Damage to Tree Crops (Cacao, Coffee, Papaya, Banana, etc.)

Tree crops such as cacao, coffee and banana bear fruit at a comparatively lower position above the ground and so some fruits will be directly damaged by flood. In the present study, an average damage rate is roughly assumed as shown below, taking into account the site conditions of these trees.

Flood Damage Rate to Tree Crops (%)

Inundation Depth (m)	Damage Rate
0.00 - 0.49	5
0.50 - 0.99	10
1.00 - 1.49	20
1.50 - 1.99	40
2.00 - 2.49	80
Over 2.50	100

Damage to Upland Crops (Palawija)

The rate of flood damage to upland crops such as cassava, potato, peanut, soybean and green pea is given as a function of water depth and duration of inundation in accordance with a standard rate being applied for the economic evaluation of flood control in Japan as follows:

Flood Damage Rate to Upland Crops (%)

Inundation		Damage Rate
Depth (m)	Duration (day)	
0.00 - 0.49	3 - 5	35
0.50 - 0.99	4 - 6	67
1.00 - 1.49	5 - 7	85
1.50 - 1.99	5 - 7	95
2.00 - 2.49	Over 7	99

Damage to Public Facilities

In the study area, there are no available data required for estimating damage by flood discharge to public facilities such as roads, railways, bridges, and electric, water supply and drainage facilities. Hence, a damage rate estimated in Japan is assumed in this study, i.e., 34% of the damage to buildings and household effects.

3.3 Flood Damage Calculation

Based on the flood inundation analysis by means of the Two Dimensional Unsteady Flow Model, flood water depth and duration are computed for each mesh under various scales of floods. The total

flood damage is firstly calculated for each river by summing up each mesh's damage for a certain scale of flood (refer to Table 3-7). The average annual flood damage is generally given using the following formula:

$$d = \int_{Q1}^{Q2} \int_{Q_1}^{Q_2} D(Q)P(Q)dQ$$

where,

- d : average annual flood damage
- Q : flood discharge
- D(Q) : damage caused by flood discharge (Q)
- P(Q) : probability of occurrence of flood discharge (Q)
- Q_1 : innocuous discharge
- Q_2 : design flood discharge

The average annual flood damage by return period is summarized in the following table.

Average Annual Flood Damage

(Unit: Rp. millions)

Return Period (Year)	Belawan River (1)	Deli River (2)	Percut River (3)	Serdang River (4)	Ular* River (5)	Belutu River (6)	Padang River (7)
10	324	32,363	2,443	10,919	-	2,019	8,961
20	711	35,687	3,059	11,909	460	2,217	9,857
30	869	36,919	3,296	12,248	1,080	2,292	10,193
50	1,001	37,968	3,491	12,527	1,520	2,354	10,469
100	-	38,795	3,647	-	-	-	-

* Source: JICA: Overall Ular River Improvement Project, 1971

4. FLOOD CONTROL FOR THE MASTER PLAN

4.1 Project Scale and Target Area

Project Scale

The project scale for the master plan is proposed to be a 50-year return period for six (6) rivers, namely Belawan, Percut, Serdang, Ular, Belutu and Padang. The project scale is bigger for the Deli River, i.e., 100-year return period, in consideration that the river passes through Medan City. The project scales of the existing flood control projects in Indonesia are as shown in Table 4-1.

Through the hydrological analysis conducted using data of new hydrological stations and for the flood in November 1990, it is recognized that the Deli River and the Percut River have the same climatic conditions, that is, a storm rainfall covers both river basins. In case that both rivers will be connected together by the proposed floodway, the two rivers are to be defined as one river system. (Refer to Fig. 4-1.)

Therefore, if the floodway is adopted, the project scale of flood control for the Percut River is proposed to be upgraded to a 100-year return period, which is the same as that of the Deli River. This is justified by the fact that Medan City is expanding outward over the Percut River Basin.

Target Area

The target stretch for river improvement is decided on the basis of the project scale for the master plan, which corresponds to the inundation area caused by an overbank flow of approximately a 100-year return period flood. The present flow capacity, present land use and future development plan are considered as well.

The assets identified as those to be protected by the project are (1) the urban areas of Medan and Tebing Tinggi, (2) the paddy fields, plantations, agricultural and residential areas, and (3) the fishponds in the lower reaches of objective rivers. The swampy area 15 km from the estuary of the Belawan River and that in the right bank area of the Deli River 2.5 km upstream of the estuary is not diked.

The target river improvement stretches are as follows:

Target River Improvement Stretch

River	Improvement Stretch	Length (km)
1. Belawan	15 km upstream of river mouth to crossing with national road	21.7
2. Deli*	River mouth to Titi Kuning	37.4
3. Percut	River mouth to Tembakau	28.0
4. Serdang		
(a) Serdang and Belumai	River mouth to about 7 km upstream of confluence with Batugingging River	16.5
(b) Batugingging	Confluence with Belumai River to crossing with national road	8.9
5. Ular	River mouth to Pulau Tagor	31.8
6. Belutu	River mouth to Bakaran Batu	32.7
7. Padang	River mouth to confluence with Sibarau River	29.5

* Except the right bank 2.5 km upstream of river mouth.

4.2 Standard Project Flood

The standard project flood to formulate the Master Plan is the discharge corresponding to the project scale, i.e., 100-year return period for Deli-Percut River System and 50-year return period for the other five (5) rivers, in the probable flood discharge presented in Fig. 4-2.

4.3 Possible Flood Control Structure

Depending upon topographical and geological conditions and the hydrology of the rivers, the following structural measures are applicable for the respective rivers, as shown in Fig. 4-3.

River Improvement

River improvement works such as diking and channel normalization are the direct measures for confining floods in the river channel. The flood control structures take into consideration the improvement works of Deli River with the scale of 10-year return period which are now underway.

Floodway

A floodway or diversion channel is generally difficult to apply to the rivers in the study area, because all the rivers are aligned in parallel with each other in the north direction. However, it is possible to divert the flood discharge from a river in an urban area to a river in a rural area in consideration of economical flood control works and the social problems in land acquisition for river improvement.

Retarding Basin

Some possible sites for the construction of a retarding basin are identified on four (4) rivers, namely Belawan, Serdang, Belutu and Padang. However, these sites are usually utilized as paddy or plantation, so that the construction of a retarding basin is rather costly. (Refer to Subsection 4.4)

Dam

As described in the Supporting Report on Dam and Reservoir, eight (8) possible dam sites are identified in the upper reaches of each river (Ular River has two dam sites on its two major tributaries). Although the efficiency in controlling floods depends on the location of the dam, dam construction is more advantageous due to the possibility of multiple uses with water supply, etc.

4.4 Optimum Flood Control Plan

In the Master Plan Study, the optimum combination of structural measures for flood control is selected from the technical and economical aspects. River improvement is examined for all objective rivers and the application of floodway from Deli River to Percut River is investigated. Then, comparison between dam and retarding basin is made and finally, the combination of dam and river improvement is compared.

The design of possible flood control structures to confine the standard project flood in the river channel is carried out on the basis of the design criteria described in the supporting reports on Dam and Reservoir and River Improvement. The project cost is then estimated.

River Improvement

The construction cost for river improvement is summarized as follows:

Construction Cost for River Improvement

River	Improvement Length (km)	Project Scale (Yr. Return Period)	Construction Cost (million Rp)
1. Belawan	21.7	50	31,300
2. Deli	37.4	100	261,600
3. Percut	28.0	50*	47,600
4. Serdang	25.4	50	114,700
5. Ular	31.8	50	27,700
6. Belutu	32.7	50	56,400
7. Padang	29.5	50	100,500

* Percut River is to be improved without the floodway, therefore the project scale is only a 50-year return period.

Floodway

The construction of floodway from the Deli River to the Percut River is identified to be possible on account of the topographic condition and land use along and around the said two rivers. In order to justify the application of floodway, the comparison of construction cost of river improvement only and of river improvement with floodway is carried out. The design criteria for the floodway are the same as those for the river improvement.

The construction costs for both river improvement only and river improvement with floodway are estimated, as shown in Fig. 4-4. The construction costs show that river improvement with floodway is economical when the discharge at Helvetia is more than 500 m^3/s.

As a result of the comparative study, the floodway from Titi Kuning to Tembakau, named as Medan Floodway, is adopted for Deli River improvement. The route and diversion facility type are described in the Supporting Report on River Improvement.

Comparison Between Dam and Retarding Basin

The selection of appropriate flood control plan between dam and retarding basin is carried out in accordance with the index of required construction cost for unit flood mitigation effect as shown in Table 4-2. The comparative study shows that the dam is economically more advantageous than the retarding basin.

Comparison Between Dam and River Improvement

The construction costs of river improvement and dam applied singly or in combination with each other are compared. The results of the comparison shows that the river improvement with dam construction is economical for Deli and Percut rivers, while dam construction only is economical for Ular River and river improvement only is economical for the other rivers, as shown in Fig. 4-5.

Project Scale of Deli-Percut River Flood Control Plan

The probable flood discharge for 10, 20, 30, 50 and 100 year return periods of Deli-Percut River which is connected by the Medan Floodway are proposed, as shown in Fig. 4-6, from the following considerations:

(a) The optimum flood control structures for the master plan with the scale of a 100-year return period are the Lausimeme Dam, the Medan Floodway, the Namobatang Dam and the river improvement works.

(b) As to implementation priority of project components in the Deli-Percut River, improvement works on the Deli River is the most urgent, followed by the Lausimeme Dam, Medan Floodway and Namobatang Dam, as described in Subsection 5.1.

(c) The urgent project presented in Subsection 5.2, except the Namobatang Dam, is formulated with a scale of 30-year return period.

(d) The construction cost of Lausimeme Dam on the Deli-Percut River is economically advantageous in case the project scale is more than a 30-year return period, as shown in Fig. 4-4.

(e) In case the project scale is a 50-year return period, the construction cost without Namobatang Dam on the Deli-Percut River is almost the same as that with the dam.

Comparison Results

In accordance with the results of the foregoing comparative studies, the optimum flood control plans for the master plan are described hereinafter. The construction costs of these plans are presented in Table 4-3. Fig. 4-7 shows the design discharge of the optimum flood control plans.

(1) Belawan River

Only river improvement on a stretch of 21.7 km is carried out to confine the design flood discharge of 550 m^3/s at Lalang which corresponds to a 50-year return period.

(2) Deli-Percut River

The project scale of the Deli-Percut River connected by the Medan Floodway is a 100-year return period. A stretch of 37.4 km of the Deli River is to be improved to confine the flood discharge of 460 m^3/s at Helvetia. The 3.8 km floodway is to be constructed to divert a part of the flood discharge of 120 m^3/s from Titi Kuning in Deli River to Tembakau in Percut River and the Namobatang Dam is to be constructed to regulate the flood discharge from 250 m^3/s to 50 m^3/s.

A stretch of 28.0 km of the Percut River is to be improved with the design discharge of 300 m^3/s including the diverted discharge of 120 m^3/s through the floodway. Lausimeme Dam is to be constructed to regulate the flood discharge of 280 m^3/s down to 60 m^3/s.

(3) Serdang River

Only river improvement on a total stretch of 25.4 km including those of the tributaries Belumai and Batugingging is to be carried out to confine the design discharges of 850 m^3/s, 330 m^3/s and 480 m^3/s at Baru (Serdang River), Buntu (Belumai River) and Gang Melaya (Batugingging River), each of which corresponds to a 50-year return period flood.

(4) Ular River

To upgrade the flood control level, Karai Dam is to be be constructed to regulate the flood discharge of 500 m^3/s down to 300 m^3/s. As a result, the flood discharge of 970 m^3/s at Pulau Tagor, which corresponds to a 50-year return period, is controlled.

(5) Belutu River

Only river improvement on a stretch of 32.7 km is to be carried out with the design discharge of 340 m^3/s at Rampah River which corresponds to a 50-year return period.

(6) Padang River

Only river improvement on a stretch of 29.5 km is to be carried out with the design discharge of 840 m^3/s at Brohol which corresponds to a 50-year return period.

5. URGENT FLOOD CONTROL PLAN

5.1 Selection of Urgent Project

Five (5) urgent projects that can be implemented in 10 years are selected for the implementation program of the integrated flood control and water supply plan; namely, (1) the Deli River Improvement Works, (2) the Percut River Improvement Works, (3) the Lausimeme Dam, (4) the Medan Floodway, and (5) the Padang River Improvement Works. The implementation program of the master plan is prepared by placing higher priority on components which can satisfy the following conditions:

(a) Urgency in implementation to mitigate the flood damage and to meet the water demand;

(b) Higher economic efficiency is expected with the implementation; and

(c) The plan will continue and strengthen the existing or ongoing projects of the Indonesian Government.

Economic viability is evaluated by cost-benefit analysis with the results expressed in percent as Economic Internal Rate of Return (EIRR). (Refer to the Main Report.)

Since the improvement works on Deli River is underway to attain safety against floods of a 10-year return period and that water shortage is very serious because the present water demand could not be met by the existing water sources, the first priority is to be put on the implementation of the project components in the Deli-Percut River.

The Padang River is to be taken as the second priority, because Tebing Tinggi has been frequently hit by floods. Besides, the rehabilitation of the dike protecting the city and its expansion area has been undertaken by DPUP. Similarly, the rehabilitation of the dike along the Serdang River has been carried out by DPUP. Therefore, the river improvement of Serdang River is to be taken as the third priority for implementation.

Following the above three (3) priorities, the Belutu River has to be improved in consideration that the river has only a small flow capacity, although the economic efficiency of the river improvement works is rather low. The implementation of flood control works on the Belawan and Ular rivers are to have lower priority than the others, because their existing flow capacity corresponds to a 10-year and a 20-year return period, respectively.

Among the components of the flood control plan for the Deli-Percut River, the construction of Lausimeme Dam is the most urgent to meet the present demand of municipal water in Medan. As a multipurpose dam, it is understood that its construction would be urgently carried out not only to mitigate the flood damage in the lower reaches of Percut River but also to compensate the increase of flood discharge by flood diversion through the floodway. The floodway is, therefore, to be constructed after the completion of the Lausimeme Dam to have more flood control capacity on the Deli River.

5.2 Project Scale

The urgent project for the Deli-Percut River is formulated with a scale of 30-year return period from the following considerations:

(a) Ular River which runs through the agricultural area has been improved with a design flood discharge of 800 m^3/s which corresponds to almost a 20-year return period flood. It is therefore reasonable that the project scale for the Deli- Percut River is set greater than a 20-year return period, because the Deli and Percut rivers run in the urban area of Medan City and its vicinity with a population of more than 1.7 million.

(b) According to the economic analysis in the master plan study, the highest Economic Internal Rate of Return (EIRR) for the Deli-Percut River is at the scale of a 10-year return period. EIRRs greater than 15% are expected for both rivers even if a 30-year return period is employed as the project scale. (Refer to the Main Report.)

DPUP has been proceeding with the river channel improvement for the Deli River at the scale of 10-year return period. The river improvement for the lowest section 7.5 km downstream of Labuhan Deli has been completed with diking and excavation/dredging, and land acquisition has been executed for the upper stretch up to the confluence with the Sikambing River. River improvement at a 30-year return period can be attained only by the provision of the proposed floodway after completion of the 10-year scale river improvement.

As for the Padang River, a project scale of 10-year return period which has the highest EIRR of 11.54% is proposed for the urgent project. The project scale of a 10-year return period is the minimum requirement for flood control in the study area. The proposed design flood discharge for the urgent project is presented in Fig. 5-1.

5.3 Project Formulation

The urgent project firstly consists of the river improvement for the Deli and Percut rivers, the Lausimeme Dam and the Medan floodway. The target stretch for the river improvement of Deli River is set from the river mouth to Titi Kuning, since the upper stream of Titi Kuning has enough capacity to flow the design flood discharge of the Master Plan. Medan Floodway is to be constructed from Titi Kuning to Tembakau and the inundation area of the upper stream caused by the floodway is to be confined by an embankment of around 3.0 m high. A few houses and the submerged area are to be compensated.

The river improvement stretch for the Percut River is from the river mouth to the floodway. The improvement lengths are 37.4 km for the Deli River and 28.0 km for Percut River. The Medan Floodway is 3.8 km.

The design flood discharge in the proposed target stretch for the urgent project (30-year return period) is almost equivalent to those of the Master Plan (100-year return period). Therefore, it is economically advantageous to pursue the improvement works at the design flood discharge of the Master

Plan in the urgent project stage. Lausimeme Dam is also to be constructed at the project scale of the Master Plan.

The urgent project for the Padang River is only the river improvement works. The target stretch of 29.5 km is set from the river mouth to the confluence with the Sibarau River and the design discharge is 630 m^3/s. The urgent project is formulated within the framework of the Master Plan. The components of the urgent project are summarized as follows:

(a) Deli River Improvement

Target Stretch	Length	Design Discharge
River Mouth to Sikambing R.	22.9 km	460 m^3/s
Sikambing R. to Babura R.	5.3 km	400 m^3/s
Babura R. to Titi Kuning	9.2 km	200 m^3/s

(b) Percut River Improvement

Length of 28.0 km with the design discharge of 300 m^3/s

(c) Medan Floodway

Length of 3.8 km (Titi Kuning to Tembakau) with the design discharge of 120 m^3/s. Length of 3.2 km (upper stream of floodway inundation area) of Deli River.

(d) Lausimeme Dam (Multipurpose Dam)

Gross storage capacity: 33 MCM

(e) Padang River Improvement

Length of 29.5 km with the design discharge of 620 m^3/s.

TABLES

Table 2-1(1/3) RESULTS OF FLOOD DAMAGE INTERVIEW SURVEY

No. of Survey Point	Location (Desa /Kecamatan)	River	Ground Elevation (m MSL)	Cause of Flood	Flood Water Depth (m)	Flood Duration (day)	Flooding Area (ha)	Remarks
1.	Kp. Sicanang/Medan Belawan	Belawan		Inland	1.50	3	100	River and Tide
2.	Belawan Sicanang/Medan Belawan	Belawan		Inland	1.50	5	150	River and Tide
3.	Dusun I/Hamparan Perak	Belawan		Inland	0.60	2	125	Insufficient Capacity Drainage
4.	Selemak/Hamparan Perak	Belawan		Inland	0.50	2	75	Insufficient Capacity Drainage
5.	Klambir/Hamparan Perak	Belawan		Inland	1.25	3	125	Insufficient Capacity Drainage
6.	Klumpang Kebon/Hamparan Perak	Belawan		Inland	0.40	15	75	Insufficient Capacity Drainage
7.	Lingk. XII, Kel. Terjun/ Medan Labuhan	Terjun		Inland	1.50	10	80	Drainage Problem
8.	Lingk. XIII, Kel. Terjun/ Medan Labuhan	Terjun		Inland	0.80	7	220	Drainage Problem
9.	Sei Mati/Medan Labuhan	Sei Mati		Inland	0.50	2	75	River and Tide
10.	Kerentang/Percut Sei Tuan	Percut		Inland	0.50	7	300	River and Tide
11.	Desa Percut/Percut Sei Tuan	Percut		Inland	0.60	7	150	River and Tide
12.	Dusun Talang/Percut Sei Tuan	Percut		Inland	0.50	7	75	River and Tide
13.	Lima Tahunan/Percut Sei Tuan	Percut		Inland	0.50	8	75	Mostly Caused by Tide
14.	Cinta Rakyat/Percut Sei Tuan	Percut		Inland	1.00	14	60	No Drainage Facility
15.	Cinta Damai/Percut Sei Tuan	Percut		-	-	-	-	No Flood
16.	Klambir/Pantai Labu	Serdang		Overbank	0.75	14	240	-ditto-
17.	Paya Gambar 1/Batang Kuis	Serdang		Overbank	1.00	8	450	Flood occurred mostly in 1970's since 1973 no flood
18.	Rantau Panjang Hilir/Pantai Labu	Serdang		Overbank	1.00	14	400	-ditto-
19.	Durian 4/Pantai Labu	Serdang		Overbank	10.50	5	75	-ditto-
20.	Arus Kabu 6/Batang Kuis	Serdang		Overbank	1.00	8	150	-ditto-

Table 2-1(2/3) RESULTS OF FLOOD DAMAGE INTERVIEW SURVEY

No. of Survey Point	Location (Desa /Kecamatan)	River	Ground Elevation (m MSL)	Cause of Flood	Flood Water Depth (m)	Flood Duration (day)	Flooding Area (ha)	Remarks
21.	Bakaran Batu/Lubuk Pakam	Batu Gingging		Overbank	2.00	30	40	-
22.	Pematang Kuala/Teluk Mengkudu	Belutu		Inland	1.00	60	700	Paddy field only (No drainage facility)
23.	Bogak Pangkal/Tanjung Beringin	-		Inland	0.20	14	300	Tide
24.	Nagur/Tanjung Beringin	Belutu		Inland	0.15	7	350	
25.	Sungai Rejo/Sei Rampah	Belutu		Overbank	0.60	15	1,000	Increase riverbed elev. due to sediment deposit
26.	Desa Rampah/Sei Rampah	Belutu		Overbank	1.00	14	350	Increase riverbed elev. due to sediment deposit
27.	Cempedak Lobang/Sei Rampah	Belutu		Overbank	1.50	120	400	Increase riverbed elev. due to sediment deposit
28.	Belidahan/Sei Rampah	Rambung		Overbank	0.30	-	50	Swampy area
29.	Durian Rejo/Sei Rampah	Rambung		Overbank	0.80	7	1,000	
30.	Sei Parit/Sei Rampah	Belutu		Overbank	1.00	120	114	Increase riverbed elev. due to sediment deposit and drainage
31.	Silau Rakyat/Sei Rampah	Belutu		Overbank	1.20	12	275	Increase riverbed elev. due to sediment deposit and drainage
32.	Tebing Tinggi/Tanjung Beringin	Lubuk Laban		Inland	1.00	14	3,000	Poor drainage capacity and Tide
33.	Pematang Cermai/Tanjung Beringin	Belutu		Overbank	1.50	30	425	Insufficient Drainage Capacity
34.	Tanjung Beringin/Tanjung Beringin	Bedagai		Inland	1.00	7	125	River and Tide
35.	Kampung Pala/Sei Rampah	Rambung		Overbank	1.20	30	75	Poor drainage capacity after the meandering was cut there was no flood
36.	Pematang Ganjang/Sei Rampah	Belutu		Overbank	1.50	14	350	Increase riverbed elev. due to sediment deposit and drainage

Table 2-1(3/3) RESULTS OF FLOOD DAMAGE INTERVIEW SURVEY

No. of Survey Point	Location (Desa /Kecamatan)	River	Ground Elevation (m MSL)	Cause of Flood	Flood Water Depth (m)	Flood Duration (day)	Flooding Area (ha)	Remarks
37.	Kampung Pon/Sei Rampah	Belutu		Overbank	-	-	50	No drainage facility
38.	Sei Bamban/Sei Rampah	Belutu		Overbank	0.80	30	800	Increase riverbed elev. due to sediment deposit and drainage
39.	Bakaran Batu/Sei Rampah	Bamban Belutu		Inland	0.40	14	300	No drainage facility
40.	Sei Sarimah/Bandar Khalipah	Martebing/Padang		Overbank	1.50	7	250	Dike protection from sea has already been broken
41.	Langau/Tebing Tinggi	Padang		Overbank	2.50	14	1,300	
42.	Sei Periok/Tebing Tinngi	Martebing/Padang		Inland	1.00	90	30	
43.	Kuta Baru/Tebing Tinggi	Martebing/Padang		Inland	0.50	7	350	
44.	Paya Mabar/Tebing Tinggi	Padang		Overbank	1.00	14	40	
45.	Paya Lombang/Tebing Tinggi	Padang		Overbank	0.75	7	150	
46.	Brohol/Rambutan	Padang		Overbank	1.00	7	100	
47.	Bah Jenis/Tebing Tinggi	Padang		Overbank	1.10	7	50	
48.	Simpang Bom/Bandar Khalipah	Martebing/Padang		Overbank	0.50	7	2,600	
49.	Pekan Bandar/Bander Khalipah	Martebing/Padang		Overbank	1.50	6	50	Estuary bottom almost flat due to sediment deposit
50.	Kayu Besar/Bandar Khalipah	Martebing/Padang		Overbank	1.50	7	80	Dike protection from sea has already been broken
51.	Juhar/Bandar Khalipah	Martebing/Padang		Overbank	1.50	7	550	Dike protection from sea has already been broken
52.	Bandartengah/Bandar Khalipah	Martebing/Padang		Overbank	0.75	5	750	No drainage facility
53.	Silaban/Bandar Khalipah	Padang		Overbank	0.50	14	-	
54.	Paluh Kuman/Tebing Tinggi	Padang		Inland	0.20	3	-	-
55.	Bulian/Rambutan	Padang		Overbank	0.30	3	150	

Table 2-2(1/3) PAST FLOOD DAMAGE RECORD (KABUPATEN DELI SERDANG)

No.	Date of Flooding	Location		No. of Household Affected	No. of People Affected	Casualties		No. of Houses Damaged		Area of Paddy (ha)		Estimated Damage (Rp.)
		Desa	Kecamatan			Dead	Injured	Full	Partial	Inundated	Damaged	
1.	2 - 01 - 1981	Lau Bicik	Kota Limbaru	11	72	-	-	2	-	-	0.25	500,000
2.	13 - 04 - 1981	Baban Statecs	Sei Rampah	220	1,425	-	-	-	-	179.90	-	26,955,000
3.	7 - 05 - 1981	Gelam/Sei Serima	Bandar Khalipah	54	405	-	-	1	-	-	13.00	3,753,000
4.	11 - 05 - 1981	Celawan	Pantai Cermin	193	908	-	-	1	-	-	93.00	2,700,000
		Pulau Gambar	Galang	40	280	-	-	-	-	-	31.00	1,200,000
5.	4 - 02 - 1982	Kota Pari	Pantai Cermin	85	580	-	-	13	-	34.48	-	4,270,000
6.	21 - 04 - 1982	Sei Serima	Bandar Khalipah	-	-	-	-	-	-	356.50	-	
		Juhar	Bandar Khalipah	391	2,724	-	-	6	-	63.00	-	83,050,000
		Kota Pari	Pantai Cermin	97	757	-	-	26	-	-	9.00	5,918,000
7.	24 - 05 - 1982	T. Nibung	Batang Kuis	5	31	-	-	1	4	-	-	1,939,000
8.	28 - 09 - 1982	B. Baru	Sibolangit	13	18	-	-	-	1	-	-	1,200,000
9.	31 - 12 - 1982	Celawan/Kota Pari	Pantai Cermin	194	1,299	-	-	4	-	-	-	12,000,000
10.	15 - 10 - 1983	Durian Pitu	Pancur Batu	16	115	-	-	-	4	41,500.00	-	14,000,000
11.	11 - 10 - 1983	Penjemuran	Namo Rambe	10	62	-	-	-	1	-	-	2,700,000
12.	28 - 10 - 1983	Paya Lombang	Tebing Tinggi	-	-	-	-	-	-	-		
		Kota Baru	Tebing Tinggi	263	1,677	-	-	-	-	34.00	20.00	22,310,000
		Penggalangan	Tebing Tinggi	-	-	-	-	-	-	-		
13.	26 - 01 - 1984	Denai Kuala	Lubuk Pakam	156	835	-	-	-	-	-	13.50	3,800,000
14.	8 - 02 - 1984	Liberia	T. Mengkudu	23	168	1	-	-	-	20.00	-	6,150,000
15.	9 - 02 - 1984	Simpang Empat	Sei Rampah	66	410	-	-	-	-	34.20	-	2,495,000
		Silau Rakyat	Sei Rampah	93	679	-	-	-	-	40.40	-	2,920,000
		P. Ganjang	Sei Rampah	24	182	-	-	-	-	8.25	-	965,000
		Pon	Sei Rampah	89	674	-	-	-	-	21.10	-	3,673,000
16.	21 - 05 - 1985	Denai Kuala	Pantai Labu	197	1,031	-	-	-	-	15.00	10.00	3,980,000
17.	18 - 12 - 1985	Kota Pari	Pantai Cermin	113	786	-	-	-	113	-	-	45,330,000
18.	20 - 04 - 1986	P. Ganjang	Sei Rampah	95	640	-	-	-	-	69.00	-	8,885,000
19.	18 - 06 - 1986	Sei Raja	Sei Rampah	218	1,502	-	-	3	28	-	-	44,120,000
20.	2 - 10 - 1986	P. Cermin	T. Beringin	53	379	-	-	15	30	-	-	32,300,000
		Penggalangan	T. Beringin	77	485	-	-	30	20	-	-	61,450,000
21.	16 - 10 - 1986	Simpang Empat	Sei Rampah	66	475	-	-	34	32	-	-	65,350,000
		Penggalangan	Sei Rampah	59	412	-	-	29	30	-	-	67,500,000
22.	4 - 11 - 1986	Kota Baru	Tebing Tinggi	31	278	-	-	19	12	-	-	9,650,000
23.	8 - 12 - 1986	Paya Lombang	Tebing Tinggi	30	198	3	-	-	30	-	-	16,500,000
24.	9 - 09 - 1987	Bah Sumbu	Tebing Tinggi	14	105	-	-	-	-	-	31.00	17,425,000
25.	20 - 09 - 1987	Mesjid	Batang Kuis	52	338	-	-	-	-	-	4.12	2,950,000
		Sei Raja	Sei Rampah	70	530	-	-	-	10	-	-	20,000,000
		Pergulaan	Sei Rampah	77	578	-	-	-	29	-	-	24,150,000
		Silau Rakyat	Sei Rampah	92	679	-	-	-	8	-	-	25,600,000
		Simpang Empat	Sei Rampah	91	687	-	-	-	17	-	-	19,100,000
		Penggalangan	Sei Rampah	61	468	-	-	-	7	-	-	20,900,000
		Cemp. Lobang	Sei Rampah	83	629	-	-	-	21	-	-	25,650,000
26.	25 - 09 - 1987	Pekan S. Buah	Teluk Mengkudu	89	670	-	-	34	-	-	-	35,000,000
27.	1 - 09 - 1988	Kota Baru	Tebing Tinggi	50	419	-	-	17	-	-	-	19,900,000
		D. Binjei	Tebing Tinggi	54	395	-	-	33	-	-	-	27,480,000
		Penggalangan	Tebing Tinggi	47	368	-	-	27	-	-	-	15,070,000
28.	8 - 09 - 1988	Timbangan	Kota Limbaru	23	178	-	-	-	23	-	-	3,270,000
29.	17 - 09 - 1988	Sugiharjo	Batang Kuis	150	909	-	-	-	-	-	743/4	13,775,000
		Total										827,834,000

Table 2-2(2/3) PAST FLOOD DAMAGE RECORD (KODYA MEDAN)

No.	Date of Flooding	Location		No. of Household Affected	No. of People Affected	Casualties		No. of Houses Damaged		Area of Paddy (ha)		Estimated Damage (Rp.)
		Desa	Kecamatan			Dead	Injured	Full	Partial	Inundated	Damaged	
1.	16 - 09 - 1987	Pulau Brayan	Medan Barat	567	3,562	-	-	-	567			
		Glugur	Medan Barat	26	153	-	-	-	26			
		Sei Agul	Medan Barat	218	1,292	-	-	-	218			
		Silalas	Medan Barat	136	768	-	-	-	136			
		Petisah Tengah	Medan Barat	65	416	-	-	-	65		n.a.	
		Tanjung Mulia	Medan Deli	89	510	-	-	2	87			
		Titi Papan	Medan Deli	155	891	-	-	-	155			
2.	12 - 07 - 1988	Kampung Terjun	Medan Labuhan	8	50	-	-	-	-			
		Rengas Pulau	Medan Labuhan									
3.	15 - 09 - 1988	Medan Tenggara,	Medan Denai	251	3,419	-	-	-	126	n.a.	26	n.a.
		Tembung	Medan Denai									
		Bantam	Medan Denai									
4.	31 - 08 - 1988	Hamdan, AUR	Medan Baru	702	4,474	-	-	-	702			
5.	3 - 09 - 1988	Petisah Hulu, Jati	Medan Baru									
6.	9 - 12 - 1988	Jati, AUR	Medan Baru	325	2,354	-	-	-	-		n.a.	
7.	15 - 09 - 1988	Suka Maju,	Medan Johor	315	2,373	-	-	-	77			
		Timbang Deli	Medan Johor									
		Titi Kuning	Medan Johor									
8.	2 - 12 - 1988	Hamdan	Medan Baru	217	1,415	-	-	-	217			
		Petisah Hulu	Medan Baru	115	705	-	-	-	115			
9.	24 - 11 - 1989	Petisah Hulu	Medan Baru	150	865	-	-	-	48			
		Madras Hulu	Medan Baru									

Note) n.a. : Data are not available

Table 2-2(3/3) PAST FLOOD DAMAGE RECORD (KODYA TEBING TINGGI)

No.	Date of Flooding	Location		No. of Household Affected	No. of People Affected	Casualties		No. of Houses Damaged		Area of Paddy (ha)		Estimated Damage (Rp.)
		Desa	Kecamatan			Dead	Injured	Full	Partial	Inundated	Damaged	
1.	6/7 - 12 - 1986	Pasar Baru	Padang Hulu	93	587	-	-					
2.	12 - 11 - 1986	Pasar Baru	Padang Hulu	489	876	-	-					16,000,000
		Mandailing	Padang Hulu	479	2,497	-	-					10,000,000
		Bandar Baru	Padang Hulu	7	56	-	-					400,000
		Persiakan	Padang Hulu	4	31	-	-					
3.	30 - 07 - 1987	Bandar Sakti	Rambutan	168	1,257	-	-					
		Mandailing	Padang Hulu	104	635	-	-					
4.	7 - 05 - 1987	Bandar Sakti	Rambutan	201	801	-	-					
5.	14 - 03 - 1987	Mandailing	Padang Hulu	152	879	-	-	n.a.	n.a.	n.a.	n.a.	7,000,000
6.	1 - 06 - 1988	Persiakan	Padang Hulu	35	216	-	-					
		Mandailing	Padang Hulu	400	24,473	-	-					
		Bandar Baru	Padang Hulu	32	181	-	-					
		Pasar Baru	Padang Hulu	125	761	-	-					
7.	17 - 12 - 1988	Persiakan	Padang Hulu	102	657	-	-					
8.		Pasar Baru	Padang Hulu	89	499	-	-					
9.		Bandar Sakti	Rambutan	303	979	-	-					
10.		Badak Bejuang	Rambutan	70	325	-	-					
11.		Mandailing	Padang Hulu	438	2,411	-	-					

Note) n.a. : Data are not available

Table 2-3 RIVER IMPROVEMENT WORKS IN THE STUDY AREA BY DPUP

Year	River	Works	Quantity	Cost(Rp.)	Remarks
1980/1981	Serdang & Padang	Rehabilitation of dike	75 km	7,499,925	Including other 1 rivers
	Serdang	- ditto -	1,465 m	36,100,000	
1981/1982	Serdang	- ditto -	3,600 m	99,872,000	
	Belawan,Belumai and Belutu	Survey	39 km	4,999,540	Including other 3 rivers
	Serdang	Survey	20 km	4,997,900	Including other 2 rivers
1982/1983	Serdang	Rehabilitation of dike	6,900 m	260,084,500	
	Batugingging	- ditto -	3,225 m	45,000,000	
1983/1984	Padang	- ditto -	2,315 m	41,300,000	
	Batugingging	Rehabilitation of dike and construction of groin	904 m	25,700,000	
1987/1988	Padang	- ditto -	1,176 m	49,817,000	
	Belutu	River widening	3,700 m	89,811,000	
	Deli	Dredging	2,478 m	445,854,000	
1988/1989	Deli	Left dike construction	2,500 m	500,000,000	
	Deli	Right dike construction	920 m	311,612,000	
	Deli	Left dike construction	984 m	440,205,000	
	Deli	Right dike construction	1,810 m	430,194,000	
	Deli	Left dike construction	1,890 m	441,898,000	

Note * : It includes cost for works in other rivers out of the study area.

Table 2-4 OUTLINE OF THE DPUP FLOOD CONTROL PLAN

No.	Item	Deli R. Downstream	Deli R. Upstream	Babura R.	Percut R.	Serdang R. (Belumai R.)	Batugingging R.	Padang R.
1.	Year of Planning	1985	1988	1988	1988	1983	1983	1988
2.	Location	River mouth to Babura R.	Babura R. to Titi Kuning	Deli R. to Selayang 2	River mouth to Sidorejo	River mouth to national road	Serdang R. to national road	Manggadua to national road
3.	Length (km)	28	12	14	20	9 (13)**	10	15
4.	Return Period (year)	10	10	10	10	10	10	20
5.	Design Discharge (m3/s)	455(408)*	267	139	379	630 (260)**	410	1450
6.	Standard Cross Section of Water Channel							
	(1) Section	Double and Single	Single	Single	Double and Single	Double(Single)**	Single	Double
	(2) Width (m)	38 to 63	27 to 36	21 to 33	25 to 57	65(44)**	55	150
	(3) Depth(m)	6	4 to 7	4 to 8	6 to 10	5	5	5 to 6
	(4) Slope of Dike	1 : 1.5	1 : 1.5	1 : 1.5	1 : 1 (Protection with concrete block)	1 : 2 (Sandy Soil)	1:2 (Sandy Soil)	1 : 1
	(5) Crown Width of Dike(m)	3	4	4	3	3	3	4
	(6) Free Board (m)	0.6	0.6	0.6	0.6	0.6	0.6	0.6
7.	Ronghness Coefficient: n	0.03	0.03	0.03	0.03 for low channel 0.035 for high channel	0.025	0.025	0.025
8.	Design Bed Slope	1/2830 to 1/890	1/2400 to 1/280	1/1210 to 1/380	1/2460 to 1/610	1/1630 to 1/1080	1/2070	1/1020
9.	Schedule of Construction	Start in 1989	1995 to 2007	1995 to 2007	1995 to 2007	Not fixed	Not fixed	Not fixed
10.	Finance Source of Construction	OECF and ADB	Foreign loan	Foreign loan	Foreign loan	Foreign loan	Foreign loan	Foreign loan

Note
* : The design discharge upstream of the confluence with Sikambing R. is 408 m3/s, and that of the downstream is 455 m3/s.
** : Figure in parenthesis shows the one for Belumai R.

Table 3-1(1/3) RESULTS OF SURVEY ON ASSETS

No. of Survey Point	Location (Desa /Kecamatan)	Ground Elevation (m MSL)	Type of House (material)	Flood Area (m)	Number of Storey	Total Floor (m2)	Cost of House (Rp.)	Remarks
1.	Kp. Sicanang/Medan Belawan		Wood	42	1	42	3,450,000	
2.	Belawan Sicanag/Medan Belawan		Wood	35	1	35	3,500,000	
3.	Dusun I/Hamparan Perak		Concrete/Wood	48	1	48	4,900,000	Houses
4.	Selemak/Hamparan Perak		Concrete/Wood	42	1	42	4,750,000	Houses
5.	Klambir/Hamparan Perak		Wood	60	1	60	4,000,000	Houses
6.	Klumpang Kebon/Hamparan Perak		Wood	36	1	36	3,000,000	Houses
7.	Lingk. XII, Kel. Terjun/ Medan Labuhan		Wood	84	1	84	3,700,000	Houses
8.	Lingk. XIII, Kel. Terjun/ Medan Labuhan		Concrete	108	1	108	20,250,000	Houses
9.	Sei Mati/Medan Labuhan		Concrete/Wood	48	1	54	4,750,000	
10.	Kerentang/Percut Sei Tuan		Wood	42	1	42	3,450,000	
11.	Desa Percut/Percut Sei Tuan		Concrete/Wood	32	1	32	4,100,000	
12.	Dusun Talang/Percut Sei Tuan		Concrete/Wood	30	1	38	3,000,000	
13.	Lima Tahunan/Percut Sei Tuan		Wood	55	1	55	3,500,000	50 ha Paddy Field
14.	Cinta Rakyat/Percut Sei Tuan		Concrete/Wood	75	1	75	6,700,000	
15.	Cinta Damai/Percut Sei Tuan		Concrete/Wood	50	1	50	5,400,000	700 houses
16.	Klambir/Pantai Labu		Concrete/Wood	60	1	60	5,500,000	
17.	Paya Gambar 1/Batang Kuis		Concrete/Wood	35	1	35	3,000,000	

Table 3-1(2/3) RESULTS OF SURVEY ON ASSETS

No. of Survey Point	Location (Desa /Kecamatan)	Ground Elevation (m MSL)	Type of House (material)	Flood Area (m)	Number of Storey	Total Floor (m2)	Cost of House (Rp.)	Remarks
18.	Rantau Panjang Hilir/Pantai Labu		Concrete/Wood	60	1	60	5,500,000	
19.	Durian 4/Pantai Labu		Wood	40	1	40	2,600,000	
20.	Arus Kabu 6/Batang Kuis		Wood	30	1	30	1,750,000	
21.	Bakaran Batu/Lubuk Pakam		Concrete	60	1	60	10,500,000	
22.	Pematang Kuala/Teluk Mengkudu		No house	-	-	-	-	
23.	Bogak Pangkal		-	-	-	-	-	
24.	Nagur/Tanjung Beringin		Wood	25	1	25	3,000,000	350 houses
25.	Sungai Rejo/Sei Rampah		Concrete/Wood	42	1	50	4,900,000	300 houses
26.	Desa Rampah/Sei Rampah		- Concrete	240	2	240	30,000,000	
			- Concrete/Wood	50	1	50	5,000,000	600 unit
			- Wood/bamboo	35	1	35	1,500,000	
27.	Cempedak Lobang/Sei Rampah		- Concrete/Wood	55	1	55	5,500,000	88 houses
28.	Belidahan/Sei Rampah		Concrete/Wood	40	1	42	3,800,000	Only paddy field area
29.	Durian Rejo/Sei Rampah		Concrete/Wood	42	1	42	4,250,000	250 houses
30.	Sei Parit/Sei Rampah		Concrete/Wood	60	1	60	4,700,000	150 houses
31.	Silau Rakyat/Sei Rampah		- Woods	80	1	80	1,500,000	49 houses
			- Concrete	288	1	288	27,500,000	Schools
32.	Tebing Tinggi/Tanjung Beringin		- Concrete	100	1	100	10,000,000	Mosque
33.	Pematang Cermai/Tanjung Beringin		- Concrete/Wood	45	1	45	4,000,000	
			- Wood/bamboo	35	1	35	2,500,000	
34.	Tj. Beringin/Tj. Beringin		- Concrete	80	2	80	30,000,000	27 houses
			- Concrete/Wood	45	1	45	4,500,000	
35.	Kampung Pala		-	-	-	-	-	
36.	Pem. Ganjang/Sei Rampah		- Concrete/Wood	42	1	42	5,000,000	100 houses
			- Concrete	140	1	140	15,000,000	Schools
37.	Kampung Pon/Sei Rampah		- Concrete	150	1	150	20,000,000	Mosque
38.	Sei Bamban/Sei Rampah		- Woods	60	1	60	4,300,000	150 houses
			- Concrete	328	1	328	50,000,000	4 schools
			- Concrete	60	1	60	10,000,000	Mosque

Table 3-1(3/3) RESULTS OF SURVEY ON ASSETS

No. of Survey Point	Location (Desa /Kecamatan)	Ground Elevation (m MSL)	Type of House (material)	Flood Area (m)	Number of Storey	Total Floor (m2)	Cost of House (Rp.)	Remarks
39.	Bakaran Batu/Sei Rampah		Concrete/Wood	42	1	42	3,700,000	400 houses
40.	Sei Sarimah/Bandar Khalipah		Wood/Bamboo	50	1	50	3,200,000	258 houses
41.	Langau/Tebing Tinggi		Concrete/Wood	70	1	70	6,500,000	
42.	Sei Perlok/Tebing Tinngi		-	-	-	-	-	Only paddy field area
43.	Kuta Baru/Tebing Tinggi		Concrete/Wood	42	1	42	3,500,000	
44.	Paya Mabar/Tebing Tinggi		-	-	-	-	-	Only paddy field area
45.	Paya Lombang/Tebing Tinggi		Concrete/Wood	63	1	63	5,700,000	
46.	Brohol/Rambutan		Concrete/Wood	48	1	48	3,600,000	
47.	Bah Jenis/Tebing Tinggi		Wood/Bamboo	10	1	10	500,000	
48.	Simpang Bom/Bandar Khalipah		Wood	35	1	35	2,900,000	
49.	Pekan Bandar/Bandar Khalipah		Concrete/Wood	80	1	80	7,000,000	70 houses
50.	Kayu Besar/Bandar Khalipah		Wood	70	1	70	5,000,000	60 houses
51.	Juhar/Bandar Khalipah		Wood/Bamboo	35	1	35	2,000,000	
52.	Bandar Tengah/Bandar Khalipah		Wood/Bamboo	35	1	35	2,200,000	100 houses
53.	Silaban/Tebing Tinggi		Wood	50	50	50	3,500,000	100 houses
54.	Palu Kuman/Tebing Tinggi		-	-	-	-	-	
55.	Bulian/Rambutan		Concrete/Wood	60	60	60	5,700,000	

Table 3-2(1/3) HEIGHT OF MAJOR HOUSEHOLD EFFECTS ABOVE FLOOR LEVEL

No. of Survey Point	Location (Desa/kecamatan)	River	Type of House (Material)	Floor Hight (m)	0 - 0.5 (m)	0.5 - 1 (m)	1.0 - 1.5 (m)	1.5 - 2.0 (m)	Over 2.0 (m)	Remarks
1.	Kp.Sicanang/Medan Belawan	Belawan	Wood	0.30	T/C	TV,CP,CL	C/M,Rf	-	-	
2.	Belawan Sicanang/Medan Belawan	Belawan	Wood	0.30	T/C	TV,CP,CL	C/M,Rf	-	-	
3.	Dusun I/Hamparan Perak	Belawan	Concrete/Wood	0.20	T/C,CP,CL C/M,Rf,TV	-	-	-	-	
4.	Selemak/Hamparan Perak	Belawan	Concrete/Wood	0.20	T/C,CP,CL C/M,Rf,TV	-	-	-	-	
5.	Klambir/Hamparan Perak	Belawan	Wood	0.30	T/C	TV,CP,CL, C/M,Rf,	-	-	-	
6.	Kelumpang kebon/Hamparan Perak	Belawan	Wood	0.20	T/C,CP,CL C/M, Rf	-	-	-	-	
7.	Lingk.XII, Kel.Terjun/ Medan Labuhan	Terjun	Wood	0.20	T/C	CP,CL T/C,CP,CL	C/M. Rf,TV	-	-	
8.	Lingk.XIII, Kel.Terjun/ Medan Labuhan	Terjun	Concrete	0.40	T/C	C/M,Rf,TV CP,CL	-	-	-	
9.	Sei Mati/Medan Labuhan	Sei Mati	Concrete/Wood	0.30	T/C,CP,TV,CL Rf, C/M	-	-	-	-	
10.	Kerentang/Percut Sei Tuan	Percut	Wood	0.30	T/C,CP,TV,CL	-	-	-	-	
11.	Desa Percut/Percut Sei Tuan	Percut	Concrete/Wood	0.30	T/C,CP,TV,CL	-	-	-	-	
12.	Dusun Talang/Percut Sei Tuan	Percut	Concrete/Wood	0.30	T/C,CP,TV,CL	-	-	-	-	
13.	Lima Tahunan/Percut Sei Tuan	Percut	Wood	0.30	T/C,CP,TV,CL	-	-	-	-	
14.	Cinta Rakyat/Percut Sei Tuan	Percut	Wood	0.30	T/C,CP,TV,CL	-	-	-	-	
15.	Cinta Damai/Percut Sei Tuan	Percut	Concrete/Wood	0.20	-	-	-	-	-	No flood
16.	Klambir/Pantai Labu	Serdang	Concrete/Wood	0.20	-	-	-	-	-	No flood
17.	Paya Gambir/Batang Kuis	Serdang	Concrete/Wood	0.20	T/C,CL	TV,CP	-	-	-	Flood occurred in 1970's since 1973 no flood
18.	Rantau Panjang Hilir/ Pantai labu	Serdang	Concrete/Wood	0.20	T/C,CL	TV,CP	-	-	-	-ditto-

Table 3-2(2/3) HEIGHT OF MAJOR HOUSEHOLD EFFECTS ABOVE FLOOR LEVEL

No. of Survey Point	Location (Desa/kecamatan)	River	Type of House (Material)	Floor Hight (m)	0 - 0.5 (m)	0.5 - 1 (m)	1.0 - 1.5 (m)	1.5 - 2.0 (m)	Over 2.0 (m)	Remarks
19.	Durian 4/Pantai Labu	Serdang	Wood	0.20	T/C,CL	TV,CP	-	-	-	-ditto-
20.	Arus Kubu/Batang Kuis	Serdang	Wood	0.20	T/C,CL	TV,CP	-	-	-	-ditto-
21.	Bakaran Batu/Lubuk Pakam	Batu Gingging	Concrete	0.40	T/C	CL,CP	TV,Rf,C/M	-	-	
22.	Pematang Kuala/teluk Mengkudu	Belutu	-	-	-	-	-	-	-	No house
23.	Bagak Pangkal/Tanjung Beringin	Belutu	-	-	-	-	-	-	-	No house
24.	Nagur/Tanjung Beringin	Belutu	Wood	0.20	-	-	-	-	-	
25.	Sungai Rejo/Sei Rampah	Belutu	Concrete/Wood	0.40	T/C,CP,TV,CL	-	-	-	-	
26.	Desa Rampah/Sei Rampah	Belutu	Concrete	0.20	T/C,CP,CL	-	-	-	-	
27.	Cempedak Lobang/Sei Rampah	Belutu	Concrete/Wood	0.30	T/C,CL	TV,Rf,C/M	C/M	-	-	
28.	Belidahan/Sei Rampah	Rambung	Concrete/Wood	-	-	CP,TV	-	-	-	Only paddy
29.	Durian Rejo/Sei Rampah	Rambung Sialang/Belutu	Concrete/Wood	0.30	T/C,CL,CP	-	-	-	-	field area
30.	Sei Parit/Sei Rampah	Belutu	Concrete/Wood	0.50	T/C,CP,TV,CL	-	-	-	-	
31.	Silau Rakyat/Sei Rampah	Belutu	Wood	1.00	T/C,CP,TV,CL	-	-	-	-	
32.	Tebing Tinggi/Tanjung Beringin	Lubuk Laban	Concret	0.30	T/C,CP,CL	C/M,TV	-	-	-	
33.	Pematang Cermin/Tanjung Beringin	Belutu	Concrete/Wood	1.00	-	-	T/C,CP,TV,CL	-	-	
34.	Tanjung Beringin/Tanjung Beringin	Bedagai	Concret	0.30	T/C,CP,CL	TV,Rf,C/M	-	-	-	No house
35.	Kampung Pala/Sei Rampah	Rambung Sialang/Belutu	-		-	-	-	-	-	
36.	Pematang Ganjang/Sei Rampah	Belutu	Concrete/Wood		-	T/C,CL,CP	TV,C/M	-	-	
37.	Kampung Pon/Sei Rampah	Belutu	Concrete/Wood		T/C,CP,TV,CL	-	-	-	-	
38.	Sei Bamban/Sei Rampah	Belutu	Concret		T/C,CP,TV,CL	-	-	-	-	
39.	Bakaran Batu/Sei Rampah	Belutu	Concrete/Wood		T/C,CP,TV,CL	-	-	-	-	
40.	Sei Serimah/Bandar Khalipah	Padang/Sei Martebing	Wood/Bamboo		-	-	CL,CP,TV	-	-	No house
41.	Langau/Tebing Tinggi	Padang	Concrete/Wood		-	-	CL,CP,TV	C/M	-	
42.	Sei Periok/Tebing Tinngi	Padang/Sei Martebing	-		-	-	-	-	-	No house

Table 3-2(3/3) HEIGHT OF MAJOR HOUSEHOLD EFFECTS ABOVE FLOOR LEVEL

No. of Survey Point	Location (Desa/kecamatan)	River	Type of House (Material)	Floor Hight (m)	0 - 0.5 (m)	0.5 - 1 (m)	1.0 - 1.5 (m)	1.5 - 2.0 (m)	Over 2.0 (m)	Remarks
43.	Kuta Baru/Tebing Tinggi	Padang/Sei Martebing	Concrete/Wood		T/C,CP,TV,CL	-	-	-	-	
44.	Paya Mabar/Tebing Tinggi	Padang	-		-	-	-	-	-	
45.	Paya Lombang/Tebing Tinggi	Padang	Concrete/Wood		T/C,CP,TV,CL	-	-	-	-	
46.	Brohol/Rambutan	Padang	Concrete/Wood		T/C	CL,Cp,TV C/M	-	-	-	
47.	Bah Jenis/Tebing Tinngi	Padang	Wood/Bamboo		-	CL,Cp,TV	-	-	-	
48.	Simpang Bom/Bandar Khalipah	Padang/Sei Martebing	Wood		T/C,CP,TV,CL	-	-	-	-	
49.	Pekan Bandar/Bandar Khalipah	Padang/Sei Martebing	Concrete/Wood		T/C,CP,CL	TV/,Rf,C/M	-	-	-	
50.	Kayu Besar/Bandar Khalipah	Padang/Sei Martebing	Wood		-	-	T/C,CP,CL	-	-	
51.	Juhar/Bandar Khalipah	Padang/Sei Martebing	Wood/Bamboo		-	-	T/C,CP,CL	-	-	
52.	Bandar Tengah Bandar Khalipah	Padang/Sei Martebing	Wood/Bamboo		-	-	T/C,CP,CL	-	-	
53.	Silaban/Tebing Tinggi	Padang	Wood		-	-	-	-	-	
54.	Palu Kuman/Tebing Tinggi	Padang	-		-	-	-	-	-	No house
55.	Bulian/Rambutan	Padang	Concrete/Wood		-	-	-	-	-	

Note : CL = Clothes
T/C = Table/Chair
C/M = Car/Motorcycle
Rf = Refrigerator
Cp = Cupboard

Table 3-3 HOUSEHOLD STATISTICS, 1989

1. By House Type

Unit : %

Type of Houses	Urban	Rural	Average
Unstoried Single	62.75	89.33	81.94
Storied Single H	1.75	0.19	0.63
Unstoried Joined	16.50	9.04	11.11
Storied Joined H	-	0.10	0.07
Unstoried Multi	9.50	1.34	3.61
Storied Multi Jo	9.50	-	2.64
T o t a l	100.00	100.00	100.00

2. By Floor Area

Unit : %

Floor Area (m2)	Urban	Rural	Average
< 30	5.25	12.60	10.56
30 - 69	57.50	72.50	68.33
70 - 149	31.85	14.61	19.37
> 150	5.50	0.29	1.74
Total	100.10	100.00	100.00
Average	68.58	48.16	53.83

3. By Floor Material

Unit : %

Floor Material	Urban	Rural	Urban & Rural
Marble Ceramic	23.00	0.77	6.94
Tile Cement	63.50	44.81	50.00
Wood	9.00	43.37	33.82
Bamboo	-	0.86	0.63
Earth	4.25	10.00	8.40
Others	0.25	0.19	0.21
Total	100.00	100.00	100.00

4. By Wall Material

Unit : %

Wall Material	Urban	Rural	Urban & Rural
Tile	46.00	10.48	20.35
Wood	49.75	79.23	71.04
Bamboo	3.75	10.00	8.26
Others	0.50	0.29	0.35
Total	100.00	100.00	100.00

5. By Roof Material

Unit : %

Roof Material	Urban	Rural	Urban & Rural
Concrete	3.25	-	0.90
Wood	-	0.77	0.56
Zinc	80.50	76.54	77.64
Tiled Roof	10.50	0.29	3.12
Palm-Fibre	0.25	3.65	2.71
Leaf	5.50	18.65	15.00
Others	-	0.10	0.07
Total	100.00	100.00	100.00

Table 3-4 STANDARD PRICE OF GOVERNMENT BUILDINGS IN THE STUDY AREA, 1989

(Unit : Thousand Rp./m2)

No.	Regency/Municipality	Un-Storied Building			Storied Bulding		
		A	B	C	A	B	C
1.	Medan	334	288	223	399	354	264
2.	Tebing Tinggi	334	288	223	399	354	264
3.	Deli Serdang	334	300	223	399	354	264
4.	Simalungun	362	311	242	415	368	275

(Note) Defintion of building class is :

Class A : Same Level with Directorate General Office or Central Office
(ex. : Governor Office, Regent Office, etc)
Class B : Same Level with Region Office
(ex. : Workshop, laboratory, fabrics, etc)
Class C : Same level with Small Office (Branch Office)
(ex. : School building, public houses, etc)

Table 3-5 APPRAISED VALUE OF ASSETS

1. Buildings and Household Effects

(Unit: Thousand Rp.)

Kinds	Buildings	Household Effects
Farmhouse	3,000	1,500
Residence	5,000	3,000
Shop	8,000	11,000
Office	70,000	75,000
School	40,000	10,000
Hospital	30,900	12,000
Factory	30,000	25,000
Mosque (or Charch)	15,000	4,000

2. Agricultural Crops

Crops	ton/ha	Million Rp/ton	Million Rp/ton
Paddy (Rainfed)	4.1	0.407	1.669
Paddy (Tidal Irrig.)	2.0	0.407	0.814
Rubber	1.0	0.143	0.143
Coconut	1.0	0.102	0.102
Palm oil	0.86	0.687	0.591
Palm kernel	0.16	0.402	0.064
Cacao	0.5	2.062	1.031
Tobacco	0.5	4.300	2.150
Maize	1.8	0.185	0.333
Cassava	14.1	0.084	1.184
Potatoes	11.0	0.106	1.166
Peanuts	1.2	0.720	0.864
Soyabeans	1.2	0.688	0.826
Green pease	0.8	0.989	0.791

Table 3-6(1/11) Area and Number of Buildings, Houses and Agricultural Crops in the Inundation Area (BELAWAN RIVER)

No.	X	Y	WP (ha)	FL (ha)	PPO (ha)	PGM (ha)	PCC (ha)	POT (ha)	HS (nos)	FA (nos)	SC (nos)	OF (nos)	HP (nos)	RL (nos)
1	1	8	25	50	0	0	0	25	25					
2	1	9	0	0	0	0	0	50	1					
3	2	6	100	0	0	0	0	0	7					
4	2	7	100	0	0	0	0	0	52					
5	2	8	25	0	0	0	0	75	31					
6	2	9	0	0	0	0	0	50	4		1			
7	2	10	0	0	0	0	0	0	350		4			3
8	2	11	0	0	0	0	0	25	41		1			
9	2	12	0	0	0	0	0	50						
10	3	4	25	0	25	0	0	0	4					
11	3	5	50	0	0	0	0	0	1					
12	3	6	25	0	0	0	0	0	2					
13	3	7	50	0	0	0	0	0	141		2			2
14	3	8	0	25	0	0	0	75	53					1
15	3	9	0	0	0	0	0	100	55					1
16	3	10	0	0	0	0	0	75	87					2
17	3	11	0	0	0	0	0	75						
18	3	12	0	0	0	0	0	100	23					1
19	3	13	0	0	0	0	0	100						
20	3	14	0	0	0	0	0	50	50					
21	4	3	50	25	0	0	0	0	124					
22	4	4	100	0	0	0	0	0						
23	4	5	75	25	0	0	0	0	11					
24	4	6	50	50	0	0	0	0	27					
25	4	7	100	0	0	0	0	0	28					
26	4	8	0	50	0	0	0	50	97		2			1
27	4	9	0	0	0	0	0	100						
28	4	10	0	0	0	0	0	100						
29	4	11	0	0	0	0	0	100	9					
30	4	12	0	0	0	0	0	100	28					
31	4	13	0	25	0	0	0	50	101		1			1
32	4	14	0	0	0	0	0	50	108					
33	4	15	0	25	0	0	0	75	9					
34	4	16	0	25	0	0	0	75						
35	5	2	0	0	0	0	0	0						
36	5	3	25	25	0	0	0	0						
37	5	4	75	25	0	0	0	0	10					
38	5	5	25	75	0	0	0	0						
39	5	6	0	100	0	0	0	0	49					
40	5	7	75	25	0	0	0	0	93					
41	5	8	0	0	50	0	0	25	69					
42	5	9	0	25	0	0	0	0	173					1
43	5	10	0	50	25	0	0	25	106		1			
44	5	11	0	50	0	0	0	50	104	1				
45	5	12	0	0	0	0	0	25	212					
46	5	13	0	0	0	0	0	0	400		2			3
47	5	14	0	0	25	0	0	25	290	1	5		2	2
48	5	15	0	0	0	0	0	25	250		2	1		1
49	5	16	0	0	0	0	0	25	471		3			4
50	6	2	0	0	0	0	0	0						
51	6	3	0	0	0	0	0	0						
52	6	4	0	50	25	0	0	0						
53	6	5	0	100	0	0	0	0	67					
54	6	6	0	75	0	0	0	0	80		1			1
55	6	7	25	75	0	0	0	0	16					
56	6	8	0	25	25	0	0	0	116					2
57	6	9	0	0	25	0	0	0	240		2	1		1
58	6	10	0	25	25	0	0	50	11					
59	6	11	0	0	0	0	0	100						
60	6	12	0	0	0	0	0	100						
61	6	13	0	0	0	0	0	100						
62	6	14	0	0	25	0	0	75						
63	6	15	0	0	50	0	0	25	22					
64	7	2	0	0	0	0	0	0						
65	7	3	0	0	0	0	0	0						
66	7	4	0	75	0	0	0	0						
67	7	5	25	25	50	0	0	0	20					
68	7	6	0	0	75	0	0	0	102					1
69	7	7	0	0	50	0	0	0	229	4	4			1
70	7	8	75	25	0	0	0	0	55					
71	7	9	0	50	50	0	0	0	110					
72	7	10	0	0	0	0	0	100						
73	7	11	0	0	0	0	0	100	16					
74	7	12	0	0	0	0	0	50	201		1			1
75	7	13	0	0	0	0	0	50	52					1
76	8	3	0	0	0	0	0	0	6					
77	8	4	0	0	0	0	0	0						
78	8	5	0	0	25	0	0	0	1					
79	8	6	0	0	25	0	0	0	148	5	2			1
80	8	7	0	25	50	0	0	0	150	2	1	1		
81	8	8	0	100	0	0	0	0	56					
82	8	9	0	75	25	0	0	0	84		1			
83	8	10	0	25	25	0	0	50						
84	8	11	0	0	0	0	0	0						
85	9	5	0	0	0	0	0	0	39					
86	9	6	0	0	0	0	0	0	31					
87	9	7	0	50	25	0	0	0	20					
88	9	8	0	25	0	0	0	0	177		1			1
89	10	6	0	0	0	0	0	0	10					
90	10	7	0	0	50	0	0	0	13					
TOTAL			1,100	1,500	750	0	0	2,550	5,768	13	37	3	2	33

Note WP:Wet Paddy; FL:Farm Land; PPO:Plantation Palm Oil; PGM:Plantation Rubber; PCC:Plantation Cacao; POT:Plantation Others; HS:House; FA:Factory; SC:School; OF:Office; HP:Hospital; RL:Mosque & Church

Table 3-6(2/11) Area and Number of Buildings, Houses and Agricultural Crops in the Inundation Area (DELI RIVER (1))

No.	X	Y	WP (ha)	FL (ha)	PPO (ha)	PGM (ha)	PCC (ha)	POT (ha)	HS (nos)	FA (nos)	SC (nos)	OF (nos)	HP (nos)	RL (nos)
1	1	9	0	25	0	0	0	0	327		3	1		
2	1	10	0	50	0	0	0	0	144		2			
3	2	8	75	0	0	0	0	0	51					
4	2	9	50	0	0	0	0	0	234					
5	2	10	0	0	0	0	0	0	400		1			1
6	2	11	0	25	0	0	0	0	300		1			
7	2	12	0	50	0	0	0	0	39					
8	2	13	0	0	25	0	0	0	148					
9	2	14	0	0	0	0	0	50	2					
10	2	15	0	0	0	0	0	50						
11	2	16	0	0	0	0	0	50						
12	2	17	0	0	0	0	0	100						
13	2	18	0	0	0	0	0	100						
14	2	19	0	0	0	0	0	50	326		1			
15	2	20	0	0	0	0	0	0	100					
16	3	5	0	0	0	0	0	0						
17	3	6	0	0	0	0	0	0						
18	3	7	0	0	0	0	0	0	28					
19	3	8	0	0	0	0	0	0	300	2				
20	3	9	0	0	0	0	0	0	400		2	3		2
21	3	10	0	0	0	0	0	0	400		1			1
22	3	11	0	0	0	0	0	0	400		7			3
23	3	12	0	0	0	0	0	0	312		2			3
24	3	13	0	0	0	0	0	0	400	4	2			2
25	3	14	0	0	0	0	0	0	400	4	5	1		1
26	3	15	0	0	0	0	0	0	400	10				3
27	3	16	0	0	0	0	0	0	500	7	3			3
28	3	17	0	0	0	0	0	25	550	6	3			2
29	3	18	0	0	0	0	0	25	600	2	2			2
30	3	19	0	25	0	0	0	0	344		6			2
31	3	20	0	0	0	0	0	0	700		3			3
32	3	21	0	0	0	0	0	0	250					
33	4	3	0	0	0	0	0	0		5				
34	4	4	0	0	0	0	0	0	49					
35	4	5	0	0	0	0	0	0	100					
36	4	6	0	0	0	0	0	0	14					
37	4	7	0	50	0	25	0	0	89					
38	4	8	0	25	0	0	0	0	339					2
39	4	9	0	0	0	0	0	0	300	4	1			1
40	4	10	0	50	0	0	0	0	100					1
41	4	11	0	0	0	0	0	0	700		3	1		1
42	4	12	0	0	0	0	0	0	550	5	4			2
43	4	13	0	0	0	0	25	0	500	17	1			1
44	4	14	0	0	0	0	0	0	606	38			1	
45	4	15	0	0	0	0	0	0	700	22	6	2		1
46	4	16	0	0	0	0	0	0	1000	16	5			5
47	4	17	0	0	0	0	0	0	850	8	3	2		5
48	4	18	0	0	0	0	0	0	1000	4	3	3		2
49	4	19	0	0	0	0	0	0	1000	2	7	2		3
50	4	20	0	0	0	0	0	0	1000	3	5			4
51	4	21	0	0	0	0	0	0	275					
52	4	22	0	0	0	0	0	0						
53	5	2	0	0	0	0	0	0	850		4			6
54	5	3	0	0	0	0	0	0	700	2		1		1
55	5	4	0	0	0	0	0	0	400	3				1
56	5	5	0	0	0	0	0	0	564		1			1
57	5	6	0	0	0	0	0	0	248		3			3
58	5	7	0	0	0	0	0	0	341	3	4	2		
59	5	8	0	25	25	0	0	0	246		2	3		3
60	5	9	0	50	0	0	0	0	257	3	1	1		1
61	5	10	0	25	25	0	0	0	423	8		1		1

Note WP:Wet Paddy; FL:Farm Land; PPO:Plantation Palm Oil; PGM:Plantation Rubber; PCC:Plantation Cacao; POT:Plantation Others; HS:House; FA:Factory; SC:School; OF:Office; HP:Hospital; RL:Mosque & Church

Table 3-6(3/11) Area and Number of Buildings, Houses and Agricultural Crops in the Inundation Area (DELI RIVER (2))

No.	X	Y	WP (ha)	FL (ha)	PPO (ha)	PGM (ha)	PCC (ha)	POT (ha)	HS (nos)	FA (nos)	SC (nos)	OF (nos)	HP (nos)	RL (nos)
62	5	11	0	0	0	0	0	0	700		1			
63	5	12	0	0	0	0	0	0	400	1	1			2
64	5	13	0	0	0	0	25	0	250	1				1
65	5	14	0	0	0	0	0	0	400	4	1			2
66	5	15	0	0	0	0	0	0	550	8	1	1		4
67	5	16	0	0	0	0	0	0	700		3			4
68	5	17	0	0	0	0	0	0	1000		2			
69	5	18	0	0	0	0	0	0	1000	4	3	1		4
70	5	19	0	0	0	0	0	0	1000	5				3
71	5	20	0	0	0	0	0	0	1000	2	2	1		5
72	5	21	0	0	0	0	0	0						
73	5	22	0	0	0	0	0	0						
74	5	23	0	0	0	0	0	0						
75	5	24	0	0	0	0	0	0						
76	6	1	0	0	0	0	0	0	1000	1	8	10		4
77	6	2	0	0	0	0	0	0	408		3			4
78	6	3	0	0	0	0	0	0	201		2			1
79	6	4	0	0	0	0	0	0	4					
80	6	5	0	0	25	0	0	0	42					1
81	6	6	0	0	100	0	0	0						
82	6	7	0	0	50	0	0	0	360		5	1		4
83	6	8	0	0	0	0	0	0	350	1	4			
84	6	9	25	25	0	0	0	0	115		1			1
85	6	10	25	75	0	0	0	0	59		1			
86	6	11	25	0	0	0	0	0	322					
87	6	12	0	0	0	0	0	0	400					1
88	6	13	0	0	0	0	100	0	20					
89	6	14	0	0	0	0	0	0	350	2	1			
90	6	15	0	0	0	0	0	0	350	3	2			1
91	6	16	0	0	0	0	0	0	400	4	3			
92	6	17	0	0	0	0	0	0	700		2			
93	6	18	0	0	0	0	0	0	700	4	3	1		4
94	6	19	0	0	0	0	0	0	1000	1				3
95	6	20	0	0	0	0	0	0						
96	6	21	0	0	0	0	0	0						
97	6	22	0	0	0	0	0	0						
98	6	23	0	0	0	0	0	0						
99	6	24	0	0	0	0	0	0						
100	7	1	0	0	0	0	0	0						
101	7	2	0	0	0	0	0	0						
102	7	3	0	0	0	0	0	0						
103	7	4	0	0	0	0	0	0						
104	7	5	0	0	100	0	0	0						
105	7	6	0	0	75	0	0	0	67		1	1		1
106	7	7	0	0	0	0	0	0	106	1	3			1
107	7	8	0	0	25	0	0	0	169	4				
108	7	9	25	0	75	0	0	0	8					
109	7	10	0	25	0	0	0	0	114					
110	7	11	50	0	0	0	0	0	100					
111	7	12	0	0	0	0	0	0	350					
112	7	15	0	25	0	0	0	0	300					
113	7	16	0	0	0	0	0	25	350		4			
114	7	17	0	0	0	0	0	50	150	2				
115	7	18	0	0	0	0	0	25	142	1				
116	7	19	0	0	0	0	0	0						
117	7	20	0	0	0	0	0	0						
118	7	21	0	0	0	0	0	0						
119	7	22	0	0	0	0	0	0						
120	7	23	0	0	0	0	0	0						
121	7	24	0	0	0	0	0	0						
122	8	1	0	0	0	0	0	0	100	4				2
123	9	1	0	0	0	0	0	0	77	2				
TOTAL			275	550	525	25	150	550	37,070	233	154	39	1	126

Note WP:Wet Paddy; FL:Farm Land; PPO:Plantation Palm Oil; PGM:Plantation Rubber; PCC:Plantation Cacao; POT:Plantation Others; HS:House; FA:Factory; SC:School; OF:Office; HP:Hospital; RL:Mosque & Church

Table 3-6(4/11) Area and Number of Buildings, Houses and Agricultural Crops in the Inundation Area (PERCUT RIVER (1))

No.	X	Y	WP (ha)	FL (ha)	PPO (ha)	PGM (ha)	PCC (ha)	POT (ha)	HS (nos)	FA (nos)	SC (nos)	OF (nos)	HP (nos)	RL (nos)
1	1	19	0	0	0	0	0	0	1000		5			9
2	1	20	0	0	0	0	0	0	1000		11			5
3	1	21	0	0	0	0	0	0	700		1			2
4	1	22	0	0	0	0	0	0	850					2
5	1	23	0	0	0	0	0	0	400					1
6	2	17	0	0	0	0	0	0	1000					
7	2	18	0	0	0	0	0	0	1000		4	1		11
8	2	19	0	0	0	0	0	0	500		7			10
9	2	20	0	0	0	0	0	0	550		4	1		1
10	2	21	0	0	0	0	0	0	500					1
11	2	22	0	0	0	0	0	0	550					1
12	2	23	0	0	0	0	0	0	400					
13	3	8	75	0	0	0	0	0	100					
14	3	9	0	0	0	0	0	50	64					
15	3	10	0	0	0	0	0	100						
16	3	11	0	0	0	0	0	100						
17	3	12	0	0	25	0	0	75	37					
18	3	13	0	0	0	0	0	75	100					
19	3	14	25	0	0	0	0	0	268					
20	3	15	0	0	0	0	75	0	17					
21	3	16	0	0	0	0	25	0	510					
22	3	17	0	0	0	0	0	0	1000					3
23	3	18	0	0	0	0	0	0	1000		5	1		14
24	3	19	0	0	0	0	0	0	700	2	5			3
25	3	20	0	0	0	0	0	0	400		5	1		5
26	3	21	25	0	0	0	25	0	212					
27	3	22	0	0	0	0	25	0	373					
28	3	23	0	0	0	0	0	0	400					
29	4	6	75	0	25	0	0	0	42					2
30	4	7	25	25	0	0	0	0	124		1	1		1
31	4	8	0	50	0	0	50	0	30					
32	4	9	0	0	0	0	0	100	36					
33	4	10	0	0	0	0	0	100						
34	4	11	0	0	0	0	0	100						
35	4	12	0	0	0	0	0	100						
36	4	13	0	0	0	0	0	100						
37	4	14	0	0	0	0	0	0	350		3			
38	4	15	0	0	0	0	100	0	49					
39	4	16	0	0	0	0	50	0	540					
40	4	17	0	0	0	0	0	0	1000					4
41	4	18	0	0	0	0	0	0	500		1	1		4
42	4	19	0	0	0	0	0	25	320		2			2
43	4	20	0	0	0	0	0	100	12					
44	4	21	0	0	0	0	100	0	4					
45	4	22	0	0	0	0	75	0	94					
46	4	23	0	0	0	0	0	0	268	2				1
47	5	4	100	0	0	0	0	0						
48	5	5	100	0	0	0	0	0	43					
49	5	6	100	0	0	0	0	0	126		3			1
50	5	7	25	0	0	0	50	0	169					
51	5	8	0	0	0	0	50	50	2					
52	5	9	0	0	0	0	0	25	300		1			1
53	5	10	0	0	0	0	0	100	31					1
54	5	11	0	0	0	0	0	100						
55	5	12	0	0	0	0	0	75	78					
56	5	13	0	0	25	0	0	50	113		2			
57	5	14	0	25	0	0	25	0	175					
58	5	15	0	0	0	0	25	0	281		1			1
59	5	16	0	0	0	0	25	0	253	5	1			1
60	5	17	0	0	0	0	0	0	550		8			5
61	5	18	0	0	0	0	0	50	241					1
62	5	19	0	0	0	0	0	100	20					
63	5	20	0	0	0	0	0	75						
64	6	3	25	0	0	0	0	0						
65	6	4	50	0	0	0	0	0						
66	6	5	100	0	0	0	0	0						
67	6	6	100	0	0	0	0	0	86		2			
68	6	7	25	0	0	0	25	0	236					1
69	6	8	0	0	0	0	25	25	200					1
70	6	9	0	0	0	0	0	0	400	1	4	2		2
71	6	10	0	0	0	0	0	100	38					
72	6	11	0	0	0	0	0	50	106		2			1
73	6	12	0	0	0	0	0	75	78					2
74	6	13	0	25	0	0	0	0	175	1	1	1		
75	6	14	0	0	0	0	0	0	300		4			3
76	6	15	0	0	0	0	0	0	400	4	1	1		
77	6	16	0	0	0	0	0	0	400	7	4			5
78	6	17	0	0	0	0	0	0	700		2			1
79	6	18	0	0	0	0	0	50	184					
80	7	1	0	25	0	0	0	0						

Note WP:Wet Paddy; FL:Farm Land; PPO:Plantation Palm Oil; PGM:Plantation Rubber; PCC:Plantation Cacao; POT:Plantation Others; HS:House; FA:Factory; SC:School; OF:Office; HP:Hospital; RL:Mosque & Church

Table 3-6(5/11) Area and Number of Buildings, Houses and Agricultural Crops in the Inundation Area (PERCUT RIVER (2))

No.	X	Y	WP (ha)	FL (ha)	PPO (ha)	PGM (ha)	PCC (ha)	POT (ha)	HS (nos)	FA (nos)	SC (nos)	OF (nos)	HP (nos)	RL (nos)
81	7	2	0	75	0	0	0	0	32					
82	7	3	0	0	0	0	0	0						
83	7	4	25	0	0	0	0	0						
84	7	5	100	0	0	0	0	0						
85	7	6	100	0	0	0	0	0	55		1			
86	7	7	25	0	0	0	0	0	326		3			1
87	7	8	25	25	0	0	0	0	203		1			
88	7	9	0	25	0	0	0	25	201		1			
89	7	10	0	25	0	0	0	75						
90	7	11	0	50	0	0	0	0	144		1			
91	7	12	0	0	0	0	0	50	141					
92	7	13	0	0	0	0	0	100						
93	7	14	25	0	0	0	0	50	144					
94	7	15	0	0	0	0	0	0	500	1	2	1		1
95	7	16	0	0	0	0	0	0	700		2			3
96	7	17	0	0	0	0	0	0	400	1	1			
97	7	18	50	0	0	0	0	0	64					
98	8	1	0	50	0	0	0	0	17					
99	8	2	0	50	0	0	0	0	47					
100	3	3	0	0	0	0	0	0						
101	8	4	0	0	25	0	0	0	19					
102	8	5	25	25	25	0	0	0	77	3				
103	8	6	50	0	0	0	0	0	148		2			1
104	8	7	25	0	0	0	0	0	236		4			4
105	8	8	50	0	0	0	0	50	2					
106	8	9	0	0	0	0	0	100						
107	8	10	0	0	0	0	0	100						
108	8	11	75	0	0	0	0	0	126		1			2
109	8	12	25	0	0	0	0	25	163		1			1
110	8	13	0	0	0	0	0	75	68		1			1
111	8	14	0	25	0	0	0	75	78					
112	8	15	0	0	0	0	0	0	210	1	1			1
113	8	16	50	0	0	0	0	0	282		2			1
114	8	17	0	0	0	0	0	0	550	1	2			
115	9	2	0	0	0	0	0	0						
116	9	3	0	0	0	0	0	0	58					
117	9	4	25	0	0	0	0	0	92					
118	9	5	75	0	25	0	0	0	15					
119	9	6	100	0	0	0	0	0						
120	9	7	50	0	0	0	0	0	139		1			1
121	9	8	100	0	0	0	0	0	14					
122	9	9	0	0	0	0	0	100	35					
123	9	10	0	0	0	0	0	100						
124	9	11	0	0	0	0	0	50	70					
125	9	12	25	0	0	0	0	0	208	1	3			1
126	9	13	0	0	25	0	0	0	75					1
127	9	14	0	0	0	0	0	0						
128	9	15	25	0	0	0	0	0	150		1			
129	9	16	75	0	0	0	0	0	120		3			
130	9	17	0	0	0	0	0	0	129					
131	10	3	0	0	0	0	0	0			1			
132	10	4	0	0	0	0	0	0	2					
133	10	5	75	0	0	0	0	0						
134	10	6	75	0	0	0	0	0	136		1			2
135	10	7	100	0	0	0	0	0	69					1
136	10	8	100	0	0	0	0	0	52					
137	10	9	50	0	0	0	0	50						
138	10	10	0	0	0	0	0	100						
139	10	11	50	0	0	0	0	50						
140	10	12	25	0	0	0	0	0	189					1
141	10	13	50	0	0	0	0	0	104					1
142	10	14	25	0	0	0	0	0	197		1			
143	10	15	50	0	0	0	0	0	134		2			
144	10	16	50	0	0	0	0	0	122	2				
145	11	3	0	0	0	0	0	0	7					
146	11	4	0	0	0	0	0	0						
147	11	5	100	0	0	0	0	0						
148	11	6	75	0	0	0	0	0	81		1			2
149	11	7	100	0	0	0	0	0	13					1
150	11	8	75	0	0	0	0	0	1					
151	12	3	0	0	0	0	0	0						
152	12	4	0	0	0	0	0	0						
153	12	5	50	25	0	0	0	0						
154	13	3	0	0	0	0	0	0						
155	13	4	0	0	0	0	0	0						
156	13	5	0	0	0	0	0	0						
TOTAL			3,025	525	175	0	750	3,125	29,830	32	130	11	0	136

Note WP:Wet Paddy; FL:Farm Land; PPO:Plantation Palm Oil; PGM:Plantation Rubber; PCC:Plantation Cacao; POT:Plantation Others; HS:House; FA:Factory; SC:School; OF:Office; HP:Hospital; RL:Mosque & Church

Table 3-6(6/11) Area and Number of Buildings, Houses and Agricultural Crops in the Inundation Area(SERDANG RIVER (1))

No.	X	Y	WP (ha)	FL (ha)	PPO (ha)	PGM (ha)	PCC (ha)	POT (ha)	HS (nos)	FA (nos)	SC (nos)	OF (nos)	HP (nos)	RL (nos)
1	1	17	0	0	100	0	0	0						
2	1	18	50	0	0	0	0	0	169	3	1			
3	1	19	0	0	0	0	0	0	550	4	1			3
4	2	6	100	0	0	0	0	0	24					1
5	2	7	0	0	25	0	0	75	42					
6	2	8	0	0	0	0	0	75	88					1
7	2	9	25	0	0	0	0	0	143		2			1
8	2	10	0	0	0	0	0	0	27		1			
9	2	11	50	0	0	0	0	0	194					1
10	2	12	25	0	0	0	0	0	150	12	2			1
11	2	13	25	0	0	0	0	0	50					
12	2	14	0	0	0	0	0	0	47					
13	2	15	0	0	0	0	0	0						
14	2	16	0	0	50	0	0	0	52	3				1
15	2	17	0	0	25	0	0	0	218	4	1			1
16	2	18	0	0	25	0	0	0	63					
17	2	19	0	0	0	0	0	0	349	2				
18	3	5	0	0	25	0	0	0						
19	3	6	0	0	50	0	0	0	118	1	2			1
20	3	7	0	0	0	0	0	100	8					
21	3	8	0	0	0	0	0	100						
22	3	9	0	0	0	0	0	25	55					
23	3	10	0	0	0	0	0	0	82					
24	3	11	0	0	0	0	0	0	350	1	3			2
25	3	12	0	0	0	0	0	0	200	5	3	1		
26	3	13	0	0	0	0	0	0	54					
27	3	14	0	0	0	0	0	0	90					
28	3	15	0	25	0	0	0	0	202	1	1			
29	3	16	0	0	0	0	0	0	222					1
30	3	17	0	0	0	0	0	0	118	1				1
31	3	18	50	0	0	0	0	0	125					
32	3	19	75	0	0	0	0	0	83					
33	4	4	0	0	0	0	0	0	22					
34	4	5	0	0	25	0	0	0	25		2			
35	4	6	25	0	25	0	0	0	106					
36	4	7	0	0	25	0	0	75	36					
37	4	8	0	0	0	0	0	100						
38	4	9	25	0	75	0	0	0	20					
39	4	10	75	0	0	0	0	0	182					2
40	4	11	50	0	0	0	0	0	240	7				
41	4	12	0	0	25	0	0	0	264		2	2		
42	4	13	0	0	100	0	0	0	25					
43	4	14	25	0	50	0	0	0	149			1		
44	4	15	50	50	0	0	0	0	60					
45	4	16	75	0	0	0	0	0	220					
46	4	17	50	0	0	0	0	0	112	1	1			1
47	4	18	100	0	0	0	0	0	127					1
48	5	3	0	0	0	0	0	0						
49	5	4	50	25	0	0	0	0						
50	5	5	100	0	0	0	0	0	25					
51	5	6	100	0	0	0	0	0						
52	5	7	100	0	0	0	0	0	31					
53	5	8	100	0	0	0	0	0	44					
54	5	9	75	0	0	0	0	0	50		1			1
55	5	10	100	0	0	0	0	0	53					
56	5	11	100	0	0	0	0	0	102					
57	5	12	0	0	75	0	0	0	135		3	1		
58	5	13	0	0	100	0	0	0						
59	5	14	25	25	50	0	0	0	65		2			1
60	5	15	100	0	0	0	0	0						
61	5	16	75	0	0	0	0	0	128	1				2
62	5	17	100	0	0	0	0	0	84	2				
63	5	18	25	0	0	0	0	0	62					1
64	6	2	0	0	0	0	0	0						
65	6	3	0	0	0	0	0	0						
66	6	4	75	0	0	0	0	0	14					
67	6	5	100	0	0	0	0	0						
68	6	6	75	0	0	0	0	0						
69	6	7	100	0	0	0	0	0	18					
70	6	8	100	0	0	0	0	0	35					

Note WP:Wet Paddy; FL:Farm Land; PPO:Plantation Palm Oil; PGM:Plantation Rubber; PCC:Plantation Cacao; POT:Plantation Others; HS:House; FA:Factory; SC:School; OF:Office; HP:Hospital; RL:Mosque & Church

Table 3-6(7/11) Area and Number of Buildings, Houses and Agricultural Crops in the Inundation Area(SERDANG RIVER (2))

No.	X	Y	WP (ha)	FL (ha)	PPO (ha)	PGM (ha)	PCC (ha)	POT (ha)	HS (nos)	FA (nos)	SC (nos)	OF (nos)	HP (nos)	RL (nos)
71	6	9	75	0	0	0	0	0	117		1			6
72	6	10	100	0	0	0	0	0	30					
73	6	11	100	0	0	0	0	0	52					
74	6	12	100	0	0	0	0	0	46					
75	6	13	0	25	75	0	0	0	14					
76	6	14	0	0	100	0	0	0	25					
77	6	15	100	0	0	0	0	0	93					
78	6	16	100	0	0	0	0	0	103	4	1			2
79	6	17	100	0	0	0	0	0	214	2		1		
80	7	2	0	0	0	0	0	0						
81	7	3	25	0	0	0	0	0	58					
82	7	4	25	25	25	0	0	0	142					
83	7	5	25	0	0	0	0	0						
84	7	6	75	0	0	0	0	0						
85	7	7	50	0	0	0	0	0						
86	7	8	75	0	0	0	0	0	66					
87	7	9	100	0	0	0	0	0	19					
88	7	10	100	0	0	0	0	0	20					
89	7	11	100	0	0	0	0	0	47					1
90	7	12	50	0	0	0	0	0	4					
91	7	13	0	0	100	0	0	0						
92	7	14	0	0	75	25	0	0	49		1			
93	7	15	50	0	0	50	0	0	50					
94	7	16	75	0	0	0	0	0	153					
95	7	17	100	0	0	0	0	0	51					
96	8	2	0	0	0	0	0	0	128		2			1
97	8	3	0	0	0	0	0	0	97					
98	8	4	50	0	0	0	0	0	119					
99	8	5	100	0	0	0	0	0	12					
100	8	6	50	0	25	0	0	0						
101	8	7	75	0	0	0	0	0			1			
102	8	8	100	0	0	0	0	0	27		1			1
103	8	9	100	0	0	0	0	0	32					
104	8	10	0	0	50	0	0	0	200					
105	8	11	25	0	25	0	0	0	228					
106	8	12	75	0	0	0	0	0	113	1				
107	8	13	75	0	25	0	0	0	8					
108	8	14	0	0	100	0	0	0	1					
109	8	15	0	0	100	0	0	0						
110	8	16	100	0	0	0	0	0	16					
111	8	17	50	0	0	0	0	0						
112	9	3	0	0	0	0	0	0						
113	9	4	75	0	0	0	0	0	3					
114	9	5	100	0	0	0	0	0	71		2			
115	9	6	100	0	0	0	0	0	54					
116	9	7	100	0	0	0	0	0	24					1
117	9	8	75	0	0	0	0	0	135					
118	9	9	25	0	50	0	0	0	57		1			1
119	9	10	25	0	75	0	0	0	45					
120	9	11	0	0	100	0	0	0						
121	9	12	0	0	75	0	0	0	27	4	2	1		1
122	9	13	25	0	0	0	0	0	255	3	2	1		2
123	9	14	50	0	25	0	0	0	156	1				
124	9	15	75	0	25	0	0	0	80					
125	9	16	75	0	0	0	0	0	62					
126	9	17	100	0	0	0	0	0	60					
127	10	3	0	0	0	0	0	0						
128	10	4	50	0	0	0	0	0	7					
129	10	5	100	0	0	0	0	0	42					
130	10	6	100	0	0	0	0	0	32					
131	10	7	50	0	25	0	0	0	28					
132	10	8	75	0	0	0	0	0	88		1			1
133	10	9	50	0	50	0	0	0	8					
134	10	10	50	0	50	0	0	0	100		1			
135	10	11	0	0	100	0	0	0	14					
136	10	12	25	0	75	0	0	0	58					
137	10	13	0	0	0	0	0	0	400	1				
138	10	14	0	0	0	0	0	0	350	1		1		1
139	10	15	50	0	0	0	0	0	203					
140	10	16	0	0	0	0	0	0	294	1	2			1
141	10	17	25	0	0	0	0	0	82		1			
TOTAL			6,100	175	2,200	75	0	550	11,376	66	47	9	0	43

Note WP:Wet Paddy; FL:Farm Land; PPO:Plantation Palm Oil; PGM:Plantation Rubber; PCC:Plantation Cacao; POT:Plantation Others; HS:House; FA:Factory; SC:School; OF:Office; HP:Hospital; RL:Mosque & Church

Table 3-6(8/11) Area and Number of Buildings, Houses and Agricultural Crops in the Inundation Area (BELUTU RIVER (1))

No.	X	Y	WP (ha)	FL (ha)	PPO (ha)	PGM (ha)	PCC (ha)	POT (ha)	HS (nos)	FA (nos)	SC (nos)	OF (nos)	HP (nos)	RL (nos)
1	1	4	0	0	0	0	0	0						
2	1	5	0	25	50	0	0	0	69		1			1
3	1	6	75	0	0	0	0	0	22					
4	1	7	0	25	75	0	0	0	48					
5	1	8	100	0	0	0	0	0	32					1
6	1	9	100	0	0	0	0	0	23					
7	2	4	0	25	0	0	0	0						
8	2	5	0	50	50	0	0	0	89		2			3
9	2	6	0	25	25	0	0	0	2					
10	2	7	25	50	25	0	0	0	43					
11	2	8	25	50	25	0	0	0	48		1			1
12	2	9	100	0	0	0	0	0	19					
13	2	10	50	0	50	0	0	0	5					
14	2	11	0	0	50	0	0	0	202					1
15	2	12	0	50	25	0	0	0	179			1		
16	2	13	0	0	0	0	0	0						
17	3	4	0	25	50	0	0	0	67		1			2
18	3	5	0	75	25	0	0	0	39					1
19	3	6	25	75	0	0	0	0	19					
20	3	7	50	0	50	0	0	0	63		1			1
21	3	8	75	25	0	0	0	0	12					
22	3	9	0	100	0	0	0	0	71					1
23	3	10	50	0	50	0	0	0	2					
24	3	11	0	50	50	0	0	0	48					
25	3	12	0	25	0	0	0	0	329	2	2	1		1
26	3	13	25	0	75	0	0	0	8		1			
27	3	14	25	0	75	0	0	0	18					
28	3	15	0	0	0	0	0	0	15					
29	3	16	0	0	0	0	0	0						
30	4	4	0	25	50	0	0	0	64					
31	4	5	25	25	25	0	0	0	61		1			
32	4	6	25	50	0	0	0	0	41		1			
33	4	7	0	0	100	0	0	0	98		2			
34	4	8	100	0	0	0	0	0	9					
35	4	9	100	0	0	0	0	0	32					
36	4	10	0	0	100	0	0	0	28					
37	4	11	0	50	50	0	0	0	20					
38	4	12	25	25	0	0	0	0	153					
39	4	13	0	0	25	0	0	0	27		1			1
40	4	14	0	0	25	0	0	0	58					1
41	4	15	0	0	0	0	0	0						
42	4	16	0	0	0	0	0	0	3					
43	4	17	0	0	0	0	0	0						
44	5	3	0	0	0	0	0	0	16					
45	5	4	0	25	50	0	0	0	28					
46	5	5	50	25	0	0	0	0	40		1			1
47	5	6	0	0	50	0	0	0	55					
48	5	7	0	25	50	0	0	0	91		1			1
49	5	8	100	0	0	0	0	0	31		1			
50	5	9	100	0	0	0	0	0	62					
51	5	10	50	0	25	0	0	0	58		1			
52	5	11	0	0	50	0	0	0	160		3	1		1
53	5	12	25	0	0	0	0	0	222		3	1		1
54	5	13	100	0	0	0	0	0	18	1				
55	5	14	50	25	0	0	0	0	35		1			
56	5	15	25	0	0	0	0	0	10					
57	5	16	50	0	0	0	0	0	26					
58	5	17	75	0	0	0	0	0	116					
59	5	18	0	0	25	0	0	0	120		1			
60	6	3	0	25	0	0	0	0						
61	6	4	0	25	50	0	0	0	16					
62	6	5	25	50	25	0	0	0	52					
63	6	6	0	50	25	0	0	0	78					
64	6	7	100	0	0	0	0	0	41					
65	6	8	100	0	0	0	0	0	26					
66	6	9	100	0	0	0	0	0	66		1			
67	6	10	0	0	0	0	0	0	73					
68	6	11	100	0	0	0	0	0	107					
69	6	12	0	0	0	0	0	0	500		2			5
70	6	13	100	0	0	0	0	0	22					
71	6	14	50	0	0	0	0	0	32	2				1
72	6	15	100	0	0	0	0	0	50					
73	6	16	25	0	75	0	0	0						
74	6	17	0	0	75	0	25	0	1					
75	6	18	0	0	0	25	50	0	47		2			1
76	6	19	0	0	0	75	0	0						
77	6	20	0	0	0	25	0	0						
78	7	3	0	0	25	0	0	0	15					
79	7	4	0	25	50	0	0	0						
80	7	5	0	50	25	0	0	0	29					
81	7	6	0	50	25	0	0	0	134					1
82	7	7	100	0	0	0	0	0	26					
83	7	8	75	0	0	0	0	0	80					
84	7	9	75	0	0	0	0	0	117					
85	7	10	0	0	100	0	0	0	46					1
86	7	11	0	0	75	0	0	0	31					
87	7	12	0	0	25	0	0	0	200					1
88	7	13	50	0	0	0	0	0	211					
89	7	14	100	0	0	0	0	0	17					
90	7	15	100	0	0	0	0	0						1
91	7	16	100	0	0	0	0	0	4					
92	7	17	75	0	0	0	25	0	3					
93	7	18	50	0	0	0	50	0	43					1
94	7	19	0	25	0	0	75	0	10					
95	7	20	0	0	25	25	25	0						
96	7	21	0	0	0	50	0	0						
97	8	3	0	0	50	0	0	0	53		1			
98	8	4	0	0	0	0	0	0	6					
99	8	5	0	50	0	0	0	0	138		3			1
100	8	6	50	0	0	0	0	0	183		2			1
101	8	7	50	0	0	0	0	0	157		1			1
102	8	8	75	0	0	0	0	0	103					
103	8	9	50	0	25	0	0	0	53					1

Note WP:Wet Paddy; FL:Farm Land; PPO:Plantation Palm Oil; PGM:Plantation Rubber; PCC:Plantation Cacao; POT:Plantation Others; HS:House; FA:Factory; SC:School; OF:Office; HP:Hospital; RL:Mosque & Church

Table 3-6(9/11) Area and Number of Buildings, Houses and Agricultural Crops in the Inundation Area (BELUTU RIVER (2))

No.	X	Y	WP (ha)	FL (ha)	PPO (ha)	PGM (ha)	PCC (ha)	POT (ha)	HS (nos)	FA (nos)	SC (nos)	OF (nos)	HP (nos)	RL (nos)
104	8	10	0	0	100	0	0	0						
105	8	11	0	0	100	0	0	0	11					
106	8	12	0	0	25	0	0	0	178		3			2
107	8	13	75	0	0	0	0	0	78	1		2		2
108	8	14	100	0	0	0	0	0	114					1
109	8	15	100	0	0	0	0	0	1					
110	8	16	100	0	0	0	0	0	143					2
111	8	17	75	0	0	0	0	0	86			1		3
112	8	18	75	0	0	0	0	0	88		1			1
113	8	19	100	0	0	0	0	0						
114	8	20	50	0	0	0	0	0						
115	8	21	0	0	0	100	0	0						
116	9	2	0	0	0	0	0	0						
117	9	3	0	0	0	0	0	0	20					
118	9	4	0	0	0	0	0	0	8					
119	9	5	0	25	0	0	0	0	76		1			
120	9	6	0	0	0	0	0	0	700		1	1		4
121	9	7	25	50	0	0	0	0	158		1			
122	9	8	75	25	0	0	0	0	8					
123	9	9	100	0	0	0	0	0	42		1			
124	9	10	50	0	50	0	0	0	36					
125	9	11	0	0	100	0	0	0	80					
126	9	12	0	0	25	0	0	0	275	1	5	1		4
127	9	13	50	0	0	0	0	0	136		3	1		1
128	9	14	100	0	0	0	0	0	55		2			
129	9	15	100	0	0	0	0	0	1					
130	9	16	100	0	0	0	0	0						
131	9	17	100	0	0	0	0	0	41		2			2
132	9	18	100	0	0	0	0	0	82		1	1		5
133	9	19	75	0	0	0	0	0	60		1			1
134	9	20	75	0	0	0	0	0						
135	9	21	0	0	0	75	0	0	13					
136	10	2	0	0	0	0	0	0						
137	10	3	0	0	0	0	0	0	7					
138	10	4	0	0	0	0	0	0						
139	10	5	25	25	25	0	0	0	17					1
140	10	6	75	25	0	0	0	0	95		1			2
141	10	7	100	0	0	0	0	0	19					
142	10	8	0	25	75	0	0	0	5					
143	10	9	75	0	0	0	0	0	12					
144	10	10	100	0	0	0	0	0	70					
145	10	11	100	0	0	0	0	0	48					
146	10	12	25	0	25	0	0	0	231		2			1
147	10	13	75	0	0	0	0	0	110	3				
148	10	14	100	0	0	0	0	0	43					
149	10	15	100	0	0	0	0	0	39					
150	10	16	100	0	0	0	0	0						
151	10	17	75	0	0	0	0	0	101		1			1
152	10	18	75	0	0	0	0	0	100					
153	10	19	100	0	0	0	0	0	10					
154	10	20	75	0	0	0	0	0	100	1	1			
155	10	21	75	0	0	25	0	0	5					
156	11	2	0	0	0	0	0	0	100					
157	11	3	0	0	0	0	0	0						
158	11	4	0	0	25	0	0	0						
159	11	5	0	50	50	0	0	0	58		1			
160	11	6	0	50	50	0	0	0	77		1			1
161	11	7	0	50	50	0	0	0						
162	11	8	25	50	25	0	0	0	2					
163	11	9	50	25	25	0	0	0	30					
164	11	10	100	0	0	0	0	0	127		1			
165	11	11	100	0	0	0	0	0	64					
166	11	12	75	0	25	0	0	0	91					
167	11	13	0	0	25	0	0	0	192		3			1
168	11	14	50	0	25	0	0	0	117		3	1		
169	11	15	50	0	0	0	0	0	108					1
170	11	16	50	0	0	0	0	0	103		1			1
171	11	17	100	0	0	0	0	0	73		1			1
172	11	18	75	0	0	0	0	0	176		3	1		3
173	11	19	75	0	0	0	0	0	89					1
174	11	20	75	0	0	0	0	0	185		3	1		4
175	11	21	50	0	0	0	0	0	17					
176	12	2	0	25	0	0	0	0						
177	12	3	0	25	0	0	0	0						
178	12	4	50	0	0	0	0	0	51					
179	12	5	25	75	0	0	0	0	31					
180	12	6	75	25	0	0	0	0	21	1				
181	12	7	75	0	0	0	0	0	122		1			1
182	12	8	75	0	0	0	0	0	29					
183	12	9	75	0	25	0	0	0	34					
184	12	10	75	0	0	0	0	0	157					
185	12	11	100	0	0	0	0	0	39					
186	12	12	25	0	0	0	0	0	22					
187	12	13	0	0	25	25	0	0						
188	12	14	0	0	0	25	0	0	100					
189	12	15	50	0	0	0	0	0	54					
190	12	16	50	0	0	0	0	0						
191	12	17	50	0	0	0	0	0						
192	12	18	50	0	0	0	0	0	18					
193	12	19	100	0	0	0	0	0						
194	12	20	100	0	0	0	0	0	86					
195	12	21	50	0	50	0	0	0	18					
196	13	2	0	0	0	0	0	0						
197	13	3	50	0	0	0	0	0						
198	13	4	75	0	0	0	0	0						
199	13	5	50	0	0	0	0	0						
200	13	6	25	0	0	0	0	0						
201	13	7	0	0	0	0	0	0						
202	14	2	0	0	0	0	0	0						
203	14	3	0	0	0	0	0	0						
204	14	4	0	0	0	0	0	0						
205	14	5	0	0	0	0	0	0						
206	14	6	0	0	0	0	0	0						
TOTAL			8,275	1,850	2,975	450	250	0	11,817	12	83	14	0	82

Note WP:Wet Paddy; FL:Farm Land; PPO:Plantation Palm Oil; PGM:Plantation Rubber; PCC:Plantation Cacao; POT:Plantation Others; HS:House; FA:Factory; SC:School; OF:Office; HP:Hospital; RL:Mosque & Church

Table 3-6(10/11) Area and Number of Buildings, Houses and Agricultural Crops in the Inundation Area (PADANG RIVER (1))

No.	X	Y	WP (ha)	FL (ha)	PPO (ha)	PGM (ha)	PCC (ha)	POT (ha)	HS (nos)	FA (nos)	SC (nos)	OF (nos)	HP (nos)	RL (nos)
1	1	3	0	0	0	0	0	0						
2	1	4	0	0	0	0	0	0						
3	1	5	0	0	0	0	0	0						
4	1	6	0	0	0	0	0	0						
5	1	7	0	0	0	0	0	0						
6	1	8	0	0	0	0	0	0						
7	2	3	0	0	0	0	0	0						
8	2	4	0	0	0	0	0	0						
9	2	5	0	0	0	0	0	0						
10	2	6	0	0	0	0	0	0						
11	2	7	0	0	0	0	0	0						
12	2	8	0	0	0	0	0	0						
13	3	3	0	0	0	0	0	0						
14	3	4	0	0	0	0	0	0						
15	3	5	50	0	0	0	0	0						
16	3	6	100	0	0	0	0	0	40					
17	3	7	100	0	0	0	0	0	13					
18	3	8	75	0	0	0	0	0	78					
19	3	9	0	0	0	0	0	0						
20	4	2	0	0	0	0	0	0						
21	4	3	0	0	0	0	0	0						
22	4	4	0	0	0	0	0	0						
23	4	5	25	0	0	0	0	0						
24	4	6	100	0	0	0	0	0	52					
25	4	7	75	0	0	0	0	0	71		1			1
26	4	8	100	0	0	0	0	0	5					
27	4	9	75	0	0	0	0	0						
28	4	10	0	0	0	0	0	0						
29	4	11	50	25	0	0	0	0						
30	4	12	25	0	25	0	0	0	29					
31	4	19	50	0	0	0	0	0	126		2	1		1
32	4	20	50	0	0	0	0	0	207		1		1	1
33	4	21	0	0	0	100	0	0						
34	4	22	0	0	0	100	0	0	13					
35	4	23	0	0	0	25	0	0	188	3	2			
36	4	24	75	0	0	0	0	0	50		1			
37	5	2	0	0	0	0	0	0						
38	5	3	0	0	0	0	0	0						
39	5	4	0	0	0	0	0	0						
40	5	5	25	0	0	0	0	0						
41	5	6	100	0	0	0	0	0						
42	5	7	100	0	0	0	0	0	23					
43	5	8	100	0	0	0	0	0						
44	5	9	50	0	0	0	0	0						
45	5	10	25	0	0	0	0	0						
46	5	11	75	0	25	0	0	0	32					
47	5	12	25	0	75	0	0	0	10					
48	5	17	25	0	25	0	0	0	16					
49	5	18	25	0	50	0	0	0	27					1
50	5	19	25	0	0	25	0	0	137		1			1
51	5	20	25	0	0	0	0	0	292		2			1
52	5	21	0	0	0	50	0	0	50					
53	5	22	0	0	0	75	0	0	43					
54	5	23	0	0	0	0	0	0	400	14	1		1	3
55	5	24	0	0	0	0	0	0	206		3	2		2
56	6	2	0	0	0	0	0	0						
57	6	3	0	0	0	0	0	0	14					
58	6	4	50	0	0	0	0	0	8					
59	6	5	50	25	0	0	0	0	7					
60	6	6	75	0	0	0	0	0	75		1			2
61	6	7	25	25	0	0	0	0	209		1			1
62	6	8	75	25	0	0	0	0	9					
63	6	9	50	0	0	0	0	0						
64	6	10	25	0	0	0	0	0						
65	6	11	50	0	50	0	0	0	28					
66	6	12	0	0	100	0	0	0	18					
67	6	13	50	0	50	0	0	0	50					
68	6	14	100	0	0	0	0	0	121		2			
69	6	15	50	0	50	0	0	0	88					
70	6	16	100	0	0	0	0	0	39					
71	6	17	0	0	50	50	0	0	59					
72	6	18	75	0	25	0	0	0	95		1			
73	6	19	50	0	0	50	0	0						
74	6	20	25	0	0	50	0	0	116	1	2	2		
75	6	21	0	0	0	0	0	0	451	4	4	2		2
76	6	22	0	25	0	0	0	0	218	4	2	1		2
77	6	23	0	0	0	0	0	0	300	5	3			4
78	6	24	0	0	0	0	0	0	550	5	6			4
79	7	2	0	0	0	0	0	0						
80	7	3	0	0	0	0	0	0	5					
81	7	4	25	0	0	0	0	0						
82	7	5	100	0	0	0	0	0	42					
83	7	6	50	50	0	0	0	0	46	1	1			
84	7	7	75	25	0	0	0	0	66		1			
85	7	8	50	25	0	0	0	0	58		1			1
86	7	9	50	0	0	0	0	0						

Note WP:Wet Paddy; FL:Farm Land; PPO:Plantation Palm Oil; PGM:Plantation Rubber; PCC:Plantation Cacao; POT:Plantation Others; HS:House; FA:Factory; SC:School; OF:Office; HP:Hospital; RL:Mosque & Church

Table 3-6(11/11) Area and Number of Buildings, Houses and Agricultural Crops in the Inundation Area (PADANG RIVER (2))

No.	X	Y	WP (ha)	FL (ha)	PPO (ha)	PGM (ha)	PCC (ha)	POT (ha)	HS (nos)	FA (nos)	SC (nos)	OF (nos)	HP (nos)	RL (nos)
87	7	10	75	0	0	0	0	0						
88	7	11	75	0	0	0	0	0	111					
89	7	12	50	0	50	0	0	0	30		1			
90	7	13	50	0	50	0	0	0	43					
91	7	14	100	0	0	0	0	0	127					2
92	7	15	100	0	0	0	0	0	64	1				
93	7	16	100	0	0	0	0	0	100	1				
94	7	17	0	0	0	100	0	0	43					1
95	7	18	0	0	0	100	0	0	1					
96	7	19	0	50	0	25	0	0	9					
97	7	20	0	0	0	25	0	0	112	1				
98	7	21	0	0	0	0	0	0	400	3	6	2		
99	7	22	0	25	0	0	0	0	773	5	4	5	2	4
100	7	23	0	0	0	0	0	0	1000	3	11	17	3	10
101	7	24	0	0	0	0	0	0	850	4	4	2		9
102	8	2	0	0	0	0	0	0						
103	8	3	0	0	0	0	0	0						
104	8	4	0	0	0	0	0	0						
105	8	5	25	0	0	0	0	0	200		6			4
106	8	6	25	0	0	0	0	0	27					
107	8	7	100	0	0	0	0	0	28					
108	8	8	75	0	0	0	0	0	121		1			2
109	8	9	50	0	0	0	0	0	204		2			2
110	8	10	50	25	25	0	0	0	65		1			
111	8	11	75	25	0	0	0	0	60		2			
112	8	12	0	0	75	0	0	0	33					1
113	8	13	25	0	75	0	0	0	7					
114	8	14	100	0	0	0	0	0	48					1
115	8	15	100	0	0	0	0	0	69					
116	8	16	100	0	0	0	0	0	108	2	3			1
117	8	17	0	0	0	100	0	0	31					
118	8	18	0	0	0	50	0	0						
119	8	19	0	50	0	0	0	0	26			1		
120	8	20	0	75	0	0	0	0	106	2	1		1	1
121	8	21	0	25	0	0	0	0	114					
122	8	22	0	0	0	0	0	0	550		6	3	1	5
123	8	23	0	0	0	0	0	0	850	2	10	7		4
124	8	24	0	0	0	0	0	0	550	3	4			3
125	9	2	0	0	0	0	0	0						
126	9	3	0	0	0	0	0	0						
127	9	4	0	0	0	0	0	0						
128	9	5	50	0	0	0	0	0	14		1			1
129	9	6	100	0	0	0	0	0	4					
130	9	7	75	0	0	0	0	0	53					1
131	9	8	50	0	0	0	0	0	150	1	6			2
132	9	9	50	0	0	0	0	0	184	1	4			6
133	9	10	50	0	25	0	0	0	41		1			
134	9	11	25	0	0	0	0	0	35					
135	9	12	0	0	50	25	0	0						
136	9	13	25	0	50	0	0	0	25					
137	9	14	75	0	0	0	0	0	64		1			
138	9	15	100	0	0	0	0	0	65		1			1
139	9	16	75	0	0	0	0	0	48		1			
140	9	17	0	25	0	25	0	0	12					
141	9	18	0	0	25	25	0	0	89	2				
142	9	19	0	0	0	50	0	0	105					
143	9	20	0	0	0	75	0	0						
144	9	21	0	25	0	50	0	0	2					
145	9	22	0	75	0	0	0	0	115		3	2		1
146	10	2	0	0	0	0	0	0						
147	10	3	0	0	0	0	0	0						
148	10	4	0	0	0	0	0	0						
149	10	5	50	0	0	0	0	0	23					
150	10	6	50	0	0	0	0	0	5					
151	10	7	75	0	0	0	0	0	2					
152	10	8	50	0	0	0	0	0	34					
153	10	9	75	0	25	0	0	0						
154	10	10	75	0	0	0	0	0	68		1			3
155	10	11	25	50	0	0	0	0	75	2	1			1
156	10	12	25	25	0	50	0	0	12					
157	10	13	25	25	0	25	0	0	18					
158	10	14	25	50	25	0	0	0	24					
159	10	15	75	25	0	0	0	0	17					
160	10	16	25	75	0	0	0	0						
161	10	17	0	50	25	0	0	0	42					
162	10	18	0	25	25	0	0	0	99	6				1
163	10	19	0	0	0	100	0	0						
164	11	10	25	0	25	0	0	0						
165	11	11	0	0	75	0	0	0	23		1			
166	11	12	25	0	25	25	0	0	77	1	1			1
167	11	13	75	0	0	0	0	0	78					
168	11	14	75	25	0	0	0	0	13					
169	11	15	50	0	0	25	0	0	55	5				1
170	11	16	0	0	25	0	0	0	114	1	2			3
171	11	17	0	0	75	0	0	0	24	1				
172	11	18	0	25	25	25	0	0	162		2	1		4
173	11	19	0	0	0	75	0	0						
TOTA			5,525	1,000	1,300	1,500	0	0	13,611	84	127	48	9	103

Note WP:Wet Paddy; FL:Farm Land; PPO:Plantation Palm Oil; PGM:Plantation Rubber; PCC:Plantation Cacao; POT:Plantation Others; HS:House; FA:Factory; SC:School; OF:Office; HP:Hospital; RL:Mosque & Church

Table 3-7(1/2) FLOOD DAMAGE BY VARIOUS FLOODS

*** Belawan River ***

(Unit : Mil. Rp.)

RETURN PERIOD	Wet Paddy	Farm Land	Palm Oil	Rubber	Cacao	Other Plantation	House	Factory	School	Office	Hospital	Mosque/ Church	Public Structure	TOTAL
100	130.60	410.85	2.81	0.00	0.00	114.70	8,006.15	34.83	185.98	175.41	17.82	71.77	2,887.27	12,038.18
50	130.60	390.13	2.36	0.00	0.00	94.08	6,690.40	23.22	127.68	154.02	0.00	56.79	2,397.72	10,066.99
30	130.60	390.13	2.36	0.00	0.00	91.50	6,486.47	23.22	127.68	154.02	0.00	56.79	2,328.38	9,791.15
20	110.15	339.22	1.77	0.00	0.00	78.61	6,067.15	0.00	119.70	102.68	0.00	56.79	2,157.75	9,033.83
10	110.15	257.22	0.89	0.00	0.00	65.73	4,288.10	0.00	79.80	102.68	0.00	41.02	1,533.94	6,479.53

*** Deli River ***

(Unit : Mil. Rp.)

RETURN PERIOD	Wet Paddy	Farm Land	Palm Oil	Rubber	Cacao	Other Plantation	House	Factory	School	Office	Hospital	Mosque/ Church	Public Structure	TOTAL
100	12.52	109.22	0.15	0.04	1.29	10.31	58,152.36	2,175.16	842.78	1,287.10	0.00	316.76	21,343.21	84,250.89
50	10.85	106.26	0.15	0.04	1.29	10.31	56,229.80	1,943.98	813.44	1,211.82	0.00	307.86	20,572.35	81,208.14
30	10.85	106.26	0.15	0.04	1.29	10.31	52,640.54	1,853.38	774.78	1,190.43	0.00	291.17	19,295.10	76,174.30
20	10.85	106.26	0.15	0.04	1.29	9.02	49,588.94	1,716.61	683.32	1,036.41	0.00	281.71	18,124.37	71,558.96
10	10.85	106.26	0.15	0.04	0.00	7.73	42,560.10	1,525.01	543.22	862.61	0.00	236.72	15,547.40	61,400.08
5	10.85	81.99	0.15	0.04	0.00	7.73	41,367.42	1,412.13	531.56	834.27	0.00	231.35	15,088.09	59,565.57
2	10.85	72.52	0.15	0.04	1.29	7.73	30,239.15	951.15	413.72	586.13	0.00	166.69	11,001.32	43,450.73

*** Percut River ***

(Unit : Mil. Rp.)

RETURN PERIOD	Wet Paddy	Farm Land	Palm Oil	Rubber	Cacao	Other Plantation	House	Factory	School	Office	Hospital	Mosque/ Church	Public Structure	TOTAL
100	338.81	51.80	0.44	0.00	5.16	69.59	11,530.80	46.44	143.02	0.00	0.00	82.95	4,013.09	16,282.09
50	338.81	51.80	0.44	0.00	2.58	59.28	10,475.10	46.44	143.02	0.00	0.00	82.95	3,654.15	14,854.57
30	325.46	41.44	0.44	0.00	2.58	51.55	10,205.83	46.44	139.34	0.00	0.00	80.06	3,560.36	14,453.49
20	313.35	31.08	0.30	0.00	2.58	51.55	9,937.32	11.61	139.34	0.00	0.00	78.61	3,456.74	14,022.47
10	289.99	31.08	0.30	0.00	1.29	48.97	7,409.50	11.61	131.36	0.00	0.00	59.68	2,588.13	10,571.91
5	284.56	31.08	0.30	0.00	1.29	45.11	6,705.87	11.61	103.74	0.00	0.00	55.08	2,337.94	9,576.58

Table 3-7(2/2) FLOOD DAMAGE BY VARIOUS FLOODS

*** Serdang River *** (Unit : Mil. Rp.)

RETURN PERIOD	Wet Paddy	Farm Land	Palm Oil	Rubber	Cacao	Other Plantation	House	Factory	School	Office	Hospital	Mosque/ Church	Public Structure	TOTAL
100	1,224.63	71.63	8.72	0.11	0.00	0.00	14,656.69	447.91	259.62	372.21	0.00	91.09	5,381.35	22,513.95
50	1,151.19	62.16	8.72	0.11	0.00	0.00	13,884.61	402.61	248.58	372.21	0.00	88.20	5,098.71	21,317.09
30	1,121.15	62.16	8.72	0.11	0.00	0.00	13,400.19	348.25	230.18	329.43	0.00	83.86	4,893.25	20,477.29
20	1,091.94	62.16	8.72	0.11	0.00	0.00	13,195.63	343.20	230.18	329.43	0.00	83.86	4,821.98	20,167.21
10	1,072.33	51.80	8.42	0.11	0.00	0.00	12,724.51	331.59	206.24	329.43	0.00	83.86	4,649.71	19,458.00
5	1,040.62	41.44	7.83	0.07	0.00	0.00	11,835.18	331.59	174.94	329.43	0.00	77.82	4,334.64	18,173.56
2	890.83	31.08	7.39	0.00	0.00	0.00	10,283.63	238.71	166.96	329.43	0.00	62.04	3,767.46	15,777.53

*** Belutu River *** (Unit : Mil. Rp.)

RETURN PERIOD	Wet Paddy	Farm Land	Palm Oil	Rubber	Cacao	Other Plantation	House	Factory	School	Office	Hospital	Mosque/ Church	Public Structure	TOTAL
100	629.63	236.50	4.43	0.00	2.58	0.00	2,848.86	13.05	99.10	56.55	0.00	51.15	1,043.36	4,985.22
50	602.09	236.50	4.14	0.00	2.58	0.00	2,796.60	12.45	93.40	56.55	0.00	51.15	1,023.45	4,878.91
30	553.27	195.95	3.55	0.00	2.58	0.00	2,619.60	12.45	82.00	56.55	0.00	49.00	958.66	4,533.61
20	545.35	175.23	3.40	0.00	2.58	0.00	2,578.76	12.45	82.00	56.55	0.00	49.00	944.78	4,450.09
10	514.89	154.51	3.10	0.00	2.58	0.00	1,938.32	12.45	64.00	43.70	0.00	34.75	711.69	3,479.99
5	486.10	144.15	2.96	0.00	2.58	0.00	1,891.52	12.45	64.00	43.70	0.00	32.60	695.05	3,375.10
2	461.06	51.80	2.36	0.00	2.58	0.00	1,657.82	12.45	58.30	38.55	0.00	28.45	610.49	2,923.87

*** Padang River *** (Unit : Mil. Rp.)

RETURN PERIOD	Wet Paddy	Farm Land	Palm Oil	Rubber	Cacao	Other Plantation	House	Factory	School	Office	Hospital	Mosque/ Church	Public Structure	TOTAL
100	1,305.99	201.28	4.58	1.14	0.00	0.00	15,086.15	594.06	520.04	350.82	21.75	160.70	5,689.40	23,935.91
50	1,291.81	201.28	4.43	1.14	0.00	0.00	13,336.49	375.48	461.74	248.14	17.82	142.83	4,958.05	21,039.21
30	1,260.51	201.28	4.43	1.14	0.00	0.00	12,868.31	375.48	454.38	248.14	17.82	141.39	4,795.87	20,368.75
20	1,177.48	190.92	4.43	1.14	0.00	0.00	12,561.94	375.48	444.68	248.14	17.82	141.39	4,688.41	19,851.83
10	1,084.85	180.56	4.43	1.14	0.00	0.00	10,175.78	308.37	310.12	102.68	8.91	102.11	3,742.71	16,021.67
5	950.50	161.62	4.43	1.14	0.00	0.00	9,041.00	250.32	263.48	102.68	8.91	86.60	3,316.02	14,186.69
2	886.66	161.62	4.28	0.82	0.00	0.00	8,462.89	238.71	251.82	102.68	8.91	78.35	3,108.74	13,305.47

Table 4-1 PROJECT SCALE OF RIVER IMPROVEMENT WORKS IN INDONESIA

No.	Name of River	Province	Catchment Area (km2)	Design Flood (m3/s)	Specific Discharge (m3/s/km2)	Return Period (Year)
1.	Cimanuk	West Java	3,006	1,440	0.48	25
2.	Serang	Central Java	937	900	0.96	25
3.	Citanduy	West Java	3,680	1,900	0.52	25
4.	Ular	North Sumatra	1,080	800	0.74	30
5.	Pemali	Central Java	1,228	1,300	1.06	25
6.	Cipanas	West Java	220	385	1.75	25
7.	Solo	Central/East Java	3,400	1,500	0.44	10 *1
				2,000	0.59	40 *2
8.	Madiun	East Java	2,400	1,100	0.46	10 *1
				2,300	0.96	40 *2
9.	Wampu	North Sumatra	3,840	1,320	0.34	20
10.	Arakundo	Aceh	5,495	1,800	0.33	20
11.	Kring Aceh	Aceh	1,775	1,300	0.73	20
12.	Brantas	East Java	10,000	1,350	0.14	10 *1
				1,500	0.15	50 *2
13.	Bah Bolon	North Sumatra	2,776	1,220	0.44	20
14.	Walanae	South Sulawesi	3,190	2,900	0.91	20
15.	Bila	South Sulawesi	1,368	1,900	1.39	20
16.	Jeneberang	South Sulawesi	729	3,700	5.08	50
17.	Ciujung	North Banten	1,850	1,100	0.59	10 *1
				1,600	0.86	50 *2
18.	Kuranji	West Sumatra	213	870	4.08	25 *1
				1,000	4.69	50 *2
19.	Air Dingin	West Sumatra	131	600	4.58	25 *1
				700	5.34	50 *2
20.	Marmoyo	East Java	290	230	0.79	20
21.	Surabaya	East Java	631	370	0.59	50

Note : *1 : 1st stage and/or urgent plan
*2 : 2nd stage and/or overall plan

Table 4-2 COMPARISON OF FLOOD MITIGATION EFFECT OF DAM AND RETARDING BASIN

River System & Flood Mitigation Structure	Catchment Area (km2)	Possible Flood Control Storage Capacity * (MCM)	Required Construction Cost (million RP.)	Reference Point & Catchment Area (km2)	Flood Mitigation Effect at R.P. W/O (m3/S)	Flood Mitigation Effect at R.P. W/ (m3/S)	Required Construction Cost for Unit Flood Mitigation Effect (million Rp./m3/S)
1. Belawan River(50-Yr.)				Lalang 254			
Tembengan Dam	76	1.8	30,000		550	410	214
Sembahe Baru Retarding Basin	155	5.1	116,300		550	150	291
2. Deli River(100-Yr.)				Helvetia 341			
Namobatang Dam	93	2.5 !	23,339		690	580	212
3. Percut River(100-Yr.)				Tembakau 171			
Lausimeme Dam	105	2.8	21,182		340	180	132
4. Serdang River(50-Yr.)				Baru 671			
Beranti Dam	159	3.3	38,800		850	690	243
Punden Retarding Basin	262	1.6	47,800		850	670	266
5. Ular River(50-Yr.)				Pulau Togor 1,013			
Buaya Dam	428	16.7	20,790		970	640	63
Karai Dam	500	19.5	21,600		970	590	57
6. Belutu River(50-Yr.)				Sei Rampah 423			
Sibakudu Dam	64	1.5	4,000		340	310	133
Bakaran Batu Retarding Basin	243	5.5	69,700		340	170	410
7. Padang River(50-Yr.)				Brohol 759			
Sampanan Dam	370	12.4	45,000		840	500	132
Tebing Tinggi Retarding Basin	414	5.0	91,000		840	590	364

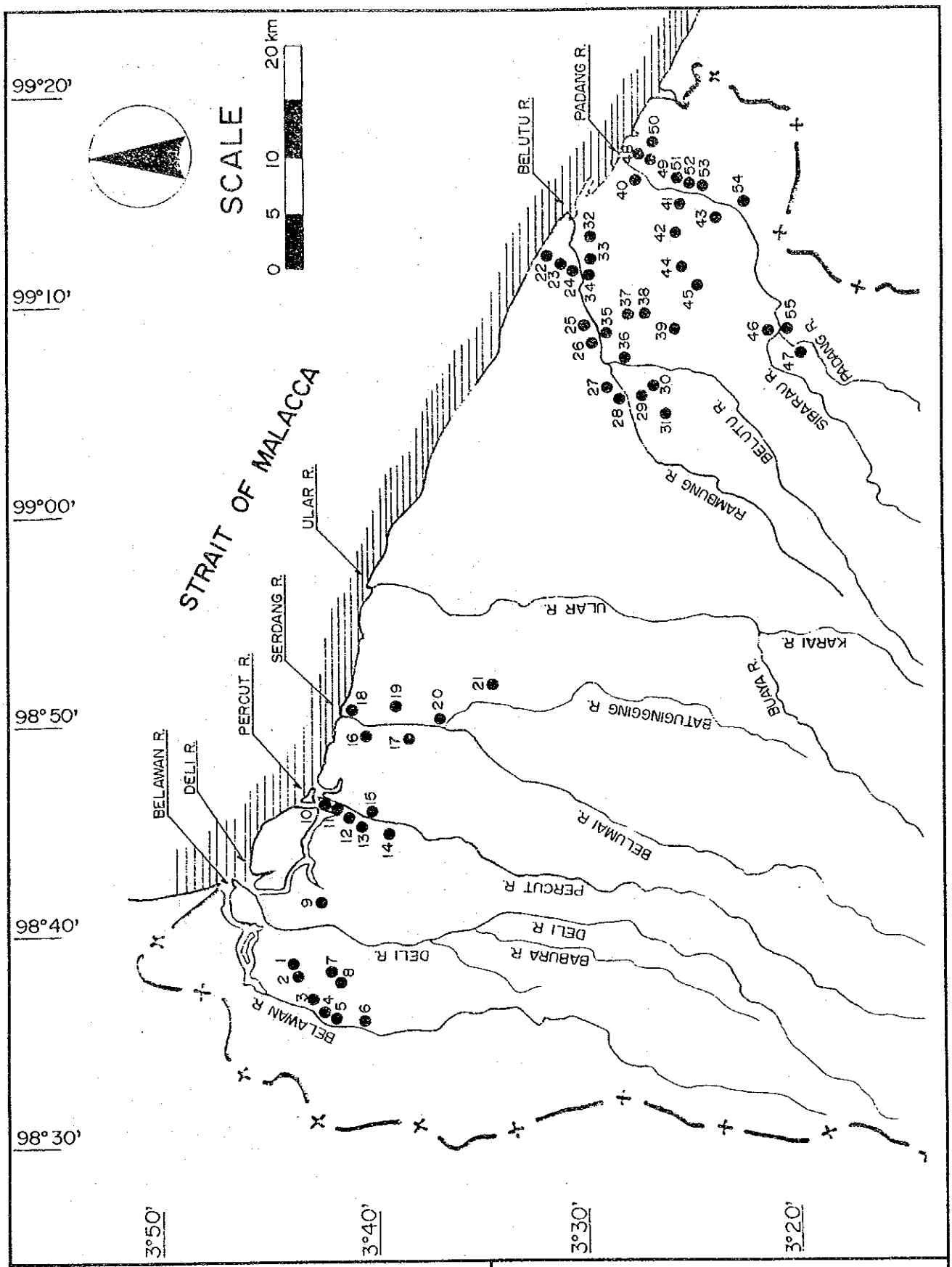
Note : * : This value is defined from flood regulation analysis by applying max. 80% reduction of the standard Project Flood or possible storage capacity under its topographic or landuse condition.

Table 4-3 CONSTRUCTION COST OF FLOOD CONTROL PROJECT FOR MASTER PLAN

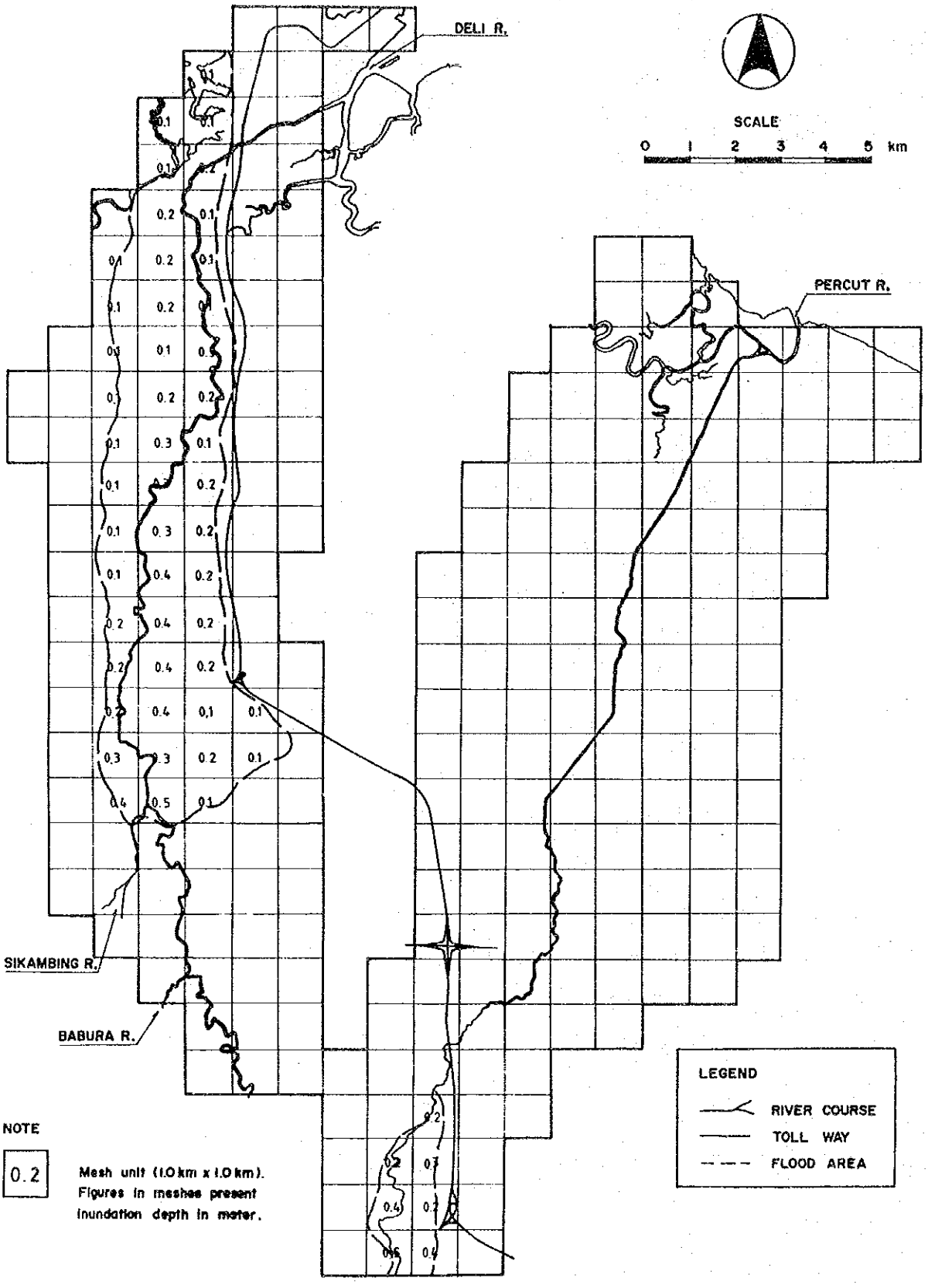
Name of River/ Work Item	Direct Cost	Indirect Cost			Physical Contingency	Total
	Construction Base Cost	Administration	Engineering Service	Compensation		
1. Belawan River						31,261
- River Improvement	20,960	1,467	3,144	2,848	2,842	31,261
2. Deli-Percut River System						242,753
2.1 Deli River						141,947
- River Improvement	76,652	5,366	11,498	14,310	10,782	118,608
- Namobatang Dam	12,012	841	7,005	1,360	2,121	23,339
2.2 Medan Floodway	21,380	1,497	3,207	3,039	2,912	32,035
2.3 Percut River						68,771
- River Improvement	29,003	2,030	4,350	7,880	4,326	47,589
- Lausimeme Dam	11,222	786	6,968	282	1,924	21,182
3. Serdang River						153,850
- River Improvement	68,752	4,813	10,313	20,372	10,425	114,675
- Belumai Aqueduct	28,782	2,015	4,317	499	3,562	39,175
4. Ular River						16,076
- Karai Dam	8,977	628	4,309	700	1,462	16,076
5. Belutu River						56,401
- River Improvement	34,897	2,443	5,235	8,699	5,127	56,401
6. Padang River						100,544
- River Improvement	69,792	4,885	10,469	6,257	9,141	100,544
Total						600,885

Note :
1) Administration cost is 7 % of direct construction cost.
2) Physical Contingency is 10% of the total of direct and indirect costs

FIGURES



THE STUDY ON BELAWAN-PADANG INTEGRATED RIVER BASIN DEVELOPMENT IN THE REPUBLIC OF INDONESIA	LOCATION OF INTERVIEW SURVEY
JAPAN INTERNATIONAL COOPERATION AGENCY	Fig.2-1

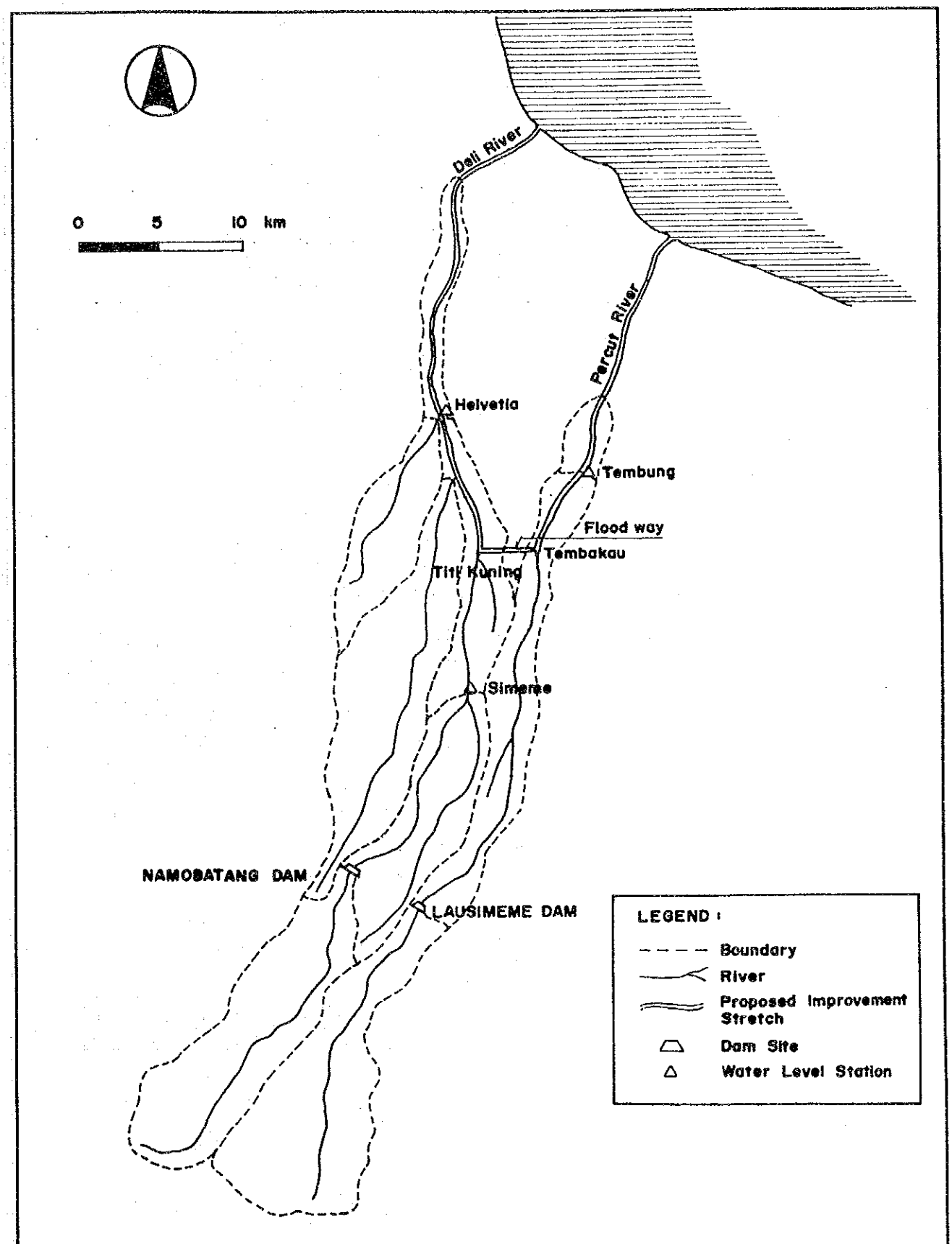


THE STUDY ON BELAWAN-PADANG INTEGRATED RIVER BASIN DEVELOPMENT IN THE REPUBLIC OF INDONESIA

JAPAN INTERNATIONAL COOPERATION AGENCY

INUNDATION AREA OF NOVEMBER 1990 FLOOD

Fig.2-2

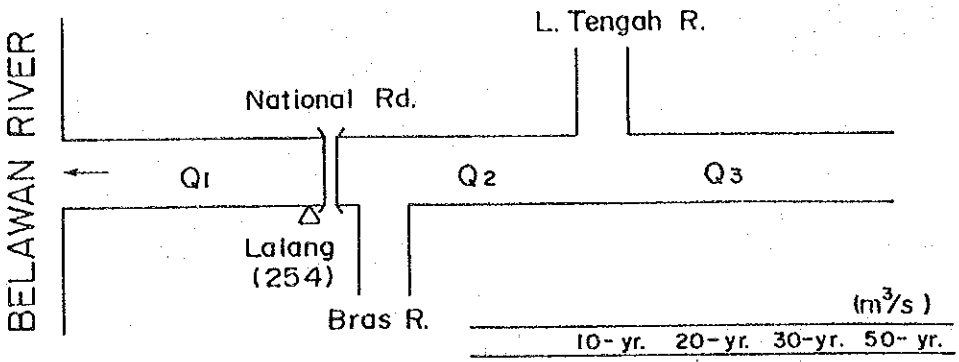


THE STUDY ON BELAWAN-PADANG INTEGRATED RIVER BASIN DEVELOPMENT IN THE REPUBLIC OF INDONESIA

JAPAN INTERNATIONAL COOPERATION AGENCY

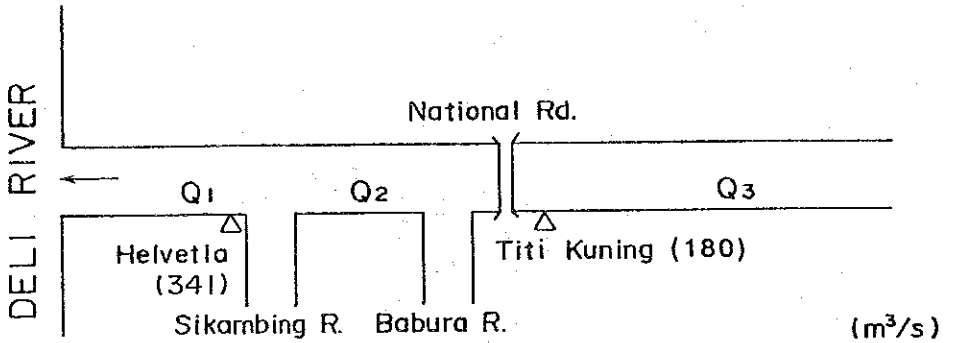
DELI-PERCUT RIVER SYSTEM

Fig.4-1



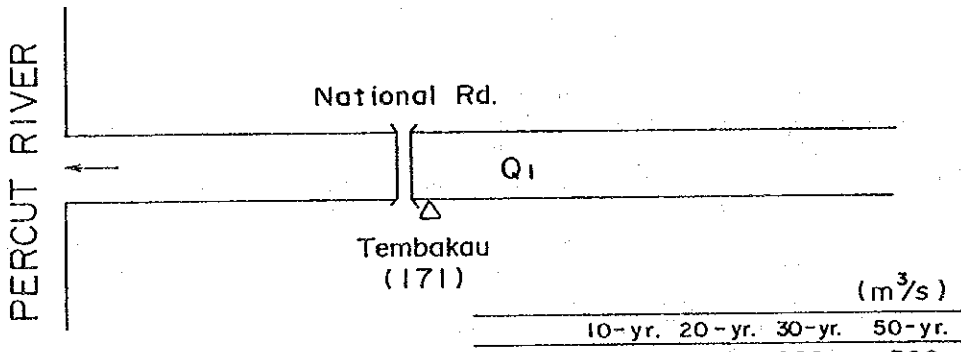
(m³/s)

	10-yr.	20-yr.	30-yr.	50-yr.
Q1	410	470	510	550
Q2	390	440	480	510
Q3	250	290	310	340



(m³/s)

	10-yr.	20-yr.	30-yr.	50-yr.	100-yr.
Q1	460	530	570	620	690
Q2	420	490	520	570	640
Q3	260	300	320	340	380



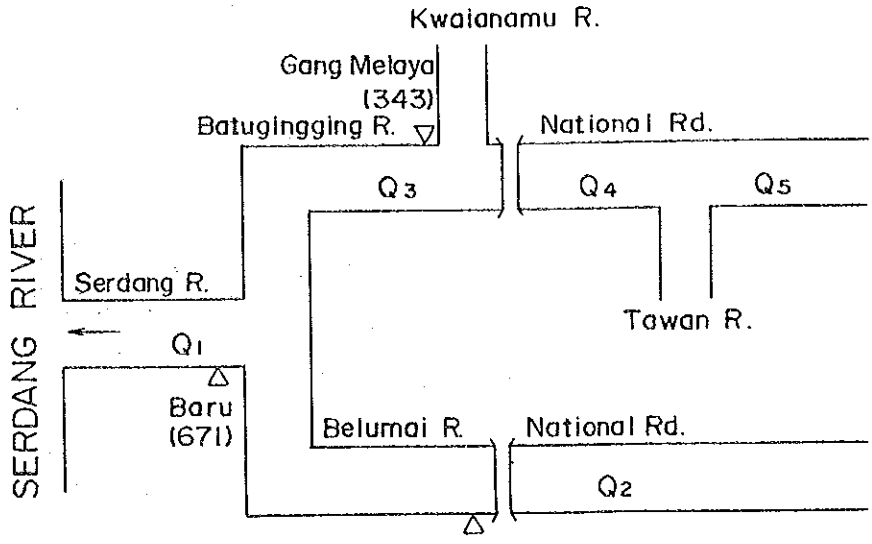
(m³/s)

	10-yr.	20-yr.	30-yr.	50-yr.	100-yr.
Q1	230	260	280	300	340

LEGEND

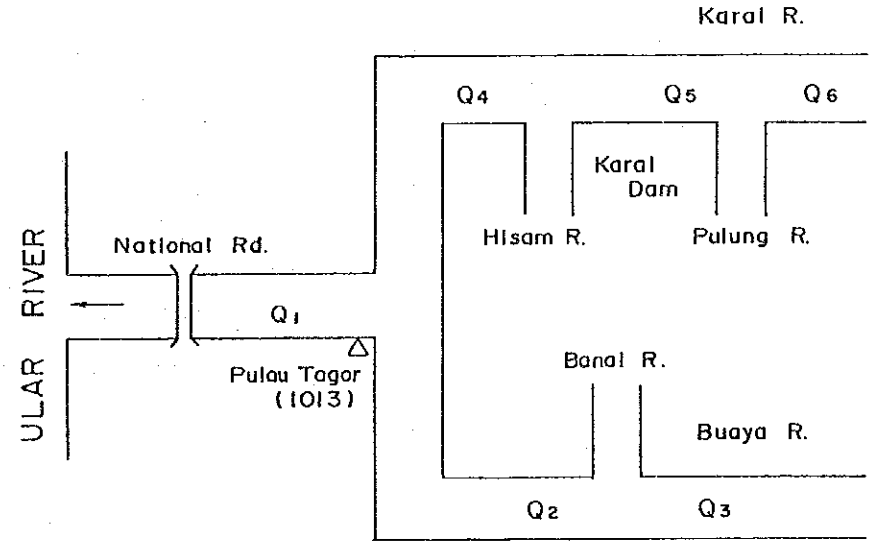
- River Course
- △ Reference Point
- (000) Catchment Area (km²)

THE STUDY ON BELAWAN-PADANG INTEGRATED RIVER BASIN DEVELOPMENT IN THE REPUBLIC OF INDONESIA JAPAN INTERNATIONAL COOPERATION AGENCY	PROBABLE FLOOD DISCHARGE DISTRIBUTION Fig.4-2(1/3)



(m³/s)

	10-yr.	20-yr.	30-yr.	50-yr.
Q1	680	750	800	850
Q2	270	290	310	330
Q3	390	420	450	480
Q4	310	340	360	380
Q5	100	110	120	130



(m³/s)

	10-yr.	20-yr.	30-yr.	50-yr.
Q1	710	820	890	970
Q2	310	360	390	420
Q3	210	240	260	290
Q4	410	470	510	550
Q5	370	420	450	500
Q6	230	260	280	310

LEGEND

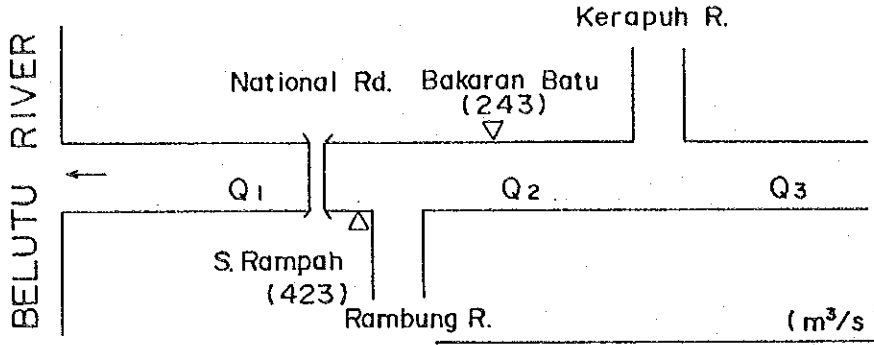
- River Course
- △ Reference Point
- (000) Catchment Area (km²)

THE STUDY ON BELAWAN-PADANG INTEGRATED RIVER BASIN DEVELOPMENT IN THE REPUBLIC OF INDONESIA

JAPAN INTERNATIONAL COOPERATION AGENCY

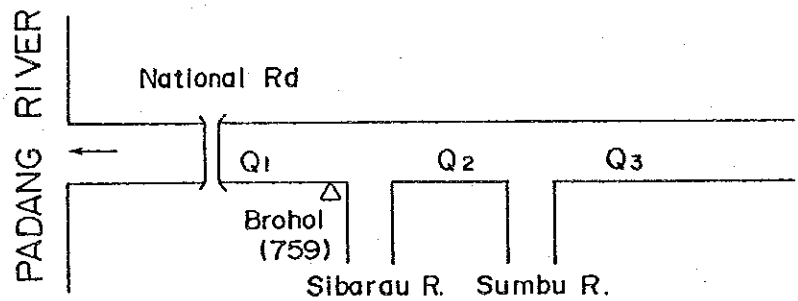
PROBABLE FLOOD DISCHARGE DISTRIBUTION

Fig.4-2(2/3)



	10-yr.	20-yr.	30-yr.	50-yr
Q1	260	290	310	340
Q2	160	180	190	210
Q3	80	90	95	100

(m^3/s)



	10-yr.	20-yr.	30-yr.	50-yr.
Q1	620	720	770	840
Q2	480	550	580	630
Q3	380	440	470	510

(m^3/s)

LEGEND

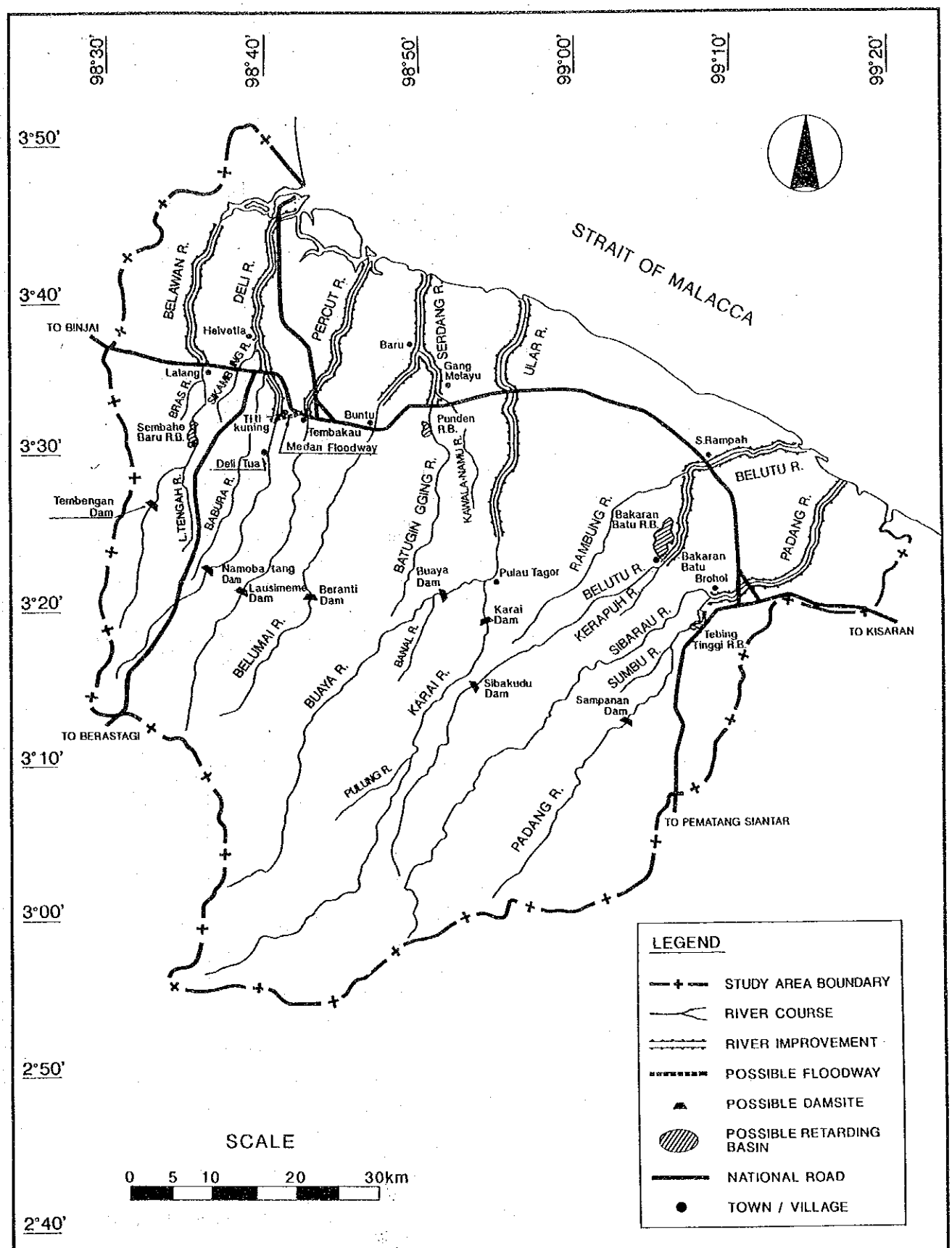
- River Course
- △ Reference Point
- (○○○) Catchment Area (km^2)

THE STUDY ON BELAWAN-PADANG INTEGRATED RIVER BASIN DEVELOPMENT IN THE REPUBLIC OF INDONESIA

JAPAN INTERNATIONAL COOPERATION AGENCY

PROBABLE FLOOD DISCHARGE DISTRIBUTION

Fig.4-2(3/3)

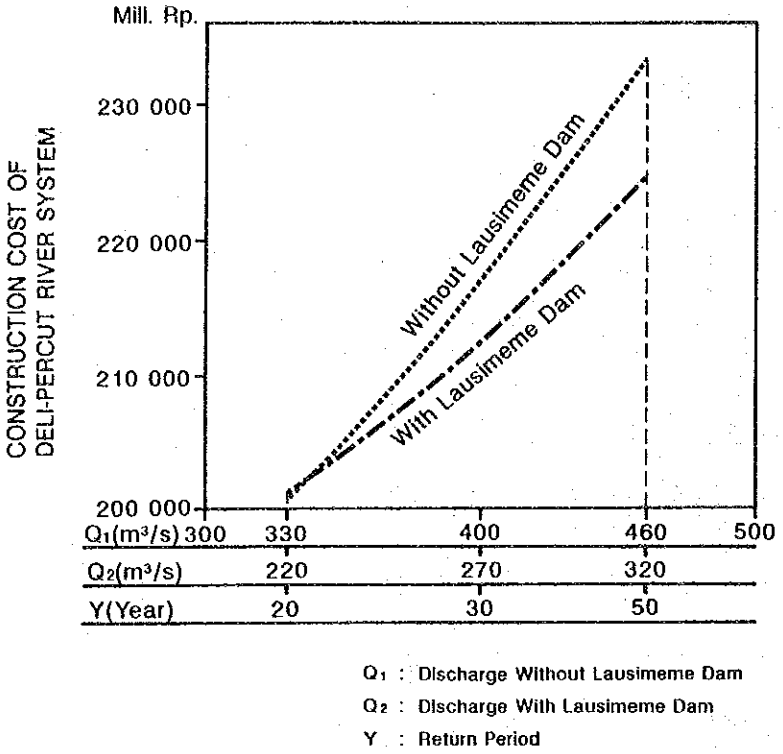


THE STUDY ON BELAWAN-PADANG INTEGRATED RIVER BASIN DEVELOPMENT IN THE REPUBLIC OF INDONESIA

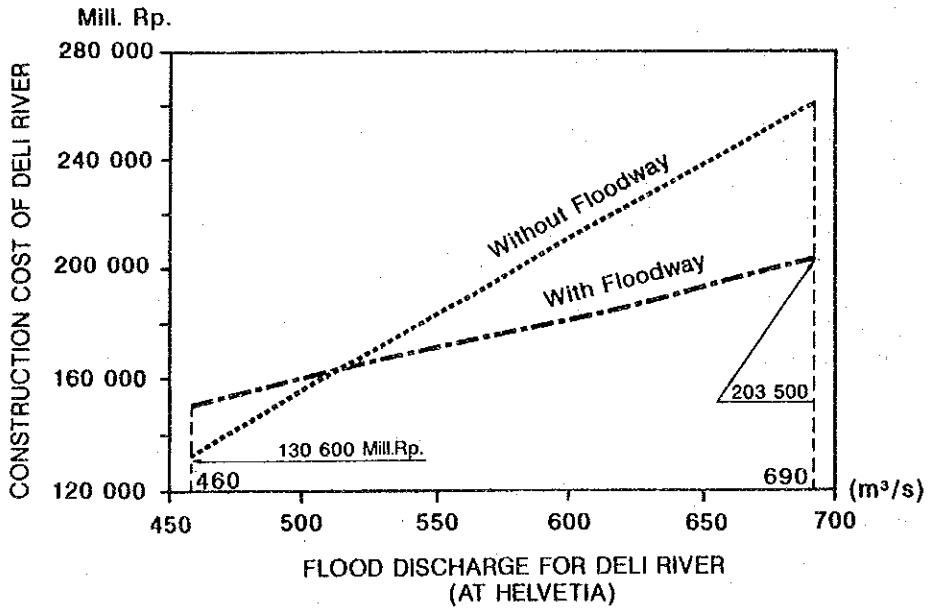
JAPAN INTERNATIONAL COOPERATION AGENCY

POSSIBLE FLOOD CONTROL STRUCTURES FOR MASTER PLAN

Fig.4-3

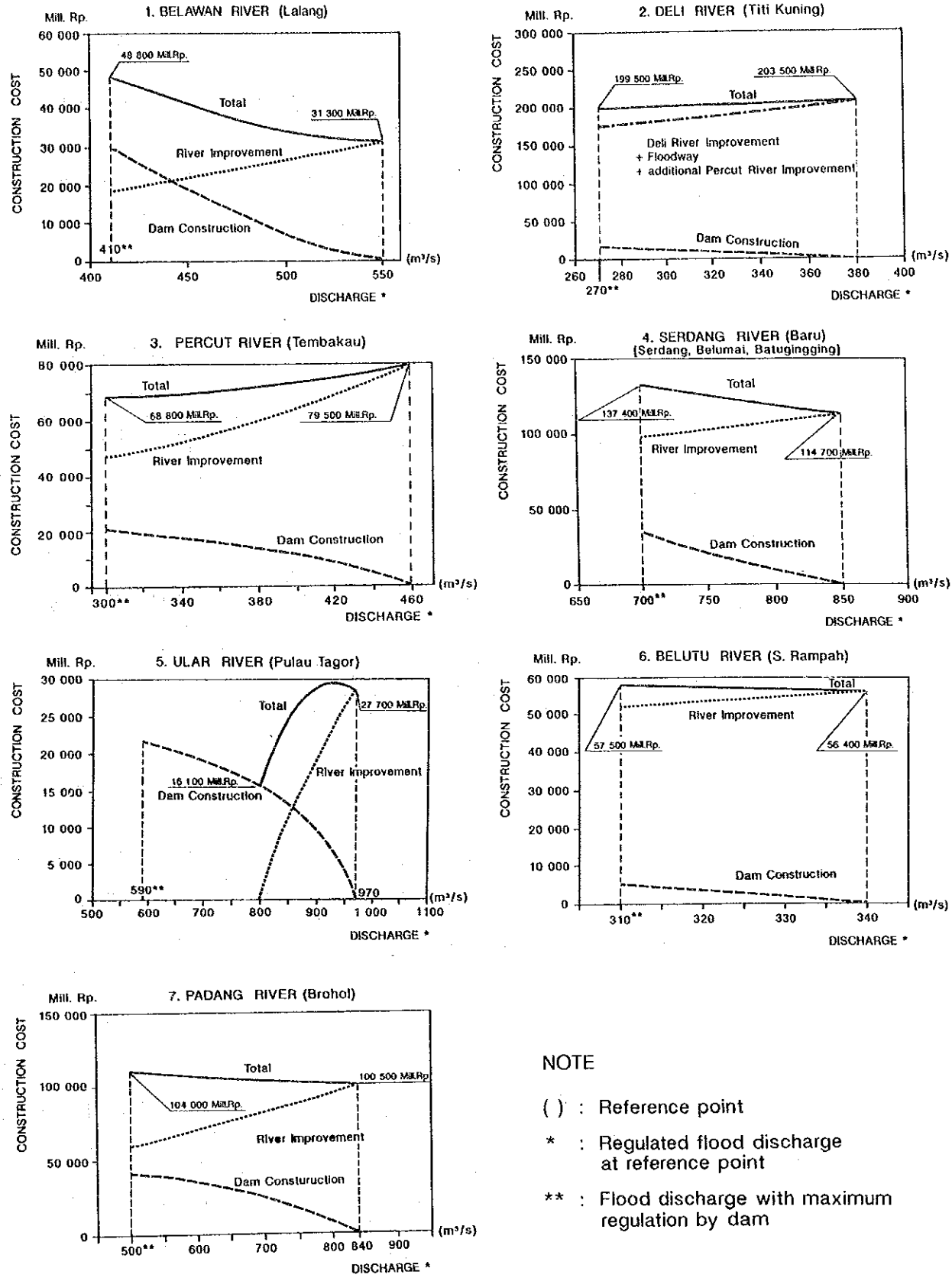


COST COMPARISON BETWEEN WITH AND WITHOUT LAUSIMEME DAM ON PERCUT RIVER



COST COMPARISON BETWEEN WITH AND WITHOUT FLOODWAY ON DELI RIVER

THE STUDY ON BELAWAN-PADANG INTEGRATED RIVER BASIN DEVELOPMENT IN THE REPUBLIC OF INDONESIA JAPAN INTERNATIONAL COOPERATION AGENCY	COST COMPARISON FOR FLOODWAY AND LAUSIMEME DAM Fig.4-4



NOTE

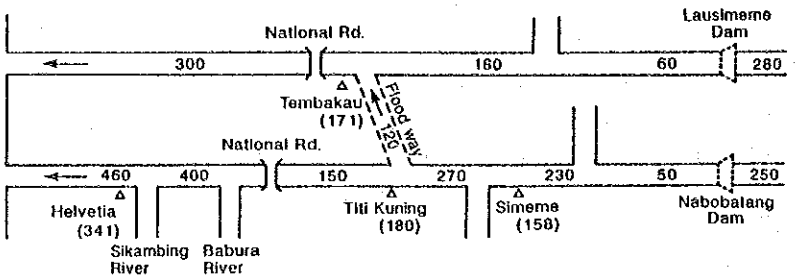
( ) : Reference point

* : Regulated flood discharge at reference point

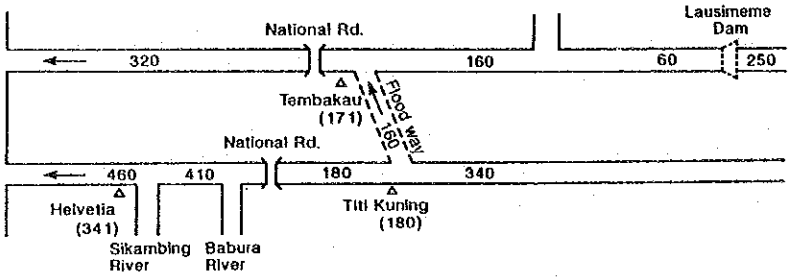
** : Flood discharge with maximum regulation by dam

THE STUDY ON BELAWAN-PADANG INTEGRATED RIVER BASIN DEVELOPMENT IN THE REPUBLIC OF INDONESIA JAPAN INTERNATIONAL COOPERATION AGENCY	COST COMPARISON BETWEEN DAM AND RIVER IMPROVEMENT WORKS Fig.4-5

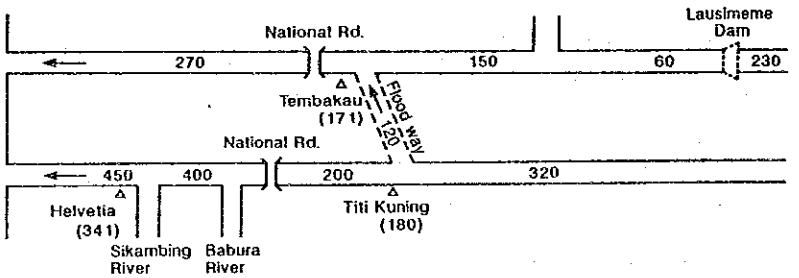
100-YEAR



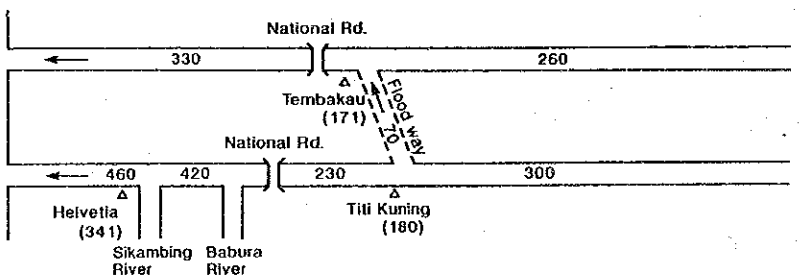
50-YEAR



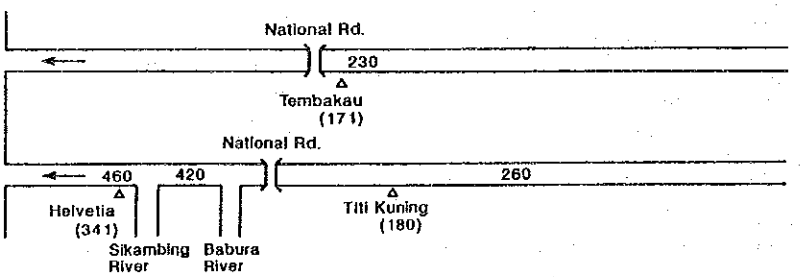
30-YEAR



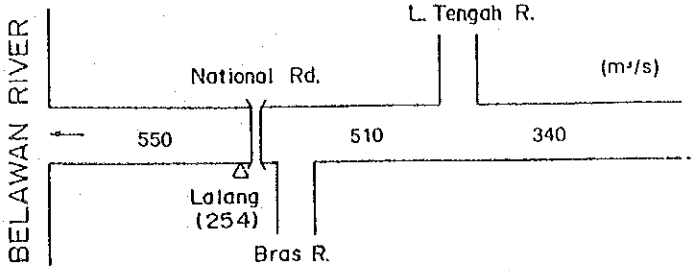
20-YEAR

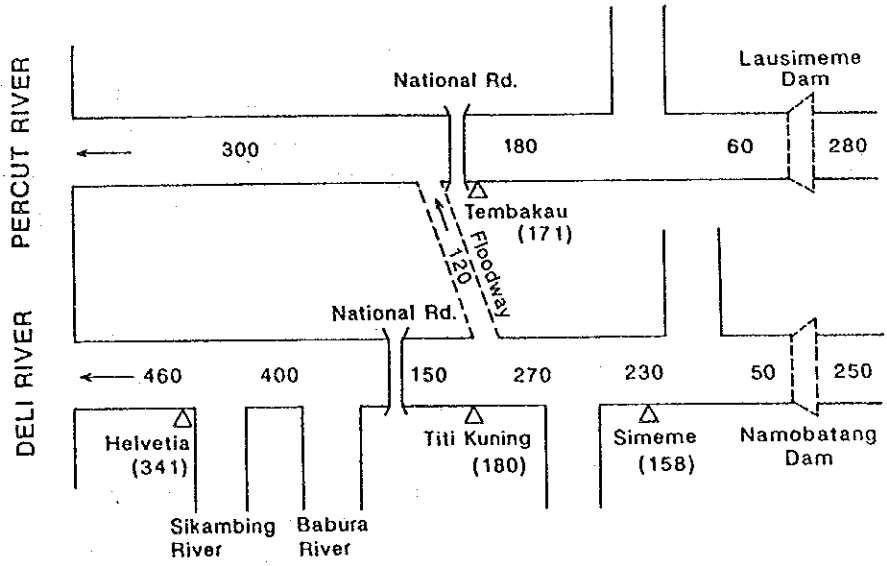


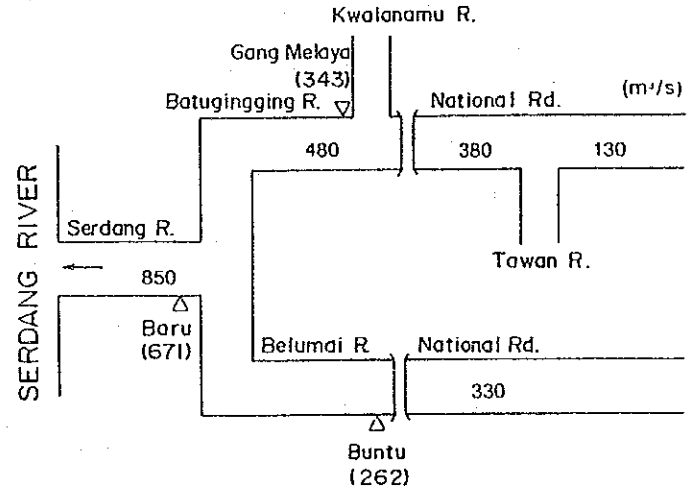
10-YEAR



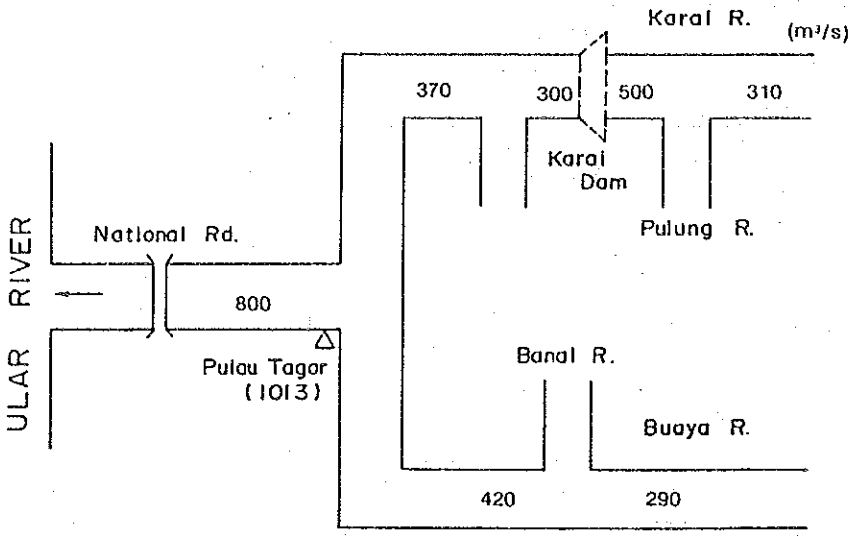
THE STUDY ON BELAWAN-PADANG INTEGRATED RIVER BASIN DEVELOPMENT IN THE REPUBLIC OF INDONESIA JAPAN INTERNATIONAL COOPERATION AGENCY	PROBABLE FLOOD DISCHARGE OF DELI-PERCUT RIVER Fig.4-6

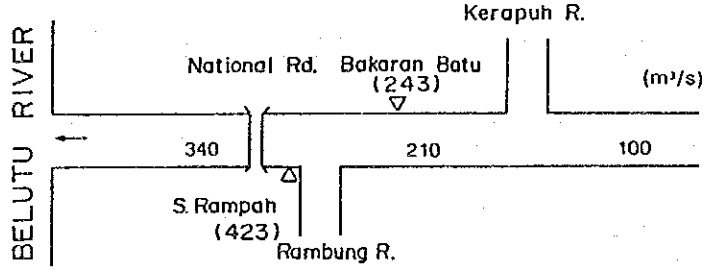


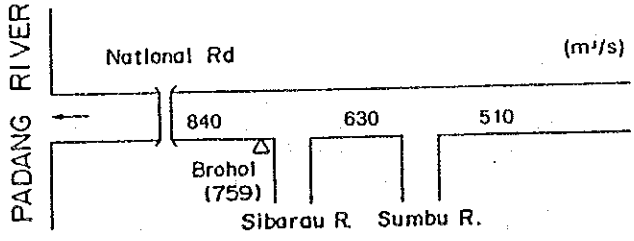




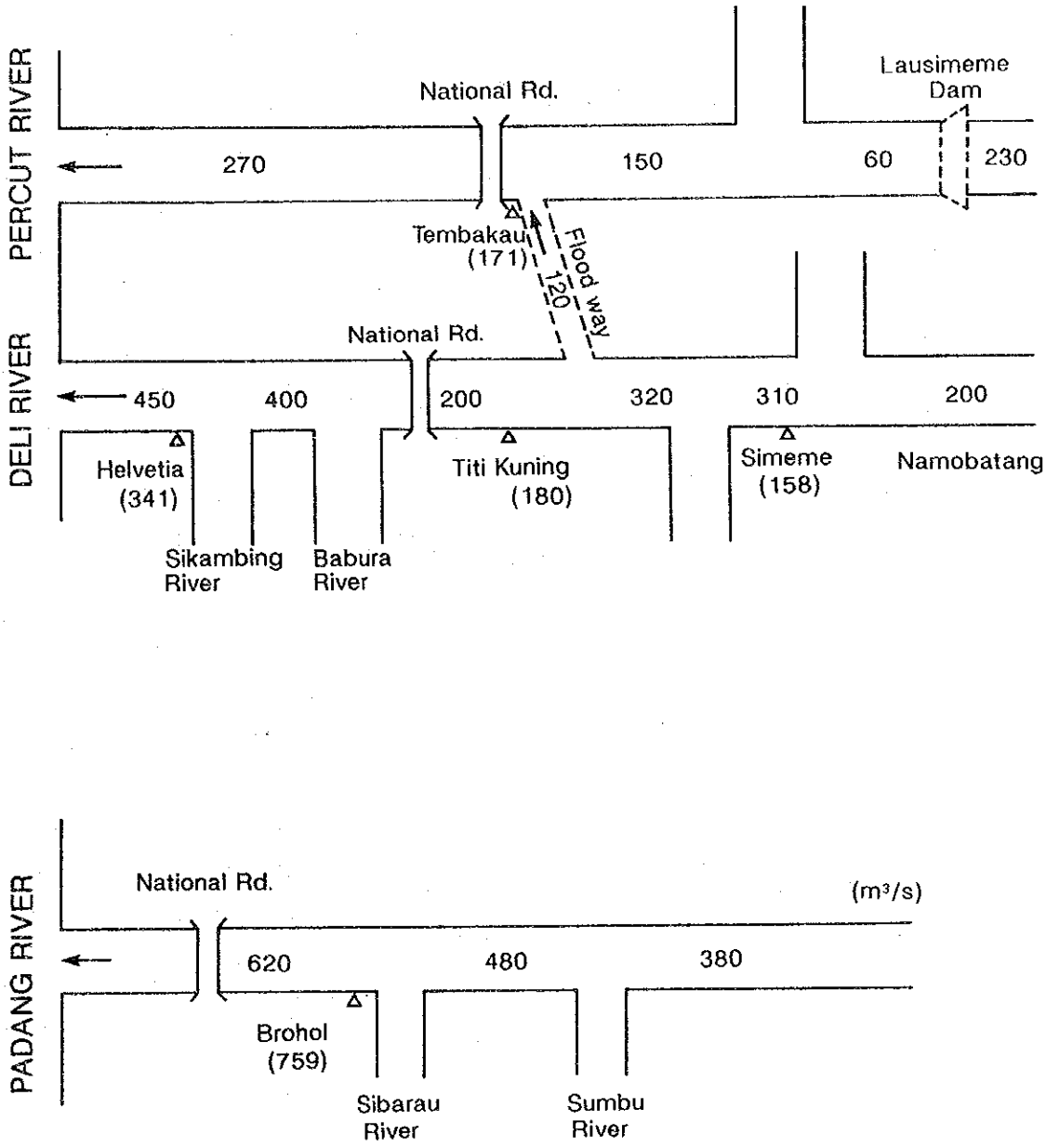
THE STUDY ON BELAWAN-PADANG INTEGRATED RIVER BASIN DEVELOPMENT IN THE REPUBLIC OF INDONESIA JAPAN INTERNATIONAL COOPERATION AGENCY	DESIGN FLOOD DISCHARGE OF OPTIMUM FLOOD CONTROL PLAN Fig.4-7(1/2)







THE STUDY ON BELAWAN-PADANG INTEGRATED RIVER BASIN DEVELOPMENT IN THE REPUBLIC OF INDONESIA JAPAN INTERNATIONAL COOPERATION AGENCY	DESIGN FLOOD DISCHARGE OF OPTIMUM FLOOD CONTROL PLAN Fig.4-7(2/2)



THE STUDY ON BELAWAN-PADANG INTEGRATED RIVER BASIN DEVELOPMENT IN THE REPUBLIC OF INDONESIA JAPAN INTERNATIONAL COOPERATION AGENCY	DESIGN FLOOD DISCHARGE OF URGENT PROJECT Fig.5-1

SC
SEDIMENT CONTROL PLAN

STUDY ON BELAWAN-PADANG
INTEGRATED RIVER BASIN DEVELOPMENT

SUPPORTING REPORT

SEDIMENT CONTROL PLAN

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SUPPORTING REPORT

SEDIMENT CONTROL PLAN

1. INTRODUCTION

Sediment analysis is performed to know the present sediment condition in the study area, and to prepare and propose a preliminary sediment control plan. The study items are as follows:

(a) Field investigation and data collection to know the sediment condition;

(b) Riverbed material survey and suspended load measurement;

(c) Estimation of sediment yield rate;

(d) Sediment balance analysis from mountain slopes to river mouths; and

(e) Preparation and proposal of a preliminary sediment control plan based on the results of the above.

2. PRESENT SEDIMENT CONDITION

2.1 Present Condition of the Study Area

Field investigation and data collection were carried out to know the present condition of sediment in the study area. The results are summarized as follows:

(a) On the steep slope in the upper stream of the river basin, a large scale debris flow occurred some 50 to 100 years ago. No recent sediment yield due to a large scale collapse has been recognized, and rivers in the study area seem to be stable.

(b) Sediment yield due to bank erosion with a small collapse is observed at the river bend in the middle stream.

(c) Sediment yield due to sheet erosion at the plantation site and upland cultivation fields is observed from the middle stream to the downstream.

(d) No remarkable sediment deposit is observed in the main course of the seven rivers. Sand banks have developed along some portions of the river channels.

(e) Irrigation canal beds downstream of Belawan River, Serdang River and Belutu River have risen due to deposits of fine sand.

Details of sedimentation and sediment deposition by river basin are described as follows:

(1) Belawan River

No large scale collapse on the mountain slopes is found, although secondary erosion on some deposits produced by the old slope collapse was observed. In the upstream riverbed, boulders of 0.5 to 2.0 m in diameter transported from the said deposits are observed. In the downstream, no remarkable erosion and deposition are observed, although a slight erosion of the concave bank is seen.

(2) Deli River

In the upstream riverbed, boulders of 1.0 to 2.0 m in diameter with moss growing over them are observed. These boulders came down with debris flow some 50 to 100 years ago. They are now being eroded and gradually transported to the downstream.

Some bank erosions are observed a little upstream of Medan City. There are boulders of 1.0 to 2.0 m in diameter in the riverbed of the Deli River, but in Babura River, almost no deposit is seen and bedrocks are cropping out.

(3) Percut River

After flowing on the steep mountain slope of the upper stream basin, the riverbed gradient of Percut River becomes rather flat and it is covered with an armor coat consisting of boulders with a diameter of 20 to 50 cm. Sediment deposition is infrequent and the riverbed is stable. In the upper reaches of Desa Sibiru Biru, sandbars exist in stratified layers of up to 5.0 cm thick each.

(4) Serdang River

In the upstream basin, no sediment is deposited in the riverbed of Belumai River, and the rock riverbed exists for a long distance. Soft bedrocks are deeply eroded downward and sediment is seen only at the site of the convex bank.

Since the riverbed of the upper reaches of Batugingging River consists of soft rock, no serious downward erosion is observed, although deposits of fine sand are seen sporadically. However, in the downstream, Batugingging River and its tributaries carry a lot of fine sands which may later be deposited as sediment in the lower reaches.

(5) Ular River

There are debris flow deposits found in almost every stream running on the mountain slope in Buaya River Basin. In paddies developed on the deposits, large boulders with a diameter of 1.0 to 2.0 m are found.

In the middle stream, deposits of sub-round boulders transported from the upper stream and outcropped rocks are occasionally observed in the riverbed. Sediment depth is thin.

In the lower reaches near Desa Mabar or the junction with Karai River, deposits of fine sands are seen only at bends of the river channel. In the riverbed of Karai River, downward erosion is dominant and the river channel forms a narrow valley.

(6) Belutu River

In the upper stream, no big scale erosion and deposit are observed with less sediment content.

From the middle stream at Desa Silau Dunia, sandbars have formed, raising the riverbed. Rambung River, as well as the other tributaries, has a high sediment content and has a tendency of sediment deposition from sheet erosion in the surrounding plantation.

(7) Padang River

In the riverbed of the upper stream of Padang River, downward erosion is dominant and the river channel forms a deep valley. The rock forming the river bank is relatively hard and has less fissures.

In the riverbed of the middle stream with a gentle slope, boulders with a diameter of 20 to 50 cm have been deposited. These boulders may have been brought by erosion of the river terrace. There are so many denuded sites due to the new plantation where sediment yield by sheet erosion is remarkable. Further, surface slides are seen on slopes of the plantation abutting on the valley.

2.2 Riverbed Materials and Suspended Load

Riverbed Material Survey

Riverbed material survey consisting of grain size analysis and specific gravity test was conducted in this Study. Ten (10) sampling sites were selected for each river, with each site having a pitch of 10 km along the river course as indicated in Fig. 2-1. The riverbed materials were gathered after removing the superficial coarse grains.

The grain size analysis consists of the sieve analysis (the grain diameter larger than 74 microns) and hydrometer analysis (the grain diameter smaller than 74 microns). The results are presented in Table 2-1 and the grain size accumulation curves are drawn combining the results of both analyses as shown in Fig. 2-2.

Suspended Load Survey

Two (2) sampling sites of suspended load survey were selected for each river basin as shown in Fig. 2-1. Sampling was executed at three (3) points along the river course at each site, i.e, the right bank side, the centre of flow and the left bank side.

Moreover, in order to draw the relation between the volume of suspended load and the discharge, the flow discharge was also measured. The measurement records are given in Table 2-2.

On the other hand, suspended load survey has been executed by DPU in six (6) river basins excluding Belutu River and has been reported in Hasil Analisa Kadar Sedimen Sungai-Sungai Propinsi Sumatera Utara 1979, 1980.

Fig. 2-3 gives the relationship between suspended load and flow discharge based on the observations by DPUP and this Study.

2.3 Sediment Damage

Through the field investigation and data collection, the following damage related to sediment has been identified:

(a) Several devastated areas in the upper reaches are identified in Ular River Basin (5,300 ha) and in the Padang River Basin (1,440 ha) by the Forestry Service (Dinas Kehutanan) of North Sumatra. Devastation in the Padang River Basin which is located east of the

Ular River, is worse than in the Ular River Basin. The devastated areas identified from the aerophoto with a scale of 1:20,000 are shown in Fig. 2-4.

(b) Intake facilities located along the Deli River suffer from sediment deposition and require more frequent removal than planned.

(c) The rise of the riverbed of the Serdang and Belutu rivers due to deposits of sediment from their upper streams has reduced the flow capacity of the river channels resulting in frequent flooding.

(d) Generally, sudden occurrence of debris flow and mudflow does not directly cause sediment damage in the study area. The indirect effects of rivedbed aggradation and channel erosion which frequently occur are longer lasting.

2.4 Existing and Planned Sediment and Erosion Control Works

No structural measure has been undertaken for sediment control. However, studies and investigations have been carried out for the Ular River Basin to determine the causes and provide countermeasures against sediment disasters, as follows:

Past Studies and Investigations

(1) Ular River Improvement Project (1977)

Changes on riverbed condition was investigated at two sites in 1955, the Serbajadi Bridge site and the Ular Railway Bridge site. The results of investigation show that the riverbed did not change but has the tendency of slight lowering at the Serbajadi Bridge site and rising at the Ular Railway Bridge site.

(2) Riverbed Fluctuation of Ular River (1988)

Future riverbed fluctuation was estimated using a mathematical model where calculation of sediment discharge and non-uniform flow were combined. The total deposition volumes were estimated at approx. 35,000 m^3/year for the whole stretch of 36.0 km; hence, the rise of riverbed was estimated at only 0.15 m at maximum. It was then concluded that the riverbed of Ular River is rather stable for a range of 10 years.

Forest Conservation

In Indonesia, certain areas in national forests are designated as conservation forests. For the purpose of conserving the forest, no activity that will change the natural condition is allowed. In the study area, 42,350 ha of forests are designated as forest conservation zone, i.e., 24,350 ha in the Ular River Basin and 18,100 ha in the Padang River Basin. Their locations are shown in Fig. 2-5.

Correspondingly, watershed management and erosion control works are under the control of the Ministry of Forestry. The ongoing projects in the study area are the Wampu and Ular Watershed Reforestation and Greening Projects (Projek Pembinaan Reboisasi dan Penghijauan DAS Wampu/Ular) under the Directorate General of Reforestation and Rehabilitation, Ministry of Forestry. Severely damaged areas are to be rehabilitated under the project through erosion control measures such as reforestation and re-greening.

3. SEDIMENT YIELD AND BALANCE ANALYSIS

3.1 Sediment Yield

Sediment yield in the study area is classified into two (2) modes, sheet erosion in the area of plantation or upland cultivation, and channel erosion and collapse of the river bank. The estimation of sediment yield is conducted on the basis of the above two modes.

Sheet Erosion

In the estimation of sheet erosion volume, land use condition of the study area is divided into seven (7) categories, and according to each category the following depths of annual soil erosion are applied taking into account the past empirical data.

Depth of Annual Soil Erosion

Land Use	Annual Soil Erosion (mm/yr)	Remarks
Settlement	0.000	---
Wetland Cultivation	0.000	---
Upland Cultivation	0.800	---
Plantation	0.509	10% x 5 mm/yr + 90% x 0.01 mm/yr
Shifting Cultivation	0.176	20% x 0.8 mm/yr + 80% x 0.02 mm/yr
Bush	0.02	---
Forest	0.01	---

Consequently, the total amount of sediment volume due to sheet erosion in the study area is estimated at 1.7 MCM/yr. Table 3-1 shows the detailed results of sediment yield estimation for each river basin and land use condition.

Channel Erosion and Collapse of Bank

Sediment yield due to bank erosion, riverbed erosion (including secondary erosion of deposits) and collapse of river bank are estimated based on the valley order analysis of the Horton's Law using topographic maps of 1:50,000 scale. The following sediment yield per unit length of channel erosion and collapse of bank in the study area are applied to each river channel to estimate the annual sediment volume by valley order.

Sediment Yield Per Channel Length

Valley Order	Channel Erosion and Collapse (m^3/km.yr)
1st	15
2nd	25
3rd	30
4th	120
5th	135
6th	180

Results of the sediment yield estimation of channel erosion and collapse of bank are given in Table 3-1. The total volume of sediment yield in the whole river basin amounts to 1.88 MCM/yr. The summary of sediment yield due to sheet erosion and channel erosion is presented as follows:

Summary of Sediment Yield

(Unit: 1000 m^3/yr.)

River	Sheet Erosion	Channel Erosion	Total
Belawan	181.9	18.2	200.1
Deli	125.9	14.9	140.8
Percut	51.3	9.8	61.1
Serdang	360.0	23.0	383.0
Ular	470.5	47.4	517.9
Belutu	152.0	15.6	167.6
Padang	376.2	37.0	413.2
Total	1,717.8	165.9	1,883.7

3.2 Volume of Sediment Transport

The volume of sediment transport can be estimated due to the sediment transportability of riverbed materials consisting of bed load and suspended load. Bed load is generated by the force of water running toward the downstream direction against the riverbed material, while suspended load is generated by the diffusion of water due to turbulent flow. For the estimation of the volume of sediment transport, Sato, Kikkawa and Ashida's Formula is employed for the bed load and the relationship between suspended load and flow discharge as estimated in Subsection 2.2 is applied for the suspended load (refer to Table 3-2).

3.3 Sediment Balance

In this study, sediment balance is considered from the upper stream to the downstream. The sediment balance analysis in each river basin is conducted using the values of sediment yield and sediment transport obtained before. The process of calculation is expressed by the following formula:

$$V_4 = V_1 + V_2 - V_3$$

where, V_1 : sediment inflow from upper unit basin (m^3/yr)
V_2 : sediment yield in a unit basin (m^3/yr)
V_3 : sediment deposit in a unit basin (m^3/yr)
V_4 : sediment discharge from a unit basin (m^3/yr)

In case that the value of sediment inflow (sediment yield in a unit basin plus sediment discharge from upper stream) of a unit basin exceeds the sediment transportability (sediment transport) in the downstream of the unit basin, the difference between both values means the quantity of deposit. The results of the calculation of sediment balance in the study area are shown in Table 3-3 and Fig. 3-1.

4. PROPOSED SEDIMENT CONTROL PLAN

4.1 Erosion Control Facilities

From the results of the field investigation and the sediment balance analysis, it is concluded that erosion control facilities such sabo dams and check dams are not required for the study area. The main reasons are summarized as follows:

(a) Sediment movement in the study area seems to be a process of regular transformation of the natural topographical characteristics, although sediment tends to deposit in the middle reaches of the Deli and Serdang rivers, and the lower reaches of the Ular, Belutu and Padang rivers.

(b) Sediment yield in the study area is usually generated by superficial erosion like sheet erosion. Generally, sheet erosion cannot be prevented from spreading by means of structural works like the construction of a check dam, because it is difficult to pinpoint the exact location of occurrence and there are many possible places where sheet erosion may occur in a large river basin.

4.2 Forest Conservation

To keep annual sediment discharge in the river basin below the harmful volume, orderly preservation works of plants such as the designation of a forest reserve area, reforestation and re-greening should be consistently implemented. In this study area, the following matters should be taken into consideration to conserve the vegetation in the river basin.

For a plantation, in case felling is required, the method of felling that will minimize erosion should be employed. For upland cultivation, land clearing by burning and/or changes of the present land use should be prohibited or restricted by the promulgation of laws and regulations to control erosion on the steep slope of a hilly land. In addition, since drifting woods and sediment deposits cause disasters such as scouring of bridge foundation and inundation at flood time, appropriate countermeasures should be considered to conduct salvage works.

4.3 Change of Land Use Condition

With the progress of land use potential by urbanization or clearing of land at the foot of mountains, vegetation in the study area has been drastically changed and the occurrence of disasters in a mountain area has rapidly increased. Considering the past records on the occurrence of large-scale debris flow as mentioned above, an erosion control plan will be required according to the degree of change of land use condition.

4.4 Sediment Deposit at Irrigation Intake Facilities

River streams contain a great deal of sediment, so that sediment deposits could aggravate the capacity of irrigation intake facilities. This situation is anticipated in all cases, so that regular

maintenance work by dredging will be required. In case economical maintenance work cannot be made, appropriate improvement works should be planned to decrease sediment inflow.

4.5 Erosion and Sediment Deposits in River Channel

Since there is no large-scale and continuous bank erosion and collapse along the river channels in the study area, large scale countermeasures may not be required. For local bank erosion and collapse affecting a residential area and/or public facilities, individual treatment works such as the installation of spurdike, bank protection works, turfing works, etc., have to be executed accordingly.

TABLES

Table 2-1(1/2) RESULTS OF RIVERBED MATERIAL SURVEY

River	Sampling Point	Specific Gravity	D60 (mm)	D30 (mm)	D10 (mm)	Dm (mm)	Uc	Uc'
Belawan	BE- 1	2.52	0.140	0.020	0.001	0.160	140.000	2.860
	BE- 2	2.88	0.410	0.330	0.200	0.530	2.050	1.330
	BE- 3	3.04	0.600	0.290	0.150	0.780	4.000	0.930
	BE- 4	2.55	0.120	0.030	0.001	0.150	120.000	7.500
	BE- 5	2.79	0.190	0.140	0.020	0.230	9.500	5.160
	BE- 6	2.94	37.450	17.080	4.540	35.550	8.250	1.720
	BE- 7	2.48	0.120	0.030	0.001	0.150	120.000	7.500
	BE- 8	2.83	21.550	6.480	0.750	22.550	28.730	2.600
	BE- 9	2.69	15.170	0.830	0.410	32.340	37.000	0.110
	BE-10	2.71	8.330	2.620	0.620	11.030	13.440	1.330
Deli	DE- 1	2.61	0.140	0.040	0.001	0.170	140.000	11.430
	DE- 2	2.76	0.160	0.110	0.001	0.160	160.000	75.630
	DE- 3	2.78	0.730	0.400	0.250	0.930	2.920	0.880
	DE- 4	2.67	0.150	0.060	0.001	0.140	150.000	24.000
	DE- 5	3.03	1.040	0.390	0.220	2.990	4.730	0.660
	DE- 6	2.61	0.640	0.340	0.180	1.030	3.560	1.000
	DE- 7	2.99	1.070	0.540	0.210	1.540	5.100	1.300
	DE- 8	2.78	57.240	6.880	0.570	44.540	100.420	1.450
	DE- 9	2.99	19.050	0.680	0.340	35.510	56.030	0.070
	DE-10	3.08	12.340	1.620	0.360	10.890	34.280	0.590
Percut	PE- 1	2.79	0.770	0.390	0.180	1.060	4.280	1.100
	PE- 2	2.76	0.410	0.250	0.130	0.720	3.150	1.170
	PE- 3	2.70	0.170	0.130	0.003	0.230	56.670	33.140
	PE- 4	2.62	0.160	0.090	0.001	0.170	160.000	50.630
	PE- 5	2.98	0.400	0.280	0.160	1.320	2.500	1.230
	PE- 6	3.27	27.340	8.570	0.350	30.970	78.110	7.680
	PE- 7	2.85	42.120	6.460	0.650	42.490	64.800	1.520
	PE- 8	2.75	39.590	11.730	0.930	42.170	42.570	3.740
	PE- 9	3.14	61.210	15.720	1.730	49.540	35.380	2.330
	PE-10	2.69	46.360	9.030	0.800	42.880	57.950	2.200
Serdang	SE- 1	2.72	1.730	0.840	0.370	1.950	4.680	1.100
	SE- 2	2.72	0.150	0.070	0.001	0.130	150.000	32.670
	SE- 3	2.76	0.170	0.130	0.002	0.260	85.000	49.710
	SE- 4	3.03	90.020	10.870	0.650	53.150	138.490	2.020
	SE- 5	3.00	92.410	20.510	1.550	58.310	59.620	2.940
	SE- 6	2.69	23.690	4.290	0.760	28.620	31.170	1.020
	SE- 7	2.63	0.690	0.400	0.290	0.760	2.380	0.800
	SE- 8	2.66	1.850	1.170	0.590	1.780	3.140	1.250
	SE- 9	2.64	0.480	0.310	0.170	0.640	2.820	1.180
	SE-10	2.64	0.670	0.390	0.200	0.620	3.350	1.140

Note D60 : 60% Diameter D30 : 30% Diameter
D10 : 10% Diameter Uc : Uniformity Coefficient
Uc': Uniformity Coefficient

Table 2-1(2/2) RESULTS OF RIVERBED MATERIAL SURVEY

River	Sampling Point	Specific Gravity	D60 (mm)	D30 (mm)	D10 (mm)	Dm (mm)	Uc	Uc'
Ular	UL- 1	2.63	0.620	0.340	0.150	0.730	4.130	1.240
	UL- 2	2.64	0.830	0.540	0.310	0.950	2.680	1.130
	UL- 3	2.65	0.700	0.410	0.290	0.680	2.410	0.830
	UL- 4	2.66	0.400	0.290	0.160	0.400	2.500	1.310
	UL- 5	2.66	0.990	0.590	0.350	1.250	2.830	1.000
	UL- 6	2.68	106.810	21.060	5.750	63.590	18.580	0.720
	UL- 7	2.72	101.470	19.460	2.690	66.230	37.720	1.390
	UL- 8	2.67	0.830	0.640	0.390	0.940	2.130	1.270
	UL- 9	2.67	0.390	0.300	0.180	0.360	2.170	1.280
	UL-10	2.90	0.810	0.400	0.240	4.680	3.380	0.820
Belutu	BT- 1	2.47	0.170	0.050	0.001	0.190	170.000	14.710
	BT- 2	2.61	0.690	0.380	0.250	0.790	2.760	0.840
	BT- 3	2.66	1.050	0.630	0.370	1.050	2.840	1.020
	BT- 4	2.62	1.180	0.600	0.340	1.240	3.470	0.900
	BT- 5	2.64	1.190	0.630	0.330	1.120	3.610	1.010
	BT- 6	2.65	1.180	0.680	0.390	1.180	3.030	1.000
	BT- 7	2.68	0.930	0.620	0.330	1.100	2.820	1.250
	BT- 8	2.64	0.800	0.400	0.250	1.130	3.200	0.800
	BT- 9	2.72	103.340	30.910	1.980	72.010	52.190	4.670
	BT-10	2.64	0.770	0.500	0.340	0.810	2.260	0.950
Padang	PA- 1	2.64	0.980	0.600	0.340	0.970	2.880	1.080
	PA- 2	2.62	1.440	0.720	0.300	1.080	4.800	1.200
	PA- 3	2.62	0.340	0.200	0.140	0.380	2.430	0.840
	PA- 4	2.65	0.770	0.610	0.390	0.760	1.970	1.240
	PA- 5	2.63	0.710	0.440	0.290	0.690	2.450	0.940
	PA- 6	2.71	12.600	1.600	0.550	11.960	22.910	0.370
	PA- 7	2.68	34.280	9.290	0.780	40.510	43.950	3.230
	PA- 8	2.69	0.420	0.340	0.220	0.470	1.910	1.250
	PA- 9	2.69	0.760	0.600	0.380	0.720	2.000	1.250
	PA-10	2.66	58.940	17.610	6.000	51.090	8.890	0.790

Note D60 : 60% Diameter D30 : 30% Diameter
D10 : 10% Diameter Uc : Uniformity Coefficient
Uc': Uniformity Coefficient

Table 2-2 RESULTS OF SUSPENDED LOAD SURVEY

River	Sampling Point	1st time		2nd time		3rd time	
		SL (ml/s)	Q (m3/s)	SL (ml/s)	Q (m3/s)	SL (ml/s)	Q (m3/s)
Belawan	BES- 1	61.70	13.40	62.23	7.46	60.30	7.46
	BES- 2	62.00	8.30	61.33	4.19	60.33	4.02
Deli	DES- 1	73.00	20.00	75.00	19.80	60.33	11.00
	DES- 2	64.33	4.55	71.33	2.64	60.00	3.30
Percut	PES- 1	64.33	7.78	74.66	4.35	59.66	6.40
	PES- 2	63.00	6.64	65.67	3.49	60.00	4.33
Serdang	SES- 1	60.66	6.29	61.66	0.02	59.33	1.51
	SES- 2	60.33	13.00	62.00	10.00	59.00	9.00
Ular	ULS- 1	62.66	38.87	62.33	27.29	60.33	44.57
	ULS- 2	62.00	62.61	61.00	45.09	59.33	38.99
Belutu	BTS- 1	61.66	5.01	61.33	4.05	59.00	0.64
	BTS- 2	61.00	8.00	61.66	7.73	59.00	7.87
Padang	PAS- 1	59.66	21.18	62.00	26.60	61.33	18.68
	PAS- 2	59.00	23.67	60.33	24.70	61.66	19.43

Note Q : Water Discharge

SL : Suspended Load

Table 3-1 VOLUME OF ANNUAL SEDIMENT YIELD

Unit-basin		Area of Present Land Use (km2)							Length of Valley Order (km)						Volume of Sediment Yield (1000m3/yr.)			
		Settle-ment	Wetland Culti-vation	Upland Culti-vation	Planta-tion	Shifting Culti-vation	Bush	Forest	1st	2nd	3rd	4th	5th	6th	Sheet Erosion	Channel Erosion	Total	Accu-mula-tion
Belawan River	1	0.0	0.0	22.6	0.6	97.7	20.1	0.0	66	38	25	0	0	0	36.0	2.7	38.7	38.7
	2	0.0	27.8	50.9	9.3	25.0	0.0	0.0	42	31	16	19	1	0	49.9	4.3	54.2	92.9
	3	0.0	8.3	0.0	6.7	0.0	0.0	0.0	0	0	0	0	19	0	3.4	2.6	6.0	98.9
	4	9.0	26.0	0.0	71.0	0.0	0.0	20.0	56	36	10	0	5	0	36.3	2.7	39.0	137.9
	5	0.0	99.0	0.0	110.1	0.0	1.8	12.1	73	65	43	8	2	0	56.2	5.2	61.4	199.3
	6	0.0	14.5	0.0	0.0	0.0	0.0	14.5	11	6	0	0	3	0	0.1	0.7	0.8	200.1
sub-total		9.0	175.6	73.5	197.7	122.7	21.9	46.6	248	176	94	27	30	0	181.9	18.2	200.1	
Deli River	1	0.0	0.0	0.0	0.0	11.2	53.8	28.0	59	12	38	1	0	0	3.3	2.4	5.7	5.7
	2	15.0	2.3	59.0	0.0	32.7	0.0	0.0	37	25	5	24	19	0	53.0	6.8	59.8	65.5
	3	6.0	0.0	35.3	37.4	20.3	0.0	0.0	49	29	23	6	0	0	50.8	2.9	53.7	119.2
	4	16.0	0.0	18.0	6.0	0.0	0.0	0.0	12	9	6	0	0	0	17.5	0.6	18.1	137.3
	5	0.5	12.9	0.0	2.6	0.0	0.0	1.0	0	0	0	0	16	0	1.3	2.2	3.5	140.8
sub-total		37.5	15.2	112.3	46.0	64.2	53.8	29.0	157	75	72	31	35	0	125.9	14.9	140.8	
Percut River	1	0.0	0.0	0.0	0.6	30.5	20.7	53.2	73	33	15	18	0	0	6.6	4.5	11.1	11.1
	2	4.2	16.6	51.9	5.2	3.1	0.0	0.0	27	5	2	39	0	0	44.7	5.3	50.0	61.1
sub-total		4.2	16.6	51.9	5.8	33.6	20.7	53.2	100	38	17	57	0	0	51.3	9.8	61.1	
Serdang River	1	0.0	0.0	73.6	0.0	3.0	46.3	15.1	62	27	30	10	0	0	60.5	3.7	64.2	64.2
	2	0.0	0.0	95.6	18.9	9.5	0.0	0.0	39	31	1	0	35	0	87.8	6.1	93.9	158.1
	3	0.0	1.4	42.2	39.4	0.0	0.0	0.0	43	21	15	11	0	0	53.8	2.9	56.7	214.8
	4	0.0	28.9	17.7	142.4	0.0	0.0	0.0	86	45	39	12	5	0	86.6	5.7	92.3	307.1
	5	0.0	3.0	0.0	68.0	0.0	0.0	0.0	24	14	30	0	0	0	34.6	1.6	36.2	343.3
	6	0.0	1.2	23.7	34.5	0.0	6.6	0.0	33	13	18	0	12	0	36.7	3.0	39.7	383.0
sub-total		0.0	34.5	252.8	303.2	12.5	52.9	15.1	287	151	133	33	52	0	360.0	23.0	383.0	
Ular River	1	0.0	0.0	185.6	0.0	6.6	96.9	2.9	193	82	66	26	19	0	151.6	12.6	164.2	164.2
	2	0.0	0.0	80.2	0.0	15.6	13.5	44.7	94	40	30	8	25	0	67.6	7.6	75.2	239.4
	3	0.0	0.0	0.0	22.5	0.0	14.6	16.9	5	0	0	0	0	21	11.9	3.9	15.8	255.2
	4	0.0	4.5	7.7	43.9	0.0	0.0	15.9	20	22	10	0	0	4	28.7	1.9	30.6	285.8
	5	0.0	0.0	55.4	0.0	42.3	54.3	38.0	112	49	28	26	10	0	53.2	8.2	61.4	347.2
	6	0.0	3.0	83.0	18.0	0.0	0.0	0.0	69	28	14	2	24	0	75.6	5.6	81.2	428.4
	7	0.0	4.8	40.9	15.0	25.1	5.0	43.2	57	32	20	5	0	0	45.3	2.9	48.2	476.6
	8	0.0	0.0	0.0	12.0	0.0	0.0	0.0	1	0	0	0	6	0	6.1	0.8	6.9	483.5
	9	0.0	8.0	0.0	60.0	0.0	0.0	0.0	27	10	18	0	0	15	30.5	3.9	34.4	517.9
sub-total		0.0	20.3	452.8	171.4	89.6	184.3	162.6	578	263	186	67	84	40	470.5	47.4	517.9	
Belutu River	1	0.0	0.0	11.2	0.0	0.0	37.9	12.9	17	4	27	0	0	0	9.8	1.2	11.0	11.0
	2	0.0	8.9	0.0	33.6	0.0	23.5	0.0	19	13	22	6	4	0	17.6	2.5	20.1	31.1
	3	0.0	7.3	0.0	25.6	0.0	60.4	2.7	29	26	19	12	0	0	14.3	3.1	17.4	48.5
	4	0.0	5.8	0.0	27.2	0.0	0.0	0.0	8	2	0	0	15	0	13.8	2.2	16.0	64.5
	5	0.0	0.0	4.1	161.9	0.0	0.0	0.0	67	23	14	25	0	0	85.7	5.0	90.7	155.2
	6	0.0	55.8	0.0	21.2	0.0	0.0	0.0	33	11	0	0	6	0	10.8	1.6	12.4	167.6
sub-total		0.0	77.8	15.3	269.5	0.0	121.8	15.6	173	79	82	43	25	0	152.0	15.6	167.6	
Padang River	1	0.0	0.0	15.0	165.0	0.0	3.0	58.0	68	72	43	4	9	0	96.6	5.8	102.4	102.4
	2	0.0	0.0	0.0	129.0	0.0	0.0	0.0	87	61	20	27	1	0	65.7	6.8	72.5	174.9
	3	0.0	0.0	0.0	44.0	0.0	0.0	0.0	19	5	10	2	0	15	22.4	3.7	26.1	201.0
	4	0.0	0.0	0.0	105.0	0.0	5.0	0.0	33	22	25	11	0	0	53.5	3.1	56.6	257.6
	5	0.0	0.0	31.4	7.7	0.0	51.7	30.2	55	28	10	29	0	0	30.4	5.3	35.7	293.3
	6	0.0	0.0	0.0	92.3	0.0	21.7	0.0	19	14	7	35	0	0	47.4	5.0	52.4	345.7
	7	0.0	14.6	0.0	45.8	0.0	0.0	0.0	19	10	20	3	0	10	23.3	3.3	26.6	372.3
	8	5.0	21.5	0.0	72.5	0.0	0.0	0.0	31	28	13	19	0	1	36.9	4.0	40.9	413.2
sub-total		5.0	36.1	46.4	661.3	0.0	81.4	88.2	331	240	148	130	10	26	376.2	37.0	413.2	
Total		55.7	376.1	1,005.0	1,654.9	322.6	536.8	410.3	1,874	1,022	732	388	236	66	1,717.8	165.9	1,883.7	1,883.7

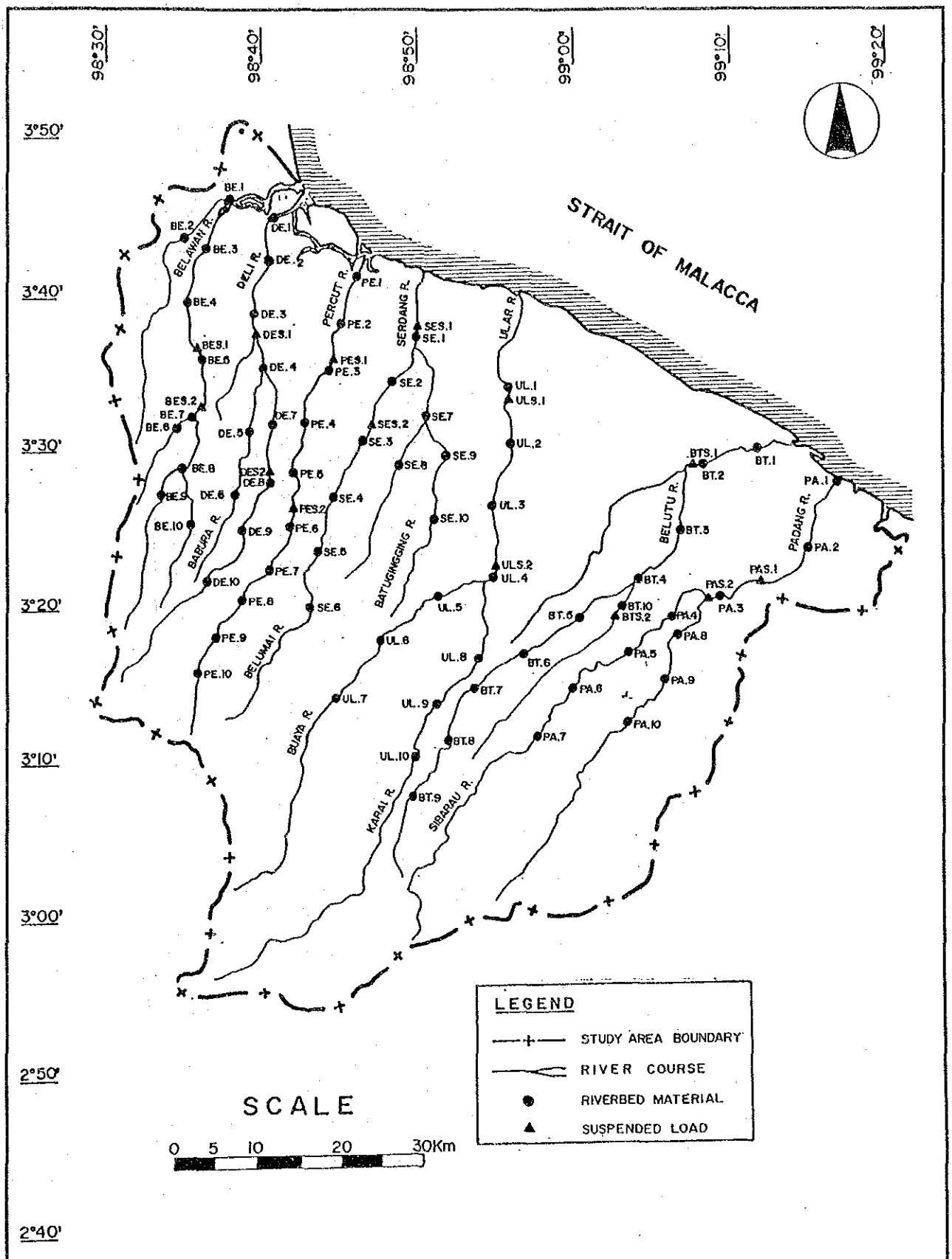
Table 3-2 VOLUME OF ANNUAL SEDIMENT TRANSPORT

Sub-basin Point		Catchment Area	Flow Regime (m3/s)							Grain Size (mm)				Volume of Sediment Transport (1000m3/yr.)		
		(km2)	Max	25%	50%	80%	95%	99%	Min	D60	D30	D10	Dm	Bed Load	Suspended Load	Total
Belawan River	1	141	22.98	5.36	3.67	2.96	2.68	2.54	2.40	21.55	6.48	0.750	22.55	35.9	5.1	41.0
	2	254	41.40	9.65	6.60	5.33	4.83	4.57	4.32	0.19	0.14	0.020	0.23	45.9	20.2	66.1
	3	269	43.85	10.22	6.99	5.65	5.11	4.84	4.57	0.14	0.02	0.001	0.16	42.1	23.2	65.3
	4	126	20.54	4.79	3.28	2.65	2.39	2.27	2.14	0.14	0.02	0.001	0.16	20.2	3.9	24.1
	5	223	36.35	8.47	5.80	4.68	4.24	4.01	3.79	0.14	0.02	0.001	0.16	35.1	14.9	50.0
	6	647	105.46	24.59	16.82	13.59	12.29	11.65	11.00	0.14	0.02	0.001	0.16	46.6	183.0	229.6
Deli River	1	93	18.41	3.91	2.60	2.33	1.95	1.86	1.86	12.34	1.62	0.360	10.89	22.9	2.9	25.8
	2	301	59.60	12.64	8.43	7.22	6.32	6.02	6.02	0.73	0.40	0.250	0.93	41.9	42.0	83.9
	3	99	19.60	4.16	2.77	2.38	2.08	1.98	1.98	0.73	0.40	0.250	0.93	25.0	3.3	28.3
	4	40	7.92	1.68	1.12	0.96	0.84	0.80	0.80	0.73	0.40	0.250	0.93	10.4	0.4	10.8
	5	358	70.88	15.04	10.02	8.59	7.52	7.16	7.16	0.14	0.04	0.001	0.17	34.9	62.5	97.4
Percut River	1	105	20.79	4.41	2.94	2.52	2.21	2.10	2.10	39.59	11.73	0.930	42.17	6.4	4.9	11.3
	2	186	36.83	7.81	5.21	4.46	3.91	3.72	3.72	0.41	0.25	0.130	0.72	33.8	13.1	46.9
Serdang River	1	138	41.81	7.45	4.42	3.59	3.31	3.17	3.04	23.69	4.29	0.760	28.62	73.6	9.8	83.4
	2	262	79.39	14.15	8.38	6.81	6.29	6.03	5.76	0.15	0.07	0.001	0.13	94.0	32.3	126.3
	3	83	25.15	4.48	2.66	2.16	1.99	1.91	1.83	0.69	0.40	0.290	0.76	20.0	3.8	23.8
	4	272	82.42	14.69	8.70	7.07	6.53	6.26	5.98	0.69	0.40	0.290	0.76	52.8	34.6	87.4
	5	71	21.51	3.83	2.27	1.85	1.70	1.63	1.56	0.69	0.40	0.290	0.76	15.3	2.9	18.2
	6	671	203.31	36.23	21.47	17.45	16.10	15.43	14.76	1.73	0.84	0.370	1.95	93.3	183.8	277.1
Ular River	1	292	39.71	18.69	15.48	12.56	11.10	10.22	10.22	0.81	0.40	0.240	4.86	175.5	3.5	179.0
	2	154	20.94	9.86	8.16	6.62	5.85	5.39	5.39	0.81	0.40	0.240	4.86	96.0	0.5	96.5
	3	500	68.00	32.00	26.50	21.50	19.00	17.50	17.50	0.83	0.64	0.390	0.94	225.7	17.3	243.0
	4	573	77.93	36.67	30.37	24.64	21.77	20.06	20.06	0.40	0.29	0.160	0.40	226.8	25.8	252.6
	5	190	25.84	12.16	10.07	8.17	7.22	6.65	6.65	96.61	19.46	2.690	66.23	28.5	1.0	29.5
	6	294	39.98	18.82	15.58	12.64	11.17	10.29	10.29	0.99	0.59	0.350	1.25	87.6	3.6	91.2
	7	134	18.22	8.58	7.10	5.76	5.09	4.69	4.69	0.99	0.59	0.350	1.25	55.8	0.4	56.2
	8	440	59.84	28.16	23.32	18.92	16.72	15.40	15.40	0.99	0.59	0.350	1.25	129.2	11.9	141.1
	9	1081	147.02	69.18	57.29	46.48	41.08	37.84	37.84	0.83	0.54	0.310	0.95	225.8	167.7	393.5
Belutu River	1	62	9.18	2.91	2.36	1.92	1.74	1.67	1.61	0.93	0.62	0.330	1.10	24.9	0.3	25.2
	2	224	33.15	10.53	8.51	6.94	6.27	6.05	5.82	1.18	0.60	0.340	1.24	40.9	4.9	45.8
	3	96	14.21	4.51	3.65	2.98	2.69	2.59	2.50	0.77	0.50	0.340	0.81	18.0	0.7	18.7
	4	423	62.60	19.88	16.07	13.11	11.84	11.42	11.00	0.69	0.38	0.250	0.79	75.0	20.5	95.5
	5	166	24.57	7.80	6.31	5.15	4.65	4.48	4.32	0.69	0.38	0.250	0.79	41.0	2.5	43.5
	6	500	74.00	23.50	19.00	15.50	14.00	13.50	13.00	0.17	0.05	0.001	0.19	57.5	29.8	87.3
Padang River	1	241	35.67	11.33	9.16	7.47	6.75	6.51	6.27	58.94	17.61	6.630	51.09	83.5	5.8	89.3
	2	129	19.09	6.06	4.90	4.00	3.61	3.48	3.35	58.94	17.61	6.630	51.09	54.8	1.4	56.2
	3	524	77.55	24.63	19.91	16.24	14.67	14.15	13.62	0.42	0.34	0.220	0.47	168.5	33.1	201.6
	4	110	16.28	5.17	4.18	3.41	3.08	2.97	2.86	0.42	0.34	0.220	0.47	38.2	1.0	39.2
	5	121	17.91	5.69	4.60	3.75	3.39	3.27	3.15	34.28	9.29	0.780	40.51	38.2	1.2	39.4
	6	235	34.78	11.05	8.93	7.29	6.58	6.35	6.11	0.34	0.20	0.140	0.38	42.9	5.5	48.4
	7	820	121.36	38.54	31.16	25.42	22.96	22.14	21.32	0.34	0.20	0.140	0.38	142.4	90.4	232.8
	8	919	136.01	43.19	34.92	28.49	25.73	24.81	23.89	0.34	0.20	0.140	0.38	149.9	116.8	266.7

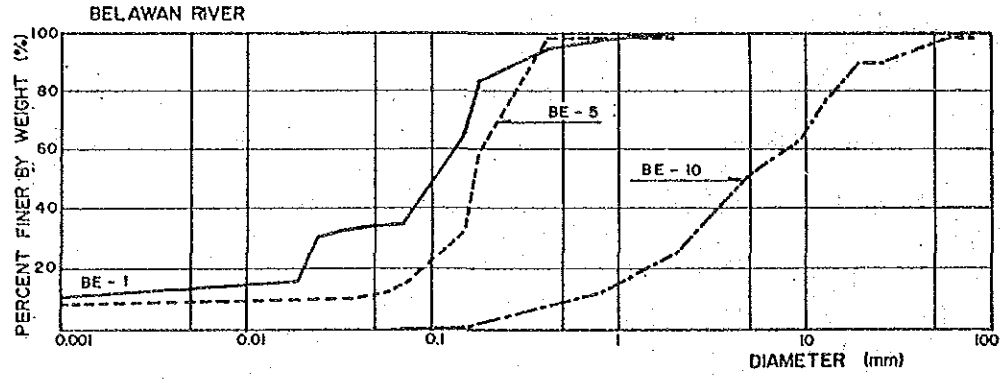
Table 3-3 ANNUAL SEDIMENT BALANCE

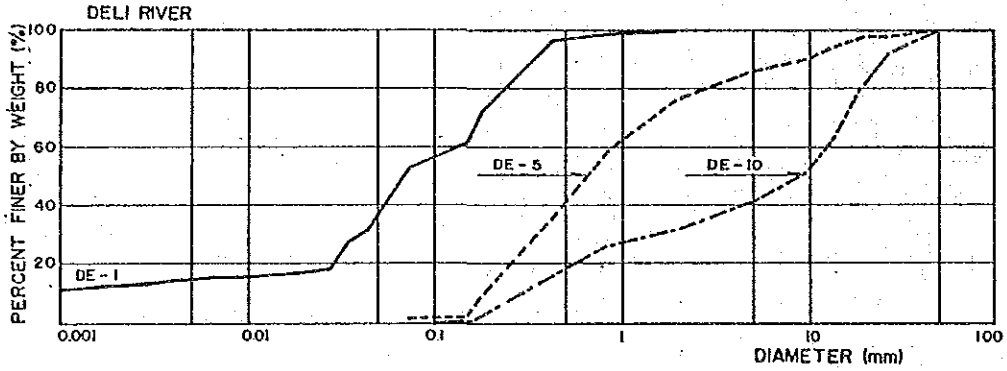
Unit-basin		Annual Sediment Volume (1000 m3/yr.) Inflows (V1)	Yield (V2)	Deposit (V3)	Discharge (V4)	Transport-ability	Depth of Sediment Deposit (cm/yr.)
Belawan River	1	0.0	38.7	0.0	38.7	41.0	0.000
	2	38.7	54.2	26.8	66.1	66.1	0.996
	3	66.1	6.0	6.8	65.3	65.3	0.795
	4	0.0	39.0	14.9	24.1	24.1	0.658
	5	0.0	61.4	11.4	50.0	50.0	0.258
	6	139.4	0.8	0.0	140.2	229.6	0.000
Deli River	1	0.0	5.7	0.0	5.7	25.8	0.000
	2	34.0	59.8	9.9	83.9	83.9	0.315
	3	0.0	53.7	25.4	28.3	28.3	1.063
	4	0.0	18.1	7.3	10.8	10.8	1.248
	5	94.7	3.5	0.8	97.4	97.4	0.111
Percut River	1	0.0	11.1	0.0	11.1	11.3	0.000
	2	11.1	50.0	14.2	46.9	46.9	0.660
Serdang River	1	0.0	64.2	0.0	64.2	83.4	0.000
	2	64.2	93.9	31.8	126.3	126.3	1.073
	3	0.0	56.7	32.9	23.8	23.8	1.597
	4	23.8	92.3	28.7	87.4	87.4	0.669
	5	0.0	36.2	18.0	18.2	18.2	1.118
	6	231.9	39.7	0.0	271.6	277.1	0.000
Ular River	1	0.0	164.2	0.0	164.2	179.0	0.000
	2	0.0	75.2	0.0	75.2	96.5	0.000
	3	239.0	15.8	12.2	242.6	243.0	0.914
	4	243.0	30.6	21.0	252.6	252.6	1.511
	5	0.0	61.4	31.9	29.5	29.5	0.609
	6	29.5	81.2	19.5	91.2	91.2	0.588
	7	0.0	48.2	0.0	48.2	56.2	0.000
	8	139.4	6.9	5.2	141.1	141.1	1.825
	9	393.7	34.4	34.6	393.5	393.5	1.652
Belutu River	1	0.0	11.0	0.0	11.0	25.2	0.000
	2	28.4	20.1	2.7	45.8	45.8	0.160
	3	0.0	17.4	0.0	17.4	18.7	0.000
	4	89.3	16.0	9.8	95.5	95.5	1.160
	5	0.0	90.7	47.2	43.5	43.5	1.573
	6	95.5	12.4	20.6	87.3	87.3	1.981
Padang River	1	0.0	102.4	13.1	89.3	89.3	0.280
	2	0.0	72.5	16.3	56.2	56.2	0.358
	3	184.7	26.1	9.2	201.6	201.6	0.544
	4	0.0	56.6	17.4	39.2	39.2	0.779
	5	0.0	35.7	0.0	35.7	39.4	0.000
	6	35.7	52.4	39.7	48.4	48.4	1.768
	7	250.0	26.6	43.8	232.8	232.8	2.361
	8	232.8	40.9	7.0	266.7	266.7	0.295

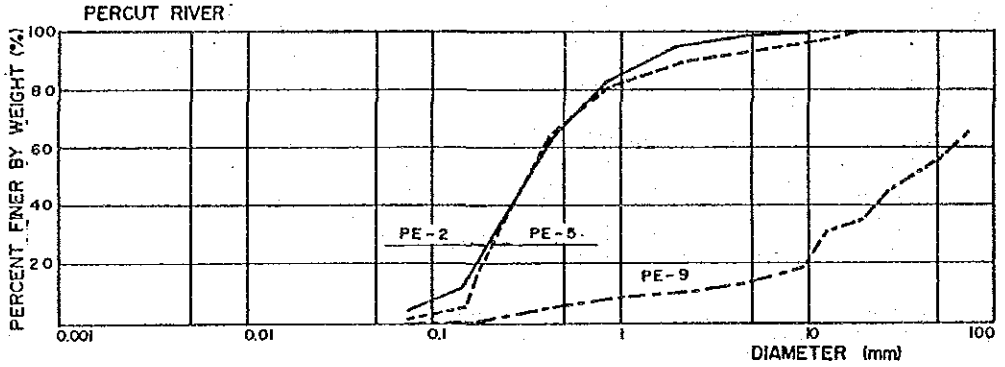
FIGURES

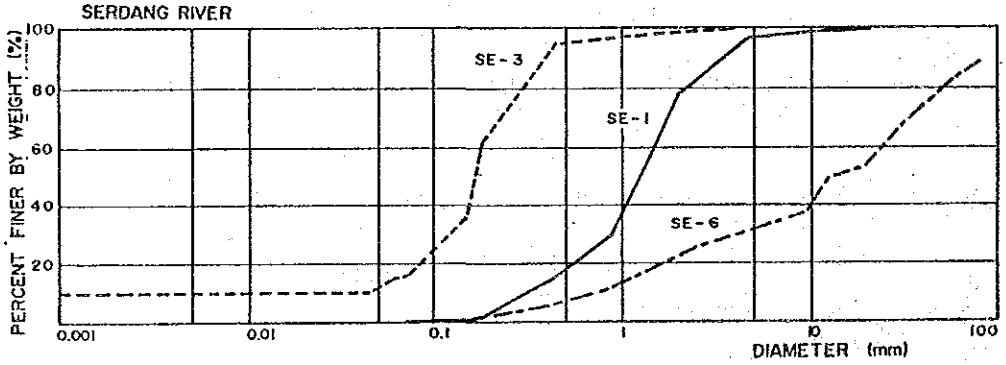


THE STUDY ON BELAWAN-PADANG INTEGRATED RIVER BASIN DEVELOPMENT IN THE REPUBLIC OF INDONESIA	RIVERBED MATERIAL AND SUSPENDED LOAD SURVEY SITES
JAPAN INTERNATIONAL COOPERATION AGENCY	Fig.2-1

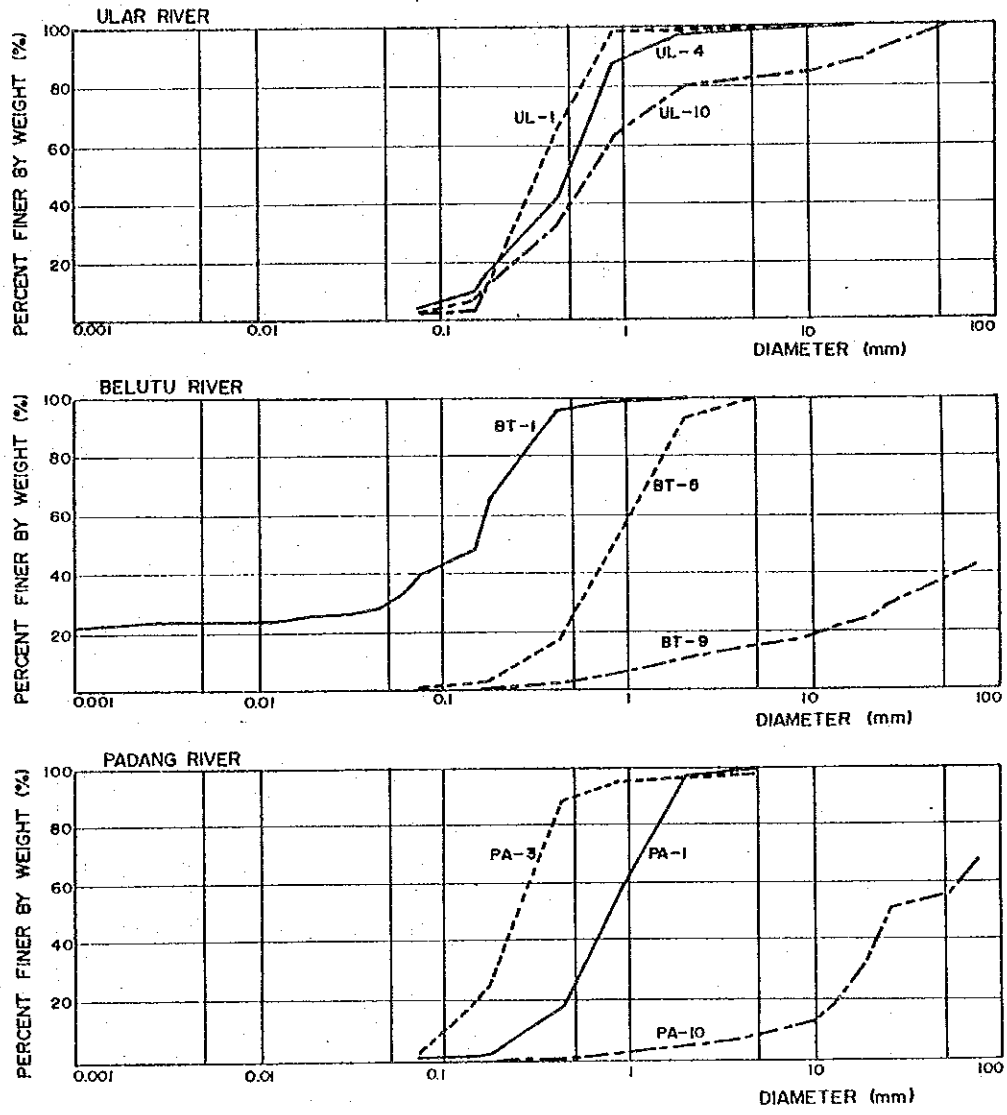




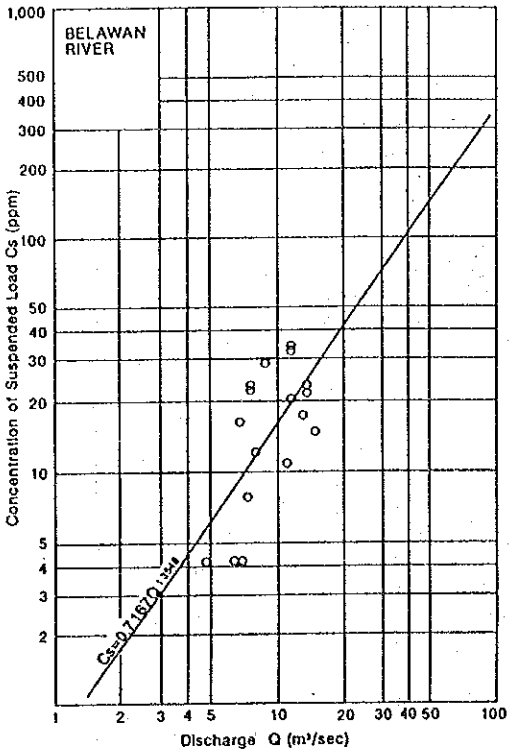


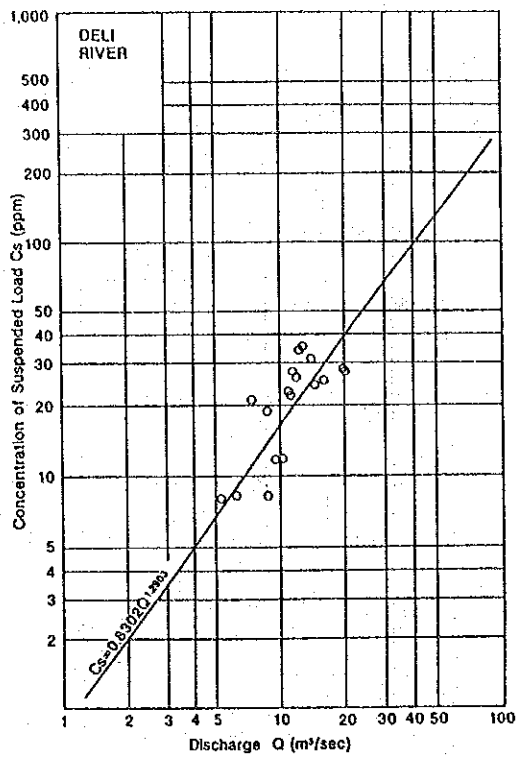


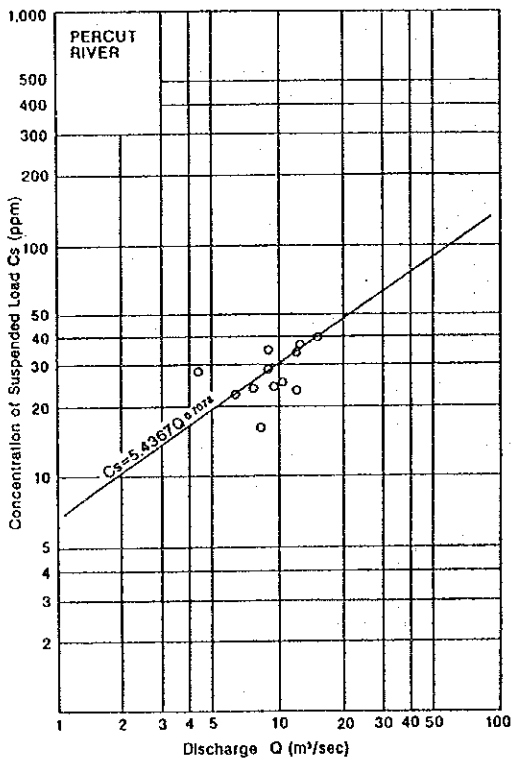
THE STUDY ON BELAWAN-PADANG INTEGRATED RIVER BASIN DEVELOPMENT IN THE REPUBLIC OF INDONESIA JAPAN INTERNATIONAL COOPERATION AGENCY	GRAIN SIZE ACCUMULATION CURVE Fig.2-2(1/2)

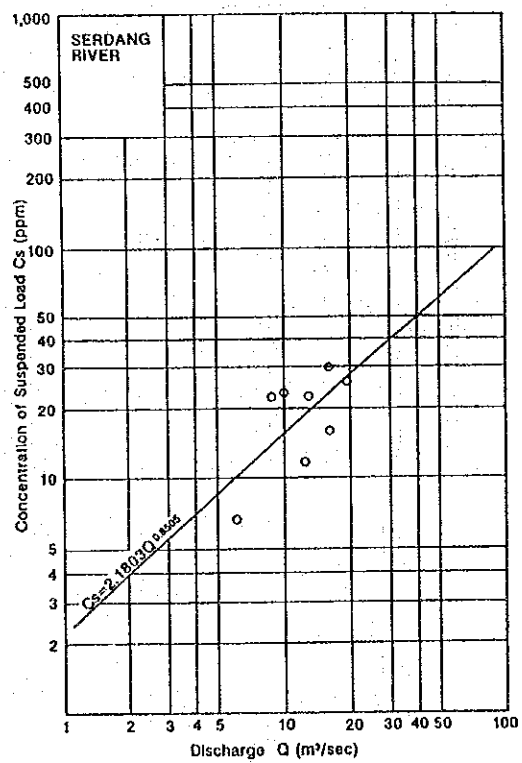


THE STUDY ON BELAWAN-PADANG INTEGRATED RIVER BASIN DEVELOPMENT IN THE REPUBLIC OF INDONESIA JAPAN INTERNATIONAL COOPERATION AGENCY	GRAIN SIZE ACCUMULATION CURVE Fig.2-2(2/2)

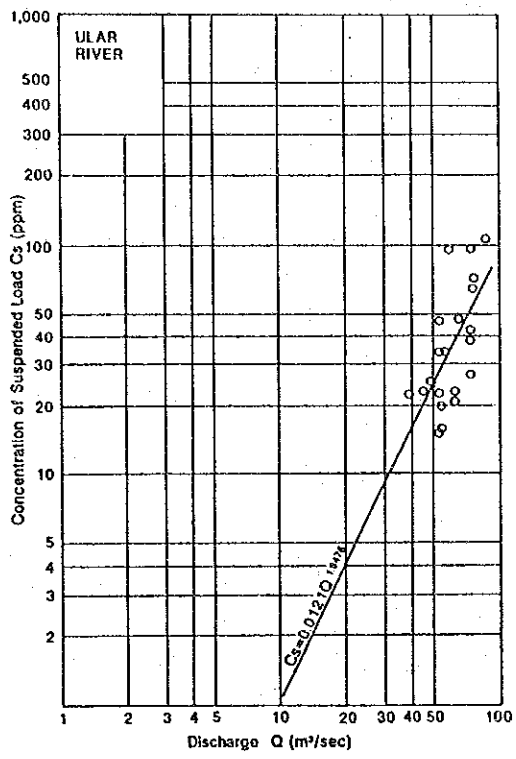


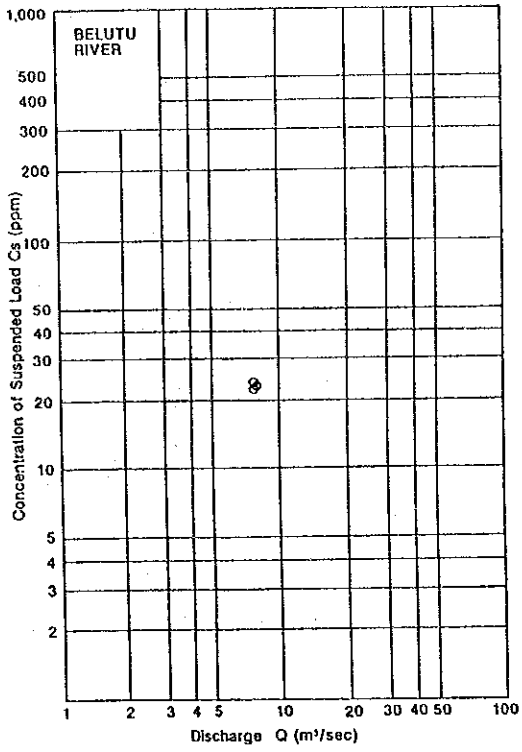


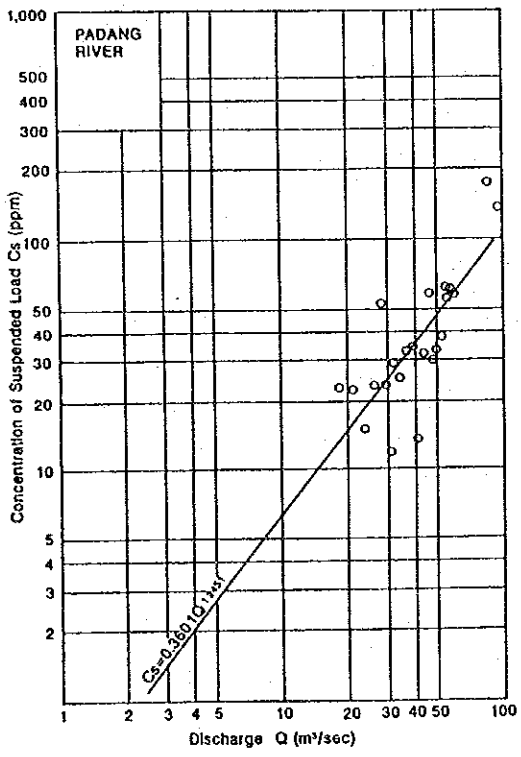




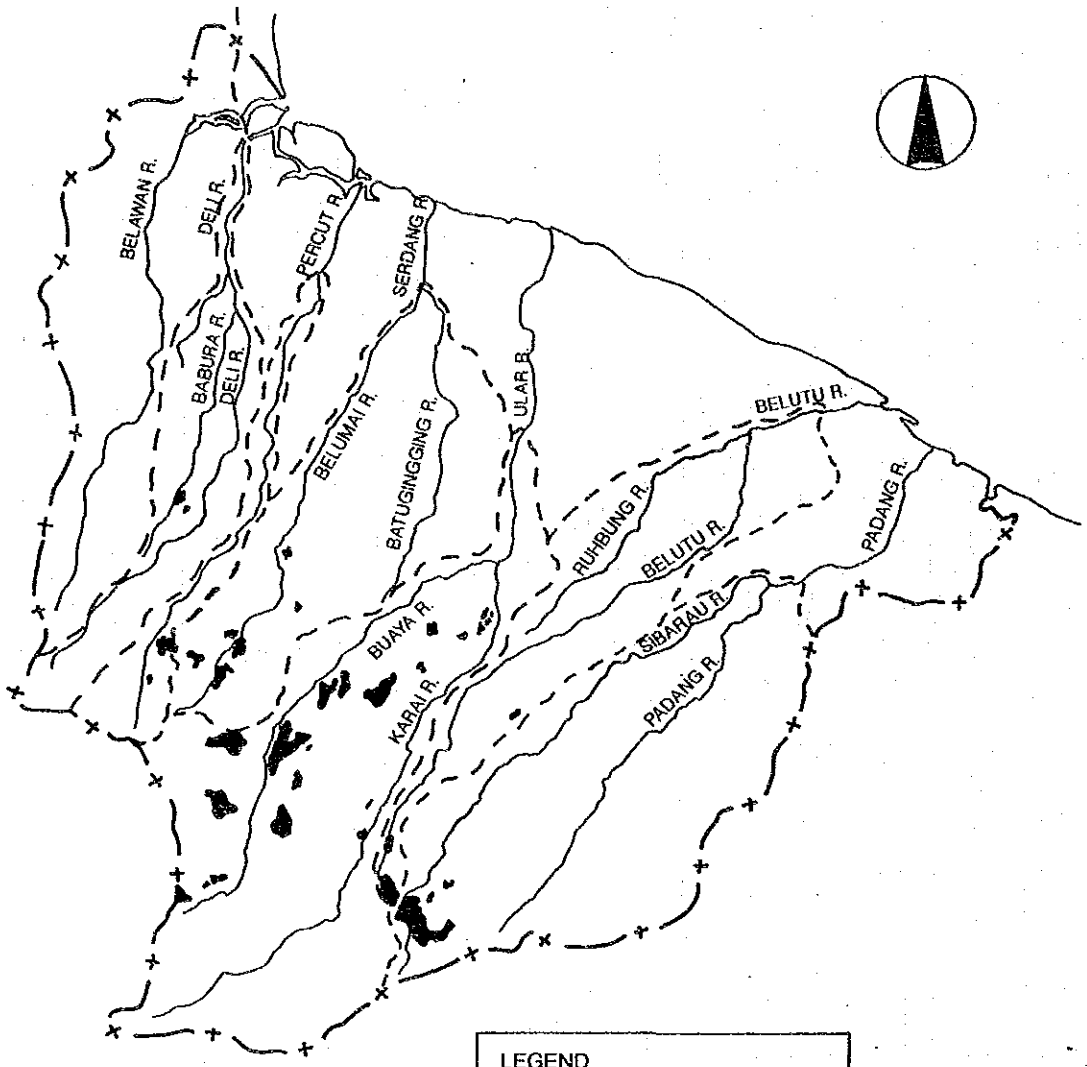
THE STUDY ON BELAWAN-PADANG INTEGRATED RIVER BASIN DEVELOPMENT IN THE REPUBLIC OF INDONESIA JAPAN INTERNATIONAL COOPERATION AGENCY	SEDIMENT DISCHARGE RATING CURVE Fig.2-3(1/2)



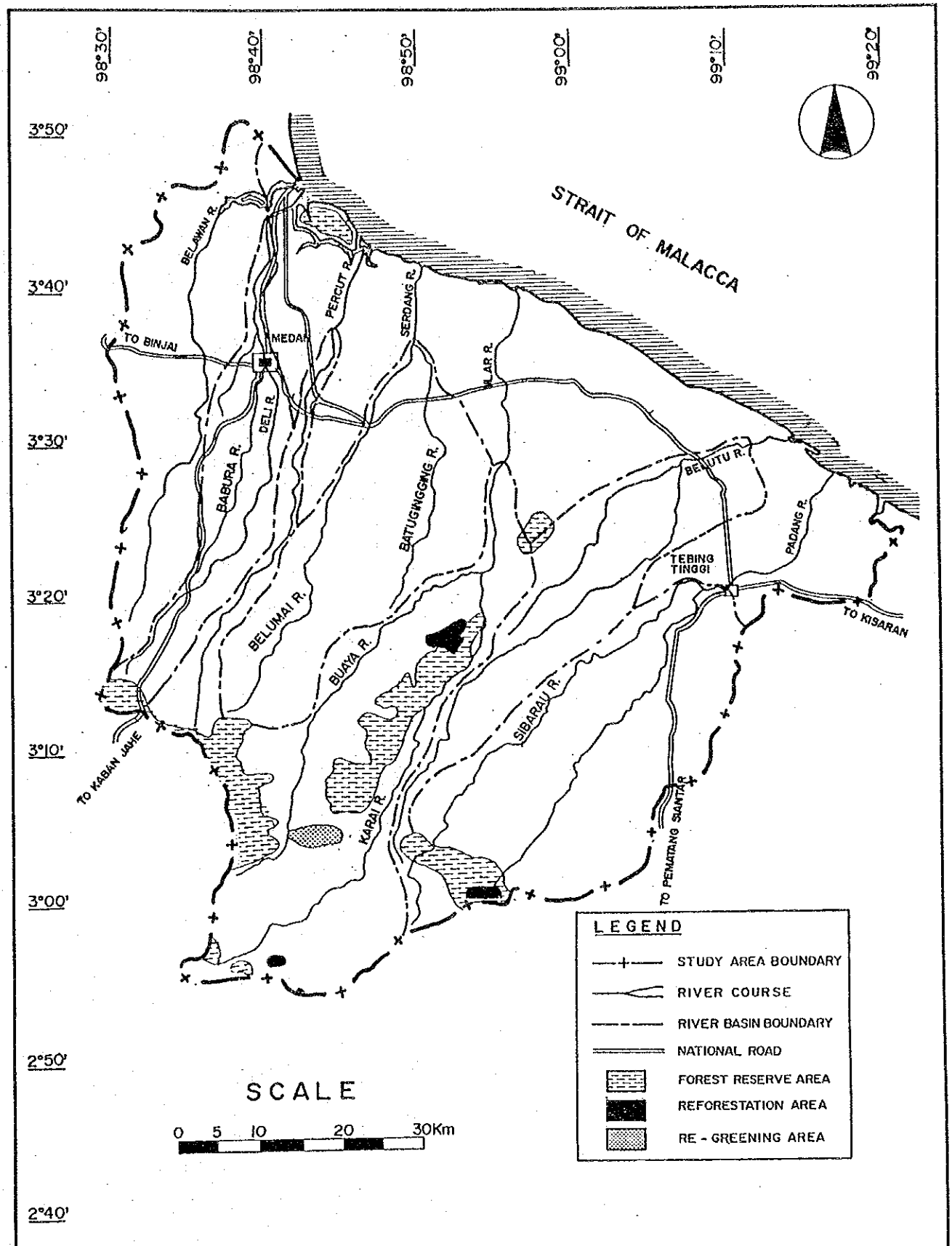




THE STUDY ON BELAWAN-PADANG INTEGRATED RIVER BASIN DEVELOPMENT IN THE REPUBLIC OF INDONESIA JAPAN INTERNATIONAL COOPERATION AGENCY	SEDIMENT DISCHARGE RATING CURVE Fig.2-3(2/2)



THE STUDY ON BELAWAN-PADANG INTEGRATED RIVER BASIN DEVELOPMENT IN THE REPUBLIC OF INDONESIA JAPAN INTERNATIONAL COOPERATION AGENCY	LOCATION OF DEVASTATED AREA Fig.2-4

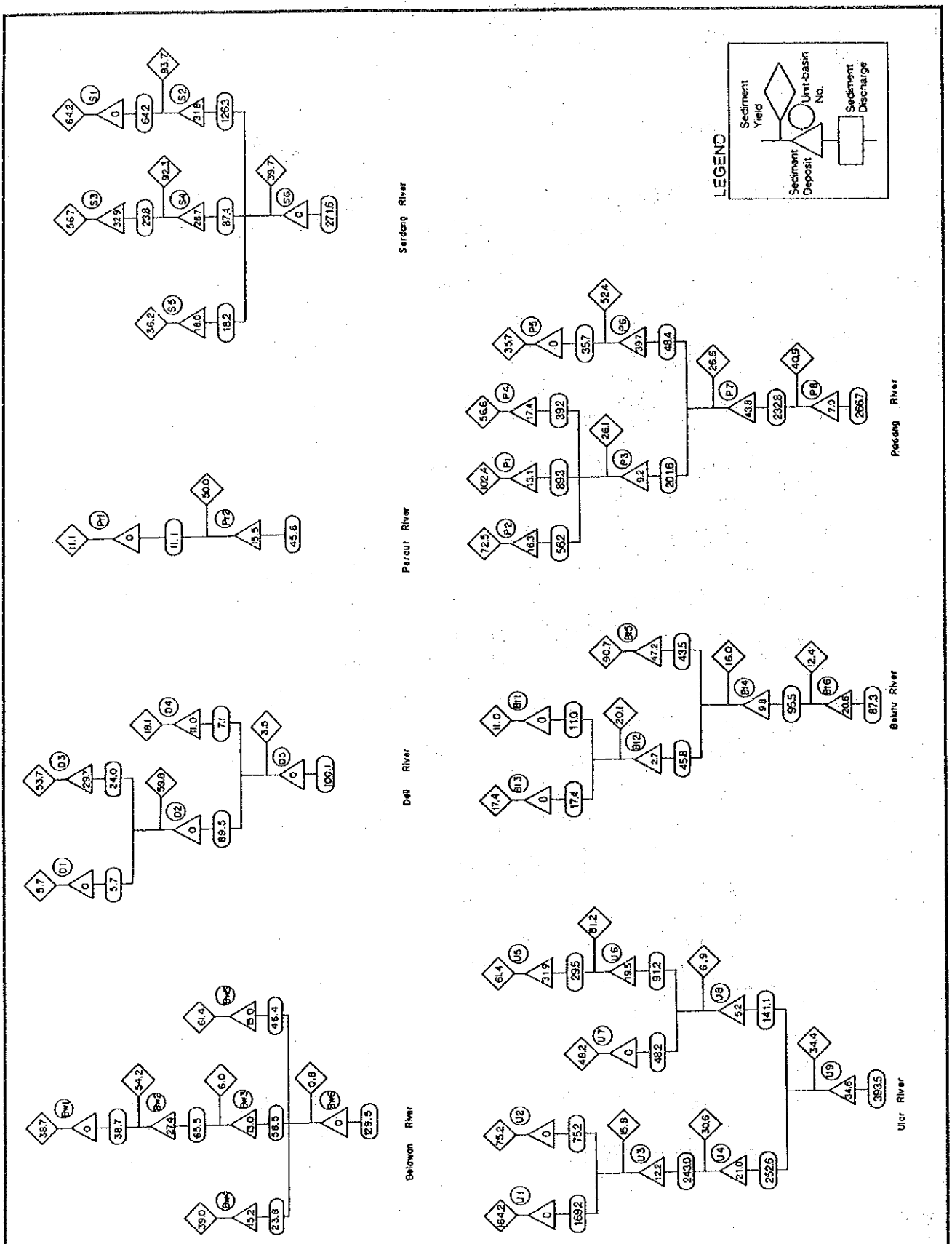


THE STUDY ON BELAWAN-PADANG INTEGRATED RIVER BASIN DEVELOPMENT IN THE REPUBLIC OF INDONESIA

JAPAN INTERNATIONAL COOPERATION AGENCY

FOREST CONSERVATION AREA

Fig.2-5



THE STUDY ON BELAWAN-PADANG INTEGRATED RIVER BASIN DEVELOPMENT IN THE REPUBLIC OF INDONESIA	FLOW DIAGRAM OF SEDIMENT BALANCE CALCULATION
JAPAN INTERNATIONAL COOPERATION AGENCY	Fig.3-1

DR

DAM AND RESERVOIR

STUDY ON BELAWAN-PADANG
INTEGRATED RIVER BASIN DEVELOPMENT

SUPPORTING REPORT

DAM AND RESERVOIR

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SUPPORTING REPORT

DAM AND RESERVOIR PLANNING

1. INTRODUCTION

This supporting report presents the results of the study on the identification of dam sites, selection of proposed dams in the master plan study, and preliminary design for the Lausimeme Multipurpose Dam.

From the viewpoint of dam development potential, eight (8) possible dam sites are identified in the upper reaches of the seven (7) major rivers of Belawan, Deli, Percut, Serdang, Ular, Belutu and Padang.

In the master plan study, Namobatang dam site on the Deli river basin and Lausimeme dam site on the Percut river basin are selected to be more advantageous due to the possibility of multiple use for flood control and water supply.

As one of the components of the urgent project, Lausimeme Multipurpose Dam is proposed to solve the shortage in municipal water supply for Medan City and also, to have a flood regulation function in the Percut river basin. Correspondingly, preliminary design of Lausimeme Multipurpose Dam is conducted by applying a rockfill dam with some 70 m in height.

2. POSSIBLE DAM AND RETARDING BASIN SITES

2.1 Methodology of Master Plan Formulation

Flood Control

Flood control works in the study area have been carried out mostly by means of river improvement, especially diking. Although the master plan for flood control is recommended on the scale of 50-year return period flood (it is a 100-year return period for Deli-Percut River), it is not necessary to make the river channel fully convey the design flood discharge. There are several measures to control the design flood other than the river improvement, as follows:

(a) Floodway
(b) Dam
(c) Retarding Basin

Water Supply

The master plan of water supply is concentrated on supplying the municipal water to the cities of Medan and Tebing Tinggi. Therefore, the planning criteria should be strict enough to assure a steady supply, while irrigation water supply and river maintenance flow are rather tolerable with a certain shortage condition.

As the water resources development, the following structures and facilities are studied:

(1) Dam

Since dam is the most reliable water source, possible dam sites are identified. They are examined to have multiple functions including flood control.

(2) River Diversion

A transbasin water diversion is taken into consideration when water supply potential in a water district (defined as the area of catchment area of the lowest reference point plus residual area) cannot meet the demand.

(3) Groundwater

Deep wells which are widely utilized are also promising water sources. Therefore, further development of deep wells is also expected for domestic water supply in the future.

2.2 Possible Dam and Retarding Basin Sites

Dam

Eight (8) possible dams sites are identified in the upper reaches of the seven rivers (Ular River has two dam sites on its two major tributaries). Although the efficiency of controlling floods depends on the location of dam, dam construction is more advantageous due to the possibility of multiple uses of water supply and others.

Retarding Basin

Some possible sites for the construction of retarding basin are identified on the four (4) rivers of Belawan, Serdang, Belutu and Padang. Their main features are presented in Table 2-1 (refer to Fig. 3-1 for their locations).

2.3 Design Criteria for Dam and Retarding Basin

Dam

Dam and reservoir design basically follow the Japanese criteria as follows:

Design Discharge	:	200-year return period for concrete gravity dam; 200-year return period with 20% allowance for rockfill dam.
Sedimentation	:	horizontal sedimentation of the estimated volume of sediment for 100 years or the project life.
Seismic Coefficient	:	0.12

Retarding Basin

Generally, the design of retarding basin is done in consideration of the design criteria for dam and reservoir.

3. DAM DEVELOPMENT POTENTIAL

3.1 Possible Dam Sites

Eight (8) possible dam sites are selected in the study area through field reconnaissance and by using the topographic maps on the scale of 1:50,000. Six (6) of them are located in the upper reaches of the six (6) rivers of Belawan, Deli, Percut, Serdang, Belutu and Padang. The other two (2) are in the middle reaches of Ular River.

The eight locations are selected in consideration of the lowest possible dam site in each river that will have hydrologic and economic advantages as to flood control and water resources development. At these dam sites, dam construction can be economical with conventional construction methods.

The maximum dam height is evaluated from 19 to 83 m depending on the topographic characteristics of the site. Reservoir storage capacity is estimated from 15 MCM to 85 MCM. At the Buaya and Karai dam sites on Ular River, a specially large storage capacity can be secured in comparison with the other six dam sites because of the wide impounding surface areas resulting from the gentle stream gradient and the large catchment area.

The locations and topographic characteristics of the eight dam sites are presented in Table 3-1 and in Fig. 3-1. Reservoir capacity curves are presented in Fig. 3-2. The geological conditions of dam sites are presented in the Supporting Report on Geology.

3.2 Water Production Capacity

The water production capacity of each dam site is roughly estimated through a mass-curve study, based on the flow regime in the droughtest year during the period from 1969 to 1988. The water production capacity to be developed at each dam site is calculated by deducting the existing supply capacity from the reservoir yield. At present, the discharge duration value of 95% is considered as nearly equivalent to the existing water supply capacity at each dam site. The mass-curve and calculation results are shown in Fig. 3-3 and in Table 3-2, respectively.

3.3 Comparison of Planned Dams

The topographic features and economic aspects of each dam site are comparatively studied. A rockfill dam is employed on account of adaptability for various geological conditions of dam foundation, although a concrete gravity type of dam may be more economical when dam height is low and the purpose is exclusively for flood control.

The results of the comparative study on condition that each dam reservoir is planned to be annually recovered to full capacity are summarized in Table 3-3. From the ratio of estimated construction cost per annually secured effective storage capacity, a relatively economical dam construction is expected in the river system of Ular, Belutu and Padang, although these dam sites are located far from the Medan city area. Among the dam sites near the Medan city area, Lausimeme in

the Percut River and Namobatang in the Deli River are considered to be promising dam sites from the economical viewpoint of reservoir storage efficiency.