## 2. Procedure for Estimation of Flood Damage

Economic losses due to the floods are classified into three categories as shown in Fig. K.1: (1) damage on accumulated capital such as structures and productive facilities; (2) damage on economic activities during suspension period, i.e., both accumulated production activities until floods occurred, and opportunity losses of production; (3) emergency activities such as rescue and medical assistance. These economic losses are reorganized into the following four items from the point of view of damage estimation procedure: (1) building damage; (2) agricultural damage; (3) infrastructural damage; and (4) indirect damage.

In the following discussion, flood damage estimation is explained under both the conditions of "without-project" and "with-project". The project mentioned here is the proposed scheme, i.e., the alternative I in Supporting Report I.

### 2.1 Hydraulic Effects

Hydraulic effects of the proposed project are shown in Table K.1. In the table, the following conditions are shown under both conditions of "without" and "with": (1) flood water depth reduction from 1986 flood at a check point of each zone; and (2) maximum flood duration at the lowest point. The details of these effects are discussed in Supporting Report G.

### 2.2 Residents

Table K.2 shows estimated victims in the flood area under both conditions of without-project and with-project in regard to various rainfall conditions. According to the table, more than 85% of residents in the area would be free from flood disaster on a scale of 1986 flood under "with-project" condition. Within Zones A to D, furthermore, more than 96% of residents would be free from flood disaster on the same scale. Although more than 70% of residents would be free in the case of 5-year recurrent flood, more than 70% of residents would be affected in the case of 50-year flood even under "with-project" condition.

## 2.3 Residential Building

Table K.3 shows the estimated number of residential buildings damaged by the 1986 floods in the flood area. Effects of the proposed flood control plan on residential building have almost the same tendency as the effects on victims mentioned above.

The building damage consists of two major items (i) residential building and (ii) industrial facilities, in general. Damage on a residential building is made up of (a) the building itself and (b) household effects furnished in the building. Industrial facilities comprise both facilities of industrial sector and commercial sector. Each sector is furthermore divided into following four items as shown in Fig. K.1: (a) fixed assets (or depreciable assets); (b) inventory assets; (c) expected net benefit; and (d) productive activity.

Each damage is assessed as the sum of the product of a damage rate and an economic value of each asset. The detail formulas used for estimation of the flood damage are illustrated in Fig. K.2. The criteria of flood damage rate is presented in Table K.4. It is based on the Japanese criteria prepared by the Ministry of Construction in Japan because a similar criteria is not available in Indonesia.

Financial cost of residential building and household effects are estimated respectively as Rp. 1.43 million and Rp. 645,000 in 1987. By applying a conversion factor to financial cost, the economic unit price of residential building and their household effects for the same year are estimated as Rp. 1.22 million and Rp. 548,000 respectively. The conversion factor (0.85) is figured out on the basis of construction cost of a typical house in Bandung area, as shown in Table K.5. Using these economic costs, damage amounts estimated under both conditions are shown in Table K.6. Flood damage of the 1986 flood is estimated as Rp. 5,948 million without any river improvement, from the economic point of view. However, once the proposed scheme is introduced in the flood area, the flood damage would be reduced to Rp. 610 million under the same rainfall condition, which is equivalent to a reduction of 85.4% from the "without-project" condition. Even under a 100-year recurrent

rainfall condition, a damage reduction of more than 80% would be accrued to the flood area from the present condition.

According to the development policy of concerned agencies such as BAPPEDA, the flood area is to be preserved as a green belt in the future and no development activities to be permitted. Based on this policy, residential buildings are assumed to increase at natural rate of population increase, as discussed in Supporting Report E. Table E.7 shows the population increase in the flood area as 1.45% per annum. Assuming that a family size remains the same at 4.6, the population and the number of households in the flood area are expected to be 149,700 and 32,500 in the year 2005, respectively.

Per capita GRDP in Kabupaten Bandung is expected to grow at a rate of 2.9% per annum between 1985 and 2000, and 2.1% per annum between 2001 and 2005, as given in Table B.10 of Supporting Report B. Thus, by the year 2005, per capita GRDP would be 1.60 times higher compared with 1987 value, if the regional economic growth remains at the same rate as projected. Then, the appraised values of housing effects would increase in proportion to the growth of per capita GRDP. The average unit values of a residential building and its household effects are estimated to increase to Rp. 1.95 million and Rp. 877,000 respectively, at economic prices in the year 2005.

## 2.4 Industrial Production

The estimated number of affected industrial and commercial facilities in the flood area are shown in Table K.7. Effects of the proposed scheme have the same tendency as the effects for the residential buildings.

Flood damages on industrial facilities and industrial activities are estimated using the same procedure as the residential buildings. In this category, however, large-scale industries provide self-instituted structures against flood disasters by themselves, hence need not be considered in the damage estimation at present time. Then, the economic damage amounts on other industrial facilities are shown in Table K.8, using economic costs converted from financial costs. Flood damage of the 1986 flood is estimated at Rp. 1,510 million in the without-

project case, from the economic point of view. The proposed scheme would reduce the flood damage to Rp. 245 million under the March 1986 rainfall condition, which is equivalent to a reduction of 83.8% from "without-project" damage, as shown in the table.

The number of industrial facilities in the future would be kept at constant as the present condition in the flood risk area, as per the development policy of the government. Thus, the future industrial production is assumed to remain the same as the present level.

## 2.5 Agricultural Production

Table K.9 shows estimation of affected areas of paddy field in the flood risk area. Effects of the proposed flood control scheme on agricultural production would be almost the same as that of residential building mentioned above, though the extent of damage reduction is smaller than that for building because paddy fields extend over lower lands.

Each damage is assessed as the sum of the product of a damage rate and an economic value of paddy production. The detail formulas used for estimation of the flood damage are illustrated in Fig. K.2. The criteria of flood damage rate is presented in Table K.10. It is also based on the same Japanese criteria as the building damage rate.

The crop damage value of paddy is assessed using the following parameters: (a) production cost; (b) cropping calendar; and (c) seasonal probability of flood. In this section, all costs and benefits are estimated at economic prices. Table K.11 shows the unit production cost of lowland paddy applying economic prices. An average cost is Rp. 334,000/ha, as shown in the table. Incidentally, Table K.12 shows price of urea at economic prices, which is an important fertilizer for crop production and is applied in Table K.11. The cropping calendar is shown in Table K.14. Based on this calendar, accumulated production cost in each month is assumed as shown in the table, which is presented as a percentage of the total production cost. The monthly probability of flood occurrence is also taken into account for the damage estimation. The flood probability for each month is expressed as a percentage distribution of the number of days with a daily rainfall greater than

60 $m^3/s$ during a year, which is decided on the basis of rainfall record at Nanjung station for eight years.

Based on the above conditions, the damageable cost value of paddy per ha is estimated at Rp. 200,000, as shown in Table K.14. On the other hand, the economic farm gate price of paddy is estimated to be Rp. 228/kg, as shown in Table K.13. Accordingly, the damageable net income is estimated as Rp. 897,000/ha, by using a similar procedure as the damageable value.

Using these economic costs, damage amounts on paddy production in the flood risk area are shown in Table K.15. Flood damage under the 1986 flood condition is estimated as Rp. 4,259 million without any river improvement, from the economic point of view. The proposed scheme would reduce the flood damage to Rp. 1,181 million under the March 1986 rainfall, which is equivalent to a reduction of 72.3% from "without-project" damage, as shown in the table.

Increase in paddy yield can be realized through provision of proper irrigation system and improved agricultural supporting services, in general. At present, yield in irrigated area with technical facilities is at a level of full exploitation in the flood area. For this reason, the paddy yield under the irrigated condition is anticipated to be only of 6.0 t/ha in the year 2005 from 5.4 t/ha at present. This is equivalent to an average annual growth rate of 0.58% per annum.

The price of paddy and fertilizer are forecasted by the Commodity Price Forecast of the World Bank. According to that projection, the price of paddy in the year 2000 would be 1.20 times more than that in 1987 at FOB price of Bangkok. This implies that the value of paddy would increase at a rate of 1.31% per annum. On the other hand, the price of urea in 2000 increases to 1.94 times or an annual growth rate of 1.23%, so the production cost of paddy would be pushed up to 1.23% annually until 2000. If these growth rates continue unchanged until the target year, the damageable cost and the damageable net income would be Rp. 248,000/ha and Rp. 1.22 million/ha, respectively. Then, the damageable value in the year 2005 would be Rp. 1.47 million/ha, which is 1.34 times higher than that in 1987.

## 2.6 Fishpond Production

Fishpond damage is assessed as the sum of the product of a damage rate and an economic value of fish production. The damage rate is assumed to be 65% in the case that the fishpond is inundated, referring to Table E.2 in Supporting Report E. The economic value of fish production is assessed by using the following parameters: (a) production cost; (b) cropping calendar; and (c) seasonal probability of flood. Table K.17 shows the unit production cost of ikan mas (golden fish; a kind of carp), as economic prices. An average cost is Rp. 340,000/crop, as shown in the table. The cropping calendar is shown in Table K.18. Based on this calendar, accumulated production cost in each month is assumed as shown in the table, which is presented as a percentage with respect to the total production cost. The monthly probability of flood occurrences is the same as mentioned in the previous Sub-section 2.5.

Based on the above conditions, the damageable cost value of fish per crop is estimated as Rp. 83,000, as shown in Table K.18. On the other hand, the economic farm gate price of fish is assessed to be Rp. 1,350/kg, as shown in Table K.17. Accordingly, the damageable net income is estimated as Rp. 282,000/crop, by using a similar procedure as the damageable value.

Using these economic costs, damage amounts on inland fishery production in the flood area are estimated as shown in Table K.19. A flood damage of the 1986 flood is estimated as Rp. 18.1 million without any river improvement from the economic point of view. The proposed scheme would eliminate the flood damage completely, because the fishponds are located in a relatively higher land than paddy fields.

Other agricultural production is quite small compared to paddy production, from the point of view of land use composition. Therefore, flood damages on these production facilities would be negligibly small, hence are not taken into account in the damage estimation.

## 2.7 Infrastructure

It is said that the degree of developments of infrastructure and that of superstructure are proportion to each other. Thus, damage on infrastructure is often estimated on the basis of this assumption. In fact, this estimation method is adopted in Japan as one of several methods of estimating flood damage on infrastructure. In this section, this method is applied to estimate the infrastructure damage. According to Table E.23 of Supporting Report E, the estimated value of infrastructure in flood risk area is Rp. 5.55 billion, which includes road and social infrastructure. On the other hand, the buildings are estimated at Rp. 61.17 billion, which include both houses and production facilities excluding large-scale industry of self-instituted flood proof system. Thus, value of the aforesaid infrastructure is about 9% of that of buildings. As a matter of fact, infrastructure should include other facilities such as electricity, wells for potable water and irrigation systems, for which values were not available at this time. Accordingly, the value of infrastructure is assumed to be about 20% of that of buildings or twice the aforesaid percentage.

## 2.8 Indirect Activity

The emergency activities consist of evacuation, flood fighting, disaster relief and temporary housing for victims. These costs are estimated as 5% of the total damage cost, referring to the official record of the 1986 flood.

# 3. Flood Damage under Various Plans

In Supporting Report G six (6) cases of river improvements, varrying from no project to 50-year plan, are analysed from a hydrological view point. In this Chapter the same six cases are analysed for flood damage reductions under seven (7) number recurrent floods, ranging from the 1986 floods to 100 year recurrent floods.

The results of the damage reduction analysis for all six cases of Flood Control Plan are summarized in Table K.20 to Table K.24. Table K.20 provides the results concerning the number of victims. Accordingly all levels of improvements (5 cases excluding the no project case) resutls in a damage reduction rate of more than 90% under the 1986 floods. In the case of 20-year flood, however, "5-year plan" reduces the damage to 60% of "without-project" condition, but the "more than 10-year" plans still have effects to relieve more than 90% of victims from flood.

As to damages on assets, both houses and paddy production are the largest items of damages on the flood area. Thus, damage characteristics of these two items are discussed in this chapter. Tables K.21 and K.22 show damage on residential buildings. Effects of the each level of river improvement have almost the same tendency as the effects for victims mentioned above, as shown in Table K.21. According to Table K.22, with a "5-year plan" in the flood, the flood damage by the 1986 flood would be reduced to Rp. 96.3 million, which is equivalent to 98.4% reduction from the "without-project" condition. In the case of 20-year flood, it would be Rp. 1,525 million, which is still 92.3%. If a "20-year plan" is applied, the damage would be reduced more than 96% even under 100-year flood

Table K.23 shows estimation of affected areas of paddy fields in the flood area. Effects of each level have almost the same tendency as the effects for residential buildings, although the damage reduction in paddy fields are lower than that of buildings. A damage of the 1986 flood is estimated at 4,259 million under present condition, as shown in Table K.24. Once "5-year plan" is applied to the flood area, the damage by the 1986 flood would be reduced to Rp. 61.3 million, which is equivalent to 98.6% reduction. In the case of 20-year flood, it would be Rp. 1,224 million, which is equivalent to 74.0% reduction. If "20-year plan" is introduced, the damage would be reduced more than 97% under the same flood.

Table K.25 shows the break-down of damages on assets for 5 cases, except the 10-year plan. It illustrates estimated damage and annual damage potential for each case in monetary terms.

# 4. Evaluation of Proposed Project

## 4.1 Economic Cost

The financial construction costs, as described in Supporting Report I, consist of the following items:

A. direct cost : (1) civil work cost
(2) flood warning system cost
B. indirect cost : (3) land acquisition and house resettlement compensation cost
(4) administration cost
(5) engineering service cost
C. contingency : (6) physical contingency
(7) price escalation

Among these costs, price contingencies are not included in the economic construction cost. Other costs are converted and provided as the economic cost by using the conversion procedure mentioned in Chapter 1.

The economic construction costs of the proposed urgent plan are summarized as follows:

| | |
|---|---|
| Foreign component | Rp. 59.1 billion |
| Local component | Rp. 20.1 billion |
| Total | Rp. 79.2 billion |

Details of these costs are shown in Table K.26. The annual disbursement of the cost is shown in Table K.33. The disbursement is estimated based on the implementation program described in Supporting Report I.

The annual operation and maintenance (O/M) cost is estimated as Rp. 285 million during the period of economic life of the project after the completion of construction works. Before the completion of the works, the O/M cost is estimated based on the following assumptions:

(1) Until three years after the commencement of the construction works, no appropriation is made for O/M cost;

(2) In the fourth year, the O/M cost is estimated as Rp. 113 million, which is 50% of 0.5% value of the completed civil works, as the works would be finished in the middle of the fourth year; and

(3) In the fifth year, since the rest of works is completed in the middle of the year, the full O/M cost would be appropriated from the second half of the year. Then, the annual O/M cost is estimated at Rp. 256 million.

## 4.2 Economic Benefit

### 4.2.1 Flood Reduction Benefit

(1) Benefit under Present Condition

Flood damages under both conditions of without-project and with-project are described in Chapter 2. Tables K.27 and K.28 summarize damages under without-project condition. Damages on houses is the largest asset damage in the flood risk area and increase rapidly with increasing return period of rainfall as shown in Table K.27. On the other hand, damages on paddy follow those on houses, but do not increase so rapidly as those of houses. Table K.28 shows flood damages by zone. Zones A, B and C occupy more than 80% of total damages, because of high concentration of assets in these areas along with more serious inundation conditions than upper zones, D and E.

Tables K.29 and K.30 summarize damages under with-project condition. When damages under "with" condition is compared with damages under "without" condition, the damages under small recurrent rainfall decreases effectively, as shown in Table K.29. It is clear that the project is very effective for zones A, B and C, and also moderately for zone D, as shown in Table K.30.

The benefit accrued from the reduction in flood damage to assets in the flood area is explained in Chapter 1. Tables K.31 and K.32 show the economic benefits under respective recurrent interval. The total benefit of flood damage reduction is estimated as Rp. 13,179 million, as shown in the table. The benefits will accrue during the period of economic life of the project. The annual flow of benefit, including partial benefits that will accrue during the construction period, is shown in Table K.33. Incidentally, the partial benefits are estimated based on the following assumption:

1) In the middle of the fourth year, the works in lower parts (0 km to 20 km) of Citarum river and Cisangkuy river are completed, so zone A would be effectively protected from floods. Then, a benefit of 50% would be accrued from zone A, because the construction finishes only in the middle of the year; and

2) In the middle of the fifth year, the whole construction works would be completed, so the whole benefit be accrued just after the middle of the fifth year.

(2) Benefit under Future Condition

Projected assets and production of each asset item under future condition are estimated in Chapter 2. Table K.34 summarizes the estimated flood damage reduction in the year 2005 under future condition. The annual benefit of Rp. 19,873 million is expected to be a matured benefit in the flood area, so the partial benefits accrued up to year 2005 are estimated as follows:

1) From 1987 to 2005, the annual benefit increase linearly; and

2) Benefits during the construction period are estimated in the same manner as explained the previous paragraph.

After the target year 2005, the benefit of Rp. 19,873 million is assumed to remain constant, as shown in Table K.35.

### 4.2.2 Other Benefits

Besides the above direct tangible benefit, the expected indirect intangible benefits are as follows:

(1) Increase in paddy production will raise the farmer income level and will contribute to the rectification of regional and sectoral inequalities in wealth, and further it will reduce the amount of rice imports resulting in saving of foreign exchange.

(2) It is expected that employment opportunities will be increased to people in the flood area by the implementation of river improvement works, and the resulting increase in cropping intensity and farm labour requirement.

(3) Local transportation will be improved so that most of road system would be free from inundation. Especially, since main provincial and Kabupaten roads are free from flood, people do not have to detour during inundation period.

(4) Intangible losses and menace would be reduced. For instance, the incidence of waterborne disease caused by contamination on potable water would be reduced. Durability of both private and public properties would not be shorten by inundation, anymore.

Although these benefits are considered derivative effects owing to the project implementation as mentioned in Chapter 1, they are intangible, so their benefits are not taken into account in the aforementioned cost benefit analysis.

## 4.3 Project Evaluation

### 4.3.1 Economic Evaluation

EIRR of the project under the urgent plan is estimated as 14.1% under the present condition and 18.5% under future condition, as shown in the following table, together with B/C and NPV for the case of a discount rate of 10%.

| Flood area condition | EIRR (%) | B/C | NPV (Rp. million) |
|---|---|---|---|
| Under present condition | 14.1 | 1.44 | 26,942 |
| Under future condition | 18.5 | 2.02 | 61,712 |

EIRR of the project is very high compared with the opportunity cost of capital (10%), hence the project is identified to be economically viable. In addition to the above, it must be emphasized that the project has a very serious social needs, and its implementation will generate much greater socio-economic impacts, as described in the following section.

### 4.3.2 Sensitivity Test

The assumptions and estimates of this study have been arrived at after a careful study based on professional experience and expert judgement, still there always remains the question on the degree of reliability of input data. It is customary, therefore, to test the results of economic analysis for sensitivity to variations in certain important inputs.

The sensitivity test is carried out only on the variations of the total discounted cost and benefits, without any examination on the variations of the major inputs. The test is made for variations of 5% and 10% of the cost and benefit with respect to EIRR of the urgent plan under present condition, and the results are given in the following table:

| Item | Sensitivity Case (Present Condition) | | | | | |
|---|---|---|---|---|---|---|
| | A | B | C | D | E | F |
| Capital Costs | 0% | 5% | 10% | 0% | 0% | 10% |
| Benefit | 0% | 0% | 0% | -5% | -10% | -10% |
| EIRR (%) | 14.1 | 13.5 | 12.9 | 13.5 | 12.8 | 11.7 |
| B/C | 1.44 | 1.38 | 1.31 | 1.37 | 1.30 | 1.18 |
| NPV (Rp. Billion) | 26.9 | 23.9 | 20.9 | 22.6 | 18.2 | 12.1 |

The analysis indicates that the level of these benefits is adequate to testify that the proposed project would be economically feasible.

## 4.4 Socio-Economic Impacts due to Project Implementation

Apart from the benefits discussed earlier, the following socio-economic impacts would be produced from the implementation and completion of the flood control works:

(1) Stabilization of the people's livelihood in the flood area by the reduction in flood menace, improvement of environmental conditions and the effective use of land;

(2) Implementation of flood control work would promote the effective use of land and land value would be expected to increase because the area is at a quite convenient distance to the center of Bandung. Therefore, unless the land use policy has to be observed throughout, the area would be urbanized disorderly.

(3) Upon completion of the proposed project, the standard of living of the people in the area will be improved because their losses would be reduced and labor opportunity would increase. The agencies concerned should endeavor to help the people to improve their quality of life through increased income and improvement of productivity by provision appropriate incentives and extension services.

Table K.1 HYDRAULIC EFFECTS

| Zone / Recurrence Interval | Without-Project Condition | | With-Project Condition | |
|---|---|---|---|---|
| | Flood Depth Reduction from 1986 Flood (m) | Maximum Flood Duration at the Lowest Point(day) | Flood Depth Reduction from 1986 Flood (m) | Maximum Flood Duration at the Lowest Point(day) |
| Zone A | | | | |
| 1986 Flood | 0.00 | Note 2 | 2.37 | 9 |
| 2-years | -0.24 | Note 2 | 2.15 | 13 |
| 5-years | -0.68 | Note 2 | 1.61 | 22 |
| 10-years | -0.99 | Note 2 | 1.24 | 39 |
| 20-years | -1.27 | Note 2 | 1.05 | 46 |
| 50-years | -1.61 | Note 2 | 0.72 | 51 |
| 100-years | -1.85 | Note 2 | 0.48 | 53 |
| Zone B | | | | |
| 1986 Flood | 0.00 | Note 2 | 2.17 | 9 |
| 2-years | -0.26 | Note 2 | 2.02 | 13 |
| 5-years | -0.85 | Note 2 | 1.50 | 22 |
| 10-years | -1.25 | Note 2 | 1.17 | 39 |
| 20-years | -1.60 | Note 2 | 0.97 | 46 |
| 50-years | -2.02 | Note 2 | 0.69 | 51 |
| 100-years | -2.32 | Note 2 | 0.48 | 53 |
| Zone C | | | | |
| 1986 Flood | 0.00 | 22 | 1.98 | 0 |
| 2-years | -0.28 | 29 | 1.89 | 0 |
| 5-years | -1.03 | 47 | 1.39 | 0 |
| 10-years | -1.51 | 55 | 1.10 | 1 |
| 20-years | -1.94 | 56 | 0.90 | 3 |
| 50-years | -2.44 | 59 | 0.66 | 7 |
| 100-years | -2.80 | 60 | 0.48 | 9 |
| Zone D | | | | |
| 1986 Flood | 0.00 | 61 | 1.01 | 30 |
| 2-years | -0.22 | Note 2 | 0.88 | 30 |
| 5-years | -0.80 | Note 2 | 0.43 | 31 |
| 10-years | -1.17 | Note 2 | 0.15 | 31 |
| 20-years | -1.50 | Note 2 | -0.06 | 37 |
| 50-years | -1.89 | Note 2 | -0.31 | 42 |
| 100-years | -2.16 | Note 2 | -0.50 | 48 |
| Zone E | | | | |
| 1986 Flood | 0.00 | 61 | 0.00 | 59 |
| 2-years | -0.12 | Note 2 | -0.12 | 61 |
| 5-years | -0.32 | Note 2 | -0.32 | Note 2 |
| 10-years | -0.54 | Note 2 | -0.54 | Note 2 |
| 20-years | -0.72 | Note 2 | -0.72 | Note 2 |
| 50-years | -0.92 | Note 2 | -0.92 | Note 2 |
| 100-years | -1.17 | Note 2 | -1.17 | Note 2 |

Note : 1. Negative figures mean that a water level by water discharge concerned exceeds a water level by 1986 flood.
2. More than two months

Table K.2 ESTIMATED NUMBER OF VICTIMS AND EFFECTS OF THE PROJECT

| Zone | Recurrence Interval | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1986 Flood | 2-years | 5-years | 10-years | 20-years | 50-years | 100-years |
| Estimated number of Victims under Without-Project Condition | | | | | | | |
| Zone A | 41,428 | 41,428 | 41,428 | 41,428 | 41,428 | 41,428 | 41,428 |
| Zone B | 25,969 | 25,969 | 25,969 | 25,969 | 25,969 | 25,969 | 25,969 |
| Zone C | 20,693 | 20,693 | 20,693 | 20,693 | 20,693 | 20,693 | 20,693 |
| Zone D | 10,859 | 10,859 | 10,859 | 10,859 | 10,859 | 10,859 | 10,859 |
| Zone E | 13,301 | 13,301 | 13,301 | 13,301 | 13,301 | 13,301 | 13,301 |
| Total | 112,250 | 112,250 | 112,250 | 112,250 | 112,250 | 112,250 | 112,250 |
| Estimated Number of Victims under With-Project Condition | | | | | | | |
| Zone A | 0 | 0 | 3,111 | 8,836 | 12,378 | 21,482 | 28,444 |
| Zone B | 2,704 | 3,518 | 7,535 | 11,564 | 14,148 | 18,902 | 22,281 |
| Zone C | 127 | 355 | 2,888 | 6,962 | 10,506 | 15,638 | 19,125 |
| Zone D | 589 | 1,968 | 3,936 | 9,490 | 10,859 | 10,859 | 10,859 |
| Zone E | 13,301 | 13,301 | 13,301 | 13,301 | 13,301 | 13,301 | 13,301 |
| Total | 16,721 | 19,142 | 33,771 | 50,153 | 61,192 | 80,182 | 94,010 |
| Reduction Rate (%) | | | | | | | |
| Zone A | 100.0 | 100.0 | 92.5 | 78.7 | 70.1 | 48.1 | 31.3 |
| Zone B | 89.6 | 86.5 | 71.0 | 55.5 | 45.5 | 27.2 | 14.2 |
| Zone C | 99.4 | 98.3 | 86.0 | 66.4 | 49.2 | 24.4 | 7.6 |
| Zone D | 94.6 | 81.9 | 63.8 | 12.6 | 0.0 | 0.0 | 0.0 |
| Zone E | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total | 85.1 | 82.9 | 72.6 | 55.3 | 45.5 | 28.6 | 16.2 |

Table K.3 ESTIMATED NUMBER OF INUNDATED RESIDENTIAL BUILDINGS AND EFFECTS OF THE PROJECT

| Zone | Recurrence Interval | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1986 Flood | 2-years | 5-years | 10-years | 20-years | 50-years | 100-years |
| Estimated Number of Inundated Residential Building under Without-Project Condition | | | | | | | |
| Zone A | 7,948 | 7,948 | 7,948 | 7,948 | 7,948 | 7,948 | 7,948 |
| Zone B | 5,617 | 5,617 | 5,617 | 5,617 | 5,617 | 5,617 | 5,617 |
| Zone C | 8,310 | 8,310 | 8,310 | 8,310 | 8,310 | 8,310 | 8,310 |
| Zone D | 2,247 | 2,247 | 2,247 | 2,247 | 2,247 | 2,247 | 2,247 |
| Zone E | 3,188 | 3,188 | 3,188 | 3,188 | 3,188 | 3,188 | 3,188 |
| Total | 27,310 | 27,310 | 27,310 | 27,310 | 27,310 | 27,310 | 27,310 |
| Estimated Number of Inundated Residential Buildings under With-Project Condition | | | | | | | |
| Zone A | 0 | 0 | 562 | 1,651 | 2,331 | 4,080 | 5,418 |
| Zone B | 645 | 847 | 1,686 | 2,541 | 3,086 | 4,070 | 4,772 |
| Zone C | 38 | 135 | 1,156 | 2,732 | 4,202 | 6,426 | 4,924 |
| Zone D | 127 | 417 | 1,455 | 1,971 | 2,247 | 2,247 | 2,247 |
| Zone E | 3,188 | 3,188 | 3,188 | 3,188 | 3,188 | 3,188 | 3,188 |
| Total | 3,998 | 4,587 | 8,047 | 12,083 | 15,054 | 20,011 | 20,549 |
| Reduction Rate (%) | | | | | | | |
| Zone A | 100.0 | 100.0 | 92.9 | 79.2 | 70.7 | 48.7 | 31.8 |
| Zone B | 88.5 | 84.9 | 70.0 | 54.8 | 45.1 | 27.5 | 15.0 |
| Zone C | 99.5 | 98.4 | 86.1 | 67.1 | 49.4 | 22.7 | 40.7 |
| Zone D | 94.3 | 81.4 | 35.2 | 12.3 | 0.0 | 0.0 | 0.0 |
| Zone E | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total | 85.4 | 83.2 | 70.5 | 55.8 | 44.9 | 26.7 | 24.8 |

Table K.4 STANDARD DAMAGE RATE ON BUILDINGS AND THEIR MOVABLE

| Item | Inundation below floor level | Inundation above floor Level | | | | |
|---|---|---|---|---|---|---|
| | | 0 - 0.49 m | 0.5 - 0.99 m | 1 - 1.99 m | 2 - 2.99 m | More than 3 m |
| 1. Residential Building | | | | | | |
| - Housing Unit /1 | 0.03 | 0.053 | 0.073 | 0.109 | 0.534 | 0.571 |
| - Household Effects | - | 0.086 | 0.191 | 0.331 | 0.499 | 0.690 |
| 2. Non-residential building | | | | | | |
| - Depreciable Assets | - | 0.180 | 0.314 | 0.419 | 0.539 | 0.630 |
| - Inventory Stock | - | 0.127 | 0.276 | 0.379 | 0.479 | 0.562 |

Note : /1 Sloop less than 1/1000

Source : Criteria for the Economic Evaluation on Flood Control Scheme; Ministry of Construction in Japan

Table K.5 ECONOMIC CONVERSION FACTOR OF HOUSING UNIT

| | | | |
|---|---|---|---|
| I. | Specification of a typical Permanent House | | |
| | 1. Floor Area (net area) | 102 m² | |
| | 2. Structure | | |
| | a. Foundation | Brick | |
| | b. Main Structure | Reinforced Concrete (Ramen Structure) | |
| | c. Roof | Waving Asbest Plate | |
| | d. Wall | Red Brick | |
| | e. Floor | Tile, Concrete | |
| II. | Construction Cost (Thousand Rupiahs) | | |
| | 1. Material | | |
| | a. Foreign Material | - | - |
| | b. Domestic Material | 10,980 | 9,882 /1 |
| | 2. Labor | | |
| | a. Skilled Labor (Head man, Carpenter, Joinner, Brick Worker, etc.) | 4,023 | 3,621 /1 |
| | b. Unskilled Labor | 3,509 | 2,105 /2 |
| | 3. Total | 18,512 | 15,608 |
| | Conversion Factor | 0.85 (← 15,608/18,512) | |

Note : /1 Transfer payment of 10% is excluded.
/2 Economic price is applied.

Table K.6 ESTIMATED DAMAGE AMOUNT OF INUNDATED RESIDENTIAL BUILDINGS AND EFFECTS OF THE PROJECT

( Unit : Million Rupiahs )

| Zone | Recurrence Interval | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1986 Flood | 2-years | 5-years | 10-years | 20-years | 50-years | 100-years |
| Estimated Damage of Inundated Residential Building under Without-Project Condition | | | | | | | |
| Zone A | 1,497 | 1,903 | 2,844 | 3,717 | 4,645 | 5,882 | 6,781 |
| Zone B | 1,767 | 2,179 | 3,215 | 4,071 | 4,905 | 5,519 | 5,751 |
| Zone C | 1,831 | 2,312 | 4,371 | 6,993 | 7,959 | 8,640 | 8,886 |
| Zone D | 339 | 428 | 671 | 887 | 1,369 | 1,851 | 2,117 |
| Zone E | 514 | 579 | 721 | 877 | 1,032 | 1,220 | 1,476 |
| Total | 5,948 | 7,401 | 11,822 | 16,545 | 19,910 | 23,112 | 25,011 |
| Estimated Damage of Inundated Residential Buildings under With-Project Condition | | | | | | | |
| Zone A | 0 | 0 | 52 | 176 | 275 | 557 | 819 |
| Zone B | 82 | 110 | 259 | 462 | 610 | 851 | 1,038 |
| Zone C | 2 | 7 | 91 | 293 | 447 | 834 | 1,118 |
| Zone D | 12 | 29 | 157 | 274 | 361 | 468 | 551 |
| Zone E | 514 | 579 | 721 | 877 | 1,032 | 1,220 | 1,476 |
| Total | 610 | 725 | 1,280 | 2,082 | 2,725 | 3,930 | 5,002 |
| Reduction Rate (%) | | | | | | | |
| Zone A | 100.0 | 100.0 | 98.2 | 95.3 | 94.1 | 90.5 | 87.9 |
| Zone B | 95.4 | 95.0 | 91.9 | 88.7 | 87.6 | 84.6 | 82.0 |
| Zone C | 99.9 | 99.7 | 97.9 | 95.8 | 94.4 | 90.3 | 87.4 |
| Zone D | 96.5 | 93.2 | 76.6 | 69.1 | 73.6 | 74.7 | 74.0 |
| Zone E | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total | 89.7 | 90.2 | 89.2 | 87.4 | 86.3 | 83.0 | 80.0 |

Table K.7 ESTIMATED NUMBER OF INUNDATED INDUSTRIAL FACILITIES AND EFFECTS OF THE PROJECT

| Zone | Recurrence Interval | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1986 Flood | 2-years | 5-years | 10-years | 20-years | 50-years | 100-years |
| Estimated Number of Inundated Industrial Facilities under Without-Project Condition | | | | | | | |
| Zone A | 207 | 207 | 207 | 207 | 207 | 207 | 207 |
| Zone B | 70 | 70 | 70 | 70 | 70 | 70 | 70 |
| Zone C | 71 | 71 | 71 | 71 | 71 | 71 | 71 |
| Zone D | 14 | 14 | 14 | 14 | 14 | 14 | 14 |
| Zone E | 72 | 72 | 72 | 72 | 72 | 72 | 72 |
| Total | 434 | 434 | 434 | 434 | 434 | 434 | 434 |
| Estimated Number of Inundated Industrial Facilities under With-Project Condition | | | | | | | |
| Zone A | 0 | 0 | 17 | 44 | 60 | 108 | 145 |
| Zone B | 12 | 15 | 28 | 39 | 46 | 56 | 63 |
| Zone C | 0 | 1 | 7 | 19 | 30 | 48 | 60 |
| Zone D | 1 | 2 | 8 | 12 | 14 | 14 | 14 |
| Zone E | 72 | 72 | 72 | 72 | 72 | 72 | 72 |
| Total | 85 | 90 | 132 | 186 | 222 | 298 | 354 |
| Reduction Rate (%) | | | | | | | |
| Zone A | 100.0 | 100.0 | 91.8 | 78.7 | 71.0 | 47.8 | 30.0 |
| Zone B | 82.9 | 78.6 | 60.0 | 44.3 | 34.3 | 20.0 | 10.0 |
| Zone C | 100.0 | 98.6 | 90.1 | 73.2 | 57.7 | 32.4 | 15.5 |
| Zone D | 92.9 | 85.7 | 42.9 | 14.3 | 0.0 | 0.0 | 0.0 |
| Zone E | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total | 80.4 | 79.3 | 69.6 | 57.1 | 48.8 | 31.3 | 18.4 |

Table K.8 ESTIMATED DAMAGE AMOUNT OF INUNDATED INDUSTRIAL FACILITIES AND EFFECTS OF THE PROJECT

( Unit : Million Rupiahs )

| Zone | Recurrence Interval | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1986 Flood | 2-years | 5-years | 10-years | 20-years | 50-years | 100-years |
| Estimated Damage of Inundated Industrial Facilities under Without-Project Condition | | | | | | | |
| Zone A | 693 | 804 | 973 | 1,056 | 1,130 | 1,211 | 1,273 |
| Zone B | 310 | 338 | 392 | 422 | 446 | 468 | 479 |
| Zone C | 256 | 294 | 368 | 415 | 446 | 483 | 495 |
| Zone D | 39 | 47 | 63 | 70 | 75 | 83 | 87 |
| Zone E | 212 | 235 | 273 | 311 | 329 | 349 | 371 |
| Total | 1,510 | 1,718 | 2,069 | 2,274 | 2,426 | 2,594 | 2,705 |
| Estimated Damage of Inundated Industrial Facilities under With-Project Condition | | | | | | | |
| Zone A | 0 | 0 | 32 | 100 | 143 | 288 | 406 |
| Zone B | 31 | 39 | 82 | 128 | 156 | 201 | 234 |
| Zone C | 0 | 1 | 15 | 39 | 68 | 117 | 154 |
| Zone D | 2 | 5 | 18 | 31 | 41 | 50 | 57 |
| Zone E | 212 | 235 | 273 | 311 | 329 | 349 | 371 |
| Total | 245 | 280 | 420 | 609 | 737 | 1,005 | 1,222 |
| Reduction Rate (%) | | | | | | | |
| Zone A | 100.0 | 100.0 | 96.7 | 90.5 | 87.3 | 76.2 | 68.1 |
| Zone B | 90.0 | 88.5 | 79.1 | 69.7 | 65.0 | 57.1 | 51.1 |
| Zone C | 100.0 | 99.7 | 95.9 | 90.6 | 84.8 | 75.8 | 68.9 |
| Zone D | 94.9 | 89.4 | 71.4 | 55.7 | 45.3 | 39.8 | 34.5 |
| Zone E | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total | 83.8 | 83.7 | 79.7 | 73.2 | 69.6 | 61.3 | 54.8 |

Table K.9 ESTIMATED AREA OF INUNDATED PADDY FIELD AND EFFECTS OF THE PROJECT

| Zone | Recurrence Interval | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1986 Flood | 2-years | 5-years | 10-years | 20-years | 50-years | 100-years |
| Estimated Area of Inundated Paddy Field under Without-Project Condition (ha) | | | | | | | |
| Zone A | 451 | 451 | 451 | 451 | 451 | 451 | 451 |
| Zone B | 1,113 | 1,113 | 1,113 | 1,113 | 1,113 | 1,113 | 1,113 |
| Zone C | 2,043 | 2,043 | 2,043 | 2,043 | 2,043 | 2,043 | 2,043 |
| Zone D | 1,022 | 1,022 | 1,022 | 1,022 | 1,022 | 1,022 | 1,022 |
| Zone E | 1,735 | 1,735 | 1,735 | 1,735 | 1,735 | 1,735 | 1,735 |
| Total | 6,364 | 6,364 | 6,364 | 6,364 | 6,364 | 6,364 | 6,364 |
| Estimated Area of Inundated Paddy Field under With-Project Condition (ha) | | | | | | | |
| Zone A | 0 | 0 | 15 | 104 | 166 | 245 | 301 |
| Zone B | 90 | 111 | 221 | 409 | 532 | 777 | 950 |
| Zone C | 22 | 94 | 622 | 1,169 | 1,176 | 1,618 | 1,711 |
| Zone D | 115 | 220 | 612 | 879 | 1,022 | 1,022 | 1,022 |
| Zone E | 1,735 | 1,735 | 1,735 | 1,735 | 1,735 | 1,735 | 1,735 |
| Total | 1,932 | 2,160 | 3,205 | 4,296 | 4,631 | 5,397 | 5,719 |
| Reduction Rate (%) | | | | | | | |
| Zone A | 100.0 | 100.0 | 96.7 | 76.9 | 63.2 | 45.7 | 33.3 |
| Zone B | 91.9 | 90.0 | 80.1 | 63.3 | 52.2 | 30.2 | 14.6 |
| Zone C | 98.9 | 95.4 | 69.6 | 42.8 | 42.4 | 20.8 | 16.3 |
| Zone D | 88.7 | 78.5 | 40.1 | 14.0 | 0.0 | 0.0 | 0.0 |
| Zone E | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total | 69.2 | 66.1 | 49.6 | 32.5 | 27.2 | 15.2 | 10.1 |

Table K.10 REDUCTION RATE OF CROP BY FLOOD INUNDATION

| Crop | Inundation Depth (m) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Less than 0.5 m | | | | 0.5 - 0.99 m | | | | More than 1.0 m | | | |
| | Duration (days) | | | | Duration (days) | | | | Duration (days) | | | |
| | 1-2 | 3-4 | 5-6 | 7- | 1-2 | 3-4 | 5-6 | 7- | 1-2 | 3-4 | 5-6 | 7- |
| Lowland Paddy | 21 | 30 | 36 | 50 | 24 | 44 | 50 | 71 | 37 | 54 | 64 | 74 |
| Upland Paddy | 20 | 34 | 47 | 60 | 30 | 40 | 50 | 60 | 44 | 60 | 72 | 82 |
| Beans | 23 | 41 | 54 | 67 | 30 | 44 | 60 | 73 | 40 | 50 | 68 | 81 |
| Leaf vegetable | 19 | 33 | 46 | 59 | 20 | 44 | 48 | 75 | 44 | 38 | 71 | 84 |
| Fruit Vegetable | 22 | 30 | 43 | 56 | 31 | 38 | 51 | 100 | 40 | 50 | 63 | 100 |
| Root Crops | 32 | 46 | 59 | 62 | 43 | 57 | 100 | 100 | 73 | 87 | 100 | 100 |
| Average Upland Crops | 27 | 42 | 54 | 67 | 35 | 48 | 67 | 74 | 51 | 67 | 81 | 91 |

Source : Criteria for the Economic Evaluation on Flood Control Scheme,
Ministry of Construction in Japan.

Table K.11 ECONOMIC PRODUCTION COST OF LOWLAND PADDY IN THE FLOOD AREA

| Item | Unit | Amount | Unit Cost (Rp./Unit) | Total Cost (Rp./ha) |
|---|---|---|---|---|
| 1. Materials | | | | |
| - Seed | kg/ha | 25 | 300 | 7,500 |
| - Fertilizers | kg/ha | 270/1 | 246 | 66,420 |
| - Agro-chemicals | l/ha | 3 | 2,700 | 8,100 |
| - Others | nos. | - | - | 23,380 |
| Sub-total | | | | 105,400 |
| 2. Labour | | | | |
| - Nursery work | persons/ha | 8 | 900 | 7,200 |
| - Land preparation | persons/ha | 90 | 900 | 81,000 |
| - Basic fertilizer | persons/ha | 10 | 900 | 9,000 |
| - Pulling & transplanting | persons/ha | 24 | 900 | 21,600 |
| - Weeding | persons/ha | 40 | 900 | 36,000 |
| - Spraying | persons/ha | 6 | 900 | 5,400 |
| - Harvesting & threshing | persons/ha | 46 | 900 | 41,400 |
| - Drying | persons/ha | 30 | 900 | 27,000 |
| Sub-total | | | | 228,600 |
| 3. Total | | | | 334,000 |

Note : /1 Including equivalent urea amount of other fertilizers.
Source : Dinas Pertanian Tanaman Pangan, Government of Kabupaten Bandung.

Table K.12 ECONOMIC PRICE FOR UREA

| Item | Unit | 1986 |
|---|---|---|
| 1. FOB N.W. Europe | US$/ton | 107/1 |
| 2. Freight and Insurance | US$/ton | 21 |
| 3. CIF at Jakarta | US$/ton | 128 |
| 4. Conversion to Rupiah | Rp./ton | 211,840 |
| 5. Handling, distribution and storage | Rp./ton | 33,000 |
| 6. Local market price | Rp./ton | 244,840 |
| 7. Transport to farm gate | Rp./ton | 1,300 |
| 8. Economic farm gate price | Rp./ton | 246,140 |
| | ( Rp./kg | 246 ) |

Note : /1 : Half-Yearly Revision of Commodity Price Forecasts by the World Bank issued on September 17, 1987.

Table K.13 ECONOMIC PRICE FOR LOWLAND PADDY

| Item | Unit | Value |
|---|---|---|
| 1. U.S. 5% broken at World market price | US$/ton | 211/1 |
| 2. 10% discount for quality | US$/ton | 190 |
| 3. Freight and insurance between Bankok and Jakarta | US$/ton | 24 |
| 4. Transport and handling between wholesaler and port | US$/ton | 10 |
| 5. Import Parity ((2) + (3) + (4)) | US$/ton | 224 |
| 6. Conversion to Rupiah | US$/ton | 370,720/2 |
| 7. Transport and handling from the site to wholesaler | Rp./ton | 11,000 |
| 8. Milling cost (12%) | Rp./ton | 40,100 |
| 9. Less of by-products | Rp./ton | 17,730 |
| 10. Value at mill | Rp./ton | 337,350 |
| 11. Conversion to dry paddy (68%) | Rp./ton | 229,400 |
| 12. Transport from farm to mill | Rp./ton | 1,300 |
| 13. Economic farm gate price | Rp./ton | 228,100 |
| | | ( Rp.228/kg ) |

Note : /1 Half-Yearly Revision of Commodity Price Forecasts by the World Bank issued on September 17, 1987.
/2 Exchange rate US$ 1.00 = Rp. 1,655

Table K.14 ESTIMATED DAMAGEABLE VALUE OF LOWLAND PADDY IN IRRIGATED FIELD

| Item | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Cropping Calendar | 1st Paddy | | | 2nd Paddy | | | | | | 1st Paddy | | |
| 2. Accumulated Cost (%) | 70 | 73 | 75 | 42 | 57 | 65 | 70 | 73 | 75 | 42 | 57 | 65 |
| 3. Flood Probability (%) | 9 | 13 | 15 | 24 | 7 | 1 | 0 | 0 | 1 | 5 | 12 | 13 |

| | 1st Paddy | 2nd Paddy | Total |
|---|---|---|---|
| 4. Production cost (Rp. 1000/ha) | 334 | 334 | 668 |
| 5. Damageable cost (Rp. 1000/ha) ((4) x (2) x (3)) | 148 | 52 | 200 |
| 6. Yield (t/ha) | 5.4 | 5.4 | - |
| 7. Price (Rp.1000/t) | 228 | 228 | - |
| 8. Grass income (Rp.1000/ha) | 1,231 | 1,231 | 2,462 |
| 9. Expected net income (Rp.1000/ha) ((8) - (4)) | 897 | 897 | 1,794 |
| 10. Damageable net income (Rp.1000/ha) ((9) x (3)) | 601 | 296 | 897 |

Table K.15 ESTIMATED DAMAGE AMOUNT OF INUNDATED PADDY FIELD AND EFFECTS OF THE PROJECT

( UNit : Million Rupiahs )

| Zone | Recurrence Interval | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1986 Flood | 2-years | 5-years | 10-years | 20-years | 50-years | 100-years |
| Estimated Damage of Inundated Paddy Field under Without-Project Condition | | | | | | | |
| Zone A | 265 | 277 | 297 | 306 | 307 | 307 | 307 |
| Zone B | 844 | 872 | 901 | 903 | 903 | 903 | 903 |
| Zone C | 1,178 | 1,521 | 1,584 | 1,584 | 1,584 | 1,584 | 1,584 |
| Zone D | 591 | 632 | 707 | 722 | 722 | 722 | 722 |
| Zone E | 1,081 | 1,105 | 1,144 | 1,181 | 1,201 | 1,226 | 1,236 |
| Total | 4,259 | 4,407 | 4,633 | 4,696 | 4,717 | 4,742 | 4,752 |
| Estimated Damage of Inundated Paddy Field under With-Project Condition | | | | | | | |
| Zone A | 0 | 0 | 8 | 51 | 80 | 141 | 180 |
| Zone B | 32 | 45 | 98 | 236 | 350 | 520 | 643 |
| Zone C | 5 | 22 | 171 | 366 | 309 | 675 | 817 |
| Zone D | 63 | 121 | 337 | 486 | 592 | 636 | 669 |
| Zone E | 1,081 | 1,105 | 1,144 | 1,181 | 1,201 | 1,226 | 1,236 |
| Total | 1,181 | 1,293 | 1,758 | 2,320 | 2,532 | 3,198 | 3,545 |
| Reduction Rate (%) | | | | | | | |
| Zone A | 100.0 | 100.0 | 97.3 | 83.3 | 73.9 | 54.1 | 41.4 |
| Zone B | 96.2 | 94.8 | 89.1 | 73.9 | 61.2 | 42.4 | 28.8 |
| Zone C | 99.7 | 98.6 | 89.2 | 76.9 | 80.5 | 57.4 | 48.4 |
| Zone D | 89.3 | 80.9 | 52.3 | 32.7 | 18.0 | 11.9 | 7.3 |
| Zone E | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total | 72.3 | 70.7 | 62.1 | 50.6 | 46.3 | 32.6 | 25.4 |

Table K.16 ESTIMATED AREA OF INUNDATED FISHPOND AND EFFECTS OF THE PROJECT

| Zone | Recurrence Interval | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1986 Flood | 2-years | 5-years | 10-years | 20-years | 50-years | 100-years |
| Estimated Area of Inundated Fishpond under Without-Project Condition (ha) | | | | | | | |
| Zone A | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 |
| Zone B | 75.2 | 75.2 | 75.2 | 75.2 | 75.2 | 75.2 | 75.2 |
| Zone C | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Zone D | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Zone E | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total | 76.6 | 76.6 | 76.6 | 76.6 | 76.6 | 76.6 | 76.6 |
| Estimated Area of Inundated Fishpond under With-Project Condition (ha) | | | | | | | |
| Zone A | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 |
| Zone B | 0.0 | 0.0 | 0.0 | 0.0 | 3.9 | 40.1 | 65.1 |
| Zone C | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Zone D | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Zone E | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total | 0.0 | 0.0 | 0.0 | 0.0 | 3.9 | 40.1 | 65.2 |
| Reduction Rate (%) | | | | | | | |
| Zone A | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 92.9 |
| Zone B | 100.0 | 100.0 | 100.0 | 100.0 | 94.8 | 46.7 | 13.4 |
| Zone C | - | - | - | - | - | - | - |
| Zone D | - | - | - | - | - | - | - |
| Zone E | - | - | - | - | - | - | - |
| Total | 100.0 | 100.0 | 100.0 | 100.0 | 94.9 | 47.7 | 14.9 |

Table K.17 ECONOMIC PRODUCTION COST OF IKAN MAS (GOLDEN FISH) IN FISHPOND

| Stage | Raising Period (Month) | Expense (Rp.10³/ha/1) | | | | |
|---|---|---|---|---|---|---|
| | | Fry | Wage | Feed & Chemicals | Equipment | Total |
| I. Unit Cost of Each Transition Stage | | | | | | |
| 1. Nursery | 1.0 | 180 | 30 | 140 | 27 | 377 |
| 2. Transition 1 | 1.0 | - | 30 | 140 | 9 | 179 |
| 3. Transition 2 | 1.0 | - | 30 | 140 | 9 | 179 |
| 4. Transition 3 | 1.0 | - | 30 | 140 | 9 | 179 |
| 5. Rearing | 3.0 | - | 75 | 185 | 9 | 269 |

II. Production cost per Unit Area of Fishpond

| | Composition of Each Stage (%) | Balanced Area Composition (ha/2) | Turnover (Times/year) | Unit Cost (Rp.10³/ha/1/Crop) | Unit Cost (Rp.10³/ha/2/year) |
|---|---|---|---|---|---|
| 1. Nursery | 0.7 | 0.004 | 12 | 377 | 18 |
| 2. Transition 1 | 2.3 | 0.012 | 12 | 179 | 26 |
| 3. Transition 2 | 9.5 | 0.048 | 12 | 179 | 103 |
| 4. Transition 3 | 37.9 | 0.191 | 12 | 179 | 410 |
| 5. Rearing | 49.4 | 0.745 | 4 | 269 | 802 |
| 6. Total | 100.0 | 1.000 | - | - | 1,359 ( Rp.340 x 10³/ha/2/crop) |

III. Expected Production per Unit Area of Fishpond

| | Balanced Area Composition (ha/2) | Harvesting (Times/year) | Unit Production (kg/ha/1/crop) | Unit Production (kg/ha/2/year) |
|---|---|---|---|---|
| 1. Nursery | 0.004 | - | - | - |
| 2. Transition 1 | 0.012 | - | - | - |
| 3. Transition 2 | 0.048 | - | - | - |
| 4. Transition 3 | 0.191 | 12 | 23 | 53 |
| 5. Rearing | 0.745 | 4 | 800 | 2,384 |
| 6. Total | 1.000 | - | - | 2,437 |
| (Gross Income/3 | | | Rp.3,290 x 10³/ha/2/year) | |
| (Gross Income/3 | | | Rp.823 x 10³/ha/2/crop) | |

Note : /1 Pond area of single stage
/2 Balanced compound area of each stage
/3 A farm gate price of Ikan Mas is Rp.1,350/kg.

Source : Dinas Perikanan, Kabupaten DT II Bandung

Table K.18 ESTIMATED DAMAGEABLE VALUE OF IKAN MAS (GOLDEN FISH) IN FISHPOND

| Item | Jan | Feb | Mar | Apr | May | June | July | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ( 1st Crop ) 1. Cropping Stage | Nursery | Transition 1 | 2 | 3 | Rearing | | | | | | | |
| 2. Accumulated Cost (%) | 1 | 3 | 10 | 40 | 60 | 80 | 100 | | | | | |
| 3. Production (kg/ha) | - | - | - | 14 | - | - | 596 | | | | | |
| ( 2nd Crop ) | | | | | | | | | | | | |
| ( 3rd Crop ) | | | | | | | | | | | | |
| : | | | | | | | | | | | | |
| : | | | | | | | | | | | | |
| : | | | | | | | | | | | | |
| ( 12th Crop ) | | | | | | | | | | | | |
| 4. Flood Probability (%) | 9 | 13 | 15 | 24 | 7 | 1 | 0 | 0 | 1 | 5 | 12 | 13 |

| Item (Unit : Rp.$10^3$/ha) | 1st Crop | 2nd Crop | 3rd Crop | 4th Crop | 5th Crop | 6th Crop | 7th Crop | 8th Crop | 9th Crop | 10th Crop | 11th Crop | 12th Crop | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5. Production Cost | 340 | 340 | 340 | 340 | 340 | 340 | 340 | 340 | 340 | 340 | 340 | 340 | 340 |
| 6. Damageable Cost ( $\Sigma$ ((2)x(4)x(5)) ) | 56 | 22 | 10 | 22 | 57 | 88 | 98 | 113 | 127 | 167 | 142 | 98 | 83 |
| 7. Expected Gross Income | 823 | 823 | 823 | 823 | 823 | 823 | 823 | 823 | 823 | 823 | 823 | 823 | 823 |
| 8. Expected Net Income ( (7)-(5) ) | 483 | 483 | 483 | 483 | 483 | 483 | 483 | 483 | 483 | 483 | 483 | 483 | 483 |
| 9. Damageable Net Income ( $\Sigma$ ((4)x(8)) ) | 333 | 290 | 232 | 184 | 126 | 155 | 193 | 256 | 328 | 440 | 449 | 396 | 282 |

Table K.19 ESTIMATED DAMAGE AMOUNT OF INUNDATED FISHPOND AND EFFECTS OF THE PROJECT

( Unit : Million Rupiahs )

| Zone | Recurrence Interval | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1986 Flood | 2-years | 5-years | 10-years | 20-years | 50-years | 100-years |
| Estimated Damage of Inundated Fishpond under Without-Project Condition | | | | | | | |
| Zone A | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 |
| Zone B | 17.8 | 17.8 | 17.8 | 17.8 | 17.8 | 17.8 | 17.8 |
| Zone C | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Zone D | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Zone E | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total | 18.1 | 18.1 | 18.1 | 18.1 | 18.1 | 18.1 | 18.1 |
| Estimated Damage of Inundated Fishpond under With-Project Condition | | | | | | | |
| Zone A | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 |
| Zone B | 0.0 | 0.0 | 0.0 | 0.0 | 0.9 | 9.5 | 15.4 |
| Zone C | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Zone D | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Zone E | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total | 0.0 | 0.0 | 0.0 | 0.0 | 0.9 | 9.5 | 15.5 |
| Reduction Rate (%) | | | | | | | |
| Zone A | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 66.7 |
| Zone B | 100.0 | 100.0 | 100.0 | 100.0 | 94.9 | 46.6 | 13.5 |
| Zone C | - | - | - | - | - | - | - |
| Zone D | - | - | - | - | - | - | - |
| Zone E | - | - | - | - | - | - | - |
| Total | 100.0 | 100.0 | 100.0 | 100.0 | 95.0 | 47.5 | 14.4 |

Table K.20 ESTIMATED NUMBER OF VICTIMS UNDER ALTERNATIVE FLOOD CONTROL PLANS BY RECURRENCE INTERVAL

| Flood Control Plan | Recurrence Interval | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1986 Flood | 2-years | 5-years | 10-years | 20-years | 50-years | 100-years |
| Estimated Number of Victims | | | | | | | |
| Without-Project | 112,250 | 112,250 | 112,250 | 112,250 | 112,250 | 112,250 | 112,250 |
| 2-year Plan | 8,261 | 11,433 | 37,464 | 68,999 | 92,343 | 108,631 | 112,250 |
| 5-year Plan | 3,398 | 4,751 | 16,030 | 32,762 | 44,953 | 67,772 | 84,308 |
| 10-year Plan | 744 | 1,081 | 5,486 | 11,036 | 19,576 | 33,489 | 48,057 |
| 20-year Plan | 528 | 696 | 2,420 | 5,288 | 10,243 | 18,582 | 28,023 |
| 50-year Plan | 310 | 540 | 1,806 | 3,367 | 7,865 | 13,018 | 23,551 |
| Estimated Number relieved from Flood Risk | | | | | | | |
| 2-year Plan | 103,989 | 100,817 | 74,786 | 43,251 | 19,907 | 6,619 | 0 |
| 5-year Plan | 108,852 | 107,499 | 96,220 | 79,488 | 67,297 | 44,478 | 27,942 |
| 10-year Plan | 111,506 | 111,169 | 106,764 | 101,214 | 92,674 | 78,761 | 64,193 |
| 20-year Plan | 111,722 | 111,554 | 109,830 | 106,962 | 102,007 | 93,668 | 84,227 |
| 50-year Plan | 111,940 | 111,710 | 110,444 | 108,883 | 104,385 | 99,232 | 88,699 |
| Reduction Rate ( % ) | | | | | | | |
| 2-year Plan | 92.6 | 89.8 | 66.6 | 38.5 | 17.7 | 3.2 | 0.0 |
| 5-year Plan | 97.0 | 95.8 | 85.7 | 70.8 | 60.0 | 39.6 | 24.9 |
| 10-year Plan | 99.3 | 99.0 | 95.1 | 90.2 | 82.6 | 70.2 | 57.2 |
| 20-year Plan | 99.5 | 99.4 | 97.8 | 95.3 | 90.9 | 83.4 | 75.0 |
| 50-year Plan | 99.7 | 99.5 | 98.4 | 97.0 | 93.0 | 88.4 | 79.0 |

Table K.21 ESTIMATED NUMBER OF INUNDATED RESIDENTIAL BUILDINGS UNDER ALTERNATIVE FLOOD CONTROL PLANS BY RECURRENCE INTERVAL

| Flood Control Plan | Recurrence Interval | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1986 Flood | 2-years | 5-years | 10-years | 20-years | 50-years | 100-years |
| Estimated Number of Iundated Residential Buildings | | | | | | | |
| Without-Project | 27,310 | 27,310 | 27,310 | 27,310 | 27,310 | 27,310 | 27,310 |
| 2-year Plan | 1,926 | 2,647 | 9,276 | 17,485 | 23,075 | 26,540 | 27,310 |
| 5-year Plan | 818 | 1,191 | 3,488 | 8,106 | 11,418 | 17,219 | 18,345 |
| 10-year Plan | 161 | 241 | 1,295 | 2,557 | 4,676 | 8,254 | 12,031 |
| 20-year Plan | 112 | 150 | 572 | 1,250 | 2,376 | 4,420 | 6,848 |
| 50-year Plan | 66 | 115 | 420 | 807 | 1,836 | 3,007 | 5,698 |
| Estimated Number relieved from Flood Risk | | | | | | | |
| 2-year Plan | 25,384 | 24,663 | 18,034 | 9,825 | 4,235 | 770 | 0 |
| 5-year Plan | 26,492 | 26,119 | 23,822 | 19,204 | 15,892 | 10,091 | 8,965 |
| 10-year Plan | 27,149 | 27,069 | 26,015 | 24,753 | 22,634 | 19,056 | 15,279 |
| 20-year Plan | 27,198 | 27,160 | 26,738 | 26,060 | 24,934 | 22,890 | 20,462 |
| 50-year Plan | 27,244 | 27,195 | 26,890 | 26,503 | 25,474 | 24,303 | 21,612 |
| Reduction Rate ( % ) | | | | | | | |
| 2-year Plan | 92.9 | 90.3 | 66.0 | 36.0 | 15.5 | 2.8 | 0.0 |
| 5-year Plan | 97.0 | 95.6 | 87.2 | 70.3 | 58.2 | 36.9 | 32.8 |
| 10-year Plan | 99.4 | 99.1 | 95.3 | 90.6 | 82.9 | 69.8 | 55.9 |
| 20-year Plan | 99.6 | 99.5 | 97.9 | 95.4 | 91.3 | 83.8 | 74.9 |
| 50-year Plan | 99.8 | 99.6 | 98.5 | 97.0 | 93.3 | 89.0 | 79.1 |

Table K.22 ESTIMATED DAMAGE OF INUNDATED RESIDENTIAL BUILDINGS UNDER ALTERNATIVE FLOOD CONTROL PLANS BY RECURRENCE INTERVAL

| Flood Control Plan | Recurrence Interval | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1986 Flood | 2-years | 5-years | 10-years | 20-years | 50-years | 100-years |
| Estimated Damage (Rp.$10^6$) | | | | | | | |
| Without-Project | 5,946.8 | 7,401.0 | 11,821.2 | 16,545.0 | 19,910.1 | 23,111.1 | 25,010.7 |
| 2-year Plan | 324.9 | 470.4 | 1,843.2 | 3,778.9 | 5,850.7 | 8,104.0 | 10,961.9 |
| 5-year Plan | 96.3 | 136.3 | 466.7 | 1,050.4 | 1,525.3 | 2,556.8 | 3,392.1 |
| 10-year Plan | 28.1 | 45.1 | 202.5 | 452.2 | 757.7 | 1,602.0 | 2,309.5 |
| 20-year Plan | 10.7 | 17.2 | 70.0 | 135.9 | 265.1 | 454.3 | 818.3 |
| 50-year Plan | 5.5 | 11.0 | 48.7 | 102.9 | 192.7 | 332.7 | 564.8 |
| Expected Amount relieved from Flood Risk | | | | | | | |
| 2-year Plan | 5,621.9 | 6,930.6 | 9,978.0 | 12,766.1 | 14,059.4 | 15,007.1 | 14,048.8 |
| 5-year Plan | 5,850.5 | 7,264.7 | 11,354.5 | 15,494.6 | 18,384.8 | 20,554.3 | 21,618.6 |
| 10-year Plan | 5,918.7 | 7,355.9 | 11,618.7 | 16,092.8 | 19,152.4 | 21,509.1 | 22,701.2 |
| 20-year Plan | 5,936.1 | 7,383.8 | 11,751.2 | 16,409.1 | 19,645.0 | 22,656.8 | 24,192.4 |
| 50-year Plan | 5,941.3 | 7,390.0 | 11,772.5 | 16,442.1 | 19,717.4 | 22,778.4 | 24,445.9 |
| Reduction Rate ( % ) | | | | | | | |
| 2-year Plan | 94.5 | 93.6 | 84.4 | 77.2 | 70.6 | 64.9 | 56.2 |
| 5-year Plan | 98.4 | 98.2 | 96.1 | 93.7 | 92.3 | 88.9 | 86.4 |
| 10-year Plan | 99.5 | 99.4 | 98.3 | 97.3 | 96.2 | 93.1 | 90.8 |
| 20-year Plan | 99.8 | 99.8 | 99.4 | 99.2 | 98.7 | 98.0 | 96.7 |
| 50-year Plan | 99.9 | 99.9 | 99.6 | 99.4 | 99.0 | 98.6 | 97.7 |

Table K.23 ESTIMATED AREA OF INUNDATED PADDY FIELD UNDER ALTERNATIVE FLOOD CONTROL PLANS BY RECURRENCE INTERVAL

| Flood Control Plan | Recurrence Interval | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1986 Flood | 2-years | 5-years | 10-years | 20-years | 50-years | 100-years |
| Estimated Area of Inundated Paddy Field (ha) | | | | | | | |
| Without-Project | 6,363 | 6,363 | 6,363 | 6,363 | 6,363 | 6,363 | 6,363 |
| 2-year Plan | 438 | 633 | 2,376 | 3,957 | 5,203 | 6,152 | 6,363 |
| 5-year Plan | 212 | 375 | 1,480 | 2,606 | 3,053 | 4,172 | 4,791 |
| 10-year Plan | 42 | 52 | 267 | 609 | 1,170 | 2,108 | 2,919 |
| 20-year Plan | 35 | 41 | 106 | 255 | 560 | 1,103 | 1,739 |
| 50-year Plan | 20 | 36 | 82 | 144 | 414 | 731 | 1,438 |
| Estimated Number relieved from Flood Risk | | | | | | | |
| 2-year Plan | 5,925 | 5,730 | 3,987 | 2,406 | 1,160 | 211 | 0 |
| 5-year Plan | 6,151 | 5,988 | 4,883 | 3,757 | 3,310 | 2,191 | 1,572 |
| 10-year Plan | 6,321 | 6,311 | 6,095 | 5,754 | 5,193 | 4,255 | 3,444 |
| 20-year Plan | 6,328 | 6,322 | 6,257 | 6,108 | 5,803 | 5,260 | 4,624 |
| 50-year Plan | 6,343 | 6,327 | 6,281 | 6,219 | 5,949 | 5,632 | 4,925 |
| Reduction Rate ( % ) | | | | | | | |
| 2-year Plan | 93.1 | 90.0 | 62.7 | 37.8 | 18.2 | 3.3 | 0.0 |
| 5-year Plan | 96.7 | 94.1 | 76.7 | 59.0 | 52.0 | 34.4 | 24.7 |
| 10-year Plan | 99.3 | 99.2 | 95.8 | 90.4 | 81.6 | 66.9 | 54.1 |
| 20-year Plan | 99.4 | 99.4 | 98.3 | 96.0 | 91.2 | 82.7 | 72.7 |
| 50-year Plan | 99.7 | 99.4 | 98.7 | 97.7 | 93.5 | 88.5 | 77.4 |

Table K.24 ESTIMATED DAMAGE OF INUNDATED PADDY FIELD UNDER ALTERNATIVE FLOOD CONTROL PLANS BY RECURRENCE INTERVAL

| Flood Control Plan | Recurrence Interval | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1986 Flood | 2-years | 5-years | 10-years | 20-years | 50-years | 100-years |
| Estimated Damage ($Rp.10^6$) | | | | | | | |
| Without Project | 4,258.6 | 4,408.5 | 4,633.0 | 4,695.9 | 4,717.0 | 4,741.8 | 4,751.7 |
| 2-year Plan | 137.0 | 246.8 | 1,047.1 | 1,914.7 | 2,561.7 | 3,050.9 | 3,299.1 |
| 5-year Plan | 61.3 | 113.4 | 477.3 | 1001.5 | 1,224.3 | 2,051.8 | 2,501.3 |
| 10-year Plan | 9.6 | 15.1 | 77.6 | 175.6 | 478.6 | 891.9 | 1,364.1 |
| 20-year Plan | 9.0 | 13.5 | 36.0 | 61.5 | 134.5 | 309.6 | 620.6 |
| 50-year Plan | 4.7 | 8.8 | 23.0 | 44.9 | 76.4 | 152.5 | 331.8 |
| Expected Amount relieved from Flood Risk | | | | | | | |
| 2-year Plan | 4,121.6 | 4,161.7 | 3,585.9 | 2,781.2 | 2,155.3 | 1,690.9 | 1,452.6 |
| 5-year Plan | 4,197.3 | 4,295.1 | 4,155.7 | 3,694.4 | 3,492.7 | 2,690.0 | 2,250.4 |
| 10-year Plan | 4,249.0 | 4,393.4 | 4,555.4 | 4,520.3 | 4,238.4 | 3,849.9 | 3,387.6 |
| 20-year Plan | 4,249.4 | 4,395.0 | 4,597.0 | 4,634.4 | 4,582.5 | 4,432.2 | 4,131.1 |
| 50-year Plan | 4,253.9 | 4,399.7 | 4,610.0 | 4,651.0 | 4,640.6 | 4,589.3 | 4,419.9 |
| Reduction Rate ( % ) | | | | | | | |
| 2-year Plan | 96.8 | 94.4 | 77.4 | 59.2 | 45.7 | 35.7 | 30.6 |
| 5-year Plan | 98.6 | 97.4 | 89.7 | 78.7 | 74.0 | 56.7 | 47.4 |
| 10-year Plan | 99.8 | 99.7 | 98.3 | 96.3 | 89.9 | 81.2 | 71.3 |
| 20-year Plan | 99.8 | 99.7 | 99.2 | 98.7 | 97.1 | 93.5 | 86.9 |
| 50-year Plan | 99.9 | 99.8 | 99.5 | 99.0 | 98.4 | 96.8 | 93.0 |

Table K.25 ESTIMATED FLOOD DAMAGE AND ANNUAL FLOOD DAMAGE BY FLOOD CONTROL PLAN

( Unit : Million Rupiahs )

| Asset Item | Recurrence Interval | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1986 Flood | 2-Years | 5-Years | 10-Years | 20-Years | 50-Years | 100-Years |
| I. Without-Project Condition | | | | | | | |
| Houses | 5,946.8 | 7,401.0 | 11,821.2 | 16,545.0 | 19,910.1 | 23,111.1 | 25,010.7 |
| Industry | 1,510.6 | 1,717.1 | 2,068.0 | 2,274.4 | 2,422.6 | 2,595.1 | 2,704.8 |
| Paddy | 4,258.6 | 4,408.5 | 4,633.0 | 4,695.9 | 4,717.0 | 4,741.8 | 4,751.7 |
| Fishpond | 18.2 | 18.2 | 18.2 | 18.2 | 18.2 | 18.2 | 18.2 |
| Infrastructure | 1,491.5 | 1,823.7 | 2,777.8 | 3,763.9 | 4,466.5 | 5,141.2 | 5,543.1 |
| Indirect Damage | 661.3 | 768.5 | 1,065.9 | 1,364.9 | 1,576.7 | 1,780.4 | 1,901.4 |
| Total | 13,887.0 | 16,137.6 | 22,384.2 | 28,662.2 | 33,111.2 | 37,387.8 | 39,929.9 |
| Average Annual Damage | | | | | | | 16,135.5 |
| II. With-Project Condition | | | | | | | |
| 1. 2-year Plan | | | | | | | |
| Houses | 324.9 | 470.4 | 1,843.2 | 3,778.9 | 5,850.7 | 8,104.0 | 10,961.9 |
| Industry | 101.6 | 139.9 | 449.1 | 872.1 | 1,296.1 | 1,689.7 | 2,072.4 |
| Paddy | 137.0 | 246.8 | 1,047.1 | 1,914.7 | 2,561.7 | 3,050.9 | 3,299.1 |
| Fishpond | 0.0 | 0.0 | 0.0 | 10.8 | 16.4 | 17.9 | 18.2 |
| Infrastructure | 85.3 | 122.1 | 458.5 | 930.2 | 1,429.4 | 1,958.7 | 2,606.9 |
| Indirect Damage | 32.4 | 49.0 | 189.9 | 375.3 | 557.7 | 741.1 | 947.9 |
| Total | 681.2 | 1,028.1 | 3,987.8 | 7,882.0 | 11,711.9 | 15,562.3 | 19,906.4 |
| Average Annual Damage | | | | | | | 2,678.2 |
| 2. 5-year Plan | | | | | | | |
| Houses | 96.3 | 136.3 | 466.7 | 1,050.4 | 1,525.3 | 2,556.8 | 3,392.1 |
| Industry | 40.9 | 53.7 | 159.8 | 313.1 | 432.9 | 703.1 | 918.1 |
| Paddy | 61.3 | 113.4 | 477.3 | 1,001.5 | 1,224.3 | 2,051.8 | 2,501.3 |
| Fishpond | 0.0 | 0.0 | 0.0 | 0.0 | 0.9 | 9.5 | 15.4 |
| Infrastructure | 27.4 | 38.0 | 125.3 | 272.7 | 391.6 | 652.0 | 862.0 |
| Indirect Damage | 11.3 | 17.1 | 61.5 | 131.9 | 178.8 | 298.7 | 384.4 |
| Total | 237.2 | 358.5 | 1,290.6 | 2,769.6 | 3,753.8 | 6,271.8 | 8,073.4 |
| Average Annual Damage | | | | | | | 924.7 |
| 3. 20-year Plan | | | | | | | |
| Houses | 10.7 | 17.2 | 70.0 | 135.9 | 265.1 | 454.3 | 818.3 |
| Industry | 5.1 | 8.6 | 27.9 | 52.9 | 100.4 | 176.7 | 274.3 |
| Paddy | 9.0 | 13.5 | 36.0 | 61.5 | 134.5 | 309.6 | 620.6 |
| Fishpond | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Infrastructure | 3.2 | 5.2 | 19.6 | 37.8 | 73.1 | 126.2 | 218.5 |
| Indirect Damage | 1.4 | 2.2 | 7.7 | 14.4 | 28.7 | 53.3 | 96.6 |
| Total | 29.4 | 46.7 | 161.2 | 302.5 | 601.8 | 1,120.1 | 2,028.3 |
| Average Annual Damage | | | | | | | 129.8 |
| 4. 50-year Plan | | | | | | | |
| Houses | 5.5 | 11.0 | 48.7 | 102.9 | 192.7 | 332.7 | 564.8 |
| Industry | 3.0 | 5.2 | 22.3 | 36.5 | 74.5 | 124.1 | 209.9 |
| Paddy | 4.7 | 8.8 | 23.0 | 44.9 | 76.4 | 152.5 | 331.8 |
| Fishpond | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Infrastructure | 1.7 | 3.2 | 14.2 | 27.9 | 53.4 | 91.4 | 154.9 |
| Indirect Damage | 0.7 | 1.4 | 5.4 | 10.6 | 19.9 | 35.0 | 63.1 |
| Total | 15.6 | 29.7 | 113.6 | 222.8 | 416.9 | 735.7 | 1,324.5 |
| Average Annual Damage | | | | | | | 88.3 |

Table K.26 ECONOMIC CONSTRUCTION COST

(Unit : Million Rupiahs)

| Item | Financial Cost | | | Economic Cost | | |
|---|---|---|---|---|---|---|
| | Foreign Potion | Local Potion | Total | Foreign Potion | Local Potion | Total |
| 1. Citarum River | 44,493 | 8,668 | 53,161 | 44,493 | 7,801 | 52,294 |
| 2. Cisangkuy River | 2,132 | 461 | 2,593 | 2,132 | 415 | 2,547 |
| 3. Flood Warning System | 1,013 | 252 | 1,265 | 1,013 | 227 | 1,240 |
| 4. Land Acquisition and Compensation | 0 | 6,645 | 6,645 | 0 | 5,980 | 5,980 |
| Direct Cost | 47,638 | 16,026 | 63,664 | 47,638 | 14,423 | 62,061 |
| 5. Government Administration | 0 | 3,183 | 3,183 | 0 | 2,865 | 2,865 |
| 6. Engineering Services | 6,069 | 1,143 | 7,212 | 6,069 | 1,029 | 7,098 |
| 7. Physical Contingency | 5,371 | 2,035 | 7,406 | 5,371 | 1,832 | 7,203 |
| 8. Price Contingency | 9,953 | 10,324 | 20,277 | 0 | 0 | 0 |
| Total | 69,031 | 32,711 | 101,742 | 59,078 | 20,149 | 79,227 |

Note : Unskilled labor cost is neghigible small, so economic conversion factor of 0.9 is applied to convert local costs.

Table K.27 ESTIMATED FLOOD DAMAGE AND AVERAGE ANNUAL DAMAGE POTENTIAL UNDER WITHOUT-PROJECT CONDITION

( Unit : Million Rupiahs )

| Asset Item | Recurrence Interval | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1986 Flood | 2-Years | 5-Years | 10-Years | 20-Years | 50-Years | 100-Years |
| Houses | 5,946.8 | 7,401.0 | 11,821.2 | 16,545.0 | 19,910.1 | 23,111.1 | 25,010.7 |
| Industry | 1,510.6 | 1,717.7 | 2,068.0 | 2,274.4 | 2,422.6 | 2,595.1 | 2,704.8 |
| Paddy | 4,258.6 | 4,408.5 | 4,633.0 | 4,695.9 | 4,717.0 | 4,741.8 | 4,751.7 |
| Fishpond | 18.2 | 18.2 | 18.2 | 18.2 | 18.2 | 18.2 | 18.2 |
| Infrastructure | 1,491.5 | 1,823.7 | 2,777.8 | 3,763.9 | 4,466.5 | 5,141.2 | 5,543.1 |
| Indirect Damage | 661.3 | 768.5 | 1,065.9 | 1,364.9 | 1,576.7 | 1,780.4 | 1,901.4 |
| Total | 13,887.0 | 16,137.6 | 22,384.2 | 28,662.2 | 33,111.2 | 37,387.8 | 39,929.9 |
| Average Annual Damage Potential | | | | | | | 16,135.5 |



Table K.28 ESTIMATED FLOOD DAMAGE AND AVERAGE ANNUAL DAMAGE POTENTIAL UNDER WITHOUT-PROJECT CONDITION

( Unit : Million Rupiahs )

| Zone | Recurrence Interval | | | | | | | Average Annual Damage Potential | Percentage Distribution (%) |
|---|---|---|---|---|---|---|---|---|---|
| | 1986 Flood | 2-Years | 5-Years | 10-Years | 20-Years | 50-Years | 100-Years | | |
| Zone A | 3,037.7 | 3,703.3 | 5,120.9 | 6,336.3 | 7,592.9 | 9,259.4 | 10,470.5 | 3,664.2 | 22.7 |
| Zone B | 3,522.1 | 4,105.0 | 5,509.0 | 6,628.1 | 7,709.6 | 8,510.4 | 8,817.5 | 3,959.9 | 24.5 |
| Zone C | 4,181.9 | 4,881.4 | 7,633.9 | 10,997.2 | 12,254.0 | 13,157.7 | 13,482.5 | 5,356.8 | 33.2 |
| Zone D | 1,096.0 | 1,262.0 | 1,667.0 | 1,964.2 | 2,577.1 | 3,195.5 | 3,535.4 | 1,233.9 | 7.6 |
| Zone E | 2,049.3 | 2,185.8 | 2,453.2 | 2,736.2 | 2,976.6 | 3,264.5 | 3,624.0 | 1,920.7 | 11.9 |
| Total | 13,887.0 | 16,137.6 | 22,384.2 | 28,662.2 | 33,111.2 | 37,387.8 | 39,929.9 | 16,135.5 | 100.0 |

Table K.29 ESTIMATED FLOOD DAMAGE AFTER COMPLETION OF THE URGENT PLAN

( Unit : Million Rupiahs )

| Asset Item | Recurrence Interval | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1986 Flood | 2-Years | 5-Years | 10-Years | 20-Years | 50-Years | 100-Years |
| Houses | 609.8 | 725.0 | 1,278.3 | 2,082.6 | 2,724.8 | 3,929.0 | 5000.4 |
| Industry | 245.2 | 279.6 | 419.4 | 608.5 | 736.5 | 1,005.8 | 1,222.2 |
| Paddy | 1,181.0 | 1,292.6 | 1,758.4 | 2,319.4 | 2,532.9 | 3,198.0 | 3,544.5 |
| Fishpond | 0.0 | 0.0 | 0.0 | 0.0 | 0.9 | 9.5 | 15.5 |
| Infrastructure | 171.0 | 200.9 | 339.7 | 538.2 | 692.3 | 987.0 | 1,244.5 |
| Indirect Damage | 110.4 | 124.9 | 189.8 | 277.4 | 334.4 | 456.5 | 551.4 |
| Total | 2,317.4 | 2,623.0 | 3,986.7 | 5,826.2 | 7,021.7 | 9,585.7 | 11,578.5 |
| Average Annual Damage | | | | | | | 2,956.2 |



Table K.30 ESTIMATED FLOOD DAMAGE BY ZONE AFTER COMPLETION OF THE URGENT PLAN

( Unit : Million Rupiahs )

| Zone | Recurrence Interval | | | | | | | Average Annual Damage | Percentage Distribution (%) |
|---|---|---|---|---|---|---|---|---|---|
| | 1986 Flood | 2-Years | 5-Years | 10-Years | 20-Years | 50-Years | 100-Years | | |
| Zone A | 0.0 | 0.0 | 113.1 | 400.9 | 610.3 | 1,212.2 | 1,731.8 | 110.0 | 3.7 |
| Zone B | 175.5 | 234.3 | 532.7 | 991.2 | 1,333.5 | 1,881.6 | 2,293.9 | 381.9 | 12.9 |
| Zone C | 8.6 | 33.2 | 312.5 | 803.0 | 973.9 | 1,906.9 | 2,460.2 | 222.0 | 7.5 |
| Zone D | 84.0 | 169.7 | 575.1 | 894.5 | 1,127.4 | 1,320.5 | 1,468.7 | 321.6 | 10.9 |
| Zone E | 2,049.3 | 2,185.8 | 2,453.2 | 2,736.2 | 2,976.6 | 3,264.5 | 3,624.0 | 1,920.7 | 65.0 |
| Total | 2,317.4 | 2,623.0 | 3,986.7 | 5,826.2 | 7,021.7 | 9,585.7 | 11,578.5 | 2,956.2 | 100.0 |

Table K.31 ESTIMATED FLOOD REDUCTION BENEFIT BY ASSET ITEM

( Unit : Million Rupiahs )

| Asset Item | Recurrence Interval | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1986 Flood | 2-Years | 5-Years | 10-Years | 20-Years | 50-Years | 100-Years |
| Houses | 5,337.0 | 6,676.0 | 10,541.9 | 14,462.4 | 17,185.3 | 19,182.1 | 20,010.3 |
| Industry | 1,265.4 | 1,438.1 | 1,648.6 | 1,665.9 | 1,686.1 | 1,589.3 | 1,482.6 |
| Paddy | 3,077.6 | 3,115.9 | 2,874.6 | 2,376.5 | 2,184.1 | 1,543.8 | 1,207.2 |
| Fishpond | 18.2 | 18.2 | 18.2 | 18.2 | 17.3 | 8.7 | 2.7 |
| Infrastructure | 1,320.5 | 1,622.8 | 2,438.1 | 3,225.7 | 3,774.3 | 4,154.3 | 4,298.6 |
| Indirect Damage | 550.9 | 643.6 | 876.1 | 1,087.4 | 1,242.4 | 1,323.9 | 1,350.1 |
| Total | 11,569.6 | 13,514.6 | 18,397.5 | 22,836.1 | 26,089.4 | 27,802.1 | 28,351.4 |
| Average Annual Benefit | | | | | | | 13,179.4 |

Table K.32 ESTIMATED FLOOD REDUCTION BENEFIT BY ZONE

( Unit : Million Rupiahs )

| Zone | Recurrence Interval | | | | | | | Average Annual Benefit | Percentage Distribution (%) |
|---|---|---|---|---|---|---|---|---|---|
| | 1986 Flood | 2-Years | 5-Years | 10-Years | 20-Years | 50-Years | 100-Years | | |
| Zone A | 3,037.7 | 3,703.3 | 5,007.8 | 5,935.4 | 6,983.3 | 8,047.2 | 8,738.7 | 3,554.2 | 27.0 |
| Zone B | 3,346.6 | 3,870.6 | 4,976.3 | 5,636.9 | 6,376.1 | 6,628.8 | 6,523.6 | 3,578.1 | 27.1 |
| Zone C | 4,173.2 | 4,848.2 | 7,321.4 | 10,194.2 | 11,280.1 | 11,250.8 | 11,022.4 | 5,134.7 | 39.0 |
| Zone D | 1,012.0 | 1,092.4 | 1,091.9 | 1,069.7 | 1,449.8 | 1,875.0 | 2,066.7 | 912.3 | 6.9 |
| Zone E | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total | 11,569.6 | 13,514.6 | 18,397.5 | 22,836.1 | 26,089.4 | 27,802.1 | 28,351.4 | 13,179.4 | 100.0 |

Table K.33 ANNUAL FLOW OF ECONOMIC COST AND BENEFIT FOR THE URGENT PLAN

(Unit : Million Rupiahs)

| No. | Year | Economic Cost | | | Economic Benefit | Difference |
|---|---|---|---|---|---|---|
| | | Construction | O/M Cost | Total | | |
| 1 | 1990 | 4,538 | 0 | 4,538 | 0 | -4,538 |
| 2 | 1991 | 14,381 | 0 | 14,381 | 0 | -14,381 |
| 3 | 1992 | 28,526 | 0 | 28,526 | 0 | -28,526 |
| 4 | 1993 | 23,132 | 113 | 23,245 | 1,777 | -21,468 |
| 5 | 1994 | 8,649 | 256 | 8,905 | 8,367 | -538 |
| 6 | 1995 | 0 | 285 | 285 | 13,179 | 12,894 |
| 7 | 1996 | 0 | 285 | 285 | 13,179 | 12,894 |
| 8 | 1997 | 0 | 285 | 285 | 13,179 | 12,894 |
| 9 | 1998 | 0 | 285 | 285 | 13,179 | 12,894 |
| 10 | 1999 | 0 | 285 | 285 | 13,179 | 12,894 |
| 11 | 2000 | 0 | 285 | 285 | 13,179 | 12,894 |
| 12 | 2001 | 0 | 285 | 285 | 13,179 | 12,894 |
| 13 | 2002 | 0 | 285 | 285 | 13,179 | 12,894 |
| 14 | 2003 | 0 | 285 | 285 | 13,179 | 12,894 |
| 15 | 2004 | 0 | 285 | 285 | 13,179 | 12,894 |
| 16 | 2005 | 0 | 285 | 285 | 13,179 | 12,894 |
| 17 | 2006 | 0 | 285 | 285 | 13,179 | 12,894 |
| 18 | 2007 | 0 | 285 | 285 | 13,179 | 12,894 |
| 19 | 2008 | 0 | 285 | 285 | 13,179 | 12,894 |
| 20 | 2009 | 0 | 285 | 285 | 13,179 | 12,894 |
| 21 | 2010 | 0 | 285 | 285 | 13,179 | 12,894 |
| 22 | 2011 | 0 | 285 | 285 | 13,179 | 12,894 |
| . | . | . | . | . | . | . |
| . | . | . | . | . | . | . |
| . | . | . | . | . | . | . |
| . | . | . | . | . | . | . |
| 54 | 2043 | 0 | 285 | 285 | 13,179 | 12,894 |
| 55 | 2044 | 0 | 285 | 285 | 13,179 | 12,894 |

EIRR : 14.1%
B/C : 1.44
NPV : Rp.26,942 million
(Discount Rate : 10%)

Table K.34 ESTIMATED FLOOD REDUCTION BENEFIT BY ASSET ITEM IN THE YEAR 2005 UNDER FUTURE CONDITION

( Unit : Million Rupiahs )

| Asset Item | Recurrence Interval | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1986 Flood | 2-Years | 5-Years | 10-Years | 20-Years | 50-Years | 100-Years |
| Houses | 8,539.2 | 10,681.6 | 16,867.0 | 23,139.8 | 27,496.5 | 30,691.4 | 32,016.5 |
| Industry | 1,265.4 | 1,438.1 | 1,648.6 | 1,665.9 | 1,686.1 | 1,589.3 | 1,482.6 |
| Paddy | 4,124.0 | 4,614.8 | 4,449.8 | 3,973.1 | 3,787.9 | 3,156.0 | 2,822.8 |
| Fishpond | 18.2 | 18.2 | 18.2 | 18.2 | 17.3 | 8.7 | 2.7 |
| Infrastructure | 1,960.9 | 2,423.9 | 3,703.1 | 4,961.1 | 5,836.5 | 6,456.1 | 6,699.8 |
| Indirect Damage | 985.4 | 958.8 | 1,334.3 | 1,687.9 | 1,941.2 | 2,095.1 | 2,151.2 |
| Total | 16,703.1 | 20,135.5 | 28,021.1 | 35,446.1 | 40,765.5 | 43,996.6 | 45,175.6 |
| Average Annual Damage | | | | | | | 19,873.2 |

Table K.35 ANNUAL FLOW OF ECONOMIC COST AND BENEFIT FOR THE URGENT PLAN UNDER FUTURE CONDITION

(Unit : Million Rupiahs)

| No. | Year | Economic Cost | | | Economic Benefit | Difference |
|---|---|---|---|---|---|---|
| | | Construction | O/M Cost | Total | | |
| 1 | 1990 | 4,538 | 0 | 4,538 | 0 | -4,538 |
| 2 | 1991 | 14,381 | 0 | 14,381 | 0 | -14,381 |
| 3 | 1992 | 28,526 | 0 | 28,526 | 0 | -28,526 |
| 4 | 1993 | 23,132 | 113 | 23,245 | 2,036 | -21,209 |
| 5 | 1994 | 8,649 | 256 | 8,905 | 12,050 | 3,145 |
| 6 | 1995 | 0 | 285 | 285 | 16,154 | 15,869 |
| 7 | 1996 | 0 | 285 | 285 | 16,526 | 16,241 |
| 8 | 1997 | 0 | 285 | 285 | 16,898 | 16,613 |
| 9 | 1998 | 0 | 285 | 285 | 17,270 | 16,985 |
| 10 | 1999 | 0 | 285 | 285 | 17,642 | 17,357 |
| 11 | 2000 | 0 | 285 | 285 | 18,014 | 17,729 |
| 12 | 2001 | 0 | 285 | 285 | 18,386 | 18,101 |
| 13 | 2002 | 0 | 285 | 285 | 18,758 | 18,472 |
| 14 | 2003 | 0 | 285 | 285 | 19,129 | 18,844 |
| 15 | 2004 | 0 | 285 | 285 | 19,501 | 19,216 |
| 16 | 2005 | 0 | 285 | 285 | 19,873 | 19,588 |
| 17 | 2006 | 0 | 285 | 285 | 19,873 | 19,588 |
| 18 | 2007 | 0 | 285 | 285 | 19,873 | 19,588 |
| 19 | 2008 | 0 | 285 | 285 | 19,873 | 19,588 |
| 20 | 2009 | 0 | 285 | 285 | 19,873 | 19,588 |
| 21 | 2010 | 0 | 285 | 285 | 19,873 | 19,588 |
| 22 | 2011 | 0 | 285 | 285 | 19,873 | 19,588 |
| . | . | . | . | . | . | . |
| . | . | . | . | . | . | . |
| . | . | . | . | . | . | . |
| . | . | . | . | . | . | . |
| 54 | 2043 | 0 | 285 | 285 | 19,873 | 19,588 |
| 55 | 2044 | 0 | 285 | 285 | 19,873 | 19,588 |

EIRR : 18.5% ; B/C : 2.02 ; NPV : Rp.61,712 million (Discount Rate : 10%)

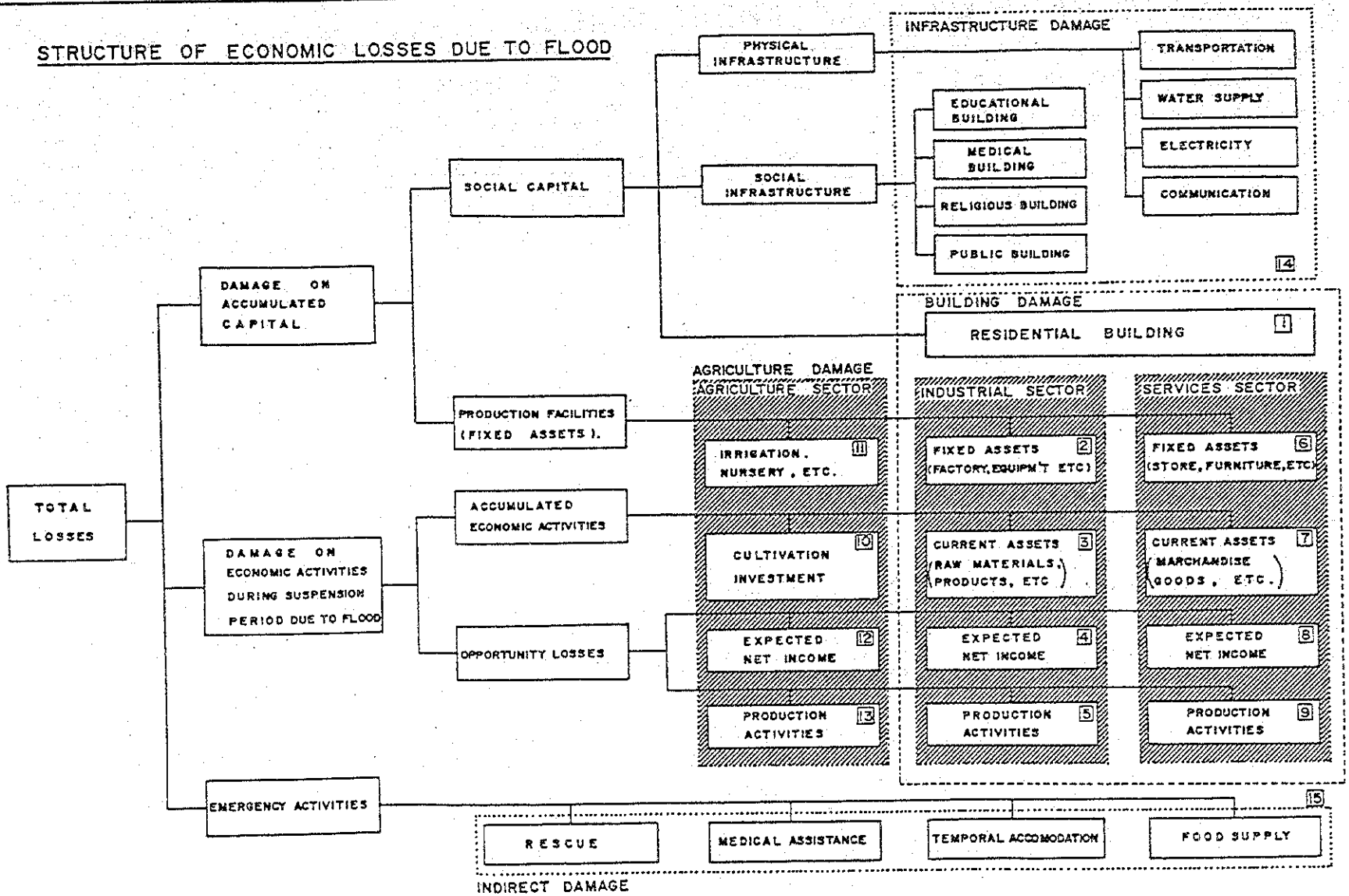


FIG. K.1 STRUCTURE OF ECONOMIC LOSSES DUE TO FLOOD

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

# FORMULAS OF FLOOD DAMAGE ESTIMATION

| DAMAGE ITEM | FORMULA |
|---|---|
| **BUILDING DAMAGE** | |
| [1] RESIDENTIAL PROPERTY | N x [BUILDING VALUE] x DR + N x [VALUE OF HOUSEHOLD EFFECTS] x DR |
| [2] INDUSTRIAL FACILITIES [6] (FIXED ASSETS) | N x [BUILDING VALUE] x DR + N x [VALUE OF EQUIPMENT] x DR |
| [3] INVENTORY STOCK [7] (CURRENT ASSETS) | N x [VALUE OF INVENTORY STOCK] x DR |
| [4] EXPECTED NET INCOME [8] | N x [NET INCOME/DAY] x [DURATION UNTIL RECOVERY (DAY)] |
| [5] PRODUCTION ACTIVITY [9] | N x [NUMBER OF EUPLOYEES/UNIT] x NW x [DURATION UNTIL RECOVERY] |
| **AGRICULTURE DAMAGE** | |
| [10] CULTIVATION INVESTMENT | N x [DAMAGEABLE VALUE OF PRODUCT] x RR |
| [11] AGRICULTURAL FACILITIES | [10] x C |
| [12] EXPECTED NET INCOME | N x [NET INCOME/CROP SEASON] x RR |
| [13] PRODUCTION ACTIVITY | N x [NUMBER OF LABOR] x NW x [DURATION OF NO WORK] |
| **INFRASTRUCTURE DAMAGE** | |
| [14] INFRASTRUCTURE DAMAGE | [TOTAL OF BUILDING DAMAGE /3] x C |
| **INDIRECT DAMAGE** | |
| [15] INDIRECT DAMAGE | [DIRECT DAMAGE /4] x C |

**REMARKS**

N : NUMBER OF UNIT
DR: DAMAGE RATE /1
RR: REDUCTION RATE /1
NW: NET WAGE /2
C : COEFFICIENT
/1 REFER TO MINISTRY OF CONSTRUCTION (JAPAN)
/2 LABOR WAGE MINUS UNSKILLED LABOR WAGE
/3 TOTAL OF [1], [2], [3], [6] AND [7]
/4 TOTAL OF [1] TO [13]

**FIG. K.2** FORMULAS OF FLOOD DAMAGE ESTIMATION

**STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN**

JICA

# SUPPORTING REPORT L

# TOPOGRAPHIC SURVEY AND ANALYSIS

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# SUPPORTING REPORT L
# TOPOGRAPHIC SURVEY AND ANALYSIS

## 1. General

The topographic survey and analysis for the feasibility study on the Flood Control Plan of the Upper Citarum Basin was conducted by the JICA Study Team in cooperation with the local survey engineers and surveyors. The survey activities were implemented in Study Stage 1 (May to August in 1987) and Study Stage 3 (January to March in 1988).

The objectives of the first survey are mainly the confirmation of available data concerned with river condition, topographic conditions of flood prone area, historical flood conditions, etc. These data are the essential data for the preparation of the overall flood control plan. The second survey was carried out to supplement the survey results of the first survey and to obtain more detailed data for the preparation of the urgent flood control plan.

The survey items are as follows:

(1) First survey (May to August in 1987)

- Control leveling survey
- River profile and cross section survey
- Flood mark survey
- Leveling survey of water level gauging stations
- Correction of topographic maps by aerial photograph

(2) Second survey (January to March in 1988)

- River profile and cross section survey
- Flood mark survey
- Cross section survey in the flood prone area
- Topographic survey at proposed river facilities

## 2. First Survey (May to August in 1987)

### 2.1 Control Leveling Survey

The elevations above M.S.L. of 64 existing bench marks located along the Citarum and Citarik Rivers between Curug Jompong and Cicalengka were checked by the direct leveling survey based on the datum points, BMBCH, BMBCH-01 and BMBCH-02 in order to achieve the following objectives;

- To confirm the available river profile and cross section data of Citarum River and its tributaries surveyed by DGWRD in the past.

- To find out the appropriate datum value for every bench marks for further surveys by the JICA Study Team.

Fig. L.1 shows the location of 64 bench marks and the routes of the control leveling survey.

As shown in Table L.1, differences between the new elevations and old elevations of the bench marks is less than 20 cm in an absolute value. This means that the new elevations of the bench marks can be considered to be sufficient for the Study.

### 2.2 Supplementary River Profile and Cross Section Survey of Citarum River

(1) Objective : Check the results of existing cross section survey of Citarum River surveyed by DGWRD

(2) Scope of Work : Observation of 22 cross sections of Citarum River between Marugahayu and Dayeuh Kolot

(3) Survey Results : River profile and cross section drawings are presented in Data Book II.
Location of river cross section survey points are shown on Fig. L.2.

## 2.3 Flood Mark Survey

(1) Objective : Study of the effects of the March 1986 Flood

(2) Scope of Work :

1. Selection of 51 points between Margahayu and Cicalengka (approximately 55 km distance) of Citarum and Citarik Rivers which were located in the flood area.

2. Observation of maximum flood elevations in the above 51 points by direct leveling based on the flood marks of March 1986 Flood.

(3) Survey Results : Survey results are shown in Table L.2 and Fig. L.3.

## 2.4 Leveling Survey of Water Level Gauging Stations

(1) Objective : Check the elevations of 0 gauge of four (4) existing water gauge stations

(2) Survey Results : Location of water gauge stations are shown in Fig. L.4. Survey results are shown below.

| Name of Station | Zero Gauge Elevation ( m abave M.S.L.) |
|---|---|
| (1) Nanjung (New) | 653.188 |
| (2) Nanjung (Old) | 648.785 |
| (3) Dayeuh Kolot | 654.440 |
| (4) Rancakemit (old) | 657.182 |

## 2.5 Topographic Analysis

In the Study of flood control plan, it is very important to estimate the whole amount of flood water and to calculate the cost of the flood damages on assets. One of the fundamental materials needed to carry out such work is topographic maps, especially detailed contour maps. This is because such a map gives the information on the extent of inundation area during floods and the depth of flood water at a given site.

### 2.5.1 Contour Correction

The purpose here is to check and correct the contours of available maps of 1:10,000 scale. Two methods are applied to this work: ground survey and aerial photograph interpretation. The ground survey conducted in the field is direct leveling. Elevations of several hundreds points were measured in the field and the results were compared with contours on the maps.

On the other hand, aerial photograph interpretation based on geomorphological land classification technique is an indirect method which can classify the area into geomorphological land units in order to identify the particular extent of lands where subtle height differences exist between them.

Geomorphological land units of depositional landforms similar to the present study area along Citarum River include natural levees (often used as "Kampong"), back swamp or flood plain, former rivers (often used as paddy field), oxbow lakes, river terraces and so on. Such land units are relatively higher or lower than the surroundings.

Aerial photograph interpretation also identifies some locally outstanding features in terms of height difference. Such features include cliff of river banks, artificial dikes and roads.

The results of both ground survey (providing "point" information) and aerial photograph interpretation (providing "areal" information) were combined to correct contours of the presently available maps in order to refine the accuracy. Some cartographic features were also improved.

### 2.5.2 Additional Plan Map

As already mentioned, topographic maps of scale 1:10,000 now available were made with the intention to cover the maximum inundation area during the flood occurred in 1984. Subsequent flood occurred in 1986, however, was severe than the previous one, resulting consequently in a larger extent of inundation area.

A new plan map (scale 1:10,000) covering wider area than the available maps is therefore required in order to cover the overall flood potential area. The aerial photograph interpretation, although not strictly accurate in plan map, quickly provided natural and artificial features such as rivers, roads, and villages.

The actual extent of the present additional plan maps is shown in Fig. L.5.

### 2.5.3 Uncontrolled Mosaic

Uncontrolled mosaic of approximately 1:10,000 scale covering the whole project area was prepared for topographic analysis.

## 3. The Second Survey (January to March in 1988)

### 3.1 Flood Mark Survey along Cisangkuy River

(1) Objectives:
1) Additional flood mark survey for 1987's survey
2) Acquisition of basic data required to decide the road raising height along the provincial road between Bandung and Pengalengan

(2) Work Contents :

| | |
|---|---|
| Flood elevation at March 1986 | 1 point |
| Flood elevation at January 1988 | 5 points |

(3) Survey Results : Survey results are as follows:

Flood Elevations along the Provincial Road between Bandung and Pengalengan

| Station No. | Flood elevation at March 1986 (m) | Flood elevation at January 1988 (m) |
|---|---|---|
| 1 | 660.25 | 660.25 |
| 2 | ------ | 660.26 |
| 3 | ------ | 660.04 |
| 4 | ------ | 659.86 |
| 5 | ------ | 659.78 |

1988 flood levels were obtained by interviewing the residents and from leveling survey. The 1986 maximum flood levels were difficult to obtain along the road. Therefore, the differences in flood levels between two floods were studied by interviewing the residents along Cisangkuy River. The differences were 0.7 m at Citarum River junction and are same at points 3 to 4 km upstream. Locations of flood mark stations are shown in Fig. L.6.

## 3.2 River Profile and Cross Section Survey

Existing river profile and cross section survey were executed based on the control leveling results which were already done from May 1987 to August 1987. The amount of river profile and cross section survey is as follows:

Amount of River Profile and Cross Section Surveys

| Name of River | Length of Profile (km) | Cross Section Average Interval (km) | Number (Place) |
|---|---|---|---|
| Citarum | 40.0 | 1.0 | 41 |
| Citarum (Upstream) | 6.0 | 1.0 | 6 |
| Citarik | 15.0 | 1.0 | 17 |
| Cikeruh | 5.0 | 1.0 | 7 |
| Cut-off A-1 | 0.63 | 0.2 | 4 |
| Cut-off A-2 | 0.55 | 0.2 | 3 |
| Cut-off C | 0.83 | 0.2 | 5 |
| Cisangkuy Diversion | 3.1 | 0.5 | 8 |
| Total | 71.11 | --- | 91 |

River profiles and cross sections are presented in Data Book II and locations of river profile and cross section survey are shown in Fig. L.7 and Fig. L.8.

## 3.3 Cross Section Survey in Flood Prone Area

Four (4) cross section surveys in the flood prone area located at upstream stretch of Dayeuh Kolot were carried out in order to estimate the flood conditions and to institute the target flood water level. Fig. L.9 shows the location of the cross section survey in flood prone area. The drawings of the four cross sections in the flood prone area (Scale: SH = 1:200, SV = 1:200) are presented in Data Book II.

## 3.4 Topographic Survey

Topographic survey by using plane tables was conducted at three (3) places, namely, Nanjung, Cilampeni and Dayeuh Kolot bridge in order to prepare the improvement plan of existing river facilities. The scale of the topographic map is 1:500. The maps are presented in Data Book II. The mapping area are as follows:

1:500 Scale Topographic Mapping Area

| Name of location | Dimension | Area |
|---|---|---|
| Dayeuh Kolot | 200 m x 200 m | 4.00 ha |
| Cilampeni | 180 m x 180 m | 2.34 ha |
| Nanjung | 180 m x 180 m | 2.34 ha |
| Total | | 8.68 ha |

Table L.1 DIFFERENCE IN ELEVATIONS OF BENCH MARKS

| Name | New Elavaion Surveyed by JICA Study Team m | Difference mm | Old Elevation Surveyed by PWD m | Remarks |
|---|---|---|---|---|
| BMBCH-01 | 660.776 | 0 | 660.776 | |
| BMBCH-02 | 660.957 | 0 | 660.957 | |
| BMBCH-03 | 662.378 | 52 | 662.326 | |
| BMBCH-04 | 663.033 | 112 | 662.891 | |
| BMBCH-05 | 664.683 | 102 | 664.581 | |
| BMBCH-06 | 666.705 | 196 | 666.509 | |
| PUDU-6 | 662.559 | 12 | 662.547 | |
| BM-VI | 659.293 | -119 | 659.412 | |
| PUDU-4 | 661.231 | -7 | 661.238 | |
| BMTG-1 | 660.687 | -115 | 660.802 | |
| PUDU-8 | 658.754 | 158 | 658.596 | |
| CP-16 | 659.775 | -39 | 659.814 | |
| CPTG-1 | 660.287 | 245 | 660.042 | |
| BM-V | 659.767 | 48 | 659.719 | |
| CP-14 | 659.816 | 45 | 659.771 | |
| CPTG-4 | 660.397 | -67 | 660.463 | |
| BMTG-02 | 659.985 | -57 | 660.042 | |
| PUDU-2 | 661.080 | 5 | 661.075 | |
| CP-13 | 659.802 | -1 | 659.803 | |
| CP-11 | 660.044 | 19 | 660.025 | |
| BM-IV | 660.839 | 23 | 660.816 | |

(Continued)

| Name | New Elavaion Surveyed by JICA Study Team m | Difference mm | Old Elevation Surveyed by PWD m | Remarks |
|---|---|---|---|---|
| CPBCH-04 | 660.251 | -415 | 660.666 | |
| BM-01 | 659.762 | 208 | 659.554 | |
| CP-10 | 660.440 | 13 | 660.427 | |
| CP-9 | 660.504 | 34 | 660.470 | |
| CP-8 | 660.479 | 20 | 660.459 | |
| CP-7 | 660.627 | -12 | 660.639 | |
| PUDU-20 | 660.718 | 11 | 660.707 | |
| PUDU-19 | 660.883 | 154 | 660.729 | |
| PUDU-18 | 662.678 | 156 | 662.522 | |
| BMCT-1 | 662.704 | 63 | 662.641 | |
| CP-01 | 661.881 | 64 | 661.817 | |
| CP-02 | 661.566 | 63 | 661.503 | |
| CP-1 | 660.961 | 361 | 660.600 | |
| CP-3 | 660.763 | -56 | 660.819 | |
| CP-4 | 660.901 | -44 | 660.945 | |
| CP-5 | 661.582 | 36 | 661.546 | |
| PUDU-16 | 663.361 | 145 | 663.216 | |
| BMCTK-1 | 661.810 | 50 | 661.760 | |
| PUDU-14 | 661.799 | 217 | 661.582 | |
| CPBCH-10 | 665.240 | 102 | 665.138 | |
| CPBCH-11 | 667.822 | 72 | 667.750 | |

(Continued)

| Name | New Elavaion Surveyed by JICA Study Team m | Difference mm | Old Elevation Surveyed by PWD m | Remarks |
|---|---|---|---|---|
| CPBCH-12 | 655.830 | 108 | 665.722 | |
| CP-19 | 659.536 | -472 | 660.008 | |
| CP-21 | 658.547 | -124 | 658.671 | |
| CP-22 | 660.210 | -74 | 660.284 | |
| CP-23 | 657.968 | 12 | 657.956 | |
| CP-24 | 658.782 | 30 | 658.752 | |
| CP-25 | 657.430 | 31 | 657.399 | |
| CP-26 | 657.645 | 42 | 657.603 | |
| BM-VII | 660.209 | 3 | 660.206 | |
| BM-VIII | 659.364 | 72 | 659.292 | |
| CP-27 | 659.152 | 58 | 659.094 | |
| CP-28 | 656.870 | -31 | 656.839 | |
| CP-29 | 656.830 | 62 | 656.768 | |
| CP-30 | 658.198 | 32 | 658.166 | |
| CP-31 | 657.044 | -188 | 657.232 | |
| CP-32 | 657.085 | -172 | 657.257 | |
| CP-33 | 656.174 | -162 | 656.336 | |
| CP-34 | 657.184 | -166 | 657.350 | |
| CP-35 | 661.771 | -136 | 661.907 | |
| CP-36 | 660.573 | -74 | 660.647 | |
| CP-37 | 660.513 | -134 | 660.647 | |
| CP-38 | 669.695 | -112 | 660.807 | |

Table L.2 MAXIMUM FLOOD ELEVATION OF 1986 FLOOD

| Point No. | Maximum Flood Elevation | Remarks | Point No. | Maximum Flood Elevation | Remarks |
|---|---|---|---|---|---|
| 1 | 661.222 | 3 / 86 | 21 | 660.746 | 3 / 86 |
| | (660.960) | 4 / 87 | | | |
| | | | 22 | 660.965 | 3 / 86 |
| 2 | 660.177 | 3 / 86 | | | |
| | | | 23 | 660.911 | 3 / 86 |
| 3 | 660.276 | 3 / 86 | | | |
| | (659.028) | 4 / 87 | 24 | 661.018 | 3 / 86 |
| 4 | 660.391 | 3 / 86 | 25 | 661.408 | 3 / 86 |
| | | | | (661.272) | 4 / 87 |
| 5 | 660.387 | 3 / 86 | | | |
| | | | 26 | 662.578 | 3 / 86 |
| 6 | 660.673 | 3 / 86 | | | |
| | | | 27 | 661.328 | 3 / 86 |
| 7 | 660.436 | 3 / 86 | | | |
| | | | 28 | 661.806 | 3 / 86 |
| 8 | 660.501 | 3 / 86 | | | |
| | | | 29 | 661.802 | 3 / 86 |
| 9 | 660.471 | 3 / 86 | | | |
| | | | 30 | 661.756 | 3 / 86 |
| 10 | 660.261 | 3 / 86 | | | |
| | | | 31 | 662.698 | 3 / 86 |
| 11 | 660.564 | 3 / 86 | | | |
| | | | 32 | 662.596 | 3 / 86 |
| 12 | 660.589 | 3 / 86 | | | |
| | | | 33 | 662.507 | 3 / 86 |
| 13 | 660.691 | 3 / 86 | | | |
| | | | 34 | 661.999 | 3 / 86 |
| 14 | 660.643 | 3 / 86 | | | |
| | | | 35 | 662.800 | 3 / 86 |
| 15 | 660.829 | 3 / 86 | | | |
| | | | 36 | 662.560 | 3 / 86 |
| 16 | 660.577 | 3 / 86 | | | |
| | (659.187) | 4 / 87 | 37 | 663.662 | 3 / 86 |
| 17 | 660.953 | 3 / 86 | 38 | 664.428 | 3 / 86 |
| 18 | 660.816 | 3 / 86 | 39 | 664.771 | 3 / 86 |
| 19 | 660.867 | 3 / 86 | 40 | 665.656 | 3 / 86 |
| 20 | 660.910 | 3 / 86 | | | |

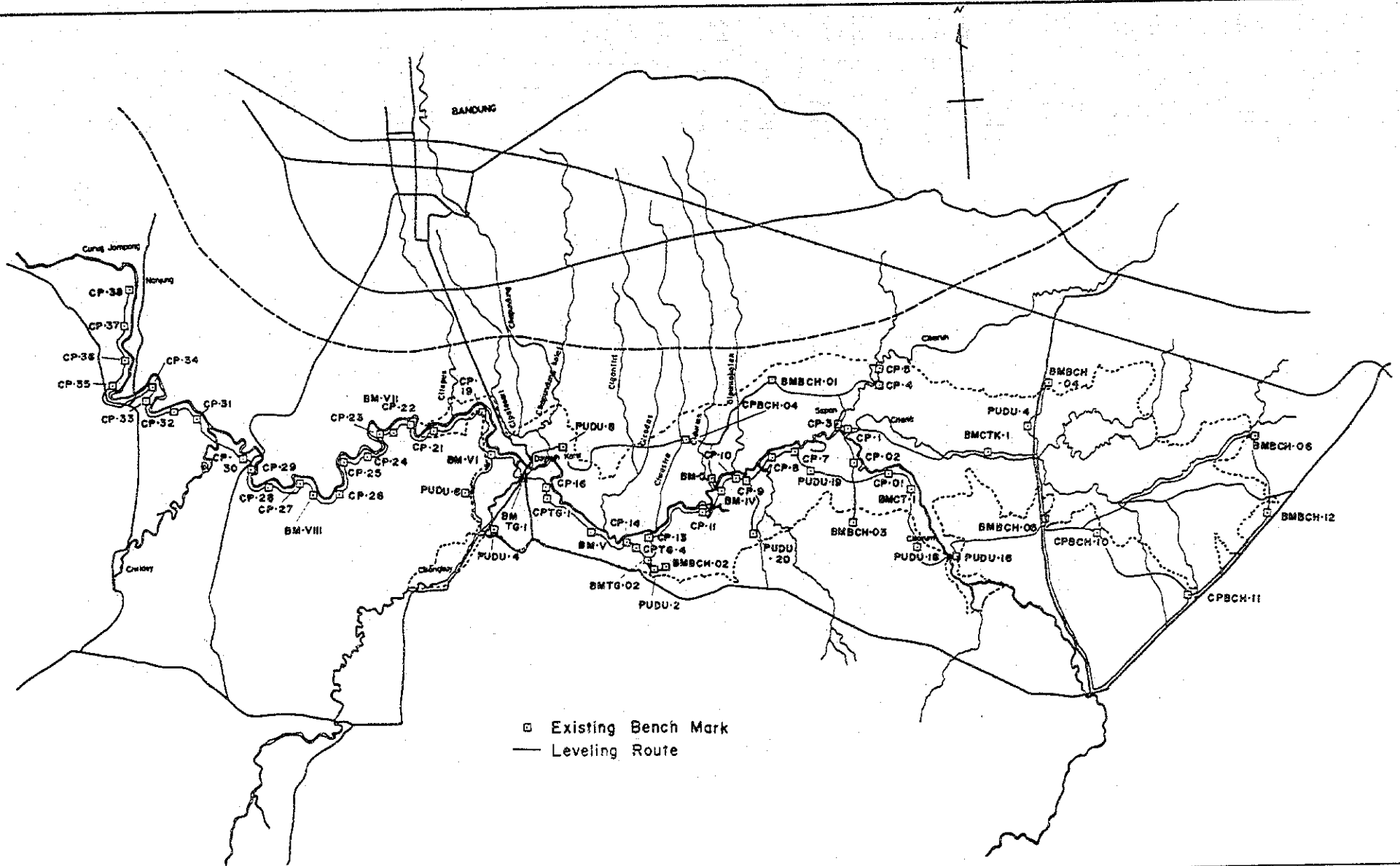
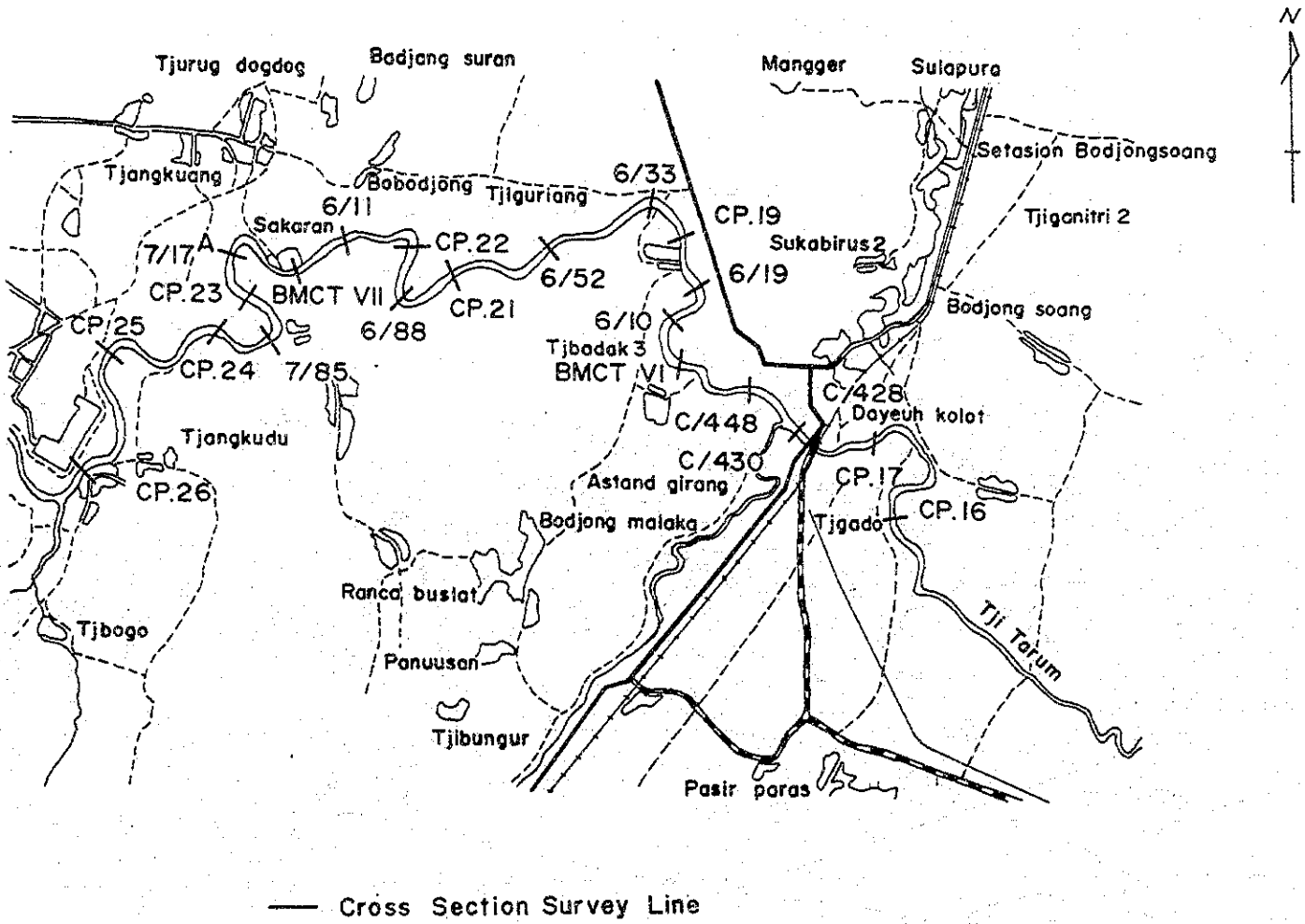



**FIG. L.1** LOCATIONS OF EXISTING BENCH MARKS AND LEVELING ROUTES

**STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN**

JICA




—— Cross Section Survey Line

| FIG. L.2 | LOCATION MAP OF RIVER CROSS SECTION SURVEY OF CITARUM RIVER (1987's Survey) |
|---|---|

**STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN**

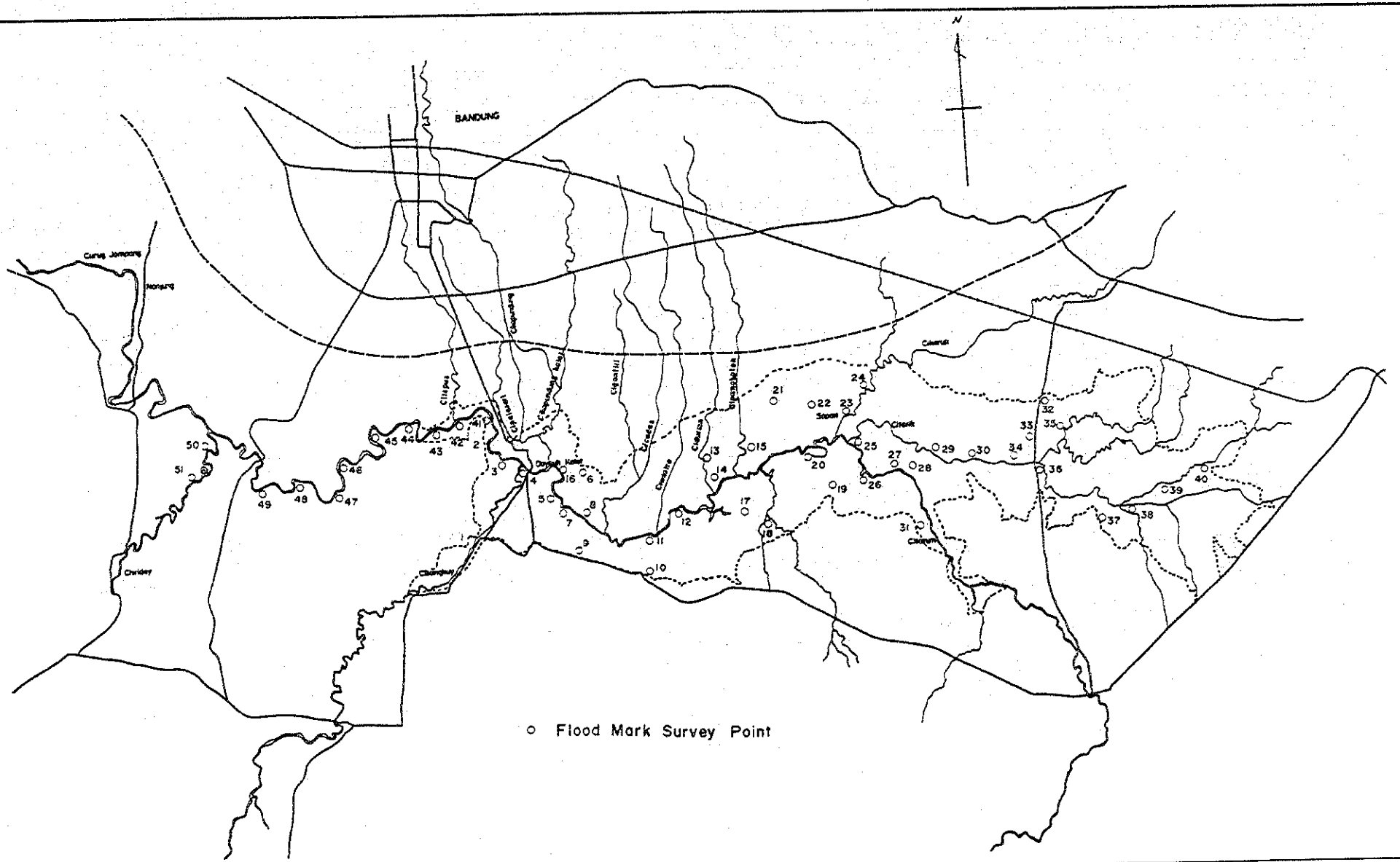



**FIG. L.3** LOCATION MAP OF FLOOD MARK SURVEY POINTS

**STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN**

JICA

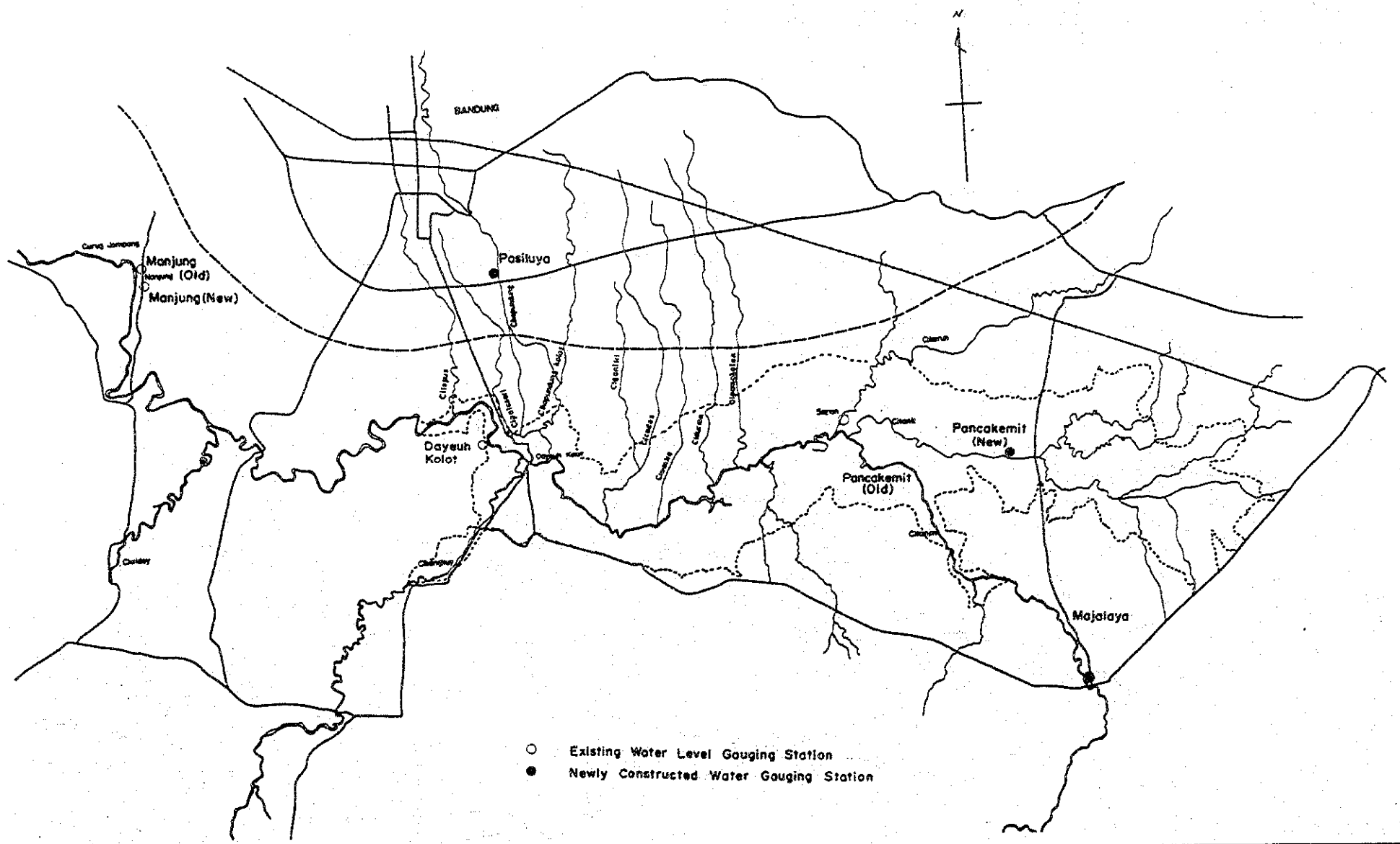



**FIG. L.4** LOCATION MAP OF WATER LEVEL GAUGE STATIONS

**STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN**

JICA

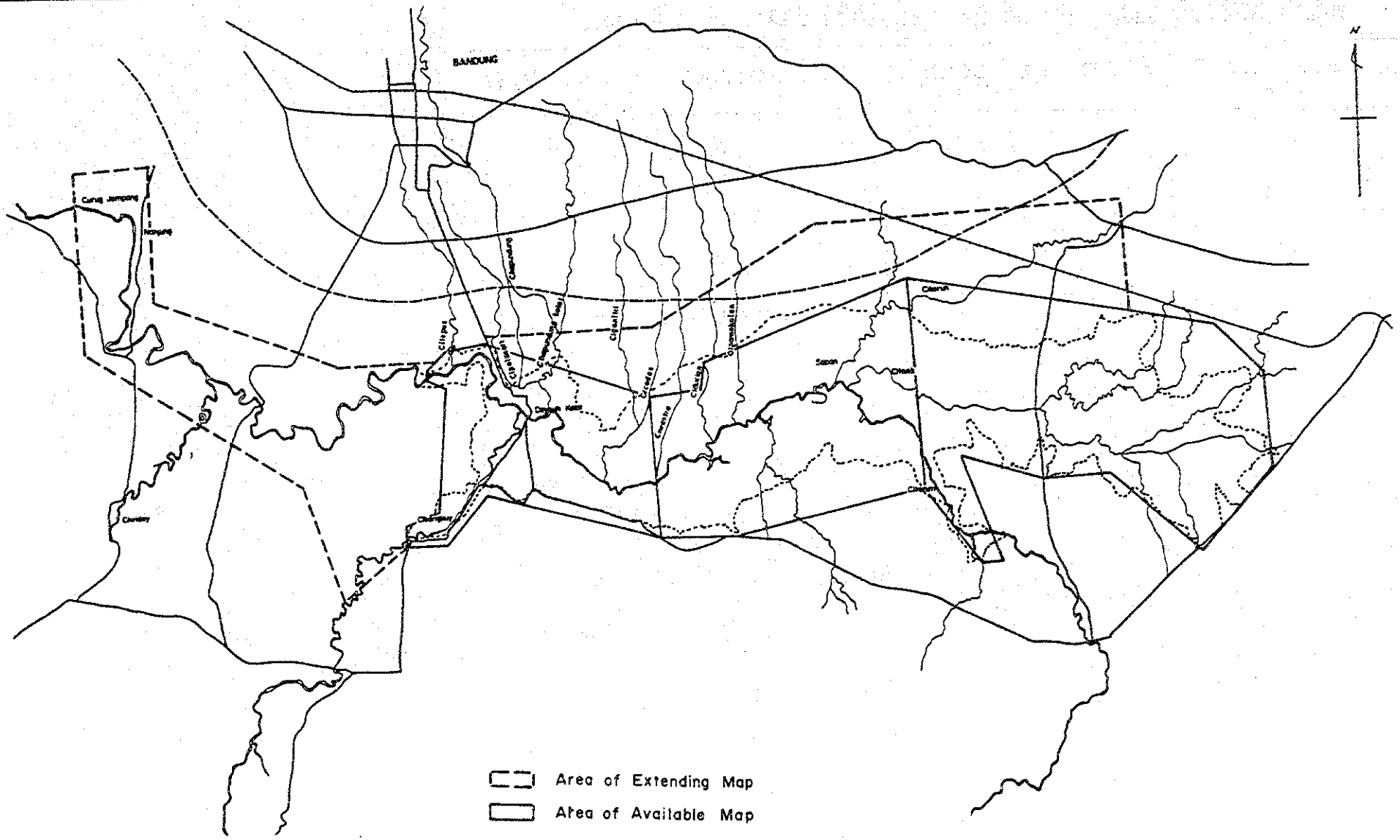
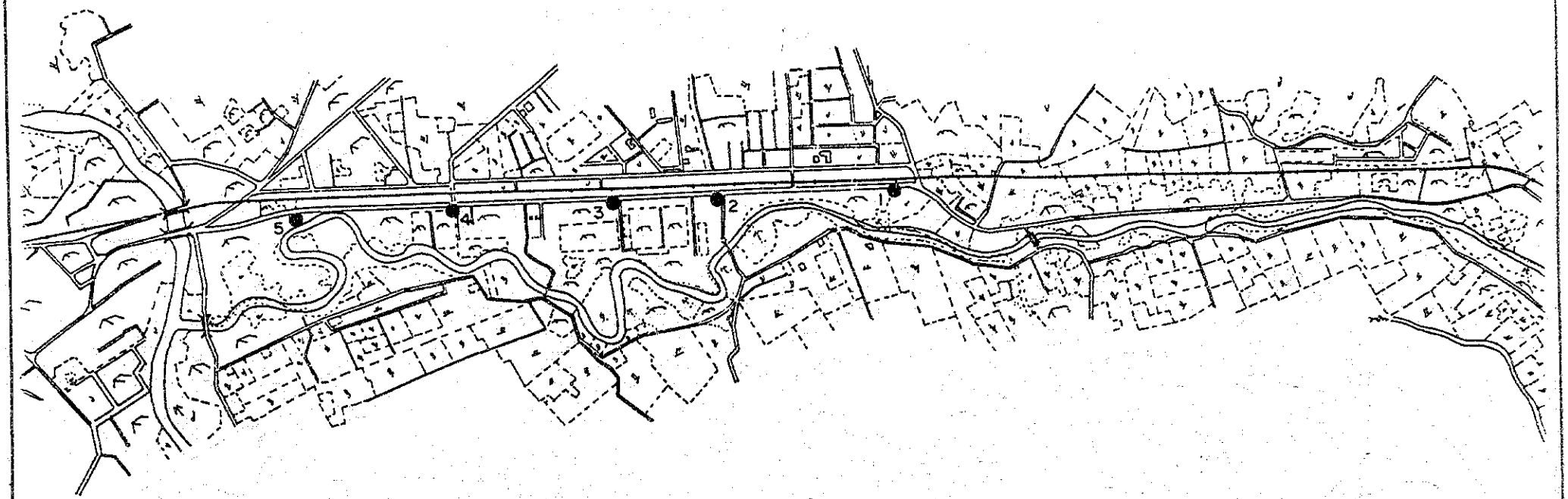



FIG. L.5 LOCATION OF ADDITIONAL PLAN MAP

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

JICA




● Flood Mark Survey Station

**FIG. L.6** LOCATION MAP OF FLOOD MARK SURVEY IN 1988

**STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN**

JICA

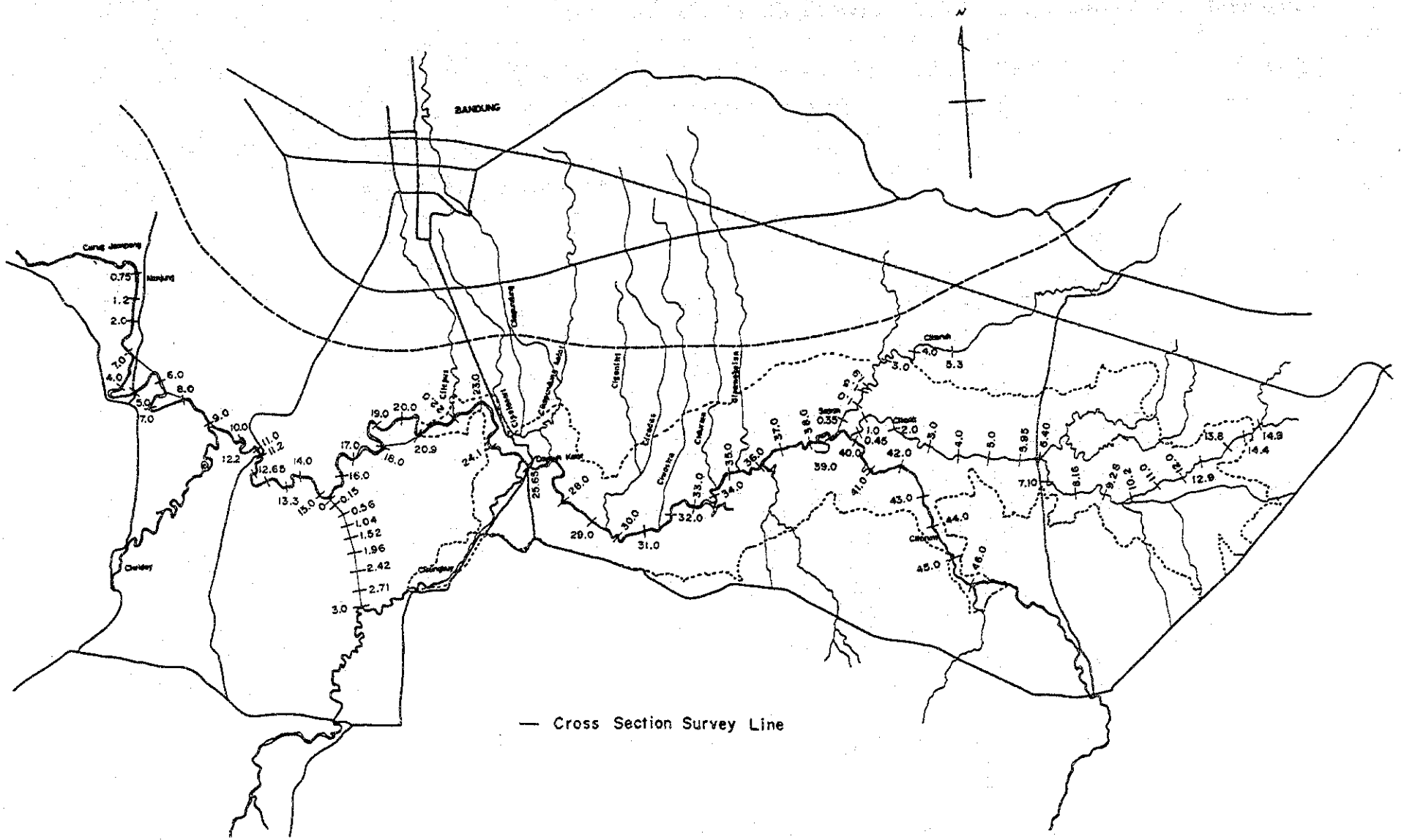



FIG. L.7 LOCATION MAP OF RIVER CROSS SECTION SURVEY

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

JICA

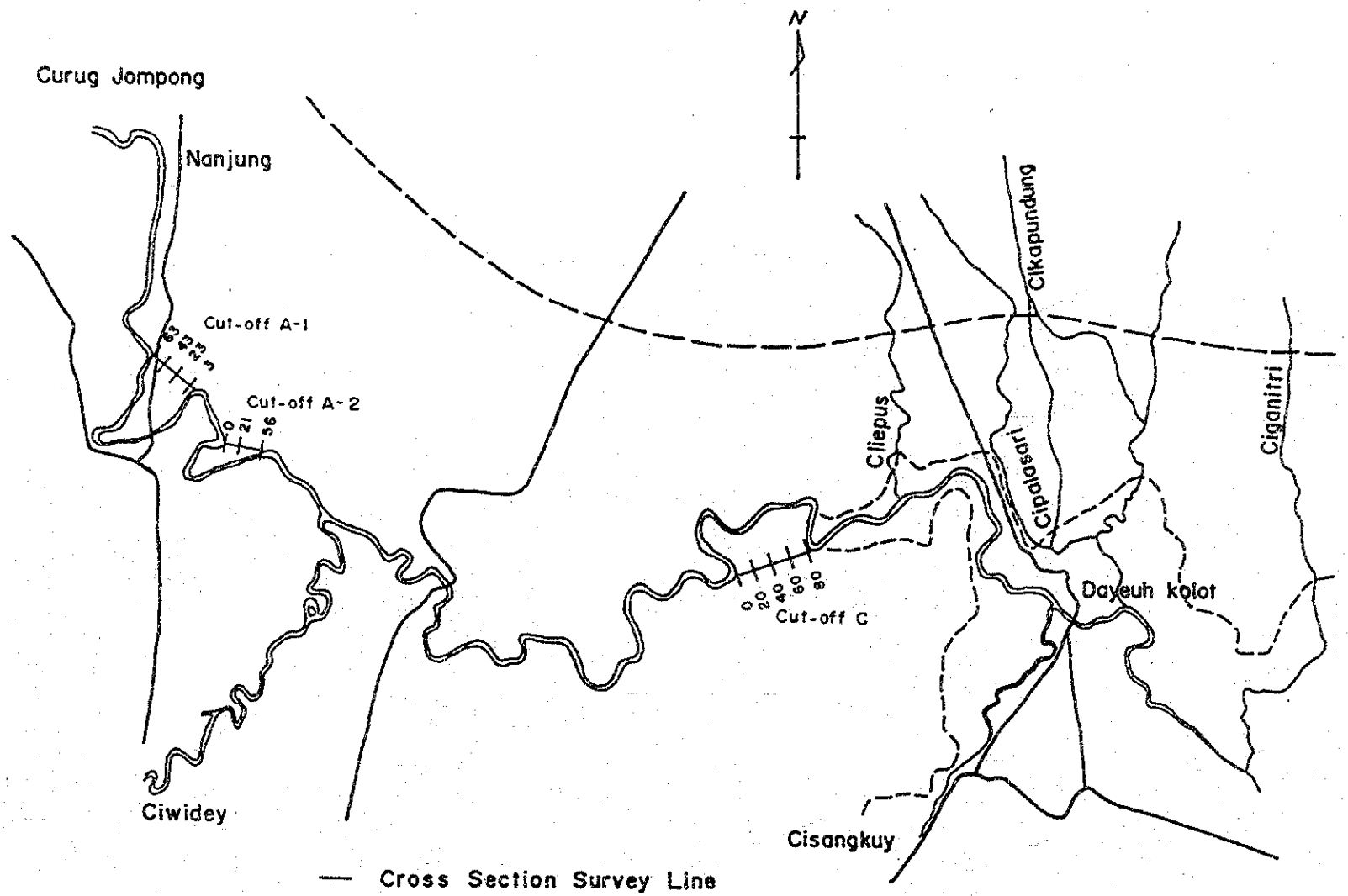



**FIG. L.8** LOCATION MAP OF RIVER CROSS SECTION SURVEY

**STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN**