2.2 Features of the River

The Jeneberang river runs through mountainous to hilly area down to Kampili weir and, then flows on a flat-lying land without heavy meandering until it pours into the Makassar strait. The stretch extending for 20 km. from its estuary up to Kampili weir, which will be attended by the river improvement works, is presented in Fig. 2-1.

Sungguminasa Bridge serves as a dividing point of the Jeneberang riverbed gradient into that in the upper reaches (1/1,400) and that in the lower reaches (1/2,000) (refer to Fig. 2-2).

The Jeneberang river is at present split into two streams at 4.4 K. upstream from its estuary. Judging from the aerophotoes, however, the river had been split into the right course and the old Jeneberang course, before 1924. According to the interview, it has been confirmed that while the old Jeneberang course was kept closed, the present left course was forced open by the flood in 1967.

Embankment work which was commenced in 1965 has so far been completed along the both banks of the Jeneberang river, from 2.0 K to 9.0 K on the left and from 2.6 K to 10.8 K on the right. However, these dikes lack sufficient safety in that they are inconsistent in cross-sections and elevation. Moreover, they are non-existent in the section from 5.2 K to 7.2 K on the left and in the section from 7.8 K to 9.0 K on the right.

The Jeneberang river considerably narrows down at the site of the Sungguminasa bridge which is located at about 9.0 km. upstream from its estuary.

2.3 Flow Capacity

The bankful flow capacities of the Jeneberang river in the lower and upper reaches of the Sungguminasa bridge as well as in the upper reaches of the Kampili weir are estimated at 1,000 m^3/s, 600 m^3/s, and 800 m^3/s, respetively. Fig. 2-3 shows the flow capacity of each seciton along the Jeneberang river.

The section having the minimum flow capacity in the lower reaches of the Sungguminasa bridge is located near 8.0 K where there has been built no dike as shown in Fig. 2-4. However, a road lying 1 m. above the ground level on the right bank is serving as a dike. The discharge which would raise the water level to the surface of the road is estimated at 1,800 m^3/s. Water inundating the right bank area would return to the river after the flood is over.

In the upper reaches of the Sungguminasa bridge, there are a road on the right bank and the Kampili irrigation channel on the left bank, both fo which are running higher than the existing ground level. The area between the road and the irrigation channel plays the role of a natural buffer (refer to Fig. 2-5).

The discharge, when it exceeds 1,800 m^3/s, will overtop the road and flow into the Bili-Bili irrigation channel on the right bank.

2.4 Riverbed Fluctuation

Although the factors conditional on the riverbed fluctuation have not yet been exactly grasped, the results of the field investigation and interview lead the one to an assumption that the Jeneberang river had used to have a narrow but deeper channel, but the riverbed has been raised to the present level due to the repeated hillside collapses in by gone years. The collapsing phenomenon has been receded to subsidence for a quite sometime in the past. However, no serious sediment discharge has occurred lately though sediments have been deposited in some parts along the river course. Riverbed materials consist of gravel at Bili-Bili and Kampili, and of fine sand at Sungguminasa, at present. The grain size accumulation curves along the Jeneberang river are given in Fig. 2-6.

2.5 Transition of Estuary

A sandbar has developed at the Jeneberang estuary due to sediment discharge from its upper reaches. Long time ago, a great deal of sediment had been flown down through the old Jeneberang course to be deposited in the Makassar port. Now that the old Jeneberang course had been closed and the main channel of the river shifted southward (the left course) is observed no sediment transportation to the Makassar port area (refer to Fig. 2-7).

Since the collapses in the upper reaches are found stable, serous sediment deposition has not been observed at its estuary.

Judging from the comparative study between the result of the newly conducted surveying and the chart prepared by the Ministry of Marine, the Netherlands in 1900, the total sediment yield since 1900 is estimated at about 60,000,000 m^3 (refer to Fig. 2-8).

2.6 River Utilization

The Jeneberang river water is being utilized for various purposes at (or from) different places as follows: water to be used in sericultural center (at 100m upstream of Bili-Bili dam site) irrigation (Bili-Bili and Kampili intakes); drinking water (point 8.8 K); industry (point 15.3 K), and fish ponds at the estuary.

At a few points, peole are ferreid across the river throughout a year. Fig. 2-9 shows the existing riparian facilities along the river. Quarrying and sand collection is briskly carried on along the river mainly during dry season.

The Jeneberang river water decreases so much during dry season that irrigation water demand for paddy cultivation is available only for about 10% of all the paddy field.

3. FLOOD DAMAGE

An extensive flooding from the Jeneberang occurred in 1967 and inflicted great damage to Ujung Pandang city. The dike breached at locations 3.0 K and 9.5 K on the right bank of the Jeneberang river. Due to insufficient record the flood damage cannot be estimated.

The area along the river between Sungguminasa bridge and Kampili, having a flow capacity of 600 m^3/s, has been annually affected by flood. Flooding water would overtop the river bank and flow down on Jl. Malino linking Ujung Pandang city to Malino, often causing traffic stagnation.

The biggest inundation ever observed, what corresponds to an 8 year return period flood, occurred in January 1976, and this inflicted a great deal of damage on the project area due to the poor drainage system and high water level of the Jeneberang. According to the rainfall data, rainfall lasted for 23 days from January 5 to 27, and the maximum daily rainfall was recorded on January 12 at 300 mm. The total rainfall during that period amounted to 984 mm.

The area which was most severely damaged during the flood inundation includes the old urban area along the Panampu channel and the city side area along Jl. Veteran; in these areas the ponding depth reached 2.1 m. The area sandwiched by Jl. Veteran and Jl. Panakukang was ponded for three days at the average ponding depth of 60 cm, to a maximum of about 1.0 m. A number of houses in the area were submerged to about floor level.

The inundation area in 1976 is estimated at 35 km^2 as shown in Fig. 2-10. The inundation damage is estimated at 450.0 million Rupiah.

4. FLOOD CONTROL

As the design scale of flood control adopted for the project being based on a 50-year return period, the project area will be relieved from any lesser flood than a 50-year return period. Among the flood control measure are:

1. construction of dam,
2. river improvement
3. excavation of flood-way, and
4. provision of retarding basin.

In our case, 3. and 4. given in the above have been found difficult as there are no adequate places obtainable from the topographical point-of-view for excavation of flood-way nor provision of retarding basin if they were meant for regulation of the flood discharge of the scale of a 50-year return period. It has, therefore, been decided to plan the flood control project through a combination of dam construction and river improvement works.

4.1 Optimum Share of Design Flood between Dam and River

Standard Project Flood

The decision as to the flood discharge on a 50-year return period has been made on the basis of hydrological analysis in the area and through a careful comparative study with the similar cases so far taken up in other parts of Indonesia. Eventually, the standard project flood discharge has been determined as follows:

Bili-Bili	:	2,400 m^3/s
Jenelata	:	1,400 m^3/s (1,300 m^3/s) *
Kampili	:	3,700 m^3/s
Sungguminasa	:	3,700 m^3/s

* When the Jenelata joins the Jeneberang at the time of the peak discharge of the latter, the former's discharge will be 1,300 m^3/s.

The distribution of standard project flood is shown in Fig. 2-11

Optimum Share of Design Flood

The optimum share of combination that of dam and river improvement work needs to be carefully determined by taking into consideration, the technical, economic and social aspects.

The standard project flood of 3,700 m^3/s at Kampili will be shared by both an impounding reservoir and the improved river channel of the Jeneberang.

The share of the Jeneberang river has been determined at 2,300 m^3/s, while the Bili-Bili dam is expected to control a discharge of 1,100 m^3/s.

The following studies have been conducted to arrive at the above shares:

1) Construction Cost

As a result of the study as to the relationship between the construction cost and the discharge at Kampili (refer to Fig. 2-12), it has been arrived at that the Jeneberang river channel should control a discharge of 2,300 m^3/s, in view of striking the most economically balanced combination of dam construction and river improvement works in the total cost.

2) Evacuation and Land Acquisition

Evacuation of houses and acquisition of land, which is unavoidable for implementation of the project and liable to cause more or less social problems, has been tried to be kept at minimum. The relation between the volume of discharge at Kampili and the evacuation/land acquisition is set forth in Fig. 2-13, according to which least number of houses and the smallest extent of land would need to be evacuated/acquired when the discharge should be made 2,300 m^3/s at Kampili. In other words, the social problem can be minimized by confining the discharge to be accommodated in the river channel to 2,300 m^3/s.

Design Flood for River Improvement

Based on the aforementioned studies, the distribution of design flood will be made as shown in Fig. 2-11 and the design flood discharges will be as follows:

		Peak Discharge	Joining Discharge
Bili-Bili	:	2,400 m^3/s	1,300 m^3/s
Jenelata river	:	1,400	1,000
Kampili	:	-	2,300
Sungguminasa	:	-	2,300

4.2 General Conception

The river improvement works have been planned with full consideratin to the technical, social and economic aspects as mentioned in the below:

1) to control 50-year return period flood by menas of the river improvement and the impounding reservoir;

2) to smoothen the river course alignment in order to stabilize the proposed river channel;

3) in principle, to keep the design high water level and height of the dike as low as possible to reduce the damage potential;

4) to taken the stability of the river channel into full consideration;

5) to plan the flood control facilities to the extent possible to mitigate the damage caused by extraordinary floods(s);

6) to minimize land acquisition and evacuation of houses; and

7) to put a priority to protection of the populous and economically significant area in the flooding area along the Jeneberang.

4.3 Basic Study for the Project Formulation

The following studies have been made for the formulation of the river improvement works.

River Improvement Stretch

The stretch which extends from the Jeneberang river estuary up to the Kampili weir has been taken up for the improvement work due to the following reasons:

1) The river course in the upper reaches of Kampili is sandwiched between the hilly lands and has a comparatively higher flow capacity. On the occasion of flooding on both the right and left banks, the inundation water is expected to flow back to the river course immediately after flooding; and

2) Judging from the economic viewpoint, the assets on the area in the upstream of Kampili are of lesser value.

Improvement Scale of the Upper Channel of the Sungguminasa Bridge.

An estimated cost for river improvement and the works related to it along the channel upper than the Sungguminasa bridge is Rp. 9,000 million, while the value of the assets in the area is estimated to range from Rp. 4,000 to 5,000 million. The annual damage due to floods is estimated to range from Rp. 400 to 500 million, on an assumption that half of the assets may be damaged by floods and that the damage rate will be 20%. Accordingly, a large scale improvement would not have to be planned, from the economic point-of-view. The improvement works in the upper channel of the Sungguminasa bridge should be limited to excavation to obtain a low water channel alone for the purpose of assuring the stability of the channel. Consequently, the area will not suffer from flood damage as long as the discharge be less than about 1,300 m^3/s, though the low water channel is designed to confine a discharge of 900 m^3/s or 1.5-year flood discharge, the bankful discharge of the low water channel is estimated at 1,300 m^3/s, which corresponds to a 8-year return period flood. This much flood control level is deemed appropriate for the area which has been invested with assets of lesser value.

Stability of the Design River Channel

Study of the river channel stability is made through calculation of tractive force at each cross-section of existing river channel and proposed river channel (refer to Fig.2-14).

In making a comparison of tractive force between the existing and the proposed river channels, as can be seen in Fig.2-14, it is obvious that there are wide variations in tractive force over the entire length of the existing river channel. On the other hand, tractive force is practically steady all over the entire length of the proposed channel except a slight difference between the upper and lower reaches of the Sungguminasa bridge.

For keeping better stability of river channels, it is indispensable to manage and maintain the river as much as practically possible.

Once a dam is built in its upper stream, the riverbed might be given a tendency to sink lower due to the decrease in supply of sediments therefrom. The ill-effects upon the existing structures expected from such a sinking of the riverbed should be avoided by installing groundsill at the points where are standing the important structures.

Closing of Right River Course

As the existing total assets on the down stream areas of the diversion point at 4.4 k., is estimated at Rp. 2,300 million, Approx., while the required construction costs of the closing right river course is roughly at Rp. 4,400 million, the construction of the proposed closing right river course at this present may not be economically viably.

It is preferable, however, that the said right river course be closed in the final stage of the river improvement works for the below-mentioned reasons, as long as the main channel of the Jeneberang river can confine a flood discharge after its improvement.

1) It is considerably difficult, if no diversion facilities are provided, to distribute the design flood as designed to the right and left courses which are splitted at 4.4 K.

2) In case the river water splits into two streams, the tractive force on both river courses will decrease; consequently, it is difficult to keep the channel stability.

3) By a closing right river course at the immediate down stream of the point 4.4 K.,370 houses, 293 ha., of farmland including paddy fields and 296 ha., of fish pond will be protected from floods in scale up to 50-year probable discharge, and further, about 70 ha. moreland will become available by a land reclamation of right river channel. All the above will contribute greatly to the development of the southwestern part of the Ujung Pandang city.

4) Makassar port might be affected by extention of sandbar from the Jeneberang river as long as the right course is left open as it is today.

Upon closing the right river course, a sluice gate and a drainage channel will be provided for to ensure drainage function as well as to guarantee the water for livelihood requirements in the area.

Drainage Facilities

Quite a number of drainage facilities are currently located along the existing dike, and most of them are of comparatively small scale, and some are not functioning alright. Accordingly, they will be unified with necessary scrapping at an interval of 2 km. on an average upon completion of new dike.

Assurance of the Vested Water Rights

The water claimed as the vested rights along the Jeneberang river includes the water for the use of the sericultural center, industrial water used by the paper mill, drinking water for Kota Sungguminasa, raw water for the old treatment plant and others, which are taken in from the Jeneberang river at present.

The total of the above vested right water amounts to 0.5 m^3/s, which will be supplied by the proposed Bili-Bili reservoir.

5. RIVER IMPROVEMENT

5.1 River Improvement

Upon taking into a careful consideration all the conditions enumerated in the above, the river improvement plan will eventually be comprised of the following.

Alignment

A new alignment is proposed in the stretch of 20 km., from the estuary to Kampili (however, in the section Sungguminasa bridge upwards will be limited to the low water channel excavation). In principle, the present river course will remain the same since the meandering is slight. The river width is proposed to be 162 m. (low water channel only) in the upper reaches and 313 m. in the lower reaches, the Sungguminasa bridge being their dividing line. Bends of the course will be widened beyond the standard width to flow down the design flood safely. Fig. 2-15 shows the proposed alignment.

Longitudinal Profile

The longitudinal profile of the design riverbed is shown in Fig. 2-16. It has been so designed as to assure the stability of the river channel and the flow capacity of each cross-section on the principle of keeping the influences on the existing structures to minimum.

The proposed longitudinal gradient in the upper and the lower reaches of the Sungguminasa bridge is 1/1,200 and 1/1,900, respectively. The ratio of the riverbed gradient between the upper and the lower reaches is planned to be less than 1 : 2, to assure the stability of the river channel. The average excavation depth is about 70 cm. in the upper reaches of Sungguminasa bridge and 60 cm. in the lower reaches.

Desing High Water Level

It is advisable that the design high water level of the river channel be planned as low as possible to reduce damage potential. However, a completely excavated channel requires much excavation work and, accordingly, the higher cost. In principle, the design high water level in the target stretch from the estuary up to the Sungguminasa bridge will be set up within 1.8 m. above the ground level (refer to Fig. 2-16).

Cross-Section

Compound cross-section is superior to a single cross-section, though more costly, from the viewpoint of channel stability. The low water discharge can flow down in the lower-water channel, and flood discharge will pass in the whole cross-sectional area. The standard cross-section shown in Fig. 2-17 can confine 900 m^3/s of 1.5-year return period discharge in the low water channel, and 2,300 m^3/s in the whole cross-sectional area.

In principle, height of dike will be set up within 3.0 m. above the ground level. However, where the height of dike is required to be over 3.0 m. above the ground level due to topographic reasons, a berm may have to be constructed to secure the safety of the dike.

The proposed cross-sections overlapping the existing ones are shown in Fig. 2-18.

5.2 Benefit

An urgent flood control project has been formulated in ahead of this project. The urgent flood control project consists of improvements to the lower reaches of the Jeneberang river (between 2.0 K and the Sungguminasa bridge) as well as to the drainage system in Ujung Pandang city.

The flood control benefit of this project will be estimated on the base of the present flood control and drainage capacity because the urgent project has not been put into execution yet.

The flood control benefit is defined as the flood damage reduction due to implementation of the project, whose calculation is based on the assets in the flooding area and also the flooding water stage under the with- and without-the-project conditions.

Assets in the Flooding Area

An urbanization plan /1 has been proposed in the project area, the first stage of which commenced in 1975 and is to terminate in 1985. Based upon its detailed data, the relation between assets value and ground height has been chalked out as illustrated in Fig. 3-13.

NOTE: /1 This plan is explained in details in 3.2.8 Urbanization plan, Main Report.

In this study, flood damage is assumed to be inflicted on the present assets/2 plus the future assets in the first stage urbanization area. This is because the flood control effect will accrue after 1985, and urbanization works in question are to be most likely completed by 1985.

Hydrological Effectiveness of the Project

The difference of the flooding water stages under the with- and without-the-project conditions is sumarized in the following Table 2-1.

Table 2-1 HYDROLOGICAL EFFECTIVENESS IN WATER STAGE

(Unit: M.S.L.m)

Return Period	Below Sunguminasa				Above Sungguminasa (12.0 K point)	
	City Side Area		Mountain Side Area			
	w/o	w	w/o	w	w/o	w
2 - year	2.03	1.27	1.45	1.30	9.4	8.1
2.4 - year	2.05	1.60	1.50	1.34	9.7	8.7
5 - year	2.61	1.78	2.04	1.42	9.9	9.2
10 - year	2.82	1.94	2.53	1.55	10.0	10.0
30 - year	2.86	2.01	2.82	1.77	10.0	10.4
50 - year	2.89	2.07	2.86	1.88	10.0	10.4

The above hydrological calculation was carried out on the following assumptions:

1) Flooding area and calculation model

Below Sungguminasa, the inundation area is divided into two parts (city side area and mountain side area) by Jl. Panakkukang. The Sinrijala channel linking these two areas has the function of transporting the inundation water. If the inundation water depth in the inundation area exceeds 2.2 m, the inundation water overflows onto the Panakkukang road.

The calculation model for the inundation water stage in each area is illustrated in Fig. 2-19 , under the with and without the project conditions.

The overtopped flooding water above Sungguminasa is confined in the area sandwiched between Jl. Malino and the Kampili irrigation channel.

NOTE: /2 The present assets are discussed in details in 3.2.7 Land Use and Assets, Main Report.

2) Breaking point below the Sungguminasa Bridge

It is assumed that the river water of the Jeneberang will overflow during floods exceeding the below-mentioned return periods, and the breaking points are inferred to be the following. (refer to Fig. 2-19).

	Without-the-Project		With-the-Project
Flood return period:	2.4-year	8-year	50-year
Breaking points:	6.0 K	9.6 K, 6.0 K	6.0 K

3) Flooding Condition on the area above Sungguminasa

Bankful discharge in the upper stream of the Sungguminasa bridge is estimated as follows:

Without the project : 600 m^3/s
With the project : 1,300 m^3/s

4) Run-off from the inner basin

Most floods are caused by 5 days of continuous rainfall. The run-off after the first development stage has been estimated by using the rainfall intensity as shown in Fig. 2-20.

5) Flood Discharge of the Jeneberang river

The flood discharge obtained at Kampili is applied for damage calculation (refer to supporting report, Dam). In the above-mentioned flood discharge, the regulation effects by completion of the coffer dam and the proposed Bili-Bili dam are taking into consideraton.

6) Outlet Water Stage

The inundation water would be drained into the Makassar strait and Tallo river through the following channels.

without the project: existing Panampu and Sinrijala channels

with the project : improved Panampu, Sinrijala and Jongaya channels

The outlet water stage of each drainage channel is shown in Fig. 2-19. The outlet water stages of the Tallo and Pampang rivers cannot be estimated exactly because of insufficient hydraulic data of the Tallo river. Consequently the tidal curve had to be used to estimate their outlet water stages, and this takes into account the topographical gradient.

Flood Control Benefit

The flood control benefit is defined as the flood damage reduction due to implementation of the project. The annual benefit is given as the reduction in annual damages; and annual damages are obtained by multiplying the total damage potential by the probable flood rate.

Flood damage consists of direct damage, indirect damage and intangible damage. Direct damages are defined as the monetary expenditure required, or which would be required, to restore the flood damaged property to its pre-flood condition. Indirect damages include the net monetary cost of evacuation, relocation, lost wages, lost production, and lost sales. Intangibles flood damages are defined as flood effects which can not be measured in monetary terms.

In this study, assessed are the direct and indirect damage inflicted on buildings as well as their interior effects and on the farm crops which will exist after the completion of the first stage of the urbanization plan, which is now going on in the inundation area. The relation curve between flood damage and flooding water stage is shown in Fig. 2-21.

The mean annual flood damage is determined by summing up the potential direct damage (from floods of different frequencies) plus the potential indirect damage (estimated by applying an indirect damage rate).

By implementing the project, benefits are expected in the city side and the mountain side areas below Sungguminasa and also the upper stream area of the Sungguminasa bridge.

The annual flood control benefit is estimated at US$13.0 million by calculating the total flood damage potential under with and without the project conditions.

The estimated annual damages to buildings and interior effects and to farm crops in the project area are sumarized in the following Table 2-2.

Table 2-2 ANNUAL EXPECTED DAMAGE REDUCTION (1)

(Unit; x 10^6m^3 US$)

		Without the Project	With the Project
Building & Interior Effects	direct	16.18	4.91
	indirect(15%)	2.43	0.74
Sub-Total		18.61	5.65
Farm crops	direct	0.50	0.45
	indirect	0.10	0.09
Sub-Total		0.60	0.54
Total		19.21	6.19
Damage reduction (Benefit)		13.0 (19.21 - 6.19 = 13.02)	

The aforementioned damage estimation is based on the following assumptions:

1) Buildings and interior effects

Inundation water with a depth of 20 cm. or less above the ground level inflicts no damage on houses. Temporary houses and their household effects are free from flood damage, because their floors are elevated at 1.5 m. to 2.0 m. above the ground level.

The damage rates as shown in Table 2-3 are applied for the damage estimation. Those rates are quoted from the report, "Feasibility Study on Surabaya River Improvement" prepared by JICA in 1973.

2) Farm Crops

Flood damage to the farm crops is estimated by only the paddy damages, because the paddy field covers most of the agricultural land in the inundation area.

Economic price of Rp. 353.0/kg (rice), is employed for the estimation (refer to Table 2-4).

The annual mean yield of rice in the project area is estimated at about 2.62 t/ha. in the wet season and at about 2.24 t/ha. in the dry season.

Damage rate can be classified as shown in Table 2-5, depending upon the growing stage and inundation water stage: In this project, however, damage rate is assumed at the constant level to be 20% in consideration of high frequency of flood occurrence in January (refer to Table 2-6), cropping pattern and ponding period.

3) Indirect damage

The indirect damage to buildings and interior effects is fixed at 15%.

The indirect damage to farm crops is fixed at 20%.

6. PRELIMINARY DESIGN

6.1 Earthwork Required

The earthwork for the river improvement consists of the followings;

(Unit: m^3)

	Below Sungguminasa	Above Sungguminasa	Drainage ditch	Road raising
Excavation	2,040,000	870,000	72,400	-
Embankment	630,000	-	-	20,000
Filling	-	360,000	-	-

Borrow Pit

Since no appropriate materials for dike embankment are obtainable from the riverbed, its materials will be conveyed from a borrow pit which is located in the right bank near Sungguminasa (see Fig. 2-22). The available volume of the soil material in the proposed borrow bit is estimated at 1.2×10^6 m^3.

Spoil Bank

There exists the low elevation area, 0.3 m above M.S.L. in a part of Ujung Pandang city which will be planned to urbanize in the future. For the urbanization of the low elevated area, it will be required that the area be filled up to avoid the flooding due to land side water. It is, therefore, recommendable that the area will be utilized as the spoil bank.

The expected volume of the spoil bank is estimated at 3.5×10^6 m^3 when the area is reclaimed up to a elevation of about 1.1 m above M.S.L.

6.2 Riparian Structures

The riparian structures which will be installed under the present improvement plan along the Jeneberang river will include dike, drainage ditch, revetment, groyne, sluice, and groundsill. And the excavation of a diversion channel of S. Garassi, and the raising of the existing road running on the right bank in the upper reaches of Sungguminasa bridge, will be also included as the part of the project.

Fig. 2-15 will show the location of the riparian sturctures referred to the above.

Dike

It is proposed, as a principle, to keep the height of dike no more than 3.0 m above ground level, including a 1.2 m freeboard. The proposed dike will have a crest width of 3.0 m, so that vehicles can pass along it for river management. The side slope gradient on the river side and land side will be 1 : 2, to assure the stability of the dike (refer to Fig. 2-23).

Where the crest height exceeds 3.0 m above the land side ground level, 3.0 m wide berms will be provided in view of:

1) protection of the dike against seepage water,
2) securig the slope stability,
3) better maintenance of the dike, and
4) easier flood defence activities.

The berms will be located every 2.0 m below the crest.

The stability of standard cross-section shown in Fig. 2-23 would need to be re-examined upon observation of the features of the soil which is available from the borrow pit.

Drainage Ditch

Drainage ditch to be provided at the land side along the dike is given two functions to fulfil, the one is to drain the seepage water through the dike and the other is to drain the run-off water from its land side area. The seepage water through the dike needs to be quickly drained for the stability of the embankment, in particular.

In the present design, drainage ditches will be excavated along the both banks of the downstream of Sungguminasa bridge, extending for 3,000 m on the right and 9,000 m on the left. Along the right bank, the drainage ditch will be designed in 3 systems so that they can also serve as drainage channels of the municipal waste water. On the left bank, 4 systems of drainage ditch will be provided. At its terminal, the drainage ditch will be connected to a sluice gate.

The scale of the drainage ditch will be determined according to the size of catchment area of each system, as is outlined in Table 2-7.

Revetment

Wet masonry will be employed for revetment by use of the cobbles which are easily obtainable at the project site. The revetment structure consists of a high water revetment, a low water revetment, and a foot protection. The foot protection will be provided at the base of the low water revetment, to prevent riverbed erosion (refer to Fig. 2-25).

Revetment will be constructed in the vicinity of a bridge as well as along the concave side of bends of the river, for a total distance of 10,300 m (on the upper reaches of Sungguminasa bridge, only low water revetment will be constructed for a length of 3,800 m), as is shown in Fig. 2-15

The slopes of the dike which are not specially protected by revetment would be sodded against erosion which might be caused by rainfall and river water.

<u>Groyne</u>

The purpose of a groyne is to prevent erosion at the foot of the side slope by slowing down flow velocity and by accelerating sediment deposit. Groyne will be provided at the concave side of a bend, which is less proof against erosion due to high flow velocity. Wooden pile permeable groyne will be employed for this purpose.

The possible directions along which groyne runs are up stream, down stream and right angle to the flow direction. The right angled groyne is recommendable for arresting sediments and accelerating their deposit.

Dimensions of groyne are based on the empirical formulate which are accepted in Japan, as follows:

$$\frac{L}{B} = 0.1$$

$$\frac{D}{L} = 1.5$$

$$\frac{D}{H} = 20$$

where,
B : width of river
L : length of groyne
D : interval of groynes
H : height of groyne

The structural dimensions and placement intervals of groyne are to be determined by the formulae given in the above. However, the interval may be modified after considering the river conditions such as degree of bend, flow velocity and so on. The structural details are shown in Fig. 2-26. The total length of the sections where groynes are to be provided is 4,700 m, and their number counts 94. The standard interval is to be determined by the above formulae.

<u>Sluice</u>

The existing sluices in the lower reaches of Sungguminasa will be unable to be used due to the construction of the proposed dikes and the drainage ditches. In this connection, 7 sluices in total, will be newly installed, whose scale is depending on the drainage discharge of each ditch (refer to Table 2-8). After the closure of the right course of the Jeneberang river, a sluice will be established at its closing point so that the river water can be taken in, as a flush water, the drainage ditch on the right course which is newly propsoed in this project.

The proposed reinforced concrete sluice has a manually operated steel sluice gate. A cut-off wall will be provided at the center to interrupt the seepage water. Wooden sheet piles will also be driven in to prevent infiltration from under the foundation. Fig. 2-27 illustrates the structure of this sluice.

Groundsill

The groundsill is installed to prevent the reparian structure from erosion of the riverbed, as a majority of sediment will be deposited in Bili-Bili reservoir after completion of Bili-Bili dam. The groundsill will be installed at 30 m downstream of Sungguminasa bridge to protect its foundation. The groundsill, as shown in Fig. 2-28, will be placed over the full width of the channel.

Groundsill of smaller dimensions will also be placed in the downstream of the intake for the paper mill's water to prevent the lowering of their intake capacity due to a sinking of riverbed.

The elevatin of the crest of groundsill will be equated to the elevation of the proposed riverbed. Land side ends of groundsill are to be embedded deep enough into the dike for security.

Aprons are to be constructed on both the head and the tail-ends of the concrete main body. Concrete blocks are to be placed, also for protection against scouring, at the immediate downstream end of the apron.

Diversion Channel of S. Garassi

Construction of dike along the Jeneberang river will necessitate a change of the course of S. Garassi which is joining the Jeneberang in the neighborhood of the estuary from the left bank side. At the present stage of designing, it is proposed to construct a diversion channel which runs for about 800 m in parallel to the dike (refer to Fig. 2-15).

Road Raising

The road which is running to Jl. Malino on the right bank in the upper reaches of Sungguminasa bridge, has some portions which are subject to overflowing of flooding water due to the lower elevation. Accordingly, the lower section of the existing road will be raised by about 1.5 m in maximum for a distance of some 3,000 m, to confine flooding water in river side area. The section of the road proposed for such raising is shown in Fig. 2-22.

The road which is proposed for raising will structurally consists of:

1) subgrade,
2) sub-base course,
3) base course, and
4) pavement.

The sub grade is an embankment with a slope gradient of 1 : 2 consisting of soil from the borrow pit. Materials for the sub-base course will be the crushed stones and gravels, both of which are available in the neighborhood of the construction site. For the base course, unscreened and crushed stones will be used. Asphalt-concrete will be employed for pavement (refer to Fig. 2-29).

6.3 Land Acquisition and House Evacuation

The land to be acquired and the houses to be evacuated for implementation of the river improvement project will be tabulated in the below:

Land Acquisition

(Unit: ha)

	Right bank side	Left bank side
Above Sungguminasa	12	6
Below Sungguminasa	43	7

House Evacuation

(Unit: nos.)

	Right bank side	Left bank side
Below Sungguminasa	180	50

7. CONSTRUCTION PLANNING AND COST ESTIMATE

7.1 Construction Schedule

Work Order

The river improvement for the urgent flood control is scheduled to be implemented from the beginning of 1982 under the financial assistance of Overseas Economic Cooperation Fund. The construction schedule for the river improvement works in this report has been planned on a basis of the completed conditions of the urgent flood control, and the works will be implemented after completion of the dam construction to avoid concentration of the construction works.

The river improvement works can be divided into four work sections including the urgent works. It is technically and economically proposed that the river improvement works are implemented following the order mentioned below taking into account the significance of the area to be protected from the flooding.

1.	Urgent river improvement	:	1982-1987
2.	Improvement of the section from 2.0 k to the Sungguminasa bridge	:	1991
3.	Improvement of the section from the estuary to the diverted point, 4.4 k	:	1992-1995
4.	Improvement of the section in the upper reaches of the Sungguminasa bridge	:	1992-1995

Workable Days

The work will take place only during dry season from April to October each year because it consists mostly of the earth work which can not expect good result under rain and also because it is a risky job to undertake under the menace of flooding.

Annual workable days are 168 days which are determined except national holidays and rainy days (above 30 mm/day) during dry season.

The work section of river improvement is shown in Fig. 2-30. Its construction schedule is presented in Fig. 2-31

7.2 Construction Machinery

Kinds and number of the construction equipment will be determined by the annual work volume which may be given below in the maximum amount:

Dredging	:	250,000 m^3/year
Land excavation	:	215,000 m^3/year
Underwater excavation	:	215,000 m^3/year
Embankment	:	189,000 m^3/year

The dredging section roughly corresponds to the tidal section that is, from the estuary up to the confluencing point with the right course of the Jeneberang. 50% of excavation work will be done on land by use of bulldozer and the remaining 50% under water by employing back hoe. The main construction equipment required for the work will be as follows:

Dredging	:	Dredger
Excavation	:	Bulldozer
Excavation & loading	:	Back hoe
Loading	:	Wheel loader
Transportation	:	Dump truck
Spreading & compaction	:	Bulldozer

The daily work volume will be calculated to be the following;

Dredging work : $\frac{250,000 \text{ m}^3}{168 \text{ days}} = 1,490 \text{ m}^3/\text{day}$

Land excavation work: $\frac{215,000 \text{ m}^3}{168 \text{ days}} = 1,280 \text{ m}^3/\text{day}$

Underwater excavation work : $\frac{215,000 \text{ m}^3}{168 \text{ days}} = 1,280 \text{ m}^3/\text{day}$

Embankment work : $\frac{189,000 \text{ m}^3}{168 \text{ days}} = 1,130 \text{ m}^3/\text{day}$

Number of Construction Equipment

1) Dredging work

Dredging work is to be performed by a pump dredger 800 PS type, since the riverbed is sandy. The dredged sand will be conveyed from the dredger to the river bank through a pipe (Dia. 500 mm) which will be floated on the river water. The sand will be loaded by a wheel loader 2.0 m^3 type, and transported by dump trucks, 8-ton type.

Dredger operation will be done on two shifts from the consideration as to its working efficiency and economicality of the operation itself.

- Pump dredger, 800 PS type

  Capacity of a dredger is fixed at 125 m^3/hr. Assuming that of the dredger is operated for 14 hours per day, the required number of units will be;

$$\frac{1,490}{14 \times 125} = 0.85$$

  A practical approximation is 1 unit.

- Wheel loader, 2.1 m^3, 1.2 m^3 type
  Work volume per hour will be;

$$Q = \frac{3,600 \times q \times E}{Cm}$$

  where,

  Q : capacity (m^3/hr)
  q : loading volume per cycle (m^3)
  E : job efficiency
  Cm : time per cycle (sec)

  therefore,

$$Q_{2.0} = \frac{3,600 \times 1.6 \times 0.65}{42}$$

$$= 89.1 \ m^3/hr$$

$$Q_{1.2} = \frac{3,600 \times 0.96 \times 0.65}{42}$$

$$= 53.5 \ m^3/hr$$

  Assuming that the time of daily operation is 14 hours, the number of required units will be;

$$\frac{1,490}{14 \times (89.1 + 53.5)} = 0.8$$

A practical approximation is 1 unit, respectively.

- Dump truck, 8-ton type

  Work volume per hour will be;

$$Q = \frac{60 \times q \times E}{Cm}$$

$$Cm = \frac{5}{1,000} L + 10$$

where,

Q : capacity (m^3/hr)
q : loading capacity (m^3)
E : job efficiency
Cm : time per cycle (min)
L : transporting distance (m)

applying L = 1,000 m, q = 4.4 m^3 and E = 0.9

$$Cm = \frac{5}{1,000} \times 1,000 + 10 = 15 \text{ min}$$

$$Q = \frac{60 \times 4.4 \times 0.9}{15} = 15.8 \text{ m}^3/\text{hr}$$

Assuming that the daily operation is of 14 hours, the number of required units will be;

$$\frac{1,490}{14 \times 15.8} = 6.7$$

A practical approximation is 7 units.

2) Land excavation work

Soil excavation and hauling will be performed by bulldozers, 21-ton type, loading by wheel loaders, 2.0 m^3 type and transportation by dump trucks, 8-ton type.

- Bulldozer, 21-ton type

  Work volume per hour will be;

$$Q = \frac{60 \times q \times E}{Cm}$$

$$Cm = \frac{0.37}{10} L + 0.25$$

where,

Q : capacity (m^3/hr)
q : loading volume per cycle (m^3)
E : job efficiency
Cm : time per cycle (min)
L : hauling distance (m)

applying L = 50 m, q = 2.8 m^3 and E = 0.5,

$$Cm = \frac{0.37}{10} \times 50 + 0.25$$

$$= 2.1 \text{ min}$$

$$Q = \frac{60 \times 2.8 \times 0.5}{2.1}$$

$$= 40.0 \text{ m}^3/\text{hr}$$

Assuming that the time of daily operation is 7 hours, the required number of units will be

$$\frac{1,280}{7 \times 40} = 4.6$$

A practical approximation is 5 units.

- Wheel loader 2.1 m^3 type

  Work volume per hour will be;

$$Q = \frac{3,600 \times q \times E}{Cm}$$

where,
Q : capacity (m^3/hr)
q : loading volume per cycle (m^3)
E : job efficiency
Cm : time per cycle (sec)

applying q = 1.6 m^3 and E = 0.65,

$$Q = \frac{3,600 \times 1.6 \times 0.65}{42} = 89.1 \text{ m}^3/\text{hr}$$

Assuming that time of daily operation is 7 hours, the required number of unit will be;

$$\frac{1,280}{7 \times 89.1} = 2.1$$

A practical approximation is 2 unit.

- Dump truck, 8-ton type

  Work volume per hour will be;

$$Q = \frac{60 \times q \times E}{Cm}$$

$$Cm = \frac{25}{6,000} (L - 1,000) + 15$$

where,
Q : capacity (m^3/hr)
q : loading volume per cycle (m^3)
E : job efficiency
Cm : time per cycle (min)
L : transporting distance (m)

applying L = 6,000 m, q = 4.4 m^3 and E = 0.9,

$$Cm = \frac{25}{6,000}(6,000 - 1,000) + 15 = 35.8 \text{ min}$$

$$Q = \frac{60 \times 4.4 \times 0.9}{35.8} = 6.6 \text{ m}^3/\text{hr}$$

Assuming that the daily operation time is 6 hours, the required number of units will be;

$$\frac{1,280}{7 \times 6.6} = 27.7$$

A practical approximation is 28 units.

3) Underwater excavation work

Excavation and loading will be performed by back hoes, 1.2 m^3 type, and transportation by dump trucks, 8-ton type.

- Back hoe, 1.2 m^3 type

Work volume per hour will be;

$$Q = \frac{3,600 \times q \times E}{Cm}$$

where,

Q	:	capacity (m^3/hr)
q	:	excavation and loading volume per cycle (m^3)
E	:	job efficiency
Cm	:	time per cycle (sec)

applying q = 1.06 m^3 and E = 0.4,

Work volume per hour will be;

$$Q = \frac{3,600 \times 1.06 \times 0.4}{36}$$

$$= 42.4 \text{ m}^3/\text{hr}$$

Assuming that the time of daily operation is 7 hours, the required number of units will be

$$\frac{1,280}{7 \times 42.4} = 4.3$$

A practical approximation is 4 units.

- Dump truck, 8-ton type

Work volume per hour will be;

$$Q = \frac{60 \times q \times E}{Cm}$$

$$Cm = \frac{25}{6,000} (L - 1,000) + 15$$

where,

Q : capacity (m^3/hr)
q : loading volume per cycle (m^3)
E : job efficiency
Cm : time per cycle (min)
L : transporting distance (m)

applying L = 6,000 m, q = 4.4 m^3 and E = 0.9,

$$Cm = \frac{25}{6,000} (6,000 - 1,000) + 15$$

$$= 35.8 \text{ min}$$

$$Q = \frac{60 \times 4.4 \times 0.9}{35.8} = 6.6 \text{ m}^3\text{/hr}$$

Assuming that the time of daily operation is 7 hours, the required number of units will be;

$$\frac{1,280}{7 \times 6.6} = 27.7$$

A practical approximation is 28 units.

4) Embankment work

Since the sand and soil obtained from dredging and excavation of the Jeneberang river are not suitable for banking material, the materials specially excavated at the borrow pit will be used.
The equipment consist of bulldozers, 21-ton type (for excavation), loaders, 1.2 m^3 type (for loading) and dump trucks, 8-ton type (for transportation to the construction site).

Spreading and compaction of embankment materials will be performed by bulldozers, 11-ton type.

- Bulldozer, 21-ton (excavation)

Work volume per hour will be;

$$Q = \frac{60 \times q \times E}{Cm}$$

$$Cm = \frac{0.37}{10} L + 0.25$$

where,

Q : capacity (m^3/hr)
q : loading volume per cycle (m^3)
E : job efficiency
Cm : time per cycle (min)
L : hauling distance (m)

aplying L = 30 m, q = 2.8 m^3 and E = 0.55,

$$Cm = \frac{0.37}{10} \times 30 + 0.25$$

$$= 1.36 \text{ min}$$

$$Q = \frac{60 \times 2.8 \times 0.55}{1.36}$$

$$= 67.9 \ m^3/hr$$

Assuming that the time of daily operation is 7 hours, the required number of units will be;

$$\frac{1,130}{7 \times 67.9} = 2.4$$

A practical approximation is 3 units.

- Wheel loader, 1.2 m^3 type

Work volume per hour will be;

$$Q = \frac{3600 \times q \times E}{Cm}$$

where,

Q : capacity (m^3/hr)
q : loading volume per cycle (m^3)
E : job efficiency
Cm : time per cycle (sec)

applying q = 0.96 m^3, E = 0.65 and Cm = 42 sec,

$$Q = \frac{3600 \times 0.96 \times 0.65}{42} = 53.5 \ m^3/hr$$

Assuming that the daily operation time is 7 hours, the required number of unit will be;

$$\frac{1,130}{7 \times 53.5} = 3.0$$

A practical approximation is 3 units.

- Dump truck, 8-ton type

  Work volume per hour will be;

$$Q = \frac{60 \times q \times E}{Cm}$$

$$Cm = \frac{25}{6,000} (L - 1,000) + 15$$

where,

Q	:	capacity (m^3/hr)
q	:	loading volume per cycle (m^3)
E	:	job efficiency
Cm	:	time per cycle (min)
L	:	transporting distance (m)

applying L = 6,000 m, q = 4.4 m^3 and E = 0.9,

$$Cm = \frac{25}{6,000} (6,000 - 1,000) + 15 = 35.8 \text{ min}$$

$$Q = \frac{60 \times 4.4 \times 0.9}{35.8} = 6.6 \text{ m}^3/\text{hr}$$

Assuming that the daily operation time is 7 hours, the required number of units will be;

$$\frac{1,130}{7 \times 6.6} = 24.5$$

A practical approximation is 25 units.

- Bulldozer 11-ton type (for spreading and compaction)

  Spreading : $Q_1 = 10E \times (11D + 8)$

  Compaction: $Q_2 = \frac{V \times W \times D \times E}{N}$

  Spreading and Compaction:

$$Q = \frac{Q_1 + Q_2}{Q_1 + Q_2}$$

where,

Q_1	:	spreading (m^3/hr)
Q_2	:	compaction (m^3/hr)
Q	:	spreading and compaction (m^3/hr)
D	:	thickness of finishing layer (m)
V	:	speed of compaction (m/hr)
W	:	width of compaction (m)
N	:	number of compaction
E_1	:	job efficiency
E_2	:	job efficiency

applying $E_1 = 0.65$ and $D = 0.3$ m,

$Q_1 = 10 \times 0.65 \times (11 \times 0.3 + 8) = 73.5\ m^3/hr$

also applying $V = 4{,}000$ m/hr, $W = 0.6$ m, $D = 0.3$m, $E_2 = 0.7$ and $N = 5$,

$$Q_2 = \frac{4{,}000 \times 0.6 \times 0.3 \times 0.7}{5}$$

$$= 100.8\ m^3/hr$$

$$Q = \frac{73.5 \times 100.8}{73.5 + 100.8}$$

$$= 42.5\ m^3/hr$$

Assuming that the daily operation time is 7 hours, the required number of unit will be;

$$\frac{1{,}130}{7 \times 42.5} = 3.8$$

A practical approximation is 4 units.

The outline of the principal construction machinery to be deployed for the entire work is given in Table 2-9.

7.3 Construction Materials

The construction materials required for the riparian structures such as cement, reinforcement bars, steel gates, etc., are almost entirely locally available as they are being manufactured in Indonesia in good quality. The concrete aggregates are also plentifully available from the riverbed at the job sites.

The necessary construction materials for the proposed structures are enumerated in Table 2-10.

7.4 Cost Estimate

Construction Cost

The river improvement cost comprises civil works, gates and equipment, land acquisition, engineering cost and plus 15% physical contingencies.

The construction cost has been estimated on the contract basis and 1981 prices.

The total cost will be US$22.9 million, out of which US$10.8 million is in foreign currency and US$12.1 million in local currency. The breakdown of the construction cost is shown in Table 2-11, and Table 2-12 shows the annual disbursement schedule.

Operation, Maintenance and Replacement Cost

The operation and maintenance cost will comprise the personnel cost, operational machinery and equipment, vehicles, administrative cost and miscellaneous. The annual operation and maintenance cost is estimated at US$0.09 million for the whole period of the project life. The replacement cost of groyne in every 10 years and sluice gate in every 25 years is estimated at US$ 0.42 million and US$ 0.37 million, respectively.

Table 2-2 ANNUAL EXPECTED DAMAGE REDUCTION (2)
(Buildings and Interior Effects)

	RETURN PERIOD	WATER STAGE MOUNTAIN SIDE (m)	WATER STAGE CITY SIDE (m)	FLOOD DAMAGE X 10^6 Rp.	AVERAGE X 10^6 Rp.	EXPECTED VALUE	EXPECTED DAMAGE X 10^6 Rp.	TOTAL X 10^6 Rp.
W/O PROJECT	(1/1)	1.30	1.89	1,935				
					2,497	0.5	1,248.5	
	1/2	1.45	2.03	3,059				
					3,175	0.084	266.7	
	1/2.4	1.50	2.05	3,290				
					11,876	0.216	2,565.2	
	1/5	2.04	2.61	20,462				
					28,344	0.1	2,834.4	
	1/10	2.53	2.82	36,225				
					38,665	0.067	2,590.6	
	1/30	2.82	2.86	41,105				
					43,365	0.014	607.1	
	1/50	2.86	2.89	45,624				
								10,112.5
W/ PROJECT	(1/1)	1.12	1.27	953.7				
					1,454.6	0.5	727.3	
	1/2	1.30	1.54	1,955.4				
					2,169.8	0.084	182.3	
	1/2.4	1.34	1.60	2,384.2				
					3,352.3	0.216	724.1	
	1/5	1.42	1.78	4,320.4				
					6,152.6	0.1	615.3	
	1/10	1.55	1.94	7,984.7				
					9,629.6	0.067	645.2	
	1/30	1.77	2.01	11,274.6				
					12,437.9	0.014	174.1	
	1/50	1.88	2.07	13,601.2				
								3,068.3

Table 2-2 ANNUAL EXPECTED DAMAGE REDUCTION (3)
(Crops)

	RETURN PERIOD	WATER STAGE MOUNTAIN SIDE (m)	WATER STAGE CITY SIDE (m)	FLOOD DAMAGE X 10^6Rp.	AVERAGE X 10^6Rp.	EXPECTED VALUE	EXPRECTED DAMAGE X 10^6Rp.	T O T A L X 10^6Rp.
W/O PROJECT	(1/1)	1.30	1.89	299				
					319	0.5	159.5	
	1/2	1.45	2.03	339				
					346	0.084	29.1	
	1/2.4	1.50	2.05	352				
					395	0.216	33.2	
	1/5	2.04	2.61	438				
					464	0.1	46.4	
	1/10	2.53	2.82	489				
					511	0.067	34.2	
	1/30	2.82	2.86	533				
					535	0.014	7.5	
	1/50	2.86	2.89	536				
								309.9
W/ PROJECT	(1/1)	1.12	1.27	191				
					227	0.5	113.5	
	1/2	1.30	1.54	262				
					291	0.084	24.4	
	1/2.4	1.34	1.60	320				
					331	0.216	71.5	
	1/5	1.42	1.78	341				
					365	0.1	36.5	
	1/10	1.55	1.94	388				
					395	0.067	26.5	
	1/30	1.77	2.01	402				
					411	0.014	5.8	
	1/50	1.88	2.07	420				
								278.2

Table 2-3 FLOOD DAMAGE RATE OF BUILDINGS AND INTERIOR EFFECTS

Ponding Depth above Floor Level (m)	Buildings	Interior Effects			
		House	Shop	Office	School and Factory
0 - 0.5	0.05	0.11	0.08	0.08	0.08
0.5 - 1.0	0.07	0.29	0.22	0.28	0.24
1.0 - 1.5	0.11	0.41	0.32	0.42	0.35
1.5 - 2.0	0.11	0.47	0.44	0.47	0.39
2.0 - 2.5	0.15	0.49	0.51	0.49	0.40
2.5 - 3.0	0.15	0.51	0.57	0.49	0.41

Table 2-4 ECONOMIC PRICE OF DRY STALK PADDY
- Import Substitution Price -

(Unit: Rp/ton)

1.	International Market Price (F.O.B. Bangkok) /1 US$557	348,125
2.	External Transportation Cost (Bangkok - Ujung Pandang)	8,125
3.	Port Handling Charge and Storing Cost (including cost of sacks) /2	5,710
4.	Selling Price of Rice at Ex-mill Gate	361,960
5.	Conversion to the Price of Dry Stalk Paddy (0.52)	188,219
6.	Milling Charge	- 6,000
7.	Handling and Transportation Cost (Farm gate to mill)	- 2,700
8.	Economic Farm Gate Price of Dry Stalk Paddy	179,519 [180,000]

Note: /1 : Source - Price prospects for Major Primary Commodities IBRD, 1980

Projected price to 1985 in 1980 constant US dollars.

/2 : Handling charge at harbor 30 Rp/ton

Storing chasrge 7 Rp/ton/day x 240 days
4000 Rp/ton

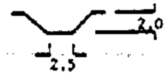
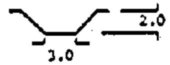
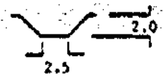
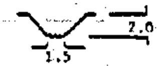
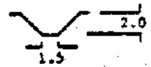
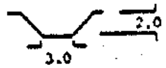
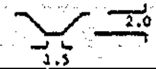
Table 2-5 FLOOD DAMAGE RATE OF PADDY

Growing Stage		Tillering Stage	Booting Stage	Heading Stage	Ripening Stage
Relative Growth (%)		0 - 59	60 - 76	77 - 79	80 - 100
Relative Growth (cm)		0 - 74	75 - 95	96 - 99	100 - 125
Overhead Flooding	1-2 day	10 %	70 %	30 %	5 %
	3-4	20	80	80	20
	5-6	30	85	90	30
	Over 7	35	95	100	30
Flooding up to 75% palnt height	1-2 day	6	40	10	4
	3-4	9	46	23	15
	5-6	14	49	26	23
	Over 7	16	55	30	23
Flooding up to 50% pland height	1-2 day	4	37	8	2
	3-4	9	42	22	4
	5-6	13	45	25	6
	Over 7	15	50	28	6

Table 2-6 FLOOD FREQUENCY

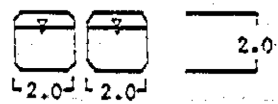
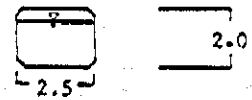
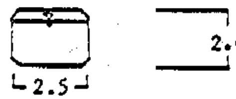
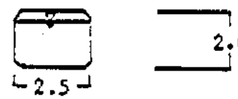
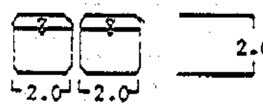
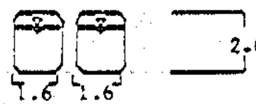
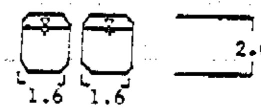
Month	Frequency %
Jan.	44
Feb.	16
Mar.	3
Apr.	9
May	3
Jun.	0
Jul.	0
Aug.	0
Sept.	0
Oct.	0
Nov.	3
Dec.	22
Total	100

Table 2-7 FIGURES OF DRAINAGE DITCH

No.	Catchment area	Specific flow	Run-off	Channel slope gradient	Roughness coefficient	Flow velocity	Length of ditch	Cross Section
	Km^2	$m^3/s/Km^2$	m^3/s			m/s	m	unit: m
1	2.4	3.3	7.42	1:1,500	0.03	0.9	4,400	 2.5, 2.0
2	0.7	7.0	4.90	1:5,000	0.03	0.5	1,400	 3.0, 2.0
3	1.0	5.0	5.00	1:4,000	0.03	0.6	2,000	 2.5, 2.0
4	0.8	6.0	4.80	1:2,000	0.03	0.7	1,200	 1.5, 2.0
5	1.8	4.0	7.20	1:1,000	0.03	1.1	1,700	 1.5, 2.0
6	1.5	4.2	6.30	1:3,000	0.03	0.7	800	 3.0, 2.0
7	1.4	4.3	6.02	1:1,000	0.03	1.0	500	 1.5, 2.0

Note: The location of drainage ditch is shown in Fig. 2-15 As for specific flow refer to Fig. 2-24

Table 2-8 FIGURES OF SLUICE

No.	Design discharge	Flow velocity of sluice inside	Cross sectional area of flow	Dimension of sluice: Height	Width	Length	Cross section
	m^3/s	m/s	m^2	m	m	m	Unit: m
(1)	7.92	1.3	6.1	2.0	2.0ᵐx2	16	
(2)	4.90	1.3	3.8	2.0	2.6ᵐ	16	
(3)	5.00	1.3	3.8	2.0	2.6ᵐ	16	
(4)	4.80	1.3	3.7	2.0	2.6ᵐ	16	
(5)	7.20	1.3	5.5	2.0	2.0x2	16	
(6)	6.30	1.3	4.8	2.0	1.6x2	16	
(7)	6.02	1.3	4.6	2.0	1.6x2	16	

Note: Design discharge is shown in Table 2-7
Dimension of sluice is including a free board.

Table 2-9 MAIN CONSTRUCTION MACHINERY FOR RIVER IMPROVEMENT

No.	Machinery	Capacity	Unit
1	Dredger	800 PS	1
2	Anchor Barge	35 PS	1
3	Wheel Loader	2.1 m^3	3
4	Wheel Loader	1.2 m^3	4
5	Back Hoe	1.2 m^3	4
6	Back Hoe	0.7 m^3	4
7	Asphalt Engine Sprayer	200 l	1
8	Asphalt Finisher	2.4 - 3.6 m	1
9	Road Roller	10/12 ton	1
10	Tire Roller	8/20 ton	1
11	Vibration Roller	25 ton	5
12	Soil Compactor	90 kg	10
13	Tamper	80 kg	10
14	Bull Dozer	21 ton	8
15	Bull Dozer	11 ton	4
16	Dump Truck	8 ton	90

Table 2-10 MAIN CONSTRUCTION MATERIALS FOR RIVER IMPROVEMENT WORKS

No.	I t e m	Unit	Figures	Main use
1	Concrete	m^3	15,000	Revetment, sluice & ground sill
2	Reinforcement bar	ton	200	Sluice, ground sill
3	Steel sluice gate (2.1m x 2.1m x 2)	PC	2	Sluice No. (1), (JR)
4	Bridge	PC	2	Sluice
5	Wire	ton	110	Gabion mattress & groyne
6	Cement	ton	4,400	
7	Sand	m^3	6,100	Concrete
8	Gravel	m^3	18,300	Concrete & revetment
9	Rubble	m^3	13,700	Revetment & road raising
10	Boulder	m^3	17,500	Gabion mattress
11	Log pile ϕ 0.15, L=5.0	PC	3,700	Groyne & sluice
12	Log pile ϕ 0.12, L=2.0	PC	5,400	Revetment
13	Log pile ϕ 0.10, L=6.0	PC	1,600	Revetment
14	Wooden sheet pile t=0.05 L=3.0	PC	100	Sluice

Table 2-11 CONSTRUCTION COST OF RIVER IMPROVEMENT

Work Item	Unit	Quantity	Total Amount ($x10^3$ US$)	Foreign Currency ($x10^3$ US$)	Local Currency ($x10^3$ US$)
1. Civil Works					
Dredging	m^3	816,000	2,685	1,371	1,314
Excavation	m^3	1,320,000	6,559	3,443	3,116
Embankment	m^3	270,000	1,565	761	804
Filling	m^3	360,000	1,043	507	536
Sodding	m^2	347,000	441	-	441
Revetment	m	5,400	732	-	732
Groyne	P.C.	54	123	-	123
Sluice	P.C.	2	44	2	42
Drainage ditch	m	1,200	69	34	35
Groundsill	P.C.	2	405	19	386
Diversion channel of S. Garassi	m^3	80,000	352	176	176
Preparatory works	L.S.	1	1,402	631	771
Sub-total	-	-	15,420	6,944	8,476
2. Gates	P.C.	2	42	-	42
3. Land Acquisition	ha	43	1,376	-	1,376
4. House Evacuation	P.C.	85	204	-	204
5. Engineering Service	L.S.	1	2,885	2,488	397
Sub-total (1 - 5)	-	-	19,927	9,432	10,495
6. Physical Contingency	L.S.	1	2,990	1,415	1,575
Grand-total (1 - 6)		-	22,917	10,847	12,070

Table 2-12 ANNUAL DISBURSEMENT SCHEDULE FOR RIVER IMPROVEMENT

(Unit: x 10^3 US$)

Work Item	Total		1988		1989		1990		1991		1992		1993		1994		1995	
	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.
1. Civil Works																		
Dredging	1,371	1,314	-	-	-	-	-	-	-	-	338	324	420	403	395	378	218	209
Excavation (over land)	1,708	1,595	-	-	-	-	-	-	548	512	479	447	362	338	268	250	51	48
(under water)	1,735	1,521	-	-	-	-	-	-	574	503	502	440	379	332	280	246	-	-
Embankment	761	804	-	-	-	-	-	-	-	-	-	-	-	-	228	241	533	563
Filling	507	536	-	-	-	-	-	-	-	-	99	104	259	274	149	158	-	-
Sodding	-	441	-	-	-	-	-	-	-	67	-	28	-	46	-	149	-	151
Revetment (high & low)	-	312	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	312
(low)	-	420	-	-	-	-	-	-	-	-	-	166	-	44	-	210	-	-
Groyne	-	123	-	-	-	-	-	-	-	-	-	50	-	18	-	55	-	-
Sluice	2	42	-	-	-	-	-	-	-	-	-	-	-	-	1	21	1	21
Drainage ditch	34	35	-	-	-	-	-	-	-	-	-	-	-	-	34	35	-	-
Groundsill	19	336	-	-	-	-	-	-	-	-	13	257	-	-	6	129	-	-
Diversion channel of S. Garassi	176	176	-	-	-	-	-	-	-	-	-	-	-	-	110	110	66	66
Preparatory works	631	771	-	-	-	-	-	-	112	108	143	182	142	146	147	198	87	137
Sub-total	6,944	8,476	-	-	-	-	-	-	1,234	1,190	1,574	1,998	1,562	1,601	1,618	2,180	956	1,507
2. Gates	-	42	-	-	-	-	-	-	-	-	-	-	-	-	-	21	-	21
3. Land Acquisition	-	1,376	-	-	-	-	-	-	-	-	-	64	-	384	-	128	-	800
4. House Evacuation	-	204	-	-	-	-	-	-	-	-	-	48	-	12	-	-	-	144
5. Engineering Service	2,488	397	704	96	227	38	80	13	341	58	284	48	284	48	284	48	284	48
Sub-total (1-5)	9,432	10,495	704	96	227	38	80	13	1,575	1,248	1,858	2,158	1,846	2,045	1,902	2,377	1,240	2,520
6. Physical Contingency	1,415	1,575	106	14	34	6	12	2	236	187	279	324	277	307	285	357	186	373
Grand total (1-6)	10,847	12,070	810	110	261	44	92	15	1,811	1,435	2,137	2,482	2,123	2,352	2,187	2,734	1,426	2,898

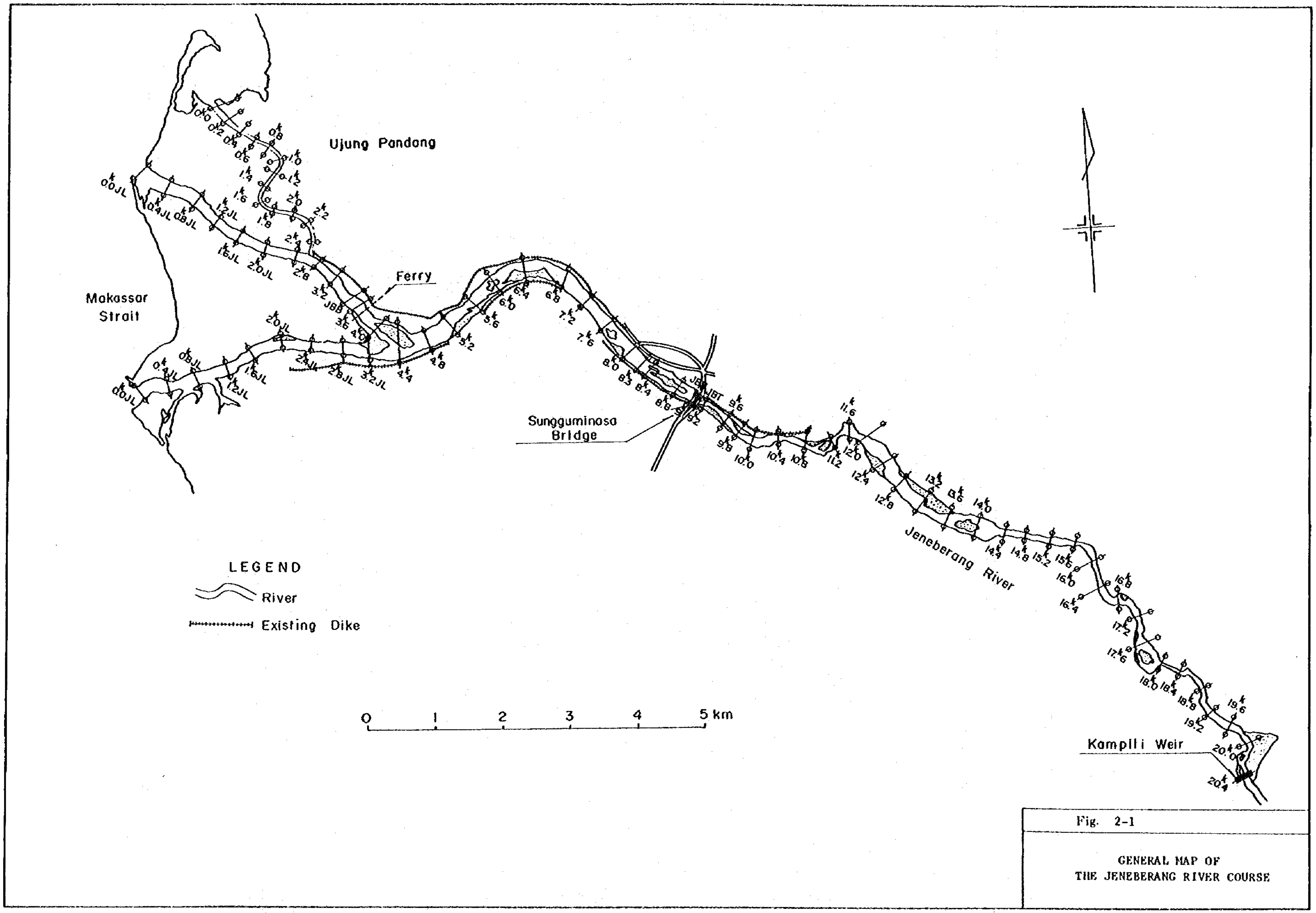


Fig. 2-1

GENERAL MAP OF THE JENEBERANG RIVER COURSE

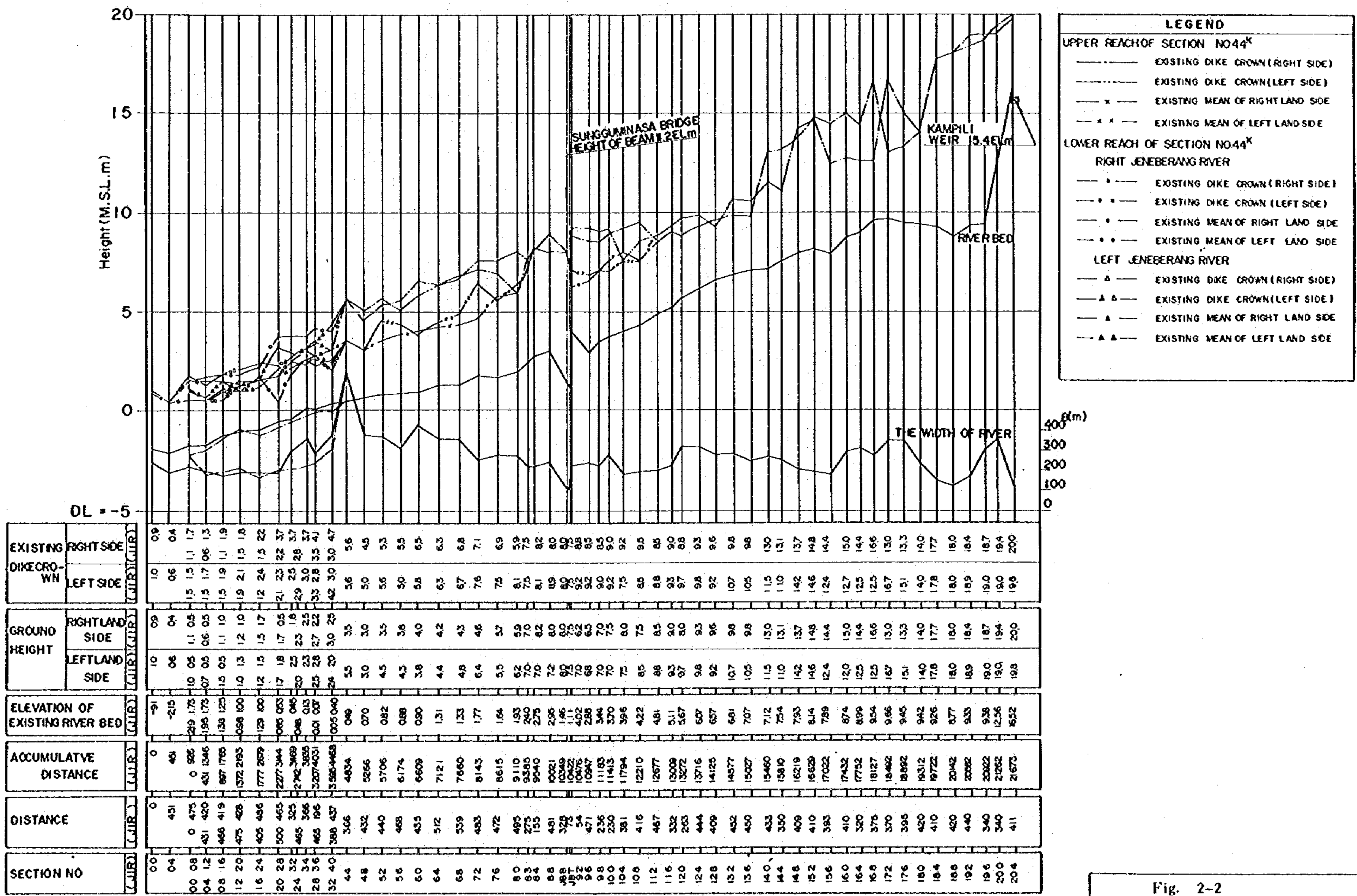


Fig. 2-2

LONGITUDINAL PROFILE OF THE JENEBERANG RIVER (EXISTING CONDITION)

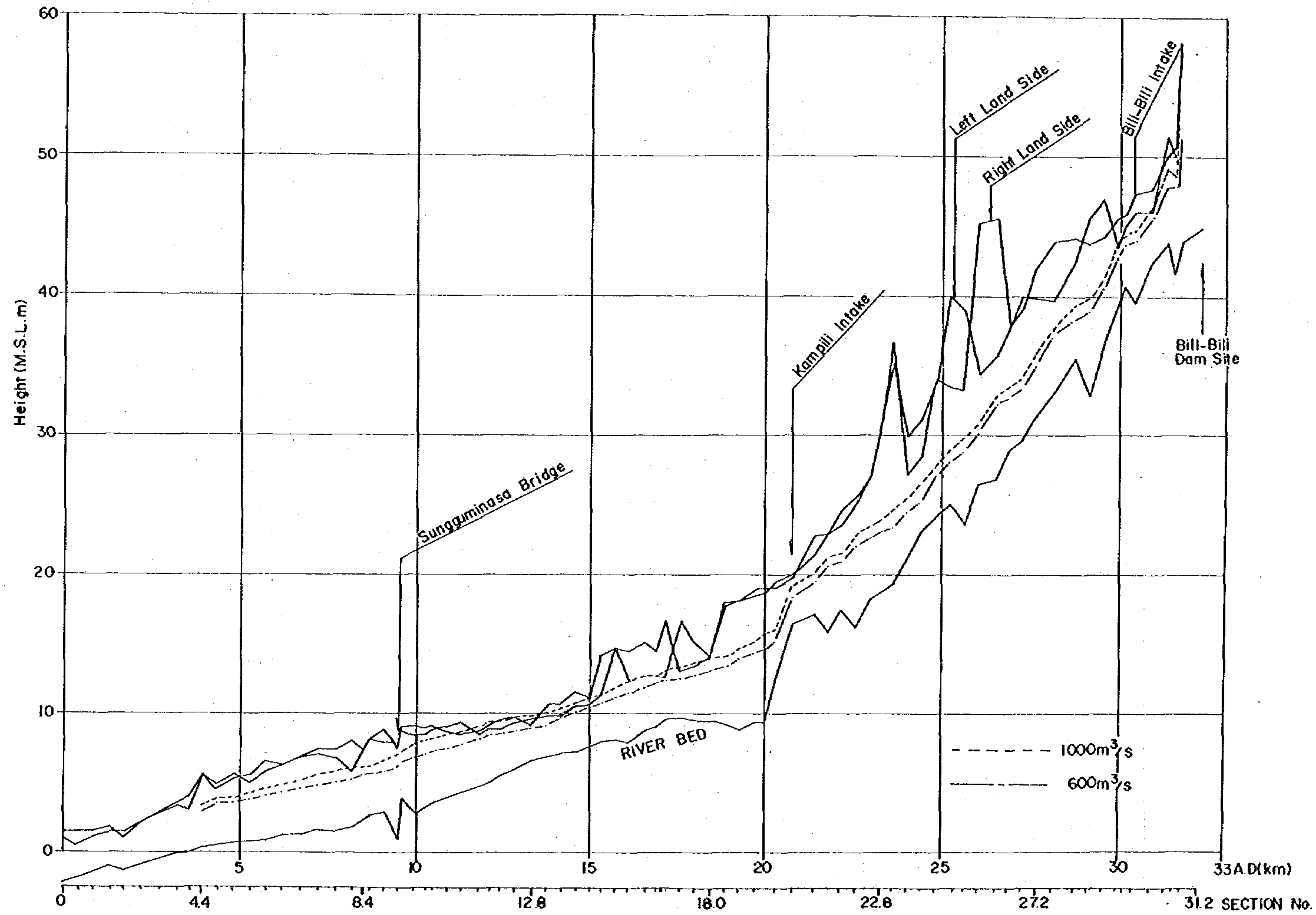


Fig. 2-3

PRESENT FLOW CAPACITY OF THE JENEBERANG RIVER (1)

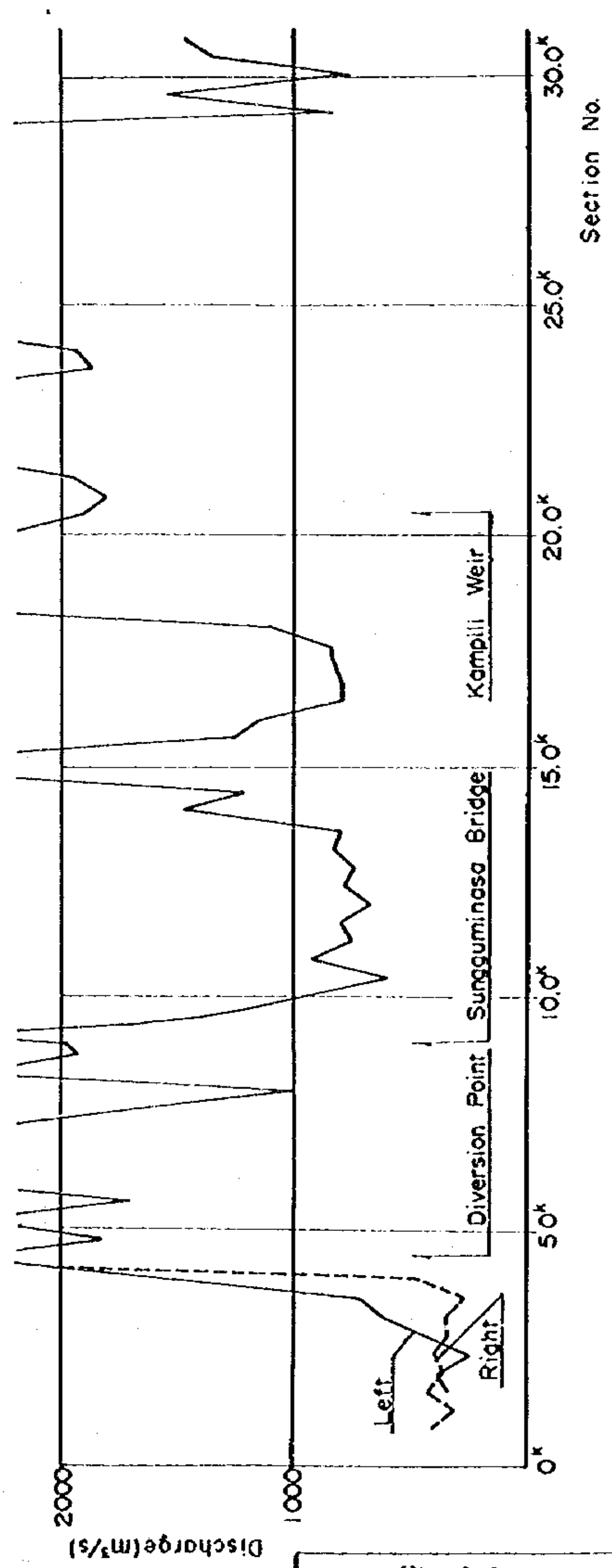


Fig. 2-3

PRESENT FLOW CAPACITY OF THE JENEBERANG RIVER (2)

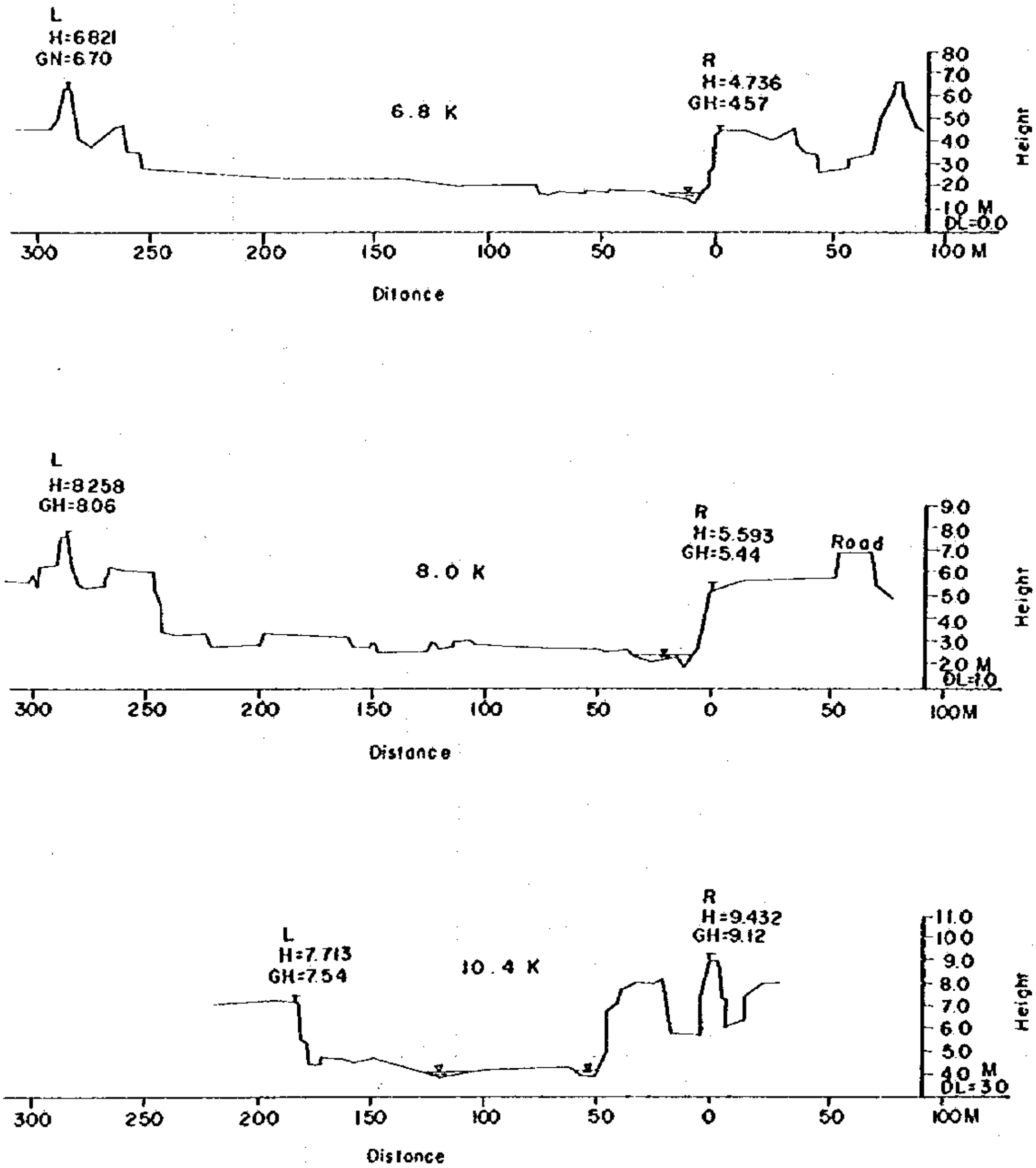


Fig. 2-4

CROSS-SECTION OF THE JENEBERANG RIVER

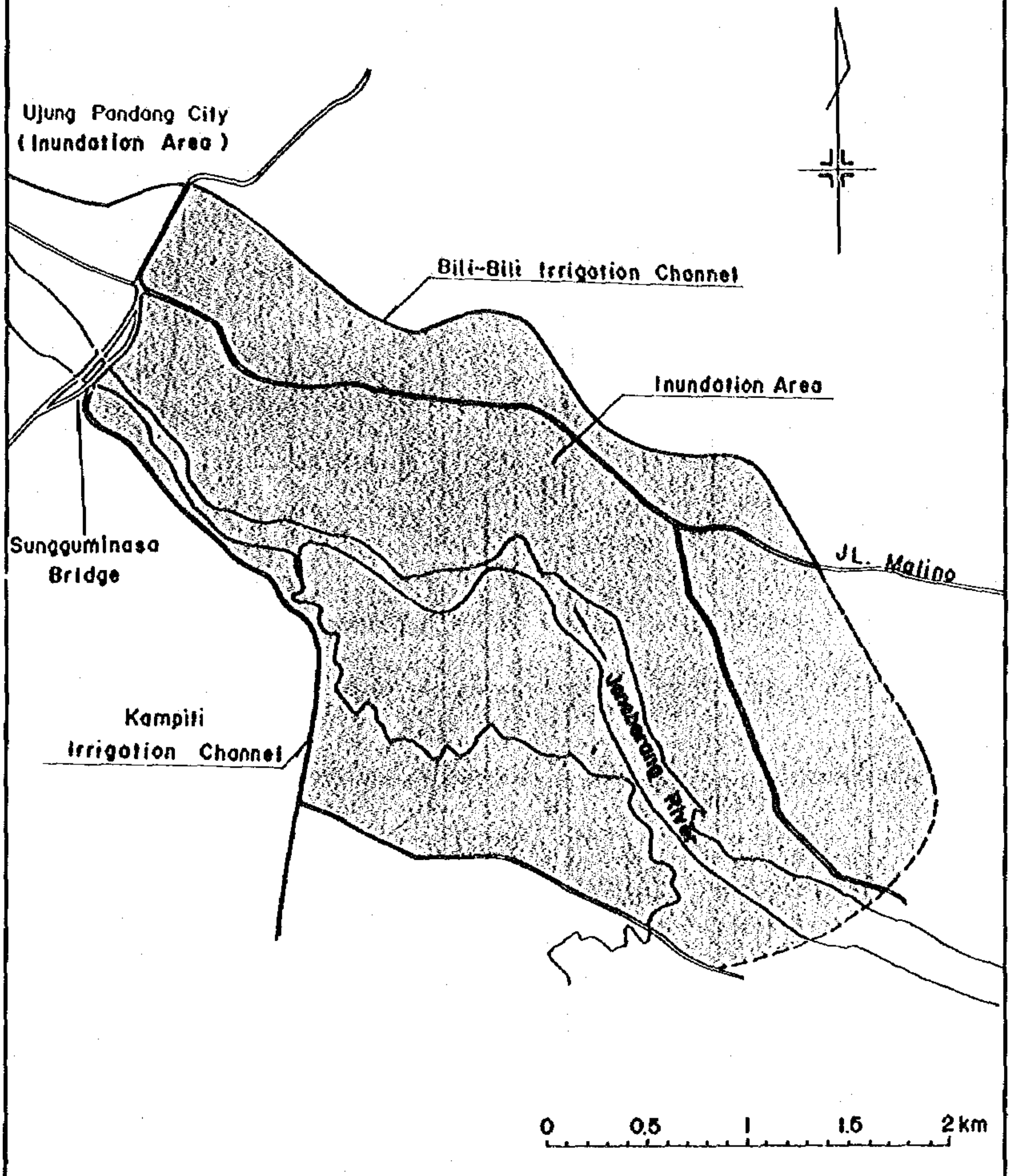


Fig. 2-5

NATURAL BUFFER

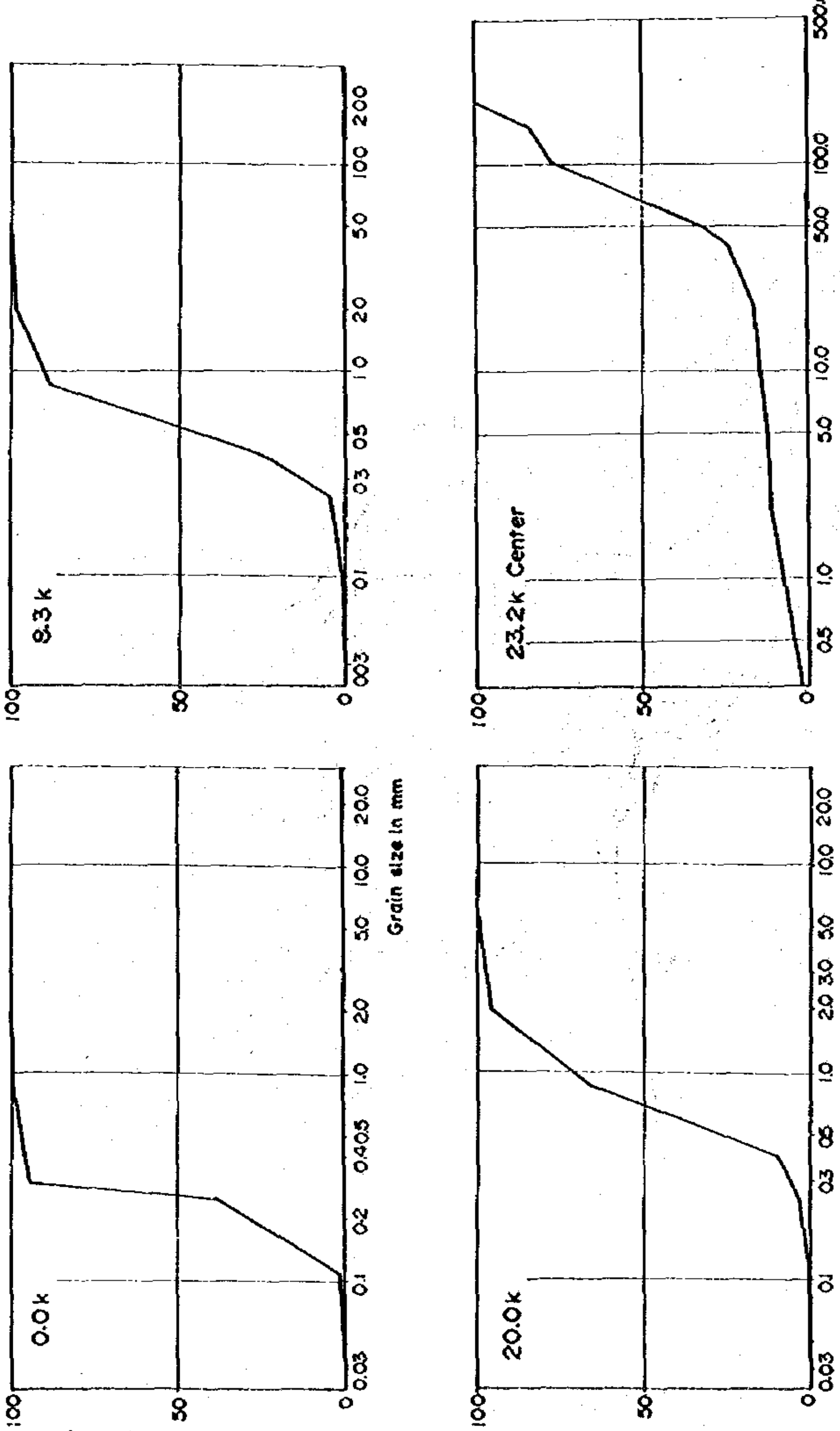


Fig. 2-6

GRAIN-SIZE ACCUMULATION CURVE
ALONG THE JENEBERANG RIVER (1)

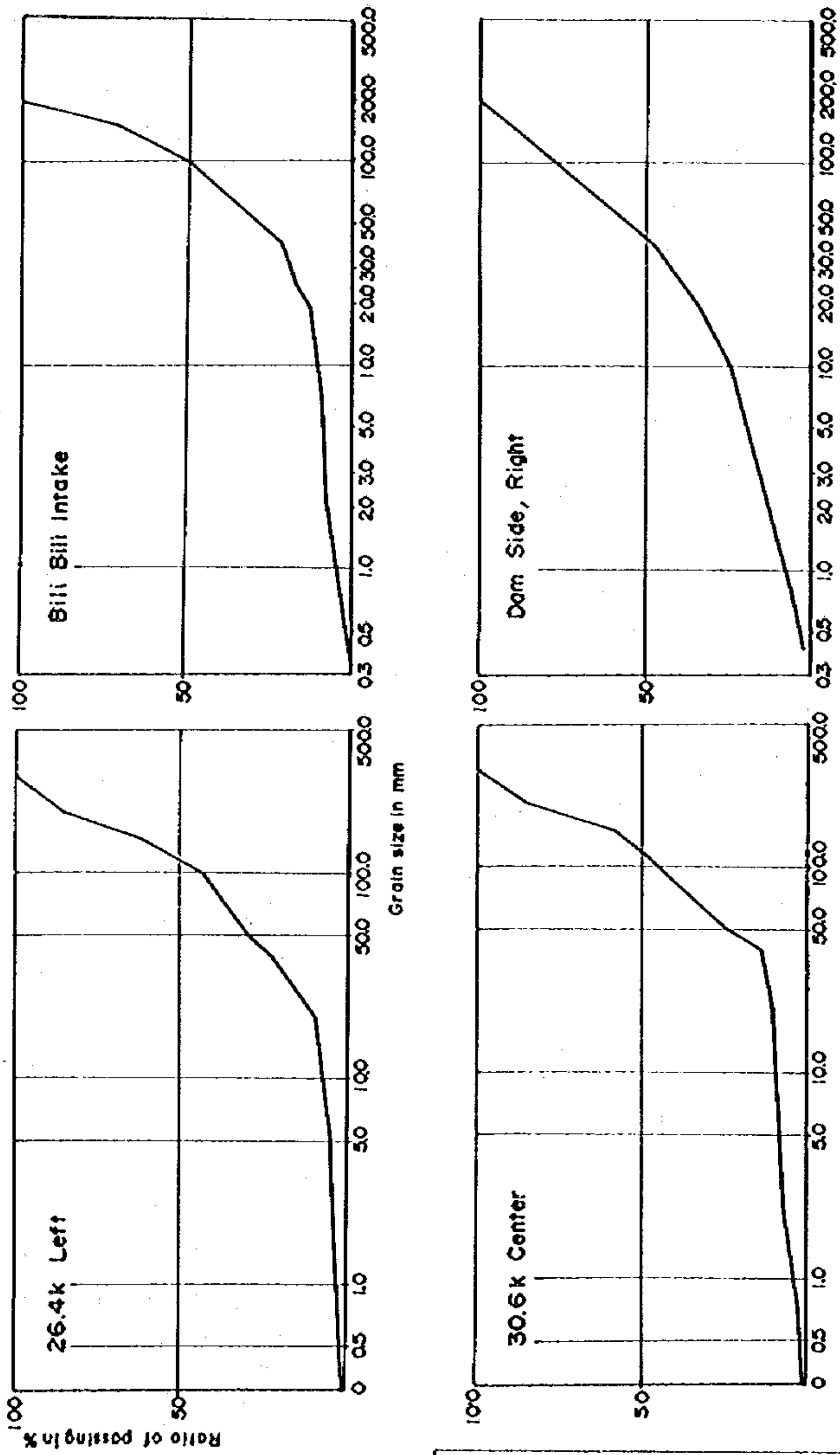


Fig. 2-6

GRAIN-SIZE ACCUMULATION CURVE
ALONG THE JENEBERANG RIVER (2)

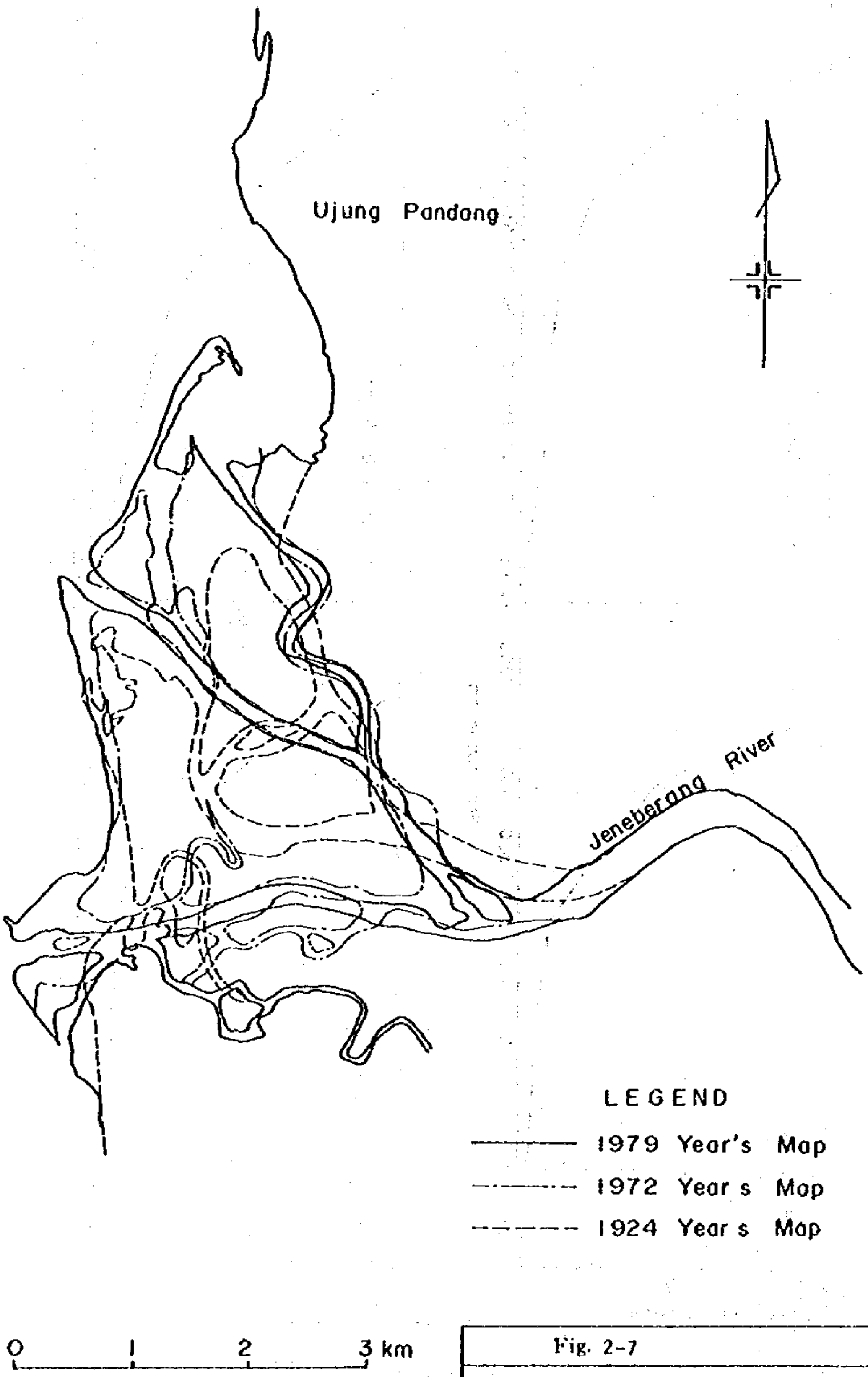
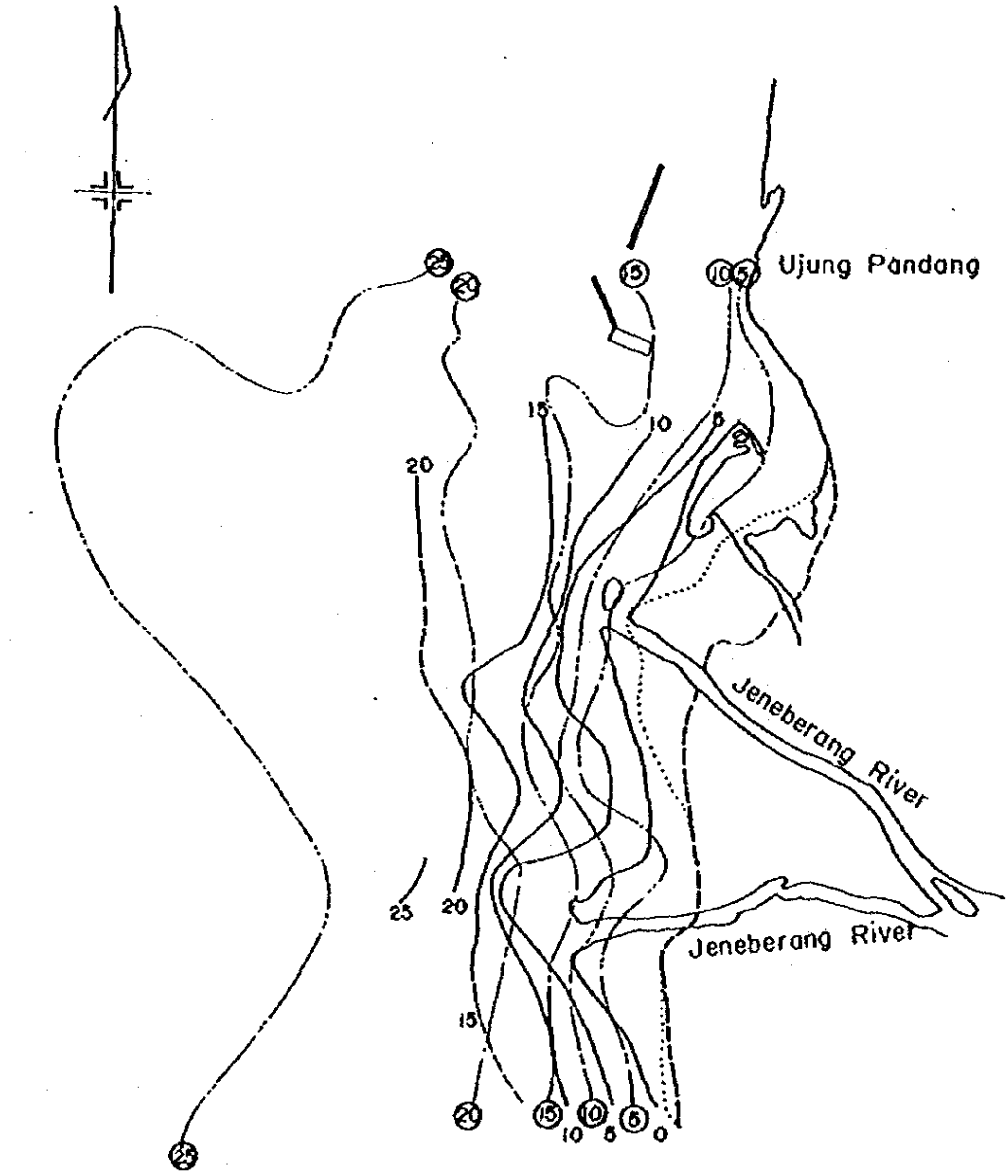


Fig. 2-7

TRANSITION OF ESTUARY SANDBAR



LEGEND

Shore Line 1979 ————

1900 - - - - - -

Shallow Delta in 1900 ....
(Less than 1m Depth)

Depth Contour 1979

1900

Depth in Meter ⑤—㉕
5 — 25

0 1 2 3km

Fig. 2-8

SEDIMENT DEPOSIT AT ESTUARY

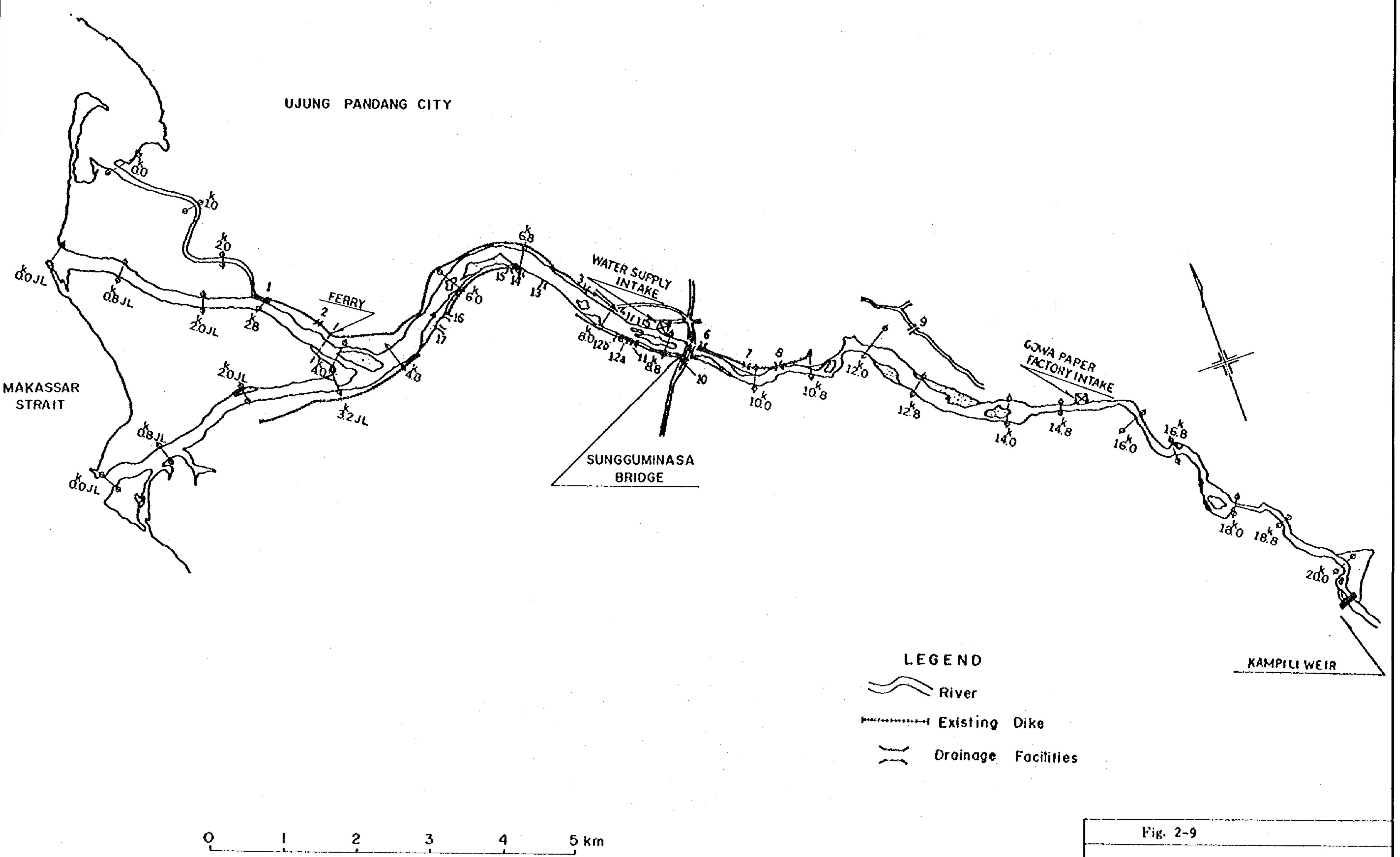
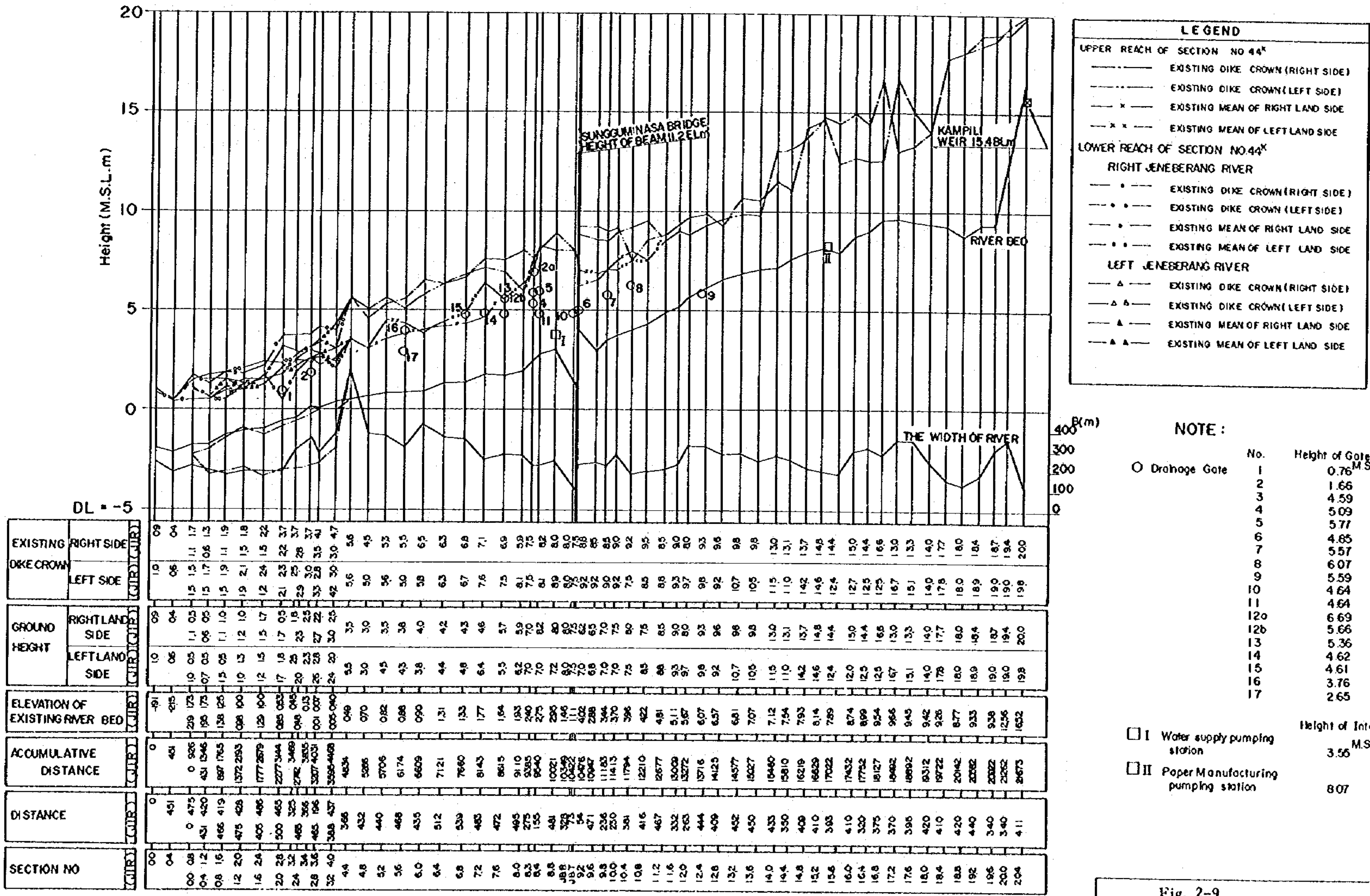


Fig. 2-9

EXISTING RIPARIAN FACILITIES OF THE JENEBERANG RIVER (1)



NOTE :

	No.	Height of Gate (M.S.L.m)
O Drainage Gate	1	0.76
	2	1.66
	3	4.59
	4	5.09
	5	5.77
	6	4.65
	7	5.57
	8	6.07
	9	5.59
	10	4.64
	11	4.64
	12a	6.69
	12b	5.66
	13	5.36
	14	4.62
	15	4.61
	16	3.76
	17	2.65

	Height of Intake (M.S.L.m)
□ I Water supply pumping station	3.56
□ II Paper Manufacturing pumping station	8.07

Fig. 2-9

EXISTING RIPARIAN FACILITIES OF THE JENEBERANG RIVER (2)

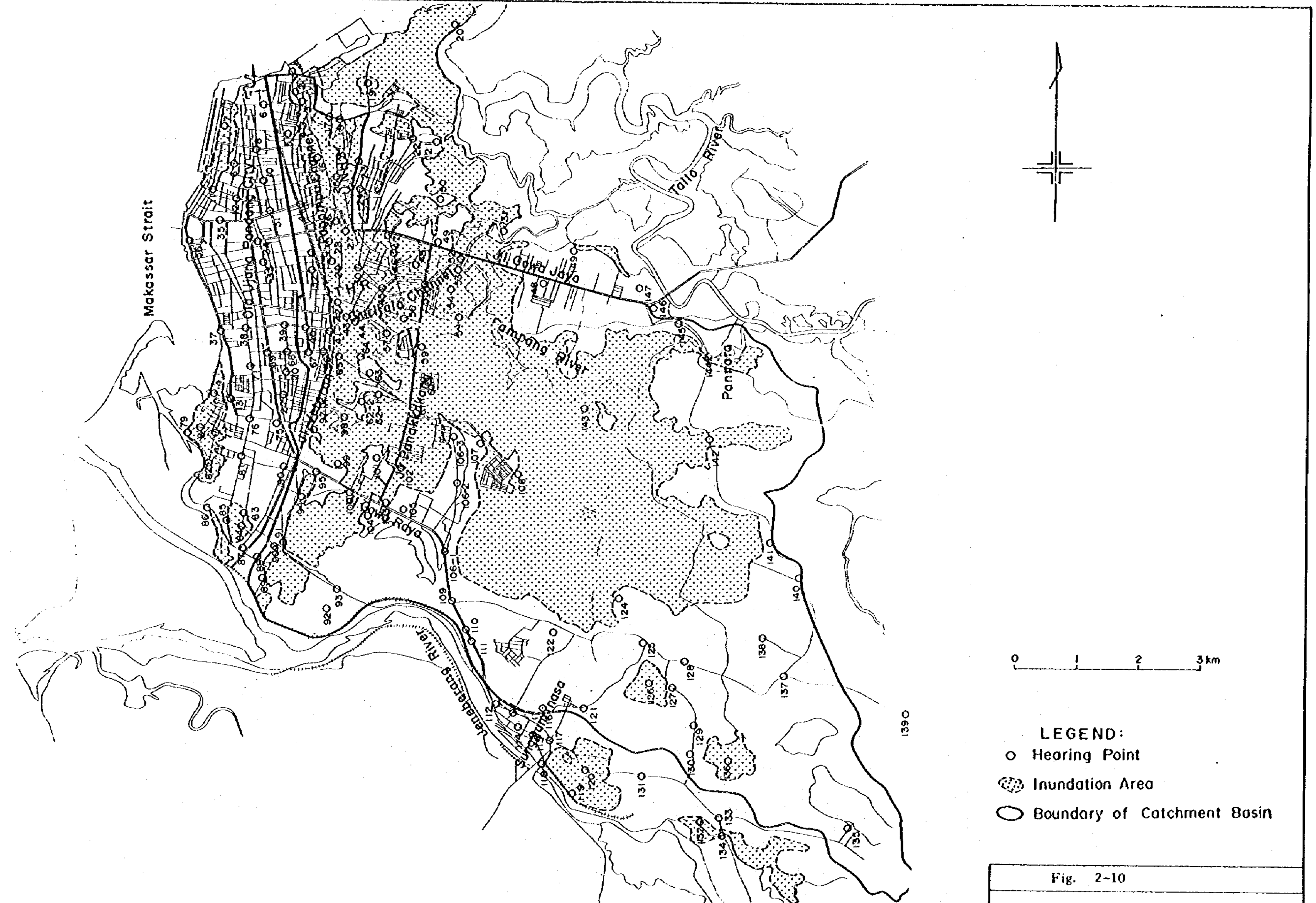
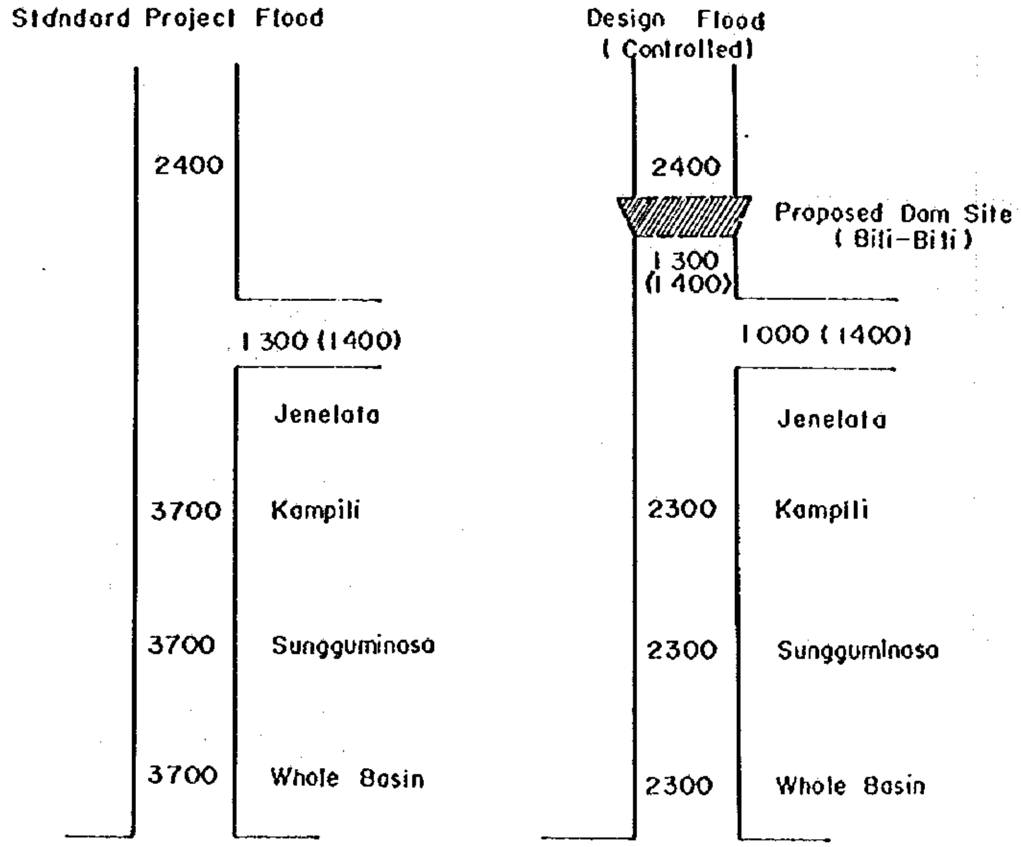


Fig. 2-10

INUNDATION MAP OF
THE FLOOD OF JAN. 1976



NOTE: Figures show discharge to join the main stream.

( ) shows the peak discharge at Jenelata.

⟨ ⟩ shows the peak discharge after dam control.

Unit: m^3/s

Fig. 2-11

STANDARD PROJECT AND DESIGN FLOOD
(50-YEAR RETURN PERIOD)

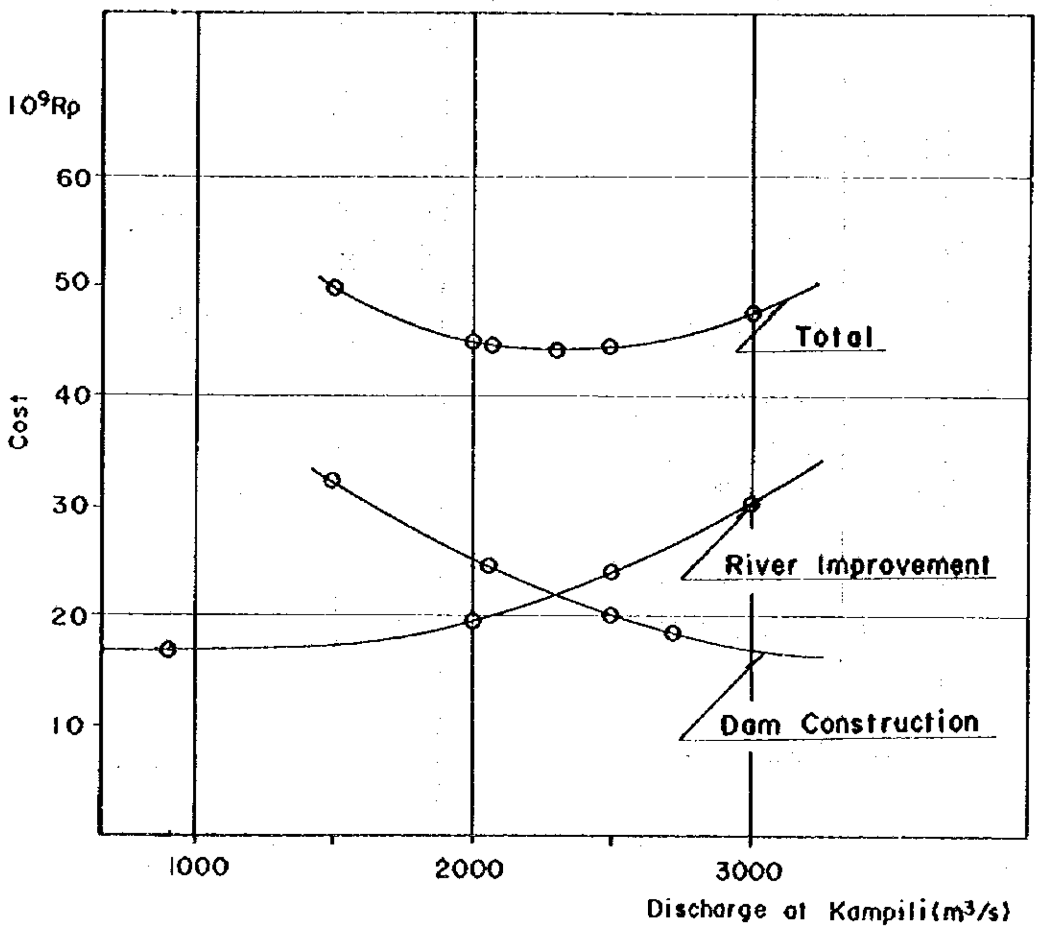


Fig. 2-12

RELATION BETWEEN COST AND DISCHARGE AT KAMPILI

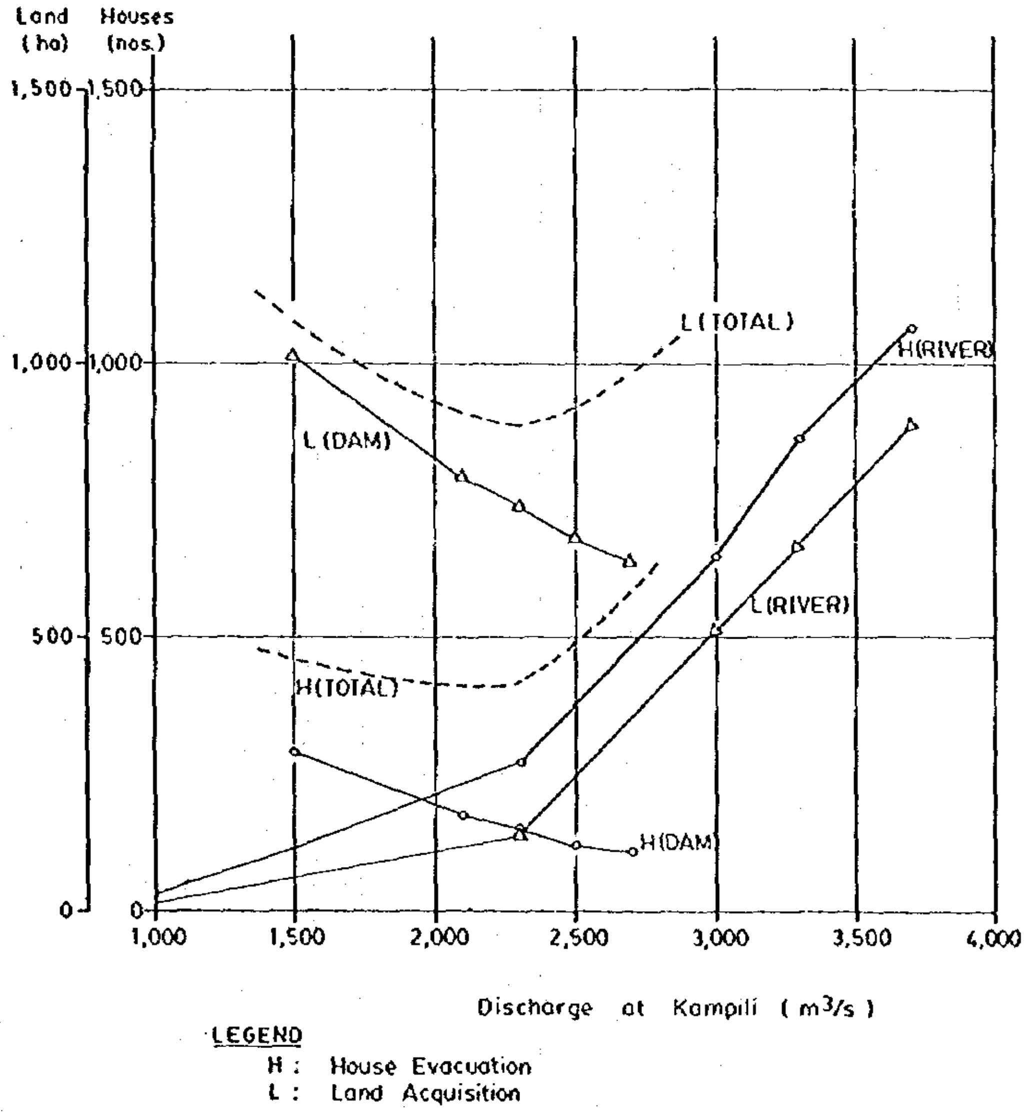


Fig. 2-13

RELATION BETWEEN THE DISCHARGE AND HOUSE EVACUATION/LAND ACQUISITION

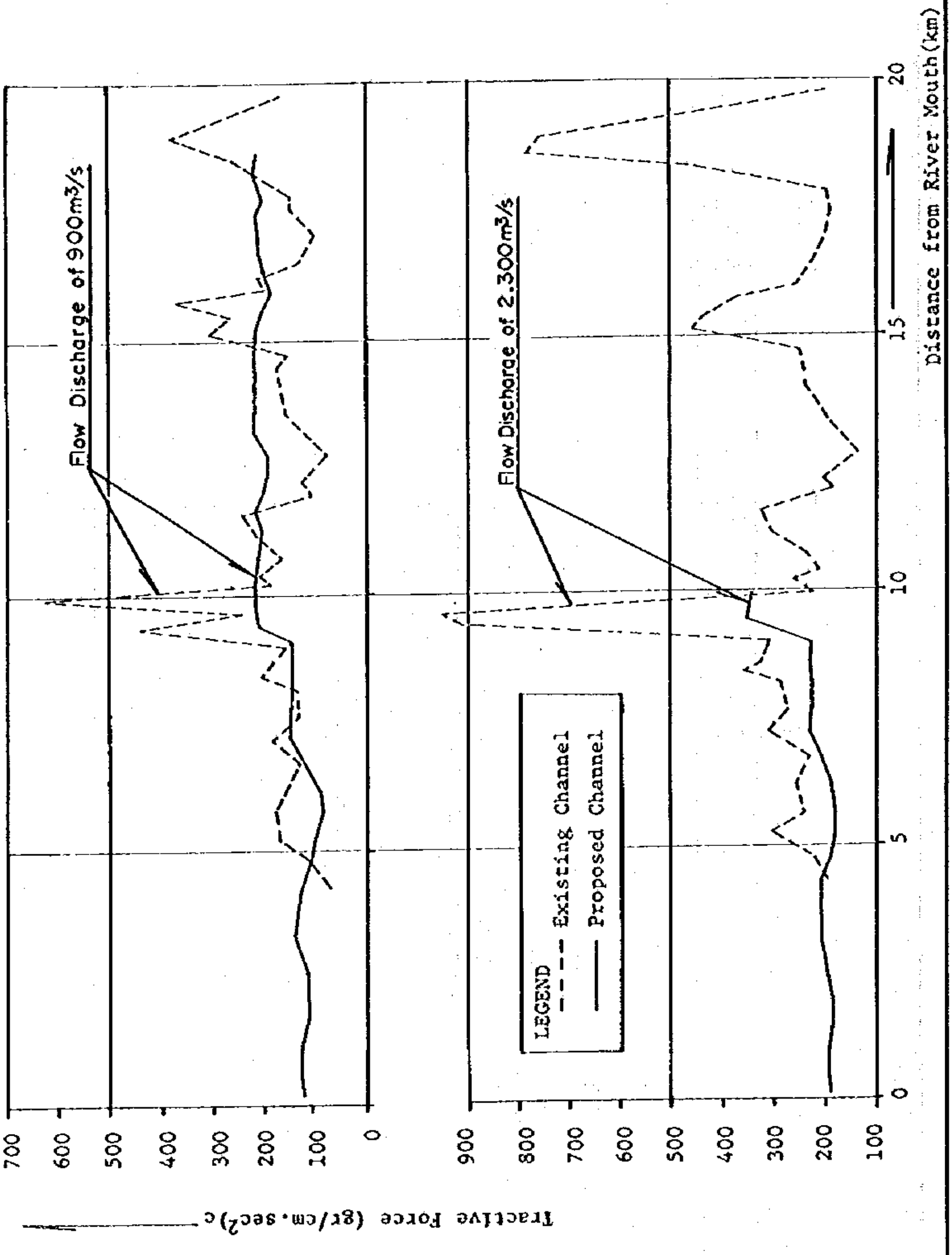
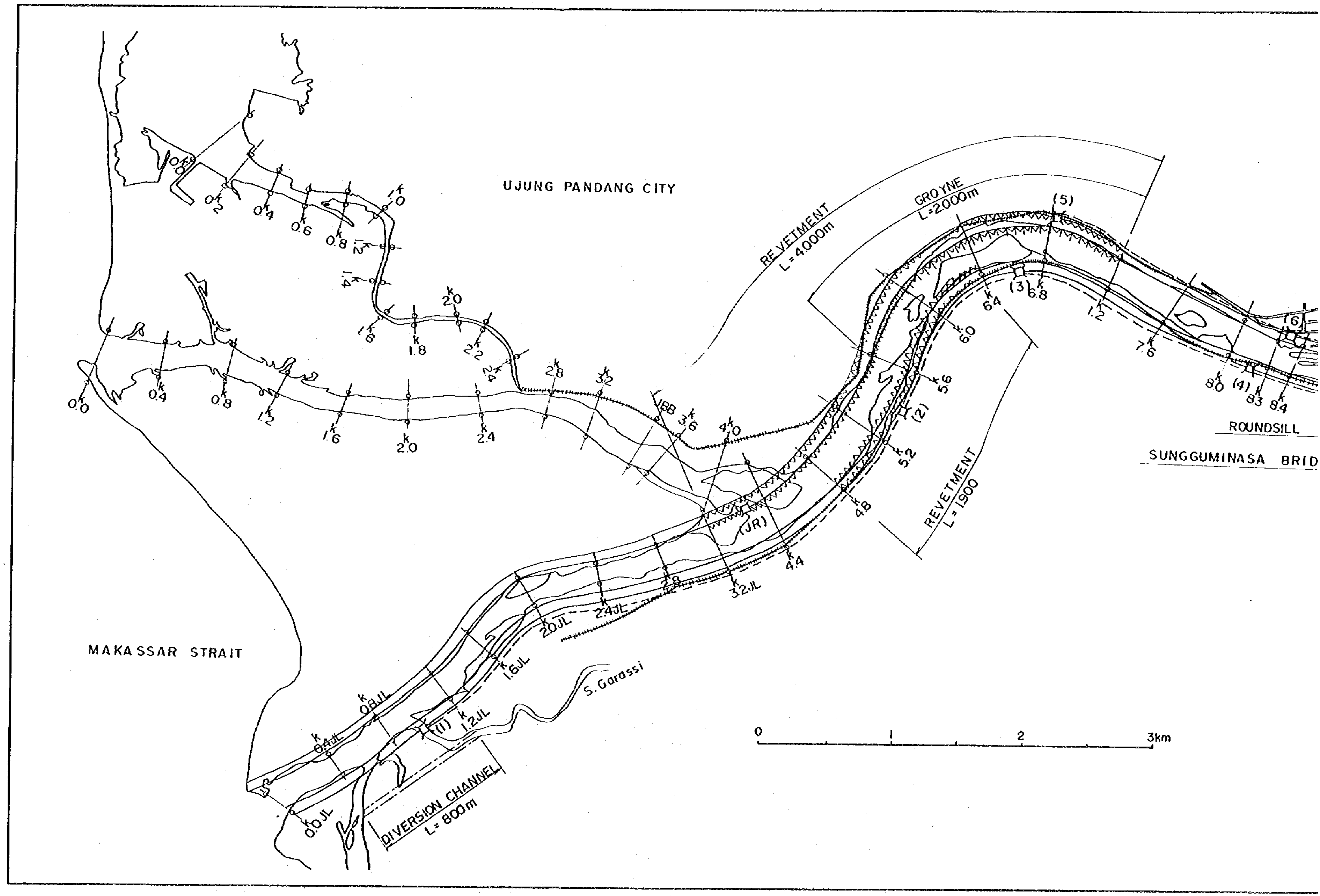
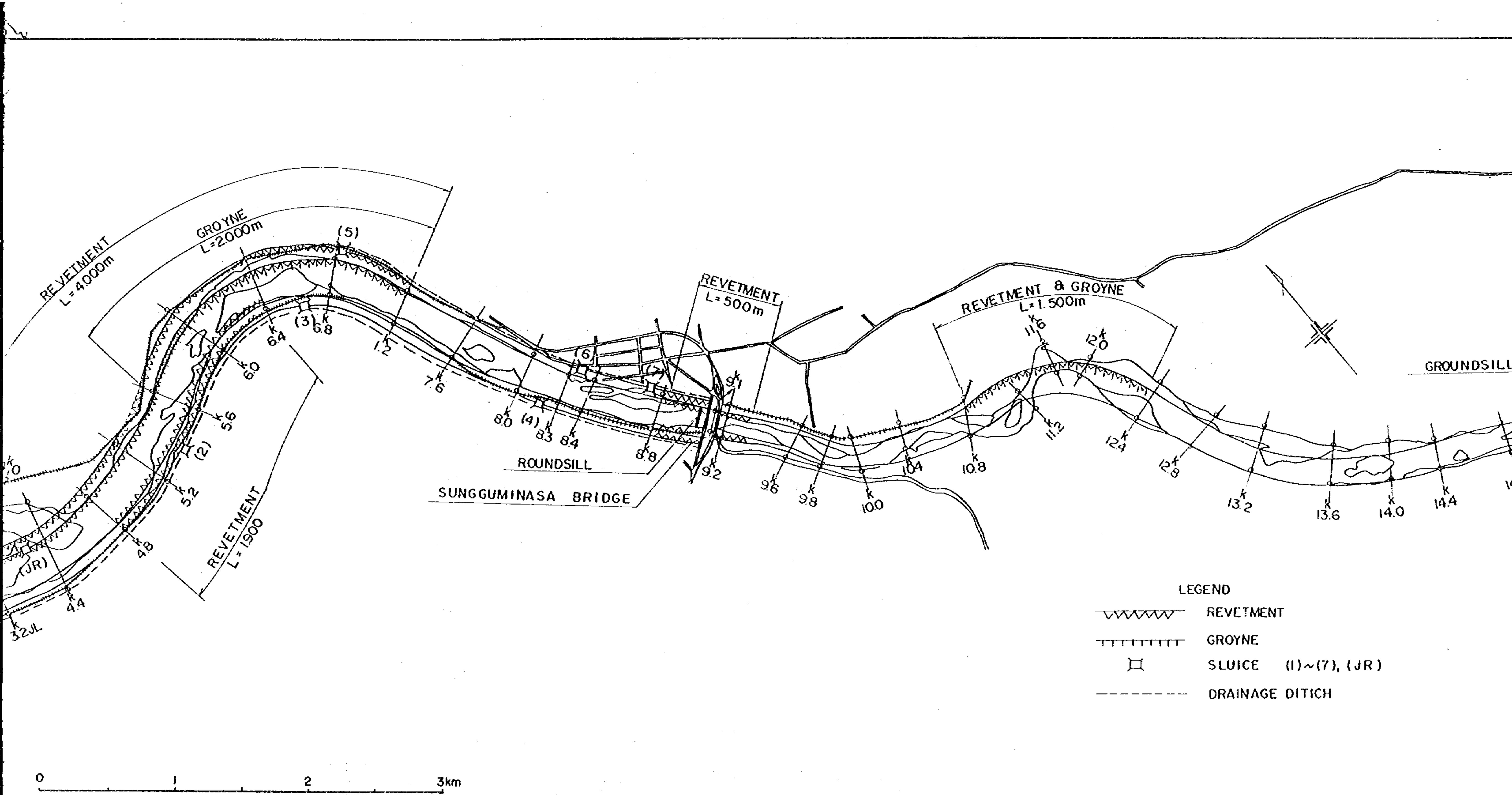


Fig. 2-14

COMPARISON OF TRACTIVE BETWEEN EXISTING CHANNEL AND PROPOSED CHANNEL



UJUNG PANDANG CITY
MAKASSAR STRAIT
REVETMENT L=4,000m
GROYNE L=2,000m
REVETMENT L=1900
DIVERSION CHANNEL L=800m
S. Garassi
ROUNDSILL
SUNGGUMINASA BRID
(1)
(2)
(3)
(4)
(5)
(6)
(JR)
0 1 2 3km


REVETMENT
L=4,000m
GROYNE
L=2,000m
(5)
(3)
6.4
6.8
7.2
6.0
5.6
(2)
5.2
4.8
4.4
(JR)
3.2JL
REVETMENT
L=1900
7.6
8.0
(4)
8.3
8.4
(6)
(7)
8.8
ROUNDSILL
SUNGGUMINASA BRIDGE
REVETMENT
L=500m
9.1
9.2
9.6
9.8
10.0
10.4
10.8
REVETMENT & GROYNE
L=1.500m
11.6
12.0
11.2
12.4
12.8
13.2
13.6
14.0
14.4
GROUNDSILL
LEGEND
REVETMENT
GROYNE
SLUICE (1)~(7), (JR)
DRAINAGE DITICH
0
1
2
3km

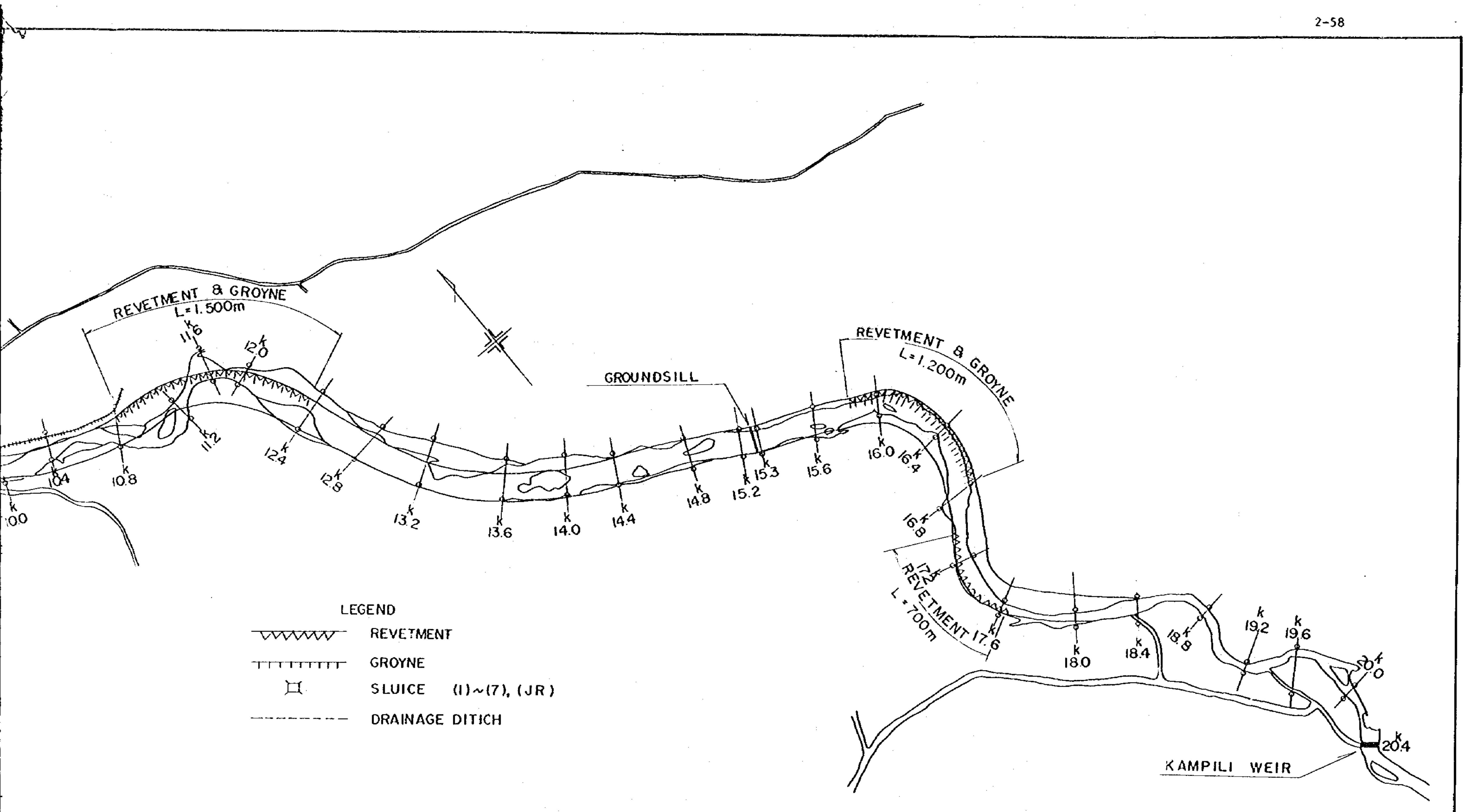


Fig. 2-15

PROPOSED ALIGNMENT
OF THE JENEBERANG RIVER

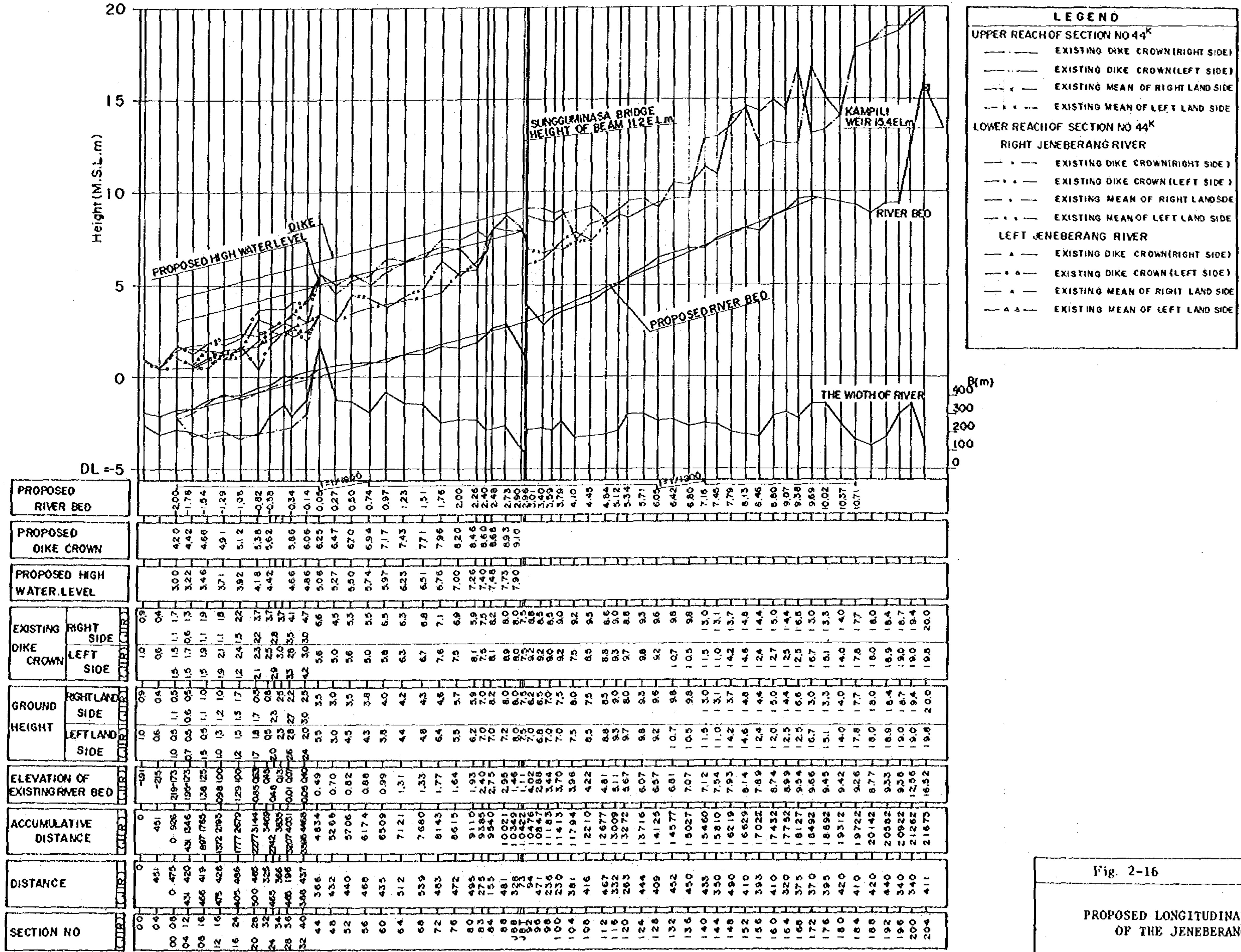


Fig. 2-16

PROPOSED LONGITUDINAL PROFILE OF THE JENEBERANG RIVER

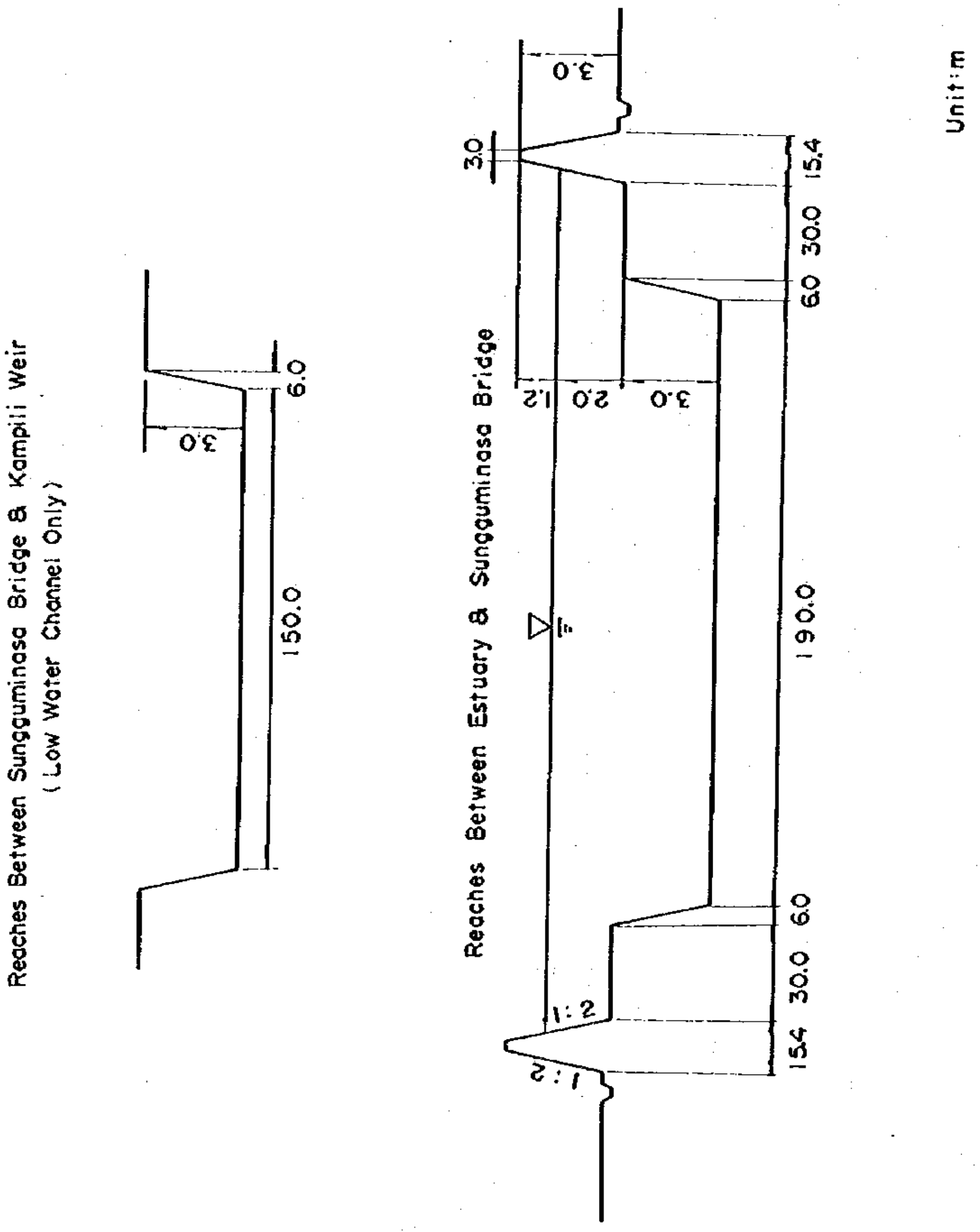


Fig. 2-17

STANDARD CROSS-SECTION

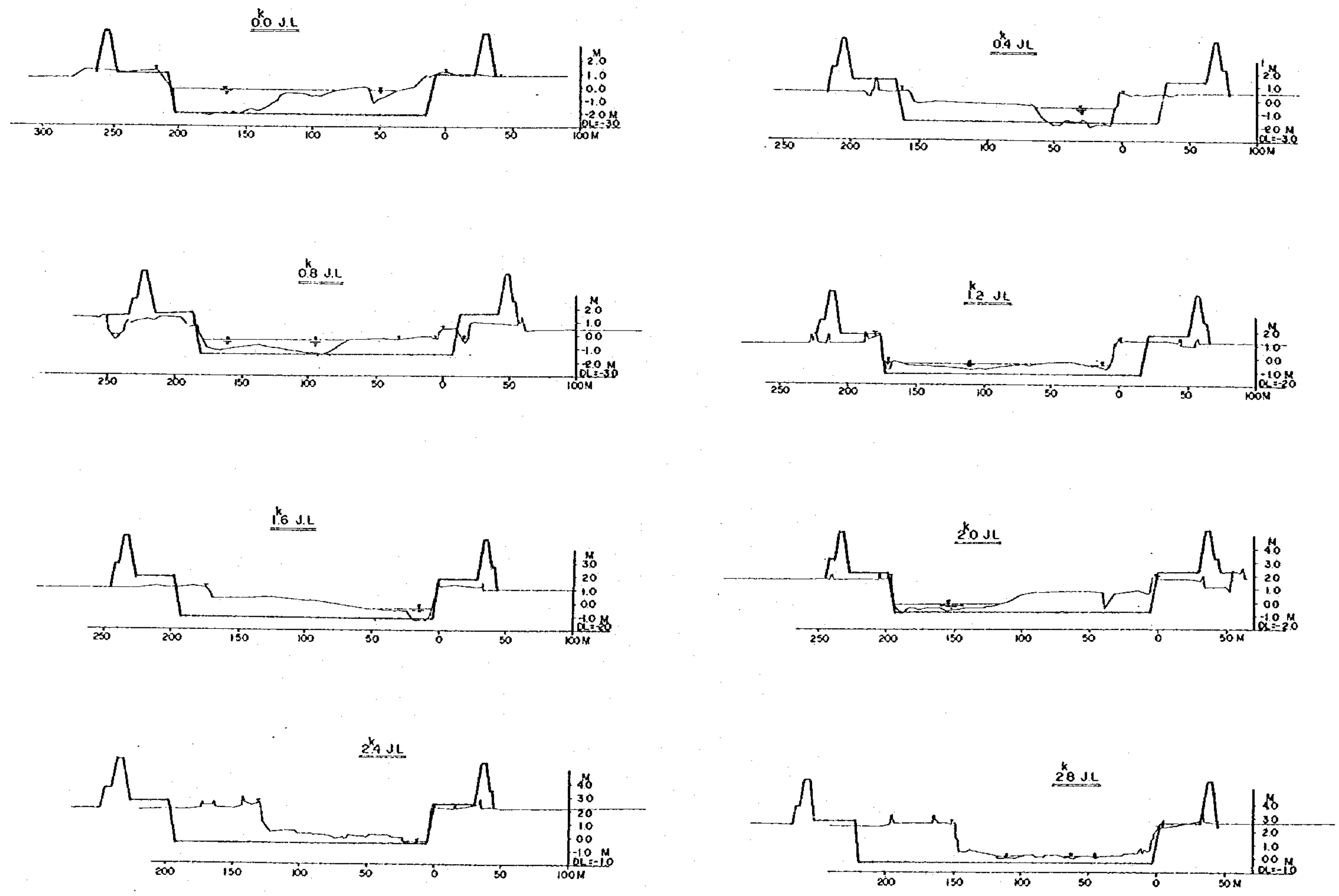


Fig. 2-18

PROPOSED CROSS-SECTION OF THE JENEBERANG RIVER CHANNEL (1)

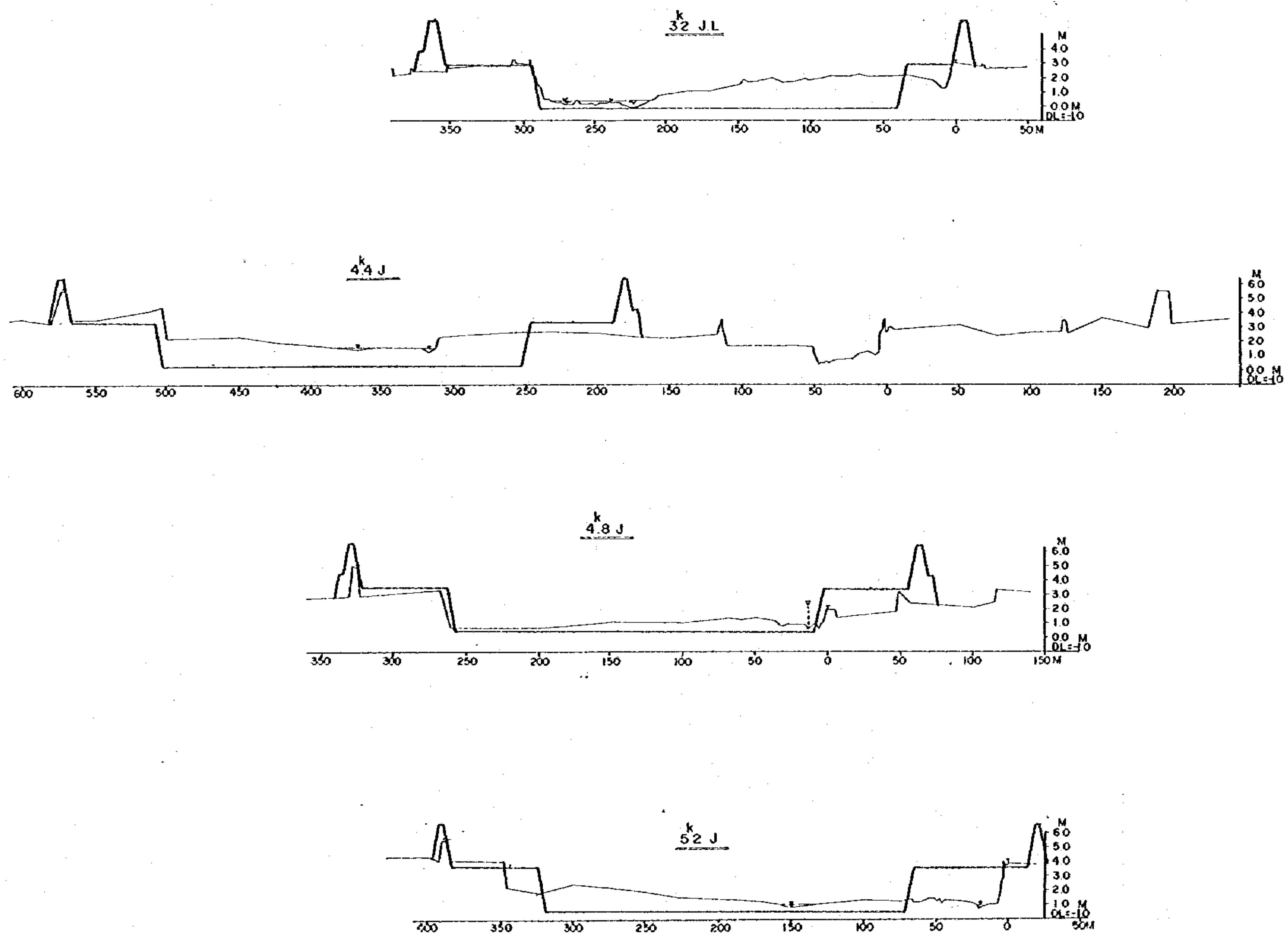


Fig.2-18

PROPOSED CROSS-SECTION OF THE JENEBERANG RIVER CHANNEL (2)

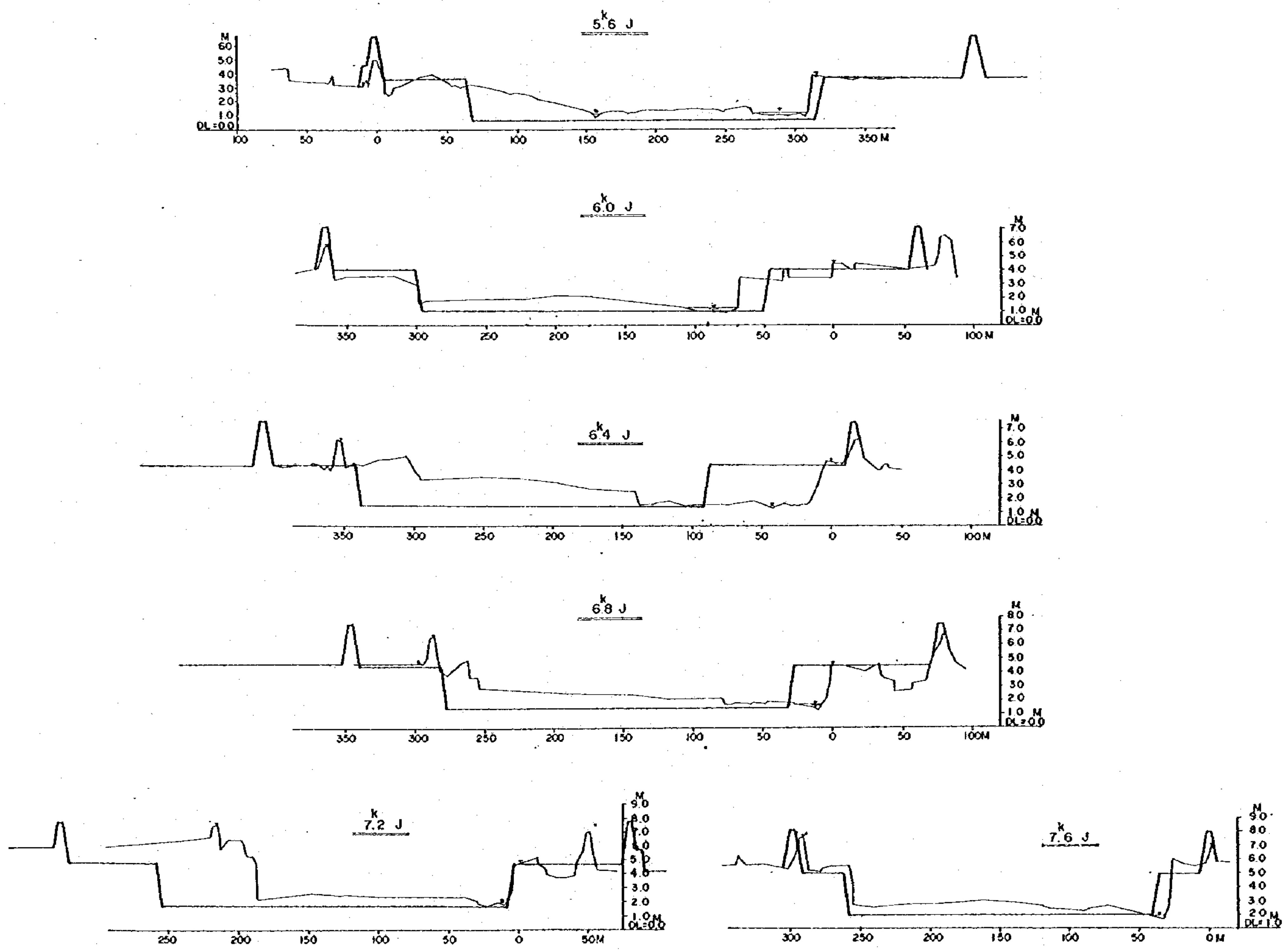


Fig. 2-18

PROPOSED CROSS-SECTION OF THE JÈNEBERANG RIVER CHANNEL (3)

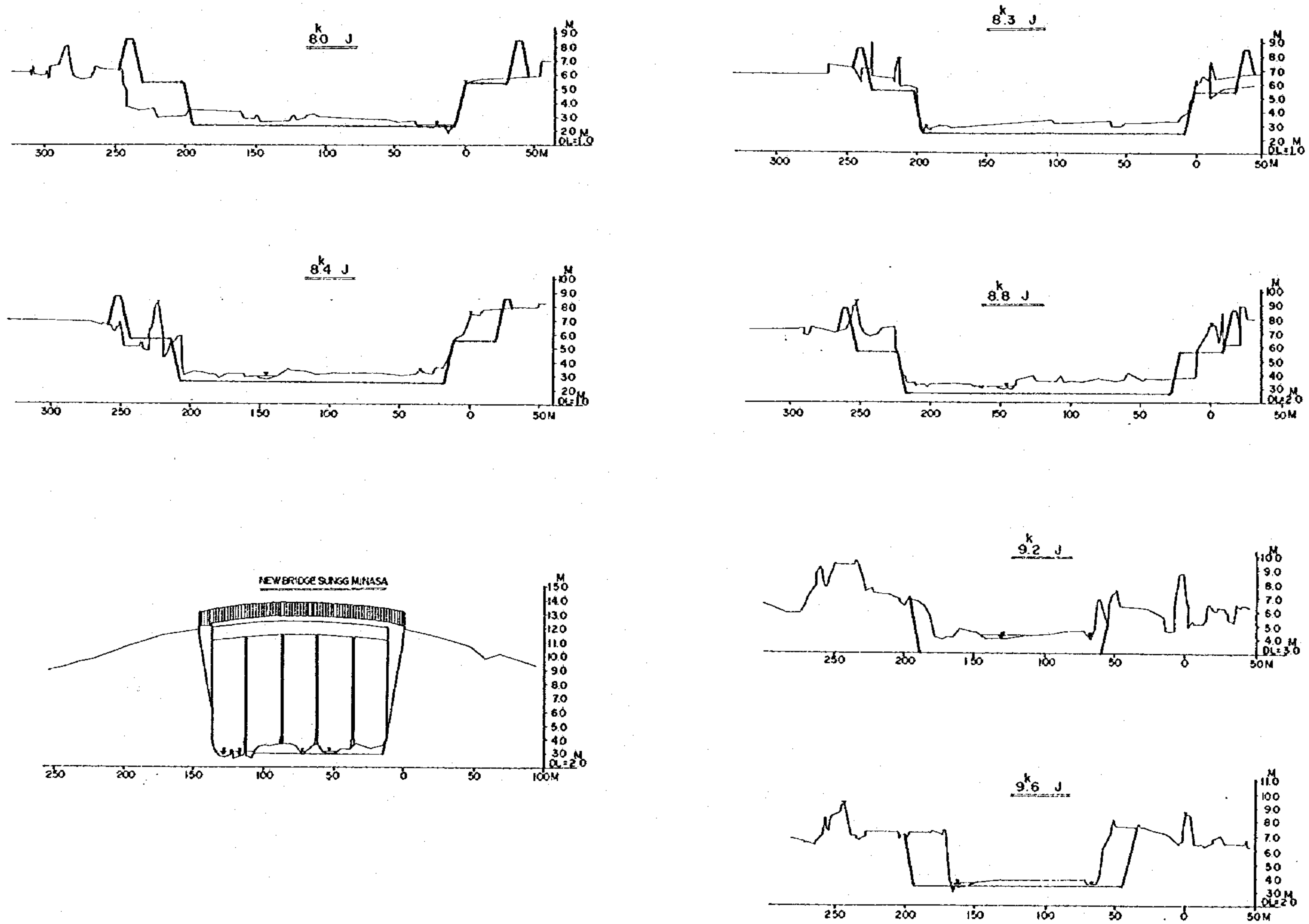


Fig.2-18

PROPOSED CROSS-SECTION OF THE JENEBERANG RIVER CHANNEL (4)

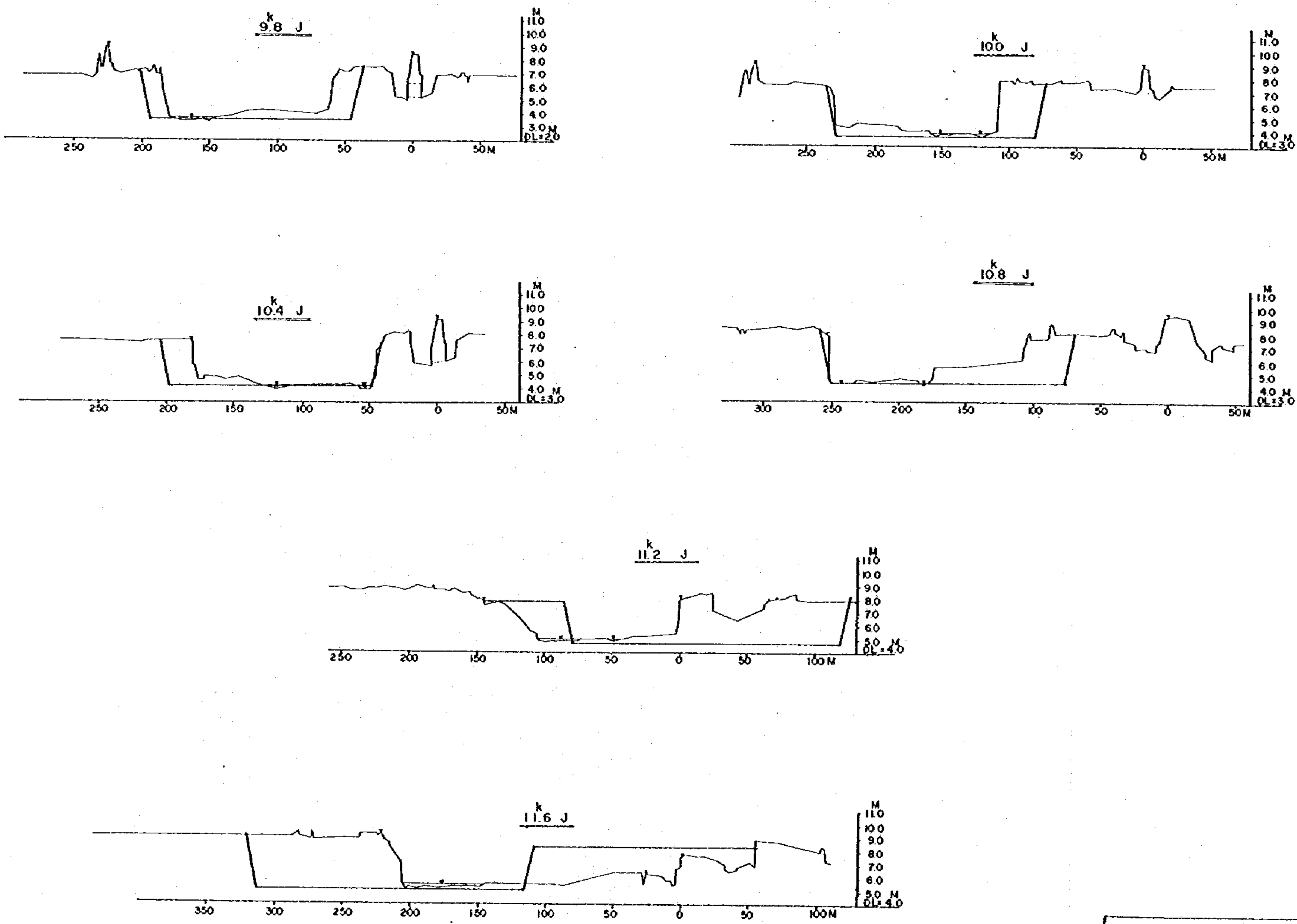


Fig. 2-18

PROPOSED CROSS-SECTION OF
THE JENEBERANG RIVER CHANNEL (5)

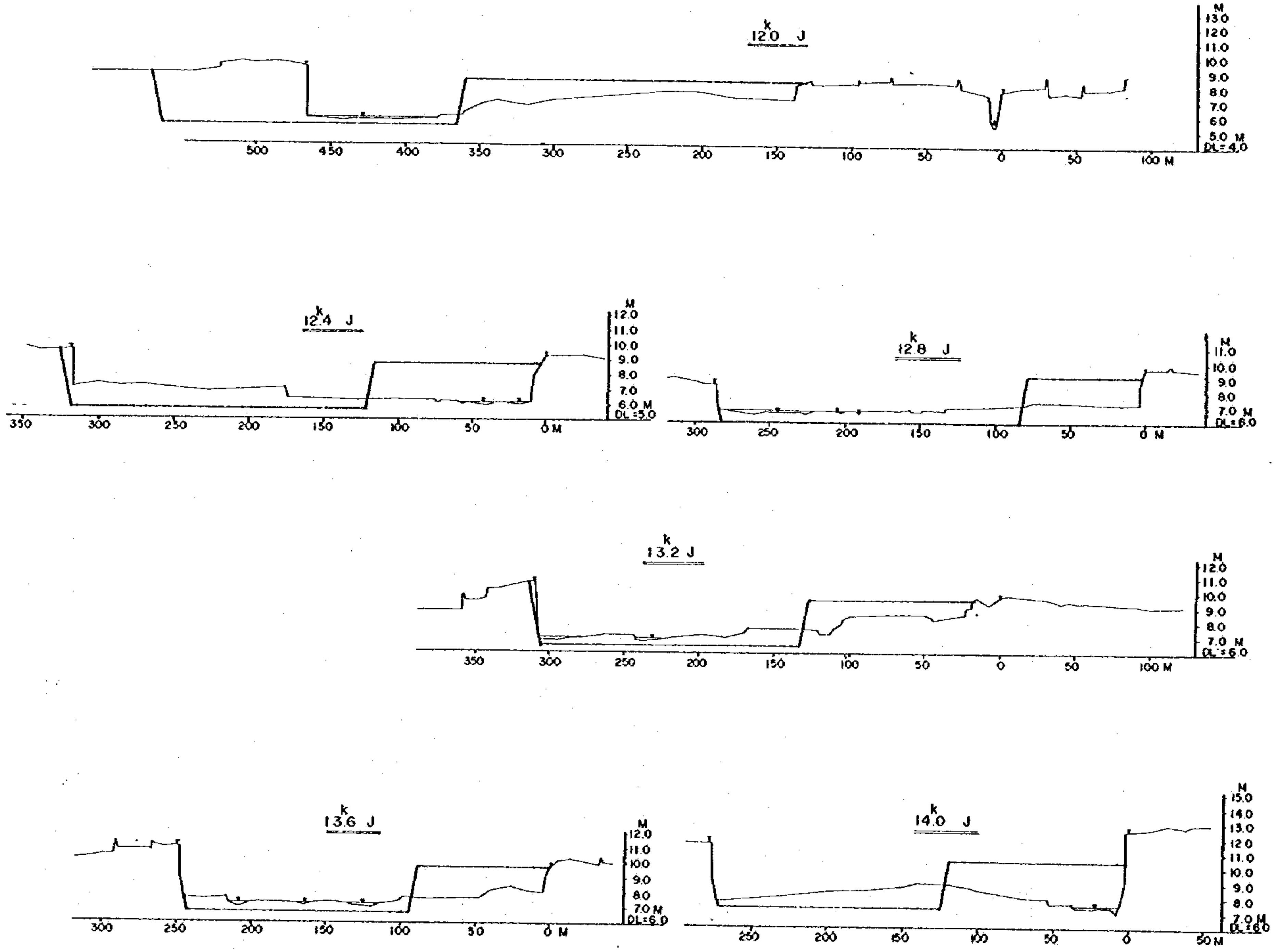


Fig. 2-18

PROPOSED CROSS-SECTION OF
THE JENEBERANG RIVER CHANNEL (6)

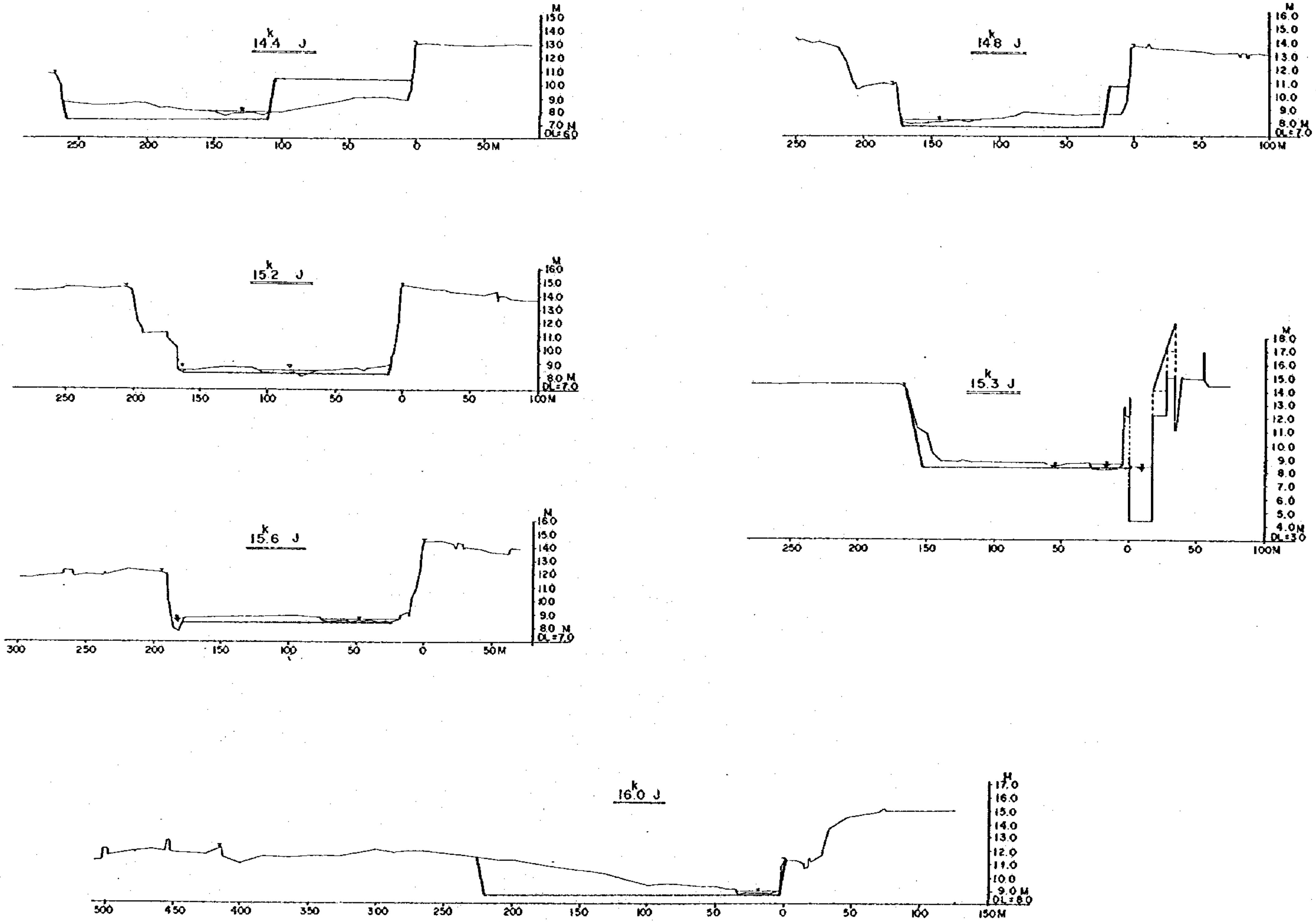


Fig.2-18

PROPOSED CROSS-SECTION OF
THE JENEBERANG RIVER CHANNEL (7)

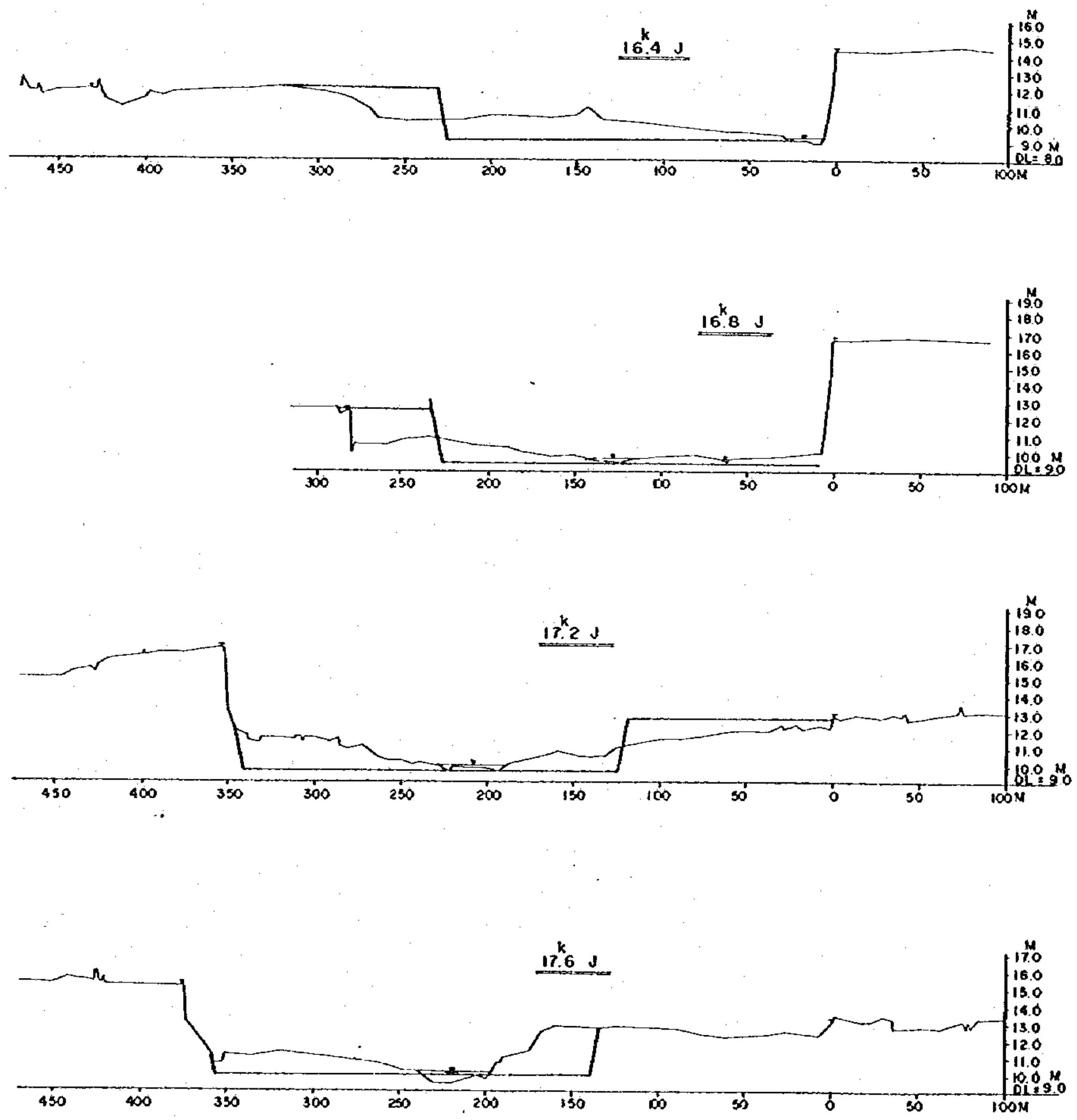


Fig. 2-18

PROPOSED CROSS-SECTION OF
THE JENEBERANG RIVER CHANNEL (8)

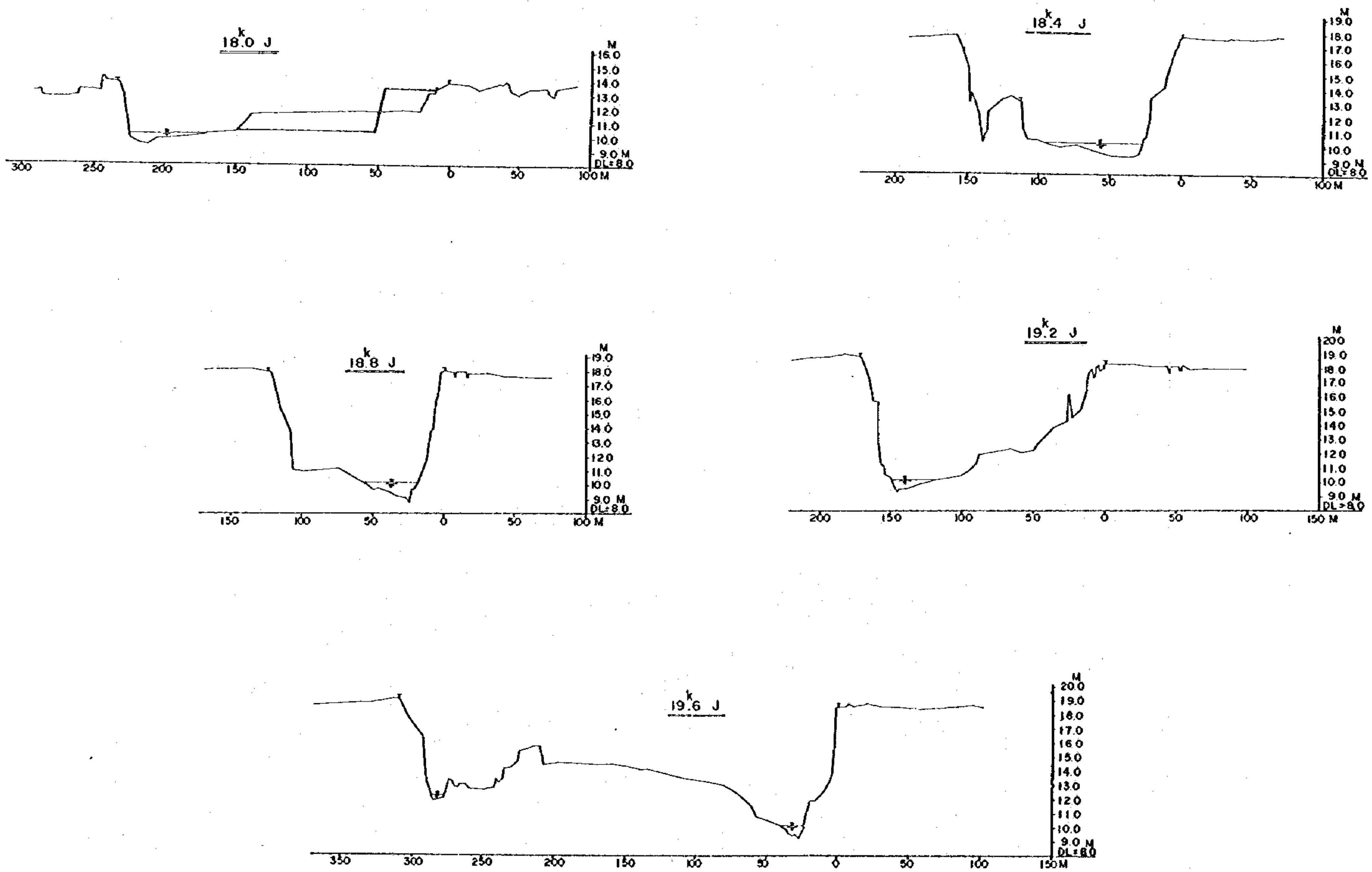
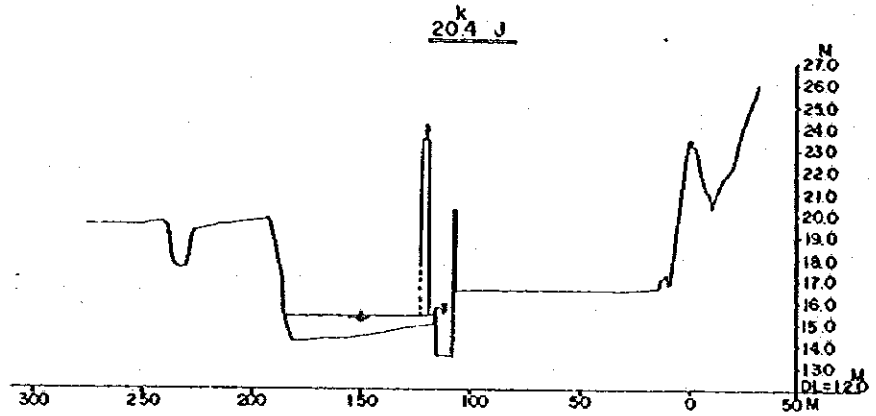


Fig. 2-18

PROPOSED CROSS-SECTION OF
THE JENEBERANG RIVER CHANNEL (9)



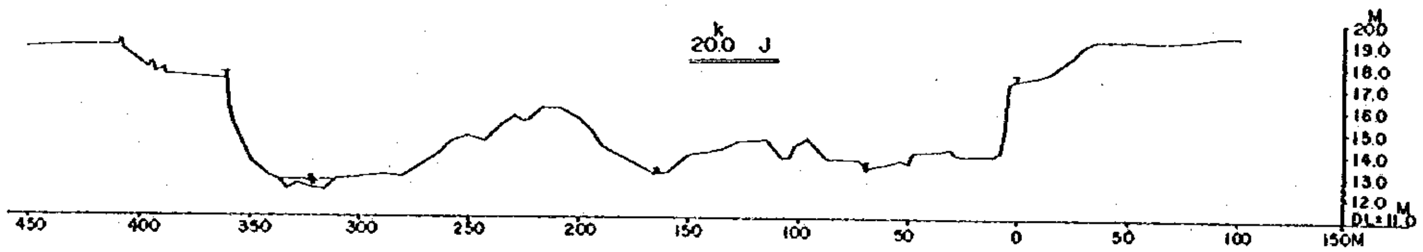
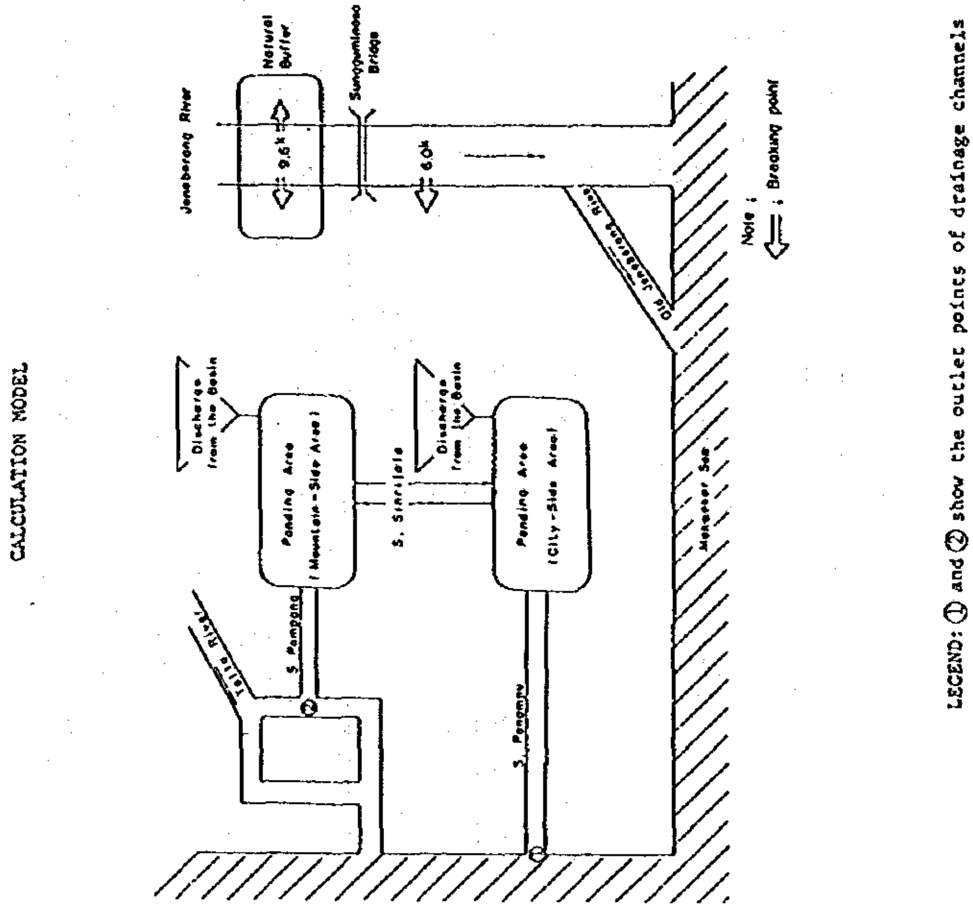


Fig. 2-18

PROPOSED CROSS-SECTION OF
THE JENEBERANG RIVER CHANNEL (10)



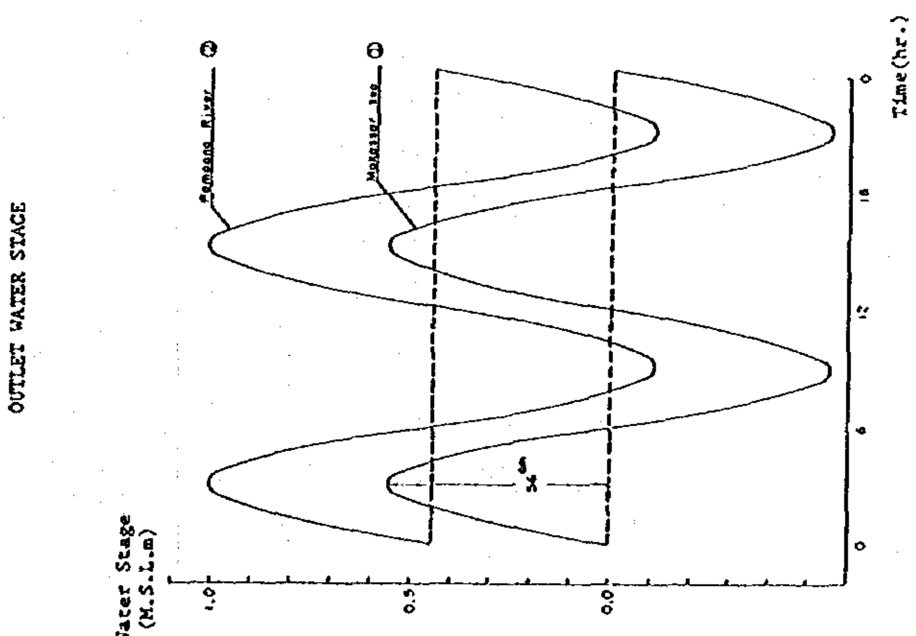
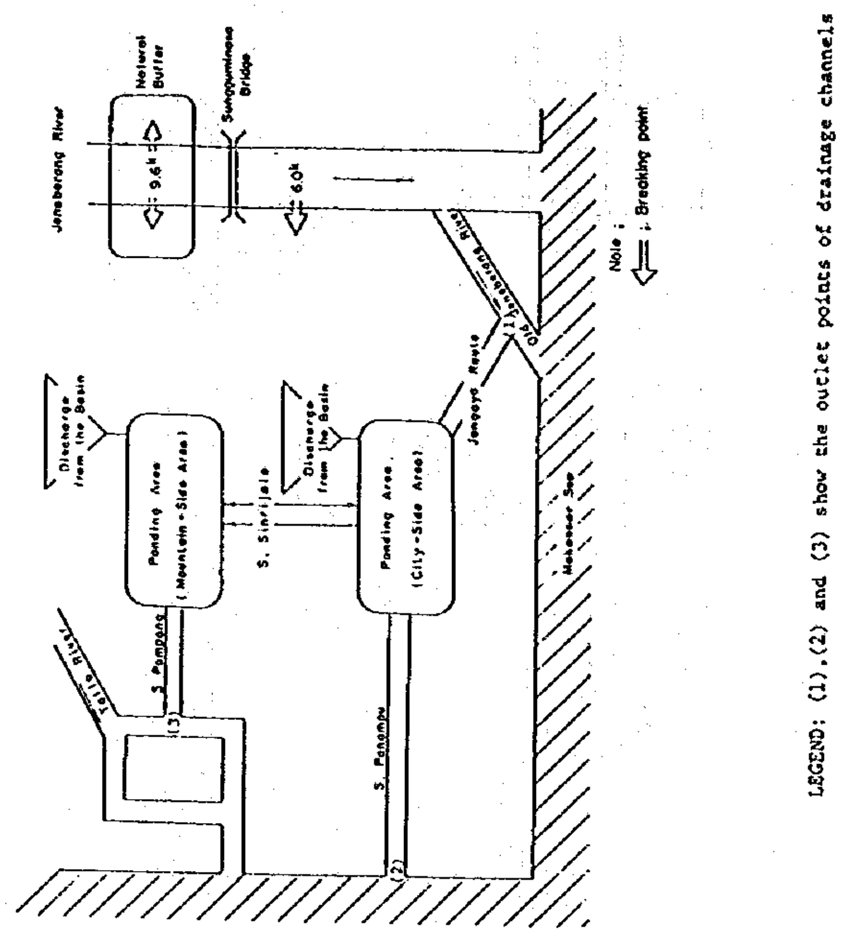


Fig. 2-19

CALCULATION MODEL AND
OUTLET WATER STAGE (1)

CALCULATION MODEL



OUTLET WATER STAGE

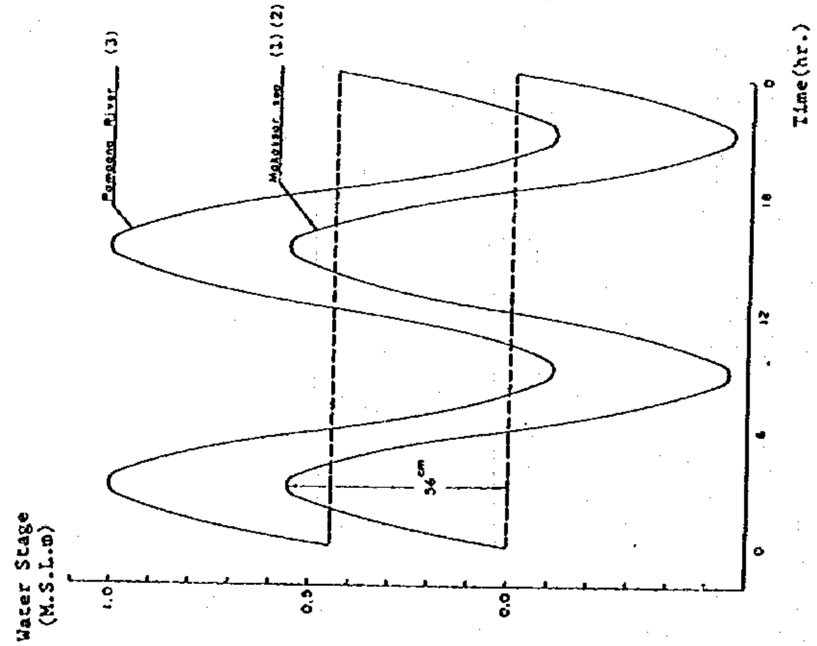


Fig. 2-19

CALCULATION MODEL AND OUTLET WATER STAGE (2)

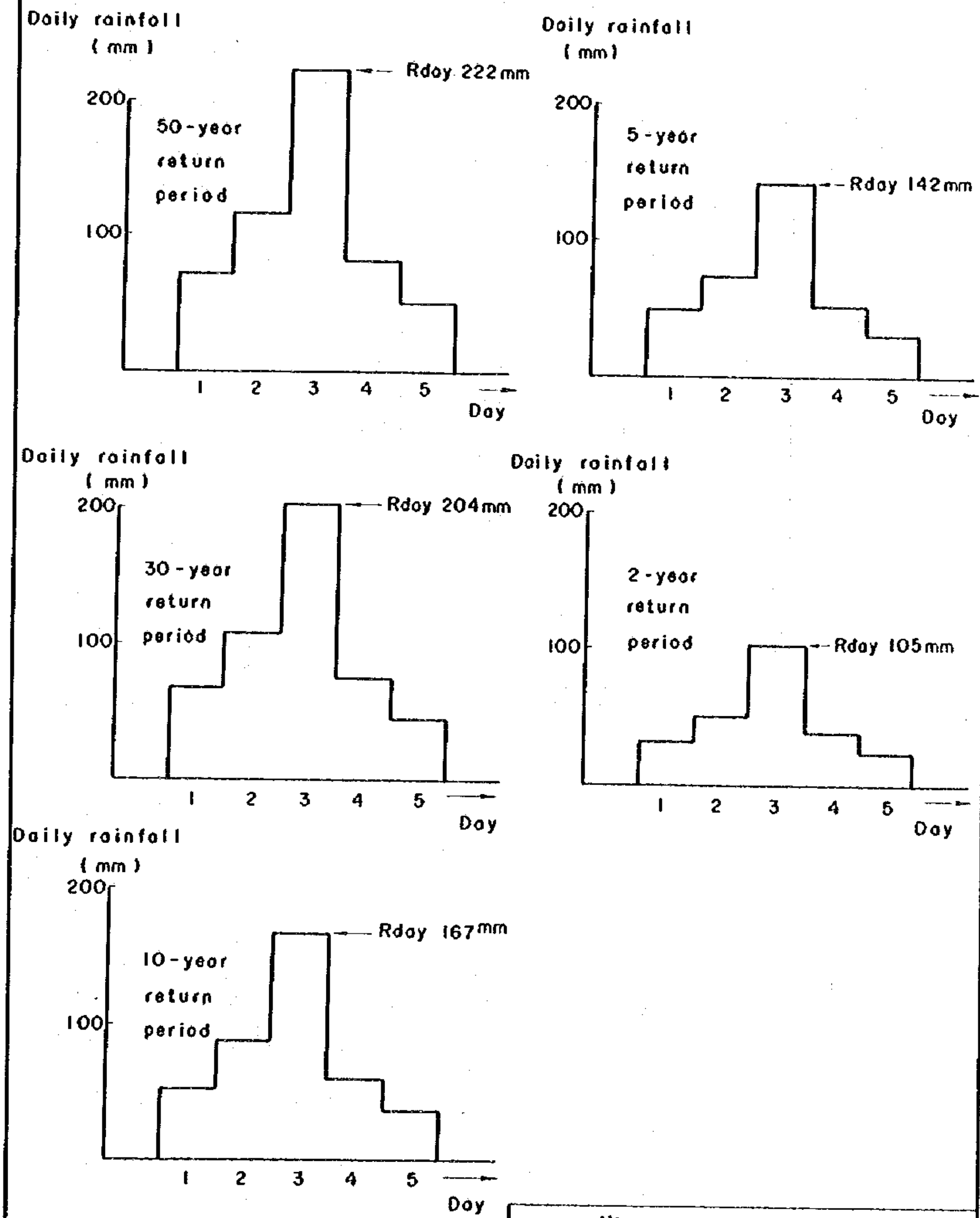


Fig. 2-20

DAILY RAINFALL DISTRIBUTION

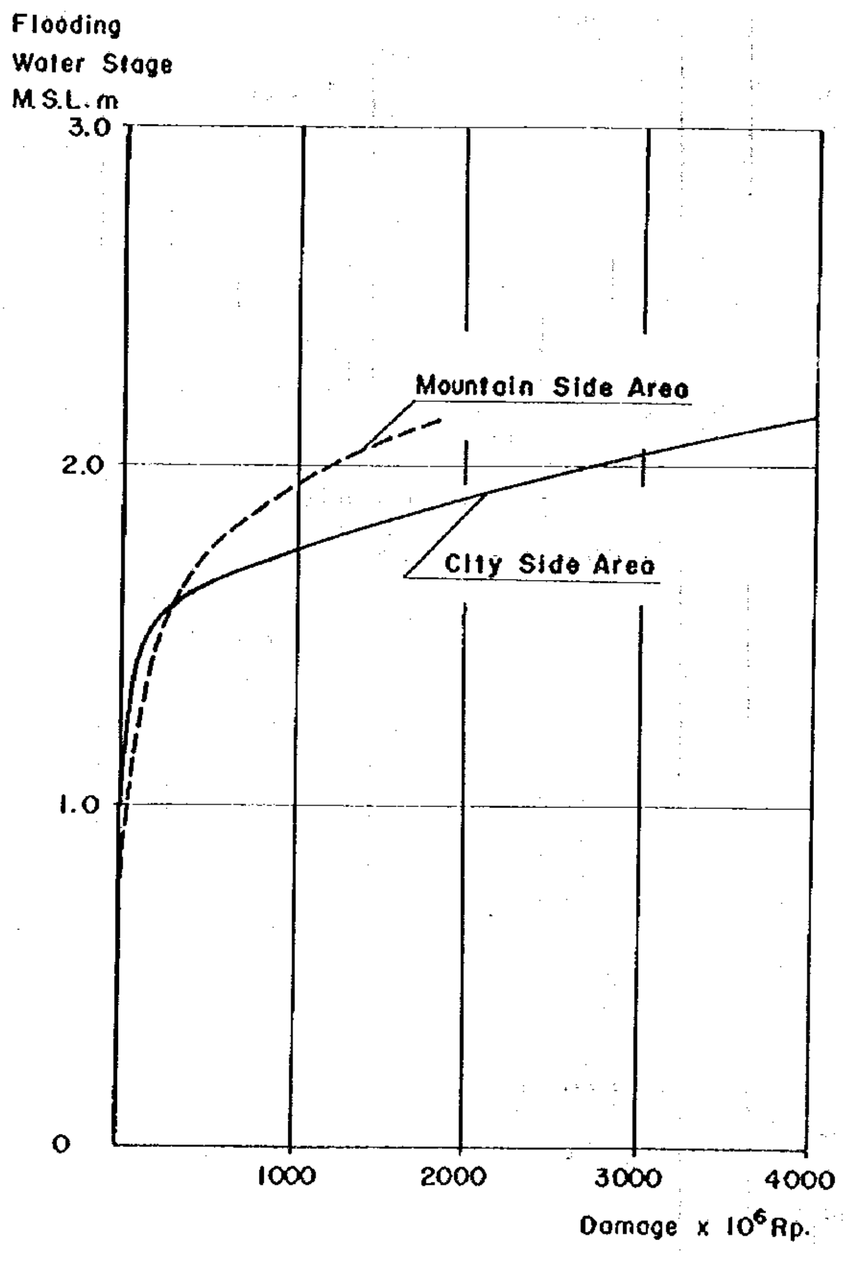


Fig. 2-21

RELATION CURVE BETWEEN DAMAGE AND FLOODING WATER STAGE

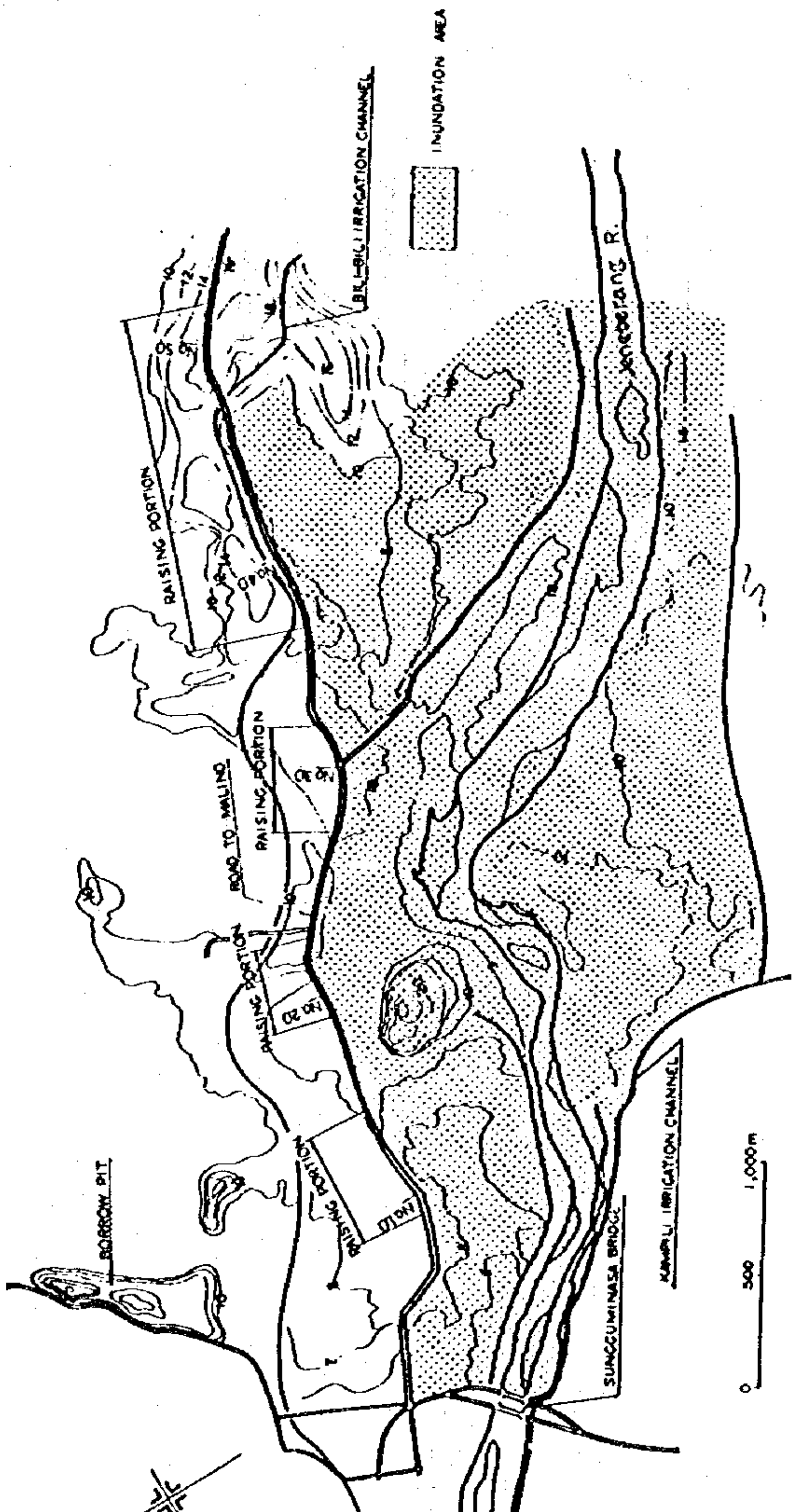


Fig. 2-22

ROAD RAISING SECTION

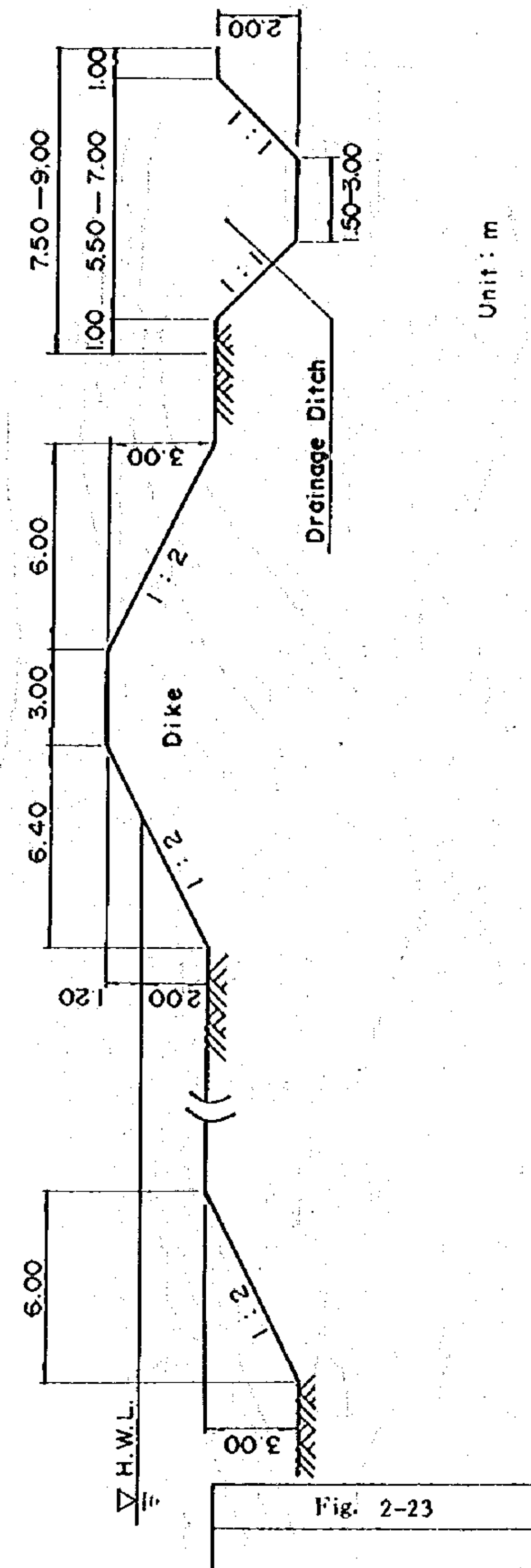


Fig. 2-23

STANDARD CROSS-SECTION OF DIKE

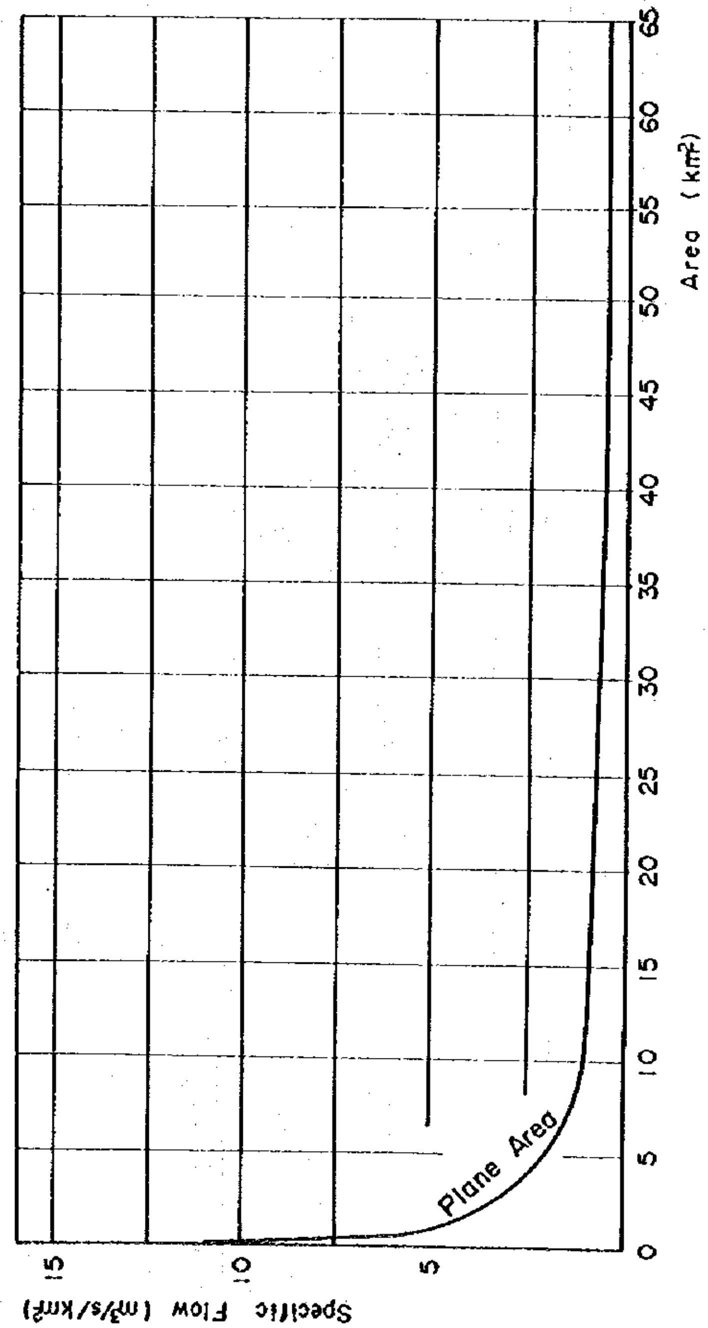


Fig. 2-24

SPECIFIC FLOW-AREA
FOR A DRAINAGE CHANNEL

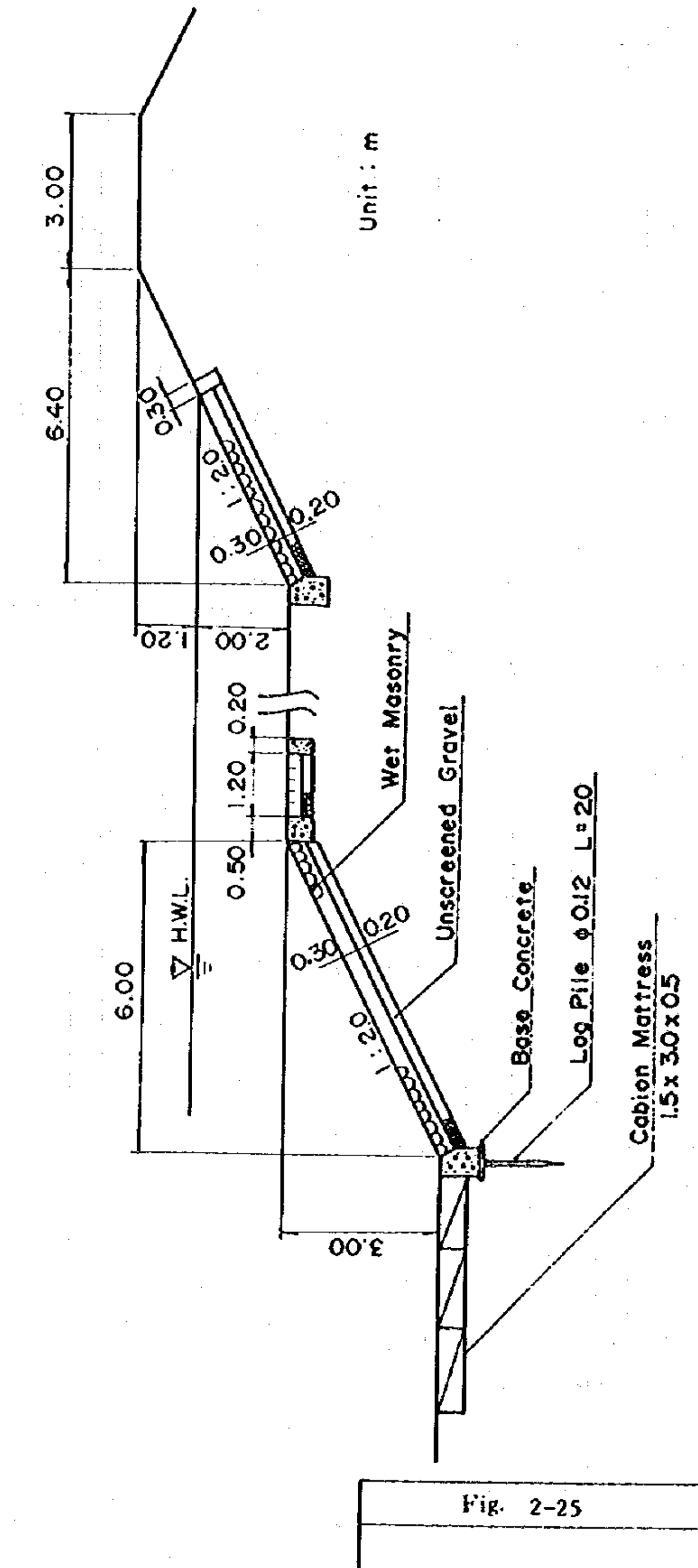


Fig. 2-25

STANDARD CROSS-SECTION OF REVETMENT

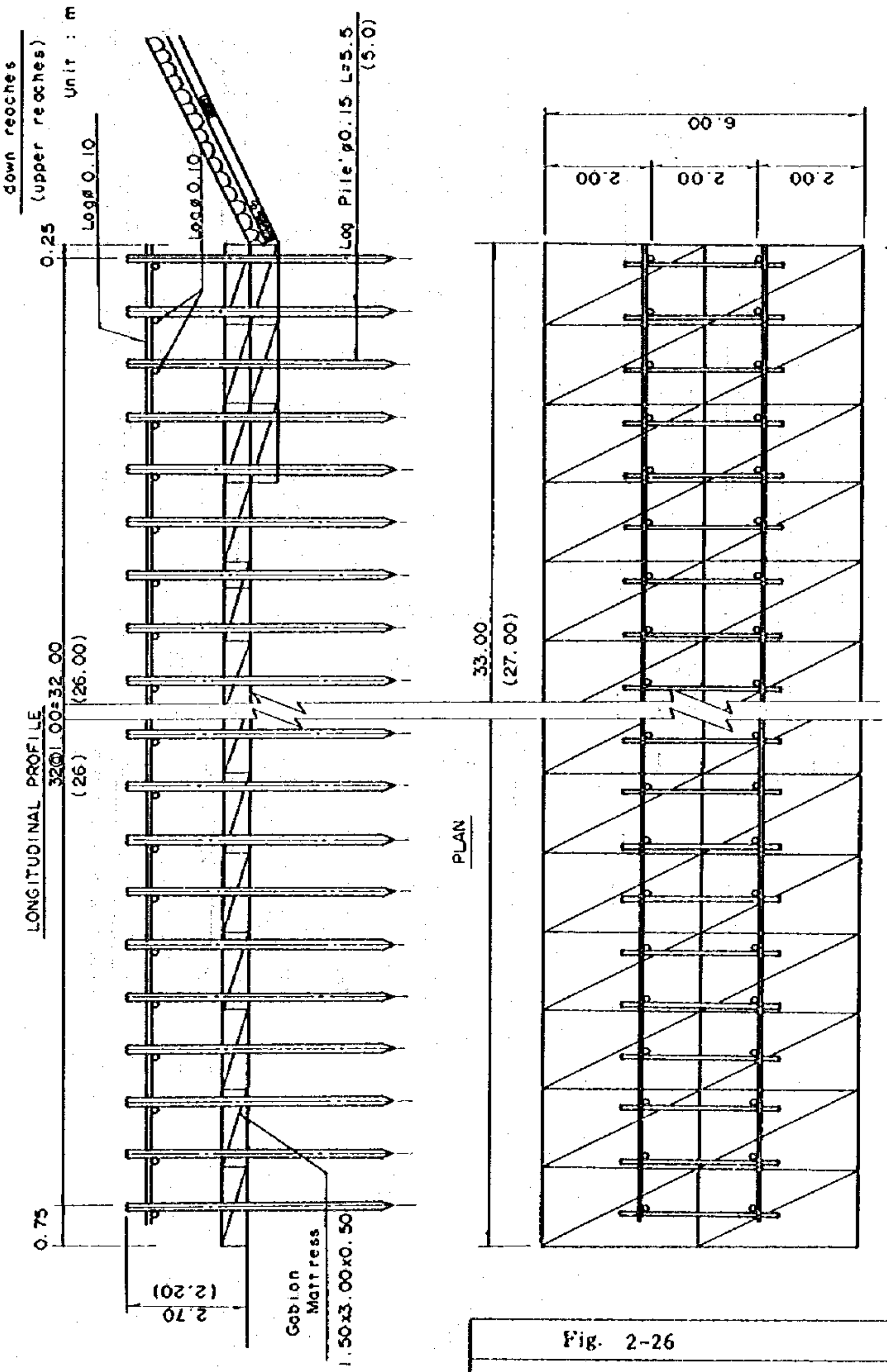


Fig. 2-26

PROFILE AND PLAN OF GROYNE

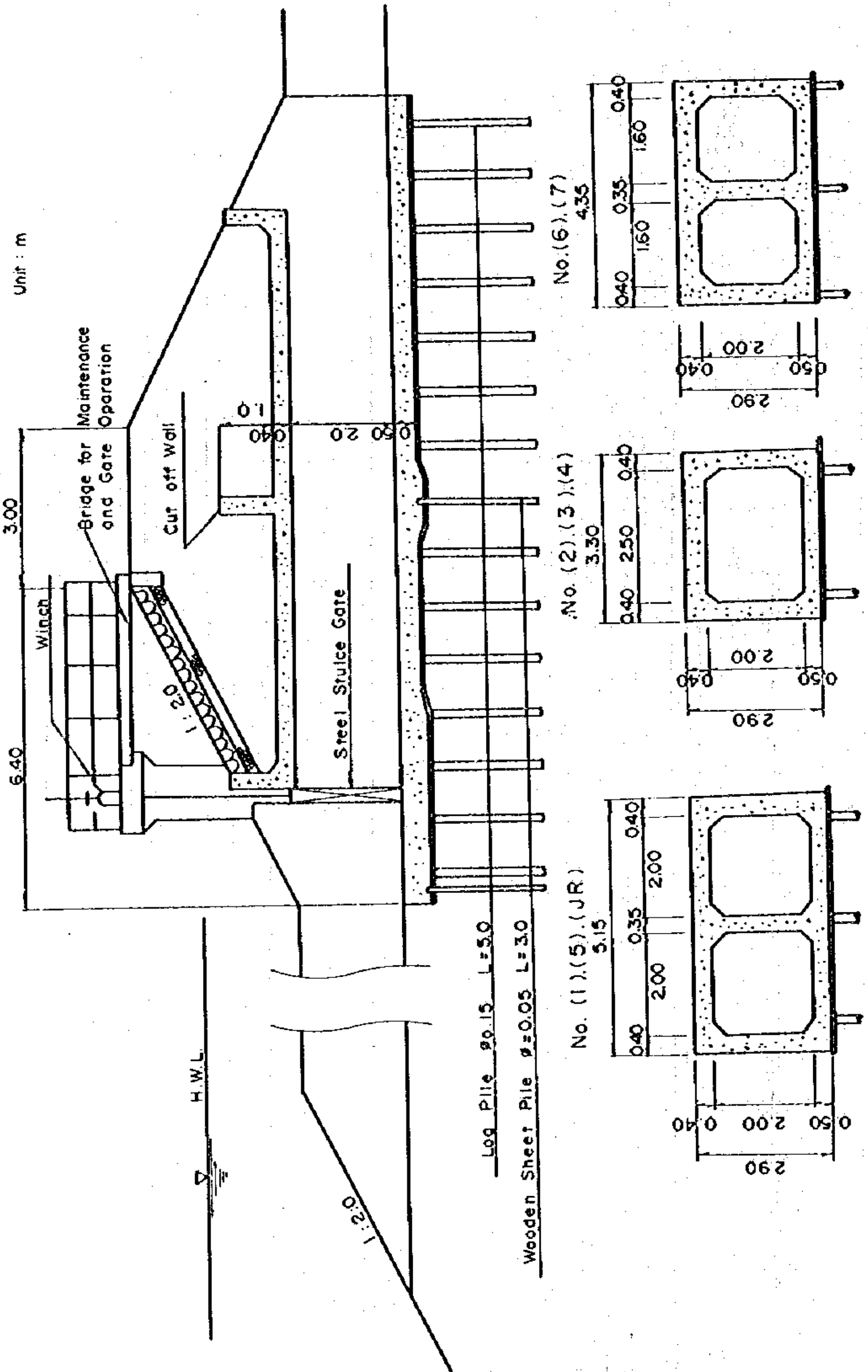


Fig. 2-27

STANDARD DESIGN OF SLUICE

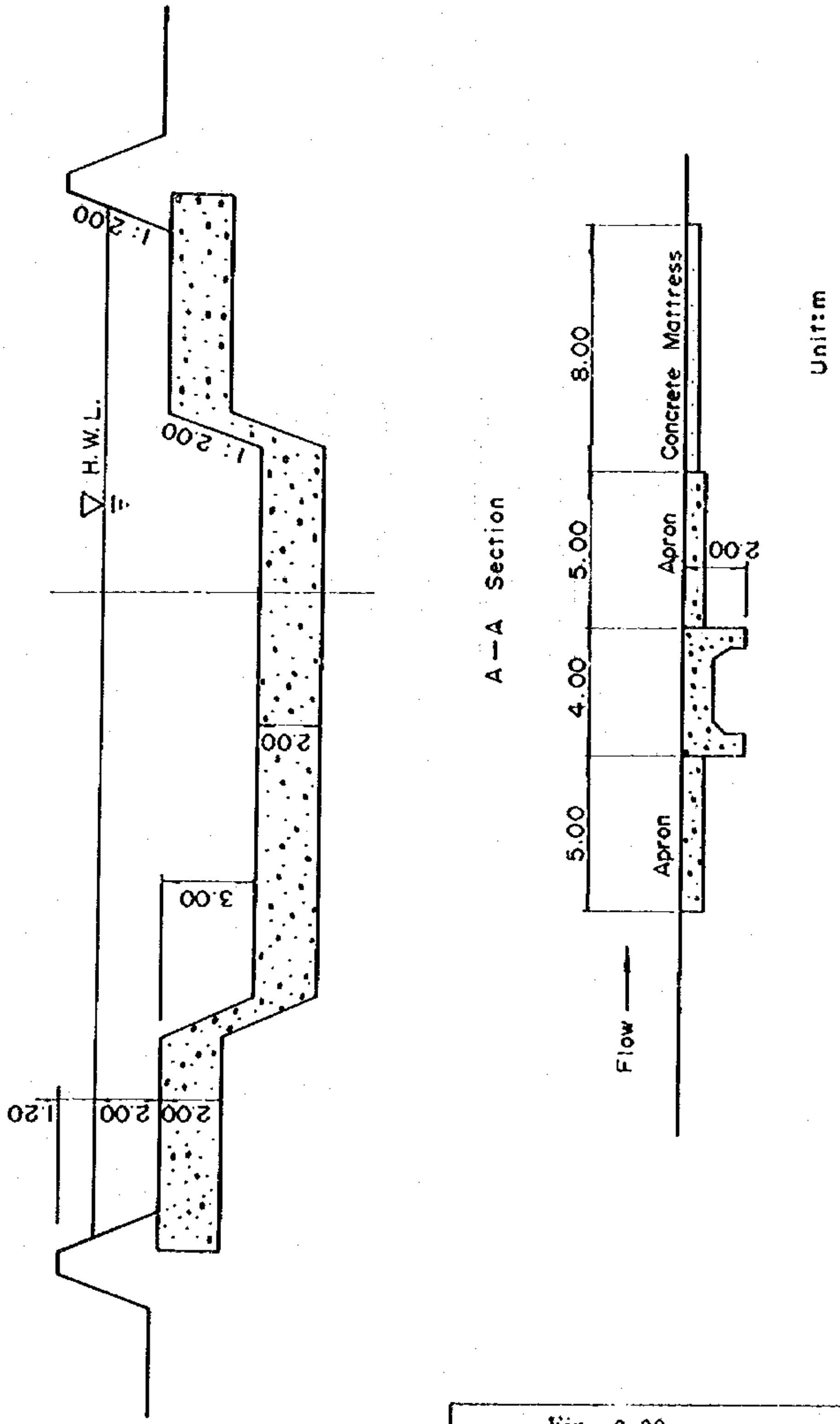


Fig. 2-28

CROSS-SECTION OF GROUNDSILL

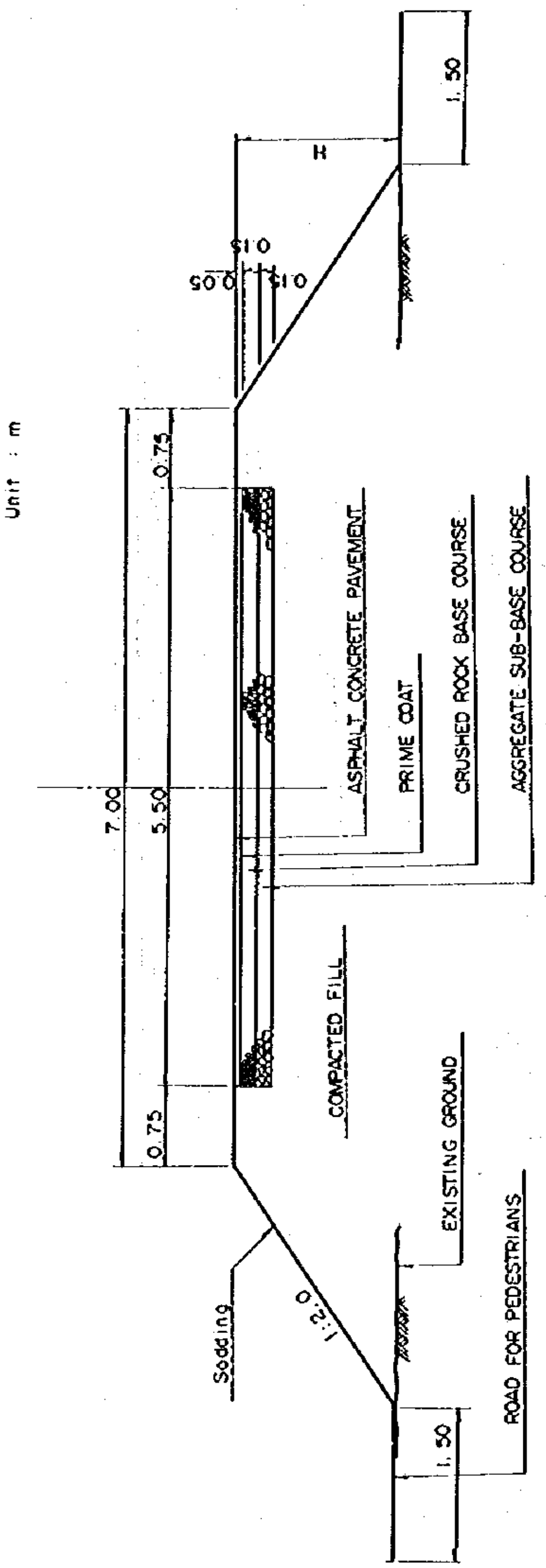


Fig 2-29

STANDARD CROSS-SECTION
OF ROAD RAISING

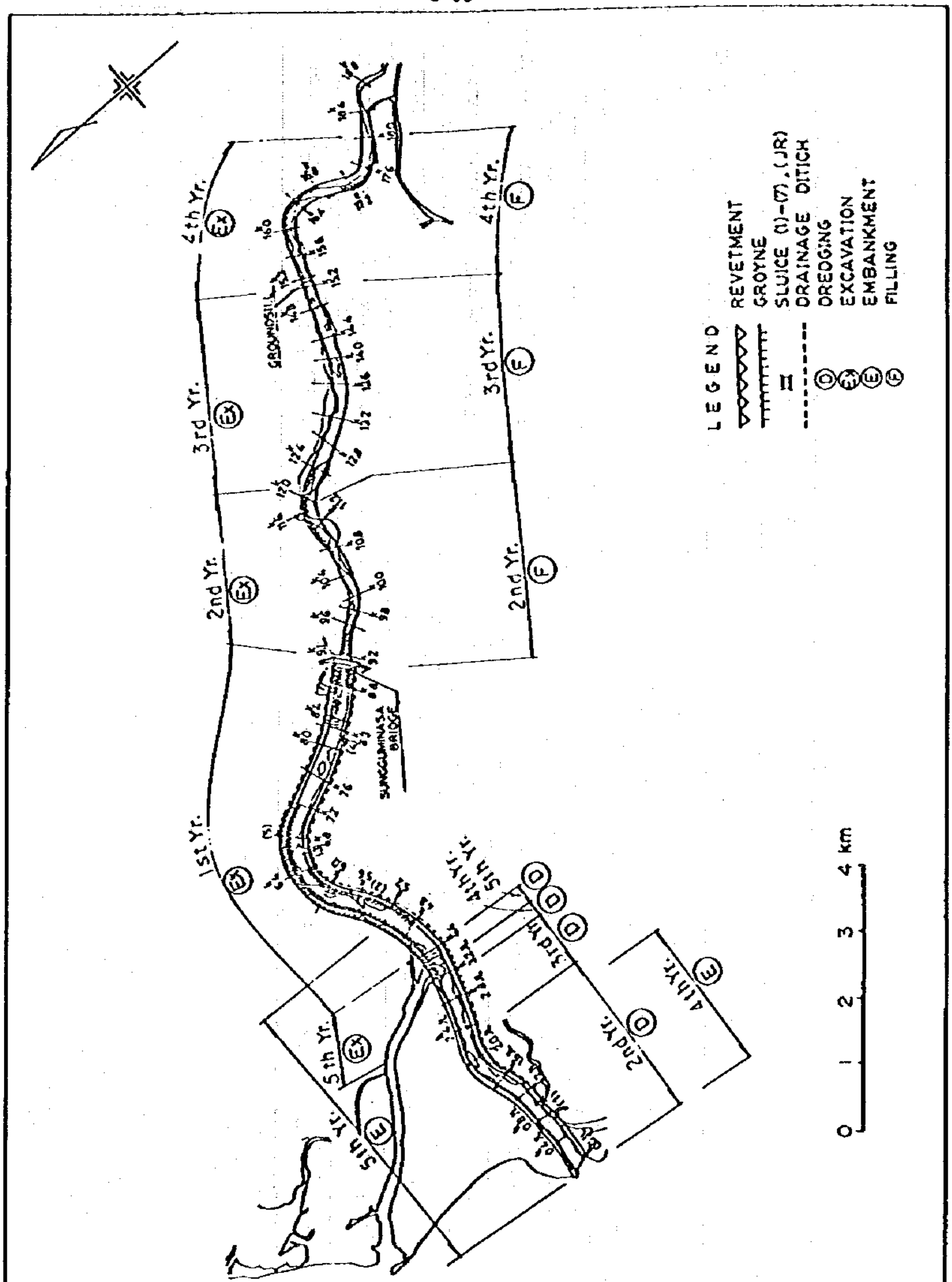


Fig 2-30

RIVER IMPROVEMENT WORK SECTION

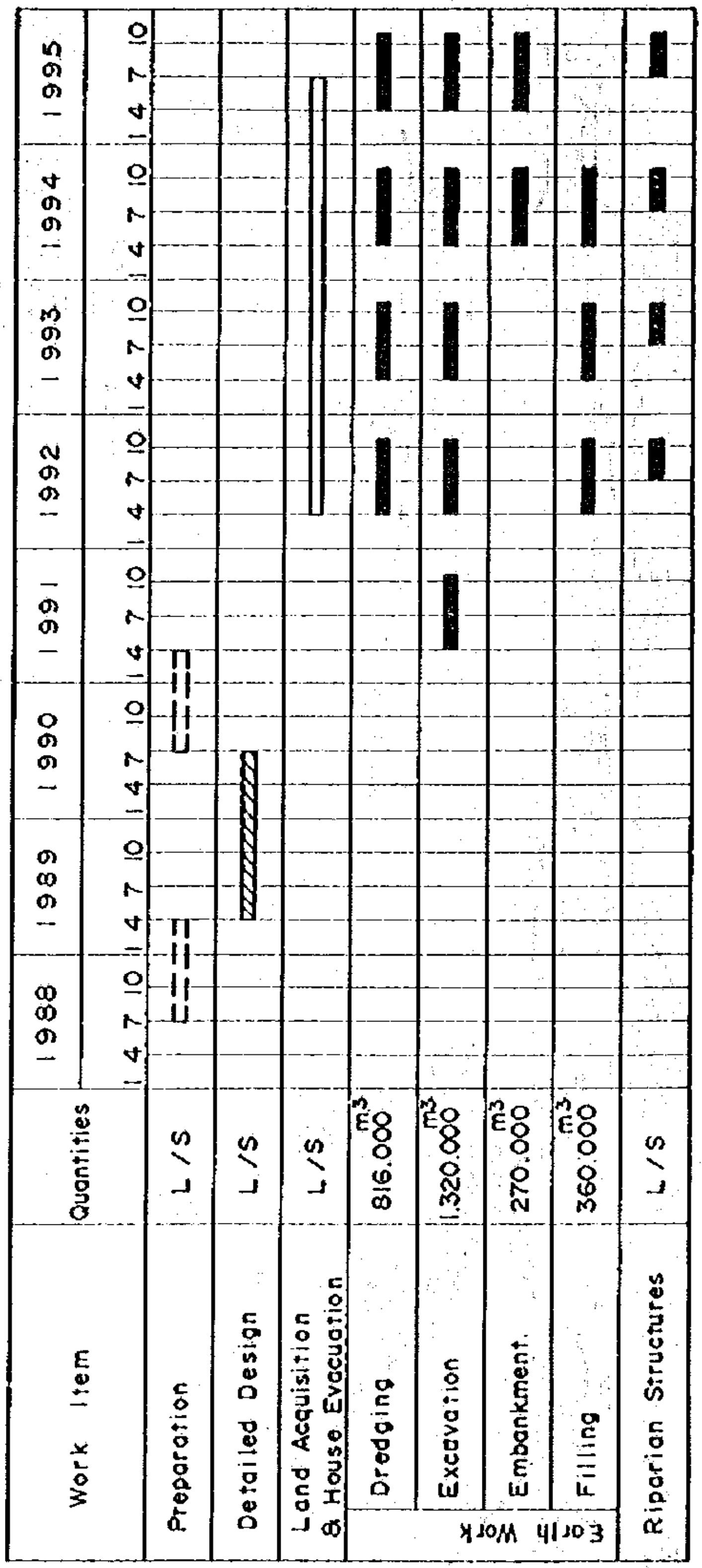


Fig. 2-31

CONSTRUCTION SCHEDULE FOR RIVER IMPROVEMENT

3. PROJECT ECONOMY

CONTENTS OF PROJECT ECONOMY

LIST OF TABLES

1. GENERAL

The proposed Bili-Bili dam and river improvement works would substantially reduce flood damage and also meet the growing demand for municipal/industrial and irrigation water, and power in the project area.

The project has been formulated primarily in order to mitigate flood damage. The secondary objectives are to secure municipal/industrial water, to intensify rice production and to increase the power generation capacity: These sectors should be regarded as a package by totalizing their effectiveness.

In this report, economic evaluation has been based on the total cost and benefit related to flood control, irrigation and hydro power sectors; in other words the cost and benefit concerning the municipal and industrial water supply are eliminated from the project cost and benefit. This is because the benefit of municipal and industrial water supply is still difficult to be quantified.

The economic viability of the project has been evaluated by means of calculating the Internal Rate of Return (IRR). Sensitivity analysis is also made on several assumptions. Cash-flow statements have been prepared for municipal and water supply, irrigation and power generation, respectively, as presented in Annex.

Repiah and Yen are converted to US Dollar at the exchange rate of Rp.625 to US$1.00 and ¥220 to US$1.00. The project life for the economic evaluation is fixed at 50 years from 1982, when the related engineering services are to be started.

2. PROJECT COST

The total project cost is estimated at US$ 603.56 million, on the contract basis by using mid-1981 prices, of which US$ 298.01 million or 49% is foreign currency, and US$ 305.55 million or 51% is local currency. The quantity of works is estimated on the basis of the preliminary design which has been prepared during the study period. Unit prices and the costs of equipment required for the project implementation are in line with the recent bid prices for similar works. These prices and costs include about 10% of taxes and duties. Physical contingencies of 15% have been applied to all the works and equipment costs. Price contingencies are also taken into account at an annual escalation rate of 8% in 1982, 7.5% in 1983, 7% in 1984 and thereafter for foreign currency portion and 14% in 1982, 12% in 1983, 1984 and 1985, 10% in 1986 and thereafter for local currency portion. Compensation payments for house evacuation are in line with those of other Government-sponsered projects. The interest of bank loan during the construction period is computed at the annual rate of 3%. The project cost is classified by work item given as follows. The cost of municipal/industrial water supply system includes only the cost for pipeline and intake facilities installment.

(x10[6] US$)

Work Item	Foreign currency	Local currency	Total
Dam and reservior	151.43	158.76	310.19
River improvement/1	38.77	66.18	104.95
Municipal/industrial water supply	56.91	14.79	71.70
Irrigation water supply	13.93	48.60	62.53
Power generatrion	36.97	17.22	54.19
T o t a l	298.01	305.55	603.56

Annual disbursements of the project cost and the base cost are presented in Tables 3-1 and 3-2, respectively.

3. ECONOMIC EVALUATION

3.1 Project Benefit

The benefit of this project will accrue from flood control sector, irrigation sector and also power generation sector. The benefit derived from the municipal and industrial water supply has not been quantified for such a reason as stated in 1. General.

Primary Benefit

Annual benefit derived from each sector which has been calculated in the monetary terms are summarized in the following page. The detailed process and assumptions for benefit calculation of each sector are described in other sections of this supporting report.

NOTE /1 : Including costs for implementation of the Urgent Flood Control Plan

Sector		Annual benefit ($\times 10^6$ US$)
Flood control	:	13.0
Irrigation	:	31.5
Power	:	3.9
Negative benefit /1	:	- 0.56
T o a l	:	47.84

The flood control benefit will begin to accrue in 1987; that is, after completion of a coffer dam due to its regulation effectiveness, and increase stepwise, in accordance with the achievement of river improvement works.

The irrigation benefit can be expected to accure after completion of all the related works: However, the annual average benefit will not be brought about immediately after then. The build-up period of irrigation benefit is assumed at five years after completion of the project, during which the irrigation benefit will increase linearly.

Benefit from power generation is to accrue in 1991, when all the works required for power generation are completed. The average benefit is assumed to come about annaully throughout the project life.

Secondary Benefit

Secondary benefit, not only primary benefit, can be also expected from the project in the sectors such as recreation/tourism, and municipal/industrial water supply.

In and around the project area, the opportunities to enjoy recreation/tourism are limited to only a few places, although the project area has the capital city of South Sulawesi Province (Ujung Pandang city) with a population of over 700,000. The Bili-Bili reservoir which is located only 31 km away after Ujung Pandang city and is quite accessible by Jl. Malino can provide a good opportunity for recreation/tourism.

Secondary benefits of municipal and industrial water supply are 1) to grade up the living standard, 2) to improve the sanitary condition, 3) to reduce the frequency of disease and 4) to intensity the commercial and industrial activities.

NOTE /1 : As negative benefit is counted a loss of production in the agricultural land to be suberged by the reservoir and to be acquired due to river improvement work. The negative benefit is subtracted from the annual benefit.

Indonesia is now importing about 2.0 million tons of rice annually, while the project area is enjoying surplus production of rice. After completion of the project, rice production will increase by 0.15 million tons, which will contribute to achievement of self-sufficiency of rice.

3.2 Economic Cost

Based on the preliminary designs, the economic construction cost was estimated in such a manner that the import duties, government subsidies and compensation cost should be excluded from the project cost, and that physical contingencies of 15% is added to the cost though no price contingency is considered. Estimation of costs required for equipment and engineering services, which are to be procured by international competitive bidding, is based on the international price levels. The local cost is estimated on the basis of researches on the prevailing prices for similar works which are now going on in and around the project area.

The construction cost will be required for construction of dam and its apputenant facilities, the urgent flood control plan and overall river improvement works, irrigation system improvement works, municipal/industrial water supply system and power generation work. The total economic cost is estimated at US$ 276.43 million, which is composed of foreign currency portion of US$ 150.95 million and local currency portion of US$ 125.48 million equivalent. These costs are summarized below.

($x10^6$ US$)

Work Item	Foreign currency	Local currency	Total
Dam & reservoir	79.54	67.00	146.54
River improvement	17.35	21.81	39.16
Municipal/industrial water supply	28.78	6.68	35.46
Irrigation	7.20	22.71	29.91
Power	18.08	7.28	25.36
T o t a l	150.95	125.48	276.43

Allocation of Dam Construction Cost

To identify the equitable cost for each purpose, the economic dam construction cost has been allocated by "Separable Cost - Remaining Benefit Method" (refer to Table 7-3). The results of cost allocation is in the following page.

(x10^6 US$)

Purpose	Foreign currency	Local currency	Total
Flood control	21.48	18.09	39.57
Municipal/industrial water supply	14.87	12.53	27.40
Irrigation	43.19	36.38	79.57
T o t a l	79.54	67.00	146.54

Cost Estimate by Purpose

Based on the above allocation of the dam construction cost, the total project economic cost can be further classified by sector as follows:

(x10^6 US$)

Sector	Foreign currency	Local currency	Total
Flood control /1	38.83	39.90	78.73
Municipal/industrial water supply /2	43.65	19.21	62.86
Irrigation water supply /3	50.39	59.09	109.48
Power generation /4	18.08	7.28	25.36
T o t a l	150.95	125.48	276.43

NOTE: Each purpose can be attained in combination of respective effectiveness of the dam and other relative works as discribed below:

/1 = Dam + Urgent Flood Control Plan + Overall River Improvement Plan
/2 = Dam + Pipeline
/3 = Dam + Irrigation Facilities
/4 = Generating Facilities + Transmission Line

Operation and Maintenance Cost

To assure the benefits throughout the project life, the related facilities should be successfully operated and safely maintained. The annual cost for operation and maintenance is estimated at US$ 0.92 million, which is composed of the following:

Item		Annual cost ($x10^3$ US$)
Dam and reservoir	:	80
River and related structures	:	87
Municipal/industrial water supply facilities	:	86
Irrigation facilities	:	500
Power generation	:	165
T o t a l	:	918

Replacement Cost

Facilities related to the project are to be replaced periodically to attain their original purposes during the project life; the facilities to be replaced and their costs are summarized as below.

		($x10^6$ US$)
1) Dam and reservoir		
Gates (Durable period of 35 yrs.)	:	1.47
2) River and related facilities		
Groyne (Durable period of 10 yrs.)	:	0.42
Sluice (Durable period of 25 yrs.)	:	0.37
3) Municipal & industrial water supply		
Gates and valves (Durable period of 25 yrs.)	:	0.48
4) Irrigation		
Wooden bar, Gabion, Screen (Durable period of 10 yrs.)	:	0.12
5) Power Generation		
Generating equipment (Durable period of 35 yrs.)	:	4.17

3.3 Internal Rate of Return (IRR)

Evaluation of the project was made by means of calculating IRR on the basis of the estimated benefit and economic cost. The Internal Rate of Return of the Jeneberang River Flood Control Project (Phase II) is calculated at 14.8%, assuming a project life of 50 years. This rate shows economic viability of the Project.

The internal rate of return has been further calculated for each sectore based on cost estimate by purpose, which results in the following percentage.

Sector	IRR (%)
Flood Control	14.9
Irrigation	15.2
Power Generation	13.3
The Project	14.8

3.4 Sensitivity Analysis

Sensitivity analysis has been also made on the assumptions of 1) increase of construction cost, 2) decrease of annual benefit and 3) extension of construction period and build-up period for irrigation. The results are summarized below.

Case	Assumption	IRR (%)
I	Construction cost + 10%	13.7
II	Construction cost + 20%	12.8
III	Annual benefit - 10%	13.6
IV	Annual benefit - 20%	12.6
V	Construction period + 3 years	12.5
VI	Build-up period + 3 years	12.7

4. Socio-Economic Impacts

In addition to the benefits stipulated in the economic evaluation, favourable socio-economic impacts are created by the implementation of the project.

Employment Opportunity

Increase of employment opportunity by the project implementation will give a favourable impact on the regional economy. About 10,000 persons will be newly employed during the construction period and 200 persons will be required permanently for the operation and maintenance works.

Employment opportunity of the population who are serving for agriculture will be certainly increased due to intensive crop cultivation. Unemployment on farm is such a serious problem in the project area that increase of employment opportunity will help considerably to solve the problem.

Transfer of Knowledge

Technical knowledge will be also transferred to the Indonesian engineers through the detailed design and construction works in various engineering fields.

The Indonesian engineers are expected to make much of the technical knowledge to be transferred in order to formulate and implement for themselves other similar projects in the future.

Regional Economy and Social Stability

Living environmnet and sanitary in the project area will be surely improved due to less frequency of flooding, sufficient municipal water supply, more stable power distribution, and so on.

Increase of industrial water supply will provide an possibility for further industrial development.

In compliance with increment of rice yield, farm income in the project area will be hightened, which will enhance the economic activity in the region through its multiple effects on other sectors of the regional economy.

All of the above mentioned project effects will thus contribute to socio-economic stability in the area.

Table 3-1 ANNUAL DISBURSEMENT OF THE PROJECT COST

Unit : $\times 10^6$ US$

WORK ITEM	F.C.	L.C.	TOTAL	1982 F.C.	1982 L.C.	1983 F.C.	1983 L.C.	1984 F.C.	1984 L.C.	1985 F.C.	1985 L.C.	1986 F.C.	1986 L.C.	1987 F.C.	1987 L.C.
D A M	151.43	158.76	310.19	-	-	2.83	0.85	1.51	0.28	0.23	2.02	18.68	20.40	20.27	26.05
RIVER IMPROVEMENT	38.77	66.18	104.95	1.22	0.19	0.30	0.04	1.71	3.52	2.82	6.97	2.61	7.25	2.63	7.44
MUNICIPAL & INDUSTRIAL WATER SUPPLY	56.91	14.79	71.70	-	-	-	-	-	-	-	-	1.63	0.27	0.87	0.17
IRRIGATION	13.93	48.60	62.53	-	-	-	-	-	-	1.19	0.24	0.04	-	2.17	9.99
HYDRO-POWER	36.97	17.22	54.19	-	-	-	-	-	-	-	-	-	-	1.28	0.25
T O T A L	298.01	305.55	603.56	1.22	0.19	3.13	0.89	3.22	3.80	4.24	9.23	22.96	27.92	27.22	43.90

(CONTINUED)

WORK ITEM	1988 F.C.	1988 L.C.	1989 F.C.	1989 L.C.	1990 F.C.	1990 L.C.	1991 F.C.	1991 L.C.	1992 F.C.	1992 L.C.	1993 F.C.	1993 L.C.	1994 F.C.	1994 L.C.	1995 F.C.	1995 L.C.
D A M	28.15	36.38	34.03	44.14	27.93	28.64	3.74	-	3.75	-	3.75	-	3.75	-	2.81	-
RIVER IMPROVEMENT	1.59	0.24	0.80	0.11	0.53	0.02	3.92	3.90	4.95	7.39	5.37	7.73	5.96	9.88	4.36	11.50
MUNICIPAL & INDUSTRIAL WATER SUPPLY	13.90	4.42	20.30	5.82	13.38	4.11	1.43	-	1.44	-	1.44	-	1.44	-	1.08	-
IRRIGATION	2.37	10.99	3.07	12.58	3.43	14.80	0.35	-	0.35	-	0.35	-	0.35	-	0.26	-
HYDRO-POWER	0.04	-	6.18	5.69	24.95	11.28	0.95	-	0.95	-	0.95	-	0.95	-	0.72	-
T O T A L	46.05	52.03	64.38	68.34	70.22	58.85	10.39	3.90	11.44	7.39	11.86	7.73	12.45	9.88	9.23	11.50

Table 3-2 ANNUAL DISBURSEMENT OF THE BASE COST

Unit : $\times 10^6$ US$

WORK ITEM	F.C.	L.C.	TOTAL	1982		1983		1984		1985		1986		1987	
				F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.
D A M	69.16	67.55	136.71	-	-	2.17	0.61	1.02	0.18	0.07	1.16	11.59	10.55	11.44	12.24
RIVER IMPROVEMENT	16.56	24.21	40.77	0.99	0.16	0.20	0.03	1.19	2.26	1.83	4.00	1.52	3.75	1.39	3.50
MUNICIPAL & INDUSTRIAL WATER SUPPLY	25.03	5.81	30.84	-	-	-	-	-	-	-	-	1.02	0.14	0.48	0.08
IRRIGATION	6.20	19.75	25.95	-	-	-	-	-	-	0.79	0.14	-	-	1.23	4.72
HYDRO-POWER	15.72	6.33	22.05	-	-	-	-	-	-	-	-	-	-	0.80	0.13
T O T A L	132.67	123.65	256.32	0.99	0.16	2.37	0.64	2.21	2.44	2.69	5.30	14.13	14.44	15.34	20.67

(CONTINUED)

WORK ITEM	1988		1989		1990		1991		1992		1993		1994		1995	
	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.
D A M	14.68	15.55	16.30	17.15	11.89	10.11	-	-	-	-	-	-	-	-	-	-
RIVER IMPROVEMENT	0.70	0.10	0.23	0.04	0.08	0.01	1.58	1.25	1.86	2.16	1.85	2.05	1.90	2.38	1.24	2.52
MUNICIPAL & INDUSTRIAL WATER SUPPLY	7.55	1.88	10.11	2.26	5.87	1.45	-	-	-	-	-	-	-	-	-	-
IRRIGATION	1.23	4.72	1.46	4.91	1.49	5.26	-	-	-	-	-	-	-	-	-	-
HYDRO-POWER	-	-	3.13	2.21	11.79	3.99	-	-	-	-	-	-	-	-	-	-
T O T A L	24.16	22.25	31.23	26.57	31.12	20.82	1.58	1.25	1.86	2.16	1.85	2.05	1.90	2.38	1.24	2.52

Table 3-3 ALLOCATION OF THE BILI-BILI DAM CONSTRUCTION COST

(Unit: 10^3 US$)

Item	Flood Control	Municipal & Industrial	Irrigation	Total
1) Alternative cost	79,262	38,543	115,506	233,311
2) Justifiable expenditure	79,262	38,543	115,506	233,311
3) Separable cost	25,675	23,521	67,014	116,210
4) Remaining justifiable expenditure (2-3)	53,587	15,022	48,492	117,101
5) Percent distribution of 4	45.8	12.8	41.4	100
6) Remaining joint cost	13,890	3,882	12,556	30,328
7) Total allocated cost (3+6)	39,565	27,403	79,570	146,538
8) Percent distribution of 7	27.0	18.7	54.3	100

A N N E X

CASH-FLOW STATEMENT

1. GENERAL

Cash flow tables have been prepared on the basis of the expected revenue and estimated fund with assumed financial conditions for municipal/industrial water supply, irrigation water supply and power generation.

The direct revenue is expected through collecting water tariff, water charge and power tariff; however, as is often the case with this kind of project, the direct revenue from municipal/industrial water supply sector and irrigation water supply sector is not sufficient to repay the fund to be required for construction.

Under this situation, the analysis for these two sectors is made to know how the direct revenue will be able to contribute to the repayment of the fund and how much subsidery of the government will be required for the repayment.

Cash flow tables of each sector have been prepared under the following financial projections, as presented in Tables 3-1(AN), 3-2(AN) and 3-3(AN).

2. FINANCIAL PROJECTIONS

2.1 Bank Loan

The foreign currency portion of the project construction cost will be financed by bilateral or international organization on the below-mentioned terms, while the government budget will be allocated for the local currency portion.

1) The interest rate is assumed to be 3%, which is the presumable lowest rate.

2) The repayment period is 30 years including 10 years of grace period from the commencement of the construction work. Interest will not be waived during the grace period.

2.3 Operating Expenses

Operating expenses are assumed at a constant level required to provide for adequate operation and maintenance of the systems. With regards to replacement cost for each sector, the preceding section can be referred to for details.

Municipal and Industrial Water Supply

The annual operating expenses are for municipal and industrial water supply are estimated on the basis of US$0.05/$m^3$, which is required for wages, chemicals, power, materials for maintenance, administration and other indirect costs.

Irrigation

The operation and maintenance costs for irrigation are estimated at US$28/ha per annum in reference of the costs applied to similar projects in the vicinity.

Hydro Power

Hydro power generation needs US$167 per annum for wages, administrtion, operation and maintenance of the related facilities, and other indirect costs. The above cost is estimated on the assumptions of 2.5% of the capital cost for generating equipment plus 0.5% of the capital cost for transmission and sub-stations.

2.4 Revenue

Municipal and Industrial Water Supply

Based on the accounting records in 1980, the water tariff is estimated at Rp.55.00/m^3, which has been applied to estimation of the future revenue. Besides the water tariff, a pipe connecting charge is also assumed to be Rp.30,000. A loss of 15% during distribution is taken into account.

Irrigation

The irrigation water charge should be principally collected from the project benefitted-farmers to cover the repayment of capital cost and opration/maintenance cost. However, the Government has a policy that the charge is not levied upon the farmers to spur incentives to agricultural production.

In this connection, the project-benefitted farmers are assumed to bear only the operation/maintenance cost of tertiary irrigation blocks, which have to be voluntarily managed by themselves, amounting to about Rp.17,000 per ha.

Hydro Power

The present power tariff is classified into more than ten blocks. According to the accounting records in 1980, the power tariff is averaged at Rp.43/KWH, which is used for power revenue calculation. A distribution loss is assumed to be 15%.

Table 3-1(AN) CASH-FLOW STATEMENT OF THE IRRIGATION SECTER

(x10[6] US$)

Year	OUT-FLOW						IN-FLOW				Net Income
	Capital Cost (F.C.)	Capital Cost (L.C.)	O.M.& R.	Interest	Repayment	Total	Loan (F.C.)	Budget (L.C.)	Revenue	Total	
1982											
83	1.52	0.46		0.02		2.00	1.54	0.46		2.00	0
84	0.77	0.15		0.06		0.98	.83	0.15		0.98	0
85	1.23	1.34		0.09		2.66	1.32	1.34		2.66	0
86	9.96	11.08		0.26		21.30	10.22	11.08		21.30	0
87	12.63	24.14		0.59		37.36	13.22	24.14		37.36	0
88	16.69	30.74		1.03		48.46	17.72	30.74		48.46	0
89	20.04	36.55		1.58		58.17	21.62	36.55		58.17	0
90	16.52	30.35		2.13		49.00	18.65	30.35		49.00	0
91			0.40	2.38		2.78			0.09	0.09	-2.69
92			0.53	2.38		2.91			0.18	0.18	-2.73
93			0.53	2.38	3.97	6.88			0.26	0.26	-6.62
94			0.53	2.26	3.97	6.76			0.35	0.35	-6.41
95			0.53	2.14	3.97	6.64			0.44	0.44	-6.20
96			0.53	2.02	3.97	6.52			0.53	0.53	-5.99
97			0.53	1.90	3.97	6.40			0.53	0.53	-5.87
98			0.53	1.78	3.97	6.28			0.53	0.53	-5.75
99			0.53	1.68	3.97	6.18			0.53	0.53	-5.65
2000			0.65	1.55	3.97	6.17			0.53	0.53	-5.64
01			0.53	1.43	3.97	5.93			0.53	0.53	-5.40
02			0.53	1.31	3.97	5.81			0.53	0.53	-5.28
03			0.53	1.19	3.97	5.69			0.53	0.53	-5.16
04			0.53	1.07	3.97	5.57			0.53	0.53	-5.04
05			0.53	0.95	3.97	5.45			0.53	0.53	-4.92
06			0.53	0.83	3.97	5.33			0.53	0.53	-4.80
07			0.53	0.71	3.97	5.21			0.53	0.53	-4.68
08			0.53	0.59	3.97	5.09			0.53	0.53	-4.56
09			0.53	0.48	3.97	4.98			0.53	0.53	-4.45
10			0.65	0.36	3.97	4.98			0.53	0.53	-4.45
11			0.53	0.24	3.97	4.74			0.53	0.53	-4.21
12			0.53	0.12	3.97	4.62			0.53	0.53	-4.09
13			0.53			0.53			0.53	0.53	0.00
14			0.53			0.53			0.53	0.53	0.00
15			0.53			0.53			0.53	0.53	0.00
16			0.53			0.53			0.53	0.53	0.00
17			1.12			1.12			0.53	0.53	-0.59
18			0.53			0.53			0.53	0.53	0.00
19			0.53			0.53			0.53	0.53	0.00
20			0.65			0.65			0.53	0.53	-0.12
21			0.53			0.53			0.53	0.53	0.00
⋮			⋮			⋮			⋮	⋮	⋮
2030			0.53			0.53			0.53	0.53	0.00
2031			0.65			0.65			0.53	0.53	-0.12

Table 3-2(AN) CASH-FLOW STATEMENT OF POWER GENERATION SECTER

(x10[6] US$)

Year	OUT-FLOW						IN-FLOW				Net Income
	Capital Cost (F.C.)	Capital Cost (L.C.)	O.M.& R.	Interest	Repayment	Total	Loan (F.C.)	Budget (L.C.)	Revenue	Total	
1982						-				-	
83						-				-	
84						-				-	
85						-				-	
86						-				-	0
87	1.26	0.25		0.02		1.53	1.28	0.25		1.53	0
88	-	-		0.04		0.04	0.04	-		0.04	0
89	6.04	5.69		0.13		11.86	6.17	5.69		11.86	0
90	24.47	11.28		0.48		36.23	24.95	11.28		36.23	0
91			0.12	0.95		1.07			4.07	4.07	3.00
92			0.17	0.95		1.12			4.07	4.07	2.95
93			0.17	0.95		1.12			4.07	4.07	2.95
94			0.17	0.95		1.12			4.07	4.07	2.95
95			0.17	0.95		1.12			4.07	4.07	2.95
96			0.17	0.95	1.59	2.71			4.07	4.07	1.36
97			0.17	0.91	1.59	2.67			4.07	4.07	1.40
98			0.17	0.86	1.59	2.62			4.07	4.07	1.45
99			0.17	0.81	1.59	2.57			4.07	4.07	1.50
2000			0.17	0.76	1.59	2.52			4.07	4.07	1.55
01			0.17	0.72	1.59	2.48			4.07	4.07	1.59
02			0.17	0.67	1.59	2.43			4.07	4.07	1.64
03			0.17	0.62	1.59	2.38			4.07	4.07	1.69
04			0.17	0.57	1.59	2.33			4.07	4.07	1.74
05			0.17	0.52	1.59	2.28			4.07	4.07	1.79
06			0.17	0.48	1.59	2.24			4.07	4.07	1.83
07			0.17	0.43	1.59	2.19			4.07	4.07	1.88
08			0.17	0.38	1.59	2.14			4.07	4.07	1.93
09			0.17	0.33	1.59	2.09			4.07	4.07	1.98
10			0.17	0.29	1.59	2.05			4.07	4.07	2.02
11			0.17	0.24	1.59	2.00			4.07	4.07	2.07
12			0.17	0.19	1.59	1.95			4.07	4.07	2.12
13			0.17	0.14	1.59	1.90			4.07	4.07	2.17
14			0.17	0.10	1.59	1.86			4.07	4.07	2.21
15			0.17	0.05	1.59	1.81			4.07	4.07	2.26
16			0.17			0.17			4.07	4.07	3.90
17			4.34			4.34			4.07	4.07	-0.27
18			0.17			0.17			4.07	4.07	3.90
19			0.17			0.17			4.07	4.07	3.90
20			0.17			0.17			4.07	4.07	3.90
21			0.17			0.17			4.07	4.07	3.90
.			.			.			.	.	.
.			.			.			.	.	.
.			.			.			.	.	.
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.			.			.			.	.	.
2031			0.17			0.17			4.07	4.07	3.90

Table 3-3(AN) CASH-FLOW STATEMENT OF THE MUNICIPAL AND INDUSTRIAL WATER SUPPLY SECTER

($x10^6$ US$)

Year	OUT-FLOW						IN-FLOW				Net Income
	Capital Cost (F.C.)	Capital Cost (L.C.)	O.M.& R.	Interest	Repayment	Total	Loan (F.C.)	Budget (L.C.)	Revenue	Total	
19o							-	-	-		
83	0.52	0.16		0.01		0.69	0.53	0.16	-	0.69	0.00
84	0.26	0.05		0.02		0.33	0.28	0.05	-	0.33	0.00
85	0.02	0.38		0.02		0.42	0.04	0.38	-	0.42	0.00
86	5.04	4.08		0.10		9.22	5.14	4.08	-	9.22	0.00
87	4.43	5.04		0.24		9.71	4.67	5.04	-	9.71	0.00
88	18.64	11.22		1.59		31.45	20.23	11.22	-	31.45	0.00
89	29.87	22.49	0.07	1.32		53.75	31.19	22.49	-	53.68	-0.07
90	21.44	18.76	0.08	2.09		42.37	23.53	18.76	-	42.29	-0.08
91	4.98	10.19	0.90	2.48		18.55	7.46	10.19	3.14	20.79	2.24
92	3.20	1.25	1.30	2.60		8.35	5.80	1.25	2.75	9.80	1.45
93	3.42	1.37	1.70	2.70	7.16	16.35	6.12	1.37	3.36	10.83	-5.52
94	3.66	1.51	2.10	2.64	7.16	17.07	6.30	1.51	3.93	11.74	-5.33
95	4.71	11.63	2.50	2.59	7.16	28.59	7.30	11.63	4.52	23.45	-5.14
96	5.03	12.79	2.70	2.56	7.16	30.24	7.59	12.79	4.55	24.93	-5.31
97	2.99	1.01	3.00	2.51	7.16	16.67	5.50	1.01	4.92	11.43	-5.24
98	3.20	1.11	3.20	2.43	7.16	17.10	5.63	1.11	5.30	12.04	-5.06
99	3.43	1.22	3.50	2.36	7.16	17.67	5.79	1.12	5.68	12.59	-5.08
2000			3.70	2.24	7.16	13.10			6.06	6.06	-7.04
01			3.70	2.07	7.16	12.93			5.43	5.43	-7.50
02			3.70	1.90	7.16	12.76			5.43	5.43	-7.33
03			3.70	1.72	7.16	12.58			5.43	5.43	-7.15
04			3.70	1.55	7.16	12.41			5.43	5.43	-6.98
05			3.70	1.38	7.16	12.24			5.43	5.43	-6.81
06			3.70	1.21	7.16	12.07			5.43	5.43	-6.64
07			3.70	1.03	7.16	11.89			5.43	5.43	-6.46
08			3.70	0.86	7.16	11.72			5.43	5.43	-6.29
09			3.70	0.69	7.16	11.55			5.43	5.43	-6.12
10			3.70	0.52	7.16	11.38			5.43	5.43	-5.95
11			3.70	0.35	7.16	11.21			5.43	5.43	-5.78
12			3.70	0.17	7.16	11.03			5.43	5.43	-5.60
13			3.70			3.70			5.43	5.43	1.73
14			3.70			3.70			5.43	5.43	1.73
15			3.70			3.70			5.43	5.43	1.73
16			3.75			3.75			5.43	5.43	1.68
17			3.70			3.70			5.43	5.43	1.73
18			3.70			3.70			5.43	5.43	1.73
19			3.70			3.70			5.43	5.43	1.73
20			3.70			3.70			5.43	5.43	1.73
21			3.70			3.70			5.43	5.43	1.73
⋮			⋮			⋮			⋮	⋮	⋮
2031			3.70			3.70			5.43	5.43	1.73