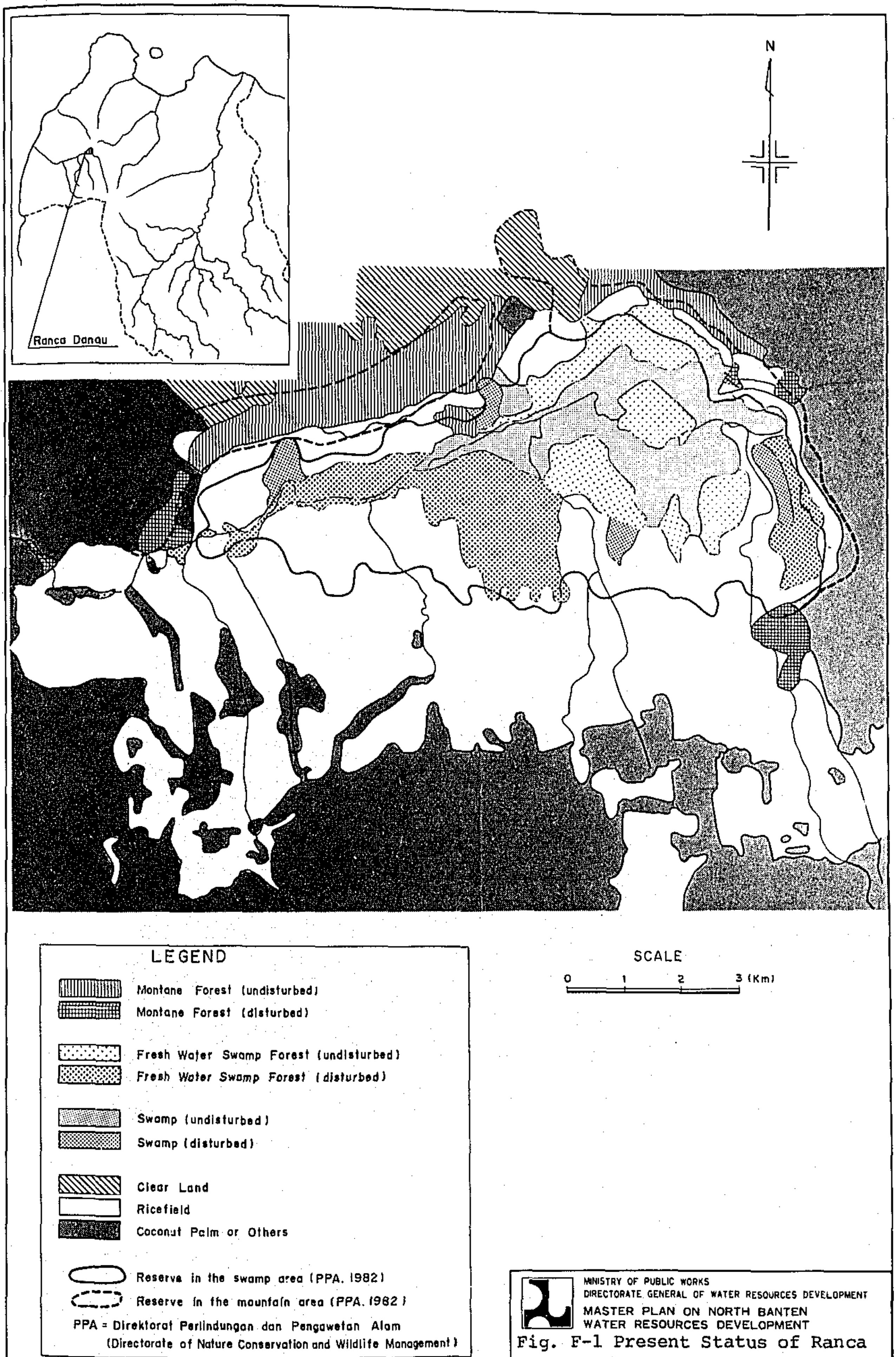
Land Use Category	Cidurian River	Ciujung River				
	Cibeureum Watershed	Ciberang Watershed	Cisimeut Watershed	Upper Ciujung Watershed	Lower Ciujung Watershed	Sub-total
Wet Paddy Field						
Double cropping	800	2,300	700	3,600	19,700	26,300
Single cropping	3,500	1,100	2,800	3,400	33,500	40,800
Sub-total	4,300	3,400	3,500	7,000	53,200	67,100
Upland Crop Field	13,500	17,700	23,300	29,300	35,100	105,400
Plantation	2,300	1,300	5,000	3,400	400	10,100
Shrub	3,800	3,200	10,900	17,900	100	32,100
Forest	1,100	7,500	3,100	1,800	600	13,000
Grass Land	500	0	0	0	200	200
Swamp	0	0	0	0	0	0
Fish Pond	0	0	0	0	4,500	4,500
Fallow Land	0	0	0	0	0	0
Total	25,500	33,100	45,800	59,400	94,100	232,400

Land Use Category	Cibanten River	Cidanau River	Kali Ke-dungingas River	Kali Anyer River	—	Whole Study Area
	Cibanten Watershed	Cidanau Watershed	Kali Ke-dungingas Watershed	Kali Anyer Watershed	Gunung Gede in Peninsular Watershed	
Wet Paddy Field						
Double cropping	700	2,600	0	600	0	31,000
Single cropping	2,700	4,300	4,900	2,800	3,000	62,000
Sub-total	3,400	6,900	4,900	3,400	3,000	93,000
Upland Crop Field	14,200	18,300	8,300	9,500	8,800	178,000
Plantation	400	200	800	4,300	300	18,400
Shrub	200	200	0	0	0	36,300
Forest	200	5,000	0	2,600	200	22,100
Grass Land	0	0	0	0	0	700
Swamp	0	1,000	0	0	0	1,000
Fish Pond	100	0	900	0	100	5,600
Fallow Land	0	0	0	0	0	0
Total	18,500	31,600	14,900	19,800	12,400	355,100

Table F-8 PRESENT LAND USE BY CATCHMENT AREA AT POSSIBLE DAM SITE

Unit: ha

Land Use Category	Ciujung River			Cidurian River	Cibanten River	Cidanau River
	Karian	Pasir Kopo	Bojongmanik	Cilawang	Cibanten	Cidanau
Wet Paddy Field						
Double cropping	2,600	100	100	300	400	3,200
Single cropping	1,300	2,000	400	200	1,300	4,400
Sub-total	3,900	2,100	500	500	1,700	7,600
Upland Crop Field	14,400	9,200	6,800	4,500	5,200	8,700
Plantation	300	100	100	900	400	100
Shrub	2,700	3,600	8,400	2,300	100	200
Forest	7,500	2,200	100	900	200	200
Grass Land	0	0	0	200	0	3,600
Swamp	0	0	0	0	0	0
Fish Pond	0	0	0	0	0	0
Fallow Land	0	0	0	0	0	800
Total	28,800	17,200	15,900	9,300	7,600	21,200



MINISTRY OF PUBLIC WORKS
DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT
MASTER PLAN ON NORTH BANTEN
WATER RESOURCES DEVELOPMENT

Fig. F-1 Present Status of Ranca Danau Nature Reserve

JAPAN INTERNATIONAL COOPERATION AGENCY

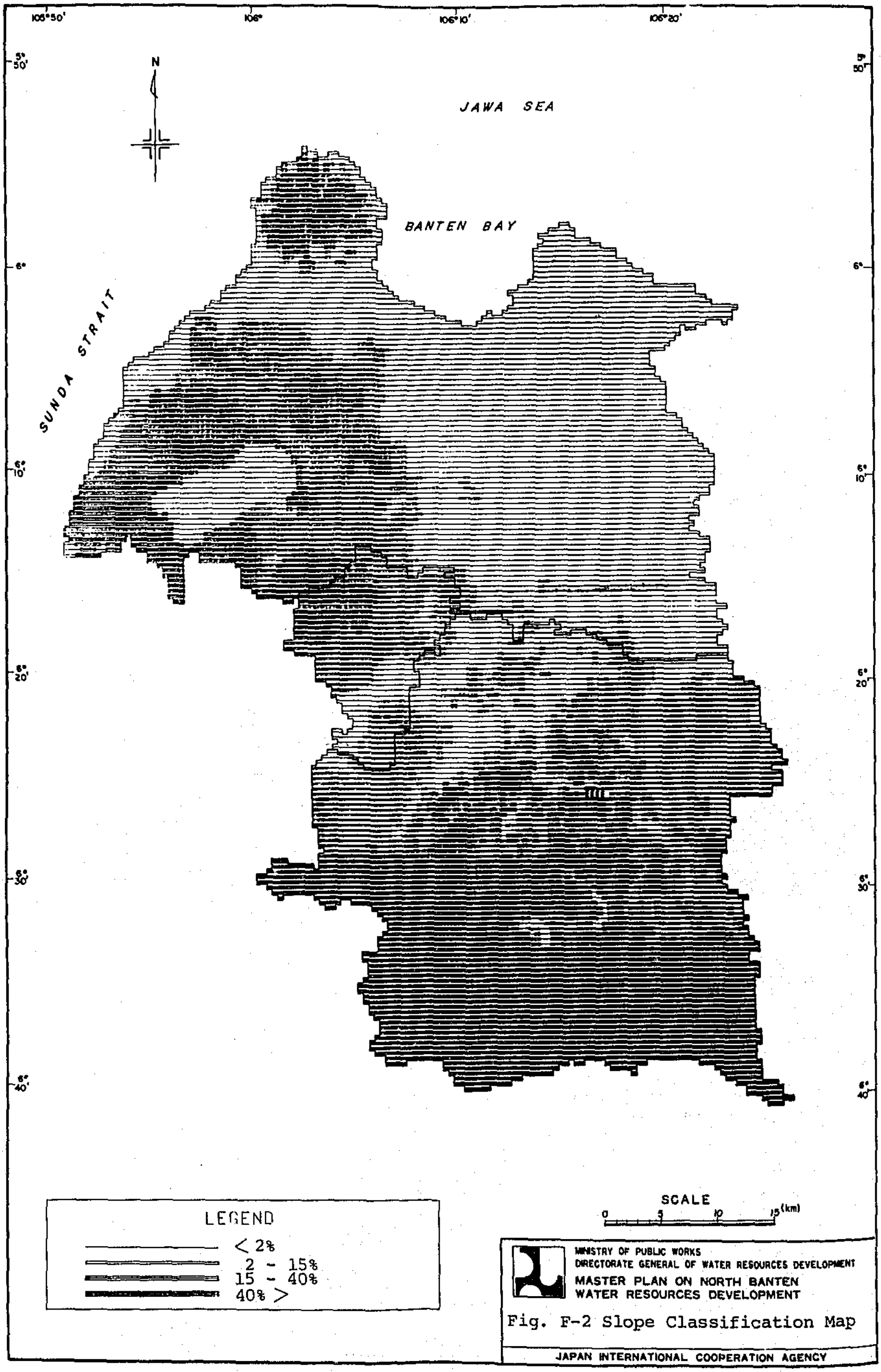


Fig. F-2 Slope Classification Map

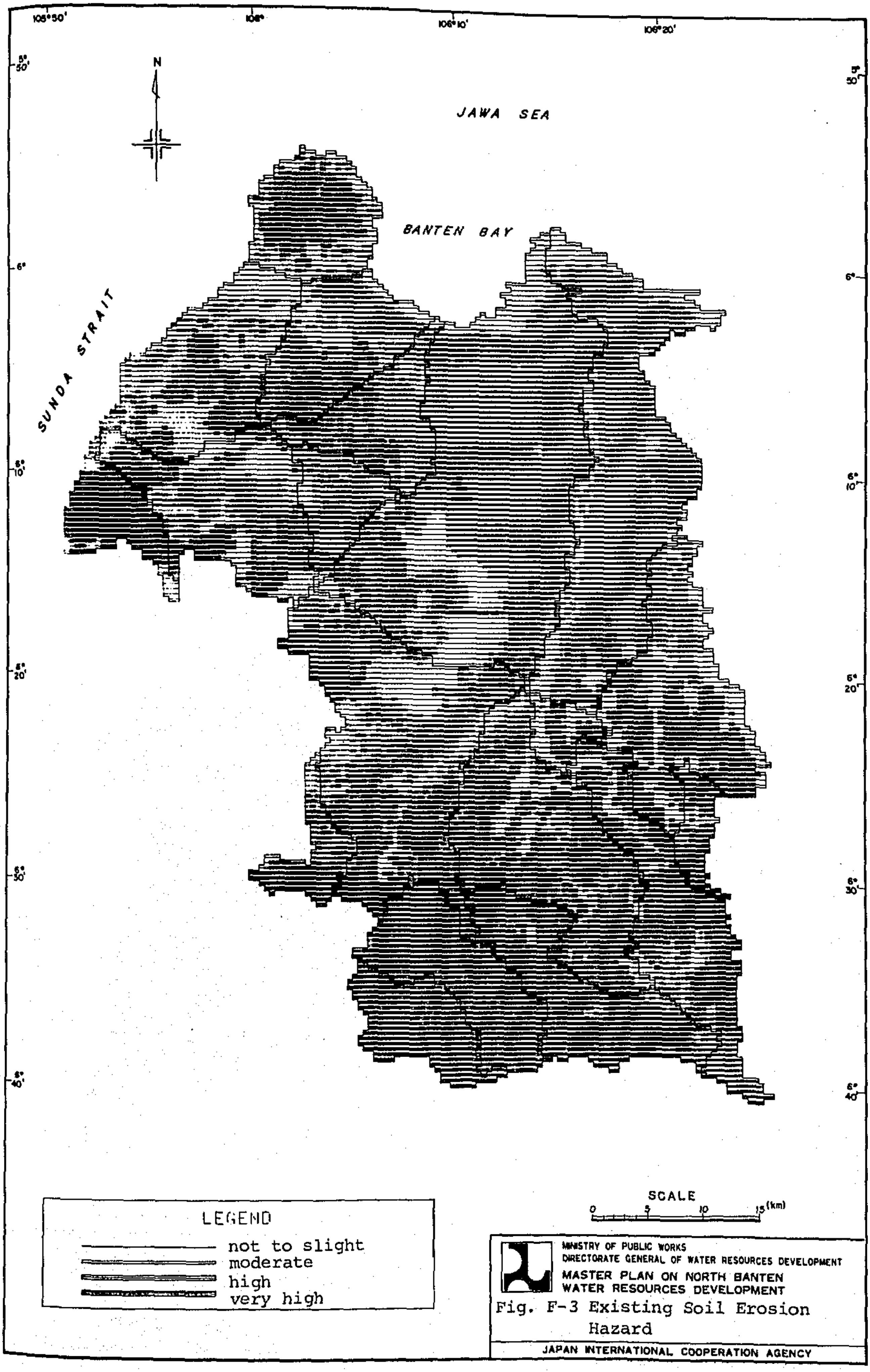
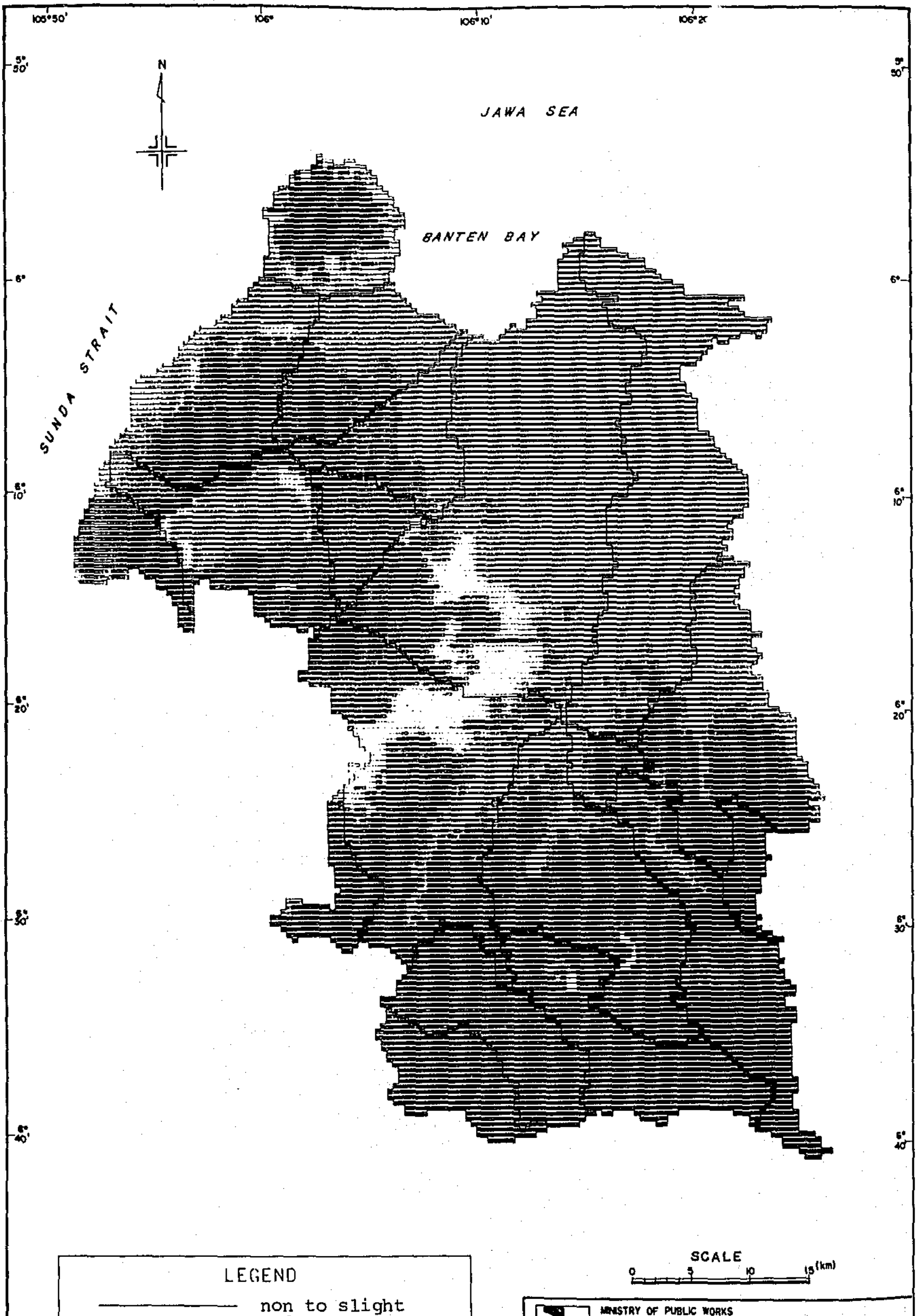


Fig. F-3 Existing Soil Erosion Hazard



MINISTRY OF PUBLIC WORKS
DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT
MASTER PLAN ON NORTH BANTEN WATER RESOURCES DEVELOPMENT

Fig. F-4 Potential Soil Erosion Hazard

JAPAN INTERNATIONAL COOPERATION AGENCY

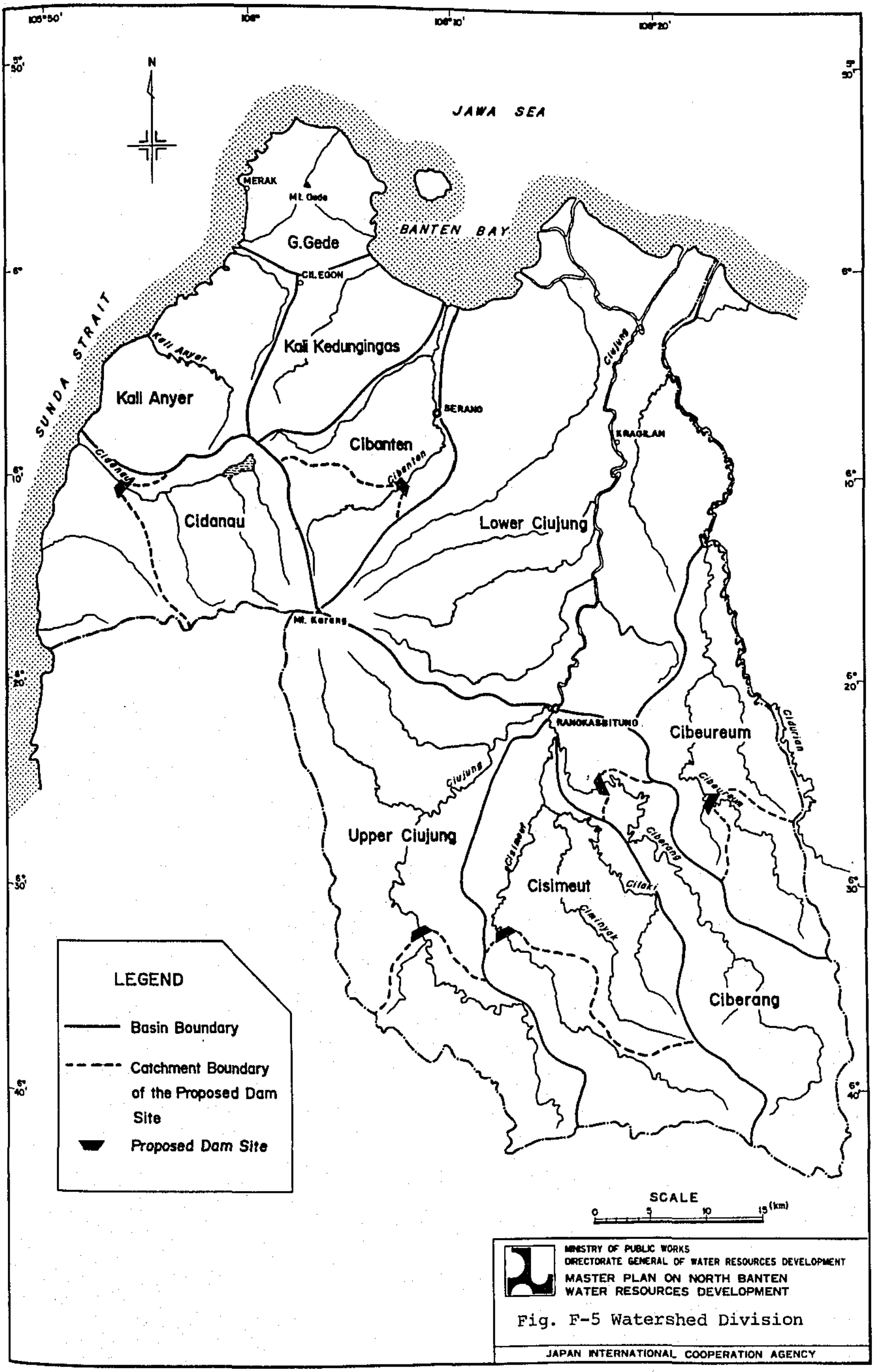


Fig. F-5 Watershed Division

APPENDIX G

AGRICULTURE

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1. INTRODUCTION

This Appendix describes the results of agricultural development study covering the present situation of agriculture and the future agricultural development programs in the Study Area. Rice is predominantly staple food crop for domestic consumption in the Study Area likewise the nation. To provide basic input data in projecting future water demand in sectors agriculturally concerned, the present study is made in line with Government policies as well as needs of water users, existing and probable, in the Study Area.

2. BACKGROUND OF AGRICULTURE

2.1 Role of Agriculture in National Economy

In Indonesia, the agricultural sector, comprising agriculture, livestock, forestry and fishery, produced Rp 2.94 x 10^{12} with a share of 36% of gross domestic product (GDP) at the 1973 constant price in 1976, Rp 3.13 x 10^{12} sharing 33% of GDP in 1978 and RP 3.37 x 10^{12} having a share of 32% in 1980. This sector has still maintained the premier position in gaining the nation's GDP, although the shares of mining, industry and commerce have sharply increased in recent years as shown in Table G-1.

As the agricultural production, however, could not meet the food demand to large extent, staple food imports have rapidly increased year by year with the growing population, the steady shift of young generation from rural to urban areas and the increasing income. During the previous five years between 1976 and 1980, import quantities went up from 1.30 x 10^6 to 2.01 x 10^6 tons, even though domestic productivity of staple food crops were improved through provision of various agricultural supporting services.

Total labour force in Indonesia was 53.1 x 10^6 persons in 1978. Among those 31.5 x 10^6 or 59% of the total were engaged in agriculture, forestry and fishery. The workers in this sector comprised employee of 9.5 x 10^6, own account workers of 6.1 x 10^6, employee of 6.5 x 10^6, unpaid family workers of 9.4 x 10^6 and social workers of several thousands.

The agricultural sector still plays important roles in the national economy of Indonesia. Its main roles are (1) to improve national economy and social well-being through self-sufficiency of staple foods, (2) to stabilize soundly the finances of the country by checking extravagance of foreign exchange reserve for food import, and (3) to increase employment opportunities in rural areas.

2.2 Role of Agriculture in Regional Economy

The gross regional product (GRP) at the 1975 constant price in the Province of West Java grew from Rp 605.8 x 10^9 in 1976 to Rp 772.6 x 10^9 in 1980. Agricultural sector has borne its share in GRP to large extent as shown in Table G-2. Recently, however, the share of the agricultural sector has slightly decreased from 32% in 1976 to 30% in 1980.

The Province of West Java is the main rice bowl in the country, producing 6.34 x 10^6 tons of wetland paddy as dry unhusked rice in 1980 which corresponds to 23% of the whole production in Indonesia. On the other hand, this Province has a population of 27.5 x 10^6 in 1980 comprising 3.6 x 10^6 for urban population and 23.9 x 10^6 for rural population. As per capita rice consumption in the Province is considered to maintain a level of 120 kg/y for urban people and 145 kg/y for rural people (Ref. 1), the total rice consumption estimated becomes 3.90 x 10^6 ton/y being equivalent to 6.52 x 10^6 ton/y as dry unhusked rice. In the

Province, therefore, there still remains the need of increase in rice production for attaining to the level of self-sufficiency.

The major upland crop products in the Province during the period between 1976 and 1980 fluctuated from 0.14×10^6 to 0.19×10^6 tons for dryland paddy, 0.08×10^6 to 0.15×10^6 tons for maize, 1.99×10^6 to 2.07×10^6 tons for cassava, 0.35×10^6 to 0.43×10^6 tons for sweet potatoes, 57,800 to 86,900 tons for peanuts and 14,600 to 21,300 tons for soybeans.

The Province is also a main producing center of fresh vegetables and fruits and has built up a good lucrative market in Jakarta for these products. In 1979, the total production was 0.46×10^6 tons for vegetables such as shallot, onion, potatoes, cabbage, mustard green and others, and 0.53×10^6 tons for fruits including banana, rambutan, mango and others.

The population of 10 years of age and over in the Province as of 1978 was 17.1×10^6 out of which 9.39×10^6 were the total labour force. The number of employed persons, permanent and temporary, amounted to 9.17×10^6. The main employment status of employed persons in the Province was labour/employee of 4.58×10^6, own account workers of 2.17×10^6, employer of 1.22×10^6, unpaid family workers of 1.19×10^6 and social workers of 0.01×10^6. Among employed persons, 5.19×10^6 were engaged in the sector of agriculture, forestry and fishery.

2.3 Organization Responsible for Agriculture

There are various agricultural agencies involved in the provision of necessary supporting services in agricultural development activities in Indonesia. The Ministry of Agriculture (DIPERTA) is responsible for production, research, education, training and extension, while infrastructural development for irrigation and drainage is managed by the Ministry of Public Works (DPU).

3. PRESENT SITUATION OF AGRICULTURE IN THE STUDY AREA

3.1 Present Land Use

The Study Area covers 3,551 km^2 in total among which 1,877 km^2 belong to the Kabupaten of Serang, 1,290 km^2 to the Kabupaten of Lebak, 239 km^2 to the Kabupaten of Pandeglang and 145 km^2 to the Kabupaten of Bogor.

Based on river system, the Study Area is divided into seven watersheds which are, from the east in order, the Cibeureum watershed with a total area of 255 km^2, the Ciujung watershed having an area of 2,324 km^2, the Cibanten watershed of 185 km^2, the Kali Kedungingas watershed of 149 km^2, the watershed of peninsula of 124 km^2, the Kali Anyer watershed of 198 km^2 and the Cidanau watershed of 316 km^2.

The latest land use survey was conducted in 1977 mainly through the field investigation and its results were published from the Directorate of Agrarian in the Province of West Java (Ref. 2). This publication consists of a set of such seven illustration maps, with a scale of 1/25,000 and prepared for each Kecamatan, as land use, administration, hydrology, land tenure, land value, erosion hazard and social infrastructures. Among these maps, the land use map has 12 categories of land use, but no textual description with statistical data is attached. In the present study, therefore, planimetric measurement is employed to grasp areal extent of the respective land use compiled to 11 categories in the Study Area. The results of measurement are further adjusted by statistical data obtained from the Kabupaten Offices in the Study Area. The schematic land use map is presented in Fig. G-1.

The largest land use category in the Study Area is upland crop fields, occupying 1,780 km^2, followed by wet paddy fields in single cropping of 620 km^2, shrub of 363 km^2, wet paddy fields in double cropping of 310 km^2, forest of 221 km^2, plantation and estate of 184 km^2, fish pond of 56 km^2 and others, grass land, swamp, fallow land of 17 km^2 as shown in Table G-3. The noteworthy characteristics of land use in each watershed are briefed as below.

(1) In the Cibeureum watershed, upland crop fields occupy 135 km^2 corresponding to 53% of the watershed. Its distribution is wide-spreading in areas of undulating to sloping hills over the watershed. Most of all the wet paddy fields are under the condition of rainfed accounting for 35 km^2 or 14% of the watershed.

(2) The Ciujung watershed is the largest, occupying 65% of the Study Area. About half of the watershed is used for upland crop fields which are mainly developed in the southern hilly areas. Wet paddy fields under rainfed condition are mostly concentrated in areas of Kopo-Cikande-Carenang (K-C-C area) accounting for 408 km^2 or 18% of the basin. Wet paddy fields with irrigation, harvesting twice a year, occupy 263 km^2 or 11% of the watershed. Nearly three-forth of this are located

in lowlying land along the downstream reaches of the Ciujung river. The lands are characterized by level topography and gleysols. Brackish water fish ponds are located along the coast of the Banten Bay. Though it occupies only 2% of the watershed, it corresponds to 80% of the total fish ponds in the Study Area.

(3) The land use in the Cibanten watershed is characterized by the category of upland crop fields which occupy 142 km^2 or 77% of the watershed. Most of all the agricultural land, accounting for 92%, depend on rainfall in the wet season due to lack of perennial rivers except for the Cibanten river.

(4) The watershed named the Kali Kedungingas has no remarkable perennial streams. Consequently, the cultivation of upland rice, diversified crops and plantation trees depends entirely on rainfall in the wet season. Brackish water fish ponds along the coast of the Banten Bay occupy the remaining 9 km^2 or 6% of the watershed.

(5) The watershed named the Gunung Gede in peninsula in physiographically independent of other watershed and has no remarkable perennial streams and catchment area. The cultivation of upland crops and wetland paddy is the mainstay of the watershed.

(6) The Kali Anyer watershed includes several streams draining into the Sunda Strait. Upland crop fields dominate the basin accounting for 95 km^2 or 48%, but the watershed is characterized by a large proportion of coconut plantation as compared with those in other watersheds. The plantation amounts to 43 km^2 corresponding to 22% of the watersheds.

(7) In the Cidanau basin, distinctive feature is in the Ranca Danau Reserve comprising forest and swamp expressed in land use category. This Reserve has been seriously affected by the cultivation of wetland paddy within the caldera. Due to easily available water from springs by the hillside of the Gunung Karang, wet paddy fields in double cropping a year with irrigation facilities are developed over 26 km^2 corresponding to 8% of the watershed.

3.2 Rice Cultivation

3.2.1 Areal extent

According to the Statistik Jawa Barat and the information obtained from agricultural office in each Kabupaten, harvested area of wetland paddy ranged between 86,000 and 100,900 ha during the period from 1977 to 1981 as shown in Table G-4. This fluctuation is mainly caused by the charge in planted area during the dry season, because its irrigation water resource depends fully upon natural river flow.

Main rice producing zones in the Study Area comprise the Ciujung irrigation scheme of which irrigation area is 24,200 ha, the Cibanten irrigation scheme with an irrigation area of 2,203 ha, the Ciwaka irrigation scheme of 1,563 ha, the Cisangu irrigation scheme of 1,442 ha and the Cicinta irrigation scheme of 1,434 ha. The total command area under these irrigation schemes has a share of 33% in average harvested area during the said period.

3.2.2 Present cropping patterns

Cropping patterns prevailing in the Study Area vary widely as illustrated in Fig. G-2. Three figures show the cropping patterns of wetland paddy and Palawija with cultivated area by Kecamatan.

In the irrigation area of the Ciujung scheme, the wet season cropping starts between October and December in the case of single cropping. Typical cropping calenders in double cropping areas are composed of the wet season cultivation starting between October and December and the dry season cultivation starting between April and June. In single cropping areas of other irrigation schemes mentioned in the above, the cropping season begins between November and January, while, in two-crop areas, the cropping starts from November to December for the wet season and from May to June for the dry season.

3.2.3 Farming practices

The farming practices of wetland paddy in the Study Area depend mostly on man power with the exception which is usage of buffaloes for land preparation works. Agricultural machineries like tractors have not broadly prevailed yet.

Although seedlings are commonly transplanted from nurseries to main paddy fields on a part of which farmers make nurseries under submerged condition, a direct sowing method called Gaga Rancah or a nursery method under dry condition called Joged is applied to very limited areas where river flow of the wet season is not available in time for puddling works.

Varieties widely used in the Study Area are a local variety called Cerai with the growing period of 150 days and high yielding varieties like Cisadane, Cimandiri and Citarum having the growing period of 120 days for the wet season cropping. Further, IR 36, short-term variety of 105 days, is grown for the dry season cropping.

Under the present BIMAS and INMAS programs, application of fertilizers and agro-chemicals for wetland rice cultivation has been accelerated in the Study Area. Official guidance given in the Kabupaten of Serang under the BIMAS program fertilizer dosage is to be urea of 200 kg/ha and triple super phosphate (TSP) of 100 kg, but, actually, farmers apply 130 kg of urea and 85 kg of TSP for the wet and dry seasons in the BIMAS program. The actual application in the INMAS program averages about 70 kg/ha for urea and 60 kg/ha for TSP in the wet season cropping and approximately 85 kg/ha for urea and 40 kg/ha for TSP in the dry season cropping.

The main pests and diseases in the Study Area are stem borers, rats, rice bugs and brown plant hoppers in decreasing order of importance. Use of insecticides and rodenticides is common to the Study Area. Diazinon and Basdin are broadly applied for controlling stem borers and bugs by using knapsack type and motorized portable sprayers. Aiming at the control of rat, zinc phosphate is used as rodenticide to wide extent.

3.2.4 Yield and production

According to crop production statistics prepared by the Kabupaten Offices, the average yield of wetland paddy in the Study Area is 2.8 ton/ha as dry paddy for the wet season and 3.2 ton/ha for the dry season, and that of dryland paddy is 1.7 ton/ha. The detailed data concerning harvested area, unit yield and production of paddy in the Study Area are given in Table G-5. The yield still varies depending on availability of water resources for irrigation water use, though a package of agricultural inputs has been provided to farmers with coordination of all the efforts of agricultural support services in the Study Area through the agricultural intensification program called BIMAS and INMAS. Under well-irrigated or drained condition supported by such program, the average yield goes up to 4.2 ton/ha for the wet season and 4.5 ton/ha for the dry season. The total dry paddy production in the Study Area was estimated to be around 380,000 tons in 1981.

3.3 Upland Crop Cultivation

As shown in previous section, upland crop fields occupy the largest portion in the Study Area, accounting for 178,000 ha or 50% of the Study Area, followed by paddy field in single cropping. Although, the yield of upland crops is generally low due to little application of fertilizers and chemicals. The harvested area, unit yield and production of such palawija crops as peanuts, cassava, maize, sweet potatoes and soybeans in 1980 are shown in Table G-6.

Peanuts are most popular among upland crops in the Study Area. In 1980, harvested areas totaled 17,730 ha of which intensively cropping area is located in the slopes just south of Cilegon. The production in 1980 was 15,340 tons with the average yield of 0.9 ton/ha in the Study Area. Harvest is done during the wet season.

Cassava is also predominant tuber crop in the Study Area. It is grown as a sole crop on rather steep foothills and interplanted with two or more crops mainly on natural levees along the river course. The harvested area in 1980 totaled 7,490 ha in the Study Area producing 80,300 tons with the average yield of 10.7 ton/ha. Growth of cassava is slow, sometimes with a period of 10 months.

Maize is broadly grown in the Study Area as a secondary crop to supplement food for home consumption. The harvested time ranges from December to February during the middle of wet season. The total harvested area in 1980 was 2,540 ha from which 3,680 tons were obtained.

Cultivation of sweet potato has a short history in the Study Area, but it has drawn farmers' attention to introduce sweet potato by its high returns in crop budget. As of 1980, the Study Area harvested 21,070 tons from 2,490 ha.

Soybeans, having enormous potential as a cash crop in the Study Area, were grown in a total area of 340 ha as of 1980. The production was 200 tons and the average yield was 0.6 ton/ha.

As for the tree crops such as rubber, coconut, coffee, pepper, cloves and vanilla, Table G-7 shows the planted area, unit yield and production. Out of the crops, the cultivation of rubber and coconut is practiced in technified plantation or estate. In recent years, old plantation of rubber has been transplanted by coconut trees. As of 1980, the total planted area amounted to 42,200 ha for coconut and 4,800 ha for rubber. Coffee plantation is predominant in the hilly area southwest of Serang, having the planted area of 2,220 ha in total in 1980. Generally, the plantation is managed by small farms and the products are processed by traditional way. Among pepper, cloves and vanilla, advance farmers in the Kecamatans of Ciomas, Padarincang and Cadasari have expanded the planted area of cloves because they can expect to earn a comfortable income from cloves. The planted area in 1980 reached 5,530 ha in total in the Study Area.

3.4 Agricultural Supporting Services

3.4.1 Research and extension services

Agricultural research has been promoted by the Agency for Research and Development within the Ministry of Agriculture. The Research Institute for Food Crops in Bogor belonging to the Agency is responsible for execution of the agricultural research for paddy and secondary crops in West Java, mainly at field stations. Experimental station at Singamarta in the Kabupaten of Serang is closely related to the bases of agricultural activities in the Study Area.

Agricultural extension services are provided through the Directorate General of Food Crop Agriculture under the Ministry of Agriculture. Extension experts consisting of Subject Matter Specialist (PPS), Extension Officer (PPM) and Field Extension Worker (PPL) are assigned to the Provincial Office of Agricultural Service maintaining close relation with the National Development Programs. The extension staffs belonging to the Provincial Office of Agricultural Service in West Java are composed of five PPSs at the Provincial Office of Agricultural Service, four PPSs at each Regional Office of Agricultural Service, one PPS and two PPMs at each Kabupaten Office of Agricultural Service, two PPMs at each Rural Extension Center Office and one PPL at each Rural Extension Working Area covering 600 to 1,000 ha. At present, 219 Rural Extension Center Offices are in full activity with a total number of 438 PPMs and 2,023 PPLs.

3.4.2 Seed multiplication and distribution

In 1971, the National Seed Corporation for the production of certified seed was established at Sukamandi in West Java. However, the present production still remains insufficient to fill the local requirement. In general, farmers retain the seed from own production for the next planting season. A part of the seed is supplied through BUUD/KUDs or local seed farms.

3.4.3 Agricultural cooperatives and credit service

Under the BIMAS program, farmers in the Study Area enjoy the following services at the village unit level:

- credit services provided by Bank Rakyat;
- retail shops for supplying agricultural inputs such as seeds, fertilizer and pesticide;
- agricultural extension service guided by one or more PPLs; and
- processing and marketing facilities by BUUD/KUD.

3.4.4 Irrigation water management

Organization responsible for irrigation water management is different in such irrigation schemes and types as DPU or non-DPU irrigation scheme and technical, semi-technical or non-technical irrigation works. The distribution of wet paddy fields by the said type is tabulated in Table G-8. These supporting services are explained below.

(1) For the technical irrigation works, DGWRD is responsible for design and construction works which cover tertiary canals and necessary facilities for quaternary canals. The Irrigation Section of DPUP and the Land Development Unit of the Provincial Agricultural Services are responsible for provision of guidance to farmers who are requested to carry out construction of quaternary canals and land reclamation of wet paddy fields by their own efforts. The operation and maintenance of irrigation system is undertaken by the Irrigation Section of DPUP which is responsible for major facilities and main and secondary canals, and also by farmers' organization managing tertiary canals down to wet paddy fields.

(2) For the semi-technical irrigation works DGWRD is responsible for design and construction of head works only. Canal works, design to construction, and daily management of the head works are generally transferred to DPUP and the Kecamatan authorities. Water distribution management below tertiary canals is the responsibility of farmer's organization.

(3) For the non-technical irrigation works, farmers living in one or two villages construct head works and canal networks by their own risk. No technical and financial supports by the Government are expected for execution of such construction works. The maintenance of structures and the irrigation water distribution are responsible for the rural communities.

3.5 Farm Economy

3.5.1 Market prices

Average market prices of major food crops at rural market in the Province of West Java are shown in Table G-9. The surplus of paddy produced by the farmers flow generally into the rice market through KUD. But KUD's activity in each Kabupaten in the Study Area is hardly functioning in proper manner due to a small amount of rice collected by KUD.

3.5.2 Crop budget

The crop production cost comprises the expenses for (1) farm inputs like seeds, fertilizers and agro-chemicals, (2) labour and (3) others including irrigation fee, operation/maintenance cost and taxes, etc. The crop budgets for major food crops in the Province West Java were analysed by Buro Pusat Statistik in 1979, as summarized in Table G-10. From the viewpoint of unit net production value, wetland rice cultivation is the most profitable to farmers, amounting to Rp 172,000/ha in 1979.

3.6 Water-related Problems and Needs

The lands in the Study Area is fully developed for agriculture. Among the whole wet paddy fields of 93,000 ha, a total of 62,741 ha is irrigated as shown in Table G-8. Irrigation water demand for the wet season cropping has been fully met by diverted natural flow of rivers. The excess of natural flow available in the wet season runs to the sea, sometimes as flood. However, transplanting works seldom forfeit a proper occasion caused by delay in the opening of wet season.

On the other hand, during the dry season, rainfall reduces to large extent and surface runoff varies every year. Although irrigation water for the dry season cropping can be withdrawn from rivers, its quantity is far below the demand for full cropping of wetland rice. At present, the dry season cropping area of the Ciujung irrigation scheme is scheduled to be 9,600 ha or 40% of the whole area of 24,200 ha before starting cultivation work of every dry season, but the average actual planted area for the recent five years from 1977 to 1981 is estimated to be 7,000 ha, corresponding to approximately 30% of the entire scheme. Consequently, it is considered that the total dry season cropping area has fluctuated between 10,000 ha under a dry spell and 30,000 ha with abundant rain in the Study Area. Table G-11 shows the record of planted and harvested areas for the past five years from 1977 to 1981 in 11 Kecamatans which are entirely or partly included in the Chiujun irrigation scheme.

The limitation of dry season irrigation area forms the determining cause that the existing irrigation water management system called Golongan in the Ciujung irrigation scheme is hardly functioning in proper manner. As a result, wet paddy fields located along the main canal and also the upper reaches of secondary canals can only take irrigation water for the dry season cropping, prior to other wet paddy fields distributed along the lower reaches of secondary canals. Thus, farmers who grow wetland paddy on the latter fields in the dry season are always forced to do very risky farming.

In the K-C-C area, the ground elevation of existing wet paddy fields, totaling 8,000 ha in net, is high compared with the water level of the Pamarayan weir and the Cibeureum river. Up to date, therefore, no intake facility of irrigation water has been developed for the K-C-C area. Rainfed cultivation of wetland rice still predominates in this area so that the average farm income is limited to a considerable extent in Study Area due to low cropping intensity. To expand the irrigation area and to stabilize the wetland rice cropping in the dry season for the Ciujung irrigation scheme, and also to provide the K-C-C area with year-round irrigation water, it is needed to create new water resources by regulating natural flow of rivers.

Seasonal flooding or inundation in the lowlying land is another problem related water. In January 1979 and November 1981, agricultural land of about 3,800 ha mainly comprising wet paddy fields in the Ciujung irrigation scheme area was flooded. Inundation caused by poor drainage occurs in alluvial depressions scattered over the Study Area. In this context, flood control with construction of dam reservoir or dike and the improvement of drainage condition should be required for the intensive use of land and water resources.

4. LAND RESOURCES

4.1 Soils

According to the soil map compiled by Direktorat Agraria Propinsi Jawa Barat (Directorate of Agrarian in the Province of West Java) and field survey, seven soil units which contain 25 soil groups and associations in national classification system are identified in the Study Area. The soils are correlated with those of FAO/UNESCO Soil Classification System and illustrated in Fig. G-3. Most of the land surface in the Study Area is formed by materials directly derived from old pyroclastic fall deposits except in the bayside tidal marshes, alluvial plains and river terraces.

Along the bay shore, tidal marshes range from 0.7 to 1.5 km wide and are affected regularly by the ebb and flow of the tides. The tidal marshes with an elevation of less than 2 m are covered with deep, fine textured Grey Hydromorphic Alluvial Soils (Gleysols in FAO/UNESCO) and are fully used for fish culture fields making numerous ponds. Gleysols extending over the plains behind the marshes and along the rivers are affected by water table which comes to or near the ground surface during the wet season. Three soil types grouped into Alluvial Soils (Fluvisols) are identified in the low terraces. In general, the soils are medium to fine in texture, and have very slow to moderately slow permeability and rather high inherent fertility. The lands, at present, are used for wet paddy fields under irrigated or rainfed condition. Gently sloping to undulating hills with an elevation ranging from El. 50 to 150 m are covered with Podzolic Soils (Acrisols). The soils are generally deep in effective soil depth, fine to medium in texture and moderately permeable. Presently, the lands are used for the diversified crops such as dryland paddy, peanuts, sweet potatoes, cassava in the wet season. During the dry season, however, the lands are left fallow due to lack of water resources. The mountain area having steep slope and undulating topography is covered with Latosol (Nitosols) characterized by the low cation exchange capacity of argillic horizon. The lands are mainly used for the cultivation of diversified crops. Rendzinas characterized by a mollic A horizon which overlie calcareous material deriving from reef coral occur in the southern and western parts of the Study Area. The occurrence means that the coast had been around here. The soils, in general, rather shallow or stony and are used for mixed cropping. In addition, Vertisols and Regosols are identified in a small extent of the Study Area, but they play no significant role for agricultural use.

4.2 Land Suitability for Rice Cultivation

Land suitability for rice cultivation is estimated in the Study Area taking account such factors as slopes, soils, effective soil depth and present land use. The factors are taken from each existing thematic map in scale of 1/250,000 compiled by Direktorat Agraria Propinsi Jawa Barat. With due consideration for the data available and local condition of the Study Area, especially for fully developed land use, the schematic land suitability map for rice cultivation is established as shown in Fig. G-4.

The lands classified in suitable category, characterized by level topography and Gleysols, extend northward of the Study Area and along the rivers accounting for 36,000 ha or about 10% of the total land area of 355,100 ha. At present, the land are mostly developed for paddy fields harvested twice a year. The land classified in moderately suitable category amounts to 133,200 ha. Out of this, 62,000 ha is presently used for the rice cultivation in the wet season and the remaining of 71,200 ha has a potential to be reclaimed for rice fields. However, terracing will generally be required due to the suitability class comprising gradient category of 2 to 15%. Marginally suitable lands are estimated to be 64,900 ha and mainly distribute around the Gunung Karang in the southwestern area. The area is overlapped with the distribution of Nitosols. At present, the lands are mainly used for the cultivation of upland crops, while wet paddy fields extend over the undulating and steep lands as many as possible whether slope is permitted using water of small perennial streams or under the rainfed condition. Consequently, new reclamation of lands for rice cultivation can not be expected in this category. Not-suitable lands having main constraint of steeply sloping topography amount to 121,000 ha which are distributed over the area southward and westward of the Study Area.

5. AGRICULTURAL DEVELOPMENT PLAN FOR THE STUDY AREA

5.1 Development Concept and Strategy

The Third Five Year Development Plan (REPELITA III) defines that one of the principal objectives is to accord priority to agricultural development in order that the agricultural sector will contribute to the raise of the living standards of the people and the more equitable distribution of welfare. For this purpose, the plan also emphasizes the requirement for stimulation of the sector to increase production and productivity. Taking these considerations into account, as well as through review of the socio-economic background and physical condition in the Study Area, the general frameworks to be basically considered in planning the agricultural development for the Study Area are formulated, among others.

(1) to improve infrastructures for agriculture, including development of irrigation, rehabilitation of existing irrigation facilities and improvement of drainage and inundation control in the Study Area;

(2) to improve productivity strategically, not only in cultivation of short circuit crops as rice, maize, sweet potatoes and peanuts, but also in such perennial crops as coconut, coffee and cloves; and

(3) to stabilize agriculture which has been vulnerable to climatic conditions and other environment. It will eventually contribute to the soil conservation and watershed management.

5.2 Development Plan

5.2.1 Future land use plan

The results of investigation on present land use and land suitability classification show that the arable lands in the Study Area are mostly cultivated for wetland rice, diversified upland crops and perennials in accordance with land suitability defined with slopes, soils, effective soil depth and water availability. Existing agricultural lands including ground for inland fishery have been developed to the possible maximum extent and there is little unused arable lands to be newly reclaimed.

Under such condition, there should be no major changes in kind of crops to be adopted in the Study Area. Lowlands should greatly contribute to wetland rice production increasing unit yield through the provision of irrigation facilities into the irrigable area and rehabilitation of present facilities in the irrigated area with applying proper farming practices and inputs. On the other hand, the intensive use of uplands will be accomplished by agro-forestry for not only sustained agriculture but also the prevention of soil erosion. The recommended crop diversification for hilly to steep upland crop fields, it is needed to intercrop fast-growing trees having two functions, erosion prevention and shade, and perennial and bienneral crops like coffee, banana, pineapple and cassava. The lands along the coast of the Banten Bay, presently used for fish culture ground on a primitive method, have enormous potentiality of intensive fish culture introducing feeding with establishment of hatchery or spawning ground.

5.2.2 Irrigated rice cultivation

In the Study Area, flat lands of lowlying area have almost developed as wet paddy field, but there still exist a lot of lands moderately suitable for rice cultivation. These lands are distributed on slopes of 2 to 15° and have partly been terraced for wetland rice cropping where river flow is available nearby and slope is not so steep. The remaining lands which belong to this moderately suitable class totaling 71,000 ha and are presently used to grow dryland rice and other upland crops and to establish tree crop plantations. It is required for the development of new wet paddy fields on such rather steep lands to provide for supplemental water source, other than rainfall, which may fill water demand fully throughout the wet season. Due to the topographic condition, however, pump facilities are indispensable from artificial water supply systems for wet paddy fields to be newly developed on these lands. In consequence, the areal increase in wet paddy fields is not taken into account in projecting the future irrigation area until the target year 2000.

The existing irrigation schemes in the Study Area comprise the double cropping area of 19,200 ha and the single cropping area of 43,500 ha under normal climate. When the dry season is abundant in rainfall and river discharge, the double cropping area increases to 31,000 ha. Out of the single cropping area, DPU irrigation schemes cover 30,500 ha in total including 14,600 ha in the Ciujung irrigation scheme, 1,800 ha in the Cibanten irrigation scheme, 1,400 ha in the Cisangu irrigation scheme and 1,300 ha each in the Cicinta and Ciwaka irrigation schemes. To increase cropping intensity through development of year-round irrigation water source, the priority is given to such existing single cropping areas in view of effective water resources development, even if some capitals have been invested to improve the existing irrigation and drainage systems.

There exist wet paddy fields totaling 30,300 ha without provision for irrigation facilities in the Study Area. Out of these rainfed paddy fields, about 8,000 ha concentrate on the terrace, fairly undulating to flat, in the Kecamatans of Pamarayan, Kopo, Cikande and Carenang. Farmers in these Kecamatans have become proficient in rice cultivation, but, due to rainfed cropping, they are obliged to gain low harvests compared with those of beneficiaries under the existing irrigation schemes. The urgent need for introduction of year-round irrigation system is envisaged at the outset.

Taking into consideration the importance and urgency of increase in self-sufficiency of rice through irrigation development, the future irrigation area is projected by water source for the target year 2000 as shown in Table G-12. The projected irrigation area in the dry season will increase from 19,200 ha in 1982 to 43,200 ha in 2000 in the Study Area.

5.3 Future Plan of Rice Cultivation

5.3.1 Proposed cropping pattern

The rice is most profitable crop among various kinds of annual crops, when it is grown on a scale of great magnitude by receiving irrigation water throughout the year. As for vegetables to be grown in the dry season, there are many competitive producing areas located nearer to the largest consuming center, Jakarta. From the viewpoint of overall planning on water resource development, two cropping of wetland rice is taken into account as the proposed cropping pattern for the whole irrigation area, aiming at the estimate of future irrigation water demand. Within the estimated water demand, some minor changes can be made in reviewing comparative patterns for the dry season cropping.

In formulating the proposed cropping pattern, a period of one month is considered as a given condition that it is required for maintenance works of the primary canals of the existing Ciujung irrigation scheme and the newly planned K-C-C irrigation scheme. To meet this condition, a medium term variety such as Cisadane is selected for the wet season cropping and a short term variety like IR 36 is chosen for the dry season cropping.

Five alternative cropping patterns by the scale of command area are made for comparison of irrigation water requirement and proper timing of farming practices as illustrated in Fig. G-5. As a result, the most effective pattern, Alternative C, comprising that the wet season cropping starts from November to mid January with its harvesting period from March to May and the dry season cropping commences from mid April to the end of June with its harvesting period from August to the end of September, is adopted as the proposed cropping pattern under the Golongan system having three blocks as illustrated in Fig. G-6. The proposed cropping pattern is almost similar to the present patterns prevailing in the irrigation schemes of the Study Area.

5.3.2 Future farming practices

Proper irrigation farming is the most essential factor for realizing full exploitation of agricultural potentiality in the Study Area. For this purpose, high yielding varieties such as IR series and improved varieties bred in Bogor will be introduced. Proper amount of fertilizers and agricultural chemicals will be applied.

The estimated total fertilizer requirements are 200 kg/ha of urea and 100 kg/ha of TSP. The estimated total chemical requirement are 3 lit/ha. Furthermore, proper irrigation water control will be carried out.

5.3.3 Anticipated crop yield

In general, through provision for proper irrigation water supply system and improved agricultural supporting services, increase in paddy yield can be expected to large extent. At present, yield in irrigated area with technified facilities comes up to full exploitation level attainable by providing normal farming practices. For this reason, the paddy yield under the irrigated condition is anticipated to be 4.2 ton/ha for wet season cropping and 4.5 ton/ha for dry season cropping.

The paddy yield in proposed irrigation development areas will gradually increase from the yield level of 3.2 ton/ha under the rain-fed condition to the anticipated yield of 5.0 ton/ha under the irrigated condition at the full development stage. The anticipated yield will be applied to the K-C-C irrigation scheme area.

5.3.4 *Production increase attributable to irrigation water supply*

The irrigation schemes of Ciujung, Cicinta and K-C-C formulated as beneficial areas in the present study will contribute to the paddy production increase in the Study Area. Three alternatives, Cases 1 to 3, in accordance with dam combination proposed are studied. The total dry paddy production by irrigation scheme in each case is estimated as shown in Tables G-13 to G-15. The increment of total paddy production by alternative case attributable to irrigation water resources development in the Study Area is estimated to be 96,000 ton/y for Case 1, Karian dam alone, 115,800 ton/y for Case 2, Karian plus Pasir Kopo dams and 116,600 ton/y for Case 3, Karian plus Cilawang dams, as shown in Table G-16.

6. EFFECT OF AGRICULTURAL DEVELOPMENT PLAN

6.1 Production Value

6.1.1 Economic price of farm input and output

The economic farm gate prices of farm input and output are derived from a projection to 1995 at the 1982 constant price level forecasted by IBRD (Ref. 4). The projected farm gate prices are Rp 180/kg for dry paddy, Rp 226/kg for urea, Rp 177/kg for TSP, Rp 116/kg for potassium, Rp 1,230/kg for agro-chemicals and Rp 250/kg for certified seed. The economic farm labour wages are estimated to be Rp 600/man-day on the basis of PROSIDA's information. Derivation of economic farm gate prices is shown in Table G-17 for wetland paddy and Table G-18 for fertilizers.

6.1.2 Crop production cost

The economic production costs estimated include seeds, fertilizers, agro-chemicals, materials and tools, draft animal and labours, but these exclude taxes and water charges.

The farm labour requirements for wetland rice cultivation are estimated to be 205 man-day/ha in the wet season and 210 man-day/ha in the dry season for the existing two irrigation schemes under the conditions with and without project. For the K-C-C irrigation scheme, the requirements estimated are 212 man-day/ha under the condition with project and 225 man-day/ha under the condition without project as shown in Table G-19.

The economic crop production cost of wetland paddy under the condition with project is estimated to be Rp 261,000/ha for the wet season cropping and Rp 265,000/ha for the dry season cropping in the Ciujung and Cicinta irrigation schemes, while the estimated cost in the K-C-C area is Rp 270,000/ha for both seasons. Under the condition without project, the economic production cost estimated for the wet season cropping is Rp 235,000/ha in the Ciujung and Cicinta irrigation schemes and Rp 243,000/ha in the K-C-C area, while that for the dry season cropping is Rp 239,000/ha in the Ciujung irrigation scheme. All of these costs are broken down in Table G-20.

6.1.3 Net production value

The economic gross production value is obtained by multiplying the anticipated crop yield by the economic farm gate price. The economic net production value is then obtained by subtracting the economic production cost from the economic gross production value. The results of calculation for each irrigation scheme are shown in Table G-21.

6.1.4 Incremental net benefit

The irrigation benefit attributable to the water resources development in the Study Area is estimated by deriving from the balance of net economic production values between the future conditions with and without projects.

In the Ciujung irrigation scheme, the economic total net production value will increase from Rp 15,656 x 10^6 to Rp 22,143 x 10^6 by constructing the Karian dam alone and to Rp 23,424 x 10^6 through the construction of two dams, Karian plus Pasir Kopo or Cilawang, as shown in Table G-22. The Cicinta irrigation scheme will only be benefited by the Cilawang dam and its economic total net production value will be go up from Rp 567 x 10^6 to Rp 1,392 x 10^6, as shown in Table G-23. The economic total net production value in the K-C-C area will increase from Rp 2,664 x 10^6 to Rp 8,921 x 10^6 by the Karian dam alone, to Rp 10,080 x 10^6 by the Karian plus Pasir Kopo dams and to Rp 9,419 x 10^6 by the Karian plus Cilawang dams, as shown in Table G-24.

Thus, the incremental net benefit calculated is Rp 12,744 x 10^6 for the alternative case of the Karian dam alone, Rp 15,184 x 10^6 for the combination of the Karian and Pasir Kopo dams and Rp 15,348 x 10^6 for the case of the Karian plus Cilawang dams, as shown in Table G-25.

6.2 Flood Damage Value

In estimating flood damages to crops in the flooded area of the Study Area in Nov. 1981, the damage rate of each crop is assumed as below taking into consideration typical cropping calender prevailing in the flood prone area.

The growth stage of rice plants when flooded was distributed over a wide range from maturation period to tillering stage just after transplanting sandwiching fallow period. It is reported that the period of inundation over wet paddy fields was four days and the inundation depth was from 0.5 to 1.5 m. As no record was available on the individual growth stages of wetland paddy on the damaged wet paddy fields, however, the damage rate in the present study is presupposed as being 50%.

On the inundated upland crop fields, cassava and maize are considered as the representative upland crops. The mean damage rate is assumed to be 10% for cassava and 100% for maize based on the typical cropping calender of each crop in the inundated area. The inundated orchards, which are mixed-cultivation lands of bananas and bamboo, suffered from no flood damage as the bamboo served as protections for fruit trees.

For estimating actual damages, unit prices of damaged crops are calculated in the following manner. The unit price is obtained by calculating first gross production value, obtained by multiplying the average yield of the inundated area by the minimum government-buying price of rice in 1982 for the inundated paddy areas and the farm gate price in 1982 for the inundated cassava and maize areas, and then subtracting the crop production cost that is not needed after damage generation. The unit prices calculated are Rp 280,000/ha for wetland paddy, Rp 45,000/ha for maize and Rp 200,000/ha for cassava.

In the future, when the year-round irrigation system will be completed and the cropping calender will be stabilized, a flood arising during the period between November and January would inundated the whole wet paddy fields within the flood prone area. In estimating the flood control benefit for wet paddy fields alone, damages calculated by the following method are used in place of the actual flood damage. The farm gate price and production value and cost are calculated by adopting the economic price of paddy as described in Sub-section 6.1.1. With the mean damage rate assumed to be 50%, the unit price of wetland paddy is estimated to be Rp 800,000/ha. Economic damages to field crops and fruit trees in the flood prone area shall be considered to be the same as the actual damage values.

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3. STATISTIK JAWA BARAT, TAHUN 1980, Kantor Statistik Propinsi Jawa Barat, 1981

4. COMODITY PRICES AND PRICE PROJECTION IN 1981 CONSTANT DOLLAR, 1982, World Bank

Table G-1 GROSS DOMESTIC PRODUCT BY SECTOR AT THE 1973 CONSTANT PRICE

Unit: Rp 10^9

Sector	1976	1977	1978	1979	1980
Agriculture, Livestock, Forestry & Fishery					
Farm food crops	1,755.5	1,734.2	1,835.8	1,880.2	2,009.8
Farm non-food crops	325.0	392.2	388.2	400.3	410.9
Estate crops	188.0	201.0	209.5	231.6	241.2
Livestock and products	215.8	177.3	184.2	191.9	200.5
Forestry	309.8	317.6	351.6	337.4	333.3
Fishery	149.6	159.0	165.5	172.2	179.1
Sub-total	2,943.7	2,981.3	3,134.8	3,213.6	3,374.8
Mining & Quarrying	952.3	1,070.0	1,048.8	1,043.6	1,028.1
Manufacturing Industries	930.0	1,057.7	1,176.5	1,280.9	1,428.6
Electricity, Gas & Water Supply	46.3	49.0	53.3	64.9	79.1
Construction	384.5	463.8	528.9	562.8	606.7
Wholesale & Retail Trades	1,350.7	1,438.2	1,530.3	1,639.2	1,770.1
Transport & Communications	342.6	427.6	490.1	541.4	595.5
Banking & Other Financial Intermediaries	117.4	151.2	164.6	182.1	209.5
Ownership of Dwelling	209.1	252.2	287.6	306.1	329.9
Public Administration & Defence	595.5	689.8	767.9	805.1	911.4
Services	284.2	290.1	296.9	304.0	311.3
Gross Domestic Product	8,156.3	8,870.9	9,479.7	9,943.7	10,645.0

Source: Ref. 1

Table G-2 GROSS REGIONAL PRODUCT BY SECTOR AT THE 1975 CONSTANT PRICE

Unit: Rp 10^9

Sector	1976	1977	1978	1979	1980
Agriculture, Livestock, Forestry & Fishery					
Farm food crops	464.2	435.0	519.6	527.1	585.0
Farm non-food crops	31.8	40.1	43.3	40.8	53.6
Estate crops	19.6	21.1	23.1	24.8	19.9
Livestock and products	58.8	62.7	70.6	66.2	60.6
Forestry	1.8	1.0	1.3	1.5	1.7
Fishery	29.7	26.3	29.6	44.0	51.8
Sub-total	605.9	586.2	687.5	704.4	772.6
Mining & Quarrying	260.0	269.7	239.5	218.4	242.0
Manufacturing Industries	159.9	180.4	238.0	243.2	256.6
Electricity, Gas & Water Supply	9.2	10.5	12.0	13.4	18.4
Construction	75.9	95.3	109.3	127.7	160.1
Wholesale & Retail Trades	430.4	464.0	518.8	529.6	580.5
Transport & Communications	77.3	93.6	99.0	113.3	124.6
Banking & Other Financial Intermediaries	17.3	17.6	20.1	21.7	25.9
Ownership of Dwelling	68.5	70.2	71.9	71.9	73.7
Public Administration & Defence	118.0	137.3	165.9	171.1	222.3
Services	90.7	96.0	100.2	109.5	118.8
Gross Regional Product	1,913.1	2,020.8	2,262.2	2,324.2	2,595.5

Source: Ref. 2

Table G-3 PRESENT LAND USE BY WATERSHED IN THE STUDY AREA

Unit: ha

Land Use Category	Cidurian River	Ciujung River				
	Cibeureum Watershed	Ciberang Watershed	Cisimeut Watershed	Upper Ciujung Watershed	Lower Ciujung Watershed	Sub-total
Wet Paddy Field						
Double cropping	800	2,300	700	3,600	19,700	26,300
Single cropping	3,500	1,100	2,800	3,400	33,500	40,800
Sub-total	4,300	3,400	3,500	7,000	53,200	67,100
Upland Crop Field	13,500	17,700	23,300	29,300	35,100	105,400
Plantation	2,300	1,300	5,000	3,400	400	10,100
Shrub	3,800	3,200	10,900	17,900	100	32,100
Forest	1,100	7,500	3,100	1,800	600	13,000
Grass Land	500	0	0	0	200	200
Swamp	0	0	0	0	0	0
Fish Pond	0	0	0	0	4,500	4,500
Fallow Land	0	0	0	0	0	0
Total	25,500	33,100	45,800	59,400	94,100	232,400

Land Use Category	Cibanten River	Cidanau River	Kali Ke-dungingas River	Kali Anyer River	—	Whole Study Area
	Cibanten Watershed	Cidanau Watershed	Kali Ke-dungingas Watershed	Kali Anyer Watershed	Gunung Gede in Peninsular Watershed	
Wet Paddy Field						
Double cropping	700	2,600	0	600	0	31,000
Single cropping	2,700	4,300	4,900	2,800	3,000	62,000
Sub-total	3,400	6,900	4,900	3,400	3,000	93,000
Upland Crop Field	14,200	18,300	8,300	9,500	8,800	178,000
Plantation	400	200	800	4,300	300	18,400
Shrub	200	200	0	0	0	36,300
Forest	200	5,000	0	2,600	200	22,100
Grass Land	0	0	0	0	0	700
Swamp	0	1,000	0	0	0	1,000
Fish Pond	100	0	900	0	100	5,600
Fallow Land	0	0	0	0	0	0
Total	18,500	31,600	14,900	19,800	12,400	355,100

Table G-4 HARVESTED AREA OF WETLAND PADDY IN THE STUDY AREA FROM 1977 TO 1981

Unit: ha

Kabupaten	1977	1978	1979	1980	1981	Average
Serang	65,100	75,800	68,000	70,000	80,800	71,900
Lebak	16,500	17,200	15,800	15,900	14,600	16,000
Pandeglang	4,400	4,500	4,700	4,800	5,500	4,800
Study Area	86,000	97,500	88,500	90,700	100,900	92,700

Source: Statistik Jawa Barat Tahun 1977 - 1980
Agricultural Office in the Kabupatens of Serang, Lebak and Pandeglang

Table G-5 HARVESTED AREA, UNIT YIELD AND PRODUCTION OF PADDY

Kabupaten	Wetland Paddy/1			Dryland Paddy/2		
	Harvested Area (ha)	Unit Yield (ton/ha)	Production (tons)	Harvested Area (ha)	Unit Yield (ton/ha)	Production (tons)
Serang	71,900	3.1	225,900	7,800	1.8	14,300
Lebak	16,000	2.8	44,300	6,800	1.4	9,800
Pandeglang	4,800	3.3	15,800	1,300	1.6	2,100
Study Area	92,700	3.1	286,000	15,900	1.6	26,200

Remarks: /1 = Average value from 1977 to 1981
/2 = Statistics in 1980

Table G-6 HARVESTED AREA, UNIT YIELD AND PRODUCTION OF UPLAND CROPS FOR THE STUDY AREA IN 1980

Crop	Item	Unit	Kabupaten			Study Area
			Serang	Lebak	Pandeglang	
Cassava	Harvested area	ha	5,850	1,260	380	7,490
	Unit yield	ton/ha	10.9	9.8	11.3	10.7
	Production	ton	63,700	12,300	4,300	80,300
Peanuts	Harvested area	ha	16,260	1,250	220	17,730
	Unit yield	ton/ha	0.9	0.7	1.0	0.9
	Production	ton	14,130	820	210	15,340
Sweet Potatoes	Harvested area	ha	2,080	220	190	2,490
	Unit yield	ton/ha	8.4	9.0	8.8	8.5
	Production	ton	17,420	1,980	1,670	21,070
Maize	Harvested area	ha	1,910	380	250	2,540
	Unit yield	ton/ha	1.5	1.4	1.1	1.4
	Production	ton	2,870	540	270	3,680
Soybeans	Harvested area	ha	200	60	80	340
	Unit yield	ton/ha	0.6	0.5	0.6	0.6
	Production	ton	120	30	50	200

Source: Ref. 3

Table G-7 PLANTED AREA, UNIT YIELD AND PRODUCTION OF TREE CROPS FOR THE STUDY AREA IN 1980

Crop	Item	Unit	Kabupaten			Study Area
			Serang	Lebak	Pandeglang	
Rubber	Harvested area	ha	390	4,310	100	4,800
	Unit yield	ton/ha	0.26	0.39	0.30	0.38
	Production	ton	100	1,690	30	1,820
Coconut	Harvested area	ha	31,400	7,500	3,300	42,200
	Unit yield	ton/ha	0.33	0.32	0.42	0.34
	Production	ton	10,400	2,400	1,400	14,200
Coffee	Harvested area	ha	1,260	730	230	2,220
	Unit yield	ton/ha	0.23	0.36	0.35	0.28
	Production	ton	290	260	80	630
Pepper	Harvested area	ha	113	-	5	118
	Unit yield	ton/ha	0.47	-	0.40	0.47
	Production	ton	53	-	2	55
Cloves	Harvested area	ha	2,240	3,050	240	5,530
	Unit yield	ton/ha	0.02	0.10	0.08	0.07
	Production	ton	50	300	20	370
Vanilla	Harvested area	ha	544	3	13	560
	Unit yield	ton/ha	0.26	0.13	0.11	0.25
	Production	ton	139.5	0.4	1.4	141.3
Banana	Harvested area	ha	1,400	200	300	1,900
	Unit yield	ton/ha	12.9	15.0	3.3	11.6
	Production	ton	18,000	3,000	1,000	22,000

Source: Ref. 3

Table G-8 DISTRIBUTION OF WET PADDY FIELDS FOR THE STUDY AREA IN 1982

Unit: ha

Item	Kabupaten Serang	Kabupaten Pandeglang	Kabupaten Lebak	Total
1. Irrigated area				
1.1 DPU irrigation				
Technical	31,103	256	2,226	33,585
Semi-technical	5,465	492	1,093	7,050
Simple	2,936	862	528	4,326
Sub-total	39,504	1,610	3,847	44,961
1.2 Non-DPU irrigation	7,058	3,800	6,922	17,780
Total irrigated area	46,562	5,410	10,769	62,741
2. Rainfed area	24,638	990	4,631	30,259
Grand Total	71,200	6,400	15,400	93,000

Table G-9 AVERAGE PRICE OF FOOD CROPS AT RURAL MARKETS IN WEST JAVA

Unit: Rp/kg

Crop	1977	1978	1979	1980
Milled Rice				
Grade 1	148	156	190	228
Grade 2	138	146	178	215
Cassava	32	32	32	41
Peanuts	349	369	456	574
Sweet Potatoes	38	40	43	53
Maize	79	76	109	133
Soybeans	232	251	295	342

Source: Indikator Ekonom: Jawa Barat, Tahun 1977
Statistik Jawa Barat, Tahun 1978-1980

Table G-10 CROP BUDGETS FOR MAJOR CROPS FOR WEST JAVA IN 1979

Unit: Rp/ha

Description	Wetland Paddy	Dryland Paddy	Cassava	Peanuts
1. Unit Yield (ton/ha)	4.2	1.9	10.0	0.9
2. Farm Gate Price (Rp/ton)	62,500	60,500	14,600	232,000
3. Gross Production Value	262,500	114,950	146,000	208,800
4. Production Cost				
4.1 Farm input				
Seed	3,300	2,800	/1	12,900
Fertilizer	15,800	4,900	2,900	7,200
Agro-chemicals	1,900	400	200	800
Sub-total	21,000	8,100	3,100	20,900
4.2 Labour	57,000	31,300	30,200	38,600
4.3 Miscellaneous	12,500	2,950	3,300	3,900
Total Cost	90,500	42,350	36,600	63,400
5. Net Production Value	172,000	72,600	109,400	145,400

Description	Sweet Potatoes	Maize	Soybeans
1. Unit Yield (ton/ha)	7.8	1.5	0.7
2. Farm Gate Price (Rp/ton)	16,400	59,000	185,600
3. Gross Production Value	127,900	88,500	129,900
4. Production Cost			
4.1 Farm input			
Seed	/1	1,500	9,400
Fertilizer	6,800	5,500	3,100
Agro-chemicals	600	100	4,500
Sub-total	7,400	7,100	17,000
4.2 Labour	25,700	16,500	39,100
4.3 Miscellaneous	1,900	1,300	2,700
Total Cost	35,000	24,900	58,800
5. Net Production Value	92,900	63,600	71,100

Remarks: /1 = Seed cost is included into miscellaneous cost.

Source: Survey Pertanian, 1979, Biro Pusat Statistik

Table G-11 PLANTED AND HARVESTED AREA BY KECAMATAN LOCATED ENTIRELY AND PARTLY IN CIUJUNG IRRIGATION SCHEME

Unit: ha

Kecamatan	1977	1978	1979	1980	1981	Average
Kramatwatu						
Wet season area	3,250	3,250	3,250	3,250	3,050	3,210
Dry season area	420	350	300	680	0	350
Total planted area	3,670	3,600	3,550	3,930	3,050	3,560
Harvested area	3,580	3,490	3,390	3,750	3,830	3,610
Kasemen						
Wet season area	4,270	4,270	4,270	4,270	4,270	4,270
Dry season area	290	4,670	1,590	1,480	1,940	1,990
Total planted area	4,560	8,940	5,860	5,750	6,210	6,260
Harvested area	3,740	8,650	5,450	5,490	6,100	5,890
Serang						
Wet season area	2,840	900	2,640	2,820	2,890	2,420
Dry season area	0	0	0	0	0	0
Total planted area	2,840	900	2,640	2,820	2,890	2,420
Harvested area	2,710	800	2,360	2,630	2,980	2,300
Ciruas						
Wet season area	3,120	3,120	3,120	3,120	3,120	3,120
Dry season area	1,380	1,420	2,220	1,580	520	1,420
Total planted area	4,500	4,540	5,340	4,700	3,640	4,540
Harvested area	4,260	4,360	5,100	4,160	4,130	4,400
Walantaka						
Wet season area	2,380	2,380	2,380	2,380	2,380	2,380
Dry season area	210	700	870	930	20	550
Total planted area	2,590	3,080	3,250	3,310	2,400	2,930
Harvested area	2,060	2,880	3,120	3,100	2,360	2,720
Pontang						
Wet season area	4,970	4,790	4,970	4,970	4,970	4,930
Dry season area	210	0	870	110	860	410
Total planted area	5,180	4,790	5,840	5,080	5,830	5,340
Harvested area	4,650	4,480	6,070	5,090	4,930	5,040
Kragilan						
Wet season area	2,260	2,260	2,260	2,260	2,260	2,260
Dry season area	590	580	610	2,150	1,370	1,060
Total planted area	2,850	2,840	2,870	4,410	3,630	3,320
Harvested area	2,730	2,840	2,650	3,980	3,440	3,130
Pamarayan						
Wet season area	3,650	3,650	3,650	3,650	3,620	3,640
Dry season area	660	690	440	970	0	550
Total planted area	4,310	4,340	4,090	4,620	3,620	4,200
Harvested area	3,930	4,070	3,930	4,840	3,430	4,040
Cikande						
Wet season area	3,630	5,180	5,240	5,240	5,240	4,910
Dry season area	0	0	1,150	650	1,660	690
Total planted area	3,630	5,180	6,390	5,890	6,900	5,600
Harvested area	5,560	4,840	5,890	5,290	7,230	5,760
Carenang						
Wet season area	4,660	4,900	4,900	4,900	4,900	4,850
Dry season area	0	1,350	210	690	930	640
Total planted area	4,660	6,250	5,110	5,590	5,830	5,490
Harvested area	4,420	5,460	4,990	4,880	4,930	4,940
Tirtayasa						
Wet season area	5,340	5,340	5,050	5,340	5,340	5,280
Dry season area	1,210	50	0	750	790	560
Total planted area	6,550	5,390	5,050	6,090	6,130	5,840
Harvested area	5,880	4,940	5,320	5,720	8,060	5,980
Total						
Wet season area	40,370	40,040	41,730	42,200	42,040	41,280
Dry season area	4,970	9,810	8,260	9,990	8,090	8,220
Total planted area	45,340	49,850	49,990	52,190	50,130	49,500
Harvested area	43,620	46,810	48,270	48,930	51,420	47,810

Table G-12 PROJECTED IRRIGATION AREA

Unit: ha

Water Source	1982		2000		After 2000	
	Wet	Dry	Wet	Dry	Wet	Dry
Ciujung						
U/S Pamarayan	13,255	3,813	13,250	3,800	13,250	8,000
At Pamarayan	24,200	9,600	24,200	24,200	24,200	24,200
D/S Pamarayan	8,747	2,087	8,750	2,100	8,750	5,000
Sub-total	46,202	15,500	46,200	30,100	46,200	37,200
Cibeureum	1,435	100	9,500	9,500	9,500	9,500
Ciwaka	2,140	435	2,150	450	3,400	700
Cibanten	2,462	432	2,500	400	2,700	1,600
Cidanau	2,264	513	2,300	550	4,300	2,600
Other rivers	8,238	2,214	8,250	2,200	12,900	3,400
Rainfed	30,259	-	22,100	-	14,000	-
Total	93,000	19,194	93,000	43,200	93,000	55,000

Remarks: U/S = Upstream
D/S = Downstream

Table G-13 PROSPECTED WETLAND PADDY PRODUCTION BY ALTERNATIVE CASE OF IRRIGATION WATER RESOURCES DEVELOPMENT FOR CIUJUNG SCHEME

	Case 1		Case 2		Case 3	
	Without Project	With Project	Without Project	With Project	Without Project	With Project
Irrigation Area (ha)						
Wet season	24,200	24,200	24,200	24,200	24,200	24,200
Dry season	9,600	18,650	9,600	21,000	9,600	21,000
Unit Yield (ton/ha)						
Wet season	3.9	4.2	3.9	4.2	3.9	4.2
Dry season	4.2	4.5	4.2	4.5	4.2	4.5
Production (ton)						
Wet season	94,380	101,640	94,380	101,640	94,380	101,640
Dry season	40,320	83,925	40,320	94,500	40,320	94,500
Total	134,700	185,565	134,700	196,140	134,700	196,140
Increment		50,865		61,440		61,440

Table G-14 PROSPECTED WETLAND PADDY PRODUCTION BY ALTERNATIVE CASE OF IRRIGATION WATER RESOURCES DEVELOPMENT FOR CICINTA SCHEME

	Case 1		Case 2		Case 3	
	Without Project	With Project	Without Project	With Project	Without Project	With Project
Irrigation Area (ha)						
Wet season	-	-	-	-	1,435	1,435
Dry season	-	-	-	-	0	1,250
Unit Yield (ton/ha)						
Wet season	-	-	-	-	3.9	4.2
Dry season	-	-	-	-	0	4.5
Production (ton)						
Wet season	-	-	-	-	5,596	6,027
Dry season	-	-	-	-	0	5,625
Total	-	-	-	-	5,596	11,652
Increment		-		-		6,056

Table G-15 PROSPECTED WETLAND PADDY PRODUCTION BY ALTERNATIVE CASE OF IRRIGATION WATER RESOURCES DEVELOPMENT FOR K-C-C AREA

	Case 1		Case 2		Case 3	
	Without Project	With Project	Without Project	With Project	Without Project	With Project
Irrigation Area (ha)						
Wet season	8,000	8,000	8,000	8,000	8,000	8,000
Dry season	0	6,160	0	8,000	0	6,950
Unit Yield (ton/ha)						
Wet season	3.2	5.0	3.2	5.0	3.2	5.0
Dry season	0	5.0	0	5.0	0	5.0
Production (ton)						
Wet season	25,600	40,000	25,600	40,000	25,600	40,000
Dry season	0	30,800	0	40,000	0	34,750
Total	25,600	70,800	25,600	80,000	25,600	74,750
Increment		45,200		54,400		49,150

Table G-16 PROSPECTED WETLAND PADDY PRODUCTION BY ALTERNATIVE CASE OF IRRIGATION WATER RESOURCES DEVELOPMENT IN THE STUDY AREA

	Case 1		Case 2		Case 3	
	Without Project	With Project	Without Project	With Project	Without Project	With Project
Irrigation ARea (ha)						
Wet season	32,200	32,200	32,200	32,200	33,635	33,635
Dry season	9,600	24,810	9,600	29,000	9,600	29,200
Unit Yield (ton/ha)						
Wet season	3.7	4.4	3.7	4.4		
Dry season	4.2	4.6	4.2	4.6		
Production (ton)						
Wet season	119,980	141,640	119,980	141,640	125,576	147,667
Dry season	40,320	114,725	40,320	134,500	40,320	134,875
Total	160,300	256,365	160,300	276,140	165,896	282,542
Increment		96,065		115,840		116,646

Table G-17 *DERIVATION OF ECONOMIC FARM GATE PRICE* OF RICE AT THE 1982 CONSTANT PRICE

Item	Unit	1982	1995
1. Export price, Thai 5% broken, F.O.B. Bangkok	US$/ton	326	435
2. 10% discount for quality	US$/ton	293	392
3. Freight and insurance Bangkok to Jakarta	US$/ton	24	24
4. Transport & handling from port to wholesaler	US$/ton	10	10
5. Import parity	US$/ton	327	426
6. Conversion to Rupiah	Rp/ton	225,630	293,940
7. Transport and handling from projedt site to wholesaler	Rp/ton	7,500	7,500
8. Milling cost (12%)	Rp/ton	24,300	31,900
9. Less of by-products	Rp/ton	8,870	11,740
10. Value at mill	Rp/ton	202,700	266,200
11. Conversion to dry paddy (68%)	Rp/ton	137,800	181,000
12. Transport from farm to mill	Rp/ton	1,000	1,000
13. Economic farm gate price	Rp/ton	136,800	180,000
	Rp/kg	137	180

Table G-18 DERIVATION OF ECONOMIC FARM GATE PRICES OF FERTILIZERS AT THE 1982 CONSTANT PRICE

Item	Unit	1982	1995
1. Urea 46% N			
Export price, F.O.B. Europe	US$/ton	185	286
Freight and insurance	US$/ton	21	21
Handling, distribution & storage	US$/ton	20	20
Economic farm gate price	US$/ton	226	327
Conversion to Rupiah	Rp/ton	155,940	225,690
	Rp/kg	156	226
2. TSP 46% P_2O_5			
Export price, F.O.B. Gulf	US$/ton	160	203
Freight and insurance	US$/ton	34	34
Handling, distribution & storage	US$/ton	20	20
Economic farm gate price	US$/ton	214	257
Conversion to Rupiah	Rp/ton	147,660	177,330
	Rp/kg	148	177
3. Potassium 60% K_2O			
Export price, F.O.B. Vancouver	US$/ton	90	114
Freight and insurance	US$/ton	34	34
Handling, distribution & storage	US$/ton	20	20
Economic farm gate price	US$/ton	144	168
Conversion to Rupiah	Rp/ton	99,360	115,920
	Rp/kg	99	116

Table G-19 FARM INPUT AND LABOUR REQUIREMENTS FOR WETLAND PADDY IN THE STUDY AREA

Item	Unit	Wet Season Cropping		Dry Season Cropping		
		Ciujung & Cicinta	K-C-C	Ciujung	Cicinta	K-C-C
Without Project						
1. Materials						
Seed	kg/ha	25	25	25	-	-
Fertilizer						
Urea	kg/ha	130	110	130	-	-
TSP	kg/ha	85	60	85	-	-
KCl	kg/ha	50	-	50	-	-
Chemicals	l/ha	2	2	2	-	-
2. Labour	man-day/ha	205	225	210	-	-
With Project						
1. Materials						
Seed	kg/ha	25	25	25	25	25
Fertilizer						
Urea	kg/ha	200	200	200	200	200
TSP	kg/ha	100	100	100	100	100
KCl	kg/ha	100	100	100	100	100
Chemicals	l/ha	3	3	3	3	3
2. Labour	man-day/ha	205	212	210	210	212

Table G-20 ECONOMIC PRODUCTION COST OF WETLAND PADDY IN THE STUDY AREA

Unit: Rp/ha

Item	Wet Season Cropping		Dry Season Cropping		
	Ciujung & Cicinta	K-C-C	Ciujung	Cicinta	K-C-C
Without Project					
1. Materials					
Seed	6,250	6,250	6,250	-	-
Fertilizer					
Urea	29,380	24,860	29,380	-	-
TSP	15,045	10,620	15,045	-	-
KCl	5,800	-	5,800	-	-
Chemicals	2,460	2,460	2,460	-	-
Others	53,065	63,810	54,065	-	-
Sub-total	112,000	108,000	113,000	-	-
2. Labour	123,000	135,000	126,000	-	-
Total	235,000	243,000	239,000	-	-
With Project					
1. Materials					
Seed	6,250	6,250	6,250	6,250	6,250
Fertilizer					
Urea	45,200	45,200	45,200	45,200	45,200
TSP	17,700	17,700	17,700	17,700	17,700
KCl	11,600	11,600	11,600	11,600	11,600
Chemicals	3,690	3,690	3,690	3,690	3,690
Others	53,560	58,360	54,560	54,560	58,360
Sub-total	138,000	142,800	139,000	139,000	142,800
2. Labour	123,000	127,200	126,000	126,000	127,200
Total	261,000	270,000	265,000	265,000	270,000

Table G-21 ECONOMIC NET PRODUCTION VALUE

Item	Unit	Ciujung	Cicinta	K-C-C
1. With Project				
Dry season cropping				
Yield	ton/ha	4.5	4.5	5.0
Gross production value	Rp/ha	810,000	810,000	900,000
Production cost	Rp/ha	265,000	265,000	270,000
Net production value	Rp/ha	545,000	545,000	630,000
Wet season cropping				
Yield	ton/ha	4.2	4.2	5.0
Gross production value	Rp/ha	756,000	756,000	900,000
Production cost	Rp/ha	261,000	261,000	270,000
Net production value	Rp/ha	495,000	495,000	630,000
2. Without Project				
Dry season cropping				
Yield	ton/ha	4.1	-	-
Gross production value	Rp/ha	738,000	-	-
Production cost	Rp/ha	239,000	-	-
Net production value	Rp/ha	499,000	-	-
Wet season cropping				
Yield	ton/ha	3.8	3.5	3.2
Gross production value	Rp/ha	684,000	630,000	576,000
Production cost	Rp/ha	235,000	235,000	243,000
Net production value	Rp/ha	449,000	395,000	333,000

Table G-22 IRRIGATION BENEFIT BY ALTERNATIVE CASE IN CIUJUNG SCHEME

Item	Case 1		Case 2		Case 3	
	Without Project	With Project	Without Project	With Project	Without Project	With Project
1. Irrigation Area (ha)						
Wet season	24,200	24,200	24,200	24,200	24,200	24,200
Dry season	9,600	18,650	9,600	21,000	9,600	21,000
2. Unit Net Production Value (Rp/ha)						
Wet season	449,000	495,000	449,000	495,000	449,000	495,000
Dry season	499,000	545,000	499,000	545,000	499,000	545,000
3. Total Net Production Value (Rp 10^6)						
Wet season	10,866	11,979	10,866	11,979	10,866	11,979
Dry season	4,790	10,164	4,790	11,445	4,790	11,445
Total	15,656	22,143	15,656	23,424	15,656	23,424
4. Net Incremental Value (Rp 10^6)	-	6,487	-	7,768	-	7,768

Table G-23 IRRIGATION BENEFIT BY ALTERNATIVE CASE IN CICINTA SCHEME

Item	Case 1		Case 2		Case 3	
	Without Project	With Project	Without Project	With Project	Without Project	With Project
1. Irrigation Area (ha)						
Wet season	-	-	-	-	1,435	1,435
Dry season	-	-	-	-	0	1,250
2. Unit Net Production Value (Rp/ha)						
Wet season	-	-	-	-	395,000	495,000
Dry season	-	-	-	-	0	545,000
3. Total Net Production Value (Rp 10^6)						
Wet season	-	-	-	-	567	711
Dry season	-	-	-	-	0	681
Total	-	-	-	-	567	1,392
4. Net Incremental Value (Rp 10^6)	-	-	-	-	-	825

Table G-24 IRRIGATION BENEFIT BY ALTERNATIVE CASE IN K-C-C AREA

Item	Case 1		Case 2		Case 3	
	Without Project	With Project	Without Project	With Project	Without Project	With Project
1. Irrigation Area (ha)						
Wet season	8,000	8,000	8,000	8,000	8,000	8,000
Dry season	0	6,160	0	8,000	0	6,950
2. Unit Net Production Value (Rp/ha)						
Wet season	333,000	630,000	333,000	630,000	333,000	630,000
Dry season	0	630,000	0	630,000	0	630,000
3. Total Net Production Value (Rp 10^6)						
Wet season	2,664	5,040	2,664	5,040	2,664	5,040
Dry season	0	3,881	0	5,040	0	4,379
Total	2,664	8,921	2,664	10,080	2,664	9,419
4. Net Incremental Value (Rp 10^6)	-	6,257	-	7,416	-	6,755

Table G-25 IRRIGATION BENEFIT BY ALTERNATIVE CASE IN THE STUDY AREA

Item	Unit	Case 1	Case 2	Case 3
1. Irrigation Area				
Wet season cropping				
Ciujung	ha	24,200	24,200	24,200
Cicinta	ha	-	-	1,435
K-C-C	ha	8,000	8,000	8,000
Total	ha	32,200	32,200	33,635
Dry season cropping				
Ciujung	ha	18,650	21,000	21,000
Cicinta	ha	-	-	1,250
K-C-C	ha	6,160	8,000	6,950
Total	ha	24,810	29,000	29,200
2. Net Incremental Value				
Ciujung	Rp 10^6	6,487	7,768	7,768
Cicinta	Rp 10^6	-	-	825
K-C-C	Rp 10^6	6,257	7,416	6,755
Total	Rp 10^6	12,744	15,184	15,348

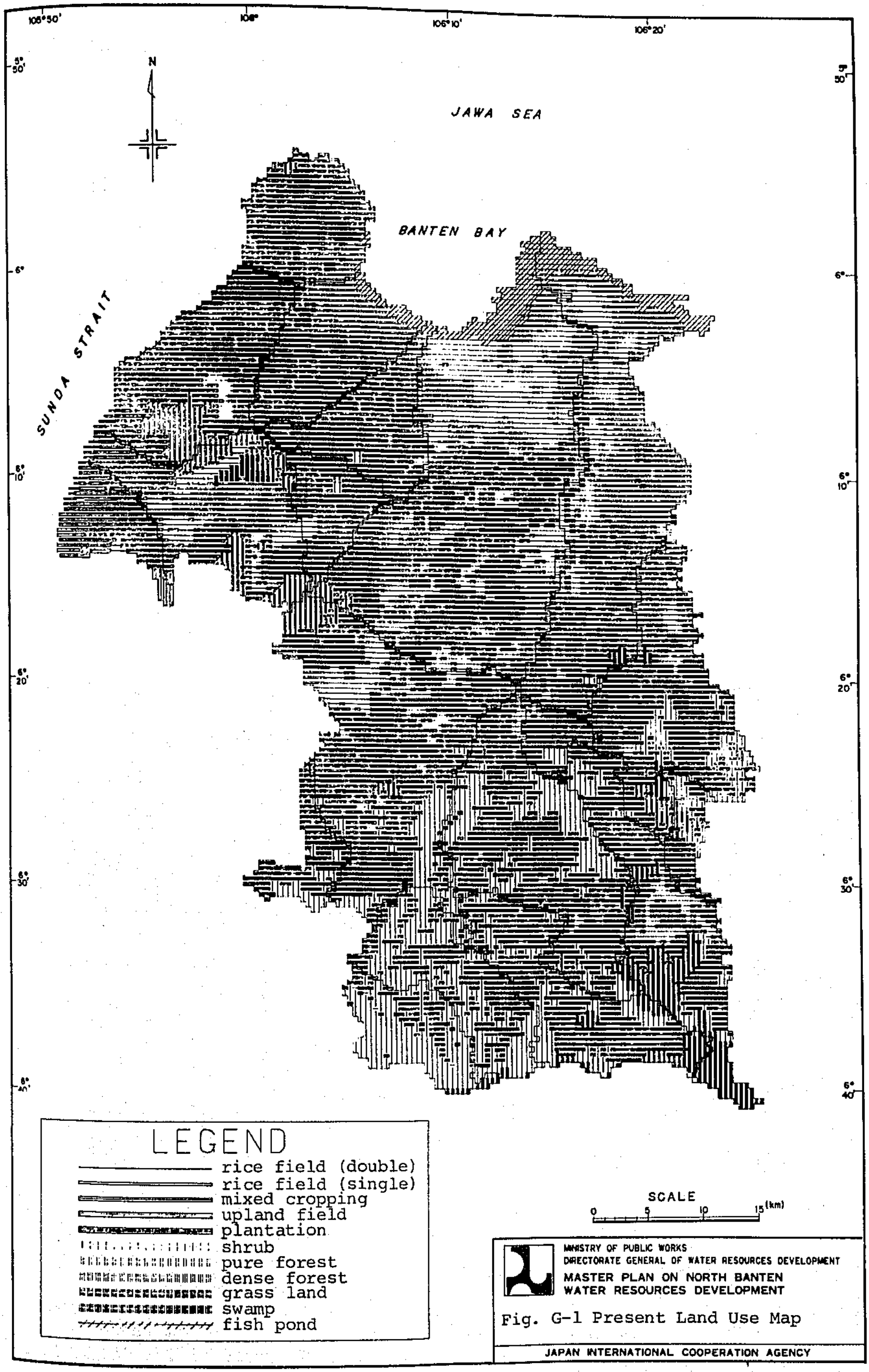
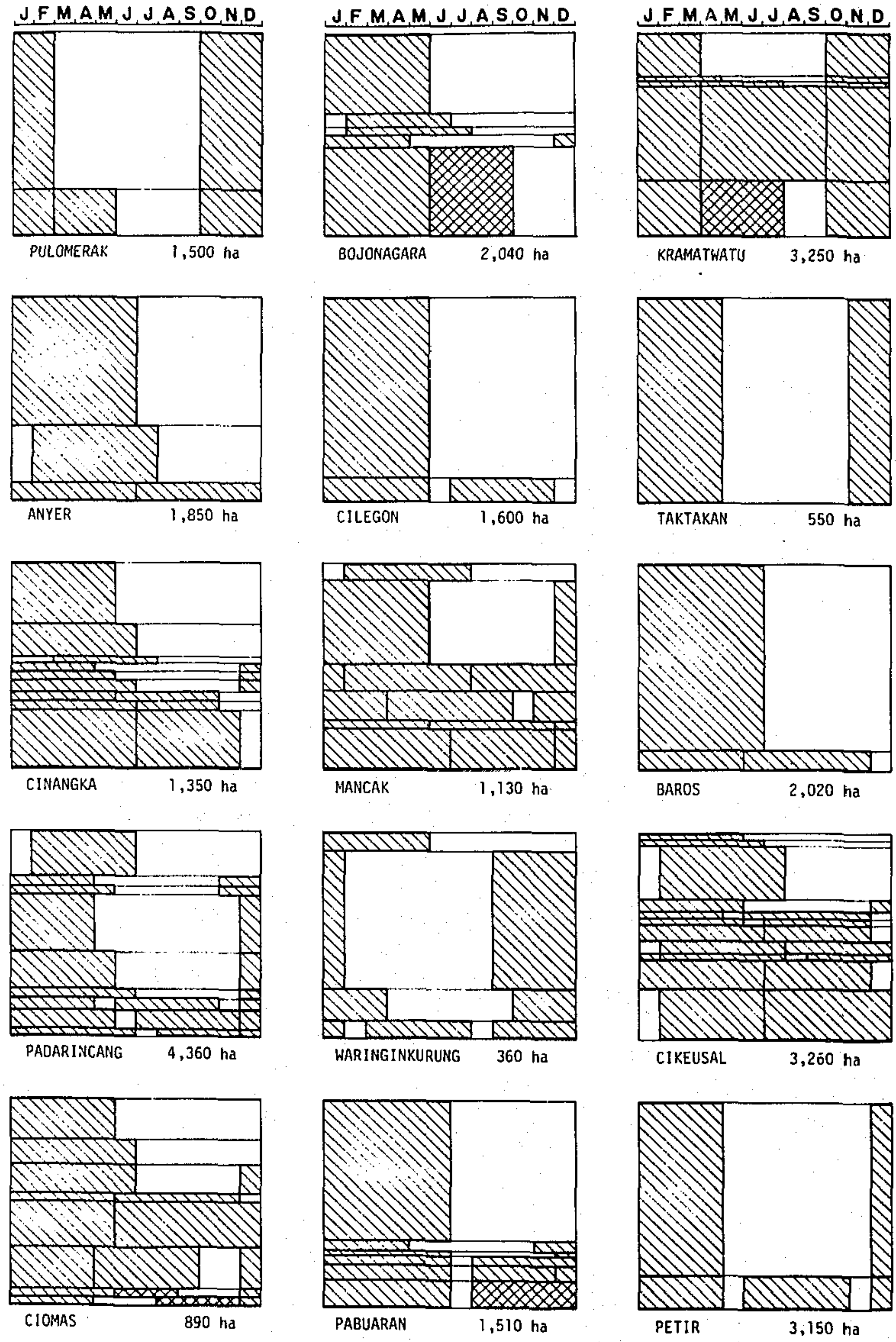


Fig. G-1 Present Land Use Map



LEGEND

Rice

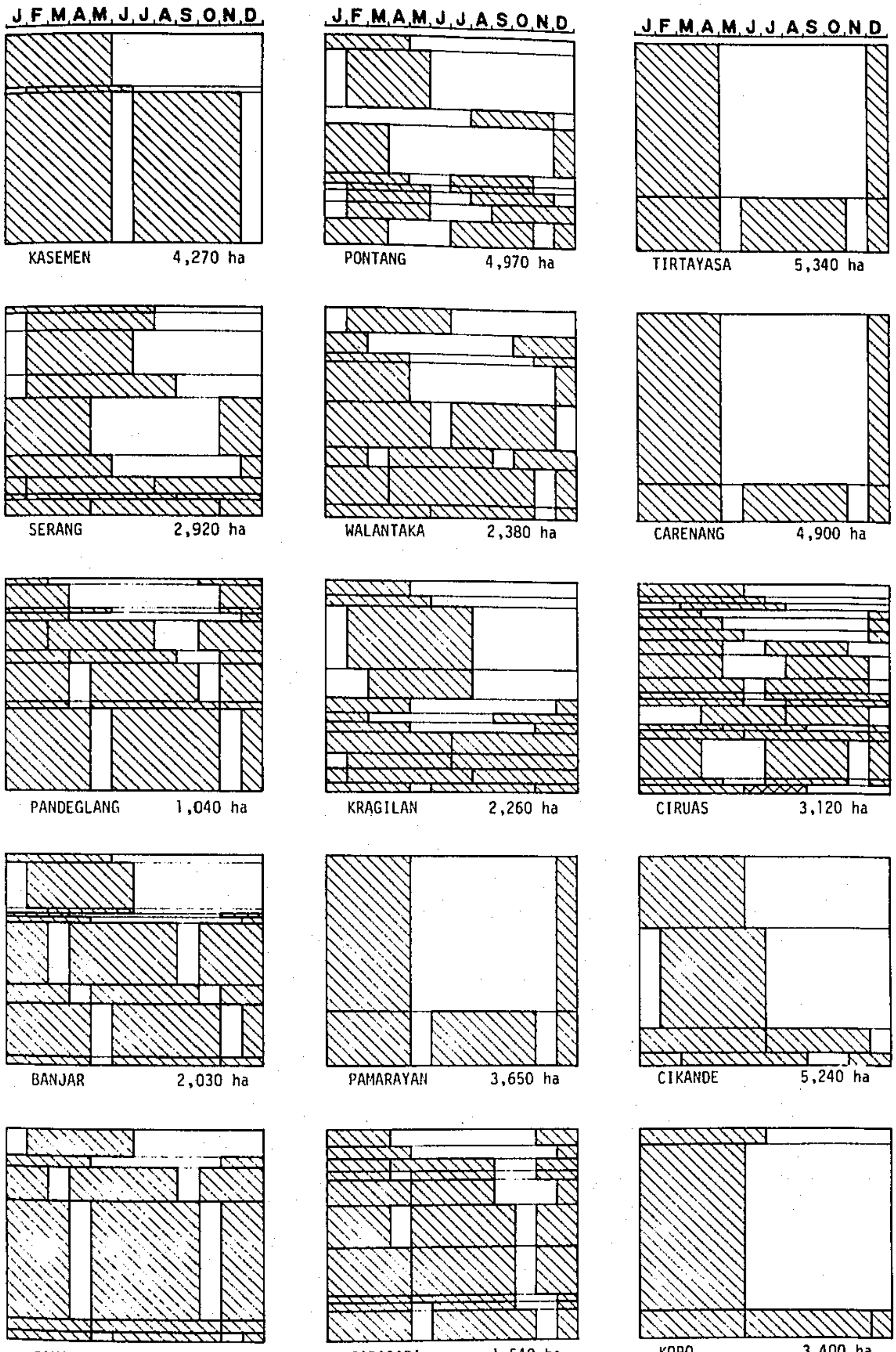
Palawija

Fallow

MINISTRY OF PUBLIC WORKS
DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT
MASTER PLAN ON NORTH BANTEN
WATER RESOURCES DEVELOPMENT

Fig. G-2 (1/3) Present Cropping Patterns

JAPAN INTERNATIONAL COOPERATION AGENCY



LEGEND

Rice

Palawija

Fallow

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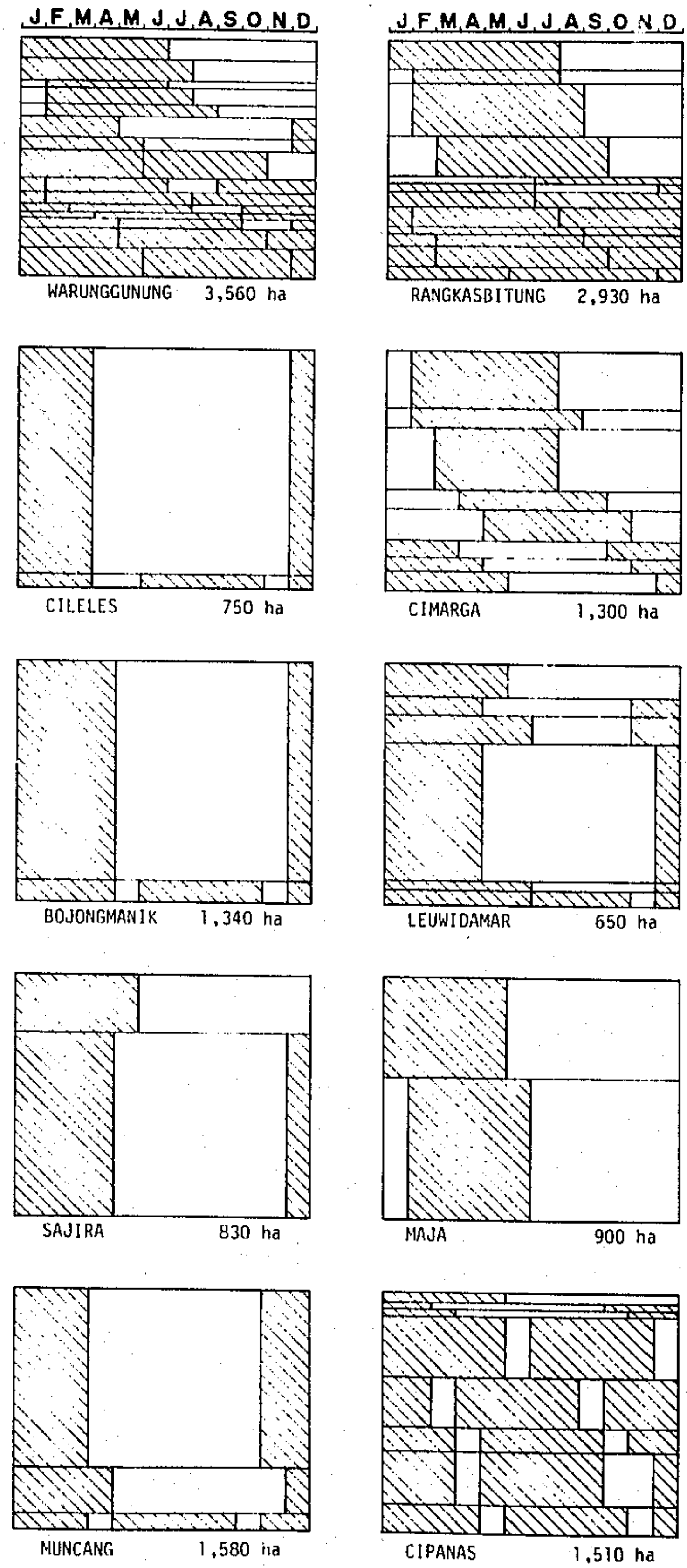
DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT
MASTER PLAN ON NORTH BANTEN
WATER RESOURCES DEVELOPMENT

Fig. G-2 (2/3) Present Cropping Patterns

JAPAN INTERNATIONAL COOPERATION AGENCY



LEGEND

Rice

Palawija

Fallow

MINISTRY OF PUBLIC WORKS
DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT
MASTER PLAN ON NORTH BANTEN WATER RESOURCES DEVELOPMENT

Fig. G-2 (3/3) Present Cropping Patterns

JAPAN INTERNATIONAL COOPERATION AGENCY

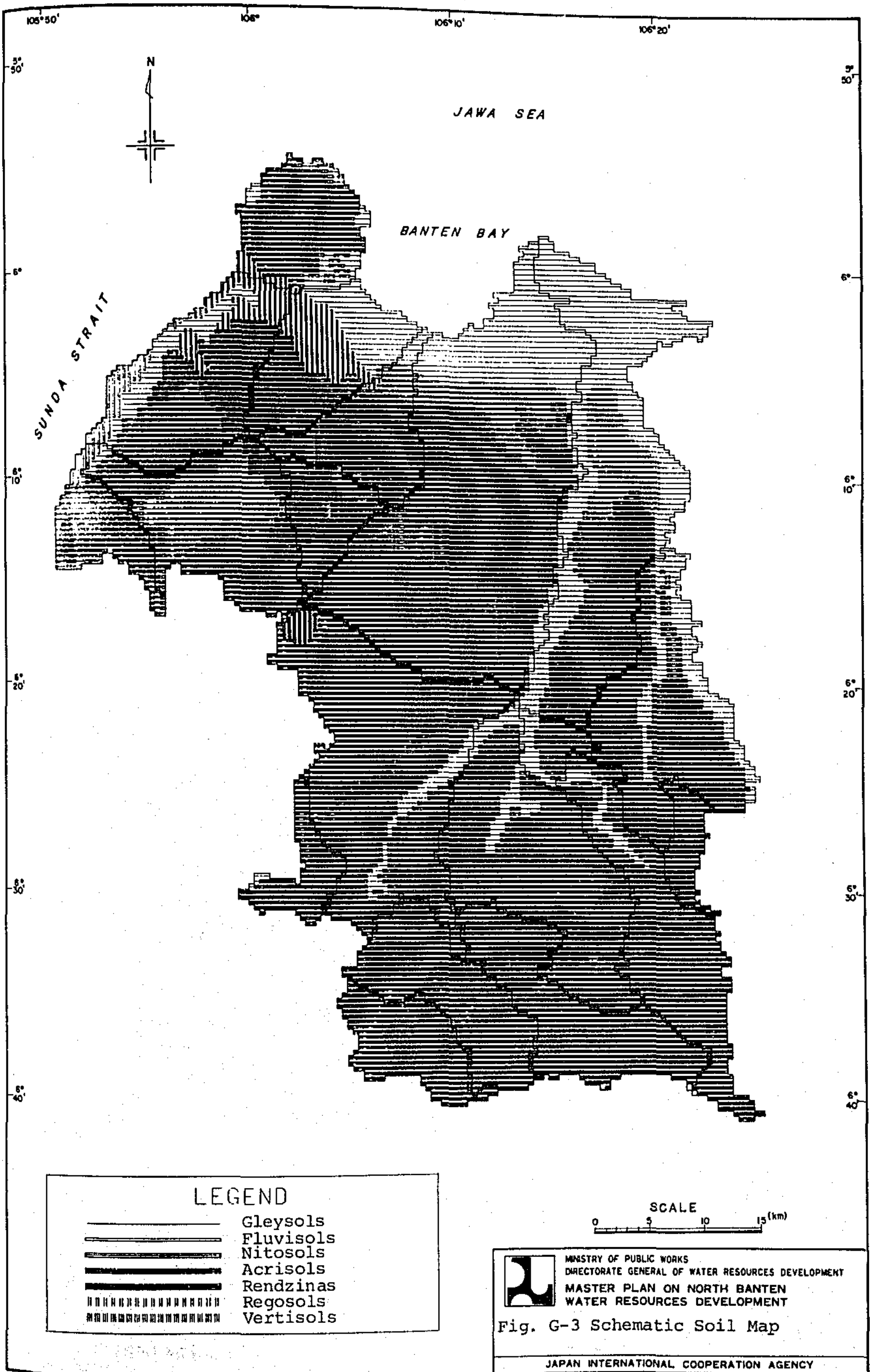


Fig. G-3 Schematic Soil Map

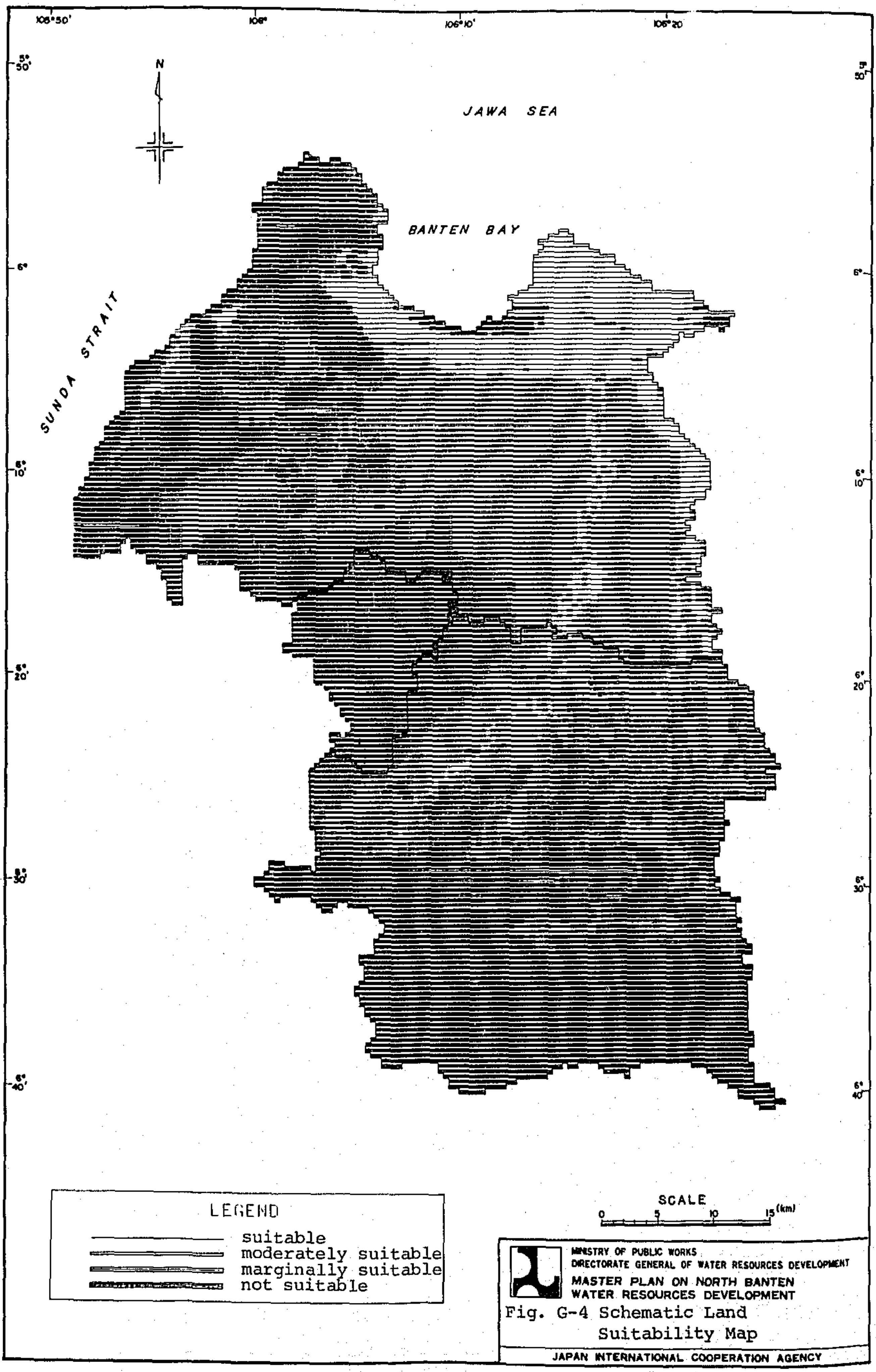


Fig. G-4 Schematic Land Suitability Map

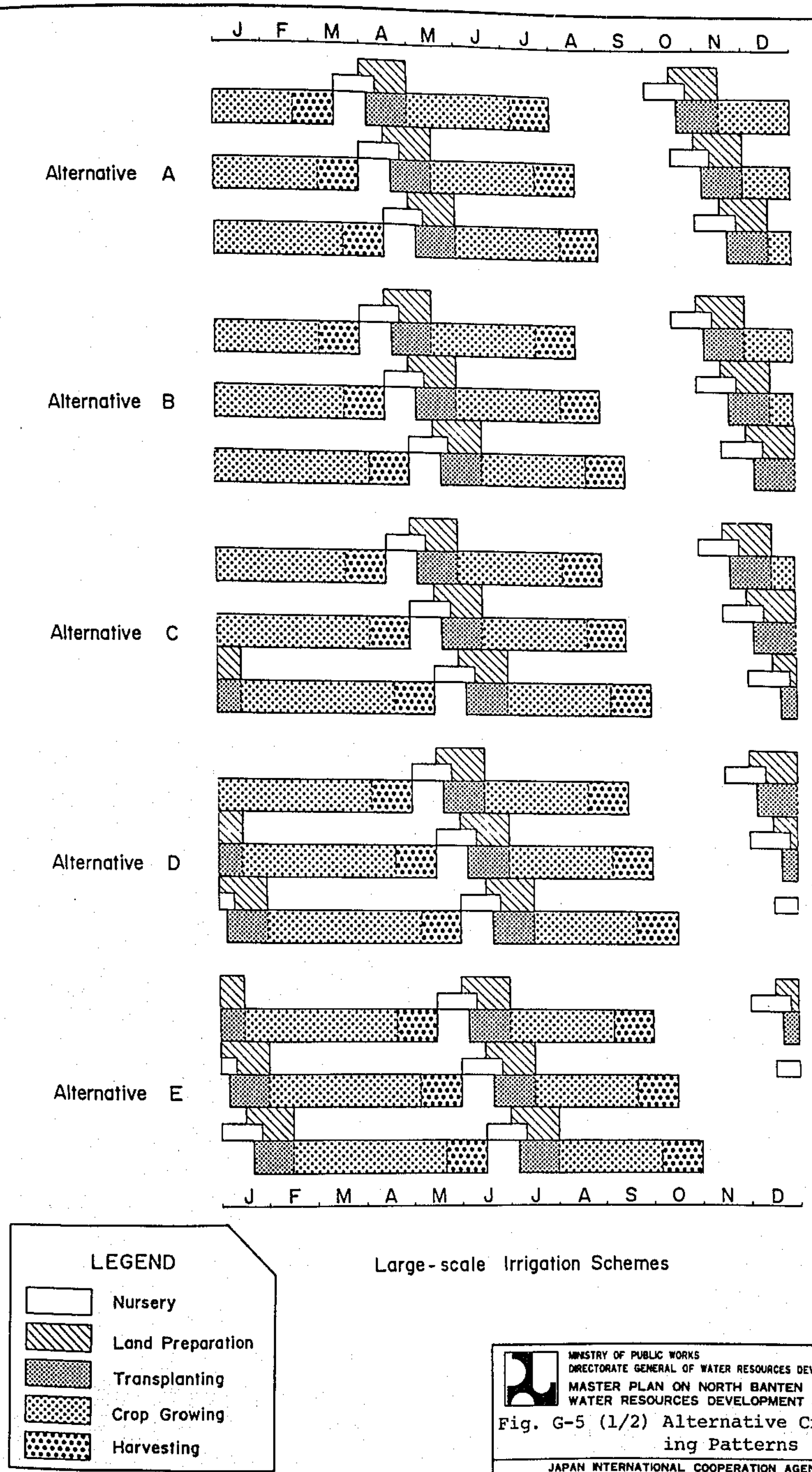


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Fig. G-5 (1/2) Alternative Cropping Patterns

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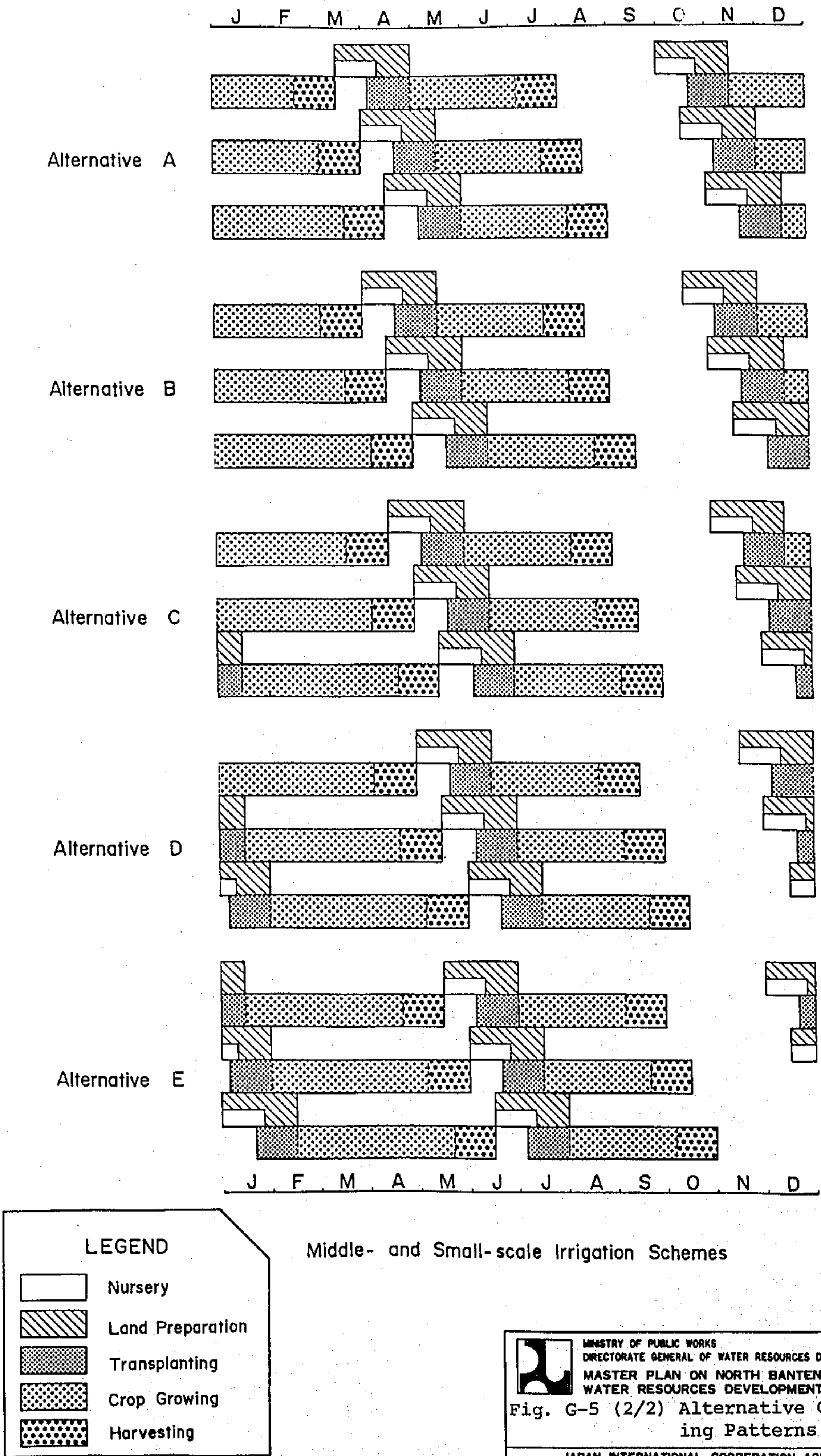

Middle- and Small-scale Irrigation Schemes

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Fig. G-5 (2/2) Alternative Cropping Patterns

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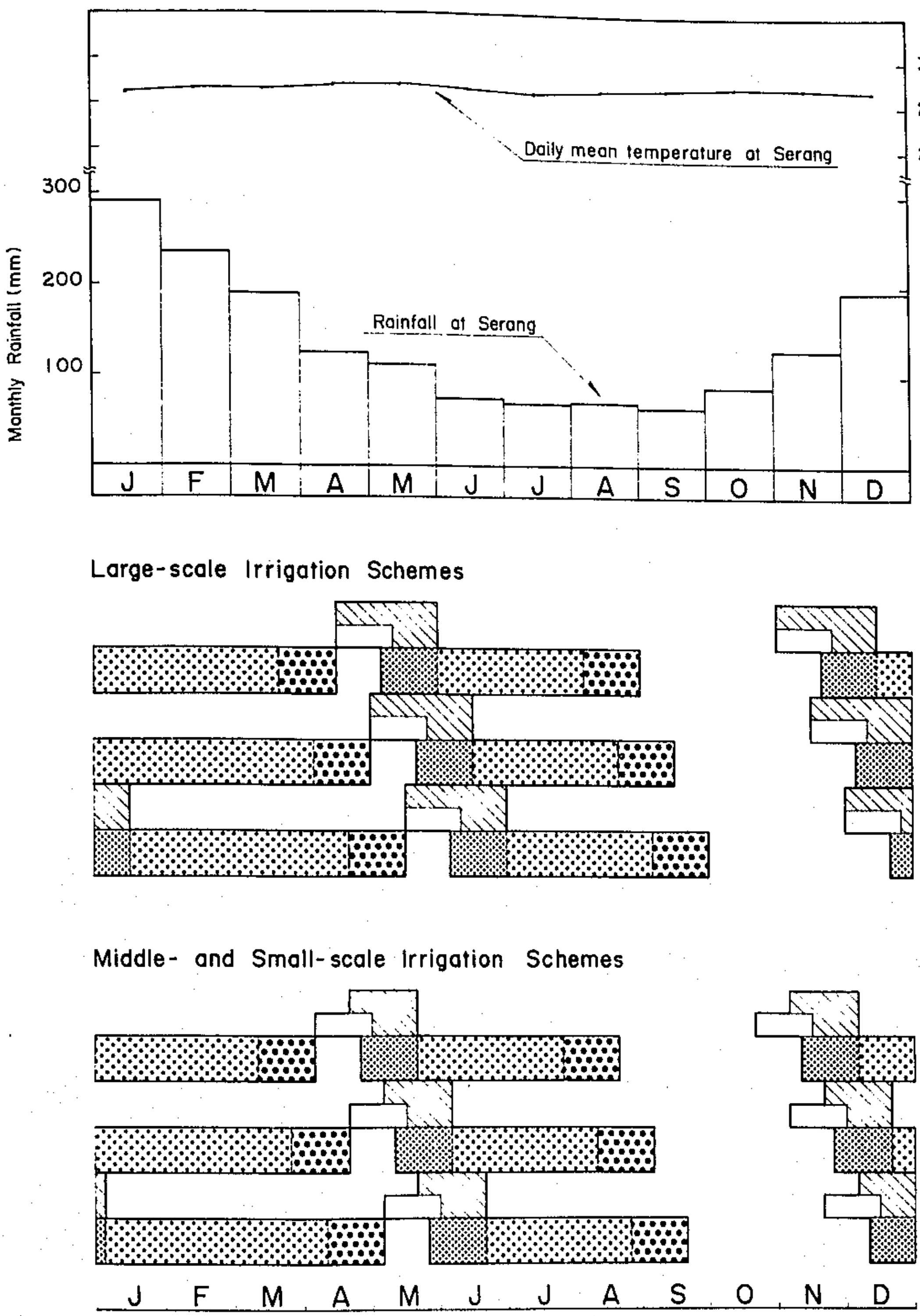

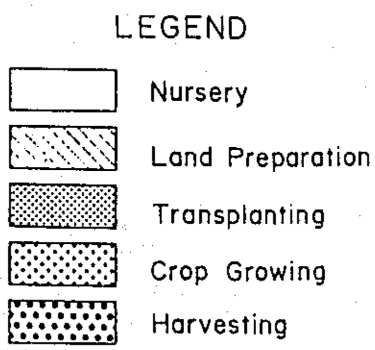

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Fig. G-6 Proposed Cropping Patterns

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APPENDIX H

IRRIGATION

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1. INTRODUCTION

This Appendix deals with the subject matters on irrigation in the Study Area based on the information and data collected mainly from the Ministry of Public Works in Indonesia from November 1982 to January 1983.

The role of irrigation in the Study Area has been devoted mostly to paddy cultivation from the early 1910's. The present condition of irrigation schemes being located in the Study Area is described in Chapter 2 of this Appendix. The possibility of future irrigation development is touched upon in Chapter 3 briefly. The methodology, assumptions and results of estimation of the irrigation water demand for paddy are summarized in Chapter 4. Based on the recommended plan formulated in the present study, the irrigation development plans are explained in Chapter 5.

2. EXISTING IRRIGATION SCHEMES AND WATER USE

2.1 Existing Irrigation Schemes and Water Use

2.1.1 Distribution and classification of schemes

In 1982, about 93,000 ha of paddy fields exist in the Study Area comprizing irrigated paddy areas of 62,741 ha (67%) and rainfed paddy areas of 30,259 ha (33%). The Ciujung irrigation scheme of 24,200 ha locating in the Kabupaten of Serang is only a large-scale irrigation scheme in the Study Area accounting for 39% of the whole irrigation area of 62,741 ha. Other irrigation areas are mostly scattered along the tributaries of the Ciujung river and on the skirt of the Gunung Karang as shown in Fig. H-1. More than 74% of the whole irrigation areas of 62,741 ha are located in the Kabupaten of Serang as summarized in Table H-1.

Irrigation schemes in the Study Area can be classified into DPU and non-DPU irrigation schemes. The former is the scheme with permanent irrigation facilities operated and maintained by the Ministry of Public Works (DPU). The latter is the scheme with temporary irrigation facilities handled by villages.

The DPU irrigation schemes consist of 3 types, i.e. technical, semi-technical and simple irrigation schemes depending on the quality of irrigation facilities. In 1982, there are 71 DPU irrigation schemes in the Study Area comprizing 13 technical, 35 semi-technical and 23 simple irrigation schemes as summarized in Table H-2. Except for the Ciujung irrigation scheme, the average size of the irrigation scheme is estimated at 297 ha. Detailed information on each DPU irrigation scheme is shown in Table H-3.

Notable small-scale irrigation schemes in the Study Area are Cibanten (2,203 ha), Ciwaka (1,563 ha), Cicinta (1,434 ha) and Cisangu (1,441 ha) technical irrigation schemes.

2.1.2 Water source and present use

(1) Water source

Major water source for irrigation in the Study Area is the surface water of the Ciujung river. About 43,100 ha of irrigation areas, or 69% of the whole irrigation area, depend on the Ciujung river for their water source as shown in Table H-4. Other water sources are the Cibeureum (a tributary of the Cidurian river), Ciwaka, Cibanten and Cidanau. These rivers supply irrigation water for 7,900 ha of wet season paddy.

Due to limitation in water source of each river during dry season, irrigation area for dry season paddy is limited to about 19,200 ha annually, or about 31% of the whole irrigation area of 62,741 ha.

(2) Present use of river water

Average annual irrigation water demand is estimated to grasp the present situation of river water use for irrigation in the Study Area based on the same calculation procedure as mentioned in Chapter 4. Assuming that the present irrigation efficiency is 56% on an average and using the average monthly rainfall from 1972 to 1982 for the estimation of effective rainfall, the present irrigation water use is estimated at 1,055 x 10^6 m^3/y in the whole of the Study Area comprizing 768 x 10^6 m^3/y (73 %) for the Ciujung river and 287 x 10^6 m^3/y (27 %) for other rivers as shown in Table H-5.

2.2 Feature of Major Irrigation Schemes

2.2.1 Ciujung irrigation scheme

The Ciujung irrigation scheme of 24,200 ha was established about 65 years ago on the northern low-lying coastlands in the North Banten area. Irrigation water for the scheme is taken from the Ciujung river through the Pamarayan weir completed in 1918. The irrigation area of this scheme is divided into two, i.e. left bank area and right bank area, by the Ciujung river running northward. The left bank area of 18,700 ha is irrigated through a 42 km long primary canal with a discharge capacity of 22 m^3/s. The right bank area of 5,500 ha is irrigated via a 28 km long primary canal with a discharge capacity of 6 m^3/s. Original scheme was designed to secure wet season irrigation for about 24,000 ha of paddy and provide dry season irrigation for about half of this area.

Since the beginning of World War II the scheme did not receive sufficient maintenance and as a result canals and structures were badly damaged and an area of about 8,000 ha of the scheme did not receive irrigation water at all (Refs. 1 and 2). Rehabilitation under the PROSIDA program started in 1971 and was completed in 1974 including; (1) renewal of all gates of the Pamarayan weir, (2) rehabilitation of aprons and embankment of the Pamarayan weir, and (3) rehabilitation of primary and secondary irrigation canals including structures.

Construction of tertiary and quaternary canals (tertiary development) for the Ciujung irrigation scheme was commenced by PROSIDA in 1977/78. By the end of 1982 tertiary development for 21,300 ha was completed successfully and remaining 2,900 ha will be completed by 1983/84. In addition, the drainage improvement program by PROSIDA has been carried out to improve poor-drainage area of 5,600 ha from 1981/82 (Ref. 3).

2.2.2 Cibanten irrigation scheme

The Cibanten irrigation scheme, commanding 2,203 ha, is located on the right bank of the Cibanten river encircling the town of Serang as shown in Fig. H-1. The irrigation water is taken from the Cibanten weir constructed on the Cibanten river, about 8 km upstream of the town of Serang, in 1931. Due to shortage in water source during the dry season, only 420 ha of dry season paddy can receive irrigation water at present.

About 21 km long main and secondary canals are maintained in better condition compared with other small-scale irrigation schemes, though a partial rehabilitation is necessary. Tertiary development for the scheme has already been completed for 1,960 ha, or 89% of the whole of the scheme, and the canal density became 88 m/ha which was sufficient for better water management.

By the urbanization of Serang, commanding area of about 50 ha has been sacrificed recently. Certain amount of sewage has entered into the irrigation canals running through the town of Serang and the quality of irrigation water becomes worse. To improve such a problem, construction of sewerage system or realignment of canal route will be necessary in the near future.

2.2.3 Ciwaka irrigation scheme

The Ciwaka irrigation scheme of 1,563 ha which is adjacent to the Cibanten irrigation scheme was constructed in 1944. Presently this scheme is considered as a component of the Ciwaka/Cablik/Kresek irrigation scheme, commanding an area of 1,825 ha as shown in Table H-3. A small reservoir, created by a diversion weir on the Ciwaka river, can supply irrigation water for dry season paddy of 295 ha, or about 20% of the Ciwaka irrigation area. Tertiary development has been completed for 1,222 ha of the scheme, or 67% of the whole area of 1,825 ha. Rehabilitation of diversion facilities, an intake gate and some structures are indispensable. Maintenance of canals is insufficient at present.

2.2.4 Cicinta irrigation scheme

The Cicinta irrigation scheme, 1,434 ha in net, is located between the Cidurian river and the Cibeureum river (tributary of the Cidurian) as shown in Fig. H-1. The water source for irrigation is the Cicinta river with a catchment area of about 30 km^2. A diversion facility and 12 km long main and secondary canals were completed in 1916. Tertiary development for the whole area has already been completed. However, the maintenance of irrigation canals and structures seems to be insufficient.

Due to water shortage in the Cicinta river during dry season, only 100 ha or less of dry season paddy area can receive irrigation water at present.

2.2.5 Cisangu irrigation scheme

The Cisangu irrigation scheme is located on the left bank of the Ciujung river between Rangkasbitung and Pamarayan. A diversion weir and 20 km long main and secondary canals were completed in 1916. Water source is the Cisangu river and no water supply can be expected for irrigation of the scheme during dry season from this river. Tertiary development of this scheme has already been completed and the canal density has augmented from 14 to 95 m/ha which is a sufficient amount to expect good water management. However, improvement of a part of canals and some structures is still necessary.

2.3 Present Water Management

2.3.1 Organization

The Director of the Serang Regional Office, DPUP, is responsible for all subject matters on water management in the Study Area. The water master (Pengamat), who is directed by the Director, is responsible for actual management of water distribution and maintenance. Existing DPU irrigation schemes including the Ciujung irrigation scheme are managed by 13 water masters, i.e. 10 in the Kabupaten of Serang and 3 in the Kabupatens of Pandeglang and Lebak. The water master directs several assistants who are engaged in actual operation of gates and other facilities and maintenance of canals and facilities. On an average, a water master manages an area of 5,000 to 7,000 ha and an assistant covers 1,000 to 1,500 ha. In addition, many temporary labours are employed in daily maintenance jobs.

2.3.2 Ciujung irrigation scheme

In 1969, the Irrigation Committee headed by the Director, Serang DPUP, was established. This Committee is responsible for decision of overall water management policy and water distribution schedule in main and secondary canals of the Ciujung irrigation scheme. In case of the drought year, the Committee is generally held every week to solve water management problems. The Water Users Association was also established in 1969. This is responsible for water distribution, operation and maintenance of tertiary and quaternary canals.

The golongan system was introduced in the Ciujung irrigation scheme in 1974. The whole scheme area of 24,200 ha is divided into three golongans, i.e. golongan I of 7,907 ha, golongan II of 8,142 ha and golongan III of 8,151 ha. Each golongan is staggered two weeks apart. According to the information obtained from the Serang Regional Office, DPUP, the golongan system in the Ciujung irrigation scheme does not work well. Main problems are caused by farmers' own farming practice. At least 10% of all farmers usually can not finish the transplanting before the limitation in schedule. Some farmers take irrigation water without permission. Due to poor maintenance of tertiary or quaternary canals, certain area can not receive irrigation water in time. In order to study water management problems in the Ciujung irrigation scheme, Institut Pertanian Bogor has been carried out field investigations and analyses from October 1982. The study report will be submitted by August 1983. It is expected that the problems and needs on the present water management in the Ciujung irrigation scheme will be made clear in the course of the study.

3. POSSIBILITIES OF FUTURE IRRIGATION DEVELOPMENT

3.1 K-C-C Area

Possibility of large-scale irrigation development in the Study Area exists only in the Kopo-Cikande-Carenang area (K-C-C area) which is located between the Ciujung right bank irrigation area and the Cidurian and Cibeureum rivers as shown in Fig. H-2. The sole limiting factor in the irrigation development for the K-C-C area is the undulated topography. Due to difficulty in conveying irrigation water from the Cibeureum river to the K-C-C area at cheeper cost, the development for the K-C-C area has not been considered seriously. In 1977, a plan to develop K-C-C area of 9,000 ha together with the construction of the Karian dam to increase supply capacity was proposed in the reconnaissance study by Binnie and Partners (Ref. 4).

In 1982, DPU prepared the topographic map drawn to a scale of 1/5,000 and contour interval of 2 m based on aerial photographs. It covers most of the K-C-C area except for the northern portion of the confluence of the Cibeureum river and Cidurian river.

Southern half of the K-C-C area is relatively the undulated topography with an elevation of 20 to 30 m. On the other hand, northern half of this area has a low-lying gentle topography with an elevation of 0 to 15 m. Most of the K-C-C area are presently used for paddy cultivation during wet season dependent on rainfall.

In the center of the northern K-C-C area, the air force area of 600 ha is located as shown in Fig. H-2 and no irrigation facilities are permitted to construct in this area. In the low-lying part of the K-C-C area, about 500 ha of swamp area are scattered and some of them is now being used as irrigation source for paddy cultivation. After the provision of irrigation system and drainage facilities for these areas, about half of such a swamp area can be expected to be used for paddy cultivation.

Taking into account the soil condition and present land use and excluding the air force area, half of the swamp area and the village area, the gross irrigable area is estimated by using a newly prepared 1/5,000 topographic map. On condition that the intake water level at the proposed Gadeg weir is El.38.5 m and the canal-bed slope is 1/4,000, the gross irrigable area by gravity irrigation system in the K-C-C area is estimated at 10,700 ha as shown in Fig. H-2. The net irrigable area is, therefore, estimated at 8,000 ha assuming that 75% of the gross irrigable area can be used for paddy planting.

3.2 Extension of Existing Irrigation Schemes

Possibility of extension of existing irrigation schemes in the Study Area has been studied by DPU (Ref. 5). In the DPU study, possibility of extension of 300 ha was pointed out, which is equivalent to

2.6% of the DPU studied area of 11,591 ha in total. It includes extension areas of (1) 100 ha for the Cibanten, (2) 100 ha for the Talagawangsa, and (3) 100 ha for the Cibulakan irrigation schemes. Possibility of extension of other irrigation schemes is not known but seems to be small. The present study takes into account only the above proposed extension areas.

4. IRRIGATION WATER DEMAND

4.1 General

The irrigation water demand for the Ciujung, K-C-C and Cicinta irrigation schemes which are the benefitted area by the proposed source development plan is estimated in this Chapter. The calculation is made on monthly basis, based on the cropping pattern proposed in Appendix G and calculation procedure and assumptions described in the succeeding section. Due to insufficiency of field measurement records on evapotranspiration, percolation rate and irrigation loss, many simplified assumptions are set in the present study.

Since the discharge records for 11 years from 1972 to 1982 at the Rangkasbitung gauging station are available, the irrigation water demand is calculated for the same period (study period) in order to estimate the required storage capacity for the proposed source facilities.

4.2 Calculation Procedure and Assumptions

4.2.1 Calculation procedure

Calculation procedure employed in this study is shown in the following equation.

$$CWR = PS + ET + PL$$

$$IDR = (CWR - RE)/IE$$

where, CWR: Crop water requirement

IDR: Irrigation diversion requirement

ET : Evapotranspiration

PL : Percolation rate

PS : Presaturation

RE : Effective rainfall

IE : Overall irrigation efficiency

4.2.2 Evapotranspiration

Evapotranspiration (ET), or consumptive use, from the paddy field varies seasonally correlating with the growing stages of paddy and meteorological factors. Since there are no field measurement records of ET in the Study Area, the empirical method to estimate the value of ET by using meteorological records is adopted.

The ET value can be estimated by the following equation.

$$ET = ETo \times KC$$

where, ET : Evapotranspiration

ETo: Potential evapotranspiration

KC : Crop coefficient

It is recognized that the value of ETo can be estimated by the Penman method (Ref. 6) with reasonable accuracy in the humid tropical region. Using the meteorological data observed at the Serang meteorological station from 1971 to 1979, the value of ET is estimated by the modified Penman method as shown in Table H-6.

The value of KC is estimated on semi-monthly basis using the value recommended by PROSIDA (Ref. 7). Table H-7 shows the average KC value estimated for wet season paddy (mid-term variety) and dry season paddy (short-term variety).

Based on the cropping pattern proposed in the Appendix G (Agriculture), the value of ET is estimated for the Ciujung, K-C-C and Cicinta irrigation schemes which are the benefitted areas by the proposed source development plan mentioned in Chapter 5.

4.2.3 Percolation rate

Field measurement records of percolation rate are not available in the Study Area. In general, after puddling works, the percolation rate becomes below 1 mm/d in clayey soils or on condition that the groundwater table is very high. In the northern coastal plains of Java the percolation rate is usually less than 1 mm/d according to the PROSIDA standard (Ref. 6). In this study, the percolation rate of 1 mm/d is adopted for the estimation of irrigation water requirement for the Ciujung irrigation schemes. The elevated area where the groundwater table is low shows high percolation rate. It is assumed that the percolation rate applicable to the K-C-C and Cicinta irrigation areas is of 2 mm/d as an average of the whole area.

4.2.4 Land preparation requirement

Land preparation requirement under the condition of plot-to-plot irrigation can be calculated by using the formula developed by Zijlstra and Van de Goor (Ref. 8). The formula is as follows:

$$I = Me^m/(e^m - 1)$$

where, I: supply required during the land preparation period

M: supply required for maintaining the water layer after land preparation is completed m: MT/S

T: duration of land preparation period

S: quantity of water required for land preparation

For the estimation of land preparation requirements by the above formula, the value of S is assumed to be 200 mm. Based on the cropping pattern proposed in the Appendix G (Agriculture), the duration of land preparation (T) is assumed to be 45 days for the Ciujung irrigation scheme and 30 days for the K-C-C and Cicinta irrigation schemes.

4.2.5 *Effective rainfall*

Effective rainfall is a part of actual rainfall used for paddy cultivation effectively. It varies widely depending on the amount of actual rainfall, irrigation method, water management practice and so on. Especially effectiveness of rainfall largely depends on water management practice. If the amount of intake discharge is not reduced after rainfall, certain amount of rainfall cannot be considered effective. In a drought year, effectiveness of rainfall tends to be increased owing to severer water management practice compared with a wet year. During watering for land preparation, effectiveness of rainfall can be considered higher than that during paddy growing season when a certain depth of standing water is maintained. In the present study, the effective rainfall is assumed to be 40% of monthly rainfall during paddy growing period and 70% of that during land preparation period.

In order to estimate the effective rainfall for each irrigation scheme, the areal rainfall of each scheme is estimated at first. Among many rainfall stations listed in Appendix B, 11 rainfall stations are selected from the viewpoint of the location, and the continuation and length of available data. The annual rainfall of these stations from 1951 to 1979 is summarized in Table H-8. For the test of the consistency for each of the rainfall stations, the double-mass analysis is carried out. As shown in Fig. H-3, a change in slope of accumulated annual rainfall is found at the Kramatwetan rainfall station (No. 23c), by comparing concurrent accumulated value of annual rainfall for a group of surrounding stations. To make the records prior to 1955 comparable with that in more recent years, the adjustment is made by the ratio of the slopes of the two segments of the double-mass curve (1.18/0.77) as shown in Fig. H-3.

Since the availability of rainfall records in recent years of most stations is poor, the areal rainfall for each irrigation scheme from 1972 to 1982 (study period) is estimated by the following procedure:

(1) estimation of the areal rainfall for the Ciujung, K-C-C and Cicinta irrigation schemes by the Thiessen method based on the average annual rainfall from 1951 to 1964;

(2) estimation of the ratio of the areal rainfall at the key station (Serang meteorological station); and

(3) estimation of the areal rainfall for each scheme for the study period (1972 to 1982) using the above ratio.

The average areal rainfall for the Ciujung, K-C-C and Cicinta irrigation schemes is calculated based on the Thiessen method as shown in Fig. H-4. The calculation of areal rainfalls is shown in Table H-9. The ratio of the areal rainfall of each scheme to that at the Serang station is estimated at 1.070, 1.052 and 1.083 for the Ciujung, K-C-C and Cicinta irrigation schemes respectively. The areal rainfall for the study period (1972 to 1982) is estimated by using monthly rainfall at Serang and the above ratio as shown in Table H-10.

4.2.6 Irrigation efficiency

Overall irrigation efficiency, or project efficiency, can be expressed as:

$$IE = Ec \times Ea$$

where, IE: Overall irrigation efficiency

Ec: Conveyance efficiency

Ea: Application efficiency

The conveyance efficiency applied to the calculation of the irrigation requirement for the Ciujung irrigation scheme is 95% for main and 90% for secondary canals. The PROSIDA guideline (Ref. 7) recommends the conveyance efficiency of major network (main and secondary canals) as 80% during initial stage and 85% as value for the possible improvement. In this study, the conveyance efficiency is assumed to be 80% for all schemes in the Study Area.

The application efficiency including tertiary loss and operation loss varies depending largely on the quality of tertiary irrigation systems, water management practice and so on. In most of existing irrigation schemes in the Study Area, the application efficiency seems to be low, say 60 to 70% or less. Hence, overall irrigation efficiency of the existing schemes is estimated to be 48 to 56% or less. In the case of the Ciujung irrigation scheme, the primary irrigation canals are fully utilized during the land preparation period (Nov. to Dec.) for the wet season paddy every year. It means that the present overall irrigation efficiency is to be 50 to 55% adopting the same crop water requirements and effective rainfall estimated in this report. In the present study, the application efficiency is assumed to be 70% under the present conditions and 80% as target value in the near future.

The overall irrigation efficiency is, therefore, estimated at 56% under present conditions and 64% as target value which is applicable to the projection of the irrigation water demand in this study.

4.3 Irrigation Diversion Requirement

The irrigation diversion requirement is estimated for the Ciujung, K-C-C and Cicinta irrigation schemes by golongan based on the proposed cropping pattern and assumptions mentioned above. The calculation results for each scheme for the year 1972 are shown in Tables H-11 to H-17 as an example. The monthly irrigation diversion requirement in terms of m^3/s for the study period (1972 to 1982) is summarized in Table H-18. The average annual irrigation diversion requirement is 2,052 mm/y for the Ciujung, 2,278 mm/y for K-C-C and 2,558 mm/y for Cicinta irrigation schemes as shown below.

Unit: mm

	Ciujung		K-C-C		Cicinta	
Item	Wet	Dry	Wet	Dry	Wet	Dry
Average	747	1,305	1,010	1,268	1,185	1,373
	(2,052)		(2,278)		(2,558)	
Maximum	1,049	1,435	1,311	1,376	1,452	1,505
Minimum	531	1,167	823	1,170	969	1,268

5. IRRIGATION DEVELOPMENT PLAN

5.1 Ciujung/K-C-C/Cicinta Irrigation Development

5.1.1 General

The Ciujung/K-C-C/Cicinta irrigation development is a component of the Karian Multipurpose Dam Project proposed in the present study. The proposed water source development of the Ciberang river at Karian and the Cibeureum river at Cilawang secures not only the wet season paddy cultivation but also the dry season cropping for three irrigation schemes. The Cilawang dam is planned so as to supply irrigation water to the Cicinta irrigation scheme (1,434 ha) through a 1.5-km long tunnel and to the proposed Gadeg weir for the K-C-C irrigation scheme (8,000 ha). The Karian dam is planned so as to supply water to the proposed Gadeg weir through a 1.5-km long tunnel and to the existing Pamarayan weir for the Ciujung irrigation scheme (24,200 ha).

In the case of full planting of dry season paddy for the Ciujung, K-C-C and Cicinta irrigation schemes, the supply capacity of the proposed Karian and Cilawang dams is not enough for two years out of 11 years (study period) as studied in Appendix K. In the reference year for planning (the year 1972), the average cropping intensity for three schemes is estimated to be 187% on condition that the Karian and Cilawang dams are fully developed. The development plan for each irrigation component is described hereunder.

5.1.2 Ciujung irrigation scheme

The Ciujung irrigation scheme of 24,200 ha is the biggest water user in the Study Area as mentioned in Chapter 2. Due to water shortage in the Ciujung river during dry season, especially from June to October, about 9,600 ha of dry season paddy can receive irrigation water annually on an average. Since annual fluctuation of river discharge is very big, the irrigable area of dry season paddy varies widely year by year.

Aiming to increase irrigation water supply during dry season, the construction of the Karian dam is proposed because of its advantage of the location and the cheeper construction cost compared with alternative dams studied in Appendix K (Dam Planning).

A limiting factor to the full irrigation development for the Ciujung irrigation scheme is the insufficient discharge capacity of the existing primary canals, i.e. 22 m^3/s for the left bank and 6 m^3/s for the right bank primary canals. In the case of full planting of dry season paddy, the peak irrigation water demand is beyond the existing canal capacity for seven years out of 11 years as shown in Table H-19. Assuming that the water source is enough, existing primary canals can convey irrigation water for 23,160 ha during dry season on an average. It is equivalent of 95.7% of the total scheme area of 24,200 ha.

Increase in the discharge capacity of the primary canals is technically possible but economically not attractive. Due to limitation of the storage capacity of the proposed Karian dam, the construction of the Pasir Kopo dam is necessary in the case that a plan is made to supply irrigation water fully to the dry season paddy in the Ciujung and K-C-C irrigation schemes. In this case, the storage requirement for the Pasir Kopo dam is small but the construction cost is very high. Requirement to increase the discharge capacity of the primary canals will arise in parallel with the new water source development program at Pasir Kopo in the future.

5.1.3 K-C-C irrigation scheme

As mentioned in Section 3.1, about 8,000 ha of the net area can be irrigated by gravity irrigation system in the K-C-C area. The proposed intake site to convey water for the whole 8,000 ha by gravity system is the Gadeg site on the Cibeureum river where is recommended in the previous study by Binnie & Partners (Ref. 4). Available river discharge at the Gadeg weir site is insufficient for the total development of the K-C-C irrigation scheme. Water source developments at the Karian and Cilawang dams are indispensable for the total development of the K-C-C area according to the water balance study in Appendix K.

Northern half of the K-C-C area is generally the low-lying alluvial plain or gently undulated area between Els. 5 and 15 m. At present this area is fully utilized for paddy cultivation depending on rainfall. Southern half of the K-C-C area is the undulated and elevated area between Els. 20 and 40 m or more. Irrigable areas in this area are located irregularly being restricted by the undulated topography as shown in Fig. H-2.

The proposed Gadeg weir is an rock fill type dam with a height of 18 m and a crest length of 160 m as shown in Fig. H-5, which is the same figure as designed in the Feasibility Study on the K-C-C irrigation scheme being carried out simultaneously with the present study. The intake water level of El. 38.5 m at the Gadeg weir is necessary in order to irrigate elevated areas in the southern part of the K-C-C area. It is 5.5 m lower than the low water level of the Karian dam of El. 44.0 m.

In order to convey irrigation water for the whole K-C-C irrigation scheme, a main irrigation canal of 30 km long and secondary irrigation canals of 95 km in total are necessary to be constructed as shown in Fig. H-2. Three golongans with 30 days land preparation period each are considered as a possible method for water management in the K-C-C area. The tertiary development is planned to cover the whole of the K-C-C area. Quarternary canals are planned to command a service area of 12 to 15 ha each and the size of tertiary block is planned to be 70 ha on its maximum. These are the same development level as being implemented in the existing Ciujung irrigation scheme.

5.1.4 Cicinta irrigation scheme

The Cicinta irrigation scheme of 1,434 ha is located between the Cidurian and Cibeureum rivers. Water source of this scheme is the Cicinta river, a tributary of the Cibeureum river. The catchment area measured at the existing Cicinta weir is 30 km^2 and the available discharge on the Cicinta river during dry season can secure dry season paddy cultivation of about 100 ha annually, or only 7% of the whole scheme area of 1,434 ha.

The proposed Cilawang dam on the Cibeureum river is located in the adjacent catchment of the Cicinta river. By the construction of a 1.5-km long tunnel, the stored water in the Cilawang reservoir can be diverted to the 10 km upstream point of the existing Cicinta weir. Based on this diversion plan, the whole Cicinta irrigation scheme can receive irrigation water for dry season paddy cultivation for nine years out of 11 years (study period).

5.1.5 Irrigation diversion requirement for the recommended plan

The feature of the recommended plan is determined by using the hydrological conditions in the reference year for planning, i.e. the year 1972. Based on the demand and supply balance study in Appendix K (Dam Planning), the proposed cropping intensity on an average of 3 irrigation schemes for recommended plan is assumed to be 187% in 1972. The irrigation area for each scheme by golongan is assumed as shown in Table H-20. The irrigation diversion requirement for the recommended plan is estimated as shown in Table H-21 based on the irrigation area (Table H-20) and unit irrigation diversion requirement (Tables H-11 to H-17). These figures are used for the water balance for the recommended plan.

5.1.6 Construction schedule and cost estimate

Among 3 irrigation schemes benefited by the proposed water source development, only the K-C-C irrigation scheme of 8,000 ha required an investment for construction.

For successful implementation of the proposed K-C-C irrigation scheme, the detailed design work is assumed to be conducted by foreign and local consultants in 1985 and 1986. The construction work is assumed to be carried out in five years from 1987 to 1991 in parallel with the construction of the Karian and the Cilawang dams.

The construction cost is estimated based on the assumed unit construction cost at the price level in December 1982 as shown in Table H-22, which is prepared by referring to the latest feasibility studies (Refs. 9 and 10) and recent contract amount for the Jatiluhur project. The preliminary design and cost estimate being carried out by the Feasibility Study on the K-C-C irrigation scheme are also referred.

In the present study, the followings are assumed for the cost estimate:

(1) Total for the government administration and engineering services are assumed to be 15% of the direct construction cost.

(2) Physical contingency is 20% of the direct construction cost, land acquisition, government administration and engineering services costs.

(3) Price escalation is assumed to be 7% per annum for foreign currency portion and 10% per annum for local currency portion.

(4) Estimation is made at the price level in December 1982, using the conversion rate of US$1 = Rp 690.

The total construction cost is estimated at Rp 24.4 billion excluding price contingency as shown in Table H-23. It is equivalent to Rp 3.05 million per ha, or US$4,420 per ha. The annual disbursement schedule of construction cost is shown in Table H-24. Based on this schedule, the price contingency is estimated at Rp 14.9 billion, which is equivalent to 61% of the above construction cost of Rp 24.4 billion. Total amount of construction cost for the K-C-C irrigation project is, therefore, estimated at Rp 39.3 billion.

5.2 Development of Small-scale Irrigation Schemes

In the Study Area, there are 70 small-scale irrigation schemes, or 20,761 ha in total. Among them, the tertiary development was implemented for 10 schemes (7,535 ha in total) by the end of 1982. The tertiary development for the remaining area of 13,226 ha is not scheduled yet. Total amount for the future tertiary development (12,757 ha in total) is estimated at Rp 2,550 million, including 20% physical contingency but excluding price contingency as shown in Table H-25.

In addition to the tertiary development, rehabilitation of existing irrigation facilities such as intake weir, canal and related structures is necessary. Due to shortage in budget for maintenance of facilities, a certain amount of rehabilitation requirement exists in each irrigation scheme as shown in Table H-26 which was informed from the Serang and Pandegrang Regional Offices, DPUP in January 1983. A total amount of necessity for rehabilitation is estimated at Rp 610 million excluding price contingency.

It is recommended to develop the small-scale irrigation schemes, aiming at better water management and effective utilization of limited water resources. The total necessary cost is estimated at Rp 3,160 million excluding price contingency.

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6. CROP WATER REQUIREMENT, 1977, Irrigation and drainage paper series No. 24, FAO

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9. UPPER JATILUHUR AND COASTAL STRIP WATER RESOURCES DEVELOPMENT STUDY, Jan. 1983, Nippon Koei Co., Ltd./ADC

10. STUDY ON CIBEET IRRIGATION FLOOD CONTROL AND WATER SUPPLY, Dec. 1982, NEDECO/Sir Alexander Gibb & Partners

Table H-1 DISTRIBUTION OF PADDY FIELDS IN THE STUDY AREA IN 1982

Unit: ha

Item	Kabupaten			Total
	Serang	Pandeglang	Lebak	
A. Irrigated area				
A-1 DPU irrigation				
Technical	31,103	256	2,226	33,585
Semi-technical	5,465	492	1,093	7,050
Simple	2,936	862	528	4,326
Sub-total	39,504	1,610	3,847	44,961
A-2 Non-DPU irrigation	7,058	3,800	6,922	17,780
Total irrigated area	46,562	5,410	10,769	62,741
B. Rainfed area	24,638	990	4,631	30,259
Grand Total	71,200	6,400	15,400	93,000

Remarks: Breakdown is shown in Table H-3.

Table H-2 CLASSIFICATION OF IRRIGATION SCHEMES MAINTAINED BY DPU IN THE STUDY AREA IN 1982

Classification	Technical		Semi-technical		Simple		Total	
	No. of Scheme	Total Area (ha)	No. of Scheme	Total Area (ha)	No. of Scheme	Total Area (ha)	No. of Scheme	Total Area (ha)
Over 5001 ha	1	24,200	-	-	-	-	1	24,200
1001 - 5000 ha	4	6,641	1	1,148	-	-	5	7,789
501 - 1000 ha	1	536	1	948	-	-	2	1,484
101 - 500 ha	6	1,891	21	3,978	19	4,367	46	10,236
51 - 100 ha	1	55	10	835	3	281	14	1,171
Under 50 ha	-	-	2	58	1	23	3	81
Total	13	33,323	35	6,967	23	4,671	71	44,961

Table H-3 (1/2) INVENTORY OF IRRIGATION SCHEMES MAINTAINED BY DPU IN 1982

Name of Scheme	Year Con- structed	Type of Scheme	Irrigation Area (ha) Wet	Irrigation Area (ha) Dry	Tertiary Develop. (ha) Com- pleted	Tertiary Develop. (ha) Not Yet	Water Source	Irrigation Canal (km) M&S	Irrigation Canal (km) Ter.	Irrigation Canal (km) Qua.	Irrigation Canal (km) Total	Canal Density (m/ha)	Nos. of Structures M&S	Nos. of Structures T&Q
Serang														
1. Gerem		ST	92	10	-	92	R	1.0	-	-	1.0	10.9	5	-
2. Kedung Ingas	1933	ST	96	10	-	96	R	1.1	-	-	1.1	11.5	16	-
3. Cibeber		ST	125	25	-	125	R	1.1	-	-	1.1	8.8	15	-
4. Cikaduweun	1951	ST	214	-	-	214	R	5.0	-	-	5.0	23.4	22	-
5. Harjatani		S	92	-	-	92	R	0.8	-	-	0.8	8.7	7	-
6. Jakung		ST	33	-	-	33	R	1.5	-	-	1.5	45.5	5	-
7. Cipaas		S	350	-	-	350	R	10.0	-	-	10.0	28.6	30	-
8. Ciwaka/Cablik/Kresek														
8.1 Ciwaka	1944	T	(1563)	(295)			R							
8.2 Cablik	1938	ST	(156)	(31)			R							
8.3 Kresek	1938	ST	(106)	(25)			R							
Sub-total			1825	351	1222	603		17.3	21.4	47.6	86.3	47.3	47	128
9. Sibugang/Jelawe														
9.1 Sibugang		ST	(328)	(89)			R							
9.2 Jelawe		ST	(77)	(16)			R							
Sub-total			405	105	-	405		5.0	-	-	5.0	12.3	31	-
10. Cipari/Ciwuni														
10.1 Cipari bawah/Atas	1938	ST	(1148)	(150)			R							
10.2 Ciwuni atas	1938	ST	(425)	(34)			R							
10.3 Ciwuni bawah	1938	ST	(273)	(15)			R							
Sub-total			1846	199	-	1846		23.2	-	-	23.2	12.6	101	-
11. Cikeusal		S	89	-	-	89	R	5.3	-	-	5.3	59.6	6	-
12. Ciujung	1918	T	24200	9600	21300	2900	R	162.4	70.3	187.2	419.9	17.4	301	1133
13. Cicinta	1916	T	1434	100	1434	-	R	12.0	28.3	11.4	51.7	36.1	16	172
14. Cisangu	1916	T	1441	-	1441	-	R	20.3	34.8	81.8	136.9	95.0	39	87
15. Kadugenep/Krajanen														
15.1 Kadugenep	1935	ST	(197)	(30)			R							
15.2 Krajanen	1935	ST	(200)	(20)			R							
Sub-total			397	50	-	397		10.0	-	-	10.0	25.2	30	-
16. Cikulur	1928	ST	172	32	-	172	R	4.5	-	-	4.5	26.2	21	-
17. Cibanten	1931	T	2203	420	1960	243	R	21.2	43.1	130.3	194.6	88.3	56	342
18. Cipelem/Cilaku														
18.1 Cipelem		ST	(198)	(31)			R							
18.2 Cilaku		S	(180)	(-)			R							
Sub-total			378	31	-	378		10.0	-	-	10.0	26.5	47	-
19. Nagara Padang		S	176	-	-	176	R	2.5	-	-	2.5	14.2	8	-
20. Cipari Atas	1938	ST	172	20	-	172	R	2.0	-	-	2.0	11.6	15	-
21. Ciwaka Atas		ST	193	62	-	193	R	2.7	-	-	2.7	14.0	17	-
22. Citaman		S	120	30	120	-	SP	2.0	-	5.3	7.3	60.8	13	-
23. Cilesung		S	215	50	-	215	SP	1.2	-	-	1.2	5.6	18	-
24. Rampones		S	125	40	-	125	R	0.5	-	-	0.5	4.0	2	-
25. Sindang Mandi		S	109	50	-	109	SP	1.7	-	-	1.7	15.6	7	-
26. Cibanten Atas	1942	ST	84	50	-	84	R	2.8	-	-	2.8	33.3	3	-
27. Cibulakan		S	401	100	401	-	SP	5.3	3.4	17.4	26.1	65.1	30	68
28. Cisuar		S	138	-	-	138	R	1.5	-	-	1.5	10.9	6	-
29. Telaga Wangsa		ST	145	41	-	145	SP	1.3	-	-	1.3	9.0	14	-
30. Cikoneng		S	424	50	-	424	R	2.0	-	-	2.0	4.7	10	-
31. Citasuk/Cikalumpang														
31.1 Citasuk		S	(165)	(-)			R							
31.2 Cikalumpang	1933	ST	(948)	(200)			R							
Sub-total			1113	200	-	1113		1.5	-	-	1.5	1.3	14	-
32. Cibojong		S	223	70	164	59	R	6.0	4.3	11.1	21.4	96.0	14	17
33. Cikuray		S	351	50	-	351	R	5.6	-	-	5.6	16.0	18	-
34. Cilampir		S	100	30	-	100	R	2.8	-	-	2.8	28.0	18	-
35. Leuwi Paseh		S	23	-	-	23	R	0.7	-	-	0.7	30.4	11	-
Total			39504	11776	28042	11462		353.8	205.6	492.1	1051.5	26.6	1013	1947

Remarks: (1) Type of Scheme; T = Technical, ST = Semi-technical, S = Simple
(2) Water Source; R = River, SP = Spring
(3) Irrigation Canal; M = Main, S = Secondary, T = Tertiary, Q = Quaternary

Table H-3 (2/2) INVENTORY OF IRRIGATION SCHEMES MAINTAINED BY DPU IN 1982

Name of Scheme	Year Con- structed	Type of Scheme	Irrigation Area (ha) Wet	Irrigation Area (ha) Dry	Tertiary Develop. (ha) Com- pleted	Tertiary Develop. (ha) Not Yet	Water Source	Irrigation Canal (km) M&S	Irrigation Canal (km) Ter.	Irrigation Canal (km) Qua.	Irrigation Canal (km) Total	Canal Deisity (m/ha)	Nos. of Structures M&S	Nos. of Structures T&Q
Pandeglang														
1. Ciaria														
1.1 Ciaria		S	(323)	(-)	(323)	(-)	R	(6.0)	(-)	(-)	(6.0)	(18.6)	(22)	(34)
1.2 Cilancar I	1955	ST	(226)	(190)	(-)	(226)	R	(5.3)	(-)	(-)	(5.3)	(23.5)	(34)	(-)
1.3 Cilancar II	1948	T	(256)	(125)	(-)	(256)	R	(5.0)	(-)	(-)	(5.0)	(19.5)	(36)	(-)
Sub-total			805	315	323	482		16.3	-	-	16.3	20.2	92	34
2. Cijebug	1952	ST	74	65	-	74	R	3.5	-	-	3.5	47.3	26	-
3. Cikoneng	1950	ST	76	60	-	76	R	3.0	-	-	3.0	39.5	22	-
4. Cipanas		S	237	-	237	-	R	2.1	2.3	14.1	18.5	78.1	8	14
5. Cicanggong		ST	91	50	-	91	R	1.0	-	-	1.0	11.0	5	-
6. Cilembur		S	302	-	-	302	SP	3.6	-	-	3.6	11.9	25	-
7. Ciraden	1945	ST	25	5	-	25	R	1.5	-	-	1.5	60.0	10	-
Total			1610	810	560	1050		31.0	2.3	14.1	47.4	29.4	188	48
Lebak														
1. Cikupa														
1.1 Ranca Dundu	1939	ST	(91)	(35)	(-)	(91)	R	(1.5)	(-)	(-)	(1.5)	(16.5)	(12)	(-)
1.2 Bunut	1939	ST	(221)	(100)	(-)	(221)	R	(1.8)	(-)	(-)	(1.8)	(8.1)	(9)	(-)
1.3 Batu	1939	ST	(106)	(50)	(-)	(106)	R	(3.8)	(-)	(-)	(3.8)	(35.8)	(16)	(-)
1.4 Cirape	1939	ST	(97)	(75)	(-)	(97)	R	(2.3)	(-)	(-)	(2.3)	(23.7)	(16)	(-)
1.5 Cikupa	1938	ST	(57)	(35)	(-)	(57)	R	(1.7)	(-)	(-)	(1.7)	(29.8)	(8)	(-)
Sub-total			572	295	-	572		11.1	-	-	11.1	19.4	61	-
2. Cisang Atas														
2.1 Cisangu	1932	T	(485)	(275)	(-)	(485)	R	(8.0)	(-)	(-)	(8.0)	(16.5)	(32)	(-)
2.2 Heas	1952	ST	(145)	(90)	(-)	(145)	R	(3.5)	(-)	(-)	(3.5)	(24.1)	(11)	(-)
2.3 Pasirbedil	1933	T	(209)	(70)	(-)	(209)	R	(3.1)	(-)	(-)	(3.1)	(14.8)	(19)	(-)
Sub-total			839	435	-	839		14.6	-	-	14.6	17.8	62	-
3. Cilembun	1939	ST	102	75	-	102	R	1.8	-	-	1.8	17.6	11	-
4. Cikondang	1915	T	312	70	-	312	R	6.5	-	-	6.5	20.8	26	-
5. Ciselaraja	1929	ST	104	70	-	104	R	6.0	-	-	6.0	57.7	16	-
6. Cijoro	1908	T	55	30	-	55	R	3.0	-	-	3.0	54.5	10	-
7. Cimarga	1915	T	217	75	-	217	R	6.0	-	-	6.0	27.6	9	-
8. Cipanas														
8.1 Guning Gebas	1935	ST	(170)	(120)	(-)	(170)	R	(5.8)	(-)	(-)	(5.8)	(34.1)	(38)	(-)
8.2 Cipanas	1935	T	(536)	(500)	(-)	(536)	R	(3.0)	(-)	(-)	(3.0)	(5.6)	(14)	(-)
Sub-total			706	620	-	706		8.8	-	-	8.8	12.5	52	-
9. Cimangeunteung		S	233	-	233	-	R	7.0	1.4	11.9	20.3	87.1	15	109
10. Bungbas		S	118	-	-	118	R	3.2	-	-	3.2	27.1	22	-
11. Cijambu		S	177	-	-	177	R	2.5	-	-	2.5	14.1	23	-
12. Cilaki	1935	T	412	200	-	412	R	3.0	-	-	3.0	7.3	24	-
Total			3847	1870	233	3614		73.5	1.4	11.9	86.8	22.6	392	109
Grand Total			44961	14456	28835	16126		458.3	209.3	518.1	1185.7	26.4	1593	2104

Remarks: (1) Type of Scheme; T = Technical, ST = Semi-technical, S = Simple
(2) Water Source; R = River, SP = Spring
(3) Irrigation Canal; M = Main, S = Secondary, T = Tertiary, Q = Quaternary
(4) Grand Total = total of all schemes

Table H-4 PRESENT IRRIGATION AREA BY WATER SOURCE

Unit: ha

Water Source	DPU Irrigation		Non-DPU Irrigation		Total	
	Wet	Dry	Wet	Dry	Wet	Dry
Ciujung						
U/S Pamarayan	2,533	956	10,722	2,857	13,255	3,813
At Pamarayan	24,200	9,600	-	-	24,200	9,600
D/S Pamarayan	5,652	1,262	3,095	825	8,747	2,087
Sub-total	32,385	11,818	13,817	3,682	46,202	15,500
Cibeureum	1,435	100	-	-	1,435	100
Ciwaka	1,825	351	315	84	2,140	435
Cibanten	2,417	420	45	12	2,462	432
Cidanau	2,219	501	45	12	2,264	513
Others	4,680	1,266	3,558	948	8,238	2,214
Total	44,961	14,456	17,780	4,738	62,741	19,194

Remarks: U/S = Upstream
D/S = Downstream

Table H-5 PRESENT IRRIGATION WATER DEMAND BY WATER SOURCE

Water Source	Catchment Area (km^2)	Irrigation Area (ha)		Annual Water Demand (10^6 m^3/y)
		Wet	Dry	
Ciujung				
U/S Pamarayan	1,451	13,255	3,813	243
At Pamarayan	1,451	24,200	9,600	371
D/S Pamarayan	1,850/1	8,747	2,087	154
Sub-total	1,850/1	46,202	15,500	768
Cibeureum	255	1,435	100	21
Ciwaka	60	2,140	435	36
Cibanten	185	2,462	432	41
Cidanau	316	2,264	513	40
Others	885	8,238	2,214	149
Total	3,551	62,741	19,194	1,055

Remarks: U/S = Upstream
D/S = Downstream
/1 = Total catchment area of the Ciujung river

Table H-6 POTENTIAL EVAPOTRANSPIRATION AT SERANG

	Mean Temp (°C)	Relative Humidity (%)	Duration Sunshine (%)	Wind Velocity (km/d)	Potential ET (mm/d)
Jan	26.3	84	39	126	4.3
Feb	26.7	82	41	141	4.5
Mar	26.6	84	48	126	4.5
Apr	27.0	82	57	116	4.4
May	27.1	81	55	126	4.2
Jun	26.6	80	61	126	4.2
Jul	26.4	80	65	124	4.3
Aug	26.6	78	65	137	4.8
Sep	26.8	77	66	132	5.1
Oct	27.2	77	55	118	5.0
Nov	27.1	78	50	124	4.8
Dec	26.6	82	46	146	4.6

Remarks: Meteorological records are the averaged figure between 1971 and 1979 (refer to Appendix B).

Table H-7 CROP COEFFICIENT FOR PADDY

		Mid-term Variety	Short-term Variety
Month 1	I	1.20	1.20
	II	1.20	1.26
Month 2	I	1.29	1.38
	II	1.39	1.34
Month 3	I	1.37	1.26
	II	1.24	-
Month 4	I	1.12	
	II	-	

Table H-8 ANNUAL RAINFALL OF SELECTED RAINFALL STATIONS

Unit: mm

Year	Rainfall Station No.										
	14a	23	23c	23f	23g	25a	32a	32c	33	35	36a
1951	1460	1419	2073	1645	1887	1677	1534	-	2040	2458	1965
1952	1677	1921	-	1763	1952	1781	1585	1724	1593	2112	1934
1953	1056	1111	1507	1118	1609	1000	733	883	1327	1511	1718
1954	1568	1827	2582	1740	2097	1588	1325	2012	1743	2294	2379
1955	1796	2258	2189	2488	2627	1837	1493	2041	1431	2172	2376
1956	-	1596	-	1887	2262	1808	1443	1663	-	2398	2684
1957	1188	-	-	2002	2114	-	1578	-	1261	1987	1775
1958	-	1971	2546	-	-	1813	2141	2237	1966	-	-
1959	-	1826	2446	2207	2050	-	1331	-	1628	2015	2261
1960	1525	1906	2762	2695	-	1744	1744	2132	2002	2350	1535
1961	967	1022	1324	1546	1284	905	1401	1443	-	1808	1229
1962	1325	1459	1887	1900	2261	1579	1531	1934	1696	2154	1805
1963	1192	1549	1621	2255	1929	1156	-	1513	-	-	1267
1964	1257	1426	2421	1848	1677	1084	1486	1875	1269	2041	1291
1965	-	-	-	-	-	-	-	-	1765	1930	1814
1966	-	-	-	-	-	-	-	-	-	2202	1538
1967	-	1539	2209	1380	1858	-	1413	2341	1815	1957	1463
1968	-	2132	3247	-	-	-	-	-	2407	-	2213
1969	-	-	2197	-	-	-	-	-	1718	-	1427
1970	-	-	3156	-	-	-	-	-	2637	-	-
1971	-	-	-	1545	-	-	1387	1418	-	1742	-
1972	-	1212	-	1434	1488	1137	1340	1252	-	-	1564
1973	-	-	2786	1686	1946	1976	-	1677	2382	2331	-
1974	-	2191	-	-	-	1780	-	-	-	-	-
1975	-	1276	-	-	-	1612	-	-	1992	-	-
1976	-	1461	-	-	-	-	-	-	1481	-	-
1977	-	1524	-	-	-	-	-	-	1469	-	-
1978	-	1797	2115	-	-	1828	-	-	-	-	-
1979	-	1665	2404	-	-	-	-	1662	-	1977	2160
Average											
(1951-64)	1365	1638	2123	1930	1979	1498	1487	1769	1632	2108	1863
(1951-79)	1365	1640	2304	1832	1936	1547	1467	1737	1778	2080	1820

Remarks: Annual rainfalls recorded at the Station No. 23c from 1951 to 1955 are modified by multiplying a conversion factor of 1.53.

Table H-9 CALCULATION OF AREAL RAINFALL FOR CIUJUNG, K-C-C AND CICINTA IRRIGATION SCHEMES BY THIESSEN METHOD

Rainfall Station No.	Name	Annual /1 Rainfall(mm)	Proportion of Thiessen Area (%) Ciujung	K-C-C	Cicinta
14a	Bajanegara	1365	9.9	-	-
23	Serang	1638	9.2	-	-
23c	Kramatwetan	2123	6.1	6.5	-
23f	Ciruas	1930	9.0	-	-
23g	Kalenpetung	1979	16.6	3.5	-
25a	Kresek	1498	-	25.1	-
32a	Jeungjing	1487	16.6	-	-
32c	Ragasilir	1769	29.5	-	-
33	Parigi	1632	-	44.0	38.5
35	Pamarayan	2108	3.1	13.0	-
36a	Maja	1863	-	7.9	61.5
	Weighted Average		1752 mm	1723 mm	1774 mm
	(Ratio to Serang Station)		(1.070)	(1.052)	(1.083)

Remarks: /1 = Average annual rainfall from 1951 to 1964 (refer to Table H-8)

Table H-10 ESTIMATED AREAL RAINFALL FOR CIUJUNG, K-C-C AND CICINTA IRRIGATION SCHEMES

Unit: mm.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ciujung												
1972	395	174	280	68	108	11	0	7	0	31	78	136
73	332	403	247	123	96	65	0*	44*	65*	58*	157*	146*
74	335	371	212	144	97	152	141	15	231	135	191	306
75	269	199	96	95	43	19	65	34	40	108	100	289
76	440	159	242	173	41	12	14	56	21	78	119	197
77	343	350	235	131	107	139	12	0	23	39	28	213
78	233	188	326	168	33	155	106	105	97	129	85	285
79	521	120	165	129	134	17	73	65	119	92	108	226
80	316	446	118	174	109	96	70	101	108	172	129	261
81	341	276	133	131	142	61	137	119	101	184	270	222
82	287	100	164	92	73	35	41	0	0	84	70	97
K-C-C												
1972	388	171	275	67	106	10	0	7	0	30	76	134
73	326	396	242	121	94	64	0*	43*	64*	57*	155*	143*
74	329	364	208	141	95	149	139	15	227	133	188	301
75	264	195	94	93	42	19	64	33	40	106	98	284
76	432	157	238	170	41	11	14	55	21	76	117	193
77	337	343	231	128	105	137	11	0	23	39	27	209
78	229	185	321	165	32	152	104	103	95	126	84	280
79	512	118	162	126	132	17	72	64	117	91	106	222
80	310	438	116	171	108	94	69	99	106	169	126	257
81	335	271	131	128	140	60	135	117	99	181	265	218
82	282	98	161	91	72	34	41	0	0	82	69	95
Cicinta												
1972	401	177	283	69	110	11	0	8	0	31	79	138
73	336	408	250	125	97	66	0*	44*	66*	59*	159*	148*
74	339	376	214	145	98	154	143	15	234	137	194	310
75	272	201	97	96	43	19	66	34	41	110	101	293
76	446	162	246	176	42	12	14	57	22	79	121	199
77	348	354	238	132	109	141	12	0	24	40	28	215
78	236	191	331	170	33	157	108	107	98	130	86	289
79	528	122	167	130	136	17	74	66	121	94	110	229
80	320	452	120	177	111	97	71	102	110	174	130	265
81	346	280	135	132	144	61	139	121	102	186	274	225
82	291	101	166	94	74	36	42	0	0	85	71	98

Remarks: * = Rainfall at Serang Station was supplemented by rainfalls at Ciruas Station (No. 23f) using a conversion factor of 0.85.

Table H-11 CALCULATION OF IRRIGATION WATER REQUIREMENT FOR CIUJUNG IRRIGATION SCHEME, GOLONGAN I, IN 1972

		ETo (mm/d)	LP (mm/d)	ET (mm/d)	P (mm/d)	CWR (mm/d)	RE (mm/d)	IDR (mm/d)	IDR (lit/s/ha)
Oct	1	5.0	-	-	-	-	-	-	-
	2	4.9	-	-	-	-	-	-	-
Nov	1	4.8	8.7	-	-	8.5	1.7	10.9	1.27
	2	4.7	8.5	-	-	8.5	1.7	10.6	1.23
Dec	1	4.6	8.5	-	-	8.5	3.1	8.4	0.98
	2	4.5	-	5.4	1.0	6.4	1.8	7.2	0.83
Jan	1	4.3	-	5.2	1.0	6.2	5.1	1.7	0.20
	2	4.3	-	5.7	1.0	6.7	5.1	2.5	0.29
Feb	1	4.4	-	6.2	1.0	7.2	2.5	7.3	0.85
	2	4.5	-	6.1	1.0	7.1	2.5	7.2	0.83
Mar	1	4.5	-	5.6	1.0	6.6	3.6	4.7	0.54
	2	4.5	-	5.0	1.0	6.0	3.6	3.8	0.43
Apr	1	4.4	-	-	-	-	-	-	-
	2	4.4	8.3	-	-	8.3	1.5	10.6	1.23
May	1	4.3	8.2	-	-	8.2	2.4	9.1	1.05
	2	4.2	8.1	-	-	8.1	2.4	8.9	1.03
Jun	1	4.2	-	5.0	1.0	6.0	0.1	9.2	1.07
	2	4.2	-	5.3	1.0	6.3	0.1	9.7	1.12
Jul	1	4.3	-	5.9	1.0	6.9	0	10.8	1.25
	2	4.4	-	5.9	1.0	6.9	0	10.8	1.25
Aug	1	4.7	-	5.9	1.0	6.9	0.1	10.6	1.23
	2	4.9	-	-	-	-	-	-	-
Sep	1	5.1	-	-	-	-	-	-	-
	2	5.1	-	-	-	-	-	-	-

Remarks: ETo = Potential evapotranspiration
LP = Land preparation requirement
ET = Evapotranspiration
P = Percolation rate
CWR = Crop water requirement
RE = Effective rainfall
IDR = Irrigation diversion requirement

Table H-12 CALCULATION OF IRRIGATION WATER REQUIREMENT FOR CIUJUNG IRRIGATION SCHEME, GOLONGAN II, IN 1972

		Eto (mm/d)	LP (mm/d)	ET (mm/d)	P (mm/d)	CWR (mm/d)	RE (mm/d)	IDR (mm/d)	IDR (lit/s/ha)
Oct	1	5.0	-	-	-	-	-	-	0
	2	4.9	-	-	-	-	-	-	0
Nov	1	4.8	-	-	-	-	-	-	0
	2	4.7	8.5	-	-	8.5	1.7	10.6	1.23
Dec	1	4.6	8.5	-	-	8.5	3.1	8.4	0.98
	2	4.5	8.4	-	-	8.4	3.1	8.3	0.96
Jan	1	4.3	-	5.2	1.0	6.2	5.1	1.7	0.20
	2	4.3	-	5.2	1.0	6.2	5.1	1.7	0.20
Feb	1	4.4	-	5.8	1.0	6.8	2.5	6.7	0.78
	2	4.5	-	6.3	1.0	7.3	2.5	7.5	0.87
Mar	1	4.5	-	6.1	1.0	7.1	3.6	5.5	0.63
	2	4.5	-	5.6	1.0	6.6	3.6	4.7	0.54
Apr	1	4.4	-	4.9	1.0	5.9	0.9	7.8	0.90
	2	4.4	-	-	-	-	-	-	0
May	1	4.3	8.2	-	-	8.2	2.4	9.1	1.05
	2	4.2	8.1	-	-	8.1	2.4	8.9	1.03
Jun	1	4.2	8.1	-	-	8.1	0.2	12.3	1.43
	2	4.2	-	5.0	1.0	6.0	0.1	9.2	1.07
Jul	1	4.3	-	5.4	1.0	6.4	0	10.0	1.16
	2	4.4	-	6.1	1.0	7.1	0	11.1	1.28
Aug	1	4.7	-	6.3	1.0	7.3	0.1	11.3	1.30
	2	4.9	-	6.2	1.0	7.2	0.1	11.1	1.28
Sep	1	5.1	-	-	-	-	-	-	0
	2	5.1	-	-	-	-	-	-	0

Remarks: See remarks in Table H-11.

Table H-13 CALCULATION OF IRRIGATION WATER REQUIREMENT FOR CIUJUNG IRRIGATION SCHEME, GOLONGAN III, IN 1972

		Eto (mm/d)	LP (mm/d)	ET (mm/d)	P (mm/d)	CWR (mm/d)	RE (mm/d)	IDR (mm/d)	IDR (lit/s/ha)
Oct	1	5.0	-	-	-	-	-	-	-
	2	4.9	-	-	-	-	-	-	-
Nov	1	4.8	-	-	-	-	-	-	-
	2	4.7	-	-	-	-	-	-	-
Dec	1	4.6	8.5	-	-	8.5	3.1	8.4	0.97
	2	4.5	8.4	-	-	8.4	3.1	8.3	0.96
Jan	1	4.3	8.2	-	-	8.2	8.9	0	0
	2	4.3	-	5.2	1.0	6.2	5.1	1.7	0.20
Feb	1	4.4	-	5.3	1.0	6.3	2.5	5.9	0.68
	2	4.5	-	5.9	1.0	6.9	2.5	6.9	0.80
Mar	1	4.5	-	6.3	1.0	7.3	3.6	5.8	0.67
	2	4.5	-	6.1	1.0	7.1	3.6	5.5	0.64
Apr	1	4.4	-	5.5	1.0	6.5	0.9	8.8	1.02
	2	4.4	-	4.9	1.0	5.9	0.9	7.8	0.90
May	1	4.3	-	-	-	-	-	-	-
	2	4.2	8.1	-	-	8.1	2.4	8.9	1.03
Jun	1	4.2	8.1	-	-	8.1	0.2	12.3	1.42
	2	4.2	8.1	-	-	8.1	0.2	12.3	1.42
Jul	1	4.3	-	5.2	1.0	6.2	0	9.7	1.12
	2	4.4	-	5.5	1.0	6.5	0	10.2	1.18
Aug	1	4.7	-	6.5	1.0	7.5	0.1	11.6	1.34
	2	4.9	-	6.6	1.0	7.6	0.1	11.7	1.36
Sep	1	5.1	-	6.4	1.0	7.4	0	11.6	1.34
	2	5.1	-	-	-	-	-	-	-

Remarks: See remarks in Table H-11.

Table H-14 CALCULATION OF IRRIGATION WATER REQUIREMENT FOR K-C-C IRRIGATION SCHEME, GOLONGAN I, IN 1972

		ETo (mm/d)	LP (mm/d)	ET (mm/d)	P (mm/d)	CWR (mm/d)	RE (mm/d)	IDR (mm/d)	IDR (lit/s/ha)
Oct	1	5.0	-	-	-	-	-	-	-
	2	4.9	-	-	-	-	-	-	-
Nov	1	4.8	11.3	-	-	11.3	1.7	15.0	1.74
	2	4.7	11.1	-	-	11.1	1.7	14.7	1.70
Dec	1	4.6	-	5.5	2.0	7.5	1.7	9.1	1.05
	2	4.5	-	5.4	2.0	7.4	1.7	8.9	1.03
Jan	1	4.3	-	5.7	2.0	7.7	5.0	4.2	0.49
	2	4.3	-	6.0	2.0	8.0	5.0	4.7	0.54
Feb	1	4.4	-	5.9	2.0	7.9	2.4	8.6	1.00
	2	4.5	-	5.6	2.0	7.6	2.4	8.1	0.94
Mar	1	4.5	-	5.0	2.0	7.0	3.5	5.5	0.63
	2	4.5	-	-	-	-	-	-	-
Apr	1	4.4	-	-	-	-	-	-	-
	2	4.4	10.9	-	-	10.9	1.5	14.7	1.70
May	1	4.3	10.9	-	-	10.9	2.4	13.3	1.54
	2	4.2	-	5.0	2.0	7.0	1.4	8.8	1.02
Jun	1	4.2	-	5.3	2.0	7.3	0.1	11.3	1.31
	2	4.2	-	5.8	2.0	7.8	0.1	12.0	1.39
Jul	1	4.3	-	5.8	2.0	7.8	0	12.2	1.41
	2	4.4	-	5.5	2.0	7.5	0	11.7	1.35
Aug	1	4.7	-	-	-	-	-	-	-
	2	4.9	-	-	-	-	-	-	-
Sep	1	5.1	-	-	-	-	-	-	-
	2	5.1	-	-	-	-	-	-	-

Remarks: See remarks in Table H-11.

Table H-15 CALCULATION OF IRRIGATION WATER REQUIREMENT FOR K-C-C IRRIGATION SCHEME, GOLONGAN II, IN 1972

		ETo (mm/d)	LP (mm/d)	ET (mm/d)	P (mm/d)	CWR (mm/d)	RE (mm/d)	IDR (mm/d)	IDR (lit/s/ha)
Oct	1	5.0	-	-	-	-	-	-	-
	2	4.9	-	-	-	-	-	-	-
Nov	1	4.8	-	-	-	-	-	-	-
	2	4.7	11.1	-	-	11.1	1.7	14.7	1.70
Dec	1	4.6	11.1	-	-	11.1	3.0	12.7	1.47
	2	4.5	-	5.4	2.0	7.4	1.7	8.9	1.03
Jan	1	4.3	-	5.2	2.0	7.2	5.0	3.4	0.39
	2	4.3	-	5.7	2.0	7.7	5.0	4.2	0.49
Feb	1	4.4	-	6.2	2.0	8.2	2.4	9.1	1.05
	2	4.5	-	6.1	2.0	8.1	2.4	8.9	1.03
Mar	1	4.5	-	5.6	2.0	7.6	3.5	6.4	0.74
	2	4.5	-	5.0	2.0	7.0	3.5	5.5	0.64
Apr	1	4.4	-	-	-	-	-	-	-
	2	4.4	-	-	-	-	-	-	-
May	1	4.3	10.8	-	-	10.8	2.4	13.1	1.52
	2	4.2	10.8	-	-	10.8	2.4	13.1	1.52
Jun	1	4.2	-	5.0	2.0	7.0	0.1	10.8	1.25
	2	4.2	-	5.3	2.0	7.3	0.1	11.3	1.31
Jul	1	4.3	-	5.9	2.0	7.9	0	12.3	1.42
	2	4.4	-	5.9	2.0	7.9	0	12.3	1.42
Aug	1	4.7	-	5.9	2.0	7.9	0.1	12.2	1.41
	2	4.9	-	-	-	-	-	-	-
Sep	1	5.1	-	-	-	-	-	-	-
	2	5.1	-	-	-	-	-	-	-

Remarks: See remarks in Table H-11.

Table H-16 CALCULATION OF IRRIGATION WATER REQUIREMENT FOR K-C-C IRRIGATION SCHEME, GOLONGAN III, IN 1972

		ETo (mm/d)	LP (mm/d)	ET (mm/d)	P (mm/d)	CWR (mm/d)	RE (mm/d)	IDR (mm/d)	IDR (lit/s/ha)
Oct	1	5.0	-	-	-	-	-	-	-
	2	4.9	-	-	-	-	-	-	-
Nov	1	4.8	-	-	-	-	-	-	-
	2	4.7	-	-	-	-	-	-	-
Dec	1	4.6	11.1	-	-	11.1	3.0	12.7	1.47
	2	4.5	11.0	-	-	11.0	3.0	12.5	1.45
Jan	1	4.3	-	5.2	2.0	7.2	5.0	3.4	0.39
	2	4.3	-	5.2	2.0	7.2	5.0	3.4	0.39
Feb	1	4.4	-	5.8	2.0	7.8	2.4	8.4	0.97
	2	4.5	-	6.3	2.0	8.3	2.4	9.2	1.06
Mar	1	4.5	-	6.1	2.0	8.1	3.5	7.2	0.83
	2	4.5	-	5.6	2.0	7.6	3.5	6.4	0.74
Apr	1	4.4	-	4.9	2.0	6.9	0.9	9.4	1.09
	2	4.4	-	-	-	-	-	-	-
May	1	4.3	-	-	-	-	-	-	-
	2	4.2	10.8	-	-	10.8	2.4	13.1	1.52
Jun	1	4.2	10.8	-	-	10.8	0.2	16.6	1.92
	2	4.2	-	5.0	2.0	7.0	0.1	10.8	1.25
Jul	1	4.3	-	5.4	2.0	7.4	0	11.6	1.34
	2	4.4	-	6.1	2.0	8.1	0	12.7	1.47
Aug	1	4.7	-	6.3	2.0	8.3	0.1	12.8	1.48
	2	4.9	-	6.2	2.0	8.2	0.1	12.7	1.47
Sep	1	5.1	-	-	-	-	-	-	-
	2	5.1	-	-	-	-	-	-	-

Remarks: See remarks in Table H-11.

Table H-17 CALCULATION OF IRRIGATION WATER REQUIREMENT FOR CICINTA IRRIGATION SCHEME IN 1972

		ETo (mm/d)	LP (mm/d)	ET (mm/d)	P (mm/d)	CWR (mm/d)	RE (mm/d)	IDR (mm/d)	IDR (lit/s/ha)
Oct	1	5.0	-	-	-	-	-	-	-
	2	4.9	-	-	-	-	-	-	-
Nov	1	4.8	11.3	-	-	11.3	1.8	14.8	1.72
	2	4.7	11.1	-	-	11.1	1.8	14.5	1.68
Dec	1	4.6	-	5.5	2.0	7.5	1.8	8.9	1.03
	2	4.5	-	5.4	2.0	7.4	1.8	8.8	1.01
Jan	1	4.3	-	5.7	2.0	7.7	5.2	3.9	0.45
	2	4.3	-	6.0	2.0	8.0	5.2	4.4	0.51
Feb	1	4.4	-	5.9	2.0	7.9	2.5	8.4	0.98
	2	4.5	-	5.6	2.0	7.6	2.5	8.0	0.92
Mar	1	4.5	-	5.0	2.0	7.0	3.7	5.2	0.60
	2	4.5	-	-	-	-	-	-	-
Apr	1	4.4	-	-	-	-	-	-	-
	2	4.4	10.9	-	-	10.9	1.6	14.5	1.68
May	1	4.3	10.9	-	-	10.9	2.5	13.1	1.52
	2	4.2	-	5.0	2.0	7.0	1.4	8.8	1.01
Jun	1	4.2	-	5.3	2.0	7.3	0.1	11.3	1.30
	2	4.2	-	5.8	2.0	7.8	0.1	12.0	1.39
Jul	1	4.3	-	5.8	2.0	7.8	0	12.2	1.41
	2	4.4	-	5.5	2.0	7.5	0	11.7	1.36
Aug	1	4.7	-	-	-	-	-	-	-
	2	4.9	-	-	-	-	-	-	-
Sep	1	5.1	-	-	-	-	-	-	-
	2	5.1	-	-	-	-	-	-	-

Remarks: See remarks in Table H-11.

Table H-18 IRRIGATION DIVERSION REQUIREMENT FOR CIUJUNG, K-C-C AND CICINTA SCHEMES IN CASE OF 200% CROPPING INTENSITY

Unit: m^3/s

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
Ciujung											
Jan	4.4	8.5	7.8	11.8	2.1	7.2	14.2	1.1	8.8	7.2	10.7
Feb	19.4	5.4	7.1	18.0	20.6	8.4	18.5	22.8	3.7	13.3	24.0
Mar	14.0	15.6	17.8	24.3	27.4	16.6	11.3	20.4	23.1	22.2	20.4
Apr	16.3	13.8	12.8	14.9	11.5	13.5	11.7	13.5	11.4	13.5	14.9
May	20.9	21.5	21.5	25.9	26.3	20.9	27.0	18.7	20.5	17.9	23.4
Jun	30.5	25.8	18.9	29.5	28.9	19.9	18.6	29.7	23.4	26.1	28.2
Jul	29.2	23.9	21.3	25.6	28.1	28.1	22.9	25.1	25.1	21.3	27.3
Aug	26.4	23.0	25.9	25.2	24.1	26.7	21.5	23.7	21.9	21.2	26.7
Sep	5.5	9.4	6.3	10.1	10.4	10.4	8.9	8.5	8.8	8.9	10.9
Oct	-	-	-	-	-	-	-	-	-	-	-
Nov	15.0	10.5	8.8	13.5	12.5	17.2	14.2	13.1	12.0	4.8	15.5
Dec	22.9	15.2	7.5	9.0	17.6	16.0	9.4	14.7	11.5	15.1	27.0
K-C-C											
Jan	3.6	4.8	4.8	5.9	2.8	4.6	6.6	1.3	5.1	4.6	5.7
Feb	8.1	3.5	4.1	7.5	8.4	4.5	7.8	9.1	2.9	5.9	9.5
Mar	4.8	5.3	5.8	7.6	5.3	5.4	4.1	6.5	7.3	7.0	6.5
Apr	3.7	3.2	3.0	3.5	2.7	3.1	2.8	2.7	2.7	3.1	3.4
May	9.5	9.8	9.7	11.1	11.1	9.5	11.3	8.1	9.5	8.6	10.2
Jun	11.3	10.0	8.1	11.1	11.1	8.4	8.1	11.1	9.4	10.1	10.6
Jul	11.2	9.8	8.7	10.1	10.9	11.1	9.3	9.9	9.8	8.8	10.1
Aug	5.9	5.2	5.8	5.6	5.4	5.9	5.0	5.4	5.0	4.9	5.9
Sep	-	-	-	-	-	-	-	-	-	-	-
Oct	-	-	-	-	-	-	-	-	-	-	-
Nov	6.9	5.4	4.8	6.3	6.0	7.5	6.6	6.2	5.9	3.6	7.1
Dec	10.0	7.8	5.6	6.1	8.5	8.0	6.2	8.7	6.8	7.8	11.5
Cicinta											
Jan	0.7	1.0	0.9	1.2	0.6	0.9	1.3	0.3	1.0	0.9	1.1
Feb	1.4	0.5	0.7	1.3	1.5	0.7	1.4	1.6	0.4	1.0	1.7
Mar	0.9	1.0	1.0	1.5	1.0	1.0	0.7	1.2	1.4	1.4	1.3
Apr	1.2	2.1	2.0	2.3	1.8	2.0	1.8	2.1	1.8	2.0	2.3
May	1.9	1.9	1.9	2.2	2.2	1.9	2.2	1.7	1.9	1.7	2.0
Jun	2.0	1.8	1.5	1.9	1.9	1.5	1.5	1.9	1.7	1.8	1.9
Jul	2.0	1.8	1.5	1.8	2.0	2.0	1.7	1.8	1.8	1.6	1.8
Aug	-	-	-	-	-	-	-	-	-	-	-
Sep	-	-	-	-	-	-	-	-	-	-	-
Oct	-	-	-	-	-	-	-	-	-	-	-
Nov	2.5	2.0	1.8	2.3	2.2	2.8	2.4	2.3	2.2	1.3	2.6
Dec	1.5	1.2	0.9	1.0	1.3	1.2	1.0	1.2	1.1	1.2	2.4

Table H-19 IRRIGABLE AREA OF DRY SEASON PADDY FOR THE CIUJUNG IRRIGATION SCHEME UNDER EXISTING DISCHARGE CAPACITY OF PRIMARY CANALS

Year	Month	*Irrigation Requirement* Monthly Max. /1	*Irrigation Requirement* Peak Value (Semi-monthly)	Irrigable Area (ha)
1972	Jun	30.5	31.7	21,380
1973	Jun	25.8	26.9	24,200
1974	Aug	25.9	27.0	24,200
1975	Jun	29.5	30.8	22,000
1976	Jun	28.9	30.1	22,510
1977	Jul	28.1	29.3	23,130
1978	May	27.0	28.2	24,030
1979	Jun	29.7	31.0	21,860
1980	Jul	25.1	26.2	24,200
1981	Jun	26.1	27.2	24,200
1982	Jun	28.2	29.4	23,050
Average				23,160

Remarks: Water source is assumed to be sufficient in calculation of this table.

/1 = Refer to Table H-18.

Table H-20 IRRIGATION AREA FOR RECOMMENDED PLAN

Unit: ha

Scheme	Golongan	Wet Season	Dry Season
Ciujung	I	7,907	6,860
	II	8,142	7,060
	III	8,151	7,080
Sub-total		24,200	21,000
K-C-C	I	2,600	2,250
	II	2,700	2,350
	III	2,700	2,350
Sub-total		8,000	6,950
Cicinta		1,434	1,250
Total		33,634	29,200

Table H-21 IRRIGATION DIVERSION DEMAND FOR RECOMMENDED PLAN

Unit: m^3/s

		Ciujung				K-C-C				Cicinta	Total
		G1	G2	G3	Total	G1	G2	G3	Total		
Oct	1	-	-	-	-	-	-	-	-	-	-
	2	-	-	-		-	-	-		-	
Nov	1	10.0	-	-	14.9	4.5	-	-	6.8	2.5	2.5
	2	9.7	10.0	-		4.4	4.6	-		2.4	
Dec	1	7.7	8.0	7.9	22.9	2.7	4.0	4.0	10.1	1.5	1.5
	2	6.6	7.8	7.8		2.7	2.8	3.9		1.4	
Jan	1	1.6	1.6	0	4.4	1.3	1.1	1.1	3.7	0.6	0.7
	2	2.3	1.6	1.6		1.4	1.3	1.1		0.7	
Feb	1	6.7	6.4	5.5	19.4	2.6	2.8	2.6	8.1	1.4	1.4
	2	6.6	7.1	6.5		2.4	2.8	2.9		1.3	
Mar	1	4.3	5.1	5.5	14.0	1.6	2.0	2.2	4.8	0.9	0.5
	2	3.4	4.4	5.2		-	1.7	2.0		-	
Apr	1	-	6.3	7.3	14.1	-	-	2.8	3.2	-	1.1
	2	8.4	-	6.3		3.7	-	-		2.1	
May	1	7.2	7.4	-	18.1	3.5	3.6	-	8.3	1.9	1.7
	2	7.1	7.3	7.3		2.3	3.6	3.6		1.4	
Jun	1	7.3	10.1	10.1	26.4	2.9	2.9	4.5	9.8	1.6	1.7
	2	7.7	7.6	10.1		3.1	3.1	2.9		1.7	
Jul	1	8.6	8.2	7.9	25.3	3.2	3.3	3.1	9.7	1.7	1.8
	2	8.6	9.0	8.3		3.0	3.3	3.5		1.7	
Aug	1	8.4	9.2	9.5	22.9	-	3.3	3.5	5.2	-	-
	2	-	9.0	9.6		-	-	3.5		-	
Sep	1	-	-	9.5	4.8	-	-	-	-	-	-
	2	-	-	-		-	-	-		-	

Remarks: G1 = Golongan I
G2 = Golongan II
G3 = Golongan III

Table H-22 UNIT CONSTRUCTION COST FOR CANAL SYSTEM

Unit: Rp

Description	Unit	Foreign	Local	Total
Clearing & Grubbing	m^2	100	50	150
Stripping Topsoil	m^2	200	200	400
Excavation				
Common, Mechanical	m^3	400	200	400
Common, Manual	m^3	-	800	800
Weathered Rock	m3	1,700	900	2,600
Embankment: Type A/1	m3	400	400	800
Type B/2	m^3	2,500	2,400	4,900
Backfilling	m^3	1,200	1,000	2,200
Gravel Pavement	m^2	100	2,200	2,300
Sod-facing	m^2	-	400	400
Concrete: Type A/3	m^3	5,900	37,100	43,000
Type B/4	m^3	5,900	35,400	41,300
Type C/5	m^3	5,900	29,000	34,900
Form: Wooden	m^2	-	5,400	5,400
Steel	m^2	1,200	1,400	2,600
Reinforcement Bar	ton	-	447,500	447,500
Stone Masonry	m^3	-	33,400	33,400
Riprap Protection	m^3	1,400	8,400	9,800
Stoplog	m^3	-	93,200	93,200
Precast Concrete Pipe:				
(Dia. 1,000 mm)	m	-	29,700	29,700
(Dia. 800 mm)	m	-	23,700	23,700
(Dia. 500 mm)	m	-	10,700	10,700
Tertiary Development	ha	-	200,000	200,000

Remarks: /1 = By excavated materials
/2 = By borrowed materials within 5 km
/3 = Reinforced concrete
/4 = Plain concrete
/5 = For bed of structures

Table H-23 CONSTRUCTION COST FOR THE K-C-C IRRIGATION SCHEME

Unit: Rp 10^6

Item	Amount
1. Direct Construction Cost	
1.1 Preparatory works	1,090
1.2 Gadeg weir	
Dam (78,100 m^3)	790
Spillway	1,200
Intake	60
Miscellaneous	10
Sub-total	2,060
1.3 Main irrigation canal (30 km)	
Earthworks (1.9 x 10^6 m^3)	1,500
Structures and others	2,000
Sub-total	3,500
1.4 Secondary irrigation canal (65 km)	
Earthworks (1.7 x 10^6 m^3)	2,600
Structures and others	3,100
Sub-total	5,700
1.5 Tertiary development (8,000 ha)	1,600
1.6 Drainage canal and structures	1,200
1.7 Farm road (gravel pavement only)	950
Total for item 1	16,100
2. Land Acquisition	1,800
3. Government Administration	350
4. Engineering Services	2,070
5. Physical Contingency	4,080
Total for item 1 to 5	24,400
6. Price Contingency	14,900
Grand Total	39,300

Table H-24 ANNUAL DISBURSEMENT SCHEDULE OF CONSTRUCTION COST FOR THE K-C-C IRRIGATION SCHEME

Unit: Rp 10^6

Item	Total		1985		1986		1987		1988		1989		1990		1991	
	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC
Direct construction cost	5635	10465	-	-	-	-	1127	2093	1409	2616	1409	2616	1127	2093	563	1047
Land acquisition	-	1800	-	-	-	600	-	600	-	600	-	-	-	-	-	-
Govenment administration	-	350	-	-	-	-	-	70	-	70	-	70	-	70	-	70
Engineering services	1570	500	390	125	390	125	158	50	198	50	198	50	158	50	78	50
Physical contingency	1440	2640	78	25	78	145	257	580	321	667	321	547	257	443	128	233
Sub-total	8645	15755	468	150	468	870	1542	3393	1928	4003	1928	3283	1542	2656	769	1400
Price contingency	3899	11001	68	38	105	298	499	1567	776	2444	965	2533	934	2520	552	1601
Total	12544	26756	536	218	573	1198	2041	4943	2704	6447	2893	5816	2476	5176	1321	3001

Table H-25 (1/2) REQUIREMENT FOR TERTIARY DEVELOPMENT FOR SMALL-SCALE IRRIGATION SCHEMES

Kabupaten Name of Scheme	Total Irri. Area (ha)	Tertiary Development (ha)		Development Cost (Rp 10^6)
		Completed	Not Yet	
Serang				
1. Gerem	92	0	92	18.4
2. Kedung Ingas	96	0	96	19.2
3. Cibeber	125	0	125	25.0
4. Cileaduweum	214	0	214	42.8
5. Harjatani	92	0	92	18.4
6. Jakung	33	0	33	6.6
7. Cipaas	350	0	350	70.0
8. Ciwaka	1,563	1,222	341	68.2
9. Cablik	156	0	156	31.2
10. Kresek	106	0	106	21.2
11. Sibugang	328	0	328	65.6
12. Jelawe	77	0	77	15.4
13. Cipari Bawah /Atas	1,148	0	1,148	229.6
14. Ciwuni atas	425	0	425	85.0
15. Ciwuni bawah	273	0	273	54.6
16. Cikeusal	89	0	89	17.8
17. Kadugenep	197	0	197	39.4
18. Krajanen	200	0	200	40.0
19. Cikulur	172	0	172	34.4
20. Cibanten/1	2,213	1,960	253	50.6
21. Cipelem	198	0	198	39.6
22. Cilaku	180	0	180	36.0
23. Nagara Padang	176	0	176	35.2
24. Cipari Atas	172	0	172	34.4
25. Ciwaka Atas	193	0	193	38.6
26. Cilesung	215	0	215	43.0
27. Rampones	125	0	125	25.0
28. Sindang Mandi	109	0	109	21.8
29. Cibanten Atas	84	0	84	16.8
30. Cisuar	138	0	138	27.6
31. Citasuk	165	0	165	33.0
32. Cikalumpang	948	0	948	189.6
33. Cibojong	223	164	59	11.8
34. Cikuray	351	0	351	70.2
35. Cilampir	100	0	100	20.0
36. Leuwi Paseh	23	0	23	4.6
Total	11,439	3,346	8,093	1,618.6

Remarks: /1 = Including potential area of 100 ha each. (refer to Section 3.2)

Table H-25 (2/2) REQUIREMENT FOR TERTIARY DEVELOPMENT FOR SMALL-SCALE IRRIGATION SCHEMES

Kabupaten Name of Scheme	Total Irri. Area (ha)	Tertiary Development (ha)		Development Cost (Rp 10^6)
		Completed	Not Yet	
Pandeglang				
1. Cilancar I	226	0	226	45.2
2. Cilancar II	256	0	256	51.2
3. Cijebug	74	0	74	14.8
4. Cikoneng	76	0	76	15.2
5. Cicanggong	91	0	91	18.2
6. Cilembur	302	0	302	60.4
7. Ciraden	25	0	25	5.0
Total	1,050	0	1,050	210.0
Lebak				
1. Ranca Dundu	91	0	91	18.2
2. Bunut	221	0	221	44.2
3. Batu	106	0	106	21.2
4. Cirape	97	0	97	19.4
5. Cikupa	57	0	57	11.4
6. Cisangu	485	0	485	97.0
7. Heas	145	0	145	29.0
8. Pasirbedil	209	0	209	41.8
9. Cilembun	102	0	102	20.4
10. Cikondang	312	0	312	62.4
11. Ciselaraja	104	0	104	20.8
12. Cijoro	55	0	55	11.0
13. Cimarga	217	0	217	43.4
14. Guning Gebas	170	0	170	34.0
15. Cipanas	536	0	536	107.2
16. Bungbas	118	0	118	23.6
17. Cijambu	177	0	177	35.4
18. Cilaki	412	0	412	82.4
Total	3,614	0	3,614	722.8
Grand Total	16,103	3,346	12,757	2,551.4

Table H-26 (1/2) REHABILITATION REQUIREMENT FOR EXISTING SMALL-SCALE IRRIGATION SCHEMES

Kabupaten	Name of Scheme	Irri. Area (ha)	Rehabilitation Requirement Intake Weir (nos.)	Structure (nos.)	Canal (km)	Cost (Rp 10^6)
Serang						
1.	Gerem	92	1	6	2.2	10
2.	Kedungingas	96	1	7	1.9	11
3.	Cibeber	125	0	4	1.3	5
4.	Cikaduwen	214	1	5	1.1	8
5.	Harjatani	92	0	0	0.2	1
6.	Jakung	33	0	5	1.4	6
7.	Cipaas	350	0	1	6.0	7
8.	Ciwaka/Ciblik/Kreselc	1,825	1	6	5.5	12
9.	Sibugang/Jelawe	405	0	5	2.9	8
10.	Cipari/Ciwuni	1,846	0	6	6.3	12
11.	Cikeusal	89	1	1	2.8	6
12.	Cicinta	1,434	0	9	5.7	14
13.	Cisangu	1,441	0	12	16.2	26
14.	Kadugenep/Krajanan	397	0	13	5.3	17
15.	Cikulur	172	0	7	2.4	9
16.	Cibanten	2,203	0	9	11.5	19
17.	Cipelem/Cilaku	378	0	10	2.9	12
18.	Nagarapadang	176	1	4	7.0	12
19.	Cipari Atas	172	1	7	2.7	11
20.	Ciwaka Atas	193	1	2	2.4	6
21.	Citaman	120	0	3	0.1	3
22.	Cilesung	215	0	1	0	1
23.	Rampones	125	0	0	0.9	1
24.	Sindangmandi	109	0	0	0.4	1
25.	Cibanten Atas	84	0	0	0.2	1
26.	Cibulakan	401	1	0	1.5	4
27.	Cisuar	138	1	5	2.7	10
28.	Telagawangsa	145	0	3	0.1	3
29.	Cikoneng	424	0	2	1.9	4
30.	Citasuk/Cikalumpang	1,113	2	3	3.1	4
31.	Cibojong	223	0	2	2.2	5
32.	Cikuray	351	0	2	2.8	5
33.	Cilampir	100	2	3	0	7
34.	Leuwipaseh	23	1	1	0	2
	Sub-total		15	144	103.6	263

Table H-26 (2/2) REHABILITATION REQUIREMENT FOR EXISTING SMALL-SCALE IRRIGATION SCHEMES

Kabupaten	Name of Scheme	Irri. Area (ha)	Rehabilitation Requirement Intake Weir (nos.)	Structure (nos.)	Canal (km)	Cost (Rp 10^6)
Pandeglang						
1.	Ciaria	805	1	15	53.3	33
2.	Cijebug	74	1	12	12.1	12
3.	Cikoneng	76	1	5	5.1	9
4.	Cipanas/Cibaring Kung	237	0	2	2.1	4
5.	Cicanggong	91	1	3	3.1	6
6.	Cilembur	302	0	1	1.4	8
7.	Ciraden	25	1	7	7.1	19
	Sub-total		5	45	84.2	91
Lebak						
1.	Cikupa	572	0	58	18.6	64
2.	Cisang Atas	839	0	27	23.0	45
3.	Cilembun	102	0	3	1.1	19
4.	Cikondang	312	0	30	5.7	24
5.	Ciselaraja	104	0	13	9.2	14
6.	Cijoro	55	0	4	4.3	22
7.	Cimarga	217	0	16	9.3	32
8.	Cipanas	706	1	17	4.6	15
9.	Bungbas	118	1	3	0.8	7
10.	Cilaki	412	1	3	0.1	14
	Sub-total		3	174	76.7	256
	Total		23	363	264.5	610

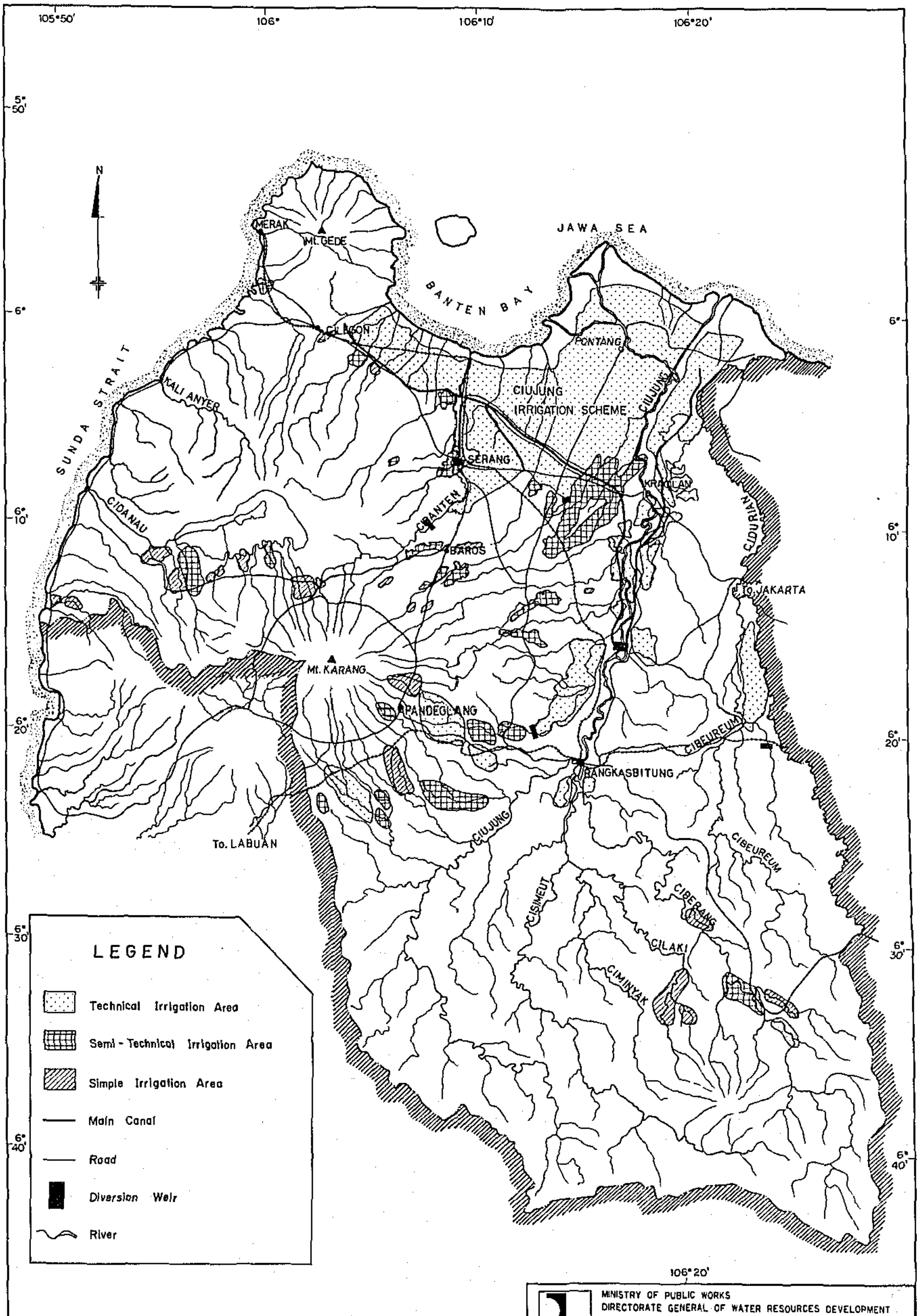

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Fig. H-1 Location of Irrigation Schemes

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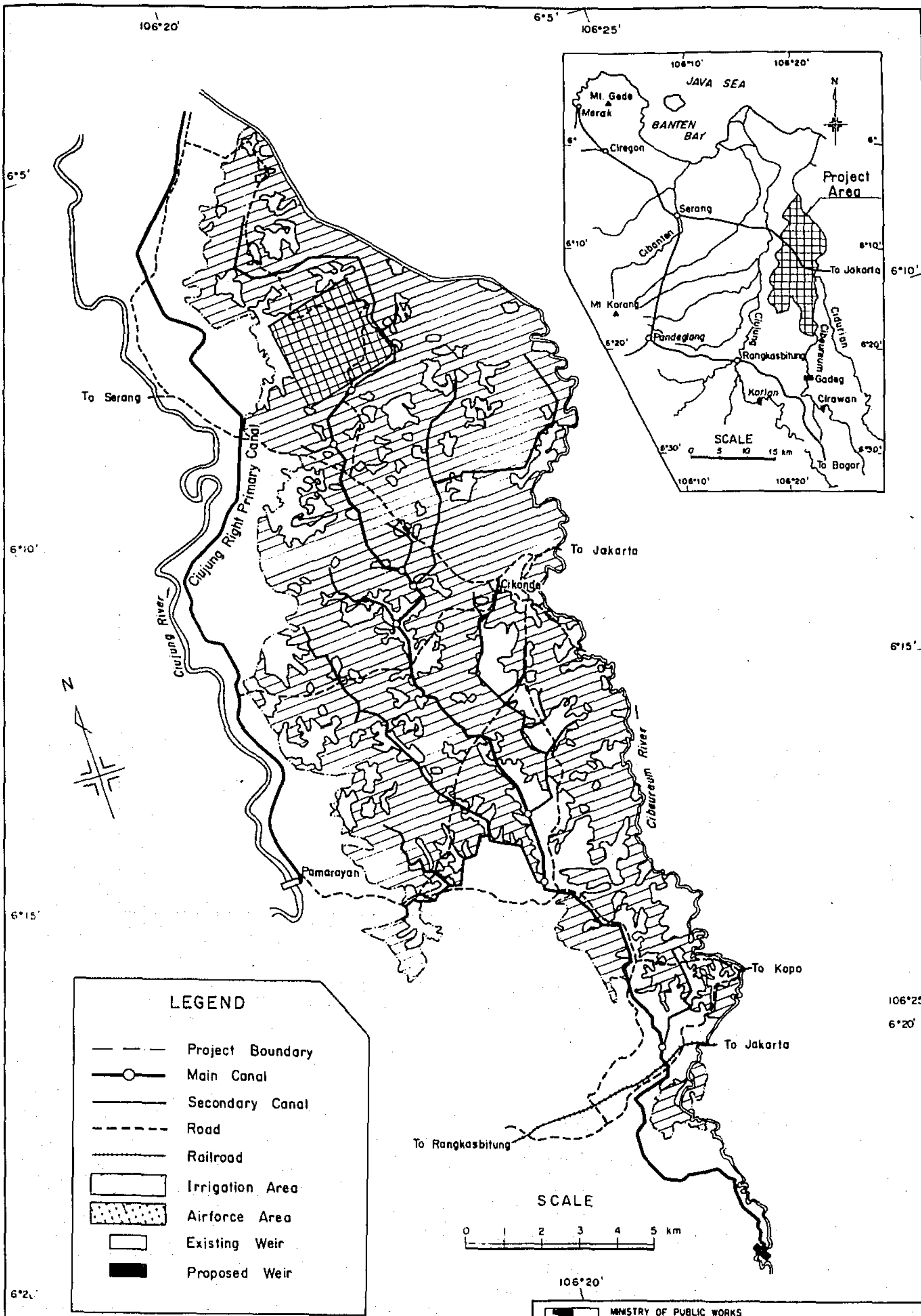

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Fig. H-2 Development Plan for K-C-C Irrigation Scheme

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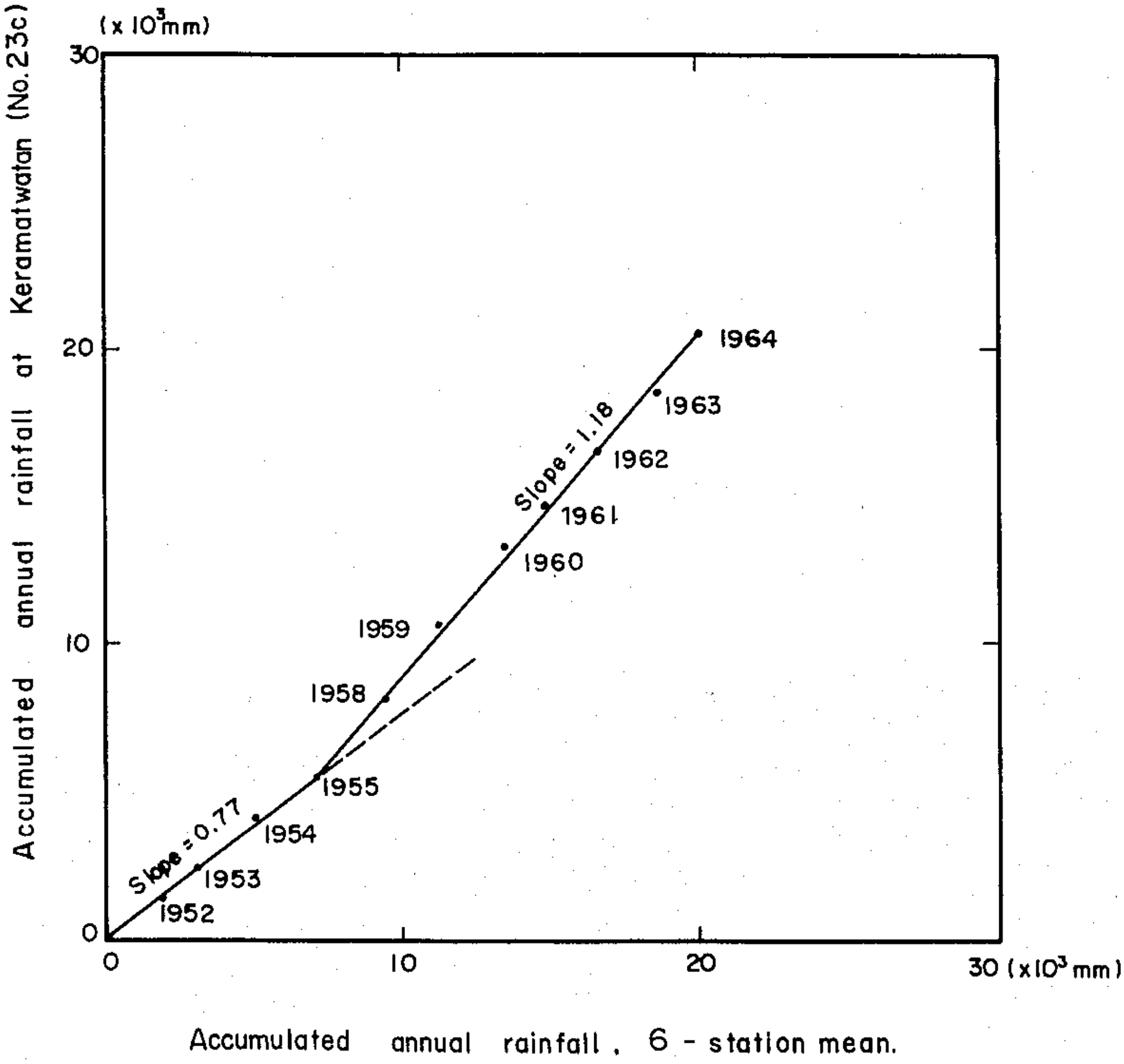

Remarks:

Rainfall station used

23C	Keramatwatan.
23	Serang
23 f	Ciruas
23 g	Kalenpetung
32 c	Ragasilir
25 a	Kresek
33	Parigi

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Fig. H-3 Adjustment of Rainfall Data by Double-mass Curve

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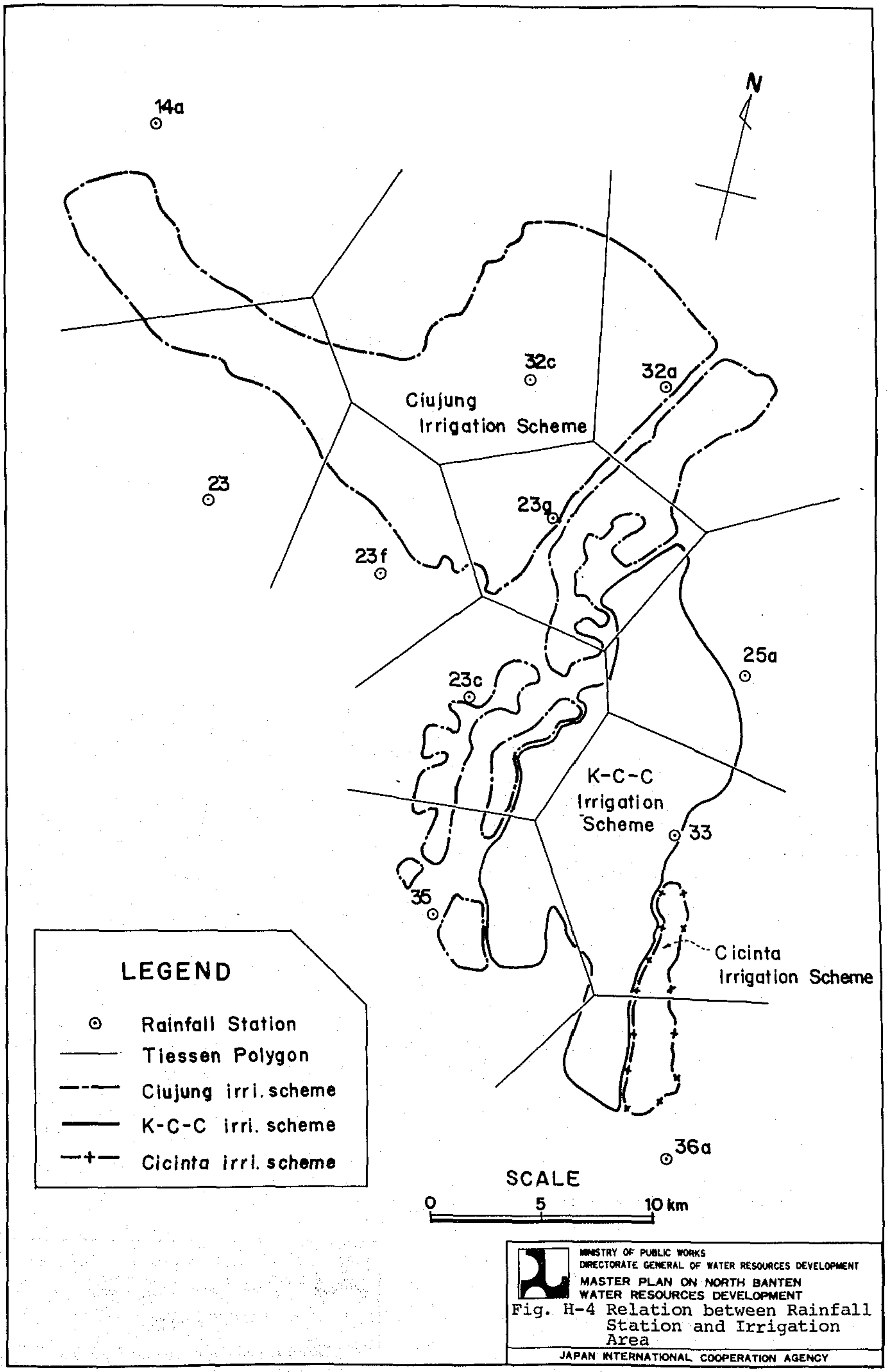

Fig. H-4 Relation between Rainfall Station and Irrigation Area

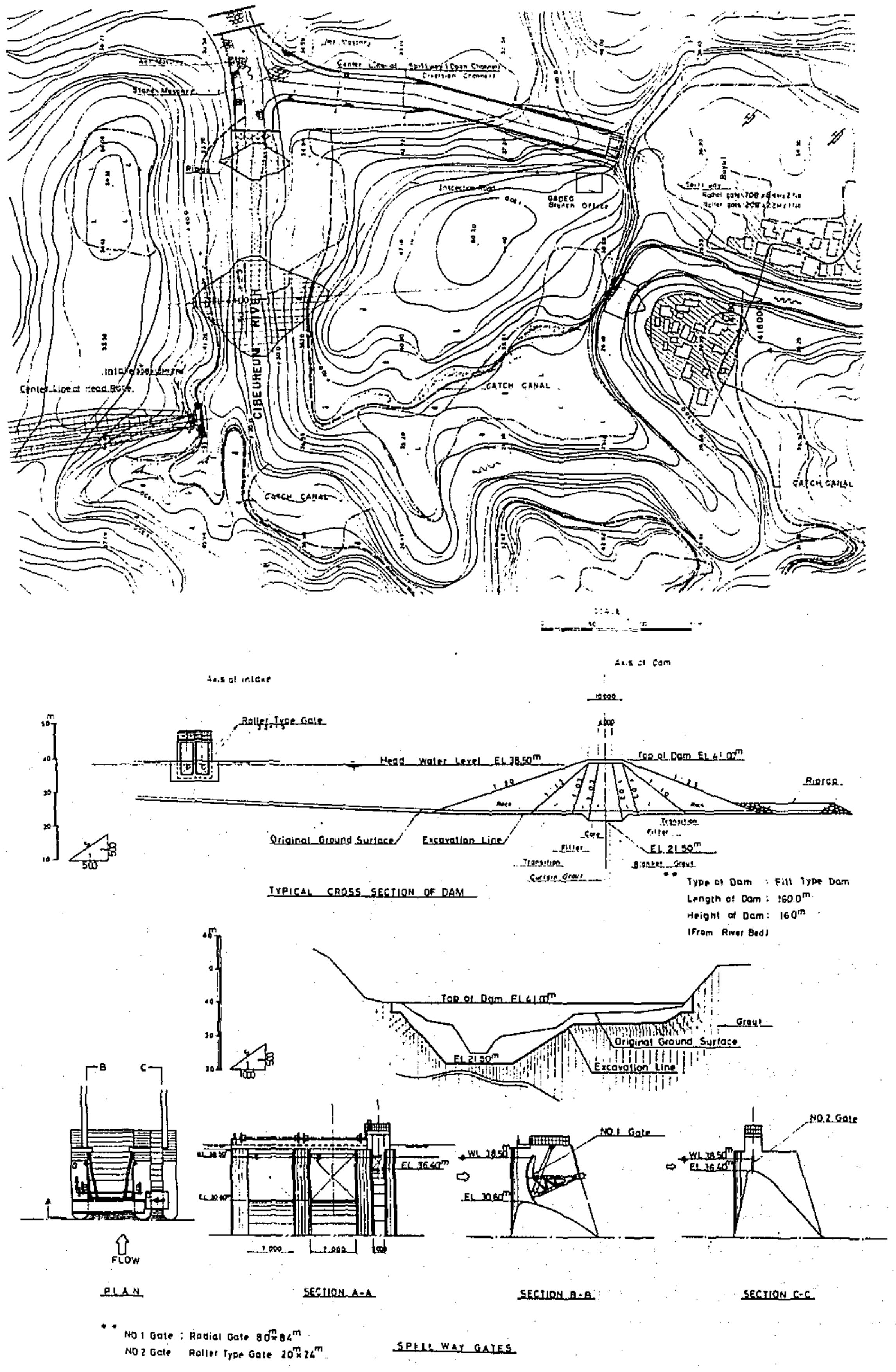

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Fig. H-5 Proposed Gadeg Weir

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APPENDIX I

DOMESTIC AND INDUSTRIAL WATER SUPPLY

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1. INTRODUCTION

The present Indonesian water supply administrative system is divided into two groups. One is urban water supply system under the control of the Ministry of Public Works and the other is rural water supply system under the control of the Ministry of Health. Water works in Indonesia have been developed according to the First, Second and Third Five Year Development Plans (REPELITA I to REPELITA III) (Ref. 1).

The target of REPELITA III in water supply schemes is to serve 60% of the populations of 150 small towns and 1,700 sub-district towns (IKK) with an average of 60 lit/capita/d (Ref. 2). The financing scheme is formulated as follows:

(1) To meet the requirement of water supply up to an average of 60 lit/capita/d, the Central Government will provide funds as grants through the DIP-budget.

(2) For cities which have a potential consumption of more than the average, with a limit of 125 lit/capita/d, the fund for the additional capacity about 60 lit/capita/d will be provided by a loan-equity. For these cities, the standard operating procedures have been established in the Joint Decision of the Minister of Public Works, Minister of Finance and Minister of Home Affairs.

(3) For cities above the average of 125 lit/capita/d, the cost will be financed entirely from loans.

IKK water supply systems belong to Directorate General of Housing, Building, Planning and Urban Development (CIPTA KARYA). Although IKK has an administrative connotation, it is not the administrative status of the town itself. But the IKK water supply program puts more emphasis on the approach and level of services envisaged in this particular program. There are three basic premises, which are the foundation of this program as follows:

(1) Cost effective facilities will be designed and constructed for those IKKs which are considered to be capable of supporting a water supply system.

(2) The long-term operation and maintenance of these systems is deemed to be equally as important as the construction of them.

(3) The institutional capacity to insure both of the above is to be developed to coordinate physical, human and momentary resources.

The basic factor for water supply planning of a water work is the projection of water demand which is to be determined by the water consumption per capita, percentage of served population, etc. For the present study, these factors are studied through our site reconnaissance and various reports previously prepared (Refs. 1 to 18).

2. EXISTING WATER SUPPLY FACILITIES

There is no specially distinguished water supply system between domestic and industry use in the Study Area. The classification of urban and rural will be discussed hereunder taking into consideration the previous study (Ref. 1).

2.1 Urban Water Supply

Urban water supply systems are administrated by Regional Water Supply Enterprise (PDAM) in Kabupaten or Kotamadya under the control of project manager in provincial offices of Directorate of Sanitary Engineering (DSE). PDAM is controlled, after two years operation, by the Ministry of Interior. DSE is one of the Departments of CIPTA KARYA (Ref. 1).

Main municipalities in the Study Area are such four towns as Serang, Pandeglang, Rangkasbitung and Cilegon. Serang, Pandeglang and Rangkasbitung are supplying water by pipes from water sources of springs and deep wells, but Cilegon will start to supply water by pipes from the Krenceng water treatment plant of P.T. Krakatau Steel Works in May 1983. One of the main component of urban water supply program is the provision of clear water to IKKs in which urbanized settlements are mostly served (Ref. 3).

The urban areas are classified into five categories as shown in below (Ref. 10).

Category	Definition	Population
I	Metropolitan	1,000,000 or more
II	City	500,000 to 1,000,000
III	Medium town	100,000 to 500,000
IV	Small town	20,000 to 100,000
V	IKK	3,000 to 20,000

2.1.1 Serang town water supply system

The Serang town water supply system was started in 1885 and the water sources of the town consist of two groups. One is dug boreholes with the actual yield of about 5.3 lit/s and the other is springs with the yield of 303 lit/s.

The dug boreholes consist of 14 old dug boreholes and one new dug borehole (Ref. 4). Among 14 old dug boreholes, three are private-owned and 11 are government-owned. Eight of the 11 boreholes are out of order. Two of the remaining three boreholes have the combined yield of 2.8 lit/s (242 m^3/d) and the remaining one has the yield of about

0.5 lit/s (43.2 m^3/d). The new dug borehole at Cipare has the pumping-up yield of 2 lit/s (173 m^3/d).

The springs have replaced lately the above old dug boreholes (Ref. 5). The springs are the new water source for the Serang town water supply system and consist of Sukacai spring with safe yield of 114 lit/s and Citaman spring having safe yield of 189 lit/s. The Sukacai spring, which is located near the Kampung of Randucukrom on the foot slope of the Gunung Karang and about 17 km apart from the town of Serang, provides water to the new water supply system of Serang with the capacity of more than the present demand in the town.

The Citaman spring, which is located near the Kampung of Tamansari in a small valley of about 100 m long and about 15 km apart from Serang, is scheduled to be used in 1990 for meeting the future water demand of the town. The water level is about El. 224 m at the Sukacai spring and El. 168 m at the Citaman spring, and the elevation of served area is below El. 95 m, so water from the both springs can be transmitted by gravity. The water quality of the both springs is potable under the conditions of removal of aggressive carbon dioxide and safety chlorination (Ref. 5).

In the past, the available water for the Serang town water supply system was limited to not more than about 3.5 lit/s, so that about 93% of inhabitants' households dug their own wells for the purpose of drinking (about 90% of households), bathing (about 85% of households) and laundry (about 50% of households). Also the river water is used for washing and laundry if a river is available nearby, especially in the market area.

2.1.2 Pandeglang town water supply system

The Pandeglang town water supply system was commenced in 1938. The town is located between Els. 220 m and 250 m. Water taken out from two springs, Ciwasiat and Ciraden, is transmitted by pipes to the town. The Ciwasiat spring, consisting of three springs with the water level of El. 240 m, has the average total yield of 9 lit/s (777.6 m^3/d). The Ciraden spring with the water level of El. 290 m, has the average yield of 3.2 lit/s (276.5 m^3/d) (Refs. 4, 8 and 11).

The transmission pipe from the Ciwasiat spring and the distribution pipe installed in 1938 are in bad condition. The transmission pipe from the Ciraden spring is 75 mm in diameter and of galvanized iron pipe. It was installed in 1971 and is presently in good condition. Water of the Ciwasiat and Ciraden is reserved in the distribution tank of 30 m^3 in capacity and 5 m in height and supplied to the town. In the past, the available capacity of water source for the town water supply was 12.2 lit/s.

The new Karang Tanjung spring, which is located about 2 km northeast from the town of Pandeglang, yields about 20 lit/s and partly serves for the town. The new raw water supply plan designed by IWACO Consultant is as follows (Ref. 8):

(1) The Karang Tanjung spring with water level of El. 152 m is equipped with two units of pump of 17 lit/s in quantity and 70 m in total pump head with generator of 75 kVA. One unit is for standby use. Water is transmitted from the spring to the reservoir in the Kampung of Pabrik with water level of El. 215 m.

(2) The Kampung Pabrik reservoir has the capacity of 100 m^3 and chlorination will be done here.

(3) Water from the Kampung Pabrik reservoir is distributed to the supply reservoir in the Kampung of Ciaseum with water level of El. 252 m, which is apart to the northeast of the town, by two units of pump of 17 lit/s in quantity and 58 m in total pump head with generator of 75 kVA. One unit is for standby use.

(4) The Kampung Ciaseum supply reservoir located on high level ground has the capacity of 500 m^3 and supplies water by gravity.

(5) The existing tower, being too low for the new supply system and having the small capacity, is separated from the new water supply system.

(6) For the time being, the Ciwasiat spring system is separated from the new system.

(7) The Kampung Ciaseum supply reservoir is situated too low to supply to the high area depending on the Ciraden spring system. Hence, the Ciraden spring system will be used only for the higher supply area.

2.1.3 Rangkasbitung town water supply system

The former water supply facilities of this town were constructed in 1931. They consisted of (1) the Ciwasiat spring at the Gunung Karang, (2) a transmission steel pipe of 26 km from the spring to the town of Rangkasbitung, (3) aeration facilities and (4) a distribution reservoir of 100 m^3 in capacity. Due to decreasing yield of the spring of which available capacity finally dropped to 4 lit/s (345.6 m^3/d), the water supply system was abandoned in 1960. Since then, there was no water supply system up to 1980.

Recently, No. 1 deep well of 317.5 mm in diameter and 156 m in depth was dug at Malang Nengah about 3 km northeast from the town and it had a yield of 20 lit/s (1,728 m^3/d). At present, 15 lit/s (1,296 m^3/d), being pumped up from the well, is supplied to the town.

No. 2 deep well, located 1 km from No. 1 deep well, was also dug and succeeded in getting a yield of 15 lit/s. In the same area, the other three deep wells with a yield of 40 lit/s in total are now under construction. According to the previous report (Ref. 11), the specific yield of these deep wells would be about 1.3 lit/s and the water quality can be allowed to use for the potable water supply.

The new deep well system designed by IWACO is as follows (Ref. 8):

(1) A deep-ground water supply system is under construction and water of the deep wells is used as the source for the town water supply system of Rangkasbitung.

(2) Submergible pumps for deep wells pump up the water from new wells to a treatment plant.

(3) The treatment process includes chlorination and aeration depending on the quality of water from new wells.

(4) The treated water flows into a reservoir near the treatment plant and is pumped up to water tower at a higher level situated approximately 1 km away.

(5) From the water tower, it is supplied by gravity to the town area in Rangkasbitung which is 2.4 km away from the water sources and the Narimbang housing complex of 450 houses for governmental employees, being 0.1 km away from the water sources.

(6) Since the existing tower is too low in height and insufficient in capacity, it is not used in the new system.

2.1.4 Cilegon town water supply system

As for water facilities, this town had no water supply system in the past. However, the town obtained the agreement from the P.T. Krakatau Steel Works to receive water of 50 lit/s from the Krenceng treatment plant. The first stage construction to receive water of 20 lit/s for 400 consumers has been commenced in 1982 and will be completed in 1983. The next stage supply system of 30 lit/s will follow the first stage construction. The pipe laying schedule of the Cilegon town water supply system is shown in Table I-1.

2.1.5 IKK water supply system

The introduction of water supply system to IKKs was started in 1981 by CIPTA KARYA. The following IKKs in the Study Area have already been taken up for the introduction of this system as shown in Table I-2: the system for Ciruas, Pontang, Carenang and Baros is under construction, and the system for Cadasari and Sajira will be started soon.

2.2 Rural Water Supply

Rural water works are administrated by Provincial Water Management Unit (BPAM) and Water User's Association, etc. under the control of Directorate of Hygiene and Sanitation, Directorate General of Communicable Disease Control, Ministry of Health (Ref. 1).

In the rural area, there is no special water supply system except hand operated pump facilities for villages. The recent status of rural water supply in the Study Area is summarized as follows (Ref. 4):

(1) Most of the inhabitants in the rural area are grouped in small villages with 100 to 1,000 persons. The water demand for each 10 to 100 villagers is taken from one dug well of 6 to 12 m in depth. The served amount is about 8 to 70 lit/capita/d except under the severe drought.

(2) Water of rivers and canals is used for washing and laundry purposes, and groundwater taken out from dug wells is used for cooking and drinking purposes. To cope with the water famine of dug wells in dry season, the hand operated pump installation is promoted by the aid of the Ministry of Health.

(3) There are many springs around the Gunung Karang. The villagers in this area use these springs for domestic and irrigation purposes. The natural yield of each spring is about 5 to 20 lit/s. The Kabupaten of Pandeglang included into the Study Area depends on springs in this area.

(4) The Ministry of Health is responsible for the improvement of rural water supply system and gives aid until 2000 for the improvement plan of rural water supply. For this, guidance is given and a hand operated pump for each 100 villagers is installed.

(5) The present status and future plan for the hand operated pump installation is summarized in Table I-3. It is reported that about 40% of installed hand operated pumps were out of order in 1974 due to shortage of pump head pressure and small diameter of dug wells, while the pump installed up to 2000 would be about 19,200 units in total (Ref. 4).

(6) The Ministry of Health gave an aid for the construction of 10 deep wells in the poor water quality area of the Kecamatan of Bojonegara depending on springs in the Kecamatan of Kramatwatu.

The drinking water in the rural area is obtained from springs and dug wells. The dug wells are classified into three groups based on groundwater table: (1) less than 5 m, (2) 5 to 10 m and (3) more than 10 m. In the Kabupaten of Serang, most of well water stand at less than 5 m in depth. The depth of groundwater in the Kecamatans of Baros, Waringinkurung and Pabuaran is around and more than 10 m. In the

Kabupaten of Lebak, the depth of groundwater varies in every Kecamatans. In the Kabupaten of Pandeglang, the depth of groundwater is less than 5 m. In these areas, groundwater is used for either drinking or irrigation and industrial purposes. In the dry season, as these shallow wells become often insufficient to meet water demand, the hand operated pump system with water depth of more than 10 m has been introduced in the rural area.

2.3 Industrial Water Supply

The Government has been paying much attention to the industrial development in Cilegon. The main industries presently operated in the Study Area are P.T. Krakatau Steel Works at Cilegon, P.T. Satya Raya Indah Woodbased Industries at Anyer, P.T. Statomer PVC Resin Factory at Merak, and Port and Ferry Installations at Merak. The others are small scale factories such as brick and tiles, bamboos products, coconut products, etc. with employees less than 20 persons (Ref. 4).

Since there is no public water supply system for these industries, the main industries have their own water supply systems and small scale industries have their own shallow wells with yield of less than 0.34 lit/s (29.4 m^3/d) (Ref. 4). The main industries newly invited in the Study Area up to 2000 are P.T. Suralaya Power Station near Merak and Cilegon Industrial Estate.

In the Presidential address to the Parliament meeting in August 15, 1981, efforts for the development of regional industries and the constitution of integral development of national industries are stressed. For the recent several years, the Government has already started the development of industrial estates to urge the industrial development more rapidly in various places. The Cilegon-Merak area, taking advantage of its location, is paid much attention by the Government. This area possesses a strategic position on the main route between Java and Sumatra and will be developed efficiently as logistic lines to other Provinces in Indonesia and oversea countries through the port of Cigadin.

Recently, the Investment Coordination Board of the Province of West Java (BKPM-D) and the University of Padjadjaran carried out a coordinated preliminary study on the investment in Banten area (Ref. 16).

The study recommends, through careful screenings, that 20 sectors are promising in the Banten area, which are selected out of 66 sectors firstly taken into consideration. The principal sectors among the recommended sectors are as follows:

- rubber and rubber commodities;
- textile leather and clothes;
- timber and wooden commodities;

- chemical industry such as oxygen, carbonic acid, ammonia, caustic soda, soap and cleanser material, plastic commodities and asphalt except fertilizer;
- steel and iron based industries such as cast iron, scrap iron, beam, rolled steel, pipe and tube, sheet iron and casting mold;
- metal based industries such as agricultural tools, construction materials and other metal appliances;
- electric machine and electric supply appliances;
- electric power, gas and drinking water;
- construction;
- maritime transportation; and
- financing institution.

2.3.1 Anyer-Merak area water supply system

Main industries in the Anyer-Merak area are P.T. Satya Raya Indah Woodbased Industries, P.T. Statomer PVC Resin Factory, and Port and Ferry Installations. They have their own domestic and industrial water supply systems. The number of their employees and/or workers at present is 1,300 in P.T. Satya Raya Indah Woodbased Industries, 135 in P.T. Statomer PVC Resin Factory and 200 in Port and Ferry Installations. The number of ferryboat passengers is about 10,000 a day.

P.T. Satya Raya Indah Woodbased Industries have water demand for domestic use of 4.05 lit/s (350 m^3/d) and for industrial use of 2.90 lit/s (250 m^3/d) as shown in Table I-4. The domestic water is pumped up from their deep wells about 400 m apart from the factory, and the industrial water is taken up from the Kali Anyer river about 7 km apart from the factory. The industrial water is used mainly for two boilers and will not increase in the future as the factory has no expansion plan up to 2000.

P.T. Statomer PVC Resin Factory has its own domestic and industrial water supply system. Its water demand is 0.03 lit/s (2.8 m^3/d) for domestic use and 1.63 lit/s (141 m^3/d) for the industrial use as shown in Table I-5. The factory has a industrial water plant with rated capacity of 5.5 m^3/h to produce clean water from sea water and a deep well of 7 m in depth to take fresh water of 9 m^3/d for the purpose of water supply to PVC pipe production.

Port and Ferry Installation at Merak has its own four dug shallow wells with total yield capacity of approximately 50 m^3/d for the washing and bathing use by the passengers and working people. Another industrial water of 15 m^3/d and potable water of small amount for the drinking and cooking purposes are bought from private companies in Cilegon area. The effective capacity of existing industrial reservoir is 20 m^3. The potential industrial water demand is 1.50 lit/s (130 m^3/d), so that the available water of 65 m^3/d can meet only 50% of the future demand. The ferry terminal is used for ferryboats of 500 to

2,000 tons connecting Merak and Bakaukuni in Sumatra. The potable water for these ferryboats is supplied at Bakaukuni.

2.3.2 P.T. Krakatau Steel Works water supply system

The water supply source for P.T. Krakatau Steel Works is river water taken from the Cidanau river. A diversion structure has been built on the river and the river water is fed to an intake pumping station adjacent to the river. The river water is taken out in the intake pumping station and is transmitted through a steel pipeline of 1,400 mm in diameter and 27.2 km in length to the Krenceng treatment plant near the factory. The intake pumping station is equipped with four units of pump one of which is for stand-by use. Each one has the rating of 833 lit/s in quantity and 67.1 m in total pump head and is driven by electric power. The station is designed to carry 2,500 lit/s (9,000 m^3/h) in the full rated capacity. Automatic pre-chlorination system of which dosage is 15 ppm is adopted, using a chlorinator and a chlorine container of 1 ton in capacity at the intake pumping station. There is a one-way surge tank on the way of transmission pipeline.

At the Krenceng treatment plant, impurities of the raw water are coagulated by adding alum of which dosage is about 70 ppm at the turbidity of 100 to 200 ppm, sedimented by three units of contact type flocculator facilities among which one unit is in operation at present, filtered by five units of constant level type rapid sand filters among which two units are in operation at present raised by adding lime of which dosage is about 29 ppm for raising pH from 6 to 7 up to 8.7 to 9 and post-chlorinated by adding liquid chlorine of which dosage is about 5 ppm. The treated water is partly pumped up to a elevated reservoir of 1,600 m^3 in capacity and partly fed directly by gravity to P.T. Krakatau Steel Works. It will be partly served by pumps to Cilegon town and P.T. Suralaya Thermal Power Station having each demand of 50 lit/s (4,320 m^3/d). The total water demand for the treatment plant is only 350 lit/s (30,240 m^3/d) as of 1982.

The Krenceng raw water reservoir, which has a capacity of 1.45 x 10^6 m^3 in effect and 2.5 x 10^6 m^3 in gross, is constructed adjacent to the treatment plant to keep the necessary raw water for such emergency cases that the intake pumping station or the transmission steel pipeline is out of order.

2.3.3 P.T. Suralaya Power Station water supply system

P.T. Suralaya Power Station is now under construction on the northernmost coast running out to the Java Sea. The construction schedule is shown in Table I-6. Due to absence of satisfying groundwater, it is decided to use two units of desalination plant for the generation system and to receive treated water of 50 lit/s (4,320 m^3/d) from the Krenceng treatment plant for the use of general service in the power plant and housing colony of about 500 houses. P.T. Suralaya Power Station has already obtained an agreement on provision of potable water of 50 lit/s (4,320 m^3/d) from P.T. Krakatau Steel Works and started the construction of transmission line of 250 mm in diameter from the Krenceng treatment plant to the power station site.

2.3.4 Cilegon Industrial Estate water supply system

At present, there is no water supply system in the Cilegon Industrial Estate. One of the targets of P.T. Krakatau Steel Works is to attract the secondary steel based industries to the Cilegon area. According to the official announcement by the Minister of Industry in November 14, 1981 at Cilegon, it was stressed as follows:

(1) In the near future, the industry sector will function to bring about the development of capability of supplying machines and tools for machinery manufacturing.

(2) The development of main metal and steel based industries at the Cilegon Industrial Estate supported with the steel products from P.T. Krakatau Steel Works will constitute a main support base for the development of national machinery industry.

(3) Besides, the Cilegon Industrial Estate will be gradually linked together with the machinery development centers which have already been formed in Surabaya and Medan, and will become the supporting centers of components to build small industries in West Java and other regions, taking advantage of its location.

The latest information is given by the letter of P.T. Krakatau Industrial Estate Cilegon dated September 30, 1982 as shown in Tables I-7 and I-8. According to the letter, the Cilegon Industrial Estate will be in operation around 1985. The domestic and industrial water will be supplied from the Krenceng treatment plant.

3. WATER DEMAND

The percentage of served population and unit average daily water demand are very important factors in studying the future water demand (Refs. 5, 10 and 12). Taking into consideration that (1) most municipalities are under the preparation of plan to supply stable and safe water to served population and (2) shortage of raw water has given some special political conditions to inhabitants in served area, the percentage of served population and unit average daily water demand are determined as shown in Table I-9 and Fig. I-1.

As to the population in served areas for main municipalities in the Study Area, the urbanized ratio for each town of Serang, Pandeglang, Rangkasbitung and Cilegon is statistically determined as shown in Fig. I-1. Based on this, the population in served area for each town is calculated and the results are given in Table I-10. As all towns of Serang, Pandeglang, Rangkasbitung and Cilegon are classified into Categories III to V and there would be not so much difference of unit average daily water demand among these categories, the calculation of water demand for main municipalities in the Study Area is made based on the values given in Tables I-9 and I-10.

3.1 Urban Water Demand

In this section, the water demand in 2000 for each municipality of Serang, Pandeglang, Rangkasbitung and Cilegon and for IKKs in the Study Area is studied. The projected water demand in 2000 is summarized in Table I-11.

3.1.1 Serang town water demand

In the past, the served water of Serang was limited to not more than about 3.5 lit/s corresponding to the available capacity of raw water. The data of water supply to this town in the past are not kept in good condition. The water demand for the future stage will be more than the amount estimated in the previous study (Ref. 5), if a stable, safety and sufficient water supply system is established.

The projected water demand for the town of Serang is summarized as below and its details are tabulated in Tables I-12 and I-13.

Water Demand (lit/s)	1985	1990	1995	2000
(1) Average	73	108	157	216
(2) Maximum (1) x 1.2	88	130	188	259
(3) Maximum in Ref. 5	-	114	-	204

As the raw water of 303 lit/s is available in the Sukacai and Citaman springs, the projected maximum water demand of 259 lit/s in 2000 is easily satisfied.

3.1.2 Pandeglang town water demand

The projected water demand for the town of Pandeglang is summarized as below and its details are given in Tables I-14 and I-15.

Water Demand (lit/s)	1985	1990	1995	2000
(1) Average	22	26	33	42
(2) Maximum (1) x 1.2	26	32	40	51
(3) Maximum in Ref. 12	26	33	42	52

At present, the town of Pandeglang has started to use the Karang Tanjung springs. These springs have the sufficient yield and good quality. Though some of springs have already been used for irrigation purposes, the projected maximum water demand of 51 lit/s in 2000 will be fully covered by the springs in the Karang Tanjung as shown in Table I-16.

3.1.3 Rangkasbitung town water demand

The projected water demand for the town of Rangkasbitung is summarized as below and its details are presented in Tables I-17 and I-18.

Water Demand (lit/s)	1985	1990	1995	2000
(1) Average	51	63	82	103
(2) Maximum (1) x 1.2	61	76	98	124
(3) Maximum in Ref. 12	60	73	94	118

The projected water demand up to the early 1990's may be met by the No. 1 and No. 2 deep wells, but, taking into consideration the present phenomena that the water level of deep wells has dropped year by year, it is necessary that the raw water sources will be changed from the existing deep wells to the proposed Karian reservoir and the stable and sufficient water supply system of the town will be established.

3.1.4 Cilegon town water demand

The projected water demand for the town of Cilegon is summarized as below and its details are tabulated in Tables I-19 and I-20.

Water Demand (lit/s)	1985	1990	1995	2000
(1) Average	15	23	35	51
(2) Maximum (1) x 1.2	18	28	42	61
(3) Average in Ref. 13	21	32	47	65
(4) Maximum in Ref. 13	26	40	58	81

The difference between (2) and (4) in the above is due to the difference of estimated served population. Taking into account industrial development potentiality in the Cilegon area, the maximum water demand of (4) is adopted in the present study.

3.1.5 IKK water demand

Due to the shortage of raw water for domestic water supply system, 17 IKKs in the Study Area would depend their water resources on the proposed reservoirs in the future. The projected water demand for 17 IKKs is shown in Tables I-21 to I-26. The necessary amount of raw water for each IKK is summarized in Table I-27.

3.2 Rural Water Demand

In rural area, the expansion of hand operated pump system is scheduled up to 2000. The potential water demand is estimated on a basis of the data given in Table I-28 for the reference purpose. The potential raw water demand is summarized as below.

Raw Water Demand (lit/s)	1985	1990	1995	2000
Kabupaten of Serang	298	458	616	777
Kabupaten of Pandeglang	40	61	82	104
Kabupaten of Rangkasbitung	126	192	256	322
Rounded up Total	470	720	960	1,210

3.3 Industrial Water Demand

3.3.1 Anyer-Merak area water demand

The domestic and industrial water demand for P.T. Satya Raya Indah Woodbased Industries, P.T. Statomer PVC Resin Factory and Port & Ferry Installations is calculated as shown in Table I-29 and the estimated water demand is as below.

Water Demand (lit/s)	1985	1990	1995	2000
P.T. Satya Raya Indah Woodbased Industries	4.1	4.1	4.1	4.1
P.T. Statomer PVC Resin Factory	0.1	0.1	0.2	0.2
Port and Ferry Installations	1.4	1.7	1.9	2.2
Total	5.6	5.9	6.2	6.5

The future water demand for P.T. Satya Raya Indah Woodbased Industries will not increase up to 2000 in accordance with the past trend. If the domestic water supply system of the company is changed to public water supply system, it would amount to 4.1 lit/s (350 m^3/d) in constant.

The industrial water demand for P.T. Statomer PVC Resin Factory will be provided by the desalination plant and the domestic water demand will be changed to public water supply system. The domestic water in 2000 will amount to 0.2 lit/s (12.96 m^3/d).

For the projections of water demand for Port and Ferry Installations, the unit water demand for employees and passengers is assumed as shown in Table I-30.

3.3.2 P.T. Krakatau Steel Works water demand

The latest information from P.T. Krakatau Steel Works can only give the water demand in 1983 and at the full development stage as shown in Table I-31. The projected water demand in 2000 corresponds to the maximum quantity of 2,000 lit/s (7,184 m^3/d) at the full development stage. Its summary is as below.

Water Demand (lit/s)	1983	1985	1990	1995	2000
P.T. Krakatau Steel Works	980	980	980	980	2,000

3.3.3 P.T. Suralaya Power Station water demand

As the projected water demand is given in Table I-6, the water demand for industrial use will be met by desalination plant. The estimated demand for domestic use is summarized as below.

Water Demand (lit/s)	1985	1990	1995	2000
Domestic Use	30	40	40	50

3.3.4 Cilegon Industrial Estate water demand

The water demand for the Cilegon Industrial Estate is estimated based on the following assumptions:

(1) The industries to be introduced in the Cilegon Industrial Estate will be mainly the common machinery industries of which share will be 70% of the estate area.

(2) The special industries already registered (Ref. 9) and other main industries recommended in the investment study by BKPM-D and Padjadjaran University (Ref. 16) are also taken into account. These industries occupy the remaining 30% of the estate area.

(3) The unit water demand for each category of industry is assumed taking account of the recent study on the unit industrial water demand in Japan as shown in Table I-32 (Ref. 17). In this assumption, the water recovery ratio is reduced to 80% of the recovery ratio in Japan.

(4) The ratio of the net factory site to the gross estate area is assumed to be 85% (Ref. 9).

Based on the above-mentioned assumptions, the weighted average unit industrial demand is estimated to be 1.25 lit/s/ha. By using construction schedule as shown in Table I-7, the total water demand from Cilegon Industrial Estate of 550 ha will be estimated to be around 690 lit/s (59,616 m^3/d) in 2000 as shown in below.

The estimation of domestic water demand for the housing colony of Cilegon Industrial Estate is more complicated and delicate than that of industrial water demand. Hence, the amount is estimated taking analogy of the case of Cilegon and Pulo-Merak as shown in Table I-33. The summary of water demand for the Cilegon Industrial Estate is as below.

Water Demand (lit/s)	1985	1990	1995	2000
Industrial Water	93	148	480	688
Domestic Water	13	17	24	33
Total	106	165	504	721

4. DEVELOPMENT PLAN

In the present study, any development plan for water treatment and distribution piping systems is not included, but the development plan of water sources necessary for domestic and industrial water supply is studied. The development plan limitedly covers such towns and industries that their water demand will exceed the available water sources at present.

4.1 Urban Water Supply Development Plan

As described in Chapter 2, most municipalities in the Study Area depend on the underdeveloping water supply systems, and are trying to get stable and sufficient raw water sources to meet the future water demands especially to cope with the shortage of water supply in dry season.

Most of the urban water supply system in the Study Area depend on water sources consisting of springs and deep wells. Taking into account the following items, it is recommendable to continue the present policy to obtain water sources for urban water supply so long as stable and sufficient raw water is obtained.

(1) Groundwater is bacteriologically safer than surface water in general.

(2) Physical quality of groundwater such as turbidity, color and so on is generally much better than that of surface water.

(3) Seasonal variation of groundwater quality is much less than that of the surface water.

(4) Maintenance and operation works for water treatment facilities in general are much easier in the case of groundwater than that of surface water.

4.1.1 Serang town water supply development plan

The newly developed water sources of the Sukacai and Citaman springs are already taken into the town water supply system and it is reasonable to proceed the development of the water supply system according to the master plan (Ref. 5). As to the projected water demand for this town, there is some difference between the present study and the master plan (Ref. 5), so it is recommendable to review the projected water demand in 2000 made in the master plan.

4.1.2 Pandeglang town water supply development plan

The water sources for the town water supply system shall be taken out from the springs in succession. The reason is that there are many springs in the surroundings of Pandeglang and these springs partly emerge from groundwater which is replenished by the abundant rainfall on the Gunung Karang.

4.1.3 Rangkasbitung town water supply development plan

From the hydrologically viewpoint, it is said that the surroundings of Rangkasbitung are not suitable for obtaining plentiful domestic water from springs and deep wells. The town water supply for Rangkasbitung has been served from deep wells being overused at present, so it is apprehended that these deep wells will be dried up until around 2000. There is no potential to develop springs and deep wells in the surroundings of Rangkasbitung. Therefore, it is recommendable to use the proposed Karian reservoir water as the stable and sufficient water resources for the town water supply system by 2000.

There are two measures for taking out water from the proposed Karian reservoir. One is to feed storage water directly from Karian dam to a receiving well in the town through a conveyance pipe by gravity and the other is to pump up regulated flow from the Ciujung river to the said receiving well by the town. In the former case, the total length of conveyance pipe of 500 mm in diameter is about 12 km and PC pipe would be recommendable. In the latter case, the total length of conveyance pipe of 450 mm in diameter from intake pumps is about 300 m and unlined ductile cast iron pipe is recommendable. The hydraulic condition is as follows:

- lowest water level of the Karian dam: El. 44 m;
- lowest water level of the Ciujung river at the intake pumping station: El. 11 m; and
- highest water level of the receiving well in the treatment plant of Rangkasbitung town: El. 23 m.

The direct receiving system from the Karian reservoir through the conveyance pipe by gravity is more economical than the intake pumping system. Further, taking into consideration the following demerits of the latter system, the former system is recommendable:

(1) The total construction, operation and maintenance costs are higher than those of direct receiving system.

(2) The operator of water treatment plant is compelled to be wary all the time about the possibility of bacteriological pollution of river water on the course of running.

(3) The physical quality such as turbidity of raw water is much worse than that of reservoir water and the frequency and degree of change in water quality is more severe compared with the case of reservoir water.

(4) From the above item (3), skillful operators are required to get optimal treat in the water treatment plant.

(5) Skillful operators are also required for proper operation and maintenance of the intake pumping system.

(6) The treatment cost of river water is more expensive compared with that of reservoir water.

4.1.4 Cilegon town water supply development plan

The Cilegon town water supply system will be started in May 1983. This system will receive water from the private Krenceng water treatment plant of P.T. Krakatau Steel Works. From the viewpoint of public utility, it is recommendable that the Krenceng water treatment plant would be succeeded to the town office to solve the shortage of potable water for the town of Cilegon and nearby IKKs. In the future, if raw water for the Krenceng plant is insufficient to cope with the water demand, the storage water in the proposed Karian reservoir could be fed through the existing left bank primary canal of the Ciujung irrigation scheme. In this case, the existing treatment plant will be expanded to necessary extent.

As to the other water sources for the Cilegon town water supply system, surface water of the Cidanau and Cibanten rivers as well as springs and groundwater are studied, but, taking such conditions into consideration that (1) any suitable and economical spring and groundwater with sufficient yield is not found and (2) the Cidanau and Cibanten rivers have no more capacity in the dry season, it is considered to be the best solution to receive the present water service system from the Krenceng water treatment plant up to 1995 and thereafter to receive regulated flow from the proposed Karian reservoir through the Ciujung river and the said irrigation canal.

4.1.5 IKK water supply development plan

Among 17 IKKs as listed up in Table I-27, eight IKKs could receive raw water from the existing primary irrigation canals and other nine IKKs could take raw water from the nearby river after the proposed Karian and Cilawang reservoirs regulate and release the natural flow of the Ciujung and Cibeureum river systems. The on-going and planned IKK water supply system shall be proceeded individually by CIPTA KARYA according to each own initial plan for the time being until the completion of the proposed reservoirs.

Directorate of Building Research of CIPTA KARYA has already completed the standard design of new economical and simple treatment of river flow plant with capacity of 5 lit/s based on the experimental results in the Cikapayang water purification pilot plant as shown in Table I-34. The new water purification process is the corrosion process of iron contained in water. So, if the new process can be applied to the purification of released water from the proposed Karian and Cilawang reservoirs, it can be said that the IKK water supply system could provide economically and sufficiently treated water to users to necessary extent.

4.2 Rural Water Supply Development Plan

As for the rural water supply system, the water demand per unit area is not so much. If it is planned to construct a water supply system to cover rural areas to large extent, its served areas are scattered so that it will not be economical in terms of construction, operation and maintenance costs. Therefore, the hand operated pump installation plan for villages may be reasonable from the mid term viewpoint. When the rural water supply system is considered from the long term viewpoint, however, the physical, environmental and social conditions such as (1) urbanization, (2) pollution of water sources, (3) land subsidence problem by pumping up groundwater, (4) improvement in public health and (5) effect of irrigation shall be studied in the near future. Therefore, when rural water demand per unit area become much in the 2000's, it is recommendable to study the needs for introduction of regional water supply system into places where the hand operated pump system is under operation at present. The regional water supply system will assure quantitatively and qualitatively potable water for the increasing inhabitants in the rural area in the future.

4.3 Industrial Water Supply Development Plan

Each industry in the Study Area has its own water supply system. However, the Cilegon Industrial Estate will require industrial water of 690 lit/s (59,616 m^3/d) in 2000. The cost of industrial water affects the cost of materials produced by industries. So unless stable and sufficient water is provided to industries with cheep water rate, public water supply system for the industrial purpose will not be expanded into all industries in Indonesia and will not come to the fundamental settlement to fill up shortage of industrial water.

4.3.1 Anyer-Merak area water supply development plan

P.T. Satya Raya Indah Woodbased Industries, P.T. Statomer PVC Resin Factory and Port and Ferry Installations are the main industries in the area. They have their own water supply systems and the first two industries could expand, if necessary, their own industrial water supply systems. As to the domestic water supply, however, if it can be served from a nearby public water supply system, they will change the present private domestic water supply system to the public domestic and industrial water supply system taking into consideration (1) welfare and health of employees and (2) economical and safe production of potable water.

If the proposed Karian reservoir is completed and the irrigation canal water serves raw water to the Krenceng treatment plant or the Cilegon town water supply system, the projected amount of 6.5 lit/s for the said industries will be easily supplemented.

4.3.2 P.T. Krakatau Steel Works water supply development plan

The domestic and industrial water demand for P.T. Krakatau Steel Works in 2000 will be sufficiently met by the present water supply system, but the Krenceng water treatment plant owned by the P.T. Krakatau Steel Works shall be transferred to a public utility for the town of Cilegon, taking into consideration that (1) the Krenceng water treatment plant has enough capacity to supply not only industrial water but also for domestic water and (2) it will be expected to supply domestic water widely to people living in such housing colonies as P.T. Suralaya Thermal Power Station and Cilegon Industrial Estate as well as inhabitants in the town of Cilegon.

In the case that the Krenceng treatment plant is transferred to the town of Cilegon as its public utility, it is recommendable to study (1) the necessity of the expansion of the Krenceng water supply system to secure enough capacity which can meet the projected water demand in 2000, (2) the availability of raw water source and (3) the possibility of separation the domestic water supply system from the existing industrial water supply system.

4.3.3 P.T. Suralaya Power Station water supply development plan

The industrial water supply system for thermal power generation is scheduled to be developed by itself and the provision of domestic water for its housing colony is already agreed by P.T. Krakatau Steel Works. The treated water of 50 lit/s will be transferred from the Krenceng water treatment plant.

4.3.4 Cilegon Industrial Estate water supply development plan

The supply system of domestic and industrial water for the Cilegon Industrial Estate depends on the Krenceng water treatment plant. P.T. Krakatau Industrial Estate Cilegon assures the service of domestic and industrial water supply and their estimated amount is 151 lit/s. By our calculation of water demand in 2000, it is projected to be 688 lit/s for industrial use and 33 lit/s for domestic use. The projected industrial unit water demand of 1.25 lit/s/ha is adopted in the present study whereas the unit water demand estimated by P.T. Krakatau Industrial Estate Cilegon is about 0.27 lit/s/ha.

The existing Pulogadung Industrial Estate in Jakarta has been constructed since 1973 with the expected total area of 570 ha. Judging from the progress of development in the Pulogadung Industrial Estate and taking into consideration that (1) the Pulogadung Industrial Estate is developed for light industries, (2) present served area is 335 ha as of 1982, (3) present capacity of unit water demand is 0.60 lit/s/ha and (4) projected capacity of unit water demand is 7.02 lit/s/ha, the future water demand for the Cilegon Industrial Estate will increase to our projected amount of 690 lit/s in 2000. When this water demand is served by the existing Krenceng water treatment plant, the available raw water will become insufficient to meet the whole demand. Hence, it is needed that the shortage of raw water is filled up by newly developed water resources and it is recommended to feed regulated river flow by the proposed Karian reservoir through the left bank primary canal of the Ciujung irrigation scheme.

The total amount of water needed to be fed from the said irrigation canal is 957 lit/s in 2000. An intake pumping station will be constructed nearby the end point of irrigation canal to transmit the raw water of 957 lit/s to the Krenceng treatment plant. The system of raw water intake facilities from the irrigation canal will consist grit chambers, pumping house, three units of pumping facilities with a quantity of 28.7 m^3/min and pump head of 42 m and including one unit of standby, main transmission PC pipe of 1,000 mm in diameter and power receiving substation.

4.4 Water Quality

During the course of the field reconnaissance, water samples were collected from springs, deep wells and rivers. The results of water quality analysis are shown in Appendix B, Hydrology. In general, the physical and chemical quality of spring and deep well water is suitable for the drinking purpose. The river water is possibly conditioned to potable water by conventional water treatment process. However, in the case of small demand less than 5 lit/s such as IKK, water may be treated by the standardized corrosion process of iron in water (Ref. 15). Judging from the water quality test, it would be needed to treat and disinfect impounded water in the proposed Karian reservoir for producing a safe potable water.

4.5 Cost and Benefit

In general, it is said that the social benefits, especially the benefits related to improve health conditions, are important in domestic water supply projects and it is difficult to quantify the relationship between the safe and stable water supply and the economic effects of improved health. Therefore, it is usually considered that the social benefits is made up of the difference between the opportunity costs of capital.

In the present study, however, it is stressed on the development of water resources and it is not intended to touch upon the water supply facilities including water purification facilities. Thus, it is mainly studied to recommend new water sources suitable for each development plan of water supply system after economical and engineering comparisons of a few alternatives. There are two alternative cases, i.e. Case 1 is raw water intake system for the town of Rangkasbitung and Case 2 is intake pumping system from the existing left bank primary irrigation canal of the Ciujung irrigation scheme to the Cilegon Industrial Estate.

4.5.1 Raw water intake system for Rangkasbitung town water supply

The town of Rangkasbitung is not developing its water supply system consisting of deep wells, but in case these deep wells are dried up in the future, the town will be requested to find out surface water source for its water supply system. So, the following two cases of receiving surface water from the proposed Karian reservoir studied; Case 1-a is direct receiving system from the Karian reservoir by gravity and Case 1-b is intake pumping system from the Ciujung river.

The costs of both methods are as follows:

Case 1-a: Rp 361.4 x 10^6 in construction cost; and

Case 1-b: Rp 391.2 x 10^6 in construction cost
Rp 24.8 x 10^6 in annual operation and maintenance costs.

The benefit in the Case 1-a of direct receiving system from the Karian reservoir is estimated to be Rp 54.6 x 10^6.

4.5.2 Intake pumping system for Cilegon Industrial Estate water supply

It is estimated that there will be much water demand in the Cilegon Industrial Estate and that the shortage of raw water for the Krenceng treatment plant will have to be supplemented from anywhere in 2000. There are three alternatives to supplement the shortage of raw water as mentioned below.

Case 2-a is to increase the capacity of the existing water source facilities, Case 2-b is to endevour to find other available water sources of springs and deep wells, and Case 2-c is to install an intake pumping system from the irrigation canal. Due to limited natural river flow and lack of development potential of new springs and deep wells, Case 2-b has no possibility among the three alternatives. If the Cidanau dam is constructed, the Cidanau river can fully fill up industrial water demand in the dry season. The estimated cost for Case 2-a is Rp 21.32 x 10^9 for construction and Rp 539 x 10^6 for annual operation and maintenance, while the estimated cost for Case 2-a is Rp 1.18x10^9

for construction and Rp 345 x 10^6 for annual operation and maintenance cost.

The benefit in the Case 2-c of intake pumping system from the irrigation canal is estimated to be Rp 20.34 x 10^9.

5. CONCLUSION

For the study of domestic and industrial water supply in the North Banten area, it is grouped in three categories of urban water supply, rural water supply and industrial water supply including its housing colony.

Existing water supply facilities, water demand and development plan have been described in the foregoing chapters. The projected raw water demand to be newly developed for domestic and industrial water use is tabulated in Tables I-35 to I-40 and summarized as below.

Average Raw Water Demand	1985	1990	1995	2000
in lit/s	130	180	240	1,380
in 10^3 m^3/d	11.2	15.6	20.7	119.2

The main existing urban water supply facilities in the Study Area are as follows:

(1) Serang; The water supply system is now serving sufficient amount of water depending on springs.

(2) Pandeglang; The raw water for the town water supply system consists of old springs and the newly developed Karang Tanjung spring.

(3) Rangkasbitung; Groundwater from deep wells is used for the town water supply system and additional deep wells are now under development to meet increasing water demand.

(4) Cilegon; The construction of new water supply system will be commenced from May 1983. The provision of potable water with the upper limit of 50 lit/s is agreed by P.T. Krakatau Steel Works and it will be served from the Krenceng water treatment plant.

(5) IKK; The water supply system for each IKK has been introduced since 1981 and its water source depends on deep well, irrigation canal, river, shallow well and spring according to the geographical condition of each IKK. As the planned capacity of each IKK is limited to three kinds of standard type, i.e. 2.5 lit/s, 5 lit/s and 10 lit/s, the ratio of served population and the average per capita water demand are administratively controlled.

There is no special rural water supply system except hand operated pump facilities for villages. The hand operated pump system is promoted by the aid of Ministry of Health and it will be continued until 2000. In the dry season of 1982, most dug wells dried up and only the hand operated pumps could meet the water demand of villagers.

Main industries in the Study Area have their own industrial water supply systems and are composed of four groups, i.e. Anyer-Merak Area, P.T. Krakatau Steel Works, P.T. Suralaya Power Station and Cilegon Industrial Estate. In the future, the Krenceng treatment plant of P.T. Krakatau Steel Works will supplement 50 lit/s for the domestic water supply to P.T. Suralaya Power Station and 151 lit/s for the industrial and domestic water supply to the Cilegon Industrial Estate.

The projected water demand for urban and rural water supply is summarized as below.

Projected Water Demand (lit/s)	1985	1990	1995	2000
(1) Urban Water Supply				
- Serang	88	130	188	259
- Pandeglang	26	32	40	51
- Rangkasbitung	61	76	98	124
- Cilegon	26	40	58	81
- IKK	120	170	233	309
Total	321	448	617	824
(2) Rural Water Supply	405	618	829	872

The projected water demand for industrial water supply is summarized as below.

Industrial Water Demand (lit/s)	1985	1990	1995	2000
(1) Industrial Use				
- P.T. Satya Raya Indah Woodbased Industries	2.9	2.9	2.9	2.9
- P.T. Statomer PVC Resin Factory	1.6	1.6	1.6	1.6
- Port & Ferry Installations	1.6	1.8	2.0	2.3
- P.T. Krakatau Steel Works (including domestic use)	980	980	980	2,000
- P.T. Suralaya Power Station	18	47	59	70
- Cilegon Industrial Estate	93	148	480	688
Total	1,097	1,181	1,526	2,765

Industrial Water Demand (lit/s)	1985	1990	1995	2000
(2) Domestic Use				
- P.T. Satya Raya Indah Woodbased Industries	4.1	4.1	4.1	4.1
- P.T. Statomer PVC Resin Factory	0.1	0.1	0.2	0.2
- Port & Ferry Installations	0.3	0.4	0.4	0.5
- Suralaya Power Station and Housing Colony	30	40	40	50
- Cilegon Industrial Estate Housing Colony	13	17	24	33
Total	48	62	69	88

The development plan in the present study is enphatically described for only the towns and industries of which water demands exceed the existing available water sources. As the water sources for most municipalities in the Study Area depend on springs, deep wells, the policy to obtain water sources from springs and deep wells is recommendable so long as stable and sufficient yield is secured. Only the town of Rangkasbitung and some IKKs will change their future water sources to the impounded water in the proposed Karian reservoir.

The Serang town water supply system can depend on the Sukacai and Citaman springs to meet its water demand in 2000. The Pandeglang town water supply system has just found the new Karang Tanjung springs. The total available water sources is about 32.2 lit/s at present. When additional water sources to cope with the increasing water demand in the future are needed, it will be possible to develop new springs and deep wells in the surrounding area of the town because there is favourable groundwater development potential.

The Rangkasbitung town water supply system currently depends on deep wells to meet the present water demand giving heavy burden to these deep wells. Therefore, the town will have to depend on the impounded water in the proposed Karian reservoir. The system of conveying raw water from the proposed Karian reservoir will be the direct intake pipe system and the raw water will be transmitted to receiving well of the town treatment plant through a gravity pipeline. The alternative to take raw water for the town is the intake pumping system which pumps up the raw water to the receiving well from a pumping station located on the bank of the Ciujung river nearby the town. The alternative system needs more expensive construction cost than the direct conveying pipe system and also is not recommendable from the viewpoint of operation and maintenance costs.

The Cilegon town water supply system will be expanded to a great extent in the future and the shortage of the town water demand will be supplemented by the Krenceng water treatment plant of P.T. Krakatau Steel Works.

IKKs will develop their own water supply systems individually for the time being and, when the impounded water in the proposed Karian and Cilawang reservoirs become available, the shortage of raw water in 17 IKKs could be met by the regulated flow by these two dams. Among them, eight IKKs could take up the regulated flow from the nearby primary canals of the Ciujung irrigation scheme. The possibility that the pollution of water in the irrigation canal by drainage from villages and farms is very scarce. It is because (1) all drainage from villages and farms flows into rivers and (2) all the rivers crossing the irrigation canal are siphoned to downstream at the crossing points.

In the rural area, the hand operated pump system will be retained for the time being until the construction of regional water supply systems becomes economically feasible.

Each industry in the Study Area has its own water supply system. The Krenceng water treatment plant, however, will have to be expanded to cope with the shortage of water supply for the projected water demand. The shortage of raw water for main industries in the Study Area will be 957 lit/s in 2000, and this amount will be transferred from the existing left bank primary irrigation canal of the Ciujung irrigation scheme to the Krenceng treatment plant through the proposed intake pumping system.

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Table I-1 PIPE LAYING SCHEDULE OF CILEGON TOWN WATER SUPPLY SYSTEM

Classes of Pipe	Pipe Diameter (mm)	Scheduled Length (m)	Pipe Laying Schedule 1982/83 (m)	Pipe Laying Schedule Future (m)
Transmission line	250	2,800	2,316	484
Distribution line	200	2,500	1,500	1,000
	150	4,500	1,500	3,000
	100	9,227	1,227	8,000
Supply line	75	6,750	1,750	5,000
	50	7,000	1,000	6,000
	20	1,500	-	1,500

Source: Town Office of Cilegon

Table I-2 IKK WATER SUPPLY SYSTEM IN THE STUDY AREA

IKK	(1)	(2)	(3)	Water Source	Transmission System	Existing Water Supply
(1) Kabupaten of Serang						
Ciruas	I	4,500	2.5	Kamayungan River & Irrigation Canal, TP	Pumped	-
Pontang	I	4,500	2.5	Ciujung River & Irrigation Canal, TP	Pumped	SW, RIV
Carenang	I	5,400	5	Cidanau River & Irrigation Canal, TP	Pumped	-
Baros	I	8,500	5	Tapping from distribution pipe of Serang	Pumped	-
Pulo Merak	III	13,560	5	SW, TP	Pumped	-
(2) Kabupaten of Lebak						
Sajira	II	3,530	2.5	RIV, TP	Pumped	SW, RIV
(3) Kabupaten of Pandeglang						
Cadasari	II	4,920	2.5	SP	Pumped	SP

Remarks: (1) = Priority, (2) = Inhabitants in 1985 and (3) Supply capacity (lit/s)

TP = Treatment Plant for Surface Water, SW = Shallow Well, SP = Spring and RIV = River

Table I-3 PROJECTED NUMBER OF HAND OPERATED PUMP IN RURAL AREA OF THE STUDY AREA

Kabupaten/1	Item	1977-1979	1985	1990	1995	2000	2005
Serang	Population in Rural ARea (10^3 person)	925	972	1,084	1,210	1,400	1,506
	Number of Hand Operated Pumps (Units)						
	Installed	935	-	-	-	-	-
	Estimated/2	-	3,110	4,770	6,420	14,000	9,790
Lebak	Population in Rural Area (10^3 person)	354.7	408	454	504	520	622
	Number of Hand Operated Pumps (Units)						
	Installed	618	-	-	-	-	-
	Estimated	-	1,310	2,000	2,670	5,200	4,050
Total		1,553	4,420	6,770	9,090	19,200	13,840

Remarks: /1 = The rural area belonging to the Kabupaten of Pandeglang and Bogor is not included because such area does not affect the planning of proposed reservoir capacity.

/2 = For the calculation of estimated number of hand operated pump, the percentage of served population in rural area as shown in Fig. I-1 is applied for each year.

Source: Ref. 4

Table I-4 P.T. SATYA RAYA INDAH WOODBASED INDUSTRIES WATER DEMAND

Item	Records in Each Year								Remarks
	1975	1976	1977	1978	1979	1980	1981	1982	
Area of Land (ha)	20	20	20	20	20	20	20	20	
Number of Employees (person)	350	600	900	1,000	1,000	1,000	1,300	1,300	
Domestic Water Usage from Deep Wells (m^3/d)	100	200	300	300	300	300	350	350	
Industrial Water Usage from Anyer River (m^3/d)	150	200	150	150	150	150	250	250	Make-up water
Industrial Water Demand (m^3/d)	250	400	450	450	450	450	600	600	For boiler supply
Production (m^3/month)	-	-	4,000	4,000	4,000	6,000	7,000	8,000	For manufacturing

Table I-5 P.T. STATOMER POLYVINYL CHLORIDE RESIN FACTORY WATER DEMAND

Item	Records in Each Year					
	1977	1978	1979	1980	1981	1982
Area of Land (ha)	11	11	11	11	11	11
Number of Employees (person)	125	125	125	125	135	135
Consumed Water (m^3/d)						
Domestic Water (Drinking, etc.)	2.0	2.1	2.1	2.5	2.5	2.8
Industrial Water /1	-	-	-	-	-	141
Production Amount of PVC Pipe, etc. (100 ton/y)	24	24	30	36	36	48

Remarks: /1 = Industrial Water

A. From the sea water; 5.5 m^3/hour x 24 x 30 = 3,960 m^3/month

B. From deep well (7 m depth); 270 m^3/month
Total consumed water; 3,960 + 270 = 4,230 m^3/month = 141 m^3/day

Table I-6 THE CONSTRUCTION SCHEDULE AND WATER DEMAND OF P.T. SURALAYA POWER STATION

No.	Item: Generating Facilities	Unit	Construction and Generating Capacity /1: First Stage 1984	1985	Second Stage 1987	1988	Third Stage 1990	1995	2000
1	Generator (400 MW x 4 Units)	MW	400	400	400	400			
2	Generator (500 MW x 3 Units)	MW					500	500	500
3	Total Generating Capacity	MW	400	800	1,200	1,600	2,100	2,600	3,100
4	Desalination Capacity /3 ($130\ m^3/h \times 3$)	m^3/h	130	260	260	260	/2 (390)	(390)	(390)
		m^3/d	3,120	6,240	6,240	6,240	9,360	9,360	9,360
5	Industrial Water Demand ($1.95\ m^3/d/MW$) x (MW)	lit/s	9	18	27	36	47	59	70
		m^3/d	780	1,560	2,340	3,120	4,095	5,070	6,045
6	Potable Water /4 Demand for Plant and Housing Colony	lit/s	30	30	30	30	40	40	50
		m^3/d	2,230	2,473	2,837	2,959	3,193	3,736	4,279

Remarks: /1 = Accurate data would not be supplied, so all data including construction schedule are assumed.

/2 = Assumed capacity

/3 = Two units of desalinator (unit capacity = $130\ m^3/h$) are already scheduled to be installed for 1,600 MW generation, so another unit of desalinator ($130\ m^3/h$) for standby use is assumed to be installed in 1990. In general, industrial unit water demand for thermal generating plant is about 1.90 to 1.95 $m^3/d/MW$.

/4 = Potable water is scheduled to be served from the Krenceng treatment plant up to 50 lit/s ($4,320\ m^3/d$).

Table I-7 CONSTRUCTION SCHEDULE AND MARKETED CILEGON INDUSTRIAL ESTATE

Unit: ha

Item	Stage I	Stage II	Stage III	Stage IV	Stage V
Gross Area	40	90	120	134	166
Net Area	37	72.2	105	117	141.1
Sub-total of Gross Area	-	130	-	384	550
Sub-total of Net Area	-	109.2	-	331.2	472.3
Net Area/Gross Area (%)	92.5	80.2	87.5	87.3	85.0
Construction Schedule	/1	/1	/2	/2	/3
Total Marketed Area					
1985	74				
1990	118				
1995			384		
2000					550

Remarks: /1 = Finished in 1982, /2 = Planning will be finished until 1988., /3 = Planning is assumed to be completed in 1990.

Source: Ref. 18

Table I-8 PRESENT STATUS OF CILEGON INDUSTRIAL ESTATE

No.	Market Planning	Name of Investor	Land Area (ha)	Status of Enterprise	Product
1	1982	P.T. Hoechst Cilegon Kimia	9	Foreign Investment (PMA)	Dye Stuff/ Chemical
2	1983	P.T. Pelat Timah Nusantara	9	Local Investment (PMDN)	Tin Plate
3	1983	P.T. Industri Mesin Perkakas Indonesia	5	PMDN	Machine Tools
4	1983	P.T. Krakatau Rubber	18	PMA	Tyre & Belt Conveyor
5	1984	P.T. Indocarf	9	PMA	Carbon Black
6	1984	P.T. Barata Indonesia	4	PMDN	Workshop
7	1984	P.T. Barata/Combustion Engineering	17	PMA	Boilers
8	1984	P.T. Bobindo Perkasa	3	PMDA	High Pressure Tube
		Sub-total	74		
9	1985	P.T. First Aluminium Indonesia	7	PMDN	Aluminium Sheet & Foil
10	1986	P.T. Aneka Tambang	17	PMDN	Copper Smelter
11	1987	BPPT/Dept. Ristek	20	PMDN	Forging Center
		Sub-total	44		
		Total	118		

Table I-9 SERVED POPULATION AND WATER DEMAND

Item	1980	1985	1990	1995	2000	2005
Percentage of served population (%)						
Urban area	44	62	70	76	80	81
Rural area	19.5	32	44	53	60	65
Unit average daily water demand (lit/capita/d)						
Urban area (Category III & IV)	100	113	125	143	160	180
IKK (Category V)	75	85	94	107	120	135
Rural area	60	60	60	60	60	60

Table I-10 PROJECTION OF POPULATIONS IN SERVED AREA AND CLASSIFICATION OF CATEGORY FOR MAIN MUNICIPALITIES IN THE STUDY AREA

Item	Name	1980	1985	1990	1995	2000	2005
Population in Administrative Area (10^3 persons)	Serang	111.3	130.1	152.1	177.7	207.7	242.8
	Pandeglang	48.7	55.4	63.1	71.8	81.8	93.1
	Rangkasbitung	103.7	117.7	133.6	151.7	172.3	195.6
	Cilegon	51.2	60.2	70.7	83.0	97.5	114.4
Percentage of Urbanization (%)	Serang	70	70	70	70	70	70
	Pandeglang	28	28.5	29	29.5	30	30.5
	Rangkasbitung	25	26	27.4	28.7	30	31
	Cilegon	30	31	32.3	33.7	35	36.4
Population in Served Area (10^3 persons)	Serang	77.9	91.1	106.5	124.4	145.4	170.0
	Pandeglang	13.7	15.8	18.3	21.2	24.6	28.4
	Rangkasbitung	26.0	30.6	36.7	43.6	51.7	60.7
	Cilegon	15.4	18.9	23.0	28.0	34.1	41.6
Classification of Category by CIPTA KARYA	Serang	IV	IV	III	III	III	III
	Pandeglang	V	V	V	IV	IV	IV
	Rangkasbitung	IV	IV	IV	IV	IV	IV
	Cilegon	V	V	IV	IV	IV	IV

Table I-11 PROJECTED WATER DEMAND IN 2000

Unit: lit/s

Water Supply Works	Daily Water Demand		Available Capacity of Water Source	Shortage of Water Quantity		Necessary Raw Water Quantity/3	
	Average	Maximum		Dam	Canal	Dam	Canal
(A) Municipalities							
- Serang Town	216	259	303	-	-	-	-
- Cilegon Town	65	81	50/1	15	31	17	36
- Pandeglang Town	42	51	51/2	-	-	-	-
- Rangkasbitung Town	103	124	-	103	124	119	-
- IKKs	258	309	-	-	-	294	180
Sub-total		824				430	216
(B) Industries and Housing Colony							
- Anyer-Merak Area	-	9	-	9	9	10	10
- P.T. Krakatau Steel	-	2,000	-	100	100	115	115
- P.T. Suralaya							
Power station	-	70	70	-	-	-	-
Housing colony	-	50	50/1	-	-	-	-
- *Cilegon*							
Industrial estate	-	688	-	690	690	794	794
Housing colony	27	33	-	27	33	31	38
Sub-total		2,850				950	957
Total		3,674				1,380	1,173
Required Capacity for Domestic & Industrial Use							
- Canal							1,180
- Dam						1,380	

Remarks: /1 = From the Krenceng treatment plant, /2 = Necessary deep well sources shall be found.,
/3 = (Shortage Water Quantity) x 1.15

Table I-12 PROJECTED WATER DEMAND FOR SERANG IN PREVIOUS STUDY

Item			No.	1980	1985	1990	1995	2000	2005	Remarks
Population	Within Served Area		(1)			94,500		124,500		
	Served Population		(2)			69,000		99,600		
	Served Percentage (%)		(3)			73		80		
Residential	Served Population	House Connection	(4)			20,800		41,100		
		Yard Connection	(5)			38,700		58,500		
		Public Yard	(6)			9,500		-		
	Unit Demand (lit/capita/d)	House Connection	(7)			125		135		
		Yard Connection	(8)			75		80		
		Public Tap	(9)			20		20		
	Water Demand (m^3/d)	House Connection	(10)			2,599		5,546		
		Yard Connection	(11)			2,906		4,681		
		Public Tap	(12)			189		-		
		Sub-total (m^3/d)	(13)			5,694		10,227		
Non-residential	Hospitals, etc.	No. of Bed	(14)			246		247		
		Unit (lit/bed/d)	(15)			300		350		
		Water Demand (m^3/d)	(16)			74		87		
	Religious Facilities	No. of Visitor	(17)			3,070		3,070		
		Unit (lit/visitor/d)	(18)			5		5		
		Water Demand (m^3/d)	(19)			16		16		
	Restaulants	No. of Visitor	(20)			1,335		1,542		
		Unit (lit/visitor/d)	(21)			15		20		
		Water Demand (m^3/d)	(22)			20		31		
	Hotels, etc.	No. of Bed	(23)			484		559		
		Unit (lit/bed/d)	(24)			175		200		
		Water Demand (m^3/d)	(25)			85		112		
	Markets, etc.	Land Area (ha)	(26)			1.25		1.25		
		Unit (m^3/ha/d)	(27)			18		24		
		Water Demand (m^3/d)	(28)			23		30		
	Offices	No. of Employee	(29)			1,528		1,528		
		Unit (lit/capita/d)	(30)			15		20		
		Water Demand (m^3/d)	(31)			23		31		
	Educational Facilities	No. of Pupil & Teacher	(32)			4,512		4,512		
		Unit (lit/capita/d)	(33)			15		20		
		Water Demand (m^3/d)	(34)			68		90		
	Industries	Land Area (ha)	(35)			-		-		
		Unit (m^3/ha/d)	(36)			-		-		
		Water Demand (m^3/d)	(37)			41		42		
	Others		(38)							
			(39)							
		Water Demand (m^3/d)	(40)			786		1,555		
		Sub-total (m^3/d)	(41)			1,136		1,994		
	Total Demand [(13) + (41)] (m^3/d)		(42)			6,830		12,221		
Water Supply	Unaccounted	m^3/d	(43)			1,366		2,445		
	for Water	(43)/(45) %	(44)	16.67	16.67	16.67	16.67	16.67	16.67	(51) = (2) of
	Average Daily	m^3/d	(45)			8,196		14,666		Table I-13
	Water Demand	m^3/s	(46)			0.095		0.170		(53) =
	Maximum Daily	m^3/s	(47)			0.114		0.204		Average
	Water Demand	(47)/(46) %	(48)	120	120	120	120	120	120	Daily Water
	Hourly Peak	m^3/s	(49)			0.171		0.306		Demand
	Water Demand	(49)/(47) %	(50)	150	150	150	150	150	150	(54) =
Projection of Water Demand	Served Population		(51)	34,300	56,500	74,600	94,600	116,400	137,700	(53) x $\frac{(48)}{100}$
	Unit (lit/capita/d)		(52)	100	112	125	143	160	180	x 1.15
	Water Demand (m^3/s)		(53)	0.040	0.073	0.108	0.157	0.216	0.287	(55) = (53)
Raw Water Quantity for Canal		m^3/s	(54)	0.055	0.101	0.149	0.217	0.298	0.396	x 1.15
Raw Water Quantity for Dam		m^3/s	(55)	0.046	0.084	0.124	0.181	0.248	0.330	

Source: Ref. 5

Table I-13 PROJECTED WATER DEMAND FOR SERANG IN THE PRESENT STUDY

Item			No.	1980	1985	1990	1995	2000	2005	Remarks
Population	Within Served Area		(1)	77900	91100	106500	124400	145400	170000	
	Served Population		(2)	34300	56500	74600	94600	116400	137700	
	Served Percentage (%)		(3)	44	62	70	76	80	81	
Residential	Served Population	House Connection	(4)							
		Yard Connection	(5)							
		Public Yard	(6)							
	Unit Demand (lit/capita/d)	House Connection	(7)							
		Yard Connection	(8)							
		Public Tap	(9)							
	Water Demand (m^3/d)	House Connection	(10)							
		Yard Connection	(11)							
		Public Tap	(12)							
		Sub-total (m^3/d)	(13)							
Non-residential	Hospitals, etc.	No. of Bed	(14)							
		Unit (lit/bed/d)	(15)							
		Water Demand (m^3/d)	(16)							
	Religious Facilities	No. of Visitor	(17)							
		Unit (lit/visitor/d)	(18)							
		Water Demand (m^3/d)	(19)							
	Restaurants	No. of Visitor	(20)							
		Unit (lit/visitor/d)	(21)							
		Water Demand (m^3/d)	(22)							
	Hotels, etc.	No. of Bed	(23)							
		Unit (lit/bed/d)	(24)							
		Water Demand (m^3/d)	(25)							
	Markets, etc.	Land Area (ha)	(26)							
		Unit (m^3/ha/d)	(27)							
		Water Demand (m^3/d)	(28)							
	Offices	No. of Employee	(29)							
		Unit (lit/capita/d)	(30)							
		Water Demand (m^3/d)	(31)							
	Educational Facilities	No. of Pupil & Teacher	(32)							
		Unit (lit/capita/d)	(33)							
		Water Demand (m^3/d)	(34)							
	Industries	Land Area (ha)	(35)							
		Unit (m^3/ha/d)	(36)							
		Water Demand (m^3/d)	(37)							
	Others		(38)							
			(39)							
		Water Demand (m^3/d)	(40)							
		Sub-total (m^3/d)	(41)							
	Total Demand [(13) + (41)] (m^3/d)		(42)							
Water Supply	Unaccounted	m^3/d	(43)							
	for Water	(43)/(45) %	(44)							
	Average Daily	m^3/d	(45)							
	Water Demand	m^3/s	(46)	0.040	0.073	0.108	0.157	0.216	0.287	(46) = (53) of Table I-12
	Maximum Daily	m^3/s	(47)	0.048	0.088	0.130	0.188	0.259	0.344	
	Water Demand	(47)/(46) %	(48)	120	120	120	120	120	120	
	Hourly Peak	m^3/s	(49)	0.072	0.132	0.195	0.282	0.389	0.516	
	Water Demand	(49)/(47) %	(50)	150	150	150	150	150	150	
Projection of Water Demand	Served Population		(51)	34300	56500	74600	94600	116400	137700	(51) = (2)
	Unit (lit/capita/d)		(52)	100	112	125	143	160	180	
	Water Demand (m^3/s)		(53)	0.040	0.073	0.108	0.157	0.216	0.287	
Raw Water Quantity for Canal		m^3/s	(54)							
Raw Water Quantity for Dam		m^3/s	(55)							

Table I-14 PROJECTED WATER DEMAND FOR PANDEGLANG IN THE PREVIOUS STUDY

Item			No.	1980	1985	1990	1995	2000	2005	Remarks
Population	Within Served Area		(1)	20556	22275	24139	26159	28347	30719	
	Served Population		(2)	14389	16038	17863	19881	22110	24575	
	Served Percentage (%)		(3)	70	72	74	76	78	80	
Residential	Served Population	House Connection Yard Connection	(4) (5)	6167	8019	10138	12556	15307	18431	
		Public Yard	(6)	8222	8019	7725	7325	6803	6144	
	Unit Demand (lit/capita/d)	House Connection Yard Connection	(7) (8)	100	110	120	130	140	150	
		Public Tap	(9)	30	30	30	30	30	30	
	Water Demand (m^3/d)	House Connection Yard Connection	(10) (11)	617	882	1217	1632	2143	2765	
		Public Tap	(12)	247	241	232	220	204	184	
		Sub-total (m^3/d)	(13)	864	1123	1449	1852	2347	2949	
Non-residential	Hospitals, etc.	No. of Bed	(14)	92	112	132	152	172	192	
		Unit (lit/bed/d)	(15)	150	200	250	300	350	400	
		Water Demand (m^3/d)	(16)	14	22	33	46	60	77	
	Religious Facilities	No. of Visitor	(17)	-	-	-	-	-	-	
		Unit (lit/visitor/d)	(18)	-	-	-	-	-	-	
		Water Demand (m^3/d)	(19)	34	46	60	74	86	100	
	Restaurants	No. of Visitor	(20)	-	-	-	-	-	-	
		Unit (lit/visitor/d)	(21)	-	-	-	-	-	-	
		Water Demand (m^3/d)	(22)	-	-	-	-	-	-	
	Hotels, etc.	No. of Bed	(23)	37	39	42	45	49	53	
		Unit (lit/bed/d)	(24)	100	110	120	130	140	150	
		Water Demand (m^3/d)	(25)	4	4	5	6	7	8	
	Markets, etc.	Land Area (ha)	(26)	-	-	-	-	-	-	
		Unit ($m^3/ha/d$)	(27)	-	-	-	-	-	-	
		Water Demand (m^3/d)	(28)	5	6	7	8	9	10	
	Offices	No. of Employee	(29)	1028	1337	1690	2093	2551	3072	
		Unit (lit/capita/d)	(30)	20	22	24	26	28	30	
		Water Demand (m^3/d)	(31)	21	29	41	54	71	92	
	Educational Facilities	No. of Pupil & Teacher	(32)	4728	5123	5552	6017	6520	7065	
		Unit (lit/capita/d)	(33)	20	22	24	26	28	30	
		Water Demand (m^3/d)	(34)	95	113	133	156	183	212	
	Industries	Land Area (ha)	(35)	-	-	-	-	-	-	
		Unit ($m^3/ha/d$)	(36)	-	-	-	-	-	-	
		Water Demand (m^3/d)	(37)	5	6	7	8	9	10	
	Others		(38)	-	-	-	-	-	-	
			(39)	-	-	-	-	-	-	
		Water Demand (m^3/d)	(40)	139	156	173	191	210	230	(40) = For Boarding Houses, Shops and Bus Terminals.
		Sub-total (m^3/d)	(41)	317	382	459	543	635	739	
	Total Demand [(13) + (41)] (m^3/d)		(42)	1181	1505	1908	2395	2982	3688	(51) = Selected Larger Value of Either (2) or (1) x Value of (3) of Table I-15 and Rounded up in Hundreds.
Water Supply	Unaccounted for Water	m^3/d	(43)	295	376	477	599	746	922	
		(43)/(45) %	(44)	20	20	20	20	20	20	
	Average Daily Water Demand	m^3/d	(45)	1476	1881	2385	2994	3728	4610	
		m^3/s	(46)	0.017	0.022	0.028	0.035	0.043	0.053	
	Maximum Daily Water Demand	m^3/s	(47)	0.021	0.026	0.033	0.042	0.052	0.064	
		(47)/(46) %	(48)	120	120	120	120	120	120	
	Hourly Peak Water Demand	m^3/s	(49)	0.032	0.039	0.050	0.063	0.078	0.096	(53) = Average Daily Water Demand.
		(49)/(47) %	(50)	150	150	150	150	150	150	
Projection of Water Demand	Served Population		(51)	14400	16100	17900	19900	22700	24900	
	Unit (lit/capita/d)		(52)	100	112	125	143	160	180	
	Water Demand (m^3/s)		(53)	0.017	0.022	0.026	0.033	0.042	0.052	
Raw Water Quantity for Canal		m^3/s	(54)	0.024	0.030	0.036	0.046	0.058	0.072	(54) = ((53)x(48)) x 1.15
Raw Water Quantity for Dam		m^3/s	(55)	0.020	0.025	0.030	0.038	0.048	0.060	(55) = (53) x 1.15

Source: Ref. 12

Table I-15 PROJECTED WATER DEMAND FOR PANDEGLANG IN THE PRESENT STUDY

Item			No.	1980	1985	1990	1995	2000	2005	Remarks
Population	Within Served Area		(1)	13700	15800	18300	21200	24600	28400	
	Served Population		(2)	6100	9800	12900	16200	19700	23000	
	Served Percentage (%)		(3)	44	62	70	76	80	81	
Residential	Served Population	House Connection	(4)							
		Yard Connection	(5)							
		Public Yard	(6)							
	Unit Demand (lit/capita/d)	House Connection	(7)							
		Yard Connection	(8)							
		Public Tap	(9)							
	Water Demand (m^3/d)	House Connection	(10)							
		Yard Connection	(11)							
		Public Tap	(12)							
		Sub-total (m^3/d)	(13)							
Non-residential	Hospitals, etc.	No. of Bed	(14)							
		Unit (lit/bed/d)	(15)							
		Water Demand (m^3/d)	(16)							
	Religious Facilities	No. of Visitor	(17)							
		Unit (lit/visitor/d)	(18)							
		Water Demand (m^3/d)	(19)							
	Restaurants	No. of Visitor	(20)							
		Unit (lit/visitor/d)	(21)							
		Water Demand (m^3/d)	(22)							
	Hotels, etc.	No. of Bed	(23)							
		Unit (lit/bed/d)	(24)							
		Water Demand (m^3/d)	(25)							
	Markets, etc.	Land Area (ha)	(26)							
		Unit (m^3/ha/d)	(27)							
		Water Demand (m^3/d)	(28)							
	Offices	No. of Employee	(29)							
		Unit (lit/capita/d)	(30)							
		Water Demand (m^3/d)	(31)							
	Educational Facilities	No. of Pupil & Teacher	(32)							
		Unit (lit/capita/d)	(33)							
		Water Demand (m^3/d)	(34)							
	Industries	Land Area (ha)	(35)							
		Unit (m^3/ha/d)	(36)							
		Water Demand (m^3/d)	(37)							
	Others		(38)							
			(39)							
		Water Demand (m^3/d)	(40)							
		Sub-total (m^3/d)	(41)							
	Total Demand [(13) + (41)] (m^3/d)		(42)							
Water Supply	Unaccounted	m^3/d	(43)							
	for Water	(43)/(45) %	(44)							
	Average Daily	m^3/d	(45)							
	Water Demand	m^3/s	(46)	0.017	0.022	0.026	0.033	0.042	0.052	(46) = (53) of
	Maximum Daily	m^3/s	(47)	0.021	0.026	0.032	0.040	0.051	0.063	Table I-14
	Water Demand	(47)/(46) %	(48)	120	120	120	120	120	120	
	Hourly Peak	m^3/s	(49)	0.032	0.039	0.048	0.060	0.077	0.095	
	Water Demand	(49)/(47) %	(50)	150	150	150	150	150	150	
Projection of Water Demand	Served Population		(51)	6100	9800	12900	16200	19700	23000	(51) = (2)
	Unit (lit/capita/d)		(52)	100	112	125	143	160	180	
	Water Demand (m^3/s)		(53)	0.007	0.013	0.019	0.027	0.037	0.048	
Raw Water Quantity for Canal		m^3/s	(54)							
Raw Water Quantity for Dam		m^3/s	(55)							

Table I-16 GROUP OF SPRINGS FOR PANDEGLANG TOWN

Name of Spring	Altitude (El. m)	Yield (lit/s)	Date of Measurement	Uses
Ciwasiat I	240	2.5		Captated for water supply Pandeglang and Rangkasbitung
Ciwasiat II	240	4.0		
Ciwasiat III	240	2.5		
Ciraden	350	3.2		Captated for water supply of Pandeglang
Cibulakan I	350	30.0	14-9-1977	Captated for military complex
Cibulakan II	240	20.0		Local population
Karang Tanjung I	180	50.0	22-8-1978	Captated for irrigation purposes
Karang Tanjung II	180	40.0	22-8-1978	Local population
Karang Tanjung III	180	15.0	22-8-1978	Local population
Karang Tanjung IV	180	50.0	22-8-1978	Local population
Karang Tanjung V	180	40.0	22-8-1978	Local population & irrigation purposes
Cikabayan	220	5.8	30-8-1978	Local population
Ciherang	220	0.5		Local population
Curugkuda	850	5.0	30-8-1978	Irrigation purposes

Source: Sistim Penyediaaan Air Minum Kota Pandeglang, by P.T. Mesa Jaya

Table I-17 PROJECTED WATER DEMAND FOR RANGKASBITUNG IN THE PREVIOUS STUDY

Item			No.	1980	1985	1990	1995	2000	2005	Remarks
Population	Within Served Area		(1)	-	-	-	-	-	-	
	Served Population		(2)	34128	39162	43258	49390	55680	62486	
	Served Percentage (%)		(3)	-	-	-	-	-	-	
Residential	Served Population	House Connection	(4)	11974	14687	17729	23056	29087	35878	
		Yard Connection	(5)	2994	4895	5673	6352	7479	8669	
		Public Yard	(6)	19160	19580	19856	19982	19114	17939	
	Unit Demand (lit/capita/d)	House Connection	(7)	100	110	120	130	140	150	
		Yard Connection	(8)	60	60	60	60	60	60	
		Public Tap	(9)	30	30	30	30	30	30	
	Water Demand (m^3/d)	House Connection	(10)	1198	1616	2128	2997	4072	5382	
		Yard Connection	(11)	180	294	340	381	449	520	
		Public Tap	(12)	575	587	600	600	573	538	
		Sub-total (m^3/d)	(13)	1953	2497	3068	3978	5094	6440	
Non-residential	Hospitals, etc.	No. of Bed	(14)	180	190	200	215	230	250	
		Unit (lit/bed/d)	(15)	250	280	310	340	370	400	
		Water Demand (m^3/d)	(16)	45	53	62	73	85	100	
	Religious Facilities	No. of Visitor	(17)	-	-	-	-	-	-	
		Unit (lit/visitor/d)	(18)	-	-	-	-	-	-	
		Water Demand (m^3/d)	(19)	45	45	45	60	65	71	
	Restaurants	No. of Visitor	(20)	-	-	-	-	-	-	
		Unit (lit/visitor/d)	(21)	-	-	-	-	-	-	
		Water Demand (m^3/d)	(22)	-	-	-	-	-	-	
	Hotels, etc.	No. of Bed	(23)	80	90	100	110	120	130	
		Unit (lit/bed/d)	(24)	150	160	170	180	190	200	
		Water Demand (m^3/d)	(25)	12	15	17	20	23	26	
	Markets, etc.	Land Area (ha)	(26)	-	-	-	-	-	-	
		Unit ($m^3/ha/d$)	(27)	-	-	-	-	-	-	
		Water Demand (m^3/d)	(28)	60	64	68	95	100	105	
	Offices	No. of Employee	(29)	20954	22845	24820	26899	29086	31393	
		Unit (lit/capita/d)	(30)	15	17	17	21	23	25	
		Water Demand (m^3/d)	(31)	314	388	472	565	667	785	
	Educational Facilities	No. of Pupil & Teacher	(32)	19500	20133	24065	26310	28765	31423	
		Unit (lit/capita/d)	(33)	10	12	14	16	18	20	
		Water Demand (m^3/d)	(34)	195	242	337	421	518	628	
	Industries	Land Area (ha)	(35)	-	-	-	-	-	-	
		Unit ($m^3/ha/d$)	(36)	-	-	-	-	-	-	
		Water Demand (m^3/d)	(37)	80	90	100	165	180	210	
	Others		(38)	-	-	-	-	-	-	
			(39)	-	-	-	-	-	-	(40) = Army Forces
		Water Demand (m^3/d)	(40)	19	22	24	28	32	38	
		Sub-total (m^3/d)	(41)	770	919	1125	1427	1670	1963	
	Total Demand [(13) + (41)] (m^3/d)		(42)	2723	3416	4193	5405	6764	8403	
Water Supply	Unaccounted for Water	m^3/d	(43)	681	854	1048	1351	1691	2101	
		(43)/(45) %	(44)	20	20	20	20	20	20	
	Average Daily Water Demand	m^3/d	(45)	3404	4270	5241	6756	8455	10504	
		m^3/s	(46)	0.039	0.050	0.061	0.078	0.098	0.122	
	Maximum Daily Water Demand	m^3/s	(47)	0.047	0.060	0.073	0.094	0.118	0.146	
		(47)/(46) %	(48)	120	120	120	120	120	120	
	Hourly Peak Water Demand	m^3/s	(49)	0.071	0.090	0.110	0.141	0.176	0.219	
		(49)/(47) %	(50)	150	150	150	150	150	150	
Projection of Water Demand	Served Population		(51)	34128	39162	43258	49390	55680	62486	
	Unit (lit/capita/d)		(52)	100	112	125	143	160	180	
	Water Demand (m^3/s)		(53)	0.049	0.051	0.063	0.082	0.103	0.130	
Raw Water Quantity for Canal		m^3/s	(54)	0.055	0.070	0.087	0.113	0.142	0.180	(54)=((53)x(48))x 1.15
Raw Water Quantity for Dam		m^3/s	(55)	0.046	0.059	0.073	0.094	0.119	0.150	(55)=(53) x 1.15

Source: Ref. 12

Table I-18 PROJECTED WATER DEMAND FOR RANGKASBITUNG *IN THE PRESENT STUDY*

Item			No.	1980	1985	1990	1995	2000	2005	Remarks
Population	Within Served Area		(1)	26000	30600	36700	43600	51700	60700	
	Served Population		(2)	11500	19000	25700	33200	41400	49200	
	Served Percentage (%)		(3)	44	62	70	76	80	81	
Residential	Served Popula- tion	House Connection	(4)							
		Yard Connection	(5)							
		Public Yard	(6)							
	Unit Demand (lit/capita/d)	House Connection	(7)							
		Yard Connection	(8)							
		Public Tap	(9)							
	Water Demand (m^3/d)	House Connection	(10)							
		Yard Connection	(11)							
		Public Tap	(12)							
		Sub-total (m^3/d)	(13)							
Non-residential	Hospitals, etc.	No. of Bed	(14)							
		Unit (lit/bed/d)	(15)							
		Water Demand (m^3/d)	(16)							
	Religious Facilities	No. of Visitor	(17)							
		Unit (lit/visitor/d)	(18)							
		Water Demand (m^3/d)	(19)							
	Restaurants	No. of Visitor	(20)							
		Unit (lit/visitor/d)	(21)							
		Water Demand (m^3/d)	(22)							
	Hotels, etc.	No. of Bed	(23)							
		Unit (lit/bed/d)	(24)							
		Water Demand (m^3/d)	(25)							
	Markets, etc.	Land Area (ha)	(26)							
		Unit (m^3/ha/d)	(27)							
		Water Demand (m^3/d)	(28)							
	Offices	No. of Employee	(29)							
		Unit (lit/capita/d)	(30)							
		Water Demand (m^3/d)	(31)							
	Educational Facilities	No. of Pupil & Teacher	(32)							
		Unit (lit/capita/d)	(33)							
		Water Demand (m^3/d)	(34)							
	Industries	Land Area (ha)	(35)							
		Unit (m^3/ha/d)	(36)							
		Water Demand (m^3/d)	(37)							
	Others		(38)							
			(39)							
		Water Demand (m^3/d)	(40)							
		Sub-total (m^3/d)	(41)							
	Total Demand [(13) + (41)] (m^3/d)		(42)							
Water Supply	Unaccounted	m^3/d	(43)							
	for Water	(43)/(45) %	(44)							
	Average Daily	m^3/d	(45)	-	-	-	-	-	-	
	Water Demand	m^3/s	(46)	0.040	0.051	0.063	0.082	0.103	0.130	(46) = (53) of Table I-17
	Maximum Daily	m^3/s	(47)	0.048	0.061	0.076	0.098	0.124	0.156	
	Water Demand	(47)/(46) %	(48)	120	120	120	120	120	120	
	Hourly Peak	m^3/s	(49)	0.072	0.092	0.114	0.148	0.185	0.234	
	Water Demand	(49)/(47) %	(50)	150	150	150	150	150	150	
Projection of Water Demand	Served Population		(51)	11500	19000	25700	33200	41400	49200	(51) = (2)
	Unit (lit/capita/d)		(52)	100	112	125	143	160	180	
	Water Demand (m^3/s)		(53)	0.013	0.025	0.037	0.055	0.077	0.103	
Raw Water Quantity for Canal		m^3/s	(54)							
Raw Water Quantity for Dam		m^3/s	(55)							

Table I-19 PROJECTED WATER DEMAND FOR CILEGON IN THE PREVIOUS STUDY

Item			No.	1980	1985	1990	1995	2000	2005	Remarks
Population	Within Served Area		(1)	30720	36390	42060	47730	53400	-	
	Served Population		(2)	18432	24746	31545	39616	48060		
	Served Percentage (%)		(3)	60	68	75	83	90		
Residential	Served Population	House Connection	(4)	10752	16376	23133	31025	40050		
		Yard Connection	(5)	-	-	-	-	-		
		Public Yard	(6)	7680	8370	8412	8591	8010		
	Unit Demand (lit/capita/d)	House Connection	(7)	60	70	80	90	100		
		Yard Connection	(8)	-	-	-	-	-		
		Public Tap	(9)	20	21	23	24	25		
	Water Demand (m^3/day)	House Connection	(10)	645	1146	1850	2792	4005		
		Yard Connection	(11)	-	-	-	-	-		
		Public Tap	(12)	1572	1757	1934	2062	2003		
		Sub-total (m^3/d)	(13)	802.2	1321.7	2043.4	2998.2	4205.3		
Non-residential	Hospitals, etc.	No. of Bed	(14)							
		Unit (lit/bed/d)	(15)							
		Water Demand (m^3/d)	(16)							
	Religious Facilities	No. of Visitor	(17)	-	-	-	-	-		
		Unit (lit/visitor/d)	(18)	-	-	-	-	-		
		Water Demand (m^3/d)	(19)	20	37.5	60	87.5	120		
	Restaulants	No. of Visitor	(20)							
		Unit (lit/visitor/d)	(21)							
		Water Demand (m^3/d)	(22)							
	Hotels, etc.	No. of Bed	(23)	25	29	34	39	43		
		Unit (lit/bed/d)	(24)	150	175	200	225	250		
		Water Demand (m^3/d)	(25)	3.75	5.07	6.80	8.77	10.75		
	Markets, etc.	Land Area (ha)	(26)	-	-	-	-	-		(28) = Including
		Unit (m^3/ha/day)	(27)	-	-	-	-	-		Commercials and
		Water Demand (m^3/d)	(28)	8	13.5	20	30	42		Industries
	Offices	No. of Employee	(29)	768	1289	1928	2685	3560		
		Unit (lit/capita/d)	(30)	15	15	19	22	275		
		Water Demand (m^3/d)	(31)	11.52	19.33	36.62	59.06	97.90		
	Educational Facilities	No. of Pupil & Teacher	(32)	7680	9098	10515	11933	13350		
		Unit (lit/capita/d)	(33)	10	12	13	14	15		
		Water Demand (m^3/d)	(34)	76.8	109.1	136.6	167.1	200.2		
	Industries	Land Area (ha)	(35)							
		Unit (m^3/ha/day)	(36)							
		Water Demand (m^3/d)	(37)							
	Others		(38)							
			(39)							
		Water Demand (m^3/d)	(40)							
		Sub-total (m^3/d)	(41)	120.07	184.5	260.02	352.43	470.85		
	Total Demand [(13) + (41)] (m^3/d)		(42)	922.27	1506.2	2303.42	3350.63	4676.15		(51) = (2) of
Water Supply	Unaccounted	m^3/d	(43)	183.73	301.8	461.58	671.37	937.85		Table I-20
	for Water	(43)/(45) %	(44)	16.6	16.7	16.7	16.7	16.7		
	Average Daily	m^3/d	(45)	1106	1808	2765	4022	5614		
	Water Demand	m^3/s	(46)	0.013	0.021	0.032	0.047	0.065	(0.090)	
	Maximum Daily	m^3/s	(47)	0.016	0.026	0.040	0.058	0.081	(0.113)	Annex I.4105-(2/2)
	Water Demand	(47)/(46) %	(48)	125	125	125	125	125	(125)	(51) = (2) of
	Hourly Peak	m^3/s	(49)	0.020	0.036	0.060	0.092	0.142		(53) = Average
	Water Demand	(49)/(47) %	(50)	125	137	150	162	175	-	Daily Water
Projection of Water Demand	Served Population		(51)	6800	11800	16100	21300	27300	33700	Demand
	Unit (lit/capita/d)		(52)	100	112	125	143	160	180	
	Water Demand (m^3/s)		(53)	0.008	0.015	0.023	0.035	0.051	0.070	(54)=((53)x(48))x
Raw Water Quantity for Canal		m^3/s	(54)	0.011	0.021	0.032	0.049	0.070	0.097	1.15
Raw Water Quantity for Dam		m^3/s	(55)	0.009	0.018	0.027	0.041	0.058	0.081	(55)=(53) x 1.15

Source: Ref. 13

Table I-20 PROJECTED WATER DEMAND FOR CILEGON IN THE PRESENT STUDY

Item			No.	1980	1985	1990	1995	2000	2005	Remarks
Population	Within Served Area		(1)	15400	18900	23000	28000	34100	41600	
	Served Population		(2)	6800	11800	16100	21300	27300	33700	
	Served Percentage (%)		(3)	44	62	70	76	80	81	
Residential	Served Population	House Connection	(4)							
		Yard Connection	(5)							
		Public Yard	(6)							
	Unit Demand (lit/capita/d)	House Connection	(7)							
		Yard Connection	(8)							
		Public Tap	(9)							
	Water Demand (m^3/d)	House Connection	(10)							
		Yard Connection	(11)							
		Public Tap	(12)							
		Sub-total (m^3/d)	(13)							
Non-residential	Hospitals, etc.	No. of Bed	(14)							
		Unit (lit/bed/d)	(15)							
		Water Demand (m^3/d)	(16)							
	Religious Facilities	No. of Visitor	(17)							
		Unit (lit/visitor/d)	(18)							
		Water Demand (m^3/d)	(19)							
	Restaulants	No. of Visitor	(20)							
		Unit (lit/visitor/d)	(21)							
		Water Demand (m^3/d)	(22)							
	Hotels, etc.	No. of Bed	(23)							
		Unit (lit/bed/d)	(24)							
		Water Demand (m^3/d)	(25)							
	Markets, etc.	Land Area (ha)	(26)							
		Unit (m^3/ha/d)	(27)							
		Water Demand (m^3/d)	(28)							
	Offices	No. of Employee	(29)							
		Unit (lit/capita/d)	(30)							
		Water Demand (m^3/d)	(31)							
	Educational Facilities	No. of Pupil & Teacher	(32)							
		Unit (lit/capita/d)	(33)							
		Water Demand (m^3/d)	(34)							
	Industries	Land Area (ha)	(35)							
		Unit (m^3/ha/d)	(36)							
		Water Demand (m^3/d)	(37)							
	Others		(38)							
			(39)							
		Water Demand (m^3/d)	(40)							
		Sub-total (m^3/d)	(41)							
	Total Demand [(13) + (41)] (m^3/d)		(42)							
Water Supply	Unaccounted for Water	m^3/d	(43)							
		(43)/(45) %	(44)							
	Average Daily Water Demand	m^3/d	(45)	-	-	-	-	-	-	
		m^3/s	(46)	0.008	0.015	0.023	0.035	0.051	0.070	(46)=(53) of Table I-19
	Maximum Daily Water Demand	m^3/s	(47)	0.010	0.018	0.028	0.042	0.061	0.084	
		(47)/(46) %	(48)	120	120	120	120	120	120	
	Hourly Peak Water Demand	m^3/s	(49)							
		(49)/(47) %	(50)	150	150	150	150	150	150	
Projection of Water Demand	Served Population		(51)	6800	11800	16100	21300	27300	33700	(51) = (2)
	Unit (lit/capita/d)		(52)	100	112	125	143	160	180	
	Water Demand (m^3/s)		(53)	0.008	0.015	0.023	0.035	0.051	0.070	
Raw Water Quantity for Canal		m^3/s	(54)							
Raw Water Quantity for Dam		m^3/s	(55)							

Table I-21 PROJECTED RURAL WATER DEMAND FOR THE YEAR 1980

IKK	Population (10^3)			Unit Water Demand (lit/capita/d)	Daily Water Demand (lit/s)		Raw Water/2 Quantity (lit/s)	
	Keca-matan	Served Area	Served Popu-lation		Average	Maximum/1	Average	Maximum
Bojonegara	40.5	8.1	3.6	75	3	4	4	4*
Carenang	40.7	8.2	3.6	75	3	4	4	4
Cikande	52.3	10.5	4.7	75	4	5	5	6
Cikeusal	60.7	12.2	5.4	75	5	6	5	6*
Ciruas	33.0	6.6	2.9	75	3	3	3	4*
Kasemen	42.4	8.5	3.8	75	3	4	4	5*
Kopo	43.5	8.7	3.9	75	3	4	4	5
Kragilan	34.7	7.0	3.1	75	3	3	3	4
Kramatwatu	28.7	4.4	2.0	75	2	2	2	3*
Pamarayan	41.1	8.3	3.7	75	3	4	4	5
Pontang	33.2	6.7	3.0	75	3	3	3	4
Pulomerak	89.7	18.0	8.0	75	7	8	8	10*
Tirtayasa	49.3	9.9	4.4	75	4	5	4	5
Waringinkurung	21.0	4.2	1.9	75	2	2	2	2*
Walantaka	34.8	7.0	3.1	75	3	3	3	4*
Sub-total		128.3					58	
Maja	42.8	8.6	3.8	75	3	4	4	5
Warunggunung	52.0	10.4	4.6	75	4	5	5	6
Sub-total		19.0					9	
Total		147.3					67	(38)/3
For Canal								40/3
For Dam							70	

Remarks: /1 = (Average daily water demand) x 1.2
/2 = (Daily water demand) x 1.15
/3 = Total of marked IKKs only

Table I-22 PROJECTED RURAL WATER DEMAND FOR THE YEAR 1985

IKK	Population (10^3)			Unit Water Demand (lit/capita/d)	Daily Water Demand (lit/s)		Raw Water/2 Quantity (lit/s)	
	Kecamatan	Served Area	Served Population		Average	Maximum/1	Average	Maximum
Bojonegara	44.1	8.9	5.6	84	5	7	6	8*
Carenang	43.4	8.7	5.4	84	5	6	6	7
Cikande	57.8	11.6	7.2	84	7	8	8	10
Cikeusal	67.2	13.5	8.4	84	8	10	9	11*
Ciruas	35.6	7.2	4.5	84	4	5	5	6*
Kasemen	49.8	10.0	6.2	84	6	7	7	8*
Kopo	48.5	9.7	6.1	84	6	7	7	8
Kragilan	38.3	7.7	4.8	84	5	6	5	6
Kramatwatu	32.6	4.9	3.1	84	3	4	4	4*
Pamarayan	45.1	9.1	5.7	84	6	7	6	8
Pontang	35.6	7.2	4.5	84	4	5	5	6
Pulomerak	107.7	21.6	13.4	84	13	16	15	18*
Tirtayasa	53.0	10.6	6.6	84	6	8	7	9
Waringinkurung	23.0	4.6	2.9	84	3	3	3	4
Walantaka	39.2	7.9	4.9	84	5	6	6	7
Sub-total		143.2			86		99	
Maja	47.8	9.6	6.0	84	6	7	7	8*
Warunggunung	57.6	11.6	7.2	84	7	8	8	10*
Sub-total		21.2			13		15	
Total		164.4			99		114	(73)/3
For Canal								70/3
For Dam							120	

Remarks: /1 = (Average daily water demand) x 1.2
/2 = (Daily water demand) x 1.15
/3 = Total of marked IKKs only

Table I-23 PROJECTED RURAL WATER DEMAND FOR THE YEAR 1990

IKK	Population (10^3)			Unit Water Demand (lit/ capita/d)	Daily Water Demand (lit/s)		Raw Water/2 Quantity (lit/s)	
	Keca- matan	Served Area	Served Popu- lation		Average	Maximum/1	Average	Maximum
Bojonegara	48.1	9.7	6.8	94	7	9	9	10*
Carenang	46.4	9.3	6.6	94	7	9	8	10
Cikande	63.8	12.8	9.0	94	10	12	11	14
Cikeusal	74.4	14.9	10.5	94	11	14	13	16*
Ciruas	38.3	7.7	5.4	94	6	7	7	8*
Kasemen	58.6	11.8	8.3	94	9	11	10	13*
Kopo	54.2	10.9	7.7	94	8	10	10	12
Kragilan	42.2	8.5	6.0	94	7	8	8	9
Kramatwatu	37.1	5.6	4.0	94	4	5	5	6*
Pamarayan	49.4	9.9	7.0	94	8	9	9	11
Pontang	38.2	7.7	5.4	94	6	7	7	8
Pulomerak	129.4	25.9	18.2	94	20	24	23	27*
Tirtayasa	56.9	11.4	8.0	94	9	10	10	12
Waringinkurung	25.3	5.1	3.6	94	4	5	5	5*
Walantaka	44.2	8.9	6.3	94	7	8	8	10*
Sub-total		160.1					143	
Maja	53.3	10.7	7.5	94	8	10	9	11
Warunggunung	63.8	12.8	9.0	94	10	12	12	14
Sub-total		23.5					21	
Total		183.6					164	(95)/3
For Canal								100/3
For Dam							170	

Remarks: /1 = (Average daily water demand) x 1.2
/2 = (Daily water demand) x 1.15
/3 = Total of marked IKKs only

Table I-24 PROJECTED RURAL WATER DEMAND FOR THE YEAR 1995

IKK	Population (10^3)			Unit Water Demand (lit/ capita/d)	Daily Water Demand (lit/s)		Raw Water/2 Quantity (lit/s)	
	Keca- matan	Served Area	Served Popu- lation		Average	Maximum/1	Average	Maximum
Bojonegara	52.4	10.5	8.0	107	10	12	11	14*
Carenang	49.5	9.9	7.6	107	9	11	11	13
Cikande	70.5	14.1	10.8	107	13	16	15	19
Cikeusal	82.4	16.5	12.6	107	16	19	18	22*
Ciruas	41.3	8.3	6.4	107	8	10	9	11*
Kasemen	68.8	13.8	10.5	107	13	16	15	18*
Kopo	60.4	12.1	9.2	107	11	14	13	16
Kragilan	46.4	9.3	7.1	107	9	11	10	12
Kramatwatu	42.2	6.4	4.9	107	6	7	7	8*
Pamarayan	54.1	10.9	8.3	107	10	12	12	14
Pontang	41.0	8.2	6.3	107	8	9	9	11
Pulomerak	155.5	31.1	23.8	107	30	35	34	41*
Tirtayasa	61.2	12.3	9.4	107	12	14	13	16
Waringinkurung	27.7	5.6	4.3	107	5	6	6	7*
Walantaka	49.7	10.0	7.6	107	9	11	11	13*
Sub-total		179.0					194	
Maja	59.5	12.0	9.2	107	11	14	13	16
Warunggunung	70.6	14.2	10.8	107	13	16	15	19
Sub-total		26.2					28	
Total		205.2					222	(134)/3
For Canal								140/3
For Dam							230	

Remarks: /1 = (Average daily water demand) x 1.2
/2 = (Daily water demand) x 1.15
/3 = Total of marked IKKs only

Table I-25 PROJECTED RURAL WATER DEMAND FOR THE YEAR 2000

IKK	Population (10^3)			Unit Water Demand (lit/capita/d)	Daily Water Demand (lit/s)		Raw Water/2 Quantity (lit/s)	
	Kecamatan	Served Area	Served Population		Average	Maximum/1	Average	Maximum
Bojonegara	57.0	11.4	9.2	120	13	15	15	18*
Carenang	52.8	10.6	8.5	120	12	14	14	16
Cikande	77.9	15.6	12.5	120	17	21	20	24
Cikeusal	91.2	18.3	14.7	120	20	25	23	28*
Ciruas	44.5	8.9	7.2	120	10	12	12	14*
Kasemen	80.9	16.2	13.0	120	18	22	21	25*
Kopo	67.4	13.5	10.8	120	15	18	17	21
Kragilan	51.2	10.3	8.3	120	12	14	13	16
Kramatwatu	48.0	7.2	5.8	120	8	10	9	11*
Pamarayan	60.0	12.0	9.6	120	13	16	15	18
Pontang	44.0	8.8	7.1	120	10	12	11	14
Pulomerak	187.0	37.4	30.0	120	42	50	48	58*
Tirtayasa	65.7	13.2	10.6	120	15	18	17	20
Waringinkurung	30.4	6.1	4.9	120	7	8	8	9*
Walantaka	56.0	11.2	9.0	120	13	15	14	17*
Sub-total		200.7			225	270	257	309
Maja	66.4	13.3	10.7	120	15	18	17	21
Warunggunung	78.2	15.7	12.6	120	18	21	20	24
Sub-total		29.0			33	39	37	45
Total		229.7			258	309	294	(180)/3
For Canal								180/3
For Dam							300	

Remarks: /1 = (Average daily water demand) x 1.2
/2 = (Daily water demand) x 1.15
/3 = Total of marked IKKs only

Table I-26 PROJECTED RURAL WATER DEMAND FOR THE YEAR 2005

IKK	Population (10^3)			Unit Water Demand (lit/capita/d)	Daily Water Demand (lit/s)		Raw Water/2 Quantity (lit/s)	
	Kecamatan	Served Area	Served Population		Average	Maximum/1	Average	Maximum
Bojonegara	62.1	12.5	10.2	135	16	19	18	22*
Carenang	56.4	11.3	9.2	135	14	17	17	20
Cikande	86.0	17.2	14.0	135	22	26	25	30
Cikeusal	101.0	20.2	16.4	135	26	31	30	35*
Ciruas	48.0	9.6	7.8	135	12	15	14	17*
Kasemen	95.1	19.1	15.5	135	24	29	28	33*
Kopo	75.3	15.1	12.3	135	19	23	22	27
Kragilan	56.4	11.3	9.2	135	14	17	17	20
Kramatwatu	54.5	8.2	6.7	135	11	13	12	14*
Pamarayan	64.9	13.0	10.6	135	17	20	19	23
Pontang	47.2	9.5	7.7	135	12	14	14	17
Pulomerak	224.5	45.0	36.5	135	57	68	66	79*
Tirtayasa	70.6	14.2	11.6	135	18	22	21	25
Waringinkurung	33.3	6.7	5.5	135	9	10	10	12*
Walantaka	63.0	12.6	10.3	135	16	19	19	22*
Sub-total		225.5					332	
Maja	74.1	14.9	12.1	135	19	23	22	26
Warunggunung	86.6	17.4	14.1	135	22	26	25	30
Sub-total		32.3					47	
Total		257.8					379	(234)/3
For Canal								240/3
For Dam							380	

Remarks: /1 = (Average daily water demand) x 1.2
/2 = (Daily water demand) x 1.15
/3 = Total of marked IKKs only

Table I-27 NECESSARY RAW WATER QUANTITY FOR EACH IKK

Unit: lit/s

IKK	1985	1990	1995	2000
Kabupaten of Serang				
Bojonegara*	6	9	11	15
Carenang	6	8	11	14
Cikande	8	11	15	20
Cikeusal*	9	13	18	23
Ciruas*	5	7	9	12
Kasemen*	7	10	15	21
Kopo	7	10	13	17
Kragilan	5	8	10	13
Kramatwatu*	4	5	7	9
Pamarayan	6	9	12	15
Pontang	5	7	9	11
Pulomerak*	15	23	34	48
Tirtayasa	7	10	13	17
Waringinkurung*	3	5	6	8
Walantaka*	6	8	11	14
Kabupaten of Lebak				
Maja	7	9	13	17
Warunggunung	8	12	15	20
Total	114	164	222	294
For Dam	120	170	230	300
For Canal*	70	100	140	180

Remarks: * = These IKKs can take up raw water from the existing primary irrigation canals of the Ciujung irrigation scheme.

Table I-28 POTENTIAL WATER DEMAND FOR RURAL WATER SUPPLY IN THE STUDY AREA

Item/Kabupaten	Unit	1980	1985	1990	1995	2000	2005
Population of Rural Area	10^3 persons						
Serang		873	972	1,084	1,210	1,349	1,505
Pandeglang		112	126	142	160	180	203
Rangkasbitung		367	408	454	504	560	622
Percentage of Served Population	%	19.5	32	44	53	60	65
Unit Water Demand	lit/capita/d	60	60	60	60	60	60
Served Population/1	10^3 persons						
Serang		171	311	477	642	810	979
Pandeglang		22	41	63	85	108	132
Rangkasbitung		72	131	200	267	336	405
Average Daily Water Demand/2	lit/s						
Serang		119	216	332	446	563	680
Pandeglang		16	29	44	59	75	92
Rangkasbitung		50	91	139	186	234	282
Maximum Daily Water Demand/3	lit/s						
Serang		143	260	398	535	675	816
Pandeglang		19	35	53	71	90	110
Rangkasbitung		60	110	167	223	280	338
Raw Water Quantity/4	lit/s						
Serang		164	298	458	616	777	939
Pandeglang		22	40	61	82	104	127
Rangkasbitung		69	126	192	256	322	389
Projected Potential Water Demand							
Total	lit/s	255	464	711	954	1,203	1,455
(Rounded up)	(lit/s)	(260)	(470)	(720)	(960)	(1,210)	(1,460)

Remarks: /1 = (Population of rural area) x (Percentage of served population)
/2 = (Unit water demand) x (Served population)
/3 = (Average daily water demand) x 1.2
/4 = (Maximum daily water demand) x 1.15

Table I-29 PROJECTED WATER DEMAND FOR ANYER-MERAK AREA

Name of Industries	Unit	1982	1985	1990	1995	2000	2005
P.T. Satya Raya Indah Woodbased Industries/1	m^3/d lit/s	350 4.1	350 4.1	350 4.1	350 4.1	350 4.1	350 4.1
P.T. Statomer PVC Resin Factory/2	m^3/d lit/s	2.80 0.1	4.84 0.1	7.43 0.1	10.23 0.2	12.96 0.2	15.80 0.2
Port and Ferry Installations/3	m^3/d lit/s	111 1.3	121.5 1.4	141 1.7	164.1 1.9	188.3 2.2	215.7 2.5
Others/4	lit/s	1.5	1.4	2.1	1.8	2.5	2.2
Total	lit/s	7	7	8	8	9	9
Necessary Raw Water in Total	lit/s	10	10	10	10	10	10

Remarks: /1 = Unit water demand is about 269 lit/capita/d and the demand for 1,300 persons is fixed in constant.

/2 = The demand in 1982 is actual and thereafter is assumed by using the factors as shown in Fig. I-1.

/3 = Details are shown in Table I-30.

/4 = Only for adjusted amount including industrial water use by P.T. Statomer PVC Resin Factory.

Table I-30 PROJECTED WATER DEMAND FOR PORT AND FERRY INSTALLATIONS AT MERAK

Item	Unit	1982	1985	1990	1995	2000	2005
Area of Land	ha	-	-	-	-	-	-
Number of Employees	person	200	200	200	200	200	200
Unit Water Demand	lit/capita/d	105	112	125	143	160	180
Domestic Water Demand/1	m^3/d	21.0	22.4	25.0	28.6	32.0	36.0
Number of Passengers/2	10^3 persons	10.0	10.7	12.0	13.5	15.1	16.9
Unit Water Demand	lit/capita/d	13	13	13	13	13	13
Industrial Water Demand/3	m^3/d	130.0	139.1	156.0	175.5	196.3	219.7
Existing Capacity	m^3/d	40	40	40	40	40	40
Projected Water Demand/4	m^3/d (lit/s)	111.0 (1.3)	121.5 (1.4)	141.0 (1.7)	164.1 (1.9)	188.3 (2.2)	215.7 (2.5)

Remarks: /1 = (Number of employees) x (Unit water demand)
/2 = Growth rate of 2.3% per annum
/3 = (Number of passengers) x (Unit water demand)
/4 = (Domestic water demand) + (Industrial water demand) - (Existing capacity)

Table I-31 WATER DEMAND FOR P.T. KRAKATAU STEEL WORKS COMPLEX (LETTER FROM P.T. KRAKATAU STEEL WORKS DATED 14/01/1983)

No.	Classification	Unit	Water Demand in 1983	Max. Water Demand in Rated Capacity	Remarks
(1)	P.T. Krakatau Steel Works				
	- Krakatau Steel Factory Operation	m^3/h	1,568	3,450	
		lit/s	436	958	
	- Hot Strip Mill	m^3/h	1,960	3,256	
		lit/s	544	904	
	- ERW Pipe Mill	m^3/h	-	306	
		lit/s	-	85	
	- Cold Rolling Mill	m^3/h	-	129	
		lit/s	-	36	
	- Pellet Plant	m^3/h	-	39	
		lit/s	-	11	
	- Pipe Factory (KHI) Expansion	m^3/h	-	4	
		lit/s	-	1	
	Sub-total	m^3/h	3,528	7,184	For P.T. Krakatau Steel Works in total 2,000 lit/s
		lit/s	980*	2,000*	
(2)	Cilegon Industrial Estate	m^3/h	-	542	
		lit/s	-	151	
(3)	P.T. Suralaya Power Plant	m^3/h	-	180	
		lit/s	-	50	
(4)	Cilegon Town Water Supply	m^3/h	135	180	
		lit/s	38	50	
	Sub-total	m^3/h	135	902	(2) to (4)
		lit/s	38	251	
	Total	m^3/h	3,664	8,086	
		lit/s	1,020*	2,250*	
		m^3/s	1.02	2.25	

Remarks: * = These figures are rounded.

Table I-32 UNIT INDUSTRIAL WATER DEMAND IN JAPAN

Unit: lit/s/ha

Classification of Industry	Unit Water Demand	Type of Industry
A. Common Machinery Industry	1.02	/1
B. Other Industries		
- Iron and Steel Industry	2.05	/2
- Non-ferrous Metal Industry	2.06	/3
- Metal Product	1.00	/4
- Electric Machine and Appliance	1.54	/5
- Transport Machine and Appliance	2.23	/6
- Chemical Industry	5.71	/7
- Rubber Product	3.35	/8
- Ceramic Industry	1.98	/9
Mean Value of B	2.49	

Remarks: /1 = Boiler, motor, agricultural machine, construction machine, metal processing machine, textile machinery, common industrial machinery, business machine and appliance

/2 = Tinplate, forged steel, cast steel and iron foundry

/3 = Electric cable and non-ferrous metal foundry

/4 = Tinplate product, coating plate, cutlery, hand tool, ironware and metal product for construction

/5 = Industrial electric machine and electric lighting appliance

/6 = Motor vehicle and fittings, and miscellaneous transport machine and appliance

/7 = Inorganic chemical product, soap, cleanser and medicine

/8 = Tyre, tube, rubber and plastic footware, industrial rubber product and miscellaneous rubber product

/9 = Carbon and graphite product

Table I-33 DOMESTIC WATER DEMAND FOR THE HOUSING COLONY OF CILEGON INDUSTRIAL ESTATE

Item	Unit	Year			
		1985	1990	1995	2000
Inhabitants in Housing Colony	10^3	8.10	9.78	11.82	14.30
Unit Water Demand	lit/capita/d	112	125	143	160
Estimated Average Daily Water Demand	lit/s	11	14	20	27
Max. Daily Water Demand	lit/s	13	17	24	33

Table I-34 ANALYSIS OF CLEAR WATER PRODUCED BY THE "CIKAPAYANG" PLANT, FEBRUARY 1977, AND OF THE STANDARD OF CLEAR WATER TAKEN BY DEPARTMENT OF HEALTH, INDONESIA AND WHO

No.	Constituents	Units	Department of Health Indonesia			WHO	Cikapayang Water	
			A	B	C		Before Process	After Process
	I. PHYSICAL							
1.	Temperature	°C			air-temperature		-	-
2.	Colour	Pt-Co scale	-	5	50	5-50	10	10
3.	Odour	-	-	-	-	not disturb	-	-
4.	Turbidity	SiO_2 scale	-	5	25	5-25	55	12
	II. CHEMICAL							
5.	pH	-	6.5	-	9.2	6.5-9.2	7.0	8.5
6.	Total Solids	mg/l	-	500	1,500	500-1,500	-	-
7.	Organic Substance	-	-	-	10	-	7.84	5.5
8.	Aggressive CO_2	-	-	-	0.0	-	9.1	-
9.	Total Hardness	°D	5	-	10	-	2.38	3.62
10.	Calcium Ca	mg/l	-	75	200	200	7.07	17.3
11.	Magnesium Mg	mg/l	-	30	150	150	5.98	5.16
12.	Iron Fe	mg/l	-	0.1	1.0	0.3-1.0	0.40	0.20
13.	Manganese Mn	mg/l	-	0.05	0.5	0.1-0.5	trace	0.0
14.	Copper Cu	mg/l	-	0.05	1.5	1.0-1.5	none	none
15.	Zinc Zn	mg/l	-	1.00	15	5-15.0	none	none
16.	Chloride Cl	mg/l	-	200	600	200-600	6.39	8.23
17.	Sulphate SO_4	mg/l	-	200	400	200-400	5.5	5.5
18.	Hydrogen Sulphide H_2S	mg/l	-	-	0.0	-	-	-
19.	Flouride F	mg/l	1.0	-	2.0	1.0	-	-
20.	Ammonia NH_4	mg/l	-	-	0.0	-	-	-
21.*	Nitrite NO_2	mg/l	-	-	0.0	-	-	-
22.	Nitrate NO_3	mg/l	-	-	20.0	40	-	-
23.*	Phenolic (as Phenol)	mg/l	-	0.001	0.002	0.001-0.002	-	-
24.*	Arsenic As	mg/l	-	-	0.05	0.2	none	none
25.*	Lead Pb	mg/l	-	-	0.10	0.1	none	none
26.*	Selenium	mg/l	-	-	0.01	0.05	none	none
27.*	Chromium C_r	mg/l	-	-	0.05	0.05	none	none
28.*	Cyanide CN	mg/l	-	-	0.05	0.01	none	none
29.*	Cadmium Cd	mg/l	-	-	0.01	-	none	none
30.*	Mercury Hg	mg/l	-	-	0.001	-	none	none
	III. RADIOACTIVITY							
31.	Alpha Rays	μc/ml	-	-	10^{-9}	10^{-9}	-	-
32.	Beta Rays	μc/ml	-	-	10^{-8}	10^{-8}	-	-
	IV. MICROBIOLOGY							
33.	Parasitic Organism	-	-	-	0.0	-	-	-
34.	Pathogenic Organism	-	-	-	0.0	-	-	-
35.	Total Coliform limit in 100 ml of sample water	-	-	-	0.0	-	-	-

Remarks: A = Minimum Allowable Concentration, B = Maximum Permissible Concentration, C = Maximum Allowable Concentration, * = Chemical Carsinogenic matter

Source: Ref. 15

Table I-35 SUMMARY OF DOMESTIC AND INDUSTRIAL WATER DEMAND IN 1980

Unit: lit/s

Water Supply Works	Daily Water Demand		Available Capacity of Water Source	Shortage of Water Quantity		Necessary Raw Water Quantity	
	Average	Maximum		Dam	Canal	Dam	Canal
(1) Municipalities							
- Serang	40	48	303	-	-	-	-
- Cilegon	13	16	-	-	-	-	-
- Pandeglang	17	21	29	-	-	-	-
- Rangkasbitung	40	48	15	-	-	29	46
- IKKs	58	69	-	-	-	67	38
Sub-total		202				96	84
(2) Industries and Housing Colony							
- Anyer-Merak Area	-	7	-	-	-	-	-
- P.T. Krakatau Steel Works	-	350	1,984	-	-	-	-
- P.T. Suralaya							
Power station	-	-	-	-	-	-	-
Housing colony	-	-	-	-	-	-	-
- Cilegon							
Industrial estate	-	-	-	-	-	-	-
Housing colony	-	-	-	-	-	-	-
Sub-total		357				0	0
Total		559				96	84
Required Capacity							
- Canal							90
- Dam						100	

Table I-36 SUMMARY OF DOMESTIC AND INDUSTRIAL WATER DEMAND IN 1985

Unit: lit/s

Water Supply Works	Daily Water Demand		Available Capacity of Water Source	Shortage of Water Quantity		Necessary Raw Water Quantity	
	Average	Maximum		Dam	Canal	Dam	Canal
(1) Municipalities							
- Serang	73	88	303	-	-	-	-
- Cilegon	21	26	26 /1	-	-	-	-
- Pandeglang	22	26	29	-	-	-	-
- Rangkasbitung	51	61	70 /2	-	-	-	-
- IKKs	99	120	-	-	-	114	66
Sub-total		321				114	66
(2) Industries and Housing Colony							
- Anyer-Merak Area	-	7	-	7	7	10	10
- P.T. Krakatau Steel Works	-	980	1,838	-	-	-	-
- P.T. Suralaya							
Power station	-	18	18	-	-	-	-
Housing colony	-	30	30 /1	-	-	-	-
- Cilegon							
Industrial estate	-	93	93 /1	-	-	-	-
Housing colony	11	13	13 /1	-	-	-	-
Sub-total		1,141				10	10
Total		1,462				124	76
Required Capacity							
- Canal							80
- Dam						130	

Remarks: /1 = From the Krenceng treatment plant
/2 = Necessary deep well sources shall be found.

Table I-37 SUMMARY OF DOMESTIC AND INDUSTRIAL WATER DEMAND IN 1990

Unit: lit/s

Water Supply Works	Daily Water Demand		Available Capacity of Water Source	Shortage of Water Quantity		Necessary Raw Water Quantity	
	Average	Maximum		Dam	Canal	Dam	Canal
(1) Municipalities							
- Serang	108	130	303	-	-	-	-
- Cilegon	32	40	40/1	-	-	-	-
- Pandeglang	26	32	32/2	-	-	-	-
- Rangkasbitung	63	76	70/2	-	6	-	7
- IKKs	141	170	-	-	-	164	95
Sub-total		448				164	102
(2) Industries and Housing Colony							
- Anyer-Merak Area	-	8	-	8	8	10	10
- P.T. Krakatau Steel Works	-	980	1,755	-	-	-	-
- P.T. Suralaya							
Power station	-	47	47	-	-	-	-
Housing colony	-	40	40/1	-	-	-	-
- Cilegon							
Industrial estate	-	148	148/1	-	-	-	-
Housing colony	14	17	17/1	-	-	-	-
Sub-total		1,240				10	10
Total		1,688				174	112
Required Capacity							
- Canal							120
- Dam						180	

Remarks: /1 = From the Krenceng treatment plant
/2 = Necessary deep well sources shall be found.

Table I-38 SUMMARY OF DOMESTIC AND INDUSTRIAL WATER DEMAND IN 1995

Unit: lit/s

Water Supply Works	Daily Water Demand		Available Capacity of Water Sources	Shortage of Water Quantity		Necessary Raw Water Quantity	
	Average	Maximum		Dam	Canal	Dam	Canal
(1) Municipalities							
- Serang	157	188	303	-	-	-	-
- Cilegon	47	58	50/1	-	8	-	9
- Panddglang	33	40	40/2	-	-	-	-
- Rangkasbitung	82	98	70/2	-	-	-	-
- IKKs	193	233	-	-	-	222	134
Sub-total		617				222	143
(2) Industries and Housing Colony							
- Anyer-Merak Area	-	8	-	8	8	10	10
- P.T. Krakatau Steel Works	-	980	1,406	-	-	-	-
- P.T. Suralaya							
Power station	-	59	59	-	-	-	-
Housing colony	-	40	40/1	-	-	-	-
- Cilegon							
Industrial estate	-	48	48/1	-	-	-	-
Housing colony	-	24	24/1	-	-	-	-
Sub-total		1,591				10	10
Total		2,208				232	153
Required Capacity							
- Canal							160
- Dam						240	

Remarks: /1 = From the Krenceng treatment plant
/2 = Necessary deep well sources shall be found.

Table I-39 SUMMARY OF DOMESTIC AND INDUSTRIAL WATER DEMAND IN 2000

Unit: lit/s

Water Supply Works	Daily Water Demand		Available Capacity of Water Source	Shortage of Water Quantity		Necessary Raw Water Quantity	
	Average	Maximum		Dam	Canal	Dam	Canal
(1) Municipalities							
- Serang	216	259	303	-	-	-	-
- Cilegon	65	81	50/1	15	31	17	36
- Pandeglang	42	51	51/2	-	-	-	-
- Rangkasbitung	103	124	-	103	124	119	-
- IKKs	258	309	-	-	-	294	180
Sub-total		824				430	216
(2) Industries and Housing Colony							
- Anyer-Merak Area	-	9	-	9	9	10	10
- P.T. Krakatau Steel Works	-	2,000	-	100	100	115	115
- P.T. Suralaya							
Power station	-	70	70	-	-	-	-
Housing colony	-	50	50/1	-	-	-	-
- Cilegon							
Industrial estate	-	688	-	690	690	794	794
Housing colony	27	33	-	27	33	31	38
Sub-total		2,850				950	957
Total		3,674				1,380	1,173
Required Capacity							
- Canal							1,180
- Dam						1,380	

Remarks: /1 = From the Krenceng treatment plant
/2 = Necessary deep well sources shall be found.

Table I-40 SUMMARY OF DOMESTIC AND INDUSTRIAL WATER DEMAND IN 2005

Unit: lit/s

Water Supply Works	Daily Water Demand		Available Capacity of Water Source	Shortage of Water Quantity		Necessary Raw Water Quantity	
	Average	Maximum		Dam	Canal	Dam	Canal
(1) Municipalities							
- Serang	287	344	303	-	41	-	47
- Cilegon	90	113	50/1	40	63	46	73
- Pandeglang	52	63	63/2	-	-	-	-
- Rangkasbitung	130	156	-	130	156	150	180
- IKKs	328	392	-	-	-	379	234
Sub-total		1,068				575	534
(2) Industries and Housing Colony							
- Anyer-Merak Area	-	9	-	9	9	10	10
- P.T. Krakatau Steel Works	-	2,000	1,900	100	100	115	115
- P.T. Suralaya							
Power station	-	70	70	-	-	-	-
Housing colony	-	50	50/1	-	-	-	-
- Cilegon							
Industrial estate	-	688	-	690	690	794	794
Housing colony	36	43	-	36	43	42	50
Sub-total		2,860				961	969
Total		3,928				1,536	1,503
Required Capacity							
- Canal							1,510
- Dam						1,540	

Remarks: /1 = From the Krenceng treatment plant
/2 = Necessary deep well sources shall be found.

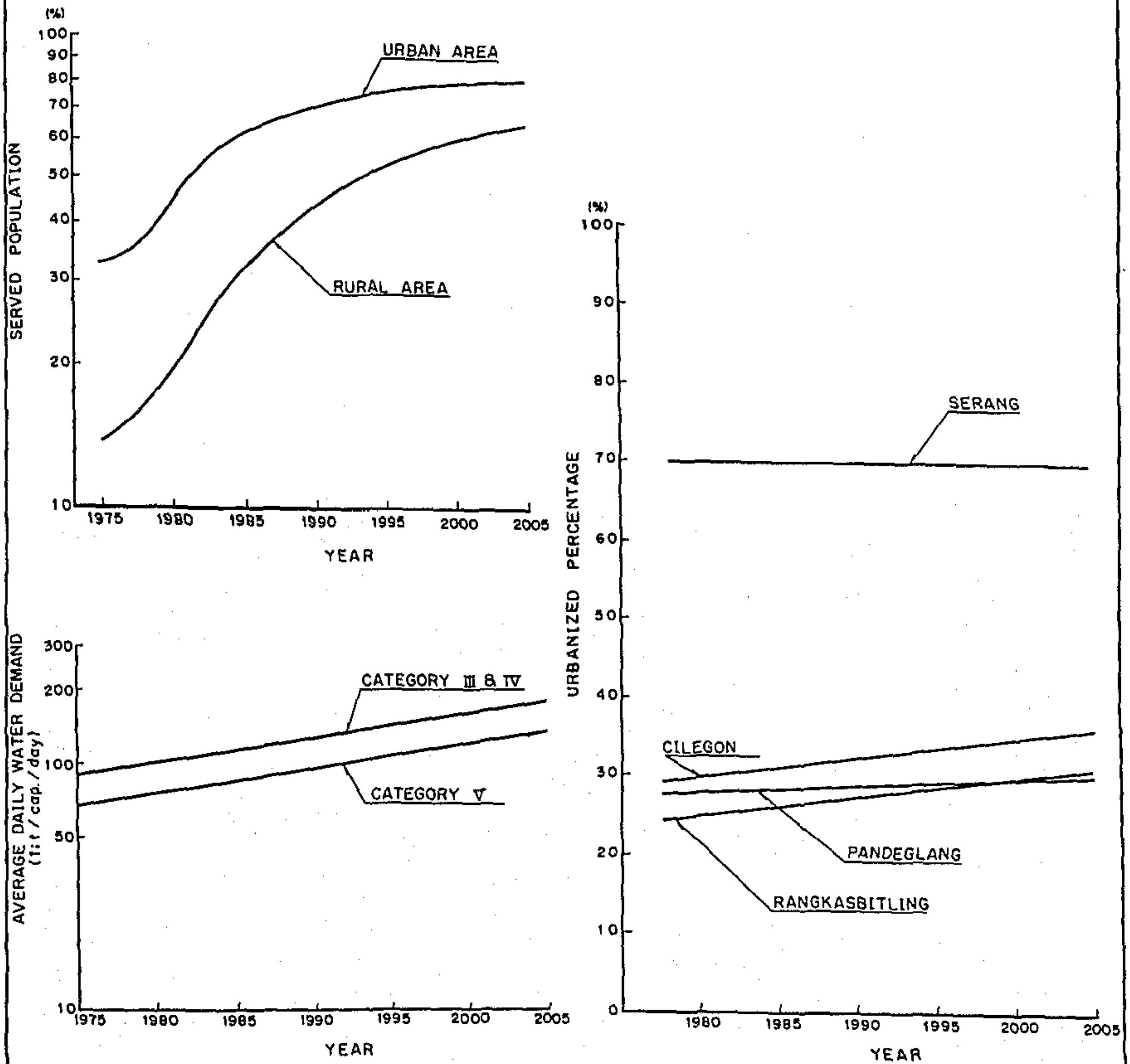

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Fig. I-1 Factors for Projection of Domestic Water Demand

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APPENDIX J

HYDROPOWER

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1. INTRODUCTION

The Study Area is located in a part of the managing area of the State Electricity Public Corporation (PLN) Banten branch which is a local organization of PLN West Java Distribution.

PLN West Java Distribution is responsible for the operation, maintenance and charge collection of power supply system in the Province.

Expected power generation in 1982/83 will reach to 34,102 MWh for the area of Banten branch (hereinafter called as the Banten area). From this figure, the peak power is assumed as 9 MW.

Nevertheless, per capita annual power consumption in the Banten area is 9 kWh only, it should be said that power situation is remarkably poor comparative with other area of West Java in which average consumption is 52 kWh.

From this regard, it is realized that the electricity supply in the Banten area has been supressed for a long time. It seems that the demand had been discouraged by limited distribution line and poor service level.

There are no existing hydroelectric power stations in the Study Area, and neither is planned for newly construction at present.

2. POWER STATISTICS

The present power system in the Study Area is shown in Fig. J-1. Supplied power is mainly fed from outside of the Study Area via Serang through 150 kV transmission lines connected to P.T. Krakatau Steel Works (private) and Jakarta PLN generation sector.

In the Study Area, PLN operates a 70 kV power transmission line which links between Serang and Rangkasbitung, and extends to outside of the Study Area.

The power is distributed to the major towns with 30 kV, 20 kV and 6 kV high tension distribution lines. The power supply service is limited in major towns and their vicinities, but most of villages are not served. Major distribution expansion schemes are shown in Fig. J-2. Though existing power facilities in the Banten area are listed in Table J-1, power generating capacities owned by PLN are about 1 MW in total and serve 5% of required power to the area.

The power consumption are composed of 68% for residential, 12% for commercial, 5% for industry and 15% for public.

The population in the managed area of Banten branch is said to be 2,535 x 10^3, from which the number of household is estimated to be about 554 x 10^3 by assuming the family size to be 4.57 persons per household. Out of those, 18 x 10^3 households are served with power supply, that is, the electrification ratio in the Banten area remains at 3% only.

Historical records about power supply and demand in the Banten area are shown in Table J-2.

3. FUTURE DEVELOPMENT

According to the PLN sales target, the future annual growth rate of power consumption is expected as 30% in the Banten branch.

In fact, BKPM-D (Investment Coordination Board of West Java Province) intends to promote the industrial estate in the Study Area. Beside industry, the investment for social, commercial, agriculture and tourism will also be made.

In the Study Area, it is planned that the Merak-Cilegon-Anyer area comes to a coastal industrial zone, P.T. Krakatau Steel Works and its surrounding area come to the Cilegon industrial estate, the Serang-Ciruas-Cikande area along the national road comes to a zone for light and chemical industries, and the Bojonegara area come to a quarry for producing coarse aggregate. In addition, the new highway is now under construction between Merak and Jakarta.

In concept with this demand, PLN proceeds to construct the new coal fired thermal power plant in Suralaya, and also the distribution network is planned to reinforce and expand.

PLN's extension plan of power system in the Study Area is listed in Table J-1.

It is deserving of special mention that the geo-thermal power project will develop in the Study Area.

4. HYDROPOWER

According to the Binnie and Partner's Report, three hydroelectric potentials are found out of the Ciujung river, named from east side, the Karian, Pasir Kopo and Bojongmanik. In the meantime, four hydro potential sites are suggested in the Study Area by the PLN national hydropower potential study team, which are named Cisimeut 1 & 2, Ciberang and Ciujung. Those are profiled in Fig. J-3.

As a result of the present study, the possibility of developing the hydroelectric project is thrown into despair by its uneconomic situation.

Notwithstanding the above, the studies for the suitable site of reservoirs to store water for optimum use of water resources in the Study Area are made. The possibilities of developing multipurpose facilities at the dam sites to include power generation are briefed as below.

(1) Karian

The Karian site is most feasible for the irrigation purpose. However, the capacity of reservoir is too small against to serve enough water for the hydropower. In October, the firm discharge come to down 2.8 m^3/sec. From this figures, the output of power station is estimated as 500 kW only. In this case, there is no space to take cost allocation against dam construction in due of its small benefit.

(2) Pasir Kopo and Bojongmanik

There are several points to decide the dam site to cope with the requirement of the irrigation and/or electric power. However, if the reservoir is not utilized for the irrigation, the construction cost of hydropower project rises to more than 10,000 US$/kW. It is too expensive for the generating facilities itself. In case the reservoir is planned to supply the irrigation storage requirement for supplementing the Ciujung irrigation scheme in the dry season, the hydropower will be expected.

5. CONCLUSION

The PLN's policy of constructing the power generating units to supply the power against whole Java power grid as a whole suggests that the construction of smaller hydroelectric schemes could not be utilized. Because, its small capacity will be interrupted to fulfill the function against the control of power system.

On the other hand, from the view point of optimum use of water resources, the scales of hydroelectric power schemes are limited in due of their low priority. And also, the extent of possible market of the hydropower in the Study Area is limited because of its small potential energy and fluctuations.

However, a national economic point of view to save the oil, it is one of suggestion that the development of hydroelectric power project is significant, though its high construction cost makes to uneconomic.

Table J-1 (1/3) LIST OF POWER FACILITIES IN BANTEN AREA

A. Power Station

1) Existing

Name	Type	Unit	Total Capacity	Dependable Output
Krakatau Steel*	T	4	400 MW	
Karanghantu	D	1	5 kVA	4.8 kVA
Kragilan	D	1	90 kVA	
Petir	D	1	12.5 kVA	8.9 kVA
Warunggunung	D	1	12.5 kVA	10.0 kVA
Cipanas	D	2	25 kVA	16.2 kVA
Batubantar	D	1	12.5 kVA	12.4 kVA
Labuan	D	3	606 kVA	
Menes	D	1	138 kVA	86.8 kVA
Malingping	D	1	126 kVA	
Saketi	D	1	40 kVA	

Remarks: T = Thermal, D = Diesel, * = Non PLN

Source: PLN Banten branch

2) On-going/Planned

Name	Type	Operating Year	Station Output at the Year
Suralaya #1 - 6	Steam Coal	1985/86	800 MW
		1987/88	1,200 MW
		1988/89	1,600 MW
		1989/90	2,200 MW
		1990/91	2,800 MW
Banten	Geothermal	1989/90	110 MW
Total Output in 1993/94			2,910 MW

Source: PLN Pusat

Table J-1 (2/3) LIST OF POWER FACILITIES IN BANTEN AREA

B. Substation

1) Existing

Name	Voltage (kV)	Capacity (MVA)	Year
Krakatau Steel*	150/20		
Serang	150/20	2 x 30	1981
	150/70	30	1982
Rangkasbitung	70/30/6	5	1967
	70/6	5	1981

Remarks: * = Non PLN

2) On-going

Name	Voltage (kV)	Capacity (MVA)	Year
PLTU Suralaya	500/150	250	1985
Cilegon	150/20	30	1985
Rangkasbitung	70/20	10	1982

3) Planned

Name	Voltage (kV)	Capacity (MVA)	Year
Labuan	70/20	10	1984
Malingping	70/20	10	1988
Cikotok	70/20	10	1986
Cinangka*	150/20		

Remarks: * = Non PLN

Source: PLN Pusat

Table J-1 (3/3) LIST OF POWER FACILITIES IN BANTEN AREA

C. Transmission Line

1) Existing

From	To	Type	km-Rute	Year
Krakatau Steel	Serang	150-2CCT	28	1980
Serang	Tangerang	150-2CCT	75	1980
Serang	Rangkasbitung	70-2CCT	41	1982
Rangkasbitung	PLTA Kracak	70-2CCT	57	1982

Remarks: 150-2CCT = 150 kV 2 circuits Line

2) On-going

From	To	Type	km-Rute	Year
PLTU Suralaya	Gandul	500-1st CCT	119	1985
PLTU Suralaya	Cilegon	150-2CCT	15	1985

Source: PLN Pusat

3) Planned

From	To	Type	km-Rute	Year
PLTU Suralaya	Gandul	500-2nd CCT	119	1990
Krakatau Steel*	Cinangka*	150-2CCT		
Rangkasbitung	Labuan	70-1st CCT	40	1984
Rangkasbitung	Malingping	70-1st CCT	60	1988
Malingping	Cikotok	70-1st CCT	50	1988
Cikotok	Palabuhan Ratu	70-1st CCT	30	1986
Rangkasbitung	Labuan	70-2nd CCT	40	1990
Rangkasbitung	Malingping	70-2nd CCT	60	1992
Malingping	Cikotok	70-2nd CCT	50	1992
Cikotok	Palabuhan Ratu	70-2nd CCT	30	1990

Remarks: * = Non PLN

Source: PLN Pusat

Table J-2 HISTORICAL POWER PRODUCTION/CONSUMPTION

Year	Production (MWh)			Consumption										Losses	
	Scattered Diesel Plant	Imported from Jakarta and Krakatau Steel	Total	Residential		Commercial		Industry		Public		Total			
				No.	MWh	No.	MWh	No.	MWh	No.	MWh	No.	MWh	MWh	%
1973	227	7,314	7,541	7,278	4,090	346	506	9	619	271	886	7,904	6,101	1,440	19.10
1974/1975	479	12,596	13,075	7,285	7,856	634	759	10	716	200	1,366	8,129	10,697	2,378	18.20
1975/1976	513	13,397	13,910	7,360	7,885	658	1,364	10	739	214	1,378	8,242	11,366	2,544	18.29
1976/1977	593	13,347	13,940	7,359	7,898	660	1,348	10	874	219	1,501	8,248	11,621	2,319	16.64
1977/1978	594	14,483	15,077	9,587	8,469	747	1,496	12	950	243	1,605	10,589	12,520	2,557	16.96
1978/1979	706	16,616	17,322	11,661	10,397	822	1,649	11	1,184	287	1,695	12,781	14,925	2,397	13.84
1979/1980	931	17,602	18,533	13,707	12,019	953	1,894	13	1,153	348	1,819	15,021	16,885	1,648	8.89
1980/1981	1,100	21,700	22,800	16,421	13,436	1,102	2,240	11	1,200	420	2,325	17,954	19,201	3,599	15.78
1981/1982	1,369	28,343	29,712	18,246	15,925	1,180	2,755	13	1,300	502	3,492	19,941	23,472	6,240	21.00
1982/1983/1	1,046	19,673	20,719	20,756	11,050	1,224	1,642	13	789	584	2,696	22,577	16,177	4,542	21.92

Remarks: /1 = Up to December

Source: PLN Banten branch

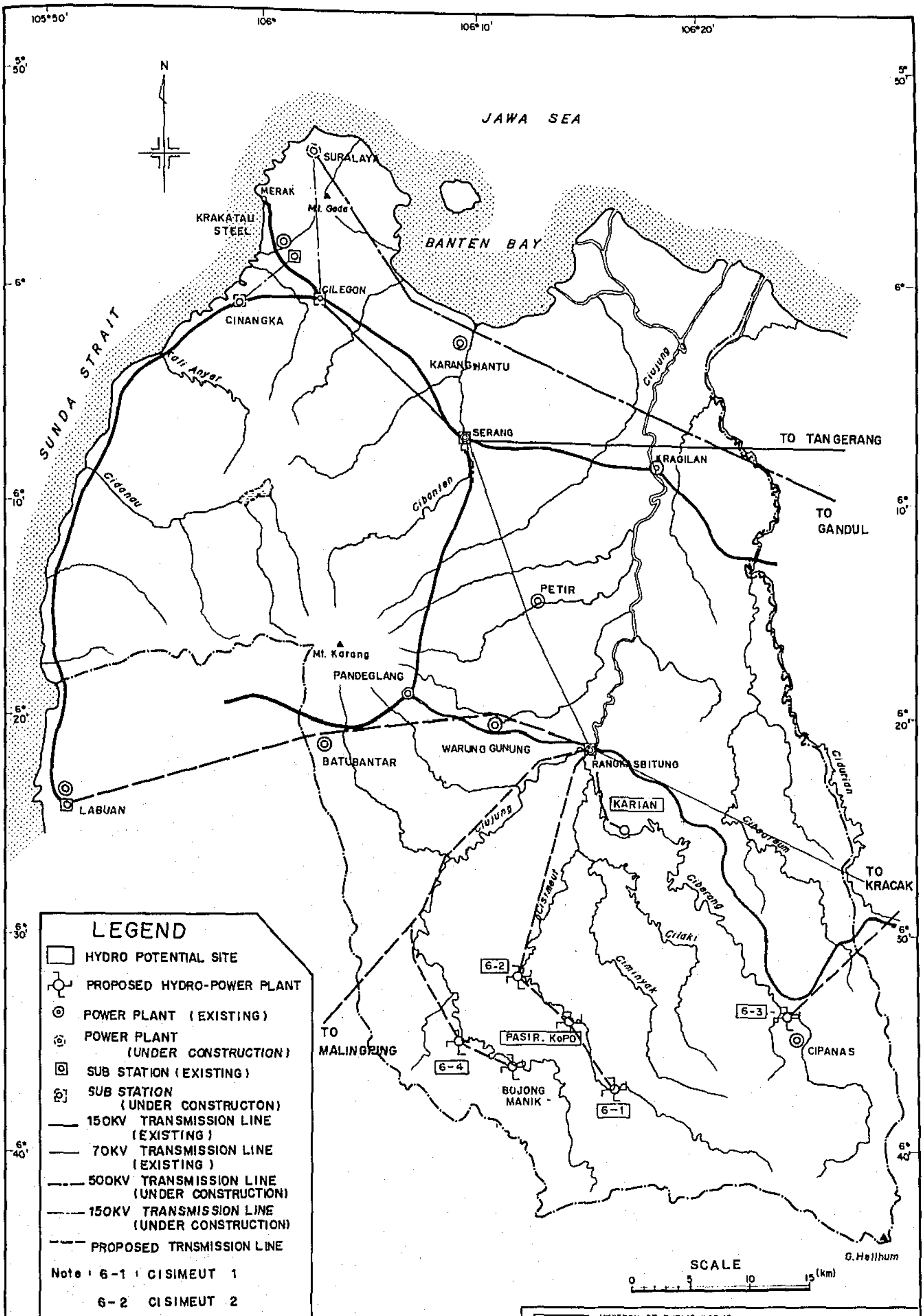

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Fig. J-1 Present Power System in the Study Area

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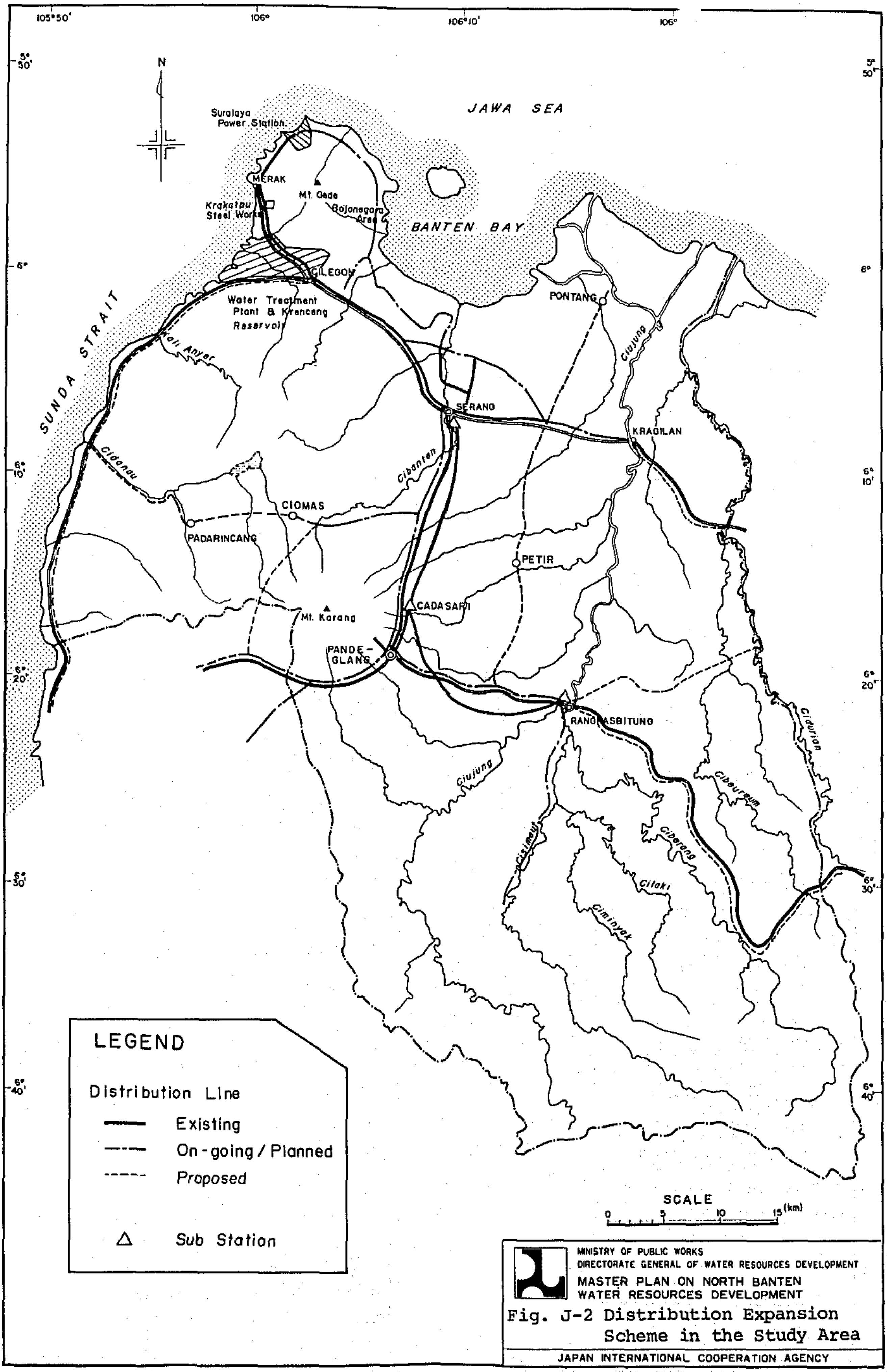
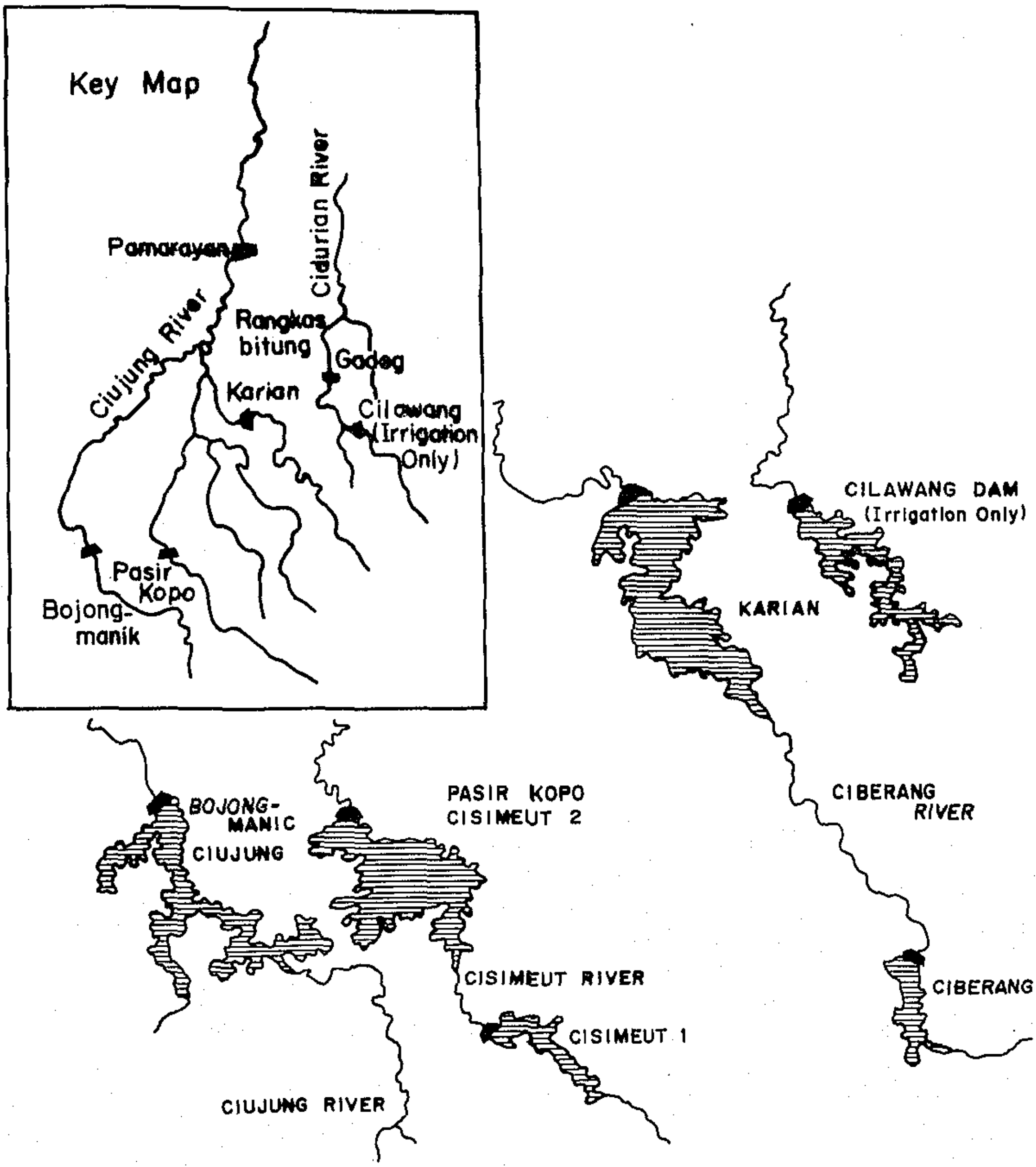


Fig. J-2 Distribution Expansion Scheme in the Study Area



No.	Name	Reservoir: Catchment km²	Reservoir: Average Inflow m³/s	Reservoir: Capacity (Net) x10⁶m³	Firm Discharge m²/s	Hydro-electric Power: Head/1 (m)	Hydro-electric Power: Installed Capacity/2 (kW)	Energy (GWh): Primary	Energy (GWh): Secondary
6-3	CIBERANG	130	-	-	6.7	59.5	6,500	28.6	17.2
	KARIAN	289.5	24.1	295	20.5	55	19,000/3	83.2/3	13.5/4
6-1	CISIMEUT 1	100	-	-	5.5	95.0	8,500	37.4	12.6
	PASIR KOPO	173.3	12.1	132	10.3	60	10,000	43.8	9.2/4
6-2	CISIMEUT 2	160	-	-	11.6	56.2	10,700	46.8	1.8
	BOJONG MANIC	153.0	9.3	104	8.0	27	3,500	15.3	3.0/4
6-4	CIUJUNG	134	-	-	7.6	56.1	7,100	30.5	1.2

Notes: /1 Optimum net head
/2 Plant factor is 0.5
/3 When no consideration about irrigation
/4 Assumption

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Fig. J-3 Hydropower Potential Reported by Other Study

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APPENDIX K

DAM PLANNING

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1. INTRODUCTION

There are many rivers and various conceivable dam sites in the Study Area. Although various dam plannings to meet the requirements can be imagined, the most desirable dam planning, including the site, scale, type, design and construction plan of the dams, should be established.

For the above purpose, the examination is made for selection of the most effective and advantageous dam sites, optimum combination of dam sites and dam scales, and design and construction plan of the selected dam plan, etc.

This Appendix K presents the details of the above examination.

2. POSSIBLE DAM SITES

2.1 General

For the purpose of the selection of advantageous dam sites for the project, the evaluation of all conceivable dam sites in the Study Area is carried out. Based on the above evaluation, the dam sites, which are possible to meet the requirement and also advantageous economically, are tried to be selected.

The investigation of conceivable dam sites in the Study Area, screening of them through a rough evaluation, detailed evaluation for the screened dam sites and final selection of dam sites, etc. are detailed in the succeeding sections.

2.2 Conceivable Dam Sites in the Study Area

There are many rivers in the Study Area as seen in Fig. K-1. Dam sites in these rivers are examined through a map study, and various conceivable dam sites for the project are selected in view of the relatively favourable topographic condition for dam construction and reasonable storage capacity to be obtained there.

Firstly, 16 dam sites are selected as follows and locations are shown as "Studied" in Fig. K-1:

Ciberang river	2 dam sites
Cibeureum river	1 dam site
Cisimeut river	2 dam sites
Upper Ciujung river	7 dam sites
Cibanten river	2 dam sites
Cidanau river	1 dam site
Kali Anyer river	1 dam site
Total	16 dam sites

No appropriate dam sites are found in other rivers.

2.3 Screening of Dam Sites

Following the above selection of the conceivable dam sites in the Study Area, screening of these dam sites is made, aiming to exclude those for which the detailed evaluation is considered unnecessary.

The screening of dam sites is made on the following basis:

(1) Plural number of dam site in the same catchment basin is not effective because of the same water resource.

(2) Therefore, number of dam site on each river should be limited to one.

(3) The desirable dam site is of larger storage capacity and higher storage efficiency which are defined as storage volume per unit dam volume. So, one dam site is selected on each river, based on the comparison of storage capacity and storage efficiency.

The results of screening on each river are as follows:

(1) Ciberang river: Two conceivable dam sites at Karian site on the Ciberang river are compared in terms of the storage capacity and storage efficiency. In the comparison, the downstream dam site indicates a considerable higher storage efficiency though its storage capacity is slightly smaller compared with the upstream dam site. Therefore, the downstream dam site is selected for further study.

(2) Cisimeut river: The further examination for two conceivable dam sites on the Cisimeut river reveales that the downstream dam site is of much less storage capacity compared with the upstream dam site. Although the storage efficiency of the downstream dam site is found to be higher than that of the upstream dam site, the downstream dam site is dropped in view of the small storage capacity as mentioned, and the upstream one is taken up for further study.

(3) Upper Ciujung river: Seven conceivable dam sites are found on the upper Ciujung river. Each of these dam sites is also examined in respect of the storage capacity and storage efficiency. Since the above examination indicates an evident advantage of the fifth dam site from downstream in terms of both the storage capacity and storage efficiency, this dam site is selected for further study and all other dam sites on this river are dropped in this screening.

(4) Cibanten river: Though two dam sites are proposed on the Cibanten river, the downstream dam site is dropped in view of no advantage in both the storage capacity and storage efficiency compared with those of the upstream dam site.

2.4 Detailed Evaluation and Final Selection of the Dam Sites

The detailed evaluation for final selection of the dam sites is made on the remaining seven dam sites after screening as mentioned above:

(1) downstream dam site on the Ciberang river (hereinafter called "Karian site");

(2) Cilawang site on the Cibeureum river;

(3) upstream dam site on the Cisimeut river (hereinafter called "Pasir Kopo site");

(4) fifth dam site from downstream on the upper Ciujung river (hereinafter called "Bojongmanik site");

(5) upstream dam site on the Cibanten river (hereinafter called "Cibanten site");

(6) Cidanau site on the Cidanau river; and

(7) Kali Anyer site on the Kali Anyer river.

The detailed evaluation for the above seven dam sites is made by means of assessing the unit effective storage cost which is defined as the dam cost required for unit effective storage volume and of evaluating each possible effective storage capacity to share in the total storage capacity as shown in Table K-1 and Fig. K-2.

The effective storage capacity curves showing relationship between the dam height and reservoir effective storage volume for the seven dam sites are given in Fig. K-3. The unit effective storage costs worked out at the seven dam sites are also graphically shown in Fig. K-4 for comparison.

As seen in Fig. K-4, three dam sites of Karian, Cilawang and Pasir Kopo show extremely low value of the unit effective storage cost at larger effective storage volume. It means that the maximum utilization at these three dam sites will economically be advantageous.

The technically possible effective storage capacity at the above three dam sites is also much more than the others as seen in Fig. K-3, indicating a high contribution to meet the requirement.

Thus, the dam planning should be made with the size as large as possible at the three dam sites of Karian, Cilawang and Pasir Kopo as well as the most suitable combination of the above to meet the requirement. In the case that the technically possible maximum effective storage capacity at the above three dam sites can not satisfy the requirement, Bojongmanik site is recommendable as the next choice in view of relatively low unit effective storage cost and large storage capacity compared with the other Cibanten, Cidanau and Kali Anyer sites.

3. DEVELOPMENT PLAN

3.1 General

In the preceding Chapter of "POSSIBLE DAM SITES", it is found that the three dam sites of the Karian, Cilawang and Pasir Kopo sites should be developed with the most suitable and beneficial combination of them to meet the requirement.

In order to determine a definite development plan of the dams at the above dam sites, the study of the most beneficial combination and scale of each dam is made in this Chapter.

The study indicates that the development of the Karian and Cilawang dams at the possible maximum scale would be the most beneficial development plan, meeting the requirement.

The detailed study for the above is given in the succeeding sections.

3.2 River Flow

In Appendix B (Hydrology), the monthly mean discharge at the selected dam sites, i.e. Karian, Cilawang and Pasir Kopo, is estimated by using the discharge records observed at Rangkasbitung for 11 years from 1972 to 1982. Based on the estimated discharge at each site, the mass curves are prepared to use for estimation of the storage requirement. Mass curves for three dam sites are shown in Fig. K-5. The average discharge at each dam site for 11 years are 28 m^3/s for Karian, 7.5 m^3/s for Cilawang and 15.0 m^3/s for Pasir Kopo. As shown on each mass curve, the driest dry season occurs in 1982. Discharge pattern fluctuates largely year by year.

3.3 Basis for Planning

3.3.1 General conditions

As mentioned in Appendix E (Flood Control), storage capacity required for flood control are recommended to be 30 x 10^6 m^3 for the Karian dam and 15 x 10^6 m^3 for the Pasir Kopo dam. These figures are assumed to be the given condition in the course of the estimation of effective storage capacity required for irrigation and D&I water demand.

The irrigation water demand varies widely depending on meteorological conditions and farming practices year by year. The conceivable irrigation schemes benefitted by the water source development are the Ciujung scheme of 24,200 ha, K-C-C area of 8,000 ha and Cicinta scheme of 1,435 ha. The monthly diversion water requirement for each from 1972 to 1982 is estimated as summarized in Table K-2.

The domestic and industrial (D&I) water demand is estimated in detail in Appendix I. The diversion water demand for D&I water supply at the existing Pamarayan weir is estimated to be 1.3 m^3/s.

The maximum effective storage capacity of the Karian dam is estimated to be 218 x 10^6 m^3, being allocated 30 x 10^6 m^3 to flood control and 188 x 10^6 m^3 to irrigation and D&I water supply. In the case of the Pasir Kopo dam, any size of reservoir can be created for irrigation and flood control as far as topography and runoff volume permit. The Cilawang dam with a maximum effective storage capacity of 54 x 10^6 m^3 is planned to be a single purpose dam for irrigation.

3.3.2 Reference year for planning

In order to determine the reference year for planning, estimation of required storage capacity of the Karian dam is made at first for the study period from 1972 to 1982 assuming the following conditions:

(1) Irrigation area benefited by the Karian dam is both the Ciujung scheme of 24,200 ha and the K-C-C area of 8,000 ha.

(2) D&I water demand is 1.3 m^3/s at the Pamarayan weir and 0.1 m^3/s for direct supply from the dam to the town of Rangkasbitung.

(3) Diversion efficiency at the intake site is 70% for the Pamarayan weir and 90% for the proposed Gadeg weir in the K-C-C area.

(4) Shut down effect is taken into account.

(5) Evaporation loss from the reservoir of the Karian dam is 5 mm/d or 0.6 m^3/s on an average.

(6) Limitation of the storage capacity at the Karian dam which is 218 x 10^6 m^3 at maximum is not considered.

Procedure of calculation for each year from 1972 to 1980 is shown in Table K-3. Results of the calculation are summarized in Table K-4. The biggest requirement for the storage capacity occurs in 1982. The second biggest requirement occurs in 1972 and the third one in 1976. Since the irrigation sector is the biggest water user for the Karian dam, the year 1972 is selected as the reference year for planning, which is equivalent to the probability of 2/11, or nearly 80% probability which is commonly accepted for irrigation planning in Indonesia.

3.4 Selection of Combination of Dams

In order ot evaluate the relationship between effective storage capacity and net present value of possible combination of dams, present worth of cost and benefit for possible development plan is estimated and then summarized visually in Fig. K-6. In the case of benefit in Fig. K-6, the Ciujung and K-C-C irrigation schemes are taken into account. Based on the results in Fig. K-6 and estimated net present value of flood control plan, Fig. K-7 can be drawn. As shown in Fig. K-7 clearly, the net present value increases if the effective storage capacity increases. It means the larger scale development is always more economical for each of combination of dams.

Based on the above understandings, the following possible combinations of development, Cases 1 to 3, are compared each other.

	Case 1	Case 2	Case 3
Combination of Dams	Karian alone	Karian + Pasir Kopo	Karian + Cilawang
Irrigation Area			
Ciujung (24,200 ha)	o	o	o
K-C-C (8,000 ha)	o	o	o
Cicinta (1,435 ha)	-	-	o

The assumptions set in this comparison is as follows:

(1) Maximum irrigation area of the Ciujung irrigation scheme during the dry season is 21,000 ha in 1972 due to limitation of discharge capacity of main canal (refer to Appendix H).

(2) In the Case 2, priority of development is set on the Karian dam development.

(3) In the Case 3, the same cropping intensity is applied to the three schemes.

The development plan and evaluation result for each alternative are featured in Tables K-5 to K-7 and summarized in Table K-8. From this, the combination of the Karian and Cilawang dams, Case 3, is the most recommendable in terms of NPV and total benefitted area in the dry season.

3.5 Proposed Development Plan

The proposed development plan in the present study is a plan to develop water source at the Karian and Cilawang dams to use for flood control, D&I water supply and irrigation purposes. By the construction of two water supply tunnels, i.e. one from Karian to Gadeg for the K-C-C scheme and the other from Cilawang to Cicinta for the Cicinta scheme, the whole of three irrigation schemes can receive regulated water source. The general layout of the dams in the proposed plan is illustrated in Fig. K-8.

In order to confirm the relationship between effective storage capacity and cropping intensity, the calculation is made for the reference year for planning, i.e. the year 1972 as shown in Tables K-9 and K-10. By the full development of the Karian and Cilawang dams, 187% cropping intensity for each irrigation scheme can be expected in 1972.

For the purpose to estimate the real irrigation benefit, the irrigable area by scheme by year is estimated from 1972 to 1982 on condition that the recommended source development plan is constructed. As shown in Table K-11, 195% cropping intensity on an average can be achieved by the recommended source development plan.

4. PRELIMINARY PLANNING OF PROPOSED DAMS

4.1 Karian Dam

4.1.1 Topography and geology

The river width at the dam site is around 20 m. The river bed elevation is around El. 18 m. There are terrace deposits of 10 to 20 m wide and 3 to 5 m high along both the banks. Both the banks shape relatively steep slope of 30° to 40° up to around El. 60 m and then the slope becomes very gentle, 3° to 5°. As such, the dam height is topographically limited to about 50 m above river bed.

The geology of the dam belongs to the marine sediments of Pliocene. Fine to coarse tuff is predominant in the foundation rock, interposing lapilli tuff and sandy shale layers. As a whole, the foundation rock is soft and weak to such an extent that the construction of a high concrete dam is difficult. The weathered layer of foundation rock is considered relatively thin, judging from the situation of outcrop observed. Its thickness will be about 3 to 5 m on both the banks and 1 m in the river channel portion. The top soil is also thin. It is a thickness of about 0.5 to 1 m as a whole. The river bed deposits are about 2 to 3 m thick.

4.1.2 Selection of dam type

As stated in the preceding section, the foundation rock consists of soft and weak tuff of which shearing strength is estimated at about 5 kg/cm^2. Under such condition of the foundation, a concrete dam of considerable size will technically be impossible to be constructed due to insufficient strength against sliding or will not be justifiable economically. Therefore, the dam at the Karian site will have to be designed as a fill type dam.

The necessary materials of the fill type dam are available from the quarry rock consisting of the andesite (the Gunung Sendi at 11 km upstream of the dam site and terrace deposits which are widely extended in the upstream of the dam site). The available quantity of them is also sufficient. Therefore, a standard zoned rockfill dam with the center core is selected as a type of the dam to be constructed at the Karian site.

4.1.3 Preliminary design of the dam

The preliminary design established is given in Fig. K-9. The principal features of the design are as summarized at the end of this subsection.

The major considerations in preparing the above preliminary design are described below.

(1) Dam

The preliminary design of the Karian dam is made based on the development plan determined in the previous Chapter of "DEVELOPMENT PLAN", i.e. the dam crest elevation of El. 70 m or dam height from the river bed of 52 m which, in general, corresponds to the topographically possible maximum scale at the dam site and meets the requirement of effective storage capacity of 218 x 10^6 m^3 including the flood control volume of 30 x 10^6 m^3. The design is also made based on the zoned rockfill dam with the center core which is determined by the reason explained in the previous Sub-section 4.1.2, "Selection of dam type".

The main dam design value adopted is as follows:

- internal friction angle of rock material 40°;
- seismic coefficient 0.15; and
- safety factor for sliding 1.2.

The internal friction angle of 40° for a dam rock material is value estimated on the assumption of use of andesite rock. Quarry site is located in a place about 11 km upstream from the dam site. The coefficient of 0.15 is adopted as the seismic coefficient for the dam design. The dam safety factor for sliding is 1.2 in accordance with the standard in Japan.

(2) River diversion

The topography at the dam site makes it possible to construct a diversion tunnel in the bank. Therefore, the usual river diversion system for the dam construction works, i.e. the system provided with a diversion tunnel and cofferdams, is considered to be applied. The diversion tunnel is provided in the right bank in consideration that the required tunnel length can be shortened.

For sizing of the diversion system, 10 years recurrence flood peak of 600 m^3/s is adopted as the diversion design flood, based on a consideration that about 10 years probable flood is appropriate for the purpose of river diversion for the dam embankment period of about 2 to 3 years.

Overtopping of the fill type dam during construction is not allowed, and therefore, the diversion system should have a capacity to handle any floods during construction without overtopping. Besides, the tunnel diameter and cofferdam site should be decided at the most economical combination. Therefore, the sizing of the diversion system was made through an economic comparative study of various cases of combinations which can handle the diversion design flood without any overtopping.

The diversion tunnel diameter and cofferdam size are finally determined at 10 m in diameter and El. 30 m in crest level respectively after the said economic comparative study.

(3) Spillway

The spillway is designed to pass the probable maximum flood of 1,510 m^3/s and is located on the right bank separately from the main dam of the fill type in accordance with the standard. Non-gated type of the spillway is preferrable from the viewpoint of the safe dam operation. However, the examination revealed that the non-gated type of the spillway would result in too wide structure, leading to a big volume of excavation, or the required storage volume of 188 x 10^6 m^3 below non-gated spillway crest can not be secured if it is intended to reduce the width by increasing the overflow depth. Accordingly, the joint use of the non-gated and gated spillway was considered as shown in Figs. K-9. The most suitable and economical energy dissipator resulted in the stilling basin type with a sub dam at its downstream end.

(4) Water supply tunnel

A water supply tunnel for supplying water of 3.7 m^3/s to the K-C-C area is required to be provided from the Karian dam reservoir to the Cibeureum river. It was intended to be aligned along the shortest route and then, the inlet in the Karian dam reservoir was located about 13 km upstream of the Karian dam on the right bank, resulting in the total tunnel length of 1,500 m. The level of the tunnel inlet was set at El. 42 m, taking into consideration the estimated 100 years silting level of the Karian dam. The calculation of the required tunnel diameter indicated 1.6 m. The diameter, however, was determined at 2.5 m which is considered to be the economical minimum diameter in the actual construction work.

Principal Features (Karian Dam)

A. Dam:

Dam type	Zoned rockfill type with center core
Crest level	El. 70 m
Dam height	52 m from river bed level
High water level	El. 65.5 m
Flood water level	El. 67.5 m
Low water level	El. 44.0 m
Dam slope	Upstream: 1:3.0 Downstream: 1:2.5
Dam volume	1.10 x 10^6 m^3
Effective storage	218 x 10^6 m^3 including 30 x 10^6 m^3 of flood control volume

B. Spillway:

Design flood	1,600 m^3/s (P.M.F.)
Overflow crest length	Non-gated: 70 m Gated: 16 m
Overflow crest level	Non-gated: El. 65.5 m Gated: El. 56.9 m
Spillway gate	8.0 x 8.6 m sluice gate (2 sets)
Energy dissipator:	
Type	Stilling basin type with subdam
Floow level	El. 33.5 m
Length	90 m

C. Water Supply Facility:

Water supply tunnel:	
Type	Standard horse shoe shape
Length	1,500 m
Diameter	2.5 m
Inlet level	El. 42.0 m
Design discharge	3.7 m^3/s

D. Diversion Tunnel:

Type	Standard horse shoe shape
Length	400 m
Diameter	10 m
Design discharge	600 m^3/s (10 years recurrence flood)

4.1.4 Cost estimate

The preliminary construction cost estimate is made based on the estimated unit price and measured quantity of each work item.

In estimating the unit price of each work item, reference was made to that of such similar project in Indonesia as the Upper Jatirhur Irrigation Project. Necessary adjustment was also made on the basis of the construction planning. The unit prices estimated as mentioned are summarized in Table K-12.

The quantity of each work item was measured based on the preliminary design carried out.

The construction cost includes the cost items not to be estimated on the basis of unit price such as the engineering service and government administration, and physical contingency. These are estimated applying the usual percentage for the total direct construction cost which has been experienced in similar kind of projects. Applied percentage for the engineering service and government administration is 15% of the direct construction cost. For the physical contingency, it is 20% of the sum of the direct construction cost and engineering service and government administration. The construction cost also includes the compensation cost for the houses and lands to be submerged by the proposed reservoir. This cost was estimated as broken down in Table K-15 based on the investigated unit compensation cost and quantity to be submerged.

The breakdown of direct construction cost is given in Table K-13 together with the estimated unit prices and measured work quantities. The total construction cost of the Karian dam is summarized in Table K-17. It resulted in Rp 71,820 x 10^6.

4.1.5 Construction planning

The construction planning is preliminarily carried out as follows, taking into consideration the site conditions and assuming the construction works on the usual international contract base.

The site conditions allow the usual construction procedure of a rockfill dam, i.e. the application of the usual river diversion system with a diversion tunnel in the bank and cofferdams, and the dam embankment method by using the usual loading and transportation equipment. Thus, the construction planning is made on the assumption of the said usual construction procedure of a rockfill dam.

The diversion tunnel work of 10 m in diameter and 400 m in length was assessed to take about ten months for its completion including six months for the tunnel excavation and four months for concrete lining and others. Therefore, assuming the tunnel work will commence after preparatory works such as access roads and necessary temporary facilities in the first year, the completion of the diversion tunnel will be at the beginning of the dry season in the second year.

Two dry seasons at least are required for the dam embankment work, taking into account the core embankment of 50 to 60 m in height. Assuming that the dam embankment work will start after river diversion and successive excavation works in the second year, the completion of the dam embankment will be at the end of fourth year.

The spillway works can be done almost in parallel with the dam embankment work and will be completed together with the dam embankment, except the installation of the spillway gates which requires more five months.

The water supply tunnel works can be done independently from the dam works. The available time to complete it together with the dam will be sufficient.

As stated, the construction works will take about 4.5 years. In addition to the above, about two years will be required for the financing, detailed investigations, tender design and contracting, resulting in about 6.5 years in total.

The construction time schedule established preliminarily for the Karian dam is as given in Fig. K-11.

4.2 Cilawang Dam

4.2.1 Topography and geology

The Cibeureum river at the Cilawang site has a width of about 15 m. The river bed elevation is around El. 50 m. The river channel shows a considerable meandering route. Both the banks at the dam site show a relatively steep slope of about 20° up to around El. 80 m and the gentle slope of about 5° above it. Therefore, the dam height at this site is limited to about 25 to 30 m from the topographic condition.

The geology of the dam site is generally same as that of the Karian dam site which is explained in the preceding section 4.1.1 except much smaller terrace deposits on both the banks compared with the Karian dam site.

4.2.2 Selection of dam type

A concrete gravity dam is chosen as the dam type of the Cilawang dam for the following reasons:

(1) The terrace deposits in the area are of very minor scale, and therefore, the dam materials for a fill type dam are not available nearby.

(2) Although the foundation base rock consists of soft and weak tuff, a low concrete gravity dam of 25 to 30 m in height will be possible to be constructed, provided with a wide base.

(3) In the case of a concrete dam, overtopping of the dam during construction can be allowed. Therefore, the cost necessary for the river diversion system can be much saved.

(4) The spillway structure can be provided in the dam body, making it unnecessary to excavate in the bank for the spillway structure like the fill type dam, which will largely save the cost for the spillway structure.

4.2.3 Preliminary design of the dam

The preliminary design prepared for the Cilawang dam is given in Fig. K-10. The principal features of the design are summarized at the end of this subsection.

Major considerations in the preliminary design of the Cilawang dam are as below.

(1) Dam

The study of the development plan disclosed that the Cilawang dam should be developed at its maximum scale as far as the technical conditions permit. Based on the above study, the Cilawang dam is provided with the crest level at El. 75.0 m which is deemed nearly maximum topographically and can meet the required effective storage volume. Then, the dam height resulted in 28 m from the foundation rock surface in the river channel portion.

The dam is considered the concrete gravity type for the reasons explained in Sub-section 4.2.2. In consideration of the weak foundation rock condition, the dam is designed provided with a wide base mat to ensure the necessary safety for sliding.

(2) Spillway

The probable maximum flood at the dam site in the Cibeureum river is estimated to be 780 m^3/s. The spillway was designed to have a capacity to pass the above flood in accordance with the standard. The economical arrangement of the spillway to satisfy the above requirement resulted in four bays of spillway, each having 6 m in width and overflow crest level at El. 66.5 m and gated with a radial gate of 6 m in width and 6.5 m in height. The spillway structure is possible to be provided in the dam body in the case of a concrete gravity dam as stated, and therefore, the structure is provided in the dam body of the river channel portion.

Similar to the Karian dam, the stilling basin type with a subdam at its end is adopted as the most economical and effective type of energy dissipator.

(3) Water supply tunnel

According to the development plan, the water supply of 1.9 m^3/s from the Cilawang reservoir to the Cicinta area is required. The shortest route of the water supply tunnel for the above purpose was found to be the route from about 3 km upstream of the Cilawang dam site to the upstream reach of the Cicinta river. The required total length of the tunnel is 1,525 m. The tunnel diameter was determined to be 2.5 m which is the minimum diameter in view of the actual construction, since the theoretically required diameter of the tunnel was worked out at 1.4 m. The bottom elevation of the tunnel inlet was set at El. 55.0 m, considering the 100 years silting level of the Cilawang reservoir. It was also found that there is no problem in the necessary covering thickness and geological condition for tunnelling.

Principal Features (Cilawang Dam)

A. Dam:

Dam type	Concrete gravity dam with concrete mat
Crest level	El. 75.0 m
Dam height	28 m
Crest length	190 m
Dam slope	Upstream: 1:0.1 Downstream: 1:0.8
High water level	El. 73.0 m
Low water level	El. 57.0 m
Effective storage	54×10^6 m^3
Dam volume	70×10^3 m^3

B. Spillway:

Design flood	780 m^3/s (P.M.F.)
Type	Gated Chuteway
Number of bays	4 Nos.
Gate	4 radial gate (6 m wide x 6.5 m high)
Energy dissipator:	
Type	Stilling basin type with a subdam
Floor level	El. 47.0 m
Length	50 m

C. Water Supply Tunnel:

Type	Standard horse shoe shape
Tunnel length	1,525 m
Tunnel diameter	2.5 m
Inlet bottom level	El. 55.0 m
Design discharge	1.9 m^3/s

4.2.4 Cost estimate

The construction cost estimate for the Cilawang dam was made in the same procedure as the case of the Karian dam explained in the preceding subsection 4.1.4.

The estimated total construction cost is shown in Tables K-14 and K-16, and summarized in Table K-17. The total construction cost of the Cilawang dam resulted in Rp $23,170 \times 10^6$.

4.2.5 Construction planning

In view that the concrete dam allows the overtopping during construction and for the purpose of saving the cost, the river diversion in the Cilawang dam construction work is considered to be done by means of the partial river coffering instead of the usual river diversion system with a diversion tunnel and cofferdams.

After the preparatory works such as access roads, concrete plants and aggregate plants, etc., the coffering to enclose the dam construction area in the right half portion of the river channel will be made with earth materials at the beginning of the dry season in the first year of the construction work. With this arrangement that river discharge flows in another half of the river, the dam concreting in the right half portion of the river can mostly be completed by the end of the dry season in the first year. The dam concreting in the left half portion of the river will be made during the dry season in the second year, making the following arrangements:

(1) The coffering in the right half portion will be removed when the dam concreting in the right half portion is placed higher than the coffering.

(2) A coffering to enclose the dam work area in the left half portion will be provided at the beginning of the dry season in the second year. The river flow will be diverted through temporary diversion conduits provided in the right half dam body constructed already.

As such, all the dam concrete will be possible to be completed by the end of dry season in the second year. The installation of spillway radial gates can be made by availing the first/second year rainy season when the dam concreting will be interrupted.

The water supply tunnel works can be done independently without any relation with the dam works, handling of the river and seasons, etc. About 1,500 m long tunnel work is estimated to take about 1.5 years. Then, commencing the work at the beginning of dry season in the first year, the work can be completed at the same time as the dam completion, i.e. at the end of the second year.

As mentioned, the construction works of the Cilawang dam will take two years. Besides the above period necessary for construction works, about two years will be required for the financing, detailed investigation, tender design and contracting, resulting in four years in total.

The construction time schedule established for the Cilawang dam is given in Fig. K-11.

4.3 Disbursement Schedule

The disbursement schedule of construction costs for the proposed Karian and Cilawang dams is prepared as tabulated in Table K-19, based on the construction time schedules as given in Fig. K-11. For the reference to economic comparison, the construction cost of the Pasir Kopo dam and its disbursement schedule are shown in Tables K-18 and K-19. The estimated cost is needed for constructing the Pasir Kopo dam with the effective storage capacity of 83 x 10^6 m^3 comprising 68 x 10^6 m^3 for irrigation to meet the water demand in the Ciujung irrigation scheme and 15 x 10^6 m^3 for flood control.

Table K-1 PRINCIPAL FEATURE OF SCREENED DAM SITES

Item		Karian	Cilawang	Pasir Kopo	Bojongmanik	Cibanten	Cidanau*	Kali Anyer*
Hydrological Condition								
Catchment area	km^2	288	93.1	172	159	76	211.8	36.5
Reservoir area	km^2	16.1	7.6	9.0	3.6	0.9	1.0	9.5
Annual runoff	10^6 m^3	760	249	341	294	74	478	36
Annual rainfall	mm	2,700	2,900	3,100	3,200	2,100	3,100	2,600
Feature of Dam								
Dam type		Rockfill	Rockfill (Concrete)	Rockfill	Rockfill	Concrete	Rockfill (Concrete)	Rockfill (Concrete)
Elevation of top of dam	m	70	75	115	90	110	70	50
Dam height	m	52	28	67	47	36	45	25
Crest length	m	510	190	245	330	210	340	560
Top width	m	10	10	10	10	10	10	10
Dam volume	10^6 m^3	1.11	0.207 (0.070)	1.19	0.84	0.36 (0.087)	0.67	0.55 (0.133)
Feature of Reservoir								
Storage capacity	10^6 m^3	261.2	69.0	162.5	56	9.9	17.0	7.0
Active storage capacity	10^6 m^3	218	54	136.7	33.0	4.3	1.1	1.5
Dead storage	10^6 m^3	43.2	15.0	25.8	23.0	5.6	15.9	5.5
Flood storage	10^6 m^3	30	0	15	16	-	-	-
Storage Efficiency/1		196	261 (771)	115	39	12 (49)	2	3 (12)

Remarks: Features of dam are determined based on 1/5,000 topographic map but dams with a mark (*) are studied based on 1/50,000 topographic map.
/1 = Storage efficiency = Active storage capacity ÷ Dam volume

Table K-2 IRRIGATION DIVERSION REQUIREMENT FOR CIUJUNG, K-C-C AND CICINTA SCHEMES IN CASE OF 200% CROPPING INTENSITY

Unit: m^3/s

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
Ciujung											
Jan	4.4	8.5	7.8	11.8	2.1	7.2	14.2	1.1	8.8	7.2	10.7
Feb	19.4	5.4	7.1	18.0	20.6	8.4	18.5	22.8	3.7	13.3	24.0
Mar	14.0	15.6	17.8	24.3	27.4	16.6	11.3	20.4	23.1	22.2	20.4
Apr	16.3	13.8	12.8	14.9	11.5	13.5	11.7	13.5	11.4	13.5	14.9
May	20.9	21.5	21.5	25.9	26.3	20.9	27.0	18.7	20.5	17.9	23.4
Jun	30.5	25.8	18.9	29.5	28.9	19.9	18.6	29.7	23.4	26.1	28.2
Jul	29.2	23.9	21.3	25.6	28.1	28.1	22.9	25.1	25.1	21.3	27.3
Aug	26.4	23.0	25.9	25.2	24.1	26.7	21.5	23.7	21.9	21.2	26.7
Sep	5.5	9.4	6.3	10.1	10.4	10.4	8.9	8.5	8.8	8.9	10.9
Oct	-	-	-	-	-	-	-	-	-	-	-
Nov	15.0	10.5	8.8	13.5	12.5	17.2	14.2	13.1	12.0	4.8	15.5
Dec	22.9	15.2	7.5	9.0	17.6	16.0	9.4	14.7	11.5	15.1	27.0
K-C-C											
Jan	3.6	4.8	4.8	5.9	2.8	4.6	6.6	1.3	5.1	4.6	5.7
Feb	8.1	3.5	4.1	7.5	8.4	4.5	7.8	9.1	2.9	5.9	9.5
Mar	4.8	5.3	5.8	7.6	5.3	5.4	4.1	6.5	7.3	7.0	6.5
Apr	3.7	3.2	3.0	3.5	2.7	3.1	2.8	2.7	2.7	3.1	3.4
May	9.5	9.8	9.7	11.1	11.1	9.5	11.3	8.1	9.5	8.6	10.2
Jun	11.3	10.0	8.1	11.1	11.1	8.4	8.1	11.1	9.4	10.1	10.6
Jul	11.2	9.8	8.7	10.1	10.9	11.1	9.3	9.9	9.8	8.8	10.1
Aug	5.9	5.2	5.8	5.6	5.4	5.9	5.0	5.4	5.0	4.9	5.9
Sep	-	-	-	-	-	-	-	-	-	-	-
Oct	-	-	-	-	-	-	-	-	-	-	-
Nov	6.9	5.4	4.8	6.3	6.0	7.5	6.6	6.2	5.9	3.6	7.1
Dec	10.0	7.8	5.6	6.1	8.5	8.0	6.2	8.7	6.8	7.8	11.5
Cicinta											
Jan	0.7	1.0	0.9	1.2	0.6	0.9	1.3	0.3	1.0	0.9	1.1
Feb	1.4	0.5	0.7	1.3	1.5	0.7	1.4	1.6	0.4	1.0	1.7
Mar	0.9	1.0	1.0	1.5	1.0	1.0	0.7	1.2	1.4	1.4	1.3
Apr	1.2	2.1	2.0	2.3	1.8	2.0	1.8	2.1	1.8	2.0	2.3
May	1.9	1.9	1.9	2.2	2.2	1.9	2.2	1.7	1.9	1.7	2.0
Jun	2.0	1.8	1.5	1.9	1.9	1.5	1.5	1.9	1.7	1.8	1.9
Jul	2.0	1.8	1.5	1.8	2.0	2.0	1.7	1.8	1.8	1.6	1.8
Aug	-	-	-	-	-	-	-	-	-	-	-
Sep	-	-	-	-	-	-	-	-	-	-	-
Oct	-	-	-	-	-	-	-	-	-	-	-
Nov	2.5	2.0	1.8	2.3	2.2	2.8	2.4	2.3	2.2	1.3	2.6
Dec	1.5	1.2	0.9	1.0	1.3	1.2	1.0	1.2	1.1	1.2	2.4

Table K-3 (1/11) ESTIMATION OF REQUIRED STORAGE CAPACITY OF THE KARIAN DAM IN 1972

Unit: m^3/s

Item	A	M	J	J	A	S	O
A. K-C-C irrigation scheme							
1. Available discharge at Gadeg							
(1) Discharge at the weir	7.8	10.2	2.4	1.3	2.0	0.6	0.9
(2) Maintenance flow/1	0.4	0.4	0.4	0.4	0.4	0.4	0.4
(3) Available discharge	7.4	9.8	2.0	0.9	1.6	0.2	0.5
2. Irrigation water demand	3.7	9.5	11.3	11.2	5.9	0	0
3. Water deficit	0	0	9.3	10.3	4.3	0	0
4. Required supply/2	0	0	10.3	11.4	4.8	0	0
B. Ciujung irrigation scheme and water supply							
1. Available discharge at the Pamarayan weir							
(1) Discharge at the weir	82.0	107.6	24.8	13.8	21.4	6.4	9.5
(2) Maintenance flow/1	4.7	4.7	4.7	4.7	4.7	4.7	4.7
(3) Shut down/3	23.9	31.3	7.2	4.0	6.2	1.9	2.8
(4) Available discharge	53.4	71.6	12.9	5.1	10.5	-0.2	2.0
2. Water demand							
(1) Irrigation	16.3	20.9	30.5	29.2	26.4	5.5	0
(2) D&I water supply	1.3	1.3	1.3	1.3	1.3	1.3	1.3
(3) Total water demand	17.6	22.2	31.8	30.5	27.7	6.8	1.3
3. Water deficit	0	0	18.9	25.4	17.2	7.0	0
4. Required supply/4	0	0	27.0	36.3	24.6	10.0	0
C. Balance at the Karian dam							
1. Required supply							
(1) to Gadeg weir	0	0	10.3	11.4	4.8	0	0
(2) to Pamarayan weir	0	0	27.0	36.3	24.6	10.0	0
(3) to Rangkasbitung/5	0.1	0.1	0.1	0.1	0.1	0.1	0.1
(4) Maintenance flow	1.4	1.4	-	-	-	-	1.4
(5) Total required supply	1.5	1.5	37.4	47.8	29.5	10.1	1.5
2. Evaporation loss	0.6	0.6	0.6	0.6	0.6	0.6	0.6
3. Total withdrawal	2.1	2.1	38.0	48.4	30.1	10.7	2.1
4. Discharge at the dam	23.9	31.3	7.2	4.0	6.2	1.9	2.8
D. Required storage capacity			$286 \times 10^6\ m^3$				

Remarks: /1 = Maintenance flow = 0.324 $m^3/s/100\ km^2$ (Ref. Appendix B)
/2 = Required supply = Water deficit x 1/0.9
/3 = Discharge at the Karian dam
/4 = Required supply = Water deficit x 1/0.7
/5 = Direct supply to Rangkasbitung town for domestic water

Table K-3 (2/11) ESTIMATION OF REQUIRED STORAGE CAPACITY OF THE KARIAN DAM IN 1973

Unit: m^3/s

Item	A	M	J	J	A	S	O
A. K-C-C irrigation scheme							
1. Available discharge at Gadeg							
(1) Discharge at the weir	16.8	18.4	10.3	4.7	6.2	12.2	10.6
(2) Maintenance flow/1	0.4	0.4	0.4	0.4	0.4	0.4	0.4
(3) Available discharge	16.4	18.0	9.9	4.3	5.8	11.8	10.2
2. Irrigation water demand	3.2	9.8	10.0	9.8	5.2	0	0
3. Water deficit	0	0	0.1	5.5	0	0	0
4. Required supply/2	0	0	0.1	6.1	0	0	0
B. Ciujung irrigation scheme and water supply							
1. Available discharge at the Pamarayan weir							
(1) Discharge at the weir	177.3	193.6	108.6	49.7	65.2	128.1	111.7
(2) Maintenance flow/1	4.7	4.7	4.7	4.7	4.7	4.7	4.7
(3) Shut down/3	51.6	56.4	31.6	14.5	19.0	37.3	32.5
(4) Available discharge	121.0	132.5	72.3	30.5	41.5	86.1	74.5
2. Water demand							
(1) Irrigation	13.8	21.5	25.8	23.9	23.0	9.4	0
(2) D&I water supply	1.3	1.3	1.3	1.3	1.3	1.3	1.3
(3) Total water demand	15.1	22.8	27.1	25.2	24.3	10.7	1.3
3. Water deficit	0	0	0	0	0	0	0
4. Required supply/4	0	0	0	0	0	0	0
C. Balance at the Karian dam							
1. Required supply							
(1) to Gadeg weir	0	0	0.1	6.1	0	0	0
(2) to Pamarayan weir	0	0	0	0	0	0	0
(3) to Rangkasbitung/5	0.1	0.1	0.1	0.1	0.1	0.1	0.1
(4) Maintenance flow	1.4	1.4	1.4	-	1.4	1.4	1.4
(5) Total required supply	1.5	1.5	1.6	6.2	1.5	1.5	1.5
2. Evaporation loss	0.6	0.6	0.6	0.6	0.6	0.6	0.6
3. Total withdrawal	2.1	2.1	2.2	6.8	2.1	2.1	2.1
4. Discharge at the dam	51.6	56.4	31.6	14.5	19.0	37.3	32.5
D. Required storage capacity				None			

Remarks: /1 = Maintenance flow = 0.324 $m^3/s/100\ km^2$ (Ref. Appendix B)
/2 = Required supply = Water deficit x 1/0.9
/3 = Discharge at the Karian dam
/4 = Required supply = Water deficit x 1/0.7
/5 = Direct supply to Rangkasbitung town for domestic water

Table K-3 (3/11) ESTIMATION OF REQUIRED STORAGE CAPACITY OF THE KARIAN DAM IN 1974

Unit: m^3/s

Item	A	M	J	J	A	S	O
A. K-C-C irrigation scheme							
1. Available discharge at Gadeg							
(1) Discharge at the weir	11.2	12.5	5.7	6.4	8.9	17.3	9.4
(2) Maintenance flow/1	0.4	0.4	0.4	0.4	0.4	0.4	0.4
(3) Available discharge	10.8	12.1	5.3	6.0	8.5	16.9	9.0
2. Irrigation water demand	3.0	9.7	8.1	8.7	5.8	0	0
3. Water deficit	0	0	2.8	2.7	0	0	0
4. Required supply/2	0	0	3.1	3.0	0	0	0
B. Ciujung irrigation scheme and water supply							
1. Available discharge at the Pamarayan weir							
(1) Discharge at the weir	117.8	131.1	59.6	67.2	93.2	182.4	98.5
(2) Maintenance flow/1	4.7	4.7	4.7	4.7	4.7	4.7	4.7
(3) Shut down/3	34.3	38.2	17.4	19.6	27.2	53.1	28.7
(4) Available discharge	78.8	88.2	37.5	42.9	61.3	124.6	65.1
2. Water demand							
(1) Irrigation	12.8	21.5	18.9	21.3	25.9	6.3	0
(2) D&I water supply	1.3	1.3	1.3	1.3	1.3	1.3	1.3
(3) Total water demand	14.1	22.8	20.2	22.6	27.2	7.6	1.3
3. Water deficit	0	0	0	0	0	0	0
4. Required supply/4	0	0	0	0	0	0	0
C. Balance at the Karian dam							
1. Required supply							
(1) to Gadeg weir	0	0	3.1	3.0	0	0	0
(2) to Pamarayan weir	0	0	0	0	0	0	0
(3) to Rangkasbitung/5	0.1	0.1	0.1	0.1	0.1	0.1	0.1
(4) Maintenance flow	1.4	1.4	-	-	1.4	1.4	1.4
(5) Total required supply	1.5	1.5	3.2	3.1	1.5	1.5	1.5
2. Evaporation loss	0.6	0.6	0.6	0.6	0.6	0.6	0.6
3. Total withdrawal	2.1	2.1	3.8	3.7	2.1	2.1	2.1
4. Discharge at the dam	34.3	38.2	17.4	19.6	27.2	53.1	28.7
D. Required storage capacity				None			

Remarks:
/1 = Maintenance flow = 0.324 $m^3/s/100\ km^2$ (Ref. Appendix B)
/2 = Required supply = Water deficit x 1/0.9
/3 = Discharge at the Karian dam
/4 = Required supply = Water deficit x 1/0.7
/5 = Direct supply to Rangkasbitung town for domestic water

Table K-3 (4/11) ESTIMATION OF REQUIRED STORAGE CAPACITY OF THE KARIAN DAM IN 1975

Unit: m^3/s

Item	A	M	J	J	A	S	O
A. K-C-C irrigation scheme							
1. Available discharge at Gadeg							
(1) Discharge at the weir	5.4	6.9	4.1	6.0	8.8	13.1	7.3
(2) Maintenance flow/1	0.4	0.4	0.4	0.4	0.4	0.4	0.4
(3) Available discharge	5.0	6.5	3.7	5.6	8.4	12.7	6.9
2. Irrigation water demand	3.5	11.1	11.1	10.1	5.6	0	0
3. Water deficit	0	4.6	7.4	4.5	0	0	0
4. Required supply/2	0	5.1	8.2	5.0	0	0	0
B. Ciujung irrigation scheme and water supply							
1. Available discharge at the Pamarayan weir							
(1) Discharge at the weir	56.8	72.4	43.4	63.5	93.0	138.3	76.6
(2) Maintenance flow/1	4.7	4.7	4.7	4.7	4.7	4.7	4.7
(3) Shut down/3	16.5	21.1	12.7	18.5	27.1	40.3	22.3
(4) Available discharge	35.6	46.6	26.0	40.3	61.2	93.3	49.6
2. Water demand							
(1) Irrigation	14.9	25.9	29.5	25.6	25.2	10.1	0
(2) D&I water supply	1.3	1.3	1.3	1.3	1.3	1.3	1.3
(3) Total water demand	16.2	27.2	30.8	26.9	26.5	11.4	1.3
3. Water deficit	0	0	4.8	0	0	0	0
4. Required supply/4	0	0	6.9	0	0	0	0
C. Balance at the Karian dam							
1. Required supply							
(1) to Gadeg weir	0	5.1	8.2	5.0	0	0	0
(2) to Pamarayan weir	0	0	6.9	0	0	0	0
(3) to Rangkasbitung/5	0.1	0.1	0.1	0.1	0.1	0.1	0.1
(4) Maintenance flow	1.4	-	-	-	1.4	1.4	1.4
(5) Total required supply	1.5	5.2	15.2	5.1	1.5	1.5	1.5
2. Evaporation loss	0.6	0.6	0.6	0.6	0.6	0.6	0.6
3. Total withdrawal	2.1	5.8	15.8	5.7	2.1	2.1	2.1
4. Discharge at the dam	16.5	21.1	12.7	18.5	27.1	10.4	22.3
D. Required storage capacity				8×10^6 m^3			

Remarks:
/1 = Maintenance flow = 0.324 $m^3/s/100$ km^2 (Ref. Appendix B)
/2 = Required supply = Water deficit x 1/0.9
/3 = Discharge at the Karian dam
/4 = Required supply = Water deficit x 1/0.7
/5 = Direct supply to Rangkasbitung town for domestic water

Table K-3 (5/11) ESTIMATION OF REQUIRED STORAGE CAPACITY OF THE KARIAN DAM IN 1976

Unit: m^3/s

Item	A	M	J	J	A	S	O
A. K-C-C irrigation scheme							
1. Available discharge at Gadeg							
(1) Discharge at the weir	9.2	5.7	3.7	2.3	2.4	1.5	4.3
(2) Maintenance flow/1	0.4	0.4	0.4	0.4	0.4	0.4	0.4
(3) Available discharge	8.8	5.3	3.3	1.9	2.0	1.1	3.9
2. Irrigation water demand	2.7	11.1	11.1	10.9	5.4	0	0
3. Water deficit	0	5.8	7.8	9.0	3.4	0	0
4. Required supply/2	0	6.4	8.7	10.0	3.8	0	0
B. Ciujung irrigation scheme and water supply							
1. Available discharge at the Pamarayan weir							
(1) Discharge at the weir	97.2	59.8	38.6	24.0	24.9	15.4	45.0
(2) Maintenance flow/1	4.7	4.7	4.7	4.7	4.7	4.7	4.7
(3) Shut down/3	28.3	17.4	11.3	7.0	7.3	4.5	13.1
(4) Available discharge	64.2	37.7	22.6	12.3	12.9	6.2	27.2
2. Water demand							
(1) Irrigation	11.5	26.3	28.9	28.1	24.1	10.4	0
(2) D&I water supply	1.3	1.3	1.3	1.3	1.3	1.3	1.3
(3) Total water demand	12.8	27.6	30.2	29.4	25.4	11.7	1.3
3. Water deficit	0	0	7.6	17.1	12.5	5.5	0
4. Required supply/4	0	0	10.9	24.4	17.9	7.9	0
C. Balance at the Karian dam							
1. Required supply							
(1) to Gadeg weir	0	6.4	8.7	10.0	3.8	0	0
(2) to Pamarayan weir	0	0	10.9	24.4	17.9	7.9	0
(3) to Rangkasbitung/5	0.1	0.1	0.1	0.1	0.1	0.1	0.1
(4) Maintenance flow	1.4	-	-	-	-	-	1.4
(5) Total required supply	1.5	6.5	19.7	34.5	21.8	8.0	1.5
2. Evaporation loss	0.6	0.6	0.6	0.6	0.6	0.6	0.6
3. Total withdrawal	2.1	7.1	20.3	35.1	22.4	8.6	2.1
4. Discharge at the dam	28.3	17.4	11.3	7.0	7.3	4.5	13.1
D. Required storage capacity			150×10^6 m^3				

Remarks: /1 = Maintenance flow = 0.324 $m^3/s/100$ km^2 (Ref. Appendix B)
/2 = Required supply = Water deficit x 1/0.9
/3 = Discharge at the Karian dam
/4 = Required supply = Water deficit x 1/0.7
/5 = Direct supply to Rangkasbitung town for domestic water

Table K-3 (6/11) ESTIMATION OF REQUIRED STORAGE CAPACITY OF THE KARIAN DAM IN 1977

Unit: m^3/s

Item	A	M	J	J	A	S	O
A. K-C-C irrigation scheme							
1. Available discharge at Gadeg							
(1) Discharge at the weir	14.1	12.3	7.3	2.9	1.5	1.5	2.1
(2) Maintenance flow/1	0.4	0.4	0.4	0.4	0.4	0.4	0.4
(3) Available discharge	13.7	11.9	6.9	2.5	1.1	1.1	1.7
2. Irrigation water demand	3.1	9.5	8.4	11.1	5.9	0	0
3. Water deficit	0	0	1.5	8.6	4.8	0	0
4. Required supply/2	0	0	1.7	9.6	5.3	0	0
B. Ciujung irrigation scheme and water supply							
1. Available discharge at the Pamarayan weir							
(1) Discharge at the weir	148.6	129.7	76.9	30.5	16.1	15.9	22.3
(2) Maintenance flow/1	4.7	4.7	4.7	4.7	4.7	4.7	4.7
(3) Shut down/3	43.3	37.8	22.4	8.9	4.7	4.6	6.5
(4) Available discharge	100.6	87.2	49.8	16.9	6.7	6.6	11.1
2. Water demand							
(1) Irrigation	13.5	20.9	19.9	28.1	26.7	10.4	0
(2) D&I water supply	1.3	1.3	1.3	1.3	1.3	1.3	1.3
(3) Total water demand	14.8	22.2	21.2	29.4	28.0	11.7	1.3
3. Water deficit	0	0	0	12.5	21.3	5.1	0
4. Required supply/4	0	0	0	17.9	30.4	7.3	0
C. Balance at the Karian dam							
1. Required supply							
(1) to Gadeg weir	0	0	1.7	9.6	5.3	0	0
(2) to Pamarayan weir	0	0	0	17.9	30.4	7.3	0
(3) to Rangkasbitung/5	0.1	0.1	0.1	0.1	0.1	0.1	0.1
(4) Maintenance flow	1.4	1.4	-	-	-	-	1.4
(5) Total required supply	1.5	1.5	1.8	27.6	35.8	7.4	1.5
2. Evaporation loss	0.6	0.6	0.6	0.6	0.6	0.6	0.6
3. Total withdrawal	2.1	2.1	2.4	28.2	36.4	8.0	2.1
4. Discharge at the dam	43.3	37.8	22.4	8.9	4.7	4.6	8.7
D. Required storage capacity			145×10^6 m^3				

Remarks: /1 = Maintenance flow = 0.324 $m^3/s/100$ km^2 (Ref. Appendix B)
/2 = Required supply = Water deficit x 1/0.9
/3 = Discharge at the Karian dam
/4 = Required supply = Water deficit x 1/0.7
/5 = Direct supply to Rangkasbitung town for domestic water

Table K-3 (7/11) ESTIMATION OF REQUIRED STORAGE CAPACITY OF THE KARIAN DAM IN 1978

Unit: m^3/s

Item	A	M	J	J	A	S	O
A. K-C-C irrigation scheme							
1. Available discharge at Gadeg							
(1) Discharge at the weir	10.5	8.6	6.7	5.9	8.1	7.2	7.5
(2) Maintenance flow/1	0.4	0.4	0.4	0.4	0.4	0.4	0.4
(3) Available discharge	10.1	8.2	6.3	5.5	7.7	6.8	7.1
2. Irrigation water demand	2.8	11.3	8.1	9.3	5.0	0	0
3. Water deficit	0	3.1	1.8	3.8	0	0	0
4. Required supply/2	0	3.4	2.0	4.2	0	0	0
B. Ciujung irrigation scheme and water supply							
1. Available discharge at the Pamarayan weir							
(1) Discharge at the weir	110.7	90.6	70.4	62.6	85.6	75.7	79.0
(2) Maintenance flow/1	4.7	4.7	4.7	4.7	4.7	4.7	4.7
(3) Shut down/3	32.2	26.4	20.5	18.2	24.9	22.1	23.0
(4) Available discharge	73.8	59.5	45.2	39.7	56.0	48.9	51.3
2. Water demand							
(1) Irrigation	11.7	27.0	18.6	22.9	21.5	8.9	0
(2) D&I water supply	1.3	1.3	1.3	1.3	1.3	1.3	1.3
(3) Total water demand	13.0	28.3	19.9	24.2	22.8	10.2	1.3
3. Water deficit	0	0	0	0	0	0	0
4. Required supply/4	0	0	0	0	0	0	0
C. Balance at the Karian dam							
1. Required supply							
(1) to Gadeg weir	0	3.4	2.0	4.2	0	0	0
(2) to Pamarayan weir	0	0	0	0	0	0	0
(3) to Rangkasbitung/5	0.1	0.1	0.1	0.1	0.1	0.1	0.1
(4) Maintenance flow	1.4	-	-	-	1.4	1.4	1.4
(5) Total required supply	1.5	3.5	2.1	4.3	1.5	1.5	1.5
2. Evaporation loss	0.6	0.6	0.6	0.6	0.6	0.6	0.6
3. Total withdrawal	2.1	4.1	2.7	4.9	2.1	2.1	2.1
4. Discharge at the dam	32.3	20.3	20.5	18.2	24.9	22.1	23.0
D. Required storage capacity				None			

Remarks: /1 = Maintenance flow = 0.324 $m^3/s/100\ km^2$ (Ref. Appendix B)
/2 = Required supply = Water deficit x 1/0.9
/3 = Discharge at the Karian dam
/4 = Required supply = Water deficit x 1/0.7
/5 = Direct supply to Rangkasbitung town for domestic water

Table K-3 (8/11) ESTIMATION OF REQUIRED STORAGE CAPACITY OF THE KARIAN DAM IN 1979

Unit: m^3/s

Item	A	M	J	J	A	S	O
A. K-C-C irrigation scheme							
1. Available discharge at Gadeg							
(1) Discharge at the weir	16.1	6.2	4.0	4.3	2.6	3.2	3.2
(2) Maintenance flow/1	0.4	0.4	0.4	0.4	0.4	0.4	0.4
(3) Available discharge	15.7	5.8	3.6	3.9	2.2	2.8	2.8
2. Irrigation water demand	2.7	8.1	11.1	9.9	5.4	0	0
3. Water deficit	0	2.3	7.5	6.0	3.2	0	0
4. Required supply/2	0	2.6	8.3	6.7	3.6	0	0
B. Ciujung irrigation scheme and water supply							
1. Available discharge at the Pamarayan weir							
(1) Discharge at the weir	169.1	65.2	42.0	45.7	27.3	33.5	33.9
(2) Maintenance flow/1	4.7	4.7	4.7	4.7	4.7	4.7	4.7
(3) Shut down/3	49.3	19.0	12.2	13.3	7.9	9.8	9.9
(4) Available discharge	115.1	41.5	25.1	27.7	14.7	19.0	19.3
2. Water demand							
(1) Irrigation	13.5	18.7	29.7	25.1	23.7	8.5	0
(2) D&I water supply	1.3	1.3	1.3	1.3	1.3	1.3	1.3
(3) Total water demand	14.8	20.0	31.0	26.4	25.0	9.8	1.3
3. Water deficit	0	0	5.9	0	10.3	0	0
4. Required supply/4	0	0	8.4	0	14.7	0	0
C. Balance at the Karian dam							
1. Required supply							
(1) to Gadeg weir	0	2.6	8.3	6.7	3.6	0	0
(2) to Pamarayan weir	0	0	8.4	0	14.7	0	0
(3) to Rangkasbitung/5	0.1	0.1	0.1	0.1	0.1	0.1	0.1
(4) Maintenance flow	1.4	-	-	-	-	1.4	1.4
(5) Total required supply	1.5	2.7	16.8	6.8	18.4	1.5	1.5
2. Evaporation loss	0.6	0.6	0.6	0.6	0.6	0.6	0.6
3. Total withdrawal	2.1	3.3	17.4	7.4	19.0	2.1	2.1
4. Discharge at the dam	49.3	19.0	12.2	13.3	7.9	9.8	9.9
D. Required storage capacity			43×10^6 m^3				

Remarks: /1 = Maintenance flow = 0.324 $m^3/s/100\ km^2$ (Ref. Appendix B)
/2 = Required supply = Water deficit x 1/0.9
/3 = Discharge at the Karian dam
/4 = Required supply = Water deficit x 1/0.7
/5 = Direct supply to Rangkasbitung town for domestic water

Table K-3 (9/11) ESTIMATION OF REQUIRED STORAGE CAPACITY OF THE KARIAN DAM IN 1980

Unit: m^3/s

Item	A	M	J	J	A	S	O
A. K-C-C irrigation scheme							
1. Available discharge at Gadeg							
(1) Discharge at the weir	9.7	8.9	4.4	5.0	8.6	8.7	6.8
(2) Maintenance flow/1	0.4	0.4	0.4	0.4	0.4	0.4	0.4
(3) Available discharge	9.3	8.5	4.0	4.6	8.2	8.3	6.4
2. Irrigation water demand	2.7	9.5	9.4	9.8	5.0	0	0
3. Water deficit	0	1.0	5.4	5.2	0	0	0
4. Required supply/2	0	1.1	6.0	5.8	0	0	0
B. Ciujung irrigation scheme and water supply							
1. Available discharge at the Pamarayan weir							
(1) Discharge at the weir	102.7	93.8	46.2	52.5	90.3	91.5	71.4
(2) Maintenance flow/1	4.7	4.7	4.7	4.7	4.7	4.7	4.7
(3) Shut down/3	29.9	27.3	13.5	15.3	26.3	26.7	20.8
(4) Available discharge	68.1	61.8	28.0	32.5	59.3	60.1	45.9
2. Water demand							
(1) Irrigation	11.4	20.5	23.4	25.1	21.9	8.8	0
(2) D&I water supply	1.3	1.3	1.3	1.3	1.3	1.3	1.3
(3) Total water demand	12.7	21.8	24.7	26.4	23.2	10.1	1.3
3. Water deficit	0	0	0	0	0	0	0
4. Required supply/4	0	0	0	0	0	0	0
C. Balance at the Karian dam							
1. Required supply							
(1) to Gadeg weir	0	1.1	6.0	5.8	0	0	0
(2) to Pamarayan weir	0	0	0	0	0	0	0
(3) to Rangkasbitung/5	0.1	0.1	0.1	0.1	0.1	0.1	0.1
(4) Maintenance flow	1.4	1.4	-	-	1.4	1.4	1.4
(5) Total required supply	1.5	2.6	6.1	5.9	1.5	1.5	1.5
2. Evaporation loss	0.6	0.6	0.6	0.6	0.6	0.6	0.6
3. Total withdrawal	2.1	3.2	6.7	6.5	2.1	2.1	2.1
4. Discharge at the dam	29.9	27.3	13.5	15.3	26.3	26.7	20.8
D. Required storage capacity				None			

Remarks:
/1 = Maintenance flow = 0.324 $m^3/s/100\ km^2$ (Ref. Appendix B)
/2 = Required supply = Water deficit x 1/0.9
/3 = Discharge at the Karian dam
/4 = Required supply = Water deficit x 1/0.7
/5 = Direct supply to Rangkasbitung town for domestic water

Table K-3 (10/11) ESTIMATION OF REQUIRED STORAGE CAPACITY OF THE KARIAN DAM IN 1981

Unit: m^3/s

Item	A	M	J	J	A	S	O
A. K-C-C irrigation scheme							
1. Available discharge at Gadeg							
(1) Discharge at the weir	10.4	12.0	14.6	12.4	8.8	10.5	10.1
(2) Maintenance flow/1	0.4	0.4	0.4	0.4	0.4	0.4	0.4
(3) Available discharge	10.0	11.6	14.2	12.0	8.4	10.1	9.7
2. Irrigation water demand	3.1	8.6	10.1	8.8	4.9	0	0
3. Water deficit	0	0	0	0	0	0	0
4. Required supply/2	0	0	0	0	0	0	0
B. Ciujung irrigation scheme and water supply							
1. Available discharge at the Pamarayan weir							
(1) Discharge at the weir	109.3	126.2	153.4	130.9	92.3	110.9	105.8
(2) Maintenance flow/1	4.7	4.7	4.7	4.7	4.7	4.7	4.7
(3) Shut down/3	31.8	36.8	44.7	38.1	26.9	32.3	30.3
(4) Available discharge	72.8	85.1	104.0	88.1	60.7	73.9	70.8
2. Water demand							
(1) Irrigation	13.5	17.9	26.1	21.3	21.2	8.9	0
(2) D&I water supply	1.3	1.3	1.3	1.3	1.3	1.3	1.3
(3) Total water demand	14.8	19.2	27.4	22.6	22.5	10.2	1.3
3. Water deficit	0	0	0	0	0	0	0
4. Required supply/4	0	0	0	0	0	0	0
C. Balance at the Karian dam							
1. Required supply							
(1) to Gadeg weir	0	0	0	0	0	0	0
(2) to Pamarayan weir	0	0	0	0	0	0	0
(3) to Rangkasbitung/5	0.1	0.1	0.1	0.1	0.1	0.1	0.1
(4) Maintenance flow	1.4	1.4	1.4	1.4	1.4	1.4	1.4
(5) Total required supply	1.5	1.5	1.5	1.5	1.5	1.5	1.5
2. Evaporation loss	0.6	0.6	0.6	0.6	0.6	0.6	0.6
3. Total withdrawal	2.1	2.1	2.1	2.1	2.1	2.1	2.1
4. Discharge at the dam	31.9	36.8	44.7	38.2	26.9	32.3	30.8
D. Required storage capacity				None			

Remarks: /1 = Maintenance flow = 0.324 $m^3/s/100\ km^2$ (Ref. Appendix B)
/2 = Required supply = Water deficit x 1/0.9
/3 = Discharge at the Karian dam
/4 = Required supply = Water deficit x 1/0.7
/5 = Direct supply to Rangkasbitung town for domestic water

Table K-3 (11/11) ESTIMATION OF REQUIRED STORAGE CAPACITY OF THE KARIAN DAM IN 1982

Unit: m^3/s

Item	A	M	J	J	A	S	O
A. K-C-C irrigation scheme							
1. Available discharge at Gadeg							
(1) Discharge at the weir	8.2	5.8	2.5	2.1	0.9	0.6	1.7
(2) Maintenance flow/1	0.4	0.4	0.4	0.4	0.4	0.4	0.4
(3) Available discharge	7.8	5.4	2.1	1.7	0.5	0.2	1.3
2. Irrigation water demand	3.4	10.2	10.6	10.1	5.9	0	0
3. Water deficit	0	4.8	8.5	8.4	5.4	0	0
4. Required supply/2	0	5.3	9.4	9.3	6.0	0	0
B. Ciujung irrigation scheme and water supply							
1. Available discharge at the Pamarayan weir							
(1) Discharge at the weir	86.6	61.3	26.4	22.0	9.1	6.1	17.7
(2) Maintenance flow/1	4.7	4.7	4.7	4.7	4.7	4.7	4.7
(3) Shut down/3	25.2	17.9	7.7	6.4	2.7	1.8	5.2
(4) Available discharge	56.7	38.7	14.0	10.9	1.7	-0.4	7.8
2. Water demand							
(1) Irrigation	14.9	23.4	28.2	27.3	26.7	10.9	0
(2) D&I water supply	1.3	1.3	1.3	1.3	1.3	1.3	1.3
(3) Total water demand	16.2	24.7	29.5	27.6	28.0	12.2	1.3
3. Water deficit	0	0	15.5	16.7	26.3	12.6	0
4. Required supply/4	0	0	22.1	23.9	37.6	18.0	0
C. Balance at the Karian dam							
1. Required supply							
(1) to Gadeg weir	0	5.3	9.4	9.3	6.0	0	0
(2) to Pamarayan weir	0	0	22.1	23.9	37.6	18.0	0
(3) to Rangkasbitung/5	0.1	0.1	0.1	0.1	0.1	0.1	0.1
(4) Maintenance flow	1.4	-	-	-	-	-	1.4
(5) Total required supply	1.5	5.4	31.6	33.3	43.7	18.1	1.5
2. Evaporation loss	0.6	0.6	0.6	0.6	0.6	0.6	0.6
3. Total withdrawal	2.1	6.0	32.2	33.9	44.3	18.7	2.1
4. Discharge at the dam	25.2	17.9	7.7	6.4	2.7	1.8	5.2
D. Required storage capacity			292×10^6 m^3				

Remarks: /1 = Maintenance flow = 0.324 $m^3/s/100$ km^2 (Ref. Appendix B)
/2 = Required supply = Water deficit x 1/0.9
/3 = Discharge at the Karian dam
/4 = Required supply = Water deficit x 1/0.7
/5 = Direct supply to Rangkasbitung town for domestic water

Table K-4 SUMMARY OF REQUIRED STORAGE CAPACITY OF THE KARIAN DAM

Year	Peak Discharge (m^3/s) /1		Storage Capacity (10^6 m^3)
	to Gadeg	to Pamarayan	
1972	11.4	36.3	286
1973	6.1	-	0/2
1974	3.1	-	0/2
1975	8.2	6.9	8
1976	10.0	24.4	150
1977	9.6	30.4	145
1978	4.2	-	0/2
1979	8.3	14.7	43
1980	6.0	-	0/2
1981	-	-	-
1982	9.4	37.6	292

Remarks: /1 = Cropping intensity of 200% is assumed for the Ciujung (24,200 ha) and K-C-C (8,000 ha) irrigation schemes.

/2 = Dam is necessary but no storage capacity for irrigation is required.

Table K-5 ESTIMATION OF REQUIRED STORAGE CAPACITY FOR CASE 1

Unit: m^3/s

Item	A	M	J	J	A	S	O
A. K-C-C irrigation scheme							
1. Available discharge at Gadeg							
(1) Discharge at the weir	7.8	10.2	2.4	1.3	2.0	0.6	0.9
(2) Maintenance flow/1	0.4	0.4	0.4	0.4	0.4	0.4	0.4
(3) Available discharge	7.4	9.8	2.0	0.9	1.6	0.2	0.5
2. Irrigation water demand	2.8	7.3	8.7	8.6	4.5	0	0
3. Water deficit	0	0	6.7	7.7	2.9	0	0
4. Required supply/2	0	0	7.4	8.6	3.2	0	0
B. Ciujung irrigation scheme and water supply							
1. Available discharge at the Pamarayan weir							
(1) Discharge at the weir	82.0	107.6	24.8	13.8	21.4	6.4	9.5
(2) Maintenance flow/1	4.7	4.7	4.7	4.7	4.7	4.7	4.7
(3) Shut down/3	23.9	31.3	7.2	4.0	6.2	1.9	2.8
(4) Available discharge	53.4	71.6	12.9	5.1	10.5	-0.2	2.0
2. Water demand							
(1) Irrigation	12.6	16.1	23.5	22.5	20.3	4.2	0
(2) D&I water supply	1.3	1.3	1.3	1.3	1.3	1.3	1.3
(3) Total water demand	13.9	17.4	24.8	23.8	21.6	5.5	1.3
3. Water deficit	0	0	11.9	18.7	11.1	5.7	0
4. Required supply/4	0	0	17.0	26.7	15.9	8.1	0
C. Balance at the Karian dam							
1. Required supply							
(1) to Gadeg weir	0	0	7.4	8.6	3.2	0	0
(2) to Pamarayan weir	0	0	17.0	26.7	15.9	8.1	0
(3) to Rangkasbitung (domestic water supply)	0.1	0.1	0.1	0.1	0.1	0.1	0.1
(4) Maintenance flow/1	1.4	1.4	-	-	-	-	1.4
(5) Total required supply	1.5	1.5	24.5	35.4	19.2	8.2	1.5
2. Evaporation loss	0.6	0.6	0.6	0.6	0.6	0.6	0.6
3. Total withdrawal	2.1	2.1	25.1	36.0	19.8	8.8	2.1
4. Discharge at Karian	23.9	31.3	7.2	4.0	6.2	1.9	2.8
5. Required storage capacity		188 x 10^6 m^3					

Remarks: /1 = Maintenance flow = 0.324 $m^3/s/100\ km^2$
/2 = Required supply = Water deficit x 1/0.9
/3 = Discharge at the Karian dam site
/4 = Required supply = Water deficit x 1/0.7

Table K-6 ESTIMATION OF REQUIRED STORAGE CAPACITY FOR CASE 2

Unit: m^3/s

Item	A	M	J	J	A	S	O
A. K-C-C irrigation scheme							
1. Available discharge at Gadeg							
(1) Discharge at the weir	7.8	10.2	2.4	1.3	2.0	0.6	0.9
(2) Maintenance flow/1	0.4	0.4	0.4	0.4	0.4	0.4	0.4
(3) Available discharge	7.4	9.8	2.0	0.9	1.6	0.2	0.5
2. Irrigation water demand	3.7	9.5	11.3	11.2	5.9	0	0
3. Water deficit	0	0	9.3	10.3	4.3	0	0
4. Required supply/2	0	0	10.3	11.4	4.8	0	0
B. Ciujung irrigation scheme and water supply							
1. Available discharge at the Pamarayan weir							
(1) Discharge at the weir	82.0	107.6	24.8	13.8	21.4	6.4	9.5
(2) Maintenance flow	4.7	4.7	4.7	4.7	4.7	4.7	4.7
(3) Shut down/3	36.7	48.1	11.1	6.2	9.6	2.9	4.3
(4) Available discharge	40.6	54.8	9.0	2.9	7.1	-1.2	0.5
2. Water demand							
(1) Irrigation	14.1	18.1	26.4	25.3	22.9	4.8	0
(2) D&I water supply	1.3	1.3	1.3	1.3	1.3	1.3	1.3
(3) Total water demand	15.4	19.4	27.7	26.6	24.2	6.1	1.3
3. Water deficit	0	0	18.7	23.7	17.1	7.3	0.8
4. Required supply/4	0	0	26.7	33.9	24.4	10.4	1.1
C. Balance at the Karian dam							
1. Required supply							
(1) to Gadeg weir	0	0	10.3	11.4	4.8	0	0
(2) to Pamarayan weir	0	0	26.7	33.9	24.4	10.4	1.1
(3) to Rangkasbitung	0.1	0.1	0.1	0.1	0.1	0.1	0.1
(4) Maintenance flow	1.4	1.4	-	-	-	-	1.4
(5) Total required supply	1.5	1.5	37.1	45.4	29.3	10.5	1.5
2. Evaporation loss	0.6	0.6	0.6	0.6	0.6	0.6	0.6
3. Total withdrawal	2.1	2.1	37.7	46.0	29.9	11.1	2.1
4. Discharge at Karian	23.9	31.3	7.2	4.0	6.2	1.9	2.8
5. Supply capacity	2.1	2.1	26.6	26.6	26.6	10.6	2.1
6. Required storage capacity			188×10^6 m^3				
D. Balance at the Pasir Kopo dam							
1. Required supply							
(1) to Pamarayan weir	0	0	11.1	19.4	3.3	0.5	0
(2) Maintenance flow/1	0.8	0.8	-	-	-	0.3	0.8
(3) Total required supply	0.8	0.8	11.1	19.4	3.3	0.8	0.8
2. Evaporation loss	0.3	0.3	0.3	0.3	0.3	0.3	0.3
3. Total withdrawal	1.1	1.1	11.4	19.7	3.6	1.1	1.1
4. Discharge at Pasir Kopo	12.8	16.8	3.9	2.2	3.4	1.0	1.5
5. Required storage capacity			68×10^6 m^3				

Remarks: /1 = Maintenance flow = 0.324 $m^3/s/100\ km^2$
/2 = Required supply = Water deficit x 1/0.9
/3 = Discharge at the Karian dam site
/4 = Required supply = Water deficit x 1/0.7

Table K-7 ESTIMATION OF REQUIRED STORAGE CAPACITY FOR CASE 3

Unit: m^3/s

Item	A	M	J	J	A	S	O
A. Cicinta irrigation scheme							
1. Available discharge at the weir							
(1) Mean discharge	1.5	2.0	0.5	0.3	0.4	0.1	0.2
(2) Maintenance flow/1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
(3) Available discharge	1.4	1.9	0.4	0.4	0.3	0	0.1
2. Irrigation water demand	1.1	1.7	1.7	1.7	0	0	0
3. Water deficit	0	0	1.3	1.3	0	0	0
4. Required supply/2	0	0	1.9	1.9	0	0	0
B. K-C-C irrigation scheme							
1. Available discharge at Gadeg							
(1) Discharge at the weir	7.8	10.2	2.4	1.3	2.0	0.6	0.9
(2) Maintenance flow/1	0.4	0.4	0.4	0.4	0.4	0.4	0.4
(3) Shut down	6.4	8.4	1.9	1.1	1.7	0.5	0.7
(4) Available discharge	1.0	1.4	0.1	-0.2	-0.1	-0.3	-0.2
2. Irrigation water demand	3.2	8.3	9.8	9.7	5.2	0	0
3. Water deficit	2.2	6.9	9.7	9.9	5.2	0.3	0.2
4. Required supply/3	2.4	7.7	10.8	11.0	5.8	0.3	0.2
C. Cilawang dam							
1. Total required supply	2.4	7.7	12.7	12.9	5.8	0.3	0.2
2. Evaporation loss	0.3	0.3	0.3	0.3	0.3	0.3	0.3
3. Total withdrawal	2.7	8.0	9.5	9.5	6.1	0.6	0.5
4. Discharge at the dam	6.4	8.4	1.9	1.1	1.7	0.5	0.7
5. Required storage capacity		54×10^6 m^3					
D. Diversion requirement	0	0	3.5	3.7	0	0	0
E. Ciujung irrigation scheme and water supply							
1. Available discharge at the Pamarayan weir							
(1) Discharge at the weir	82.0	107.6	24.8	13.8	21.4	6.4	9.5
(2) Maintenance flow/1	4.7	4.7	4.7	4.7	4.7	4.7	4.7
(3) Shut down	23.9	31.3	7.2	4.0	6.2	1.9	2.8
(4) Available discharge	53.4	71.6	12.9	5.1	10.5	-0.2	2.0
2. Water demand							
(1) Irrigation	14.1	18.1	26.4	25.3	22.9	4.8	0
(2) D&I water supply	1.3	1.3	1.3	1.3	1.3	1.3	1.3
(3) Total water demand	15.4	19.4	27.7	26.6	24.2	6.1	1.3
3. Water deficit	0	0	14.8	21.5	13.7	6.3	0
4. Required supply/4	0	0	21.1	30.7	19.6	9.0	0
F. Balance at the Karian dam							
1. Required supply							
(1) to Gadeg weir	0	0	3.5	3.7	0	0	0
(2) to Pamarayan weir	0	0	21.1	30.7	19.6	9.0	0
(3) to Rangkasbitung	0.1	0.1	0.1	0.1	0.1	0.1	0.1
(4) Maintenance flow/1	1.4	1.4	-	-	-	-	1.4
(5) Total required supply	1.5	1.5	24.7	34.5	19.7	9.1	1.5
2. Evaporation loss	0.6	0.6	0.6	0.6	0.6	0.6	0.6
3. Total withdrawal	2.1	2.1	25.3	35.1	20.3	9.7	2.1
G. Required storage capacity		188×10^6 m^3					

Remarks:
/1 = Maintenance flow = 0.324 $m^3/s/100$ km^2
/2 = Required supply = Water deficit x 1/0.7
/3 = Required supply = Water deficit x 1/0.9
/4 = Required supply = Water deficit x 1/0.7

Table K-8 SELECTION OF COMBINATION OF DAMS

		Case 1	Case 2	Case 3
Combination of Dams:		Karian alone	Karian + Pasir Kopo	Karian + Cilawang
Effective Storage Capacity (10^6 m^3):				
Karian:	Irrigation	176	176	176
	D & I water supply	12	12	12
	Flood control	30	30	30
	Total	218	218	218
Pasir Kopo:	Irrigation	-	68	-
	Flood control	-	15	-
	Total	-	83	-
Cilawang:	Irrigation	-	-	54
Total Capacity		218	301	272
Irrigation Area (ha):				
Wet season:	Ciujung	24,200	24,200	24,200
	K-C-C	8,000	8,000	8,000
	Cicinta	-	-	1,435
	Total	32,200	32,200	33,635
Dry season:	Ciujung	18,650	21,000	21,000
	K-C-C	6,160	8,000	6,950
	Cicinta	-	-	1,250
	Total	24,810	29,000	29,200
Flood Control:				
River improvement (km) /1		26	26	26
Present Worth (Rp 10^6): /2				
Cost:	Karian dam	24,712	24,712	24,712
	Pasir Kopo dam	-	15,879	-
	Cilawang dam	-	-	7,999
	K-C-C Irri. scheme	14,512	14,512	14,512
	River improvement /1	6,046	9,618	6,046
	Total	45,270	64,721	53,269
Benefit: /3	Irrigation	45,360	54,044	54,628
	Flood control	8,256	8,955	8,256
	Total	53,616	62,999	62,884
Evaluation:	NPV (Rp 10^6)	8,346	-1,722	9,615
	B/C	1.17	0.97	1.18
	EIRR	13.6	11.8	13.8

Remarks: /1 = In case of return period of 10 years.
/2 = Discount rate of 12% and 50-year project life are assumed.
/3 = D&I water supply benefit is excluded because this is common to every cases.

Table K-9 ESTIMATION OF DIVERSION REQUIREMENT FROM THE KARIAN DAM TO GADEG IN CASE OF 187% CROPPING INTENSITY IN 1972

Unit: m^3/s

Item	A	M	J	J	A	S	O
A. Cicinta irrigation scheme							
1. Available discharge at the weir							
(1) Mean discharge	1.5	2.0	0.5	0.3	0.4	0.1	0.2
(2) Maintenance flow/1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
(3) Available discharge	1.4	1.9	0.4	0.4	0.3	0	0.1
2. Irrigation water demand	1.1	1.7	1.7	1.7	0	0	0
3. Water deficit	0	0	1.3	1.3	0	0	0
4. Required supply/2	0	0	1.9	1.9	0	0	0
B. K-C-C irrigation scheme							
1. Available discharge at Gadeg							
(1) Discharge at the weir	7.8	10.2	2.4	1.3	2.0	0.6	0.9
(2) Maintenance flow/1	0.4	0.4	0.4	0.4	0.4	0.4	0.4
(3) Shut down/3	6.4	8.4	1.9	1.1	1.7	0.5	0.7
(4) Available discharge	1.0	1.4	0.1	-0.2	-0.1	-0.3	-0.2
2. Irrigation water demand	3.2	8.3	9.8	9.7	5.2	0	0
3. Water deficit	2.2	6.9	9.7	9.9	5.3	0.3	0.2
4. Required supply/4	2.4	7.7	10.8	11.0	5.9	0.3	0.2
C. Cilawang dam							
1. Total required supply	2.4	7.7	12.7	12.9	5.9	0.3	0.2
2. Evaporation loss	0.3	0.3	0.3	0.3	0.3	0.3	0.3
3. Total withdrawal	2.7	8.0	9.5	9.5	6.2	0.6	0.5
4. Discharge at the dam	6.4	8.4	1.9	1.1	1.7	0.5	0.7
5. Required storage capacity			54×10^6 m^3				
D. Diversion requirement	0	0	3.5	3.7	0	0	0

Remarks: /1 = Maintenance flow = 0.324 $m^3/s/100$ km^2
/2 = Required supply = Water deficit x 1/0.7
/3 = Discharge at the Cilawang dam
/4 = Required supply = Water deficit x 1/0.9

Table K-10 ESTIMATION OF STORAGE REQUIREMENT FOR THE KARIAN DAM IN CASE OF 187% CROPPING INTENSITY IN 1972

Unit: m^3/s

Item	A	M	J	J	A	S	O
A. Ciujung irrigation scheme and water supply							
1. Available discharge at the Pamarayan weir							
(1) Discharge at the weir	82.0	107.6	24.8	13.8	21.4	6.4	9.5
(2) Maintenance flow/1	4.7	4.7	4.7	4.7	4.7	4.7	4.7
(3) Shut down/2	23.9	31.3	7.2	4.0	6.2	1.9	2.8
(4) Available discharge	53.4	71.6	12.9	5.1	10.5	-0.2	2.0
2. Water demand							
(1) Irrigation	14.1	18.1	26.4	25.3	22.9	4.8	0
(2) D&I water supply	1.3	1.3	1.3	1.3	1.3	1.3	1.3
(3) Total water demand	15.4	19.4	27.7	26.6	24.2	6.1	1.3
3. Water deficit	0	0	14.8	21.5	13.7	6.3	0
4. Required supply/3	0	0	21.1	30.7	19.6	9.0	0
B. Balance at the Karian dam							
1. Required supply							
(1) to Gadeg weir/4	0	0	3.5	3.7	0	0	0
(2) to Pamarayan weir	0	0	21.1	30.7	19.6	9.0	0
(3) to Rangkasbitung/5	0.1	0.1	0.1	0.1	0.1	0.1	0.1
(4) Maintenance flow	1.4	1.4	-	-	-	-	1.4
(5) Total required supply	1.5	1.5	24.7	34.5	19.7	9.1	1.5
2. Evaporation loss	0.6	0.6	0.6	0.6	0.6	0.6	0.6
3. Total withdrawal	2.1	2.1	25.3	35.1	20.3	9.7	2.1
4. Discharge at the dam	23.9	31.3	7.2	4.0	6.2	1.9	2.8
C. Required storage capacity				$188 \times 10^6\ m^3$			

Remarks: /1 = Maintenance flow = 0.324 $m^3/s/100\ km^2$ (Ref. Appendix B)
/2 = Discharge at the Karian dam
/3 = Required supply = Water deficit x 1/0.7
/4 = Refer to Table K-7
/5 = Direct supply to Rangkasbitung town for domestic water

Table K-11 IRRIGABLE AREA BY THE KARIAN AND CILAWANG DAMS, CASE 1

Effective Storage Capacity: Karian Dam = 188 x 10^6 m^3
Cilawang Dam = 54 x 10^6 m^3

Unit: *ha*

Year	Ciujung		K-C-C		Cicinta		Total		% of Dry Season Irrigation
	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	
1972	24,200	21,000	8,000	6,950	1,435	1,250	33,635	29,200	87
1973	24,200	24,200	8,000	8,000	1,435	1,435	33,635	33,635	100
1974	24,200	24,200	8,000	8,000	1,435	1,435	33,635	33,635	100
1975	24,200	21,700	8,000	8,000	1,435	1,435	33,635	31,135	93
1976	24,200	22,190	8,000	8,000	1,435	1,435	33,635	31,625	94
1977	24,200	22,820	8,000	8,000	1,435	1,435	33,635	32,255	96
1978	24,200	23,750	8,000	8,000	1,435	1,435	33,635	33,185	99
1979	24,200	21,590	8,000	8,000	1,435	1,435	33,635	31,025	92
1980	24,200	24,200	8,000	8,000	1,435	1,435	33,635	33,635	100
1981	24,200	24,200	8,000	8,000	1,435	1,435	33,635	33,635	100
1982	24,200	19,840	8,000	6,560	1,435	1,180	33,635	27,580	82
Average	24,200	22,700	8,000	7,774	1,435	1,395	33,635	31,868	95

Table K-12 UNIT CONSTRUCTION COST FOR DAM

Unit: Rp

Work	Item	Unit	Foreign	Local	Total
Excavation	Stripping	m^2	100	100	200
	Common	m^3	1,100	500	1,600
	Weathered Rock	m^3	1,500	600	2,100
	Tunnel	m^3	16,200	13,000	29,200
Embankment	Earth	m^3	1,400	600	2,000
	Earth-core	m^3	2,600	1,300	3,900
	Filter	m^3	7,000	3,400	10,400
	Rock	m^3	4,500	2,700	7,200
	Riprap	m^3	4,700	2,800	7,500
Concrete	Open	m^3	16,300	28,000	44,300
	Form (Open)	m^2	1,400	1,100	2,500
	Reinforcement Bar	t	0	418,700	418,700
	Tunnel	m^3	16,500	30,000	46,500
	Form (Tunnel)	m^2	10,600	400	11,000
	Steel Support	t	0	527,000	527,000
	Cap Concrete	m^3	6,400	9,000	15,400
Grout	Backfill	m^3	15,700	18,000	33,700
	Consolidation	m	15,600	9,100	24,700
	Curtain	m	40,700	16,900	57,600
	Blanket	m	16,400	9,900	26,300

Table K-13 BREAKDOWN OF CONSTRUCTION COST FOR THE KARIAN DAM

Item	Unit	Quantity	Unit Price (Rp)	Cost (Rp 10^6)
1. Diversion Works				
1.1 Tunnel Excavation	m^3	44,900	29,200	1,311
1.2 Concrete Works				
Concrete	m^3	17,100	46,500	795
Reinforcement bar	ton	860	418,700	360
Form	m^2	13,400	11,000	147
1.3 Steel Support	ton	630	527,000	332
1.4 Grout				
Backfill	m^3	4,500	33,700	152
Curtain	m	1,100	57,600	63
Total for item 1				3,160
2. Main Dam				
2.1 Excavation				
Stripping	m^2	93,300	200	19
Common	m^3	186,500	1,600	298
2.2 Embankment				
Earth-core	m^3	116,200	3,900	453
Filter	m^3	96,600	10,400	1,005
Rock	m^3	894,500	7,200	6,439
Riprap	m^3	115,700	7,500	868
2.3 Grout				
Consolidation	m	2,800	24,700	69
Curtain	m	22,200	57,600	1,279
Total for item 2				10,430
3. Spillway and Intake				
3.1 Excavation				
Stripping	m^3	46,500	200	9
Common	m^3	57,400	1,600	92
Weathered rock	m^3	203,100	2,100	427
3.2 Concrete Works				
Open	m^3	39,700	44,300	1,760
Form	m^2	21,800	2,500	55
Reinforcement bar	ton	2,210	418,700	925
3.3 Grout				
Backfill	m^3	2,600	33,700	88
Consolidation	m	11,100	24,700	274
Total for item 3				3,630
4. Metal Work				
Total for item 4		(L.S.)		3,800
5. Tunnel				
5.1 Excavation	m^3	38,400	29,200	1,122
5.2 Concrete Works				
Concrete	m^3	6,800	46,500	316
Form	m^2	12,500	11,000	138
5.3 Steel Support	ton	160	527,000	84
Total for item 5				1,660

Table K-14 BREAKDOWN OF CONSTRUCTION COST FOR THE CILAWANG DAM

Item	Unit	Quantity	Unit Price (Rp)	Cost (Rp 10^6)
1. Main Dam				
1.1 Excavation				
Stripping	m^2	4,200	200	1
1.2 Concrete Works				
Open	m^3	73,300	44,300	3,247
Form (open)	m^2	7,000	2,500	18
Reinforcement bar	ton	1,200	418,700	502
1.3 Grout				
Consolidation	m	1,600	24,700	40
Curtain	m	3,500	57,600	202
Total for item 1				4,010
2. Spillway and Intake				
2.1 Excavation				
Stripping	m^2	1,700	200	-
Common	m^3	3,000	1,600	5
Weather rock	m^3	3,000	2,100	6
2.2 Concrete Works				
Open	m^3	1,200	44,300	53
Form (open)	m^2	1,900	2,500	5
Reinforcement bar	ton	500	418,700	209
2.3 Grout				
Backfill	m^3	4,200	33,700	142
Total for item 2				420
3. Metal Work				
Total for item 3		(L.S.)		1,280
4. Tunnel				
4.1 Excavation	m^3	40,000	29,200	1,168
4.2 Concrete Works				
Concrete	m^3	8,000	46,500	372
Form (tunnel)	m^2	13,500	11,000	15
4.3 Steel Support	ton	200	527,000	105
Total for item 4				1,660

Table K-15 COMPENSATION COST FOR THE KARIAN DAM

Unit: Rp 10^6

Item	Unit Compensation Cost	Q'ty	Amount
1. Housing & Building			
Permanent house	Rp 3 x 10^6/house	1,380	4,140
School	Rp 9 x 10^6/school	7	63
Mosque	Rp 5 x 10^6/mosque	14	70
Sub-total			4,273
2. Land			
Paddy field	Rp 5 x 10^6/ha	290	1,450
Upland	Rp 2 x 10^6/ha	80	160
Settlement area	Rp 3 x 10^6/ha	45	135
Forest/Plantation	Rp 2 x 10^6/ha	1,205	2,410
Sub-total			4,155
3. Others		L.S.	772
Total			9,200

Table K-16 COMPENSATION COST FOR THE CILAWANG DAM

Unit: Rp 10^6

Item	Unit Compensation Cost	Q'ty	Amount
1. Housing & Building			
Permanent house	Rp 3 x 10^6/house	270	810
School	Rp 9 x 10^6/school	2	18
Mosque	Rp 5 x 10^6/mosque	2	10
Sub-total			838
2. Land			
Paddy field	Rp 5 x 10^6/ha	150	
Upland	Rp 2 x 10^6/ha	60	120
Settlement area	Rp 3 x 10^6/ha	10	30
Forest/Plantation	Rp 2 x 10^6/ha	540	
Sub-total			1,980
3. Others		L.S.	282
Total			3,100

Table K-17 CONSTRUCTION COST FOR PROPOSED DAMS

Unit: Rp 10^6

Item	Karian	Cilawang
1. Direct Construction Cost		
Preparatory works	2,320	720
Diversion works	3,160	-
Coffer dam	480	20/1
Main dam	10,430	4,010
Spillway and intake	3,630	420
Metal work	3,800	1,280
Tunnel	1,660	1,660
Sub-total	25,480	8,110
2. Land Acquisition	9,200	3,100
3. Engineering and Administration	3,820	1,220
4. Physical Contingency	7,700	2,490
Total	46,200	14,920
5. Price Contingency	25,620	8,250
Grand Total	71,820	23,170

Remarks: /1 = Partial closure of river channel.

Table K-18 CONSTRUCTION COST FOR THE PASIR KOPO DAM

Unit: Rp 10^6

Item	Amount
1. Direct Construction Cost	
Preparatory works	2,060
Diversion works	3,900
Coffer dam	500
Main dam	8,650
Spillway and intake	5,130
Metal work	2,480
Sub-total	22,720
2. Land Acquisition	5,100
3. Engineering and Administration	3,410
4. Physical Contingency	6,250
Total	37,480
5. Price Contingency	21,520
Grand Total	59,000

Remarks: Effective storage capacity is assumed to be 68×10^6 m^3 for irrigation and 15×10^6 m^3 for flood control.

Table K-19 DISBURSEMENT SCHEDULE OF CONSTRUCTION COSTS FOR KARIAN, CILAWANG AND PASIR KOPO DAMS

Unit: Rp 10^6

Item	Total		1985		1986		1987		1988		1989		1990		1991	
	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC
Karian Dam																
Direct construction	15288	10192	-	-	-	-	2135	1423	3198	2133	3910	2607	3910	2606	2135	1423
Land acquisition	-	9200	-	-	-	4600	-	4600	-	-	-	-	-	-	-	-
Gov. administration	-	550	-	-	-	-	-	110	-	110	-	110	-	110	-	110
Engineering services	2670	600	522	120	522	120	253	54	325	72	398	90	398	90	252	54
Physical contingency	3592	4108	104	24	104	944	478	1243	705	463	862	561	862	561	477	312
Sub-total	21550	24650	626	144	626	5664	2866	7430	4228	2778	5170	3368	5170	3367	2864	1899
Price contingency	10603	15017	91	30	141	1875	891	3451	1702	1696	2589	2599	3132	3194	2057	2172
Total	32153	39667	717	174	767	7539	3757	10881	5930	4474	7759	5967	8302	6561	4921	4071
Cilawang Dam																
Direct construction	4866	3244	-	-	-	-	730	487	973	649	1217	811	1217	811	729	486
Land acquisition	-	3100	-	-	-	1550	-	1550	-	-	-	-	-	-	-	-
Gov. administration	-	160	-	-	-	-	-	32	-	32	-	32	-	32	-	32
Engineering services	870	190	174	38	174	38	78	17	104	22	131	29	131	29	78	17
Physical contingency	1149	1341	35	8	35	318	162	417	215	141	270	175	270	175	162	107
Sub-total	6885	8035	209	46	209	1906	970	2503	1292	844	1618	1047	1618	1047	969	642
Price contingency	3392	4858	30	10	47	631	303	1161	522	517	812	809	982	995	696	735
Total	10277	12893	239	56	256	2537	1273	3664	1814	1361	2430	1856	2600	2042	1665	1377
Pasir Kopo Dam																
Direct construction	13632	9088	-	-	-	-	2021	1373	2692	1759	3206	2060	3699	2523	2014	1373
Land acquisition	-	5100	-	-	-	2550	-	2550	-	-	-	-	-	-	-	-
Gov. administration	-	527	-	-	-	-	-	105	-	106	-	105	-	106	-	105
Engineering services	2303	580	461	116	461	116	207	52	275	70	346	87	346	87	207	52
Physical contingency	3188	3062	92	24	92	534	446	816	594	387	711	451	809	544	444	306
Sub-total	19123	18357	553	140	553	3200	2674	4896	3561	2322	4263	2703	4854	3260	2665	1836
Price contingency	9462	12058	80	29	124	1059	832	2272	1435	1419	2136	2086	2942	3093	1913	2100
Total	28585	30415	633	169	677	4259	3506	7168	4996	3741	6399	4789	7796	6353	4578	3936

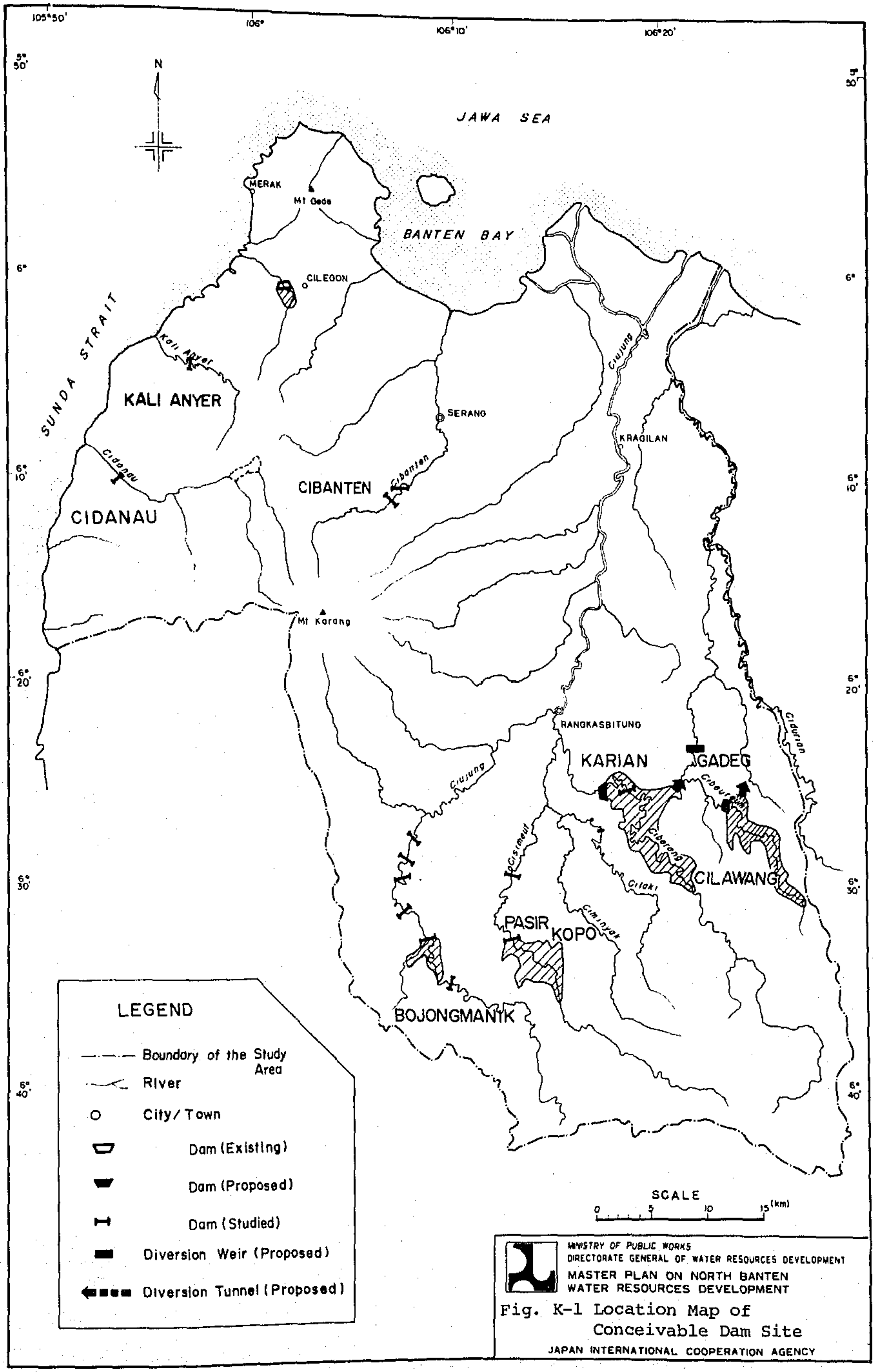

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Fig. K-1 Location Map of Conceivable Dam Site

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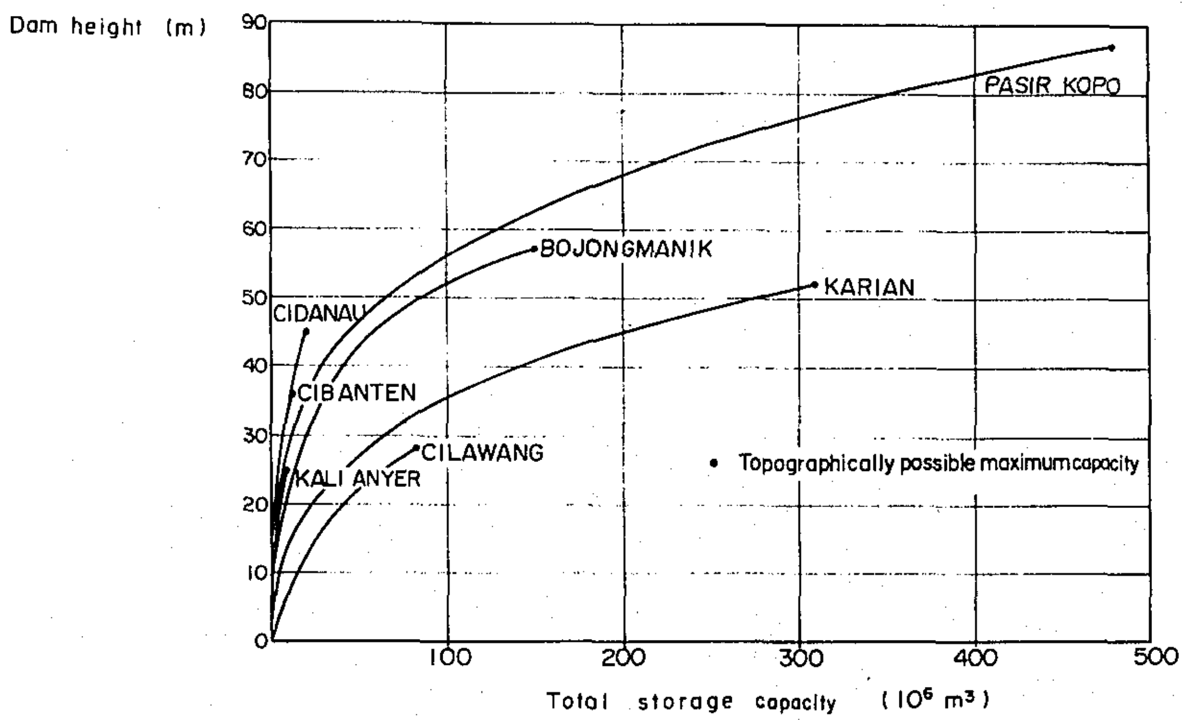

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Fig. K-2 Total Storage Capacity Curve

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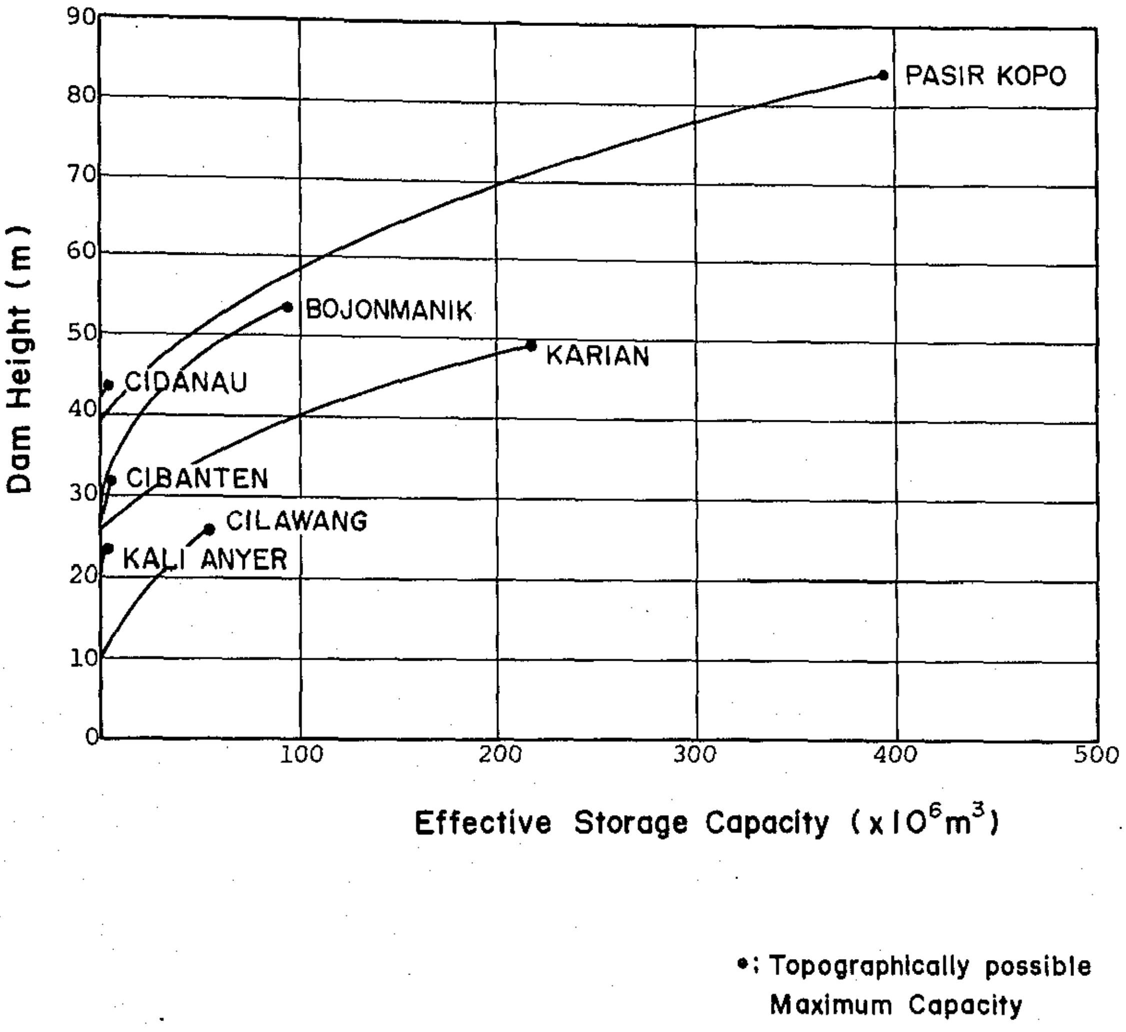

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Fig. K-3 Effective Storage Capacity Curve

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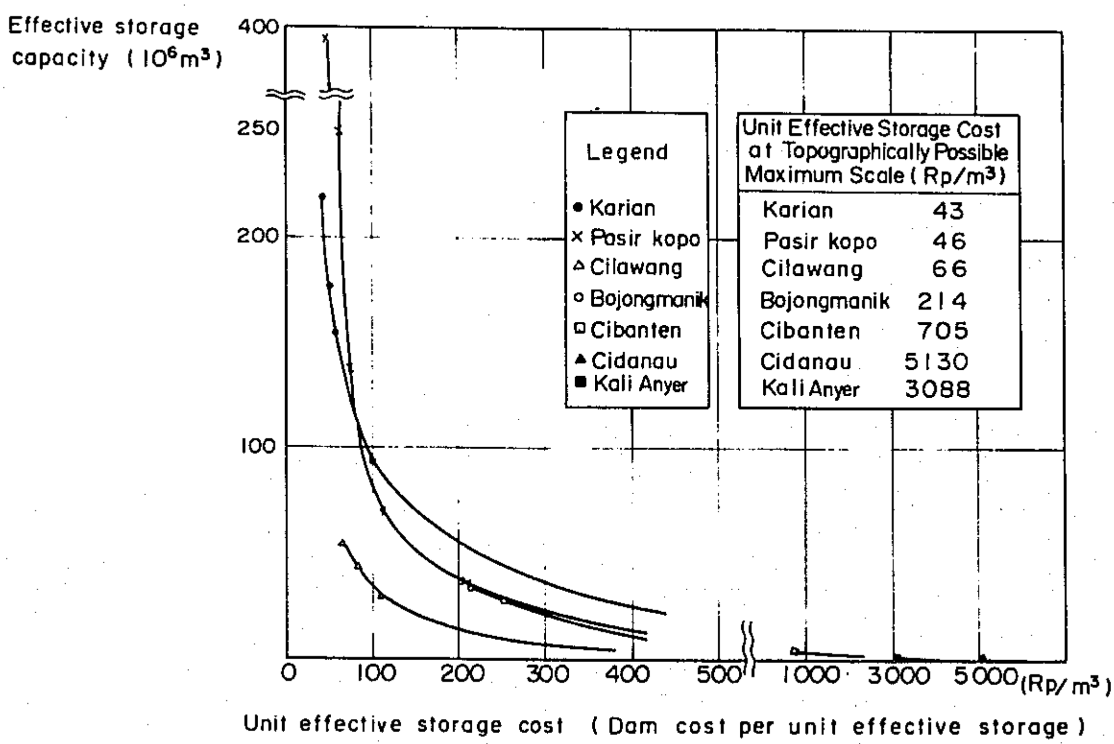

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Fig. K-4 Unit Effective Storage Cost Curve

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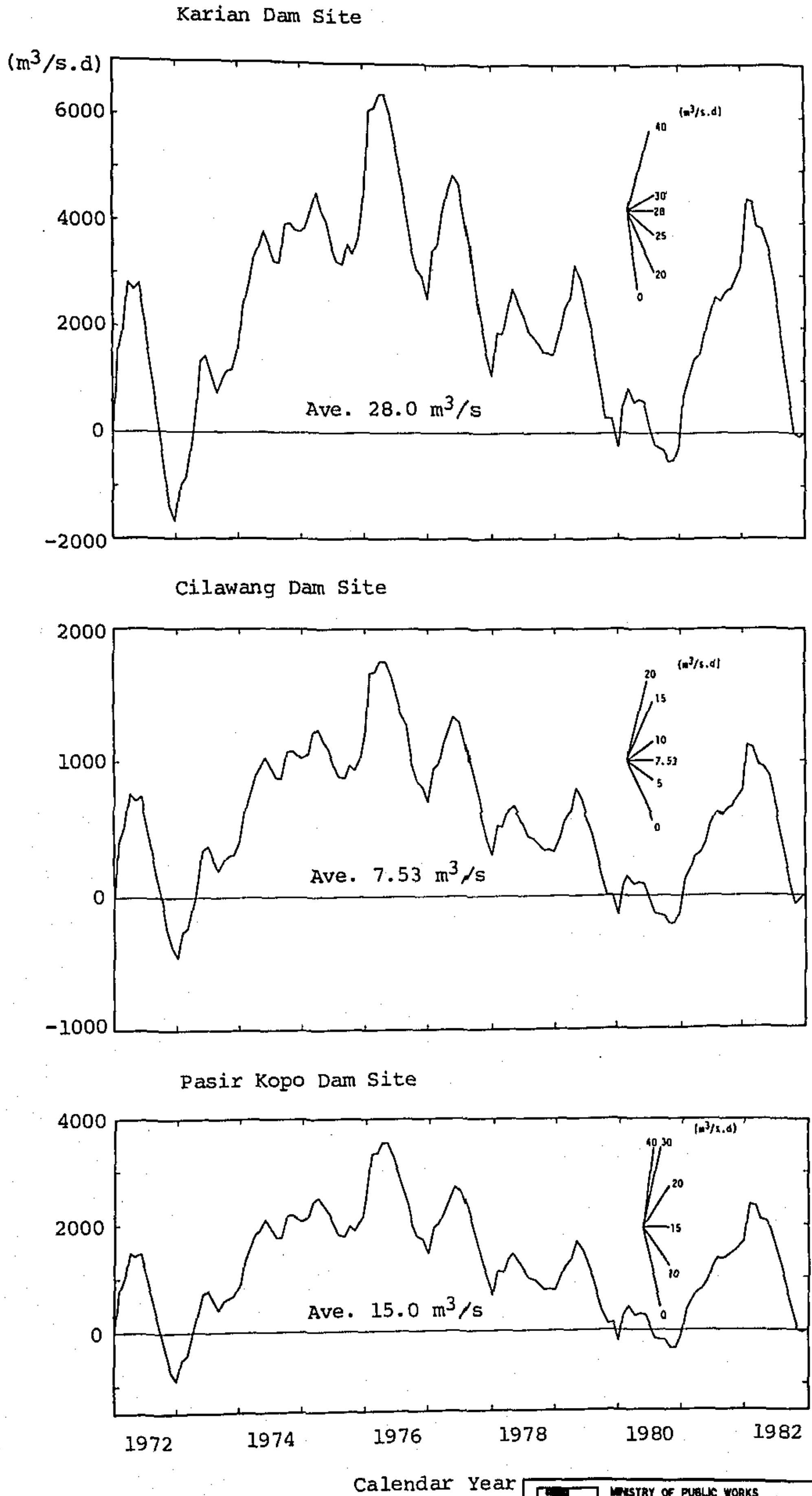

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Fig. K-5 Mass Curve at the Proposed Dam Sites

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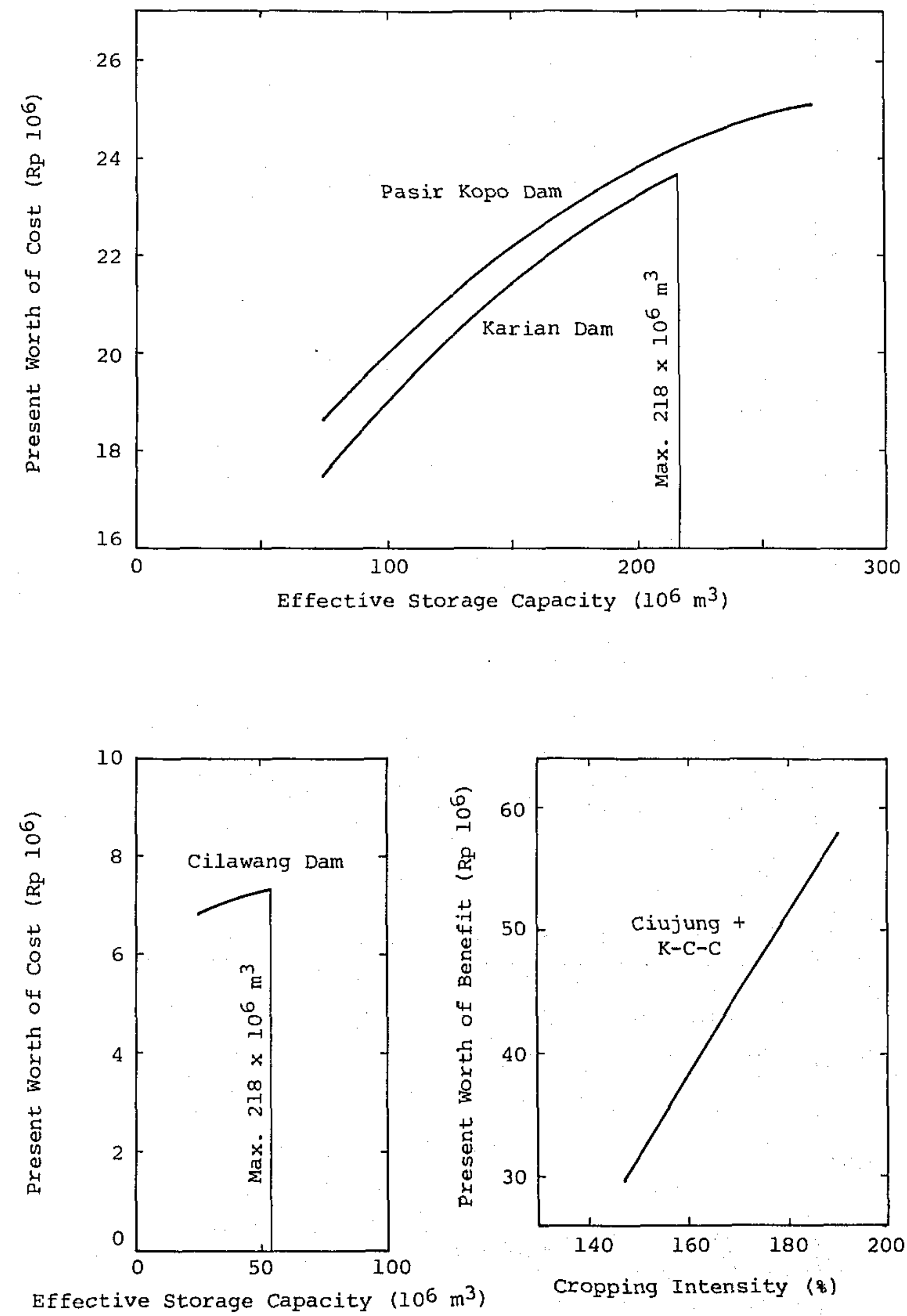

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Fig. K-6 Present Worth of Cost and Benefit

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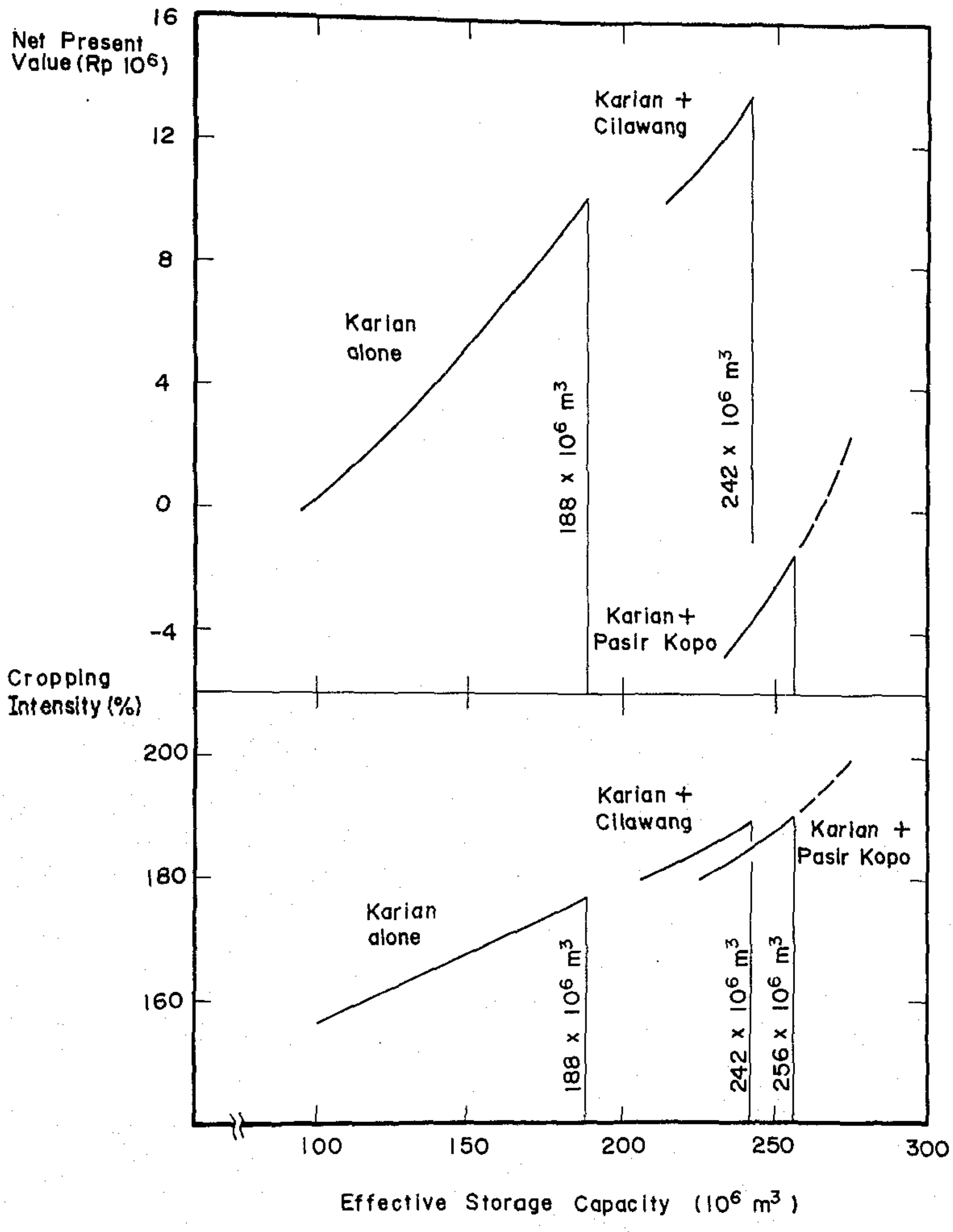

Remark: Benefitted area = Ciujung (24,200 ha) + K-C-C (8,000 ha)

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Fig. K-7 Evaluation of Combination of Dams

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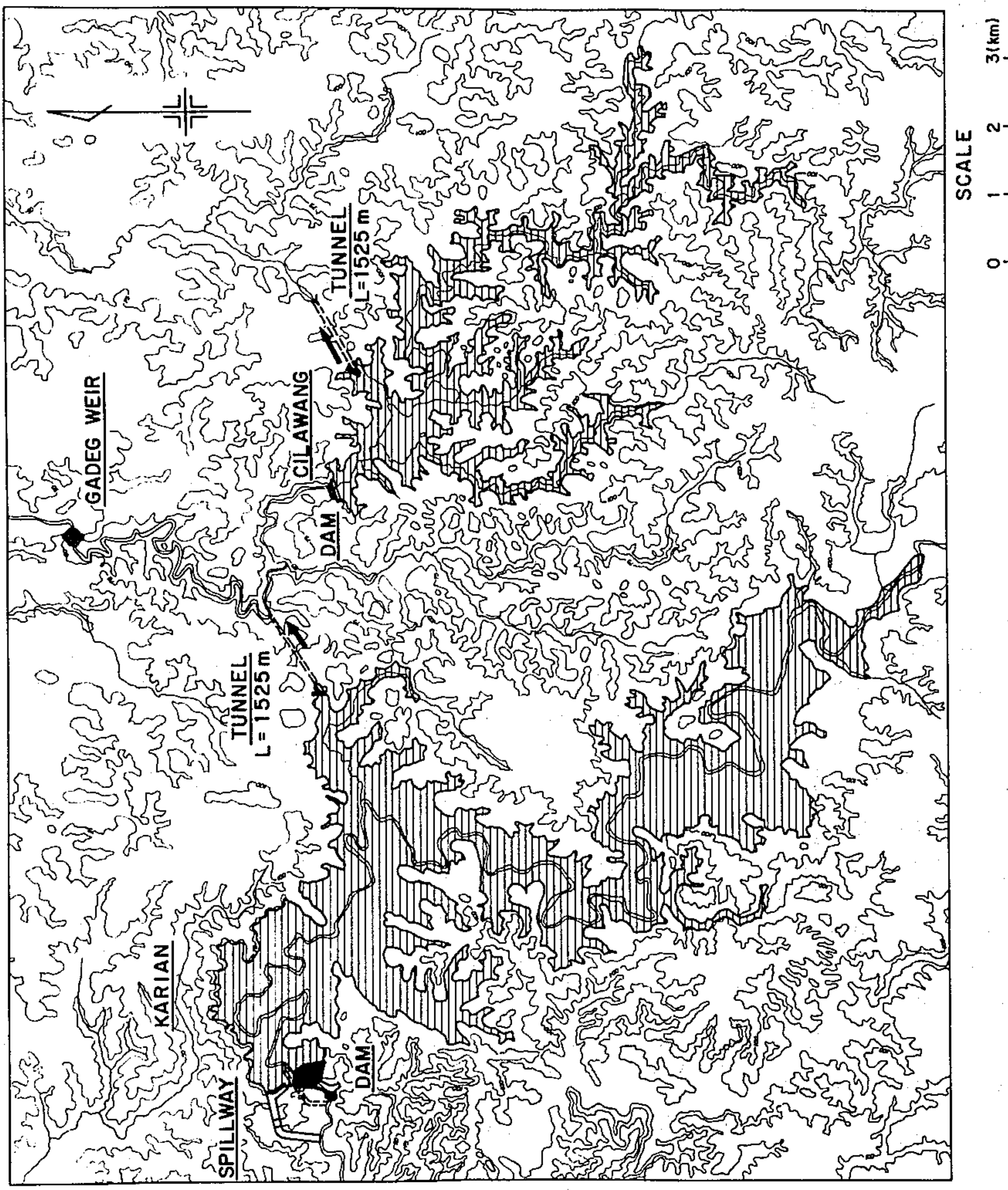

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Fig. K-8 General Map of Karian and Cilawang Dams

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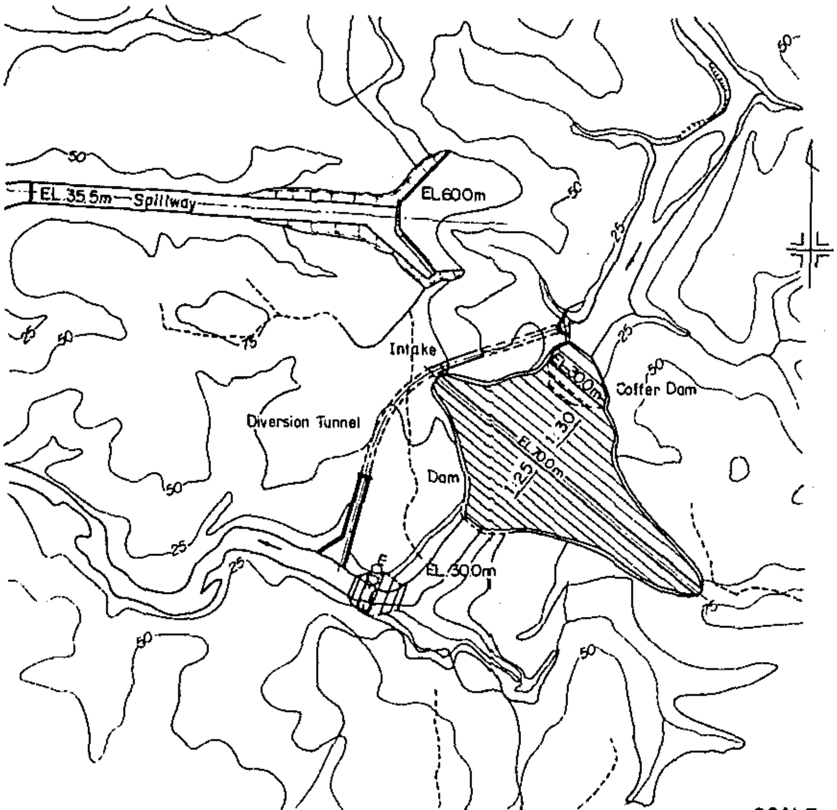
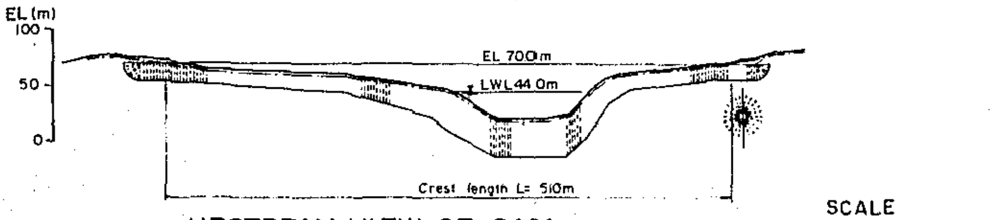
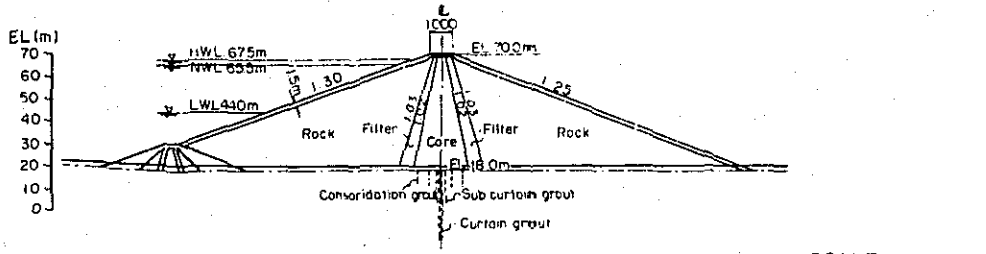


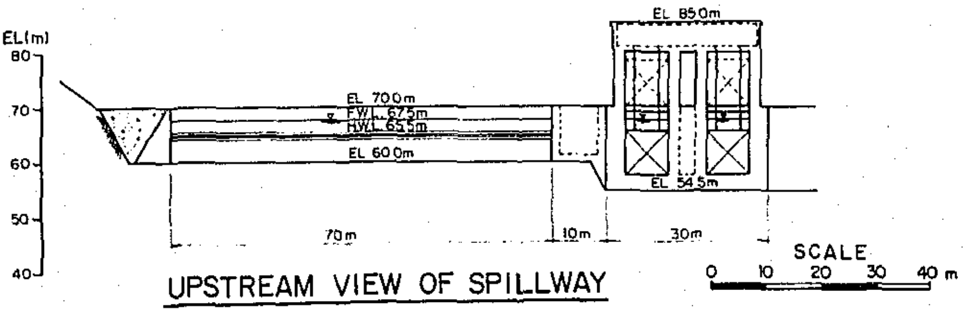
KARIAN DAM PLAN



UPSTREAM VIEW OF DAM



TYPICAL SECTION OF DAM



UPSTREAM VIEW OF SPILLWAY

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Fig. K-9 Proposed Karian Dam

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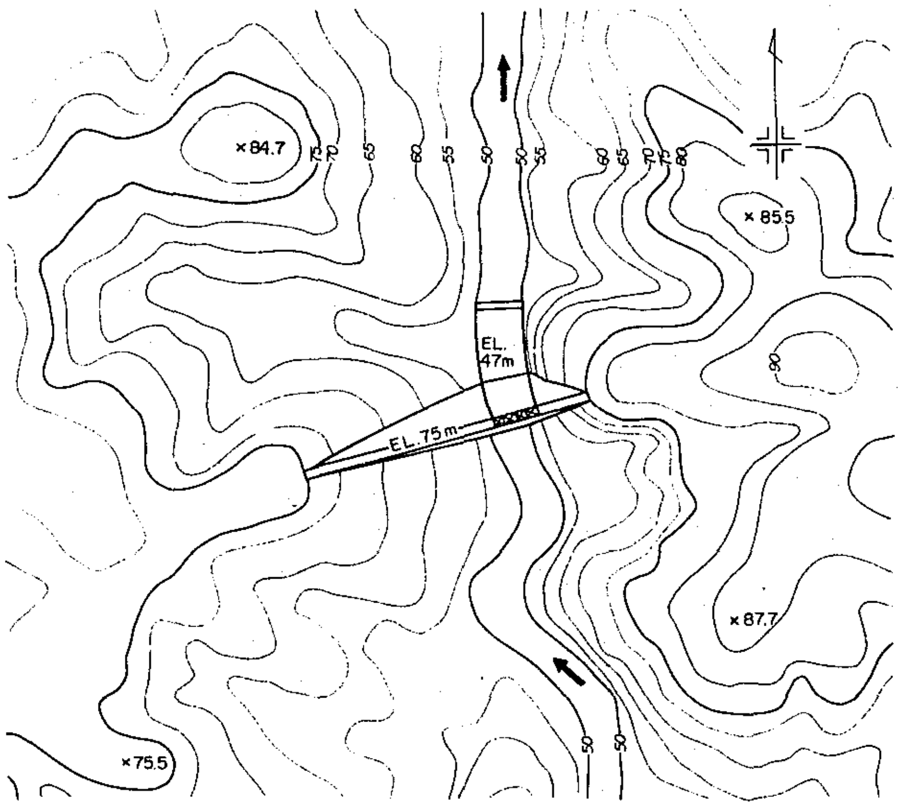
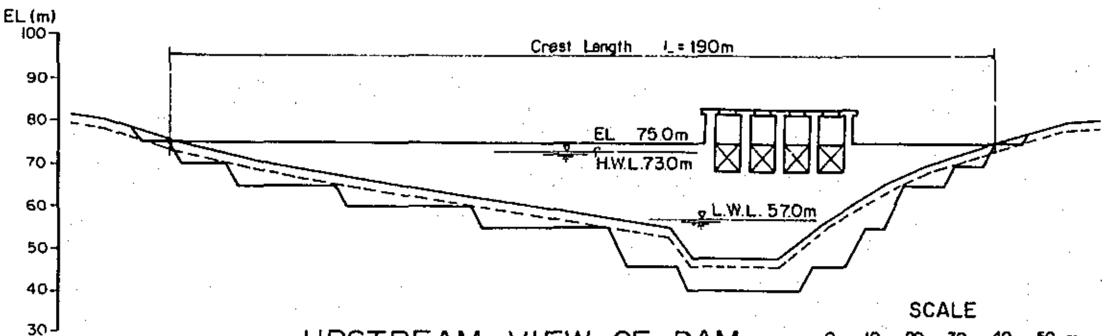
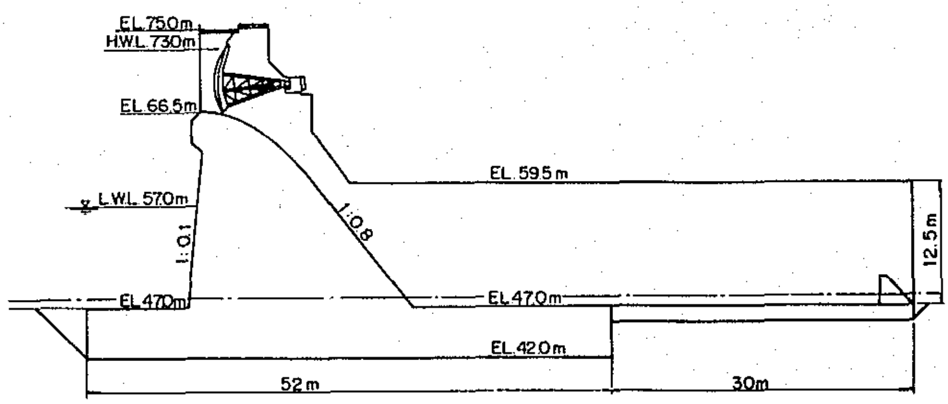


CILAWANG DAM PLAN



UPSTREAM VIEW OF DAM



OVERFLOW SECTION

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Fig. K-10 Proposed Cilawang Dam

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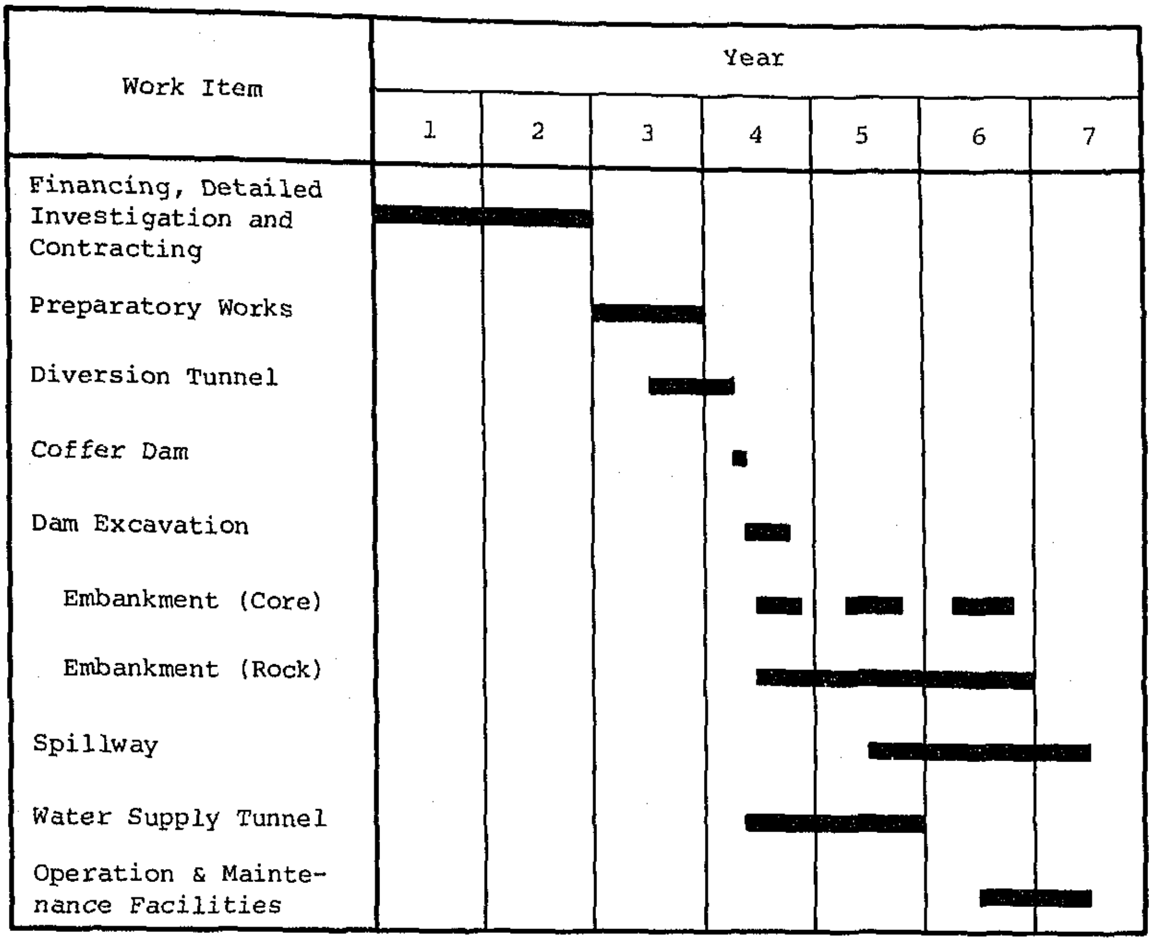
Karian Dam



Cilawang Dam

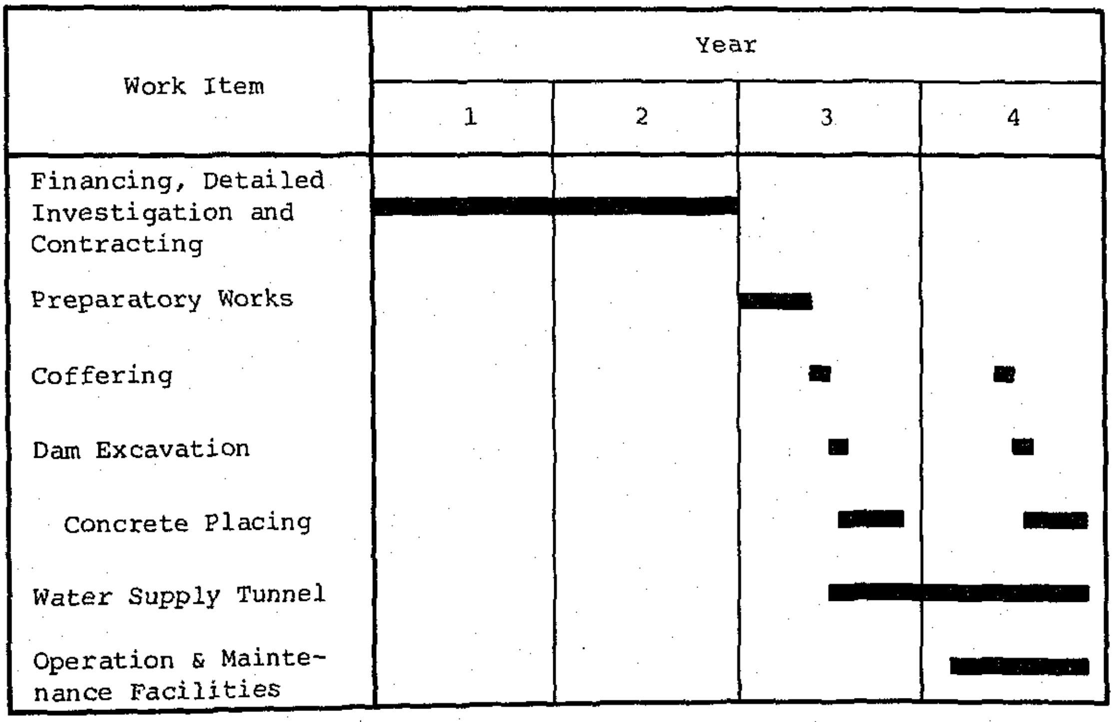


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Fig. K-11 Construction Time Schedule

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APPENDIX L

ECONOMIC ANALYSIS

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1. INTRODUCTION

An analysis is carried out to ascertain the economic viability of several alternative development schemes selected by the present study and to make priority ranking for these schemes from the economic viewpoint. The economic viability is evaluated by Net Present Value (NPV), Benefit-Cost Ratio (B/C) and Economic Internal Rate of Return (EIRR), and a sensitivity test of these results is made with respect to variations in cost and/or benefit.

The following three alternative cases for water resources development have been proposed on the basis of study of water demand and supply in the Study Area.

Case 1: Karian dam alone

Case 2: Karian plus Pasir Kopo dams

Case 3: Karian plus Cilawang dams

The Karian dam has an effective storage capacity of 218×10^6 m^3 to meet irrigation water demand in the Ciujung and K-C-C areas as well as to support industrial water supply in the Study Area. The Pasir Kopo dam is provided with an effective storage capacity of 83×10^6 m^3 to meet necessary water demand in the Ciujung area. The Cilawang dam, with an effective storage capacity of 54×10^6 m^3, covers irrigation water demand in the K-C-C and Cicinta areas. Detail descriptions with respect to the storage capacity of each dam and the irrigation area are given in Appendices H and K.

Besides the above alternative combinations, the following alternative river improvement plans have been studied for the purpose of only flood control in the Ciujung river.

Case F-0: Karian dam alone

Case F-1: River improvement alone

Case F-2: River improvement plus Karian dam

Case F-3: River improvement plus Karian and Pasir Kopo dams

The evaluation is based on the following assumptions:

(1) Economic life is taken as 50 years from 1985 to 2034, starting from the stage of detail design.

(2) As to benefits to be counted, only direct tangible benefits are counted in the evaluation, and indirect and/or intangible benefits are explained as other benefits in Section 4.2.

(3) The construction period is seven years for all alternative schemes including the period of two years for detail design.

2. ECONOMIC PRICE

To estimate economic cost and benefit, the economic price is assumed as follows:

(1) Foreign exchange rate is set at US$1.00 = Rp 690, based on the middle exchange rate of the Bank Indonesia at the end of 1982.

(2) Economic price of rice at the farm gate has been estimated to be Rp 180 per kg based on the international market price (FOB price at Bangkok) forecasted by the World Bank for the year 1995 at the 1982 constant prices.

(3) Economic price of unskilled labourers employed in the construction works is estimated to be 60% of the actual market wage for them with reference to the studies of similar projects.

(4) Transfer payments such as tax and duty are assumed that goods and services procured locally would include transfer payment of 10% of their prices, and those imported from abroad would exclude any transfer payments.

3. ECONOMIC COST

The financial construction cost for each alternative case in water resources development and river improvement is summarized in Table L-1.

Economic cost for the construction works is estimated by making the adjustment of the afore-mentioned economic price and further by subtracting the price contingency from the financial cost. As a result, the economic construction cost for each water resources development plan for the irrigation purpose is estimated to be Rp 60.88 x 10^9 for the Case 1, Rp 93.39 x 10^9 for the Case 2 and Rp 73.56 x 10^9 for the Case 3. The economic cost for each river improvement plan is estimated to be Rp 5.43 x 10^9 for the Case F-0, Rp 31.07 x 10^9 for the Case F-1, Rp 14.34 x 10^9 for the Case F-2 and Rp 20.21 x 10^9 for the Case F-3.

The economic annual operation and maintenance costs are estimated to be 0.5% of the economic direct costs for dam construction and river improvement, and 2% for irrigation facilities cost.

4. ECONOMIC BENEFIT

4.1 Direct Tangible Benefit

The direct tangible benefit of each alternative combination consists mainly of both benefits of irrigation and flood control. The economic benefit is given on the basis of the said economic price.

The direct tangible benefit of irrigation, which occupies a greater part of benefits, is given as the difference between the net production value of paddy in the future between the conditions with and without the project. The benefit will be realized immediately after all the construction works of irrigation facilities are completed, and it is expected to increase year by year and to reach its maximum in and after five years. The maximum annual irrigation benefit has been estimated to be Rp 12.74×10^9 for the Case 1, Rp 15.18×10^9 for the Case 2 and Rp 15.35×10^9 for the Case 3.

The direct tangible benefit of flood control is given as the economic effect of decrease in damage to be caused by flood. The benefit will arise immediately after the flood control works are completed. The effect is mainly estimated by decrease in flood damage to houses, household articles, stock assets of offices and shops, agricultural crops, public facilities and business activities. The average annual flood control benefit has been estimated to be Rp 0.67×10^9 for the Case F-0, Rp 3.27×10^9 for the Case F-1, Rp 1.99×10^9 for the Case F-2 and Rp 2.23×10^9 for the Case F-3.

4.2 Other Benefits

Besides the above direct tangible benefit, there would be the following indirect and intangible benefits:

(1) Construction of dam and reservoir will create some opportunities of investment to facilities of industries such as tourism, electric power and inland fishery.

(2) It is expected that great employment opportunities are given to people in the Study Area by the implementation of dam and canal construction as well as river improvement, by the increase in cropping intensity and by the increase in farm labour requirement.

(3) Increase in paddy production will raise the farmer income level and will contribute to the correction of regional and sectorial inequalities in the wealth, and further it can reduce the amount of imported rice which will result in the saving of foreign exchange.

(4) Stimulative effect is expected to cause the significant growth in industries and economic activities in the Study Area and its surrounding areas.

(5) Implementation of flood control work will promote the effective use of land and will produce such good results as decrease in diseases due to the improvement of environment and stabilization of people's livelihood due to protection from menace of flood.

(6) Local transportation will be improved by the construction of inspection roads.

5. ECONOMIC COMPARISON OF ALTERNATIVE COMBINATIONS

The annual flows of economic cost and benefit are shown in Tables L-2 to L-4 for the respective combinations of water resources and irrigation development and in Tables L-5 to L-8 for those of flood mitigation. Using the assumptions described in Chapter 1 and 2, NPV and B/C are calculated for the discount rates of 6% to 16% and EIRR is computed. The calculation result in each combination is also tabulated in Tables L-2 to L-8.

Among the three alternative combinations for water resources and irrigation development, the results summarized below show that the Case 3, Karian plus Cilawang dams, is the best, while the Case 2, Karian plus Pasir Kopo dams, is not economically viable.

Alternative Combination	Discount Rate (%)	NPV (Rp 10^6)	B/C	EIRR (%)
Case 1	12.0	6,137	1.15	13.4
Case 2	12.0	-5,265	0.91	11.3
Case 3	12.0	7,406	1.16	13.6

The incremental paddy production attributable to the proposed irrigation development has been estimated to be 96,100 ton/y for the Case 1, 115,800 ton/y for the Case 2 and 116,600 ton/y for the Case 3 at the full development stage as explained in Appendix G. It is expected to promote the development of socio-economy in the Study Area to a large extent through various effects as mentioned in Chapter 4.

The results of economic comparison of the four alternative combinations for river improvement plan are summarized below and show that the Case F-2, river improvement plus Karian dam, is most favorable under the condition that 13.8% of the construction cost for the Karian dam is shared for the flood control purpose.

Alternative Combination	Discount Rate (%)	NPV (Rp 10^6)	B/C	EIRR (%)
F-0	10.0	-323	0.91	9.2
F-1	10.0	-4,326	0.79	8.1
F-2	10.0	741	1.07	10.7
F-3	10.0	-2,143	0.85	8.6

The implementation of flood control works will decrease the damage to agricultural land of 3,500 ha and to 6,000 houses in the flood prone area.

The followings portray NPV, B/C and EIRR, when all the benefits attributable to irrigation water supply and flood control are integrated into one scheme. The annual flows for the three alternatives are shown in Tables L-9 to L-11.

Alternative Combination	Discount Rate (%)	NPV ($Rp\ 10^6$)	B/C	EIRR (%)
Karian dam alone	12.0	8,346	1.17	13.6
Karian plus Pasir Kopo dams	12.0	-1,722	0.97	11.8
Karian plus Cilawang dams	12.0	9,615	1.18	13.8

As seen in the above, the combination of Karian plus Cilawang dams is the most recommendable plan from the viewpoint of multipurpose water resources development.

6. SENSITIVITY TEST

The estimates and assumptions in the present study have been arrived after careful study based on much professional experience and expert judgement, but there always remains the question as to the degree of reliability of inputs. It is customary, therefore, to test the results of analysis for sensitivity to variations in certain important inputs.

From the nature of study, the master plan study, in general, appears to be inferior to the feasibility study with respect to accuracy of the results of analysis. Further, most of important inputs are common items to three alternatives. Therefore, the sensitivity test in the present study is carried out to only variations in the total of cost and/or benefit discounted, without any examination of variations in the major inputs. The test is made for the variations in the cost and/or benefit by 10% and 20% for the proposed development plan.

The proposed development plan in the present study will consist such items centering about the Karian dam as:

- Karian dam;
- Cilawang dam as auxiliary storage;
- a tunnel to divert water from the Karian reservoir to the Cibeureum river;
- a tunnel to divert water from the Cilawang reservoir to a tributary of the Cicinta river;
- river improvement works in and around Rangkasbitung;
- irrigation facilities to cover 8,000 ha of net irrigation area over the K-C-C area including the Gadeg weir and a main irrigation canal therefrom to the K-C-C area; and
- a pipeline from the end of existing left bank primary canal of the Ciujung irrigation scheme to Krenceng.

The results are given in Table L-12. EIRR is calculated to be 12.8% when the cost increases by 10%, while it becomes 12.7% when the cost increases by 10% and the benefit decreases by 10%. In either case, EIRR exceeds 12% which is economically viable.

Table L-1 SUMMARIZED FINANCIAL COST

Unit: Rp 10^6

Alternatives	Total	1985	1986	1987	1988	1989	1990	1991
(1) Dam and Irrigation Development								
Case 1	111,100	1,609	10,037	21,627	19,558	22,437	22,517	13,315
Case 2	170,100	2,411	14,974	32,302	28,296	33,625	36,666	21,826
Case 3	134,270	1,901	12,827	26,566	22,736	26,722	27,158	16,360
(2) River Improvement								
Case F-0	9,910	123	1,146	2,020	1,435	1,894	2,051	1,241
Case F-1	54,515	506	1,441	11,035	10,685	11,868	10,705	8,275
Case F-2	14,600	234	545	5,113	4,168	4,540	-	-
Case F-3	13,065	211	472	4,672	3,688	4,022	-	-

Remarks: Case 1 = Karian dam + Ciujung plus K-C-C irrigation schemes

Case 2 = Karian plus Pasir Kopo dams + Ciujung plus K-C-C irrigation schemes

Case 3 = Karian plus Cilawang dams + Ciujung plus K-C-C plus Cicinta irrigation schemes

Case F-0 = Karian dam

Case F-1 = River improvement

Case F-2 = Karian dam + river improvement

Case F-3 = Karian plus Pasir Kopo dams + river improvement

Table L-2 ECONOMIC EVALUATION FOR IRRIGATION SCHEME (CASE 1 KARIAN DAM ALONE)

Unit: Rp 10^6

(1) Cost-Benefit Flow

Year		Cost			Benefit	Balance
		Construction	O & M	Total		
1	1985	1,249	0	1,249	0	-1,249
2	1986	5,617	0	5,617	0	-5,617
3	1987	12,440	0	12,440	0	-12,440
4	1988	11,499	0	11,499	0	-11,499
5	1989	12,374	0	12,374	0	-12,374
6	1990	11,461	0	11,461	0	-11,461
7	1991	6,239	0	6,239	0	-6,239
8	1992	0	486	486	10,195	9,709
9	1993	0	486	486	10,832	10,346
10	1994	0	486	486	11,470	10,984
11	1995	0	486	486	12,107	11,621
12	1996	0	486	486	12,744	12,258
13	1997	0	486	486	12,744	12,258
14	1998	0	486	486	12,744	12,258
15	1999	0	486	486	12,744	12,258
.	.	.	.	.	.	.
.	.	.	.	.	.	.
.	.	.	.	.	.	.
49	2033	0	486	486	12,744	12,258
50	2034	0	486	486	12,744	12,258

(2) NPV, B/C and EIRR

Item	Discounted Rate			
	10%	12%	14%	16%
Total Discounted Benefit	61,597	45,360	34,273	26,441
Total Discounted Cost	42,785	39,223	36,147	33,448
Net Present Value (NPV)	18,812	6,137	-1,874	-7,007
Benefit Cost Ratio (B/C)	1.44	1.15	0.95	0.79
Economic Internal Rate of Return (EIRR)		13.4%		

Table L-3 ECONOMIC EVALUATION FOR IRRIGATION SCHEME (CASE 2 KARIAN PLUS PASIR KOPO DAMS)

Unit: Rp 10^6

(1) Cost-Benefit Flow

Year		Cost			Benefit	Balance
		Construction	O & M	Total		
1	1985	1,873	0	1,873	0	-1,873
2	1986	8,382	0	8,382	0	-8,382
3	1987	18,640	0	18,640	0	-18,640
4	1988	16,794	0	16,794	0	-16,794
5	1989	18,644	0	18,644	0	-18,644
6	1990	18,764	0	18,764	0	-18,764
7	1991	10,289	0	10,289	0	-10,289
8	1992	0	608	608	12,147	11,539
9	1993	0	608	608	12,906	12,298
10	1994	0	608	608	13,666	13,058
11	1995	0	608	608	14,425	13,817
12	1996	0	608	608	15,184	14,576
13	1997	0	608	608	15,184	14,576
14	1998	0	608	608	15,184	14,576
15	1999	0	608	608	15,184	14,576
.	.	.	.	.	.	.
.	.	.	.	.	.	.
.	.	.	.	.	.	.
49	2033	0	608	608	15,184	14,576
50	2034	0	608	608	15,184	14,576

(2) NPV, B/C and EIRR

Item	Discounted Rate			
	8%	10%	12%	14%
Total Discounted Benefit	102,890	73,391	54,044	40,834
Total Discounted Cost	70,851	64,621	59,309	54,690
Net Present Value (NPV)	32,039	8,770	-5,265	-13,856
Benefit Cost Ratio (B/C)	1.45	1.14	0.91	0.75
Economic Internal Rate of Return (EIRR)		11.3%		

Table L-4 ECONOMIC EVALUATION FOR IRRIGATION SCHEME (CASE 3 KARIAN PLUS CILAWANG DAMS)

Unit: Rp 10^6

(1) Cost-Benefit Flow

Year		Cost			Benefit	Balance
		Construction	O & M	Total		
1	1985	1,476	0	1,476	0	-1,476
2	1986	7,146	0	7,146	0	-7,146
3	1987	15,195	0	15,195	0	-15,195
4	1988	13,424	0	13,424	0	-13,424
5	1989	14,772	0	14,772	0	-14,772
6	1990	13,859	0	13,859	0	-13,859
7	1991	7,690	0	7,690	0	-7,690
8	1992	0	529	529	12,278	11,749
9	1993	0	529	529	13,046	12,517
10	1994	0	529	529	13,813	13,284
11	1995	0	529	529	14,581	14,052
12	1996	0	529	529	15,348	14,819
13	1997	0	529	529	15,348	14,819
14	1998	0	529	529	15,348	14,819
15	1999	0	529	529	15,348	14,819
.	.	.	.	.	.	.
.	.	.	.	.	.	.
.	.	.	.	.	.	.
49	2033	0	529	529	15,348	14,819
50	2034	0	529	529	15,348	14,819

(2) NPV, B/C and EIRR

Item	Discounted Rate			
	10%	12%	14%	16%
Total Discounted Benefit	74,183	54,628	41,275	31,846
Total Discounted Cost	51,444	47,222	43,562	40,342
Net Present Value (NPV)	22,739	7,406	-2,287	-8,496
Benefit Cost Ratio (B/C)	1.44	1.16	0.95	0.79
Economic Internal Rate of Return (EIRR)	13.6%			

Table L-5 ECONOMIC EVALUATION FOR FLOOD CONTROL SCHEME
(CASE F-0 KARIAN DAM ALONE)

(1) Cost-Benefit Flow

Unit: Rp 10^6

Year		Cost			Benefit	Balance
		Construction	O & M	Total		
1	1985	97	0	97	0	-97
2	1986	629	0	629	0	-629
3	1987	1,126	0	1,126	0	-1,126
4	1988	870	0	870	0	-870
5	1989	1,060	0	1,060	0	-1,060
6	1990	1,060	0	1,060	0	-1,060
7	1991	592	0	592	0	-592
8	1992	0	20	20	670	650
9	1993	0	20	20	670	650
10	1994	0	20	20	670	650
.	.	.	.	.	.	.
.	.	.	.	.	.	.
.	.	.	.	.	.	.
49	2033	0	20	20	670	650
50	2034	0	20	20	670	650

(2) NPV, B/C and EIRR

Item	Discounted Rate			
	6%	8%	10%	12%
Total Discounted Benefit	6,820	4,708	3,381	2,506
Total Discounted Cost	4,412	4,031	3,704	3,420
Net Present Value (NPV)	2,408	677	-323	-914
Benefit Cost Ratio (B/C)	1.55	1.17	0.91	0.73
Economic Internal Rate of Return (EIRR)	9.2%			

Table L-6 ECONOMIC EVALUATION FOR FLOOD CONTROL SCHEME (CASE F-1 RIVER IMPROVEMENT ALONE)

Unit: Rp 10^6

(1) Cost-Benefit Flow

Year		Cost			Benefit	Balance
		Construction	O & M	Total		
1	1985	394	0	394	0	-394
2	1986	935	0	935	0	-935
3	1987	7,164	0	7,164	0	-7,164
4	1988	6,394	0	6,394	0	-6,394
5	1989	6,585	0	6,585	0	-6,585
6	1990	5,579	0	5,579	0	-5,579
7	1991	4,021	0	4,021	0	-4,021
8	1992	0	141	141	3,269	3,128
9	1993	0	141	141	3,269	3,128
10	1994	0	141	141	3,269	3,128
.	.	.	.	.	.	.
.	.	.	.	.	.	.
.	.	.	.	.	.	.
49	2033	0	141	141	3,269	3,128
50	2034	0	141	141	3,269	3,128

(2) NPV, B/C and EIRR

Item	Discounted Rate			
	6%	8%	10%	12%
Total Discounted Benefit	33,277	22,972	16,497	12,228
Total Discounted Cost	25,104	22,789	20,823	19,117
Net Present Value (NPV)	8,173	183	-4,326	-6,889
Benefit Cost Ratio (B/C)	1.33	1.01	0.79	0.64
Economic Internal Rate of Return (EIRR)		8.1%		

Table L-7 ECONOMIC EVALUATION FOR FLOOD CONTROL SCHEME (CASE F-2 RIVER IMPROVEMENT PLUS KARIAN DAM)

Unit: Rp 10^6

(1) Cost-Benefit Flow

Year		Cost			Benefit	Balance
		Construction	O & M	Total		
1	1985	280	0	280	0	-280
2	1986	986	0	986	0	-986
3	1987	4,482	0	4,482	0	-4,482
4	1988	3,361	0	3,361	0	-3,361
5	1989	3,579	0	3,579	0	-3,579
6	1990	1,060	40	1,100	862	-238
7	1991	592	40	632	862	230
8	1992	0	60	60	1,986	1,926
9	1993	0	60	60	1,986	1,926
10	1994	0	60	60	1,986	1,926
.	.	.	.	.	.	.
.	.	.	.	.	.	.
.	.	.	.	.	.	.
49	2033	0	60	60	1,986	1,926
50	2034	0	60	60	1,986	1,926

(2) NPV, B/C and EIRR

Item	Discounted Rate			
	8%	10%	12%	14%
Total Discounted Benefit	15,002	10,951	8,256	6,386
Total Discounted Cost	11,062	10,210	9,466	8,807
Net Present Value (NPV)	3,940	741	-1,210	-2,421
Benefit Cost Ratio (B/C)	1.36	1.07	0.87	0.73
Economic Internal Rate of Return (EIRR)		10.7%		

Table L-8 ECONOMIC EVALUATION FOR FLOOD CONTROL SCHEME (CASE F-3 RIVER IMPROVEMENT PLUS KARIAN AND PASIR KOPO DAMS)

Unit: Rp 10^6

(1) Cost-Benefit Flow

Year		Cost			Benefit	Balance
		Construction	O & M	Total		
1	1985	375	0	375	0	-375
2	1986	1,486	0	1,486	0	-1,486
3	1987	5,604	0	5,604	0	-5,604
4	1988	4,319	0	4,319	0	-4,319
5	1989	4,714	0	4,714	0	-4,714
6	1990	2,382	36	2,418	643	-1,775
7	1991	1,325	36	1,361	643	-718
8	1992	0	80	80	2,229	2,149
9	1993	0	80	80	2,229	2,149
10	1994	0	80	80	2,229	2,149
.	.	.	.	.	.	.
.	.	.	.	.	.	.
.	.	.	.	.	.	.
49	2033	0	80	80	2,229	2,149
50	2034	0	80	80	2,229	2,149

(2) NPV, B/C and EIRR

Item	Discounted Rate			
	6%	8%	10%	12%
Total Discounted Benefit	23,571	16,444	11,941	8,955
Total Discounted Cost	16,673	15,279	14,084	13,038
Net Present Value (NPV)	6,898	1,165	-2,143	-4,083
Benefit Cost Ratio (B/C)	1.41	1.08	0.85	0.69
Economic Internal Rate of Return (EIRR)		8.6%		

Table L-9 ECONOMIC EVALUATION FOR ENTIRE SCHEME (KARIAN DAM ALONE)

Unit: Rp 10^6

(1) Cost-Benefit Flow

Year		Cost			Benefit	Balance
		Construction	O & M	Total		
1	1985	1,432	0	1,432	0	-1,432
2	1986	5,974	0	5,974	0	-5,974
3	1987	15,796	0	15,796	0	-15,796
4	1988	13,990	0	13,990	0	-13,990
5	1989	14,893	0	14,893	0	-14,893
6	1990	11,461	20	11,481	862	-10,619
7	1991	6,239	20	6,259	862	-5,397
8	1992	0	526	526	12,181	11,655
9	1993	0	526	526	12,818	12,292
10	1994	0	526	526	13,458	12,932
11	1995	0	526	526	14,093	13,567
12	1996	0	526	526	14,730	14,204
13	1997	0	526	526	14,730	14,204
14	1998	0	526	526	14,730	14,704
15	1999	0	526	526	14,730	14,204
.	.	.	.	.	.	.
.	.	.	.	.	.	.
.	.	.	.	.	.	.
49	2033	0	526	526	14,730	14,204
50	2034	0	526	526	14,730	14,204

(2) NPV, B/C and EIRR

Item	Discounted Rate			
	10%	12%	14%	16%
Total Discounted Benefit	72,548	53,616	40,659	31,484
Total Discounted Cost	49,290	45,270	41,786	38,721
Net Present Value (NPV)	23,258	8,346	-1,127	-7,237
Benefit Cost Ratio (B/C)	1.47	1.17	0.97	0.81
Economic Internal Rate of Return (EIRR)	13.6%			

Table L-10 ECONOMIC EVALUATION FOR ENTIRE SCHEME (KARIAN PLUS PASIR KOPO DAMS)

Unit: Rp 10^6

(1) Cost-Benefit Flow

Year		Cost			Benefit	Balance
		Construction	O & M	Total		
1	1985	2,038	0	2,038	0	-2,038
2	1986	8,694	0	8,694	0	-8,694
3	1987	21,718	0	21,718	0	-21,718
4	1988	19,004	0	19,004	0	-19,004
5	1989	20,883	0	20,883	0	-20,883
6	1990	18,764	16	18,780	643	-18,137
7	1991	10,289	16	10,305	643	-9,662
8	1992	0	668	668	14,376	13,708
9	1993	0	668	668	15,135	14,467
10	1994	0	668	668	15,895	15,227
11	1995	0	668	668	16,654	15,986
12	1996	0	668	668	17,413	16,745
13	1997	0	668	668	17,413	16,745
14	1998	0	668	668	17,413	16,745
15	1999	0	668	668	17,413	16,745
.	.	.	.	.	.	.
.	.	.	.	.	.	.
.	.	.	.	.	.	.
49	2033	0	668	668	17,413	16,745
50	2034	0	668	668	17,413	16,745

(2) NPV, B/C and EIRR

Item	Discounted Rate			
	8%	10%	12%	14%
Total Discounted Benefit	119,334	85,332	62,999	42,724
Total Discounted Cost	77,127	70,437	64,721	59,743
Net Present Value (NPV)	42,207	14,895	-1,722	-12,019
Benefit Cost Ratio (B/C)	1.55	1.21	0.97	0.80
Economic Internal Rate of Return (EIRR)		11.8%		

Table L-11 ECONOMIC EVALUATION FOR ENTIRE SCHEME (KARIAN PLUS CILAWANG DAMS)

Unit: Rp 10^6

(1) Cost-Benefit Flow

Year		Cost			Benefit	Balance
		Construction	O & M	Total		
1	1985	1,659	0	1,659	0	-1,659
2	1986	7,503	0	7,503	0	-7,503
3	1987	18,551	0	18,551	0	-18,551
4	1988	15,915	0	15,915	0	-15,915
5	1989	17,291	0	17,291	0	-17,291
6	1990	13,859	20	13,879	862	-13,017
7	1991	7,690	20	7,710	862	-6,848
8	1992	0	569	569	14,264	13,695
9	1993	0	569	569	15,032	14,463
10	1994	0	569	569	15,799	15,230
11	1995	0	569	569	16,567	15,998
12	1996	0	569	569	17,334	16,765
13	1997	0	569	569	17,334	16,765
14	1998	0	569	569	17,334	16,765
15	1999	0	569	569	17,334	16,765
.	.	.	.	.	.	.
.	.	.	.	.	.	.
.	.	.	.	.	.	.
49	2033	0	569	569	17,334	16,765
50	2034	0	569	569	17,334	16,765

(2) NPV, B/C and EIRR

Item	Discounted Rate			
	10%	12%	14%	16%
Total Discounted Benefit	85,134	62,884	47,661	36,889
Total Discounted Cost	57,949	53,269	49,201	45,615
Net Present Value (NPV)	27,185	9,615	-1,540	-8,726
Benefit Cost Ratio (B/C	1.47	1.18	0.97	0.81
Economic Internal Rate of Return (EIRR)		13.8%		

Table L-12 RESULTS OF SENSITIVITY TEST FOR PROPOSED DEVELOPMENT PLAN

Case	Benefit	Cost	NPV (Rp 10^6)	B/C	EIRR (%)
T-1	-	10% up	4,288	1.07	12.8
T-2	-	20% up	-1,038	0.98	11.9
T-3	10% down	-	3,327	1.06	12.7
T-4	20% down	-	-2,962	0.94	11.6
T-5	10% down	10% up	-2,000	0.97	11.7
T-6	10% down	20% up	-7,326	0.89	11.0
T-7	20% down	10% up	-8,289	0.86	10.7
T-8	20% down	20% up	-13,615	0.79	9.9

Remarks: NPV and B/C at the discounted rate of 12%

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