VIII. CONSTRUCTION PLAN AND COST ESTIMATE

1. INTRODUCTION

This Annex deals with a construction plan and cost estimate for the flood mitigation in the downstream area from Kuala Krai to protect the envisaged area against 50-year probable flood by means of construction of the Lebir dam, Kemubu dam and river improvement works.

The construction plan was worked out in consideration of the topographic and meteo-hydrological conditions in the project area, result of geological investigation and other factors affecting the implementation of the project.

2. CONSTRUCTION PLAN

2.1 Conditions for Construction

2.1.1 Site conditions

The construction works of the project comprises the execution of dam project for the Lebir and Kemubu and river improvement work for the river stretch between river mouth and Kuala Krai. Natural condition of the project area, labour condition, availability of construction equipment and other factors necessary for formulation of the construction plan are presented hereinafter.

(1) Topography

The project area in this study is situated in the mountaneous areas in the southeastern and southern part of the basin and also about 100 km long river stretch in the downstream from Kuala Krai.

(2) Meteo-hydrology

Climate in the State of Kelantan is characterized by the seasonal monsoon. The north-east monsoon, which prevails mainly October to December, brings heavy rainfall in the coastal plain. Around 50 percent of annual rainfall, which is about 2,700 mm, occurs in the coastal plain on an average during these three months.

The mean annual temperature at Kota Bharu is 26.7°C in January to 29.9°C in May. The variation of temperature depends upon a diurnal change ranging from 23°C at 6 hours to 30°C at 14 hours.

The annual mean relative humidity at Kota Bharu is 80% ranging from 79% in March to 86% in November and average surface wind velocity is relatively low ranging from 0.24 m/sec at kg.

Lalok and 1.1 m/sec at Tanah Rata.

The River Kelantan drains an abundant water and land resources, stretching down from the south to the South China sea. The mean flow of the Kelantan River is 540.6 m^3/sec at Guillemard Bridge, over the period of 1961 to 1984, which is equivalent to the annual runoff of 1,411.3 mm for the catchment area of 12,080 km^2.

The seasonal variation shows the lowest level in April with an average of 282.2 m^3/sec, whilst the north-east monsoon occurred between November and December brings the highest rate of runoff with an average of 1,121.8 m^3/sec. The period of July and August has slightly high flow of 315.0 m^3/sec.

(3) Site geology

The river bed at the Lebir dam site is about 150 m wide and El. 26 m high. River terraces develop on both banks, the top of which is El. 45 m. The terrace on the left bank is narrow, behind which decomposed rocks rise at the gradient of about 16 to 18 degrees. On the right bank, the river terrace is approximately 50 m wide, and the slope above it rises at the gradient of 20 degrees. Bedrocks underlying the dam site consist mainly of green tuffs, purple tuffs, green tuffaceous sandstones and shales with thin layers of tuffaceous conglomerates. These bedrocks, which are slightly metamorphosed and non-foliated, are hard and massive. It is found by field survey of core drilling and seismic exploration that there is little possibility of the existence of large-scale faults at the main dam site.

Two saddle dams for the Lebir dam have been proposed to keep the reservoir water level higher than El. 60 m. They are located on the right bank of the river; 1.8 and 2.0 km north-east from the proposed main dam, respectively. Both saddle dams with a rockfill type are about 30 m and 60 m in height. The bedrocks underlying saddle dam I consist mainly of tuffaceous conglomerates and tuffaceous sandstones with consistent strikes. The bedrocks underlying saddle dam II are comprised mainly of tuffs, tuffaceous sandstones and intruded meta-dacites probably with some dozen metres in width are distributed on the right bank at most. The left bank of this dam site which corresponds to the right bank of the Saddle dam I is weathered by around 25 m in depth.

The riverbed at the Kemubu dam site is about 100 m wide and around El. 60 m high. The slopes of the both banks are steep. Bedrocks consist mainly of schist and volcanics moderately foliated due to metamorphism. These rocks are exposed along the river brinks and slopes of both banks up to 15 m to 20 m above the river bed. The thickness of the river deposit seems to be rather thin, and its thickness is estimated to be 1 m to 3 m.

The flat areas of downstream reaches situated in about 40 km long endmost river stretches consist of the alluvial deposits comprising mainly sand, silt and clayey soil, and form the soft

ground. Dunes formed with coarse sands carried by the westward littoral current are developed with the 10 km wide band from the coastline, especially at the estuary of the Kelantan River.

(4) Access to the sites

The existing Gua Musang - Kuala Krai highway is located in the left bank of the proposed Lebir reservoir. To access from this road to the Lebir damsite, an additional road with width of 8 m and 2.5 km in length will have to be constructed. Since the saddle dams are located on the existing road for timber transportation, about 2 km access road connecting the main dam site with the existing road is needed.

The existing road with about 5 m in width for timber transportation is situated in the left bank of the Kemubu reservoir. To access to the Kemubu damsite from this road, about 5 km long additional road with 10 m in width is needed to be constructed.

For river improvement works in the downstream stretch from Kuala Krai, about 5 m wide existing roads located in both banks will be available as the access road.

(5) Labour force

Skilled and semi skilled labour will be recruited in such major towns as Kota Bharu, Pasir Mas, Tanah Merah and Kuala Krai. Common labour with a sufficient number can be recruited in the Kota Bharu and Pasir Mas.

(6) Construction materials

The required materials such as cement, steel materials, wooden materials, fuel and lubricant and reinforced concrete pile are available locally at the major towns.

(7) Construction equipment and plant

The required equipment to be used for a long period is considered to be purchased by the contractors. In case that the equipment will be required for construction works for a short period, it may be arranged by the contractors on a rental basis.

(8) Workable day and working hour

Since construction will be predominantly controlled by rainfall and flooding, the workable day was estimated based on the past rainfall records and regulations applied in Malaysia. The criteria is established as follows;

a) No works are carried out on the national holidays.

b) The works to be suspended due to rainfall are estimated from the following criteria:

Amount of rainfall (mm)	Suspended days	
	For embankment works	For excavation and concrete works
0 - 5	0	0
5 - 30	1	0.5
30 - 50	2	1
50 - 100	3	1.5
over 100	4	2

The workable days throughout the year are estimated at 175 days for embankment work and 276 days for excavation and concrete works on the basis of the above criteria as shown in Table VIII.2.1. The execution of works is planned under the condition that the works are generally on a single 8 hour-shift basis except for the dredging work.

(9) Swell factor of material

The following swelling and re-compression factors are assumed based on the soil investigation and test results:

Material	loose/bank	Embankment/bank
Common	1.18	0.90
Sand and gravel	1.15	0.95
Weathered rock	1.30	1.00
Rock	1.64	1.18

2.1.2 Mode of construction

In order to implement the project work within the limited construction period, it is herein proposed to execute the project works by an international contract system. In consideration of the scale of the works and anticipated amount of construction cost, it is determined to execute the construction work by dividing into 4 packages, namely, construction of the Lebir dam project (Package 1), execution of river improvement works for urban areas such as Kota Bharu, Pasir Mas, and Tanah Merah (Package 2), construction of the Kemubu dam project (Package 3), and execution of river improvement works for the rural areas (Package 4).

Construction works will be administrated by DID in association with an international engineering consulting firm.

2.1.3 Work items and quantities

The construction works for the divided 4 packages are summarized in Table VIII.2.2.

2.2 Construction Method for Lebir Dam Project (Package 1)

2.2.1 Site preparations

Main offices, quarters, labour camps, warehouses and fuel storage tank will be provided at Tualong near the existing road at about 3.5 km apart from the damsite. While repair and work shops will be provided at the damsite.

Concrete plant capacity is estimated based on the concrete volume required at peak time as follows:

(1)	Concrete volume	:	238,200 m^3
(2)	Construction period	:	36 months
(3)	Maximum monthly requirements	:	(1)/(2) x 1.5 = 9,925 m^3/month
(4)	Maximum daily requirements	:	(3)/23 days x 1.3 = 561 m^3/day
(5)	Hourly production	:	(4)/8 hours = 70 m^3/hr

Two units of concrete plant with a capacity of 1.5 m^3 will be needed to meet the requirements.

The capacity of aggregate plant which consists of grizzly, primary crusher (jaw crusher), secondary crusher (cone crusher), tertiary crusher (impact crusher), washing plant, rod mill and spiral classifier will be estimated as follows:

(1)	Maximum daily concrete requirements	:	561 m^3/day
(2)	Tonnage	:	(1) x 2.0 = 1,122 ton/day
(3)	Capacity	:	(2)/10 hours/day = 112 ton/hr
(4)	Plant capacity	:	(3) x 1.1 ≒ 150 ton/hr

The capacity of filter production plant is estimated as follows:

(1)	Requirement at peak	:	187,000 m^3
(2)	Construction period	:	21 months
(3)	Maximum monthly requirement	:	(1)/(2) = 8,905 m^3/month
(4)	Maximum daily requirement	:	(3)/23 x 1.3 = 503 m^3/day
(5)	Hourly production	:	(4)/13 = 39 m^3/hr
(6)	Plant capacity	:	(5) x 1.21 x 1.6 = 76 ton/hr

Aggregate and filter plant will be located adjacent to the quarry site to avoid double handling.

The proposed quarry site is located at 1.5 km in the north-east of the main dam. It consists of tuffs, tuffaceous breccias and rounded conglomarate. The quarry will be developed on a

bench-cut system of 7.5 m bench height.

2.2.2 Diversion tunnel

Two lane diversion tunnels with 13 m in diameter and 570 m in length will be constructed in the order of upper half, lower half, side wall and concrete lining. Simultaneous construction of two diversion tunnels was planned to complete them within 22 months.

The required construction equipment is as follows;

Drill jumbo	11-boom	4 nos
Pick hammer	7.5 kg	28 nos
Muck loader	1.4 m^3 side dump	4 nos
Vent fan	450 m^3/min	8 nos
Air compressor	50 m^3/min	8 nos
Dump truck	8 ton	12 nos
Agitator truck	4.5 m^3	12 nos
Concrete pump car	45 m^3/hr	4 nos
Sliding form, circular	9.5 m	2 nos
Vibrator	30 mm	20 nos
Leg drill/stopper drill	2.7 m^3/min	1 no
Air compressor	10 m^2/min	1 no
Boring machine	5.5 kw	16 nos
Grout pump	7.5 kw	12 nos
Grout mixer	200 lit. x 2 drums	12 nos

When the main dam embankment is completed, two diversion tunnels will be permanently closed by concrete plugs.

2.2.3 Cofferdam

Immediately after the completion of the diversion tunnels, river water will be diverted through the completed tunnels, and embankment of upstream and downstream cofferdams for the main dam and also cofferdam for the saddle dam will be commenced. The upstream cofferdam is designed as the centre core type and consists of a part of the main dam. The embankment volume of the cofferdams is as follows:

	At main damsite	At saddle damsite
Foundation excavation	25,000 m^3	18,000 m^3
Embankment;		
Core material	117,000 m^3	13,000 m^3
Filter material	29,000 m^3	4,000 m^3
Rock material	541,000 m^3	56,000 m^3

It is scheduled to complete the cofferdam for the main damsite within 7 months. It is planned that the impervious core material is transported from the borrow area at about 4 km apart from the damsite, and all of the filter material and a half of the rock material are transported from the quarry site at 1.5 km apart from the damsite. The remaining required volume of the

rock material will be obtained from the excavated rock of the dam foundation. The cofferdam for the saddle damsite will be constructed using the excavated material from the saddle damsites.

The required construction equipment for construction of the cofferdam is as follows;

<u>At borrow area</u>		
Bulldozer	21 ton	2 nos
Tractor shovel	3.2 m^3	2 nos
Dump truck	20 ton	11 nos
<u>At quarry site</u>		
Bulldozer with ripper	32 ton	3 nos
Wheel loader	5.0 m^3	3 nos
Dump truck	30 ton	25 nos
Crawler drill	15 m^3/min	2 nos
Air compressor	17 m^3/min	2 nos
<u>At cofferdam site</u>		
Bulldozer	11 ton	1 no
Tamping roller	30 ton	1 no

2.2.4 Main dam

(1) Excavation

The excavation of the main dam including dam foundation and gallery trench at higher elevation will be executed prior to the completion of the cofferdam. After the river water is diverted through the completed diversion tunnels, excavation of the dam foundation for the remaining river bottom site will be executed. The total excavated volume is estimated at 502,000 m^3. The required construction equipment is as follows;

Bulldozer with ripper	32 ton	3 nos
Tractor shovel	3.2 m^3	3 nos
Dump truck	20 ton	2 nos
Dump truck	30 ton	3 nos
Bulldozer	11 ton	1 no
Wheel loader	5 m^3	3 nos
Crawler drill	15 m^3/min	2 nos
Air compressor	17 m^3/min	2 nos

(2) Foundation treatment

The consolidation grouting will be performed from the excavated core trench. Total grouting length is estimated at about 9000 m. The curtain groutings will be executed from the gallery below the core zone, in parallel with the embankment of the dam. Total length of the grouting is estimated at 34,000 m. These grouting works are scheduled to be carried out during one

year using the following equipment;

Leg drill	2.7 m^3/min	1 no
Boring machine	5.5 kw	8 nos
Grout pump	7.5 kw	8 nos
Grout mixer	200 lit x 2 drum	8 nos

(3) Embankment

The main dam volume is estimates as follows:

Core	437,000 m^3
Filter	92,000 m^3
Rock	2,171,000 m^3
Total	2,700,000 m^3

The impervious core and filter embankment will be carried out only in dry season starting from January to September, in principle, while the rock embankment will be done throughout the year.

The core material will be obtained from the borrow area at 4 km away from the dam site and will be spread on the embankment area in 300 mm thick layers. Compaction will be executed by six passes of tamping roller.

Filter materials will be loaded out by 20 ton dump truck of filter plant and will be placed by dumping into a spreader box and then spread in layers of 600 mm thick. Water will be added to aid compaction which will be accomplished by four passes of vibrating roller.

Rockfill for the shells of the dam will be obtained from the quarry without further processing. The material will be loaded by 5.0 m^3 wheel loader and transported to the embankment by 32-ton dump trucks and it will be dumped and spread by bulldozers in up to 1500 mm thick layers and compacted by six passes of 15 ton vibrating roller.

A possible combination of equipment units is considered as follows:

Bulldozer with ripper	32 ton	3 nos
Bulldozer	21 ton	8 nos
Wheel loader	5.0 m^3	7 nos
Dump truck	30 ton	16 nos
Dump truck	20 ton	16 nos
Bulldozer	21 ton	1 no
Bulldozer	11 ton	2 nos
Tamping roller	30 ton	1 no
Tractor shovel	3.2 m^3	7 nos
Tractor shovel	2.3 m^3	1 no
Vibrating roller	15 ton	2 nos
Vibrating roller	4 tgon	2 nos
Backhoe	0.6 m^3	1 no

Crawler drill	15 m^3/min	9 nos
Air compressor	17 m^3/mikn	9 nos

The whole of dam embankment work will be completed within 3 years.

2.2.5 Spillway

(1) Excavation

Excavation for the spillway will be carried out in parallel with the excavation for dam foundation. Work quantity is estimated as follows;

Common	;	158,000 m^3
Weathered rock	;	845,000 m^3
Rock	;	757,000 m^3

Excavation in materials other than rock will be carried out using the following equipment units:

Bulldozer with ripper	32 ton	2 nos
Tractor shovel	3.2 m^3	2 nos
Dump truck	30 ton	4 nos
Bulldozer	11 ton	1 no
Dump truck	20 ton	1 no
Wheel loader	5.0 m^3	1 no

The excavated materials will be transported to the spoil bank. The excavated rock will be used for dam embankment. Rock materials will be loosened by blasting using 15 m^2/min crawler drill, then ripped by 32-ton bulldozer and loaded by 5 m^3 wheel load into 30 ton dump truck to stockpile for re-use in embankment. Final controlled excavation of the spillway will be carried out using 32-ton bulldozer to rip areas where blasting could not be carried out or will be unnecessary, and by small hand held drills where blasting is necessary.

(2) Concrete works

Concrete works for 103,000 m^3 in volume will be carried out in the order of overflow weir, stilling basin and chuteway.

Mass concrete for overvlow weir concrete will be placed by using combination of 40-ton truck crane and concrete bucket, while their wall structures will be constructed using a concrete pump.

Concrete for stilling basin will be placed in the same manner as for the above.

Concrete for chuteway will be placed using concrete pump. Concerte will be delivered by agitator trucks.

2.2.6 Saddle dams

It is scheduled to commence the construction works for the saddle dams after the completion of the main dam in order to minimize the number of the construction equipment.

The work quantity of the saddle dams is as follows:

Excavation	
Common	121,000 m^3
Weathered rock	634,000 m^3
Rock	46,000 m^3
Total	801,000 m^3
Embankment	
Core	305,000 m^3
Filter	66,500 m^3
Rock	1,143,000 m^3
Total	1,514,000 m^3

The constuction of the saddle dams is planned to be executed in the same manner as that for the main dam. The required construction equipment is as follows;

Bulldozer with ripper	32 ton	4 nos
Bulldozer	21 ton	8 nos
Wheel loader	5.0 m^3	3 nos
Dump truck	30 ton	14 nos
Dump truck	20 ton	14 nos
Bulldozer	21 ton	1 no
Bulldozer	11 ton	2 nos
Tamping roller	30 ton	1 no
Tractor shovel	3.2 m^3	4 nos
Tractor shovel	2.3 m^3	1 no
Vibrating roller	15 ton	1 no
Vibrating roller	4 ton	1 no
Backhoe	0.6 m^3	1 no
Crawler drill	15 m^3/min	10 nos
Air compressor	17 m^3/min	10 nos

2.2.7 Outlet facilities

When the main embankment has reached an adequate height, the inlet of the tunnel No. 1 which is close to the main dam will be closed by the intake gate. Immediately after the closure of the tunnel No. 1 a concrete plug will be placed. Two lane steel pipe units of 1.7 m in diameter will be embedded in the concrete plug as the river outlet use. The intake shaft with crest elevation of El. 50 m will be construded for the outlet use of reservoir water.

When this work is completed the gate at the inlet tunnel No. 1 will be removed and transferred to that for the No. 2 for plugging of the tunnel No. 2.

After the concrete plugging works for No. 1 tunnel is completed, an access tunnel with 2 m in diameter in upper half, 1.5 m in height in lower half and 280 m in total length will be excavated from toe of the main dam in the downstream site. The gated chamber with valves is constructed immediately downstream of the concrete plug.

2.3 Construction Method of River Improvement Works for Urban Area (Package 2)

2.3.1 General

To protect urgently such major towns as Kota Bharu, Pasir Mas and Tanah Merah, river improvement works comprising construction of levee, revetment and drainage gate and reconstruction of bridge is planned to be executed in the following river stretches;

Kota Bharu stretch ; 9.5 km
Pasir Mas stretch ; 5 km
Tanah Merah stretch ; 10.6 km

The construction work will be executed in parallel with the work for Package 1.

2.3.2 River improvement works

(1) Project features

The following works are planned for the river improvement works;

- Levee (earth type)
  - 9.5 km in right bank of Kota Bharu stretch
  - 5 km in left bank of Pasir Mas stretch
  - 10.6 km in left bank of Tanah Merah stretch
  - 4 km for tributaries
- Revetment
  - Revetment for low water channel ; 4.3 km
  - Revetment for high water channel; 4.3 km
- Sod facing; 829,000 m^2
- Drainage facility; 8 places
- Construction of Sultan Yahya Petra bridge

Location of these works is given in Fig. VII.5.2.

(2) Levee construction

The earth type levee with crest width of 7 m and side slope of 1:3 for both sides and toe drain and drain ditch at toe portion of inner side will be executed using the earth material at river bank near the embankment site. However, for levee embankment in Kota Bharu stretch, earth material will be

transported from high water channel portion upstream of Kota Bharu.

The embankment volume and work quantity of toe drain made from cobble stone are as follows;

- Embankment volume; 2,600,000 m^3
- Toe drain ; 29,000 m

Loading of the embankment material will be made using back-hoe, and hauling and unloading will be carried out by dump truck. The compaction work will be made with a layer of 30 cm and by six passes of combination of sheep foot roller and 13 ton class bulldozer.

The levee embankment work will be also executed in the tributary up to the stretch where design high water level reaches.

The stone necessary for construction of toe drain will be obtained from the mountaneous area at about 20 km east from the project site.

The required construction equipment for the levee construction is as follows;

Backhoe	0.6 m^3	15 nos
Dump truck	8 ton	105 nos
Swamp bulldozer	13 ton	11 nos
Soil compactor	20 ton	2 nos
Tractor	13 ton	2 nos
Tamper	80 kg	14 nos
Motor grader	2.8 m	4 nos

(3) Revetment work

The revetment work for low water channel comprising foot protection by gabion and sheet pile and wet masonry will be executed in the dry season by means of coffering.

The revetment by wet masonry without coffering high water channel will be provided on the river side slope of the newly constructed levee.

The work quantity of revetment work is as follows:

Wet masonry ; 106,900 m^2
Sheet pile (0.4 m x 7 m); 10,750 Nos

(4) Drainage facility

In order to drain the interior water to the Kelantan River and also to prevent the river water from flowing into the inner area, drainage facility comprising sluice gate will be provided at the debouch of 8 tributaries flowing into the Kelantan River

in the urban area.

(5) Construction of new Sultan Yahya Petra bridge

Since the lowest beam of the existing Sultan Yahya Petra bridge with 850 m in total span and 12 m in width is lower than the design flood water level, it is planned to construct new Sultan Yahya Petra bridge immediately upstream of the existing bridge, because this bridge was constructed about 30 years ago and consequently it seems that the strength of bridge substructure after its heightening cannot satisfy the present load condition.

The new bridge with same dimension as the existing one will be constructed at the elevation of about 2 m higher than that of the existing bridge.

2.4 Construction Method for Kemubu Dam Project (Package 3)

2.4.1 Site preparations

A 10 m wide and 5 km long access road to the dam site will be needed to construct for branching from the existing logging track. Since the proposed quarry site is located just beside this existing road, it is planned to improve about 2 km long existing road between the quarry site and junction point of the additional road and the existing road.

A main office, quarters, labour camps, warehouses and a mosque will be provided on the logging track while repair shop, motor pool will be provided at the dam site.

Concrete plant which consists of batching plant and aggregate plant, will manufacture the concrete from central batching plant located near the left abutment of the dam.

The batching capacity will be designed to produce 72 m^3/hr at a peak output as follows:

Total concrete volume	;	183,000 m^3
Construction period	;	30 months
Maximum daily requirement	;	510 m^3/day
Hourly output	;	64 m^3/hr

The plant will be equipped with 2 units of 1.5 m^3 mix drum. The concrete will be transported by bunker line and by 9 ton cable crane to the pour site.

Aggregate plant will be located adjacent to the batching plant and designed to produce 150 ton/hr at a peak output as follows:

Maximum daily concrete requirement;
510 m^3/day x 2.0 = 1,020 ton/day

Hourly production; 1,020/10 = 102 ton

Capacity; 102 x 1.1 = 112 ≒ 120 ton/hr

The aggregate plant will consist of the following components:

Plant	Aggretage size
Primary crusher (jaw crusher)	150 - 80 mm
Secondary crusher (cone crusher)	80 - 40 mm
Tertiary crusher (impact crusher)	40 - 20 mm
	20 - 5 mm
Quarternary crusher (rod mill)	5 - 0 mm

The quarry will be located at 5 km southwest from the dam site. A large pinnacles of limestones will be developed on a bench system of 3 m bench height for production of concrete aggregate and rock materials for both upstream and downstream cofferdams.

A possible combination of equipment units is considered as follows:

Crawler drill	15 m^3/min	2 nos
Air compressor	17 m^3/min	2 nos
Bulldozer	21 ton	2 nos
Tractor shovel	2.3 m^3	2 nos
Dump truck	15 ton	12 nos

A 9.5 ton cable crane will be installed for use in placing concrete in the dam except for stilling basin. Considering the topography and geology at the dam site, the cable way of which one side will be fixed on the left bank and the other side on the right bank will be movable will be installed. The cable span between the two anchors will be 320 m at El. 100m. The two anchors will be a concrete gravity type. The cycle time of 3 m^3 class bucket to be attached to the cable crane will be about 3 minutes.

Bunker line will be provided on the left abutment connecting with the batching plant.

2.4.2 Diversion tunnel

Two lane diversion tunnels with 9 m in diameter and 280 m in length are planned to be constructed in the right bank in the order of upper half, lower half and side wall and concrete lining. It is scheduled to commence the excavation work of two tunnels simultaneously to complete the tunnel works within 13 months.

The required construction equipment is as follows;

Drill jumbo	11 - 600 m	4 nos
Pick hammer	7.5 kg	28 nos
Muck loader	1.4 m^3, side dump	4 nos
Vent fan	450 m^3/min	8 nos
Air compressor	50 m^3/min	8
Dump truck	8 ton	10 nos
Agitator truck	4.5 m^3	10 nos
Concrete pump car	45 m^3/kv	4 nos
Sliding form, circular	9.5 m	2 nos
Vibrator	30 mm	20 nos
Leg hammer/stopper mill	2.7m^3/min	1 no
Air compressor	10 m^3/min	1 no
Boring machine	5.5 kw	6 nos
Grout mix.	200 lit x 2 drums	6 nos
Grout pump	7.5 kw	6 nos

After the dam and spillway concrete works are completed, the diversion tunnel will be closed by concrete plug.

2.4.3 Cofferdams

Immediately after the completion of the diversion tunnel, river water will be diverted through the completed tunnel and embankment work of the cofferdams with centre core type at the upstream and downstream sites of the damsite will be commenced. The work quantity of the cofferdams is as follows;

Foundation excavation;	21,000 m^3
Embankment;	
Core material	32,000 m^3
Filter material	8,000 m^3
Rock material	148,000 m^3

It is planned that impervious core material is transported from the borrow area at about 2 km apart from the damsite and all of the filter material and a half of the rock material are transported from the quarry site at about 5 km apart from the damsite. The remaining required volume of the rock material will be obtained from the excavated rock of the dam foundation.

It is scheduled to complete the cofferdam within 4 months. The required construction equipment is as follows;

At borrow area;		
Bulldozer	21 ton	2 nos
Tractor shovel	3.2 m^3	2 nos
Dump truck	20 ton	6 nos
At quarry site;		
Bulldozer with ripper	32 ton	2 nos
Wheel loader	5.0 m	2 nos
Dump truck	30 ton	21 nos
Crawler drill	15 m^3/min	4 nos
Air compressor	17 m^3/min	4 nos

At cofferdam site

Bulldozer	11 ton	1 no
Tamping roller	30 ton	1 no

2.4.4 Main dam

The excavation of the damsite at higher elevation will be executed prior to the completion of the cofferdam. After the river water is diverted through the completed diversion tunnel, excavation of the dam foundation for the remaining river bottom site will be executed. The required excavation volume is estimated at 336,000 m^3 comprising 30,000 m^3 at river portion and 306,000 m^3 for the remaining portion.

Immediately after the excavation work, curtain grouting and consolidation grouting will be executed. The required work quantity is as follows;

Curtain grouting	;	8,000 m
Consolidation grouting	;	4,000 m

Concrete will be batched and mixed at the central concrete plant of two 1.5 m^3 tilting type mixers and transported by 4.5 m^3 agitator trucks to the point of placement at the dam site. A mobile crane unit and bottom-discharge buckets will be utilized for concrete placement. Concrete temperature in the dam body will be controlled by artificial cooling operation during concrete works. Concrete lift layer will be 1.5 m.

The main dam volume is estimated at 152,000 m^3 and dam construction is scheduled to be completed within 37 months. The required construction equipment for a series of work for foundation excavation, foundation treatment and concrete work is as follows:

Bulldozer	32 ton	2 nos
Bulldozer	21 ton	4 nos
Tractor shovel	3.2 m^3	2 nos
Tractor shovel	2.3 m^3	2 nos
Dump truck	20 ton	8 nos
Dump truck	15 ton	12 nos
Bulldozer	11 ton	1 nos
Crawler drill	15 m^3/min	5 nos
Air compressor	17 m^3/min	5 nos
Rotary boring machine	5.5 kw	3 nos
Grout mixer	200 lit x 2 drums	4 nos
Grout pump	11 kw	4 nos
Crawler drill	7.0 m^3/min	1 no
Air compressor	10.0 m^3/min	1 no

2.4.5 Spillway

Excavation of the stilling basin will be carried out in parallel with the excavation of the dam foundation. The

excavation volume of the stilling basin is estimated at 80,000 m^3.

The concrete work for the stilling basin will be executed by the combination of truck crane and concrete pump.

2.5 Construction Method for River Improvement Works for the Rural Area (Package 4)

2.5.1 General

In parallel with the river improvement works for the urban area, river improvement in the rural areas will be executed. The required work quantity of the river improvement is as follows;

- Levee
  - 4.1 km in the right bank downstream of Kota Bharu
  - 10.0 km in the left bank downstream of Kota Bharu
  - 53.1 km in the right bank upstream of Kota Bharu
  - 38.7 km in the left bank upstream of Kota Bharu
  - 29.0 km for tributaries
- River dredging; 2,100,000 m^3
- Revetment;
  - Revetment for low water channel ; 6.5 km
  - Revetment for high water channel; 8.2 km
- Sod facing; 4,220,000 m^2
- Drainage facilities; 46 places
- Removal of existing pumping facility; 3 places

Location of these works is given in Fig. VII.5.2 (Annex VII).

2.5.2 River improvement works

(1) Levee construction

The levee with same dimension as that stated in the urban area will be constructed. The work quantity of the levee construction is as follows;

- Embankment volume; 10,600,000 m^3
- Toe drain ; 89,500 m

The levee embankment works will be executed in the same manner as stated in the river improvement work in the urban areas. The required construction equipment is referred to Section 2.3.

(2) River dredging

There are several large scale sand dunes in the river channel in the downstream of Kota Bharu. It is planned to remove these sand dunes by means of dredging work. The dredging volume is estimated at 2,100,000 m^3. The dredging work will be executed

using one unit of 600 HP suction type dredger.

(3) Revetment work

The work quantity of the revetment works is estimated as follows:

Wet masonry	;	161,000 m^2
Sheet pile (0.4 m x 7 m)	;	1,575 Nos

The revetment works will be executed in the same manner as stated in the river improvement work in the urban area.

(4) Drainage facility

In order to drain interior water of rural area to the Kelantan River, the drainage facility with sluice gate will be provided at the debouch of 46 tributaries flowing into the Kelantan River in the rural area. The construction of the gated weir will be executed in the dry season by means of coffering.

(5) Removal of existing pumping station

Due to the provision of the levee, the existing pumping stations at Lemar, Salor and Pasir Mas are obliged to be shifted to the new place. It is scheduled to construct the pumping station with same function as the existing one prior to the levee construction.

2.6 Construction Time Schedule

The implementation period of 4 packages was studied considering site condition, extent of the works, identification of land acquisition, and financial balance to meet the Malaysian five year plan. The determined construction time schedule is given in Figs. VIII.2.1 to 2.3 and summarized as follows:

Package no.	Starting time	Scheduled completion time	Duration of construction period (year)
1	January 1993	December 1998	6
2	January 1993	December 2000	8
3	January 2007	December 2010	4
4	January 1993	December 2010	18

3. CONSTRUCTION FUND TO BE REQUIRED

3.1 Conditions for Cost Estimate

The construction cost of the project works is estimated by the following conditions;

(1) Price level : August, 1988

(2) Exchange rate : US$1.00 = M$2.70 = ¥150.00

(3) The construction cost consists of 3 main items, namely, direct cost, indirect cost and contingency. The direct cost is estimated based on the required work items and quantities derived from the pre-feasibility study. The indirect cost includes the cost of land acquisition and house evaculation, government administration cost and engineering services cost for detailed design and supervision. The physical contingency is counted into direct and indirect costs accordingly.

(4) The direct cost for civil works is estimated by multiplying the unit cost and corresponding work quantity. The preparatory works and minor work items are estimated by lump sum basis with a certain percentage of main works. The unit cost for each work item consists of the cost of construction materials, labour and equipment. The contractor's indirect cost is incorporated in the unit cost of each work item.

(5) Labourer's daily charge is estimated including the living allowance, leaves, bonus, medical care and others. Table VIII.3.1 shows the unit rate of labour wages.

(6) Prices of construction material available in local market were surveyed at the project area. They are principally counted into the local currency component but their certain proportions are considered into foreign currency component according to their usage of imported raw material and production facilities. Table VIII.3.2 shows the unit price of construction materials divided into the foreign and local currencies.

(7) Equipment cost consists of depreciation and interest, maintenance and repair cost, and management cost.

The currency component of the equipment cost is assumed to be 80% of the total cost for foreign currency and 20% for local currency, taking into account the following currency components;

Foreign currency component
- CIF purchase cost
- Spare parts cost

Local currency component
- Labour cost of repairing
- Landing and delivery cost

Cost of equipment made in local market

Hourly cost per each equipment is tabulated in Table VIII.3.3 by dividing into the foreign and local currency components.

(8) A 20% of direct cost for dam works is assumed as the contractor's indirect cost (contractor's overhead and profit), and added to the direct cost in the unit cost of each work item. A 15% of direct cost for river improvement works is assumed as the contractor's indirect cost.

(9) Cost estimate for mechanical works is based on market research and past tendered record of similar works.

(10) Land acquisition and house evacuation costs are estimated on the basis of the prevailing cost for land, buildings and other private properties in the State of Kelantan. All of these costs are estimated as the local currency component.

(11) Engineering services and administration costs are estimated at 15% of total direct cost for construction supervision with 80% and 20% for foreign and local components respectively.

(12) Physical contingency is provided to cope with the unpredictable physical conditions and 10% of total cost except for land acquisition is assumed.

3.2 Financial Cost and Annual Disbursement Schedule

The construction cost divided into foreign and local currency portions was estimated by multiplying the work quantities by the respective unit costs. The bill of quantities with unit cost are tabulated in Tables VIII.3.4 to VIII.3.7 based on the foregoing conditions. The construction cost estimated for each package is summarized in Table VIII.3.8. Furthermore, the construction cost required for the Kelantan River basin-wide flood mitigation project is summarized as follows:

(Unit : 10^3 MS$)

Cost items	F.C	L.C	Total
- Direct cost (Construction cost including preparatory works)	289,186	389,574	678,760
- Indirect cost (Land acquisition, administration and engineering service cost)	96,426	408,078	504,504
- Contingency (Physical contingency)	38,561	79,765	118,326
Total	424,173	877,417	1,301,590

Based on the construction time schedule as shown in Figs. VIII.2.1 to 2.3, the annual disbursement schedule is prepared as given in Table VIII.3.9.

Table VIII.2.1 Estimate of Workable Days (1/2)

Embankment for Lebir Dam

Month	Nos of days	Holiday	National holiday	Rainy days 5-30	31-50	51-100	100<	Work to be suspended 5-30	31-50	51-100	100<	Workable days
Jan	31	5		3.3	0.6	0.4	0.0	3.3	1.2	1.2	0.0	20.3
Feb	28	4	1	3.6	0.3	0.1	0.0	3.6	0.6	0.3	0.0	18.5
Mar	31	4	2	5.8	0.2	0.0	0.0	5.8	0.4	0.0	0.0	18.8
Apr	30	4		5.5	0.7	0.3	0.0	5.5	1.4	0.9	0.0	18.2
May	31	5	4	7.2	1.0	1.0	0.0	7.2	2.0	3.0	0.0	9.8
Jun	30	4	1	5.3	0.9	0.3	0.0	5.3	1.8	0.9	0.0	17.0
Jul	31	5	1	6.0	1.0	0.4	0.0	6.0	2.0	1.2	0.0	15.8
Aug	31	4	1	5.3	1.1	0.8	0.0	5.3	2.2	2.4	0.0	16.1
Sep	30	4		7.0	1.5	0.9	0.1	7.0	3.0	2.7	0.4	12.9
Oct	31	5		9.5	1.6	0.9	0.0	9.5	3.2	2.7	0.0	10.6
Nov	30	4	1	9.2	1.1	0.6	0.7	9.2	2.2	1.8	2.8	9.0
Dec	31	4		7.8	1.0	1.9	0.8	7.8	2.0	5.7	3.2	8.3
Total	365	52	11	75.5	11.0	7.6	1.6	75.5	22.0	22.8	6.4	175.3

Excavation

Month	Nos of days	Holiday	National holiday	Rainy days 5-30	31-50	51-100	100<	Work to be suspended 5-30	31-50	51-100	100<	Workable days
Jan	31	5		3.3	0.6	0.4	0.0	0.0	0.6	0.6	0.0	24.8
Feb	28	4	1	3.6	0.3	0.1	0.0	0.0	0.3	0.2	0.0	22.5
Mar	31	4	2	5.8	0.2	0.0	0.0	0.0	0.2	0.0	0.0	24.8
Apr	30	4		5.5	0.7	0.3	0.0	0.0	0.7	0.5	0.0	24.8
May	31	5	4	7.2	1.0	1.0	0.0	0.0	1.0	1.5	0.0	19.5
Jun	30	4	1	5.3	0.9	0.3	0.0	0.0	0.9	0.5	0.0	23.6
Jul	31	5	1	6.0	1.0	0.4	0.0	0.0	1.0	0.6	0.0	23.4
Aug	31	4	1	5.3	1.1	0.8	0.0	0.0	1.1	1.2	0.0	23.7
Sep	30	4		7.0	1.5	0.9	0.1	0.0	1.5	1.4	0.2	22.9
Oct	31	5		9.5	1.6	0.9	0.0	0.0	1.6	1.4	0.0	23.0
Nov	30	4	1	9.2	1.1	0.6	0.7	0.0	1.1	0.9	1.4	21.6
Dec	31	4		7.8	1.0	1.9	0.8	0.0	1.0	2.9	1.6	21.5
Total	365	52	11	75.5	11.0	7.6	1.6	0.0	11.0	11.7	3.2	276.1

Table VIII.2.1 Estimate of Workable Days (2/2)

Embankment for Kemubu Dam

Month	Nos of days	Holiday	National holiday	Rainy days 5-30	31-50	51-100	100<	Work to be suspended 5-30	31-50	51-100	100<	Workable days
Jan	31	5		4.6	0.5	0.5	0.1	4.6	1.0	1.5	0.4	18.5
Feb	28	4	1	3.4	0.6	0.3	0.0	3.4	1.2	0.9	0.0	17.5
Mar	31	4	2	4.0	0.5	0.2	0.1	4.0	1.0	0.6	0.4	19.0
Apr	30	4		4.5	0.9	0.4	0.0	4.5	1.8	1.2	0.0	18.5
May	31	5	4	7.0	1.3	0.5	0.1	7.0	2.6	1.5	0.4	10.5
Jun	30	4	1	5.3	1.3	0.6	0.0	5.3	2.6	1.8	0.0	15.3
Jul	31	5	1	6.9	1.3	0.9	0.0	6.9	2.6	2.7	0.0	12.8
Aug	31	4	1	6.7	1.5	0.9	0.1	6.7	3.0	2.7	0.4	13.2
Sep	30	4		8.9	1.9	1.1	0.1	8.9	3.8	3.3	0.4	9.6
Oct	31	5		8.8	2.1	1.4	0.1	8.8	4.2	4.2	0.4	8.4
Nov	30	4	1	10.1	2.1	0.9	0.3	10.1	4.2	2.7	1.2	6.8
Dec	31	4		10.0	2.0	1.4	0.4	10.0	4.0	4.2	1.6	7.2
Total	365	52	11	80.2	16.0	9.1	1.3	80.2	32.0	27.3	5.2	157.3

Excavation

Month	Nos of days	Holiday	National holiday	Rainy days 5-30	31-50	51-100	100<	Work to be suspended 5-30	31-50	51-100	100<	Workable days
Jan	31	5		4.6	0.5	0.5	0.1	0.0	0.5	0.8	0.2	24.5
Feb	28	4	1	3.4	0.6	0.3	0.0	0.0	0.6	0.5	0.0	21.9
Mar	31	4	2	4.0	0.5	0.2	0.1	0.0	0.5	0.3	0.2	24.0
Apr	30	4		4.5	0.9	0.4	0.0	0.0	0.9	0.6	0.0	24.5
May	31	5	4	7.0	1.3	0.5	0.1	0.0	1.3	0.8	0.2	19.7
Jun	30	4	1	5.3	1.3	0.6	0.0	0.0	1.3	0.9	0.0	22.8
Jul	31	5	1	6.9	1.3	0.9	0.0	0.0	1.3	1.4	0.0	22.3
Aug	31	4	1	6.7	1.5	0.9	0.1	0.0	1.5	1.4	0.2	22.9
Sep	30	4		8.9	1.9	1.1	0.1	0.0	1.9	1.7	0.2	22.2
Oct	31	5		8.8	2.1	1.4	0.1	0.0	2.1	2.1	0.2	21.6
Nov	30	4	1	10.1	2.1	0.9	0.3	0.0	2.1	1.4	0.6	20.9
Dec	31	4		10.0	2.0	1.4	0.4	0.0	2.0	2.1	0.8	22.1
Total	365	52	11	80.2	16.0	9.1	1.3	0.0	16.0	14.0	2.6	269.4

Table VIII.2.2 Major Work Quantity (1/2)

Package No.	Major work items	Unit	Work quantity
1.	Lebir dam project		
	1.1 Access road	Km	7
	1.2 Diversion tunnel, 2 lanes		
	1) Tunnel excavation, l=535 m, 13 m dia.	m3	335,000
	2) Tunnel and portal lining	m3	84,400
	3) Consolidation and curtain grouting	m	14,000
	4) Gate	set	1
	1.3 Cofferdams		
	1) Excavation	m3	63,000
	2) Embankment	m3	687,000
	1.4 Main dam		
	1) Excavation	m3	527,000
	2) Embankment	m3	2,700,000
	3) Consolidation and curtain grouting	m	43,000
	4) Gallery concrete	m3	16,000
	1.5 Spillway		
	1) Excavation	m3	1,760,000
	2) Concrete	m3	103,000
	1.6 Saddle dams		
	1) Excavation for cofferdam	m3	18,000
	2) Embankment for cofferdam	m3	73,000
	3) Excavation for saddle dams	m3	801,000
	4) Embankment for saddle dams	m3	1,514,000
	5) Consolidation and curtain grouting	m	11,000
	1.7 River outlet works		
	1) Concrete	m3	1,440
	2) Metal works		L.S.
	1.8 Intake structure		
	1) Excavation	m3	1,045,500
	2) Concrete	m3	14,000
	3) Consoldation grouting	m	612
	4) Gate	set	2
	1.9 Relocation cost		
	1) Tarmac road	Km	5
	2) Feeder roads	Km	86
	3) Forest	ha	5,300
	4) Houses	no.	165
2.	River improvement in urban area		
	2.1 Main civil works		
	1) Clearing and stripping	m2	197,000
	2) Embankment	m3	2,605,000
	3) Revetment	m2	106,900
	4) Sluice	pc	8
	5) Toe drain	m	29,100
	6) Maintenance road	m	29,100
	7) Sod facing	m2	829,000

Table VIII.2.2 Major Work Quantity (2/2)

Package No.	Major work items	Unit	Work quantity
	2.2 Relocation		
	1) Land acquisition	ha	197
	2) House evacuation	no	170
	3) Bridge	no	2
3.	Kemubu dam project		
	3.1 Access road	Km	7
	3.2 Diversion tunnel, 2 lanes		
	1) Excavation , 1-271 m & 294 m, 9 m dia	m3	169,600
	2) Concrete	m3	26,000
	3) Consolidation grouting	m	4,000
	4) Gate	set	1
	3.3 Cofferdams		
	1) Excavation	m3	21,000
	2) Embankment	m3	188,000
	3.4 Main dam		
	1) Excavation	m3	413,500
	2) Concrete	m3	148,800
	3) Consolidation and curtain grouting	m	4,000
	3.5 Relocation cost		
	1) Rough road	Km	9
	2) Railway	Km	26
	3) Plantation	ha	456
	4) Feeder road	Km	5
	5) Forest	ha	790
	6) Houses	no	1,000
4.	River improvement in rural area		
	4.1 Main civil works		
	1) Clearing and stripping	m2	1,378,000
	2) Dredging	m3	2,100,000
	3) Embankment	m3	10,635,000
	4) Revetment	m2	161,100
	5) Sluice	no	46
	6) Toe drain	m	89,500
	7) Maintenance road	m	134,900
	8) Sod facing	m2	4,217,000
	4.2 Compensation		
	1) Land acquisition	ha	1,378
	2) House evacuation	no	600
	3) Pumping station for irrigation	no	3
	4) Bridge	no	4

Table VIII.3.1 Labour Wages

NO.	Description	Rate (M$)
1.	Foreman	50.00
2.	Operator for heavy equipment	35.00
3.	Operator for light equipment	30.00
4.	Assistant operator	25.00
5.	Driver for heavy truck	30.00
6.	Driver for light truck	25.00
7.	Mechanic for heavy equipment	45.00
8.	Mechanic for light equipment	40.00
9.	Electrician for high voltage	45.00
10.	Electrician for light equipment	40.00
11.	Rigger	40.00
12.	Welder	35.00
13.	Carpenter	40.00
14.	Form worker	30.00
15.	Concrete	30.00
16.	Steel worker	30.00
17.	Driller	25.00
18.	Tunnel worker	25.00
19.	Mason	30.00
20	Plumber	30.00
21.	Blaster	40.00
22.	Boring worker	30.00
23.	Grouting worker	30.00
24.	Surveyor	40.00
25.	Skilled labour	35.00
26.	Semi-skilled labour	25.00
27.	Common labour	20.00

Table VIII.3.2 Material Cost (1/3)

No.	Particular	Description	Unit	Total amount (MS$)	Assumed material unit cost Component (%) local	Foreign	Local currency (MS$)	Foreign currency (MS$)
1	Gasoline		litre	0.95	60	40	0.57	0.38
2	Light oil		litre	0.51	60	40	0.31	0.20
3	Electric power charge		kwh	0.24	60	40	0.14	0.10
4	Lubricant		litre	2.40	60	40	1.44	0.96
5	Grease		kg	3.00	60	40	1.80	1.20
6	Portland cement	by rail	ton	192.00	60	40	115.20	76.80
7	Air entraining agent		kg	3.60	40	60	1.44	2.16
8	Water reducing agent		kg	4.10	40	60	1.64	2.46
9	Air bubble agent		kg	2.10	40	60	0.84	1.26
10	Round bar		ton	891.00	60	40	534.60	356.40
11	Deformed bar		ton	921.00	60	40	552.60	368.40
12	Channel steel		ton	1,500.00	60	40	900.00	600.00
13	H-shaped steel		ton	1,500.00	60	40	900.00	600.00
14	Dynamite for open		nmb	10.00	20	80	2.00	8.00
15	Dynamite for tunnel		nmb	10.00	20	80	2.00	8.00
16	An-Fo power		nmb	0.89	20	80	0.18	0.71
17	Detonator		nmb	2.20	20	80	0.44	1.76
18	Timber, plank		cu.m.	300.00	100	0	300.00	0.00
19	Timber, square		cu.m.	280.00	100	0	280.00	0.00
20	Timber, log		cu.m.	230.00	100	0	230.00	0.00
21	Metal form	300 x 1500	nmb	41.65	40	60	16.66	24.99
22	Metal form	200 x 1500	nmb	37.55	40	60	15.02	22.53
23	Metal form	150 x 1500	nmb	33.00	40	60	13.20	19.80
24	Metal form	100 x 1500	nmb	28.05	40	60	11.22	16.83
25	Plywood		nmb	36.00	60	40	21.60	14.40
26	Separator		m	0.76	40	60	0.30	0.46
27	Cone		nmb	0.50	40	60	0.20	0.30
28	Form oil		litre	0.50	60	40	0.30	0.20
29	Cast iron pipe	75 mm	m	11.00	40	60	4.40	6.60
30	Cast iron pipe	100 mm	m	12.50	40	60	5.00	7.50
31	Cast iron pipe	150 mm	m	15.00	40	60	6.00	9.00
32	Gas pipe	20 mm	m	6.00	40	60	2.40	3.60
33	Gas pipe	40 mm	m	9.60	40	60	3.84	5.76
34	Gas pipe	65 mm	m	12.00	40	60	4.80	7.20
35	Galvanized pipe	25 mm	m	7.00	40	60	2.80	4.20
36	Galvanized pipe	100 mm	m	16.48	40	60	6.59	9.89
37	Galvanized pipe	150 mm	m	50.00	40	60	20.00	30.00
38	Galvanized pipe	200 mm	m	67.50	40	60	27.00	40.50
39	P.V.C. pipe	40 mm	m	5.68	20	80	1.14	4.54
40	P.V.C. pipe	50 mm	m	8.18	20	80	1.64	6.54
41	P.V.C. pipe	75 mm	m	15.84	20	80	3.17	12.67
42	Vinyl vent pipe	400 mm	m	319.20	20	80	63.84	255.36
43	Vinyl vent pipe	500 mm	m	385.20	20	80	77.04	308.16
44	Vinyl vent pipe	600 mm	m	464.40	20	80	92.88	371.52
45	Vinyl vent pipe	700 mm	m	538.20	20	80	107.64	430.56
46	Vinyl vent pipe	800 mm	m	646.40	20	80	129.28	517.12
47	Vinyl vent pipe	900 mm	m	725.60	20	80	145.12	580.48

Table VIII.3.2 Material Cost (2/3)

No.	Particular	Description	Unit	Total amount (MS$)	Assumed material unit cost Component (%) local	Foreign	Local currency (MS$)	Foreign currency (MS$)
48	Vinyl vent pipe	1000 mm	m	810.00	20	80	162.00	648.00
49	Vinyl vent pipe	1100 mm	m	904.80	20	80	180.96	723.84
50	Rock bolt 25 mm	grout type	m	61.00	20	80	12.20	48.80
51	Rock bolt 22 mm	grout type	m	56.00	20	80	11.20	44.80
52	Rock bolt 22 mm	non-grout	m	50.00	20	80	10.00	40.00
53	Rock bolt 25 mm	non-grout	m	56.00	20	80	11.20	44.80
54	P.V.C. water stop	flat, 200	m	15.00	60	40	9.00	6.00
55	Annealed iron wire		kg	1.00	60	40	0.60	0.40
56	Nail		kg	2.50	60	40	1.50	1.00
57	Wire mesh		sq.m	5.20	60	40	3.12	2.08
58	Fence		m	2.08	60	40	1.25	0.83
59	Welding electrode		kg	4.65	40	60	1.86	2.79
60	Cross bit	36 mm	nmb	96.00	20	80	19.20	76.80
61	Cross bit	55 mm	nmb	200.00	20	80	40.00	160.00
62	Cross bit	65 mm	nmb	232.00	20	80	46.40	185.60
63	Insert bit 22 mm	L=1.4 m	nmb	232.00	20	80	46.40	185.60
64	Insert bit 22 mm	L=1.7 m	nmb	256.00	20	80	51.20	204.80
65	Insert bit 22 mm	L=2.3 m	nmb	292.00	20	80	58.40	233.60
66	Taper rod 22 mm	L=2.0 m	nmb	274.00	20	80	54.80	219.20
67	Rod, core drill 35 D	L=3 m	nmb	247.20	20	80	49.44	197.76
68	Rod, core drill 35 D	sleeve	nmb	221.20	20	80	44.24	176.96
69	Rod, core drill 35 D	shank rod	nmb	663.20	20	80	132.64	530.56
70	Rod, core drill 795D	L=3 m	nmb	247.00	20	80	49.40	197.60
71	Rod, core drill 795D	sleeve	nmb	221.20	20	80	44.24	176.96
72	Rod, core drill 795D	shank rod	nmb	663.20	20	80	132.64	530.56
73	Rod, core drill M110	L=3 m	nmb	269.00	20	80	53.80	215.20
74	Rod, core drill M110	sleeve	nmb	221.20	20	80	44.24	176.96
75	Rod, core drill M110	shank rod	nmb	663.20	20	80	132.64	530.56
76	Boring rod	40.5 mm	nmb	269.00	20	80	53.80	215.20
77	Metal bit	46 mm	nmb	84.86	20	80	16.97	67.89
78	Metal bit	56 mm	nmb	92.54	20	80	18.51	74.03
79	Tube core barrel	46 mm	nmb	347.80	20	80	69.56	278.24
80	Tube core barrel	56 mm	nmb	2,194.00	20	80	438.80	1,755.20
81	Core lifter		nmb	117.82	20	80	23.56	94.26
82	Diamond bit	diamond	carat	270.00	0	100	0.00	270.00
83	Diamond bit	diamond	carat	270.00	0	100	0.00	270.00
84	Concrete aggregate	fine	cu.m.	37.10	100	0	37.10	0.00
85	Concrete aggregate	coarse	cu.m.	42.25	100	0	42.25	0.00
86	Crusher run		cu. m.	42.40	100	0	42.40	0.00
87	Crusher stone		cu. m.	37.10	100	0	37.10	0.00
88	Sand		cu. m.	13.25	100	0	13.25	0.00
89	Gravel		cu. m.	13.25	100	0	13.25	0.00
90	Rubble		cu. m.	37.10	100	0	37.10	0.00
91	Bentonite		ton	2,750.00	60	40	1,650.00	1,100.00
92	Turf		sq.m.	1.00	60	40	0.60	0.40
93	Fertilizer		kg	49.16	60	40	29.50	19.66

Table VIII.3.2 Material Cost (3/3)

No.	Particular	Description	Unit	Total amount (MS$)	Assumed material unit cost Component (%) local	Foreign	Local currency (MS$)	Foreign currency (MS$)
94	Rust preventing paint		kg	6.72	60	40	4.03	2.69
95	Paint		kg	15.30	60	40	9.18	6.12
96	Packer		nmb	1,786.00	60	40	1,071.60	714.40
97	Elastic packing		nmb	81.18	60	40	48.71	32.47
98	Outer tube		nmb	232.00	60	40	139.20	92.80
99	Injection tube		nmb	192.40	60	40	115.44	76.96
100	Packer holder		nmb	1,391.60	60	40	834.96	556.64
101	Injection branch		nmb	1,159.60	60	40	695.76	463.84
102	Injection hose		m	32.46	60	40	19.48	12.98
103	Return hose		m	32.46	60	40	19.48	12.98
104	Ready mixed concrete		cu.m.	100.00	60	40	60.00	40.00
105	Bamboo	L=5 m	nbm	6.00	100	0	6.00	0.00
106	Bamboo net		sq.m	13	100	0	13.00	0.00
107	Oxygen		kg	6.19	60	40	3.71	2.48
108	Acetylene		m3	16.45	60	40	9.87	6.58
109	Asphalt		ton	85	60	40	51.00	34.00
110	Steel sheet pile		ton	1,500.00	60	40	900.00	600.00
111	Rail, 32 kg/m		m	48.00	60	40	28.80	19.20

Table VIII.3.3 Hourly Equipment Cost (1/4)

No.	Description		H/T	W/T	HP	CIF Kuala Lumpur	Delivery cost at site	Life	Time	Dep	Rep	Admin	Rate	Total cost	Hourly equipment Foreign	Hourly equipment Local	P.O.L.
(1)	(2)		(3)	(4)	(5)	(M$) (6)	(M$) (7)	year	hour (8)	(9)	(10)	(11)	*10-6 (12)	(M$) (13)	(M$) (14)x0.80	(M$) (15)x0.20	(M$) (16)
1	Bulldozer with ripper	32-ton	66.00	34	320	500,000	505,280	12	1,050	90%	80%	5%	183	92.47	73.98	18.49	44.2
2	Bulldozer with ripper	21-ton	46.00	23	211	400,000	403,680	12	900	90%	55%	5%	190	76.70	61.36	15.34	29.1
3	Bulldozer with ripper	15-ton	37.00	16	150	340,000	342,960	12	900	90%	55%	5%	190	65.16	52.13	13.03	20.7
4	Bulldozer	11-ton	30.50	12	108	300,000	302,440	12	900	90%	50%	5%	185	55.95	44.76	11.19	13.2
5	Bulldozer for swamp	18-ton	46.00	19	170	360,000	363,680	12	900	90%	60%	5%	194	70.55	56.44	14.11	20.7
6	Bulldozer for swamp	13-ton	37.00	13	118	320,000	322,960	12	900	90%	55%	5%	190	61.36	49.09	12.27	14.4
7	Tractor shovel	3.1-m3	55.00	30	250	430,000	434,400	12	1,000	90%	55%	5%	171	74.28	59.42	14.86	29.8
8	Tractor shovel	2.3-m3	42.00	21	200	380,000	383,360	12	1,000	90%	55%	5%	171	65.55	52.44	13.11	23.8
9	Tractor shovel	1.2-m3	23.00	11	93	290,000	291,840	12	850	90%	45%	5%	191	55.74	44.59	11.15	11.1
10	Tractor shovel side dump	1.8-m3	46.00	20	152	340,000	343,680	10	850	90%	40%	5%	212	72.86	58.29	14.57	18.1
11	Tractor shovel side dump	1.5-m3	40.00	15	112	305,000	308,200	10	850	90%	40%	5%	212	65.34	52.27	13.07	13.3
12	Backhoe	1.0-m3	93.00	29	193	480,000	487,440	10	1,200	90%	40%	5%	150	73.12	58.50	14.62	24.9
13	Backhoe	0.6-m3	70.00	27	105	300,000	305,600	10	1,200	90%	40%	5%	150	45.84	36.67	9.17	13.5
14	Backhoe	0.3-m3	28.00	11	79	270,000	272,240	10	1,100	90%	35%	5%	159	43.29	34.63	8.66	10.5
15	Wheel loader	5-m3	113.00	35	380	505,000	514,040	12	1,100	90%	60%	5%	159	81.73	65.38	16.35	39.5
16	Wheel loader	3.5-m3	67.00	20	240	420,000	425,360	12	1,100	90%	60%	5%	159	67.63	54.10	13.53	25.0
17	Wheel loader	2.3-m3	49.00	14	159	350,000	353,920	12	1,000	90%	55%	5%	171	60.52	48.42	12.10	16.5
18	Wheel loader	1.2-m3	23.00	7	75	260,000	261,840	12	850	90%	45%	5%	191	50.01	40.01	10.00	7.8
19	Dump truck	32-ton	115.00	26	427	586,000	595,200	10	1,600	90%	65%	5%	128	76.19	60.95	15.24	24.3
20	Dump truck	20-ton	84.00	19	290	408,000	414,720	10	1,400	90%	60%	5%	143	59.30	47.44	11.86	16.5
21	Dump truck	15-ton	65.00	15	210	219,300	224,500	10	1,400	90%	60%	5%	143	32.10	25.68	6.42	12.0
22	Dump truck	11-ton	56.00	9	285	142,200	146,680	8	1,550	90%	45%	5%	141	20.68	16.54	4.14	11.1
23	Dump truck	8-ton	49.00	7	240	100,800	104,720	8	1,400	90%	45%	5%	156	16.34	13.07	3.27	9.4
24	Dump truck	6-ton	41.00	6	170	73,150	76,430	8	1,200	90%	45%	5%	182	13.91	11.13	2.78	6.6
25	Ordinary truck	6-ton	41.00	4	175	66,120	69,400	8	1,250	90%	40%	5%	170	11.80	9.44	2.36	6.3
26	Truck-bed crane	4-ton	50.00	5	162	83,220	87,220	8	1,200	90%	30%	5%	167	14.57	11.66	2.91	5.8
27	Truck crane	40-ton	140.00	37	308	480,000	491,200	14	1,000	90%	20%	5%	129	63.36	50.69	12.67	10.5
28	Truck crane	30-ton	123.00	31	285	460,000	469,840	14	1,000	90%	20%	5%	129	60.61	48.49	12.12	9.7
29	Truck crane	20-ton	96.00	22	230	410,000	417,680	14	1,000	90%	20%	5%	129	53.88	43.10	10.78	7.8
30	Truck crane	10-ton	85.00	16	230	300,000	306,800	14	900	90%	20%	5%	143	43.87	35.10	8.77	7.8
31	Crawler crane	40-ton	140.00	41	106	576,300	587,500	12	1,000	90%	40%	5%	158	92.83	74.26	18.57	3.2
32	Crawler crane	30-ton	123.00	39	106	500,000	311,000	12	1,000	90%	40%	5%	158	49.14	39.31	9.83	3.2
33	Crawler drill	17-m3/hr	12.00	5		143,280	144,240	8	800	90%	30%	5%	250	36.06	28.85	7.21	
34	Crawler drill	17-m3/hr	8.00	5		135,000	135,640	8	800	90%	30%	5%	250	33.91	27.13	6.78	
35	Crawler drill	7-m3/hr	6.00	3		94,680	95,160	8	800	90%	30%	5%	250	23.79	19.03	4.76	
36	Leg hammer	30-kg	0.05	30		4,620	4,624	4	120	90%	20%	5%	2,708	12.52	10.02	2.50	D
37	Pick hammer	7.5-kg	0.05	8		640	644	4	120	90%	20%	5%	2,708	1.74	1.39	0.35	D
38	Hydraulic heavy breaker	200-kg	1.50	0		46,550	46,670	6	120	90%	20%	5%	1,944	90.73	72.58	18.15	D
39	Tire roller	6-8ton	20.00	4	27	108,000	109,600	14	750	90%	35%	5%	186	20.39	16.31	4.08	2.0
40	Tire roller	8-20ton	32.00	9	89	133,200	135,760	14	750	90%	35%	5%	186	25.25	20.20	5.05	6.4
41	Tamping roller	30.8-ton	129.00	31	320	490,000	500,320	10	1,600	90%	60%	5%	125	62.54	50.03	12.51	38.1
42	Vibrating roller	15-ton	35.00	16	162	350,000	352,800	12	600	90%	35%	5%	257	90.67	72.54	18.13	17.7
43	Vibrating roller	8-ton	26.00	10	120	210,800	212,880	12	600	90%	35%	5%	257	54.71	43.77	10.94	13.1

Table VIII.3.3 Hourly Equipment Cost (2/4)

No.	Description		H/T	W/T	HP	CIF Kuala Lumpur	Delivery cost at site	Life	Time	Dep	Rep	Admin	Rate	Total cost	Hourly equipment Foreign	Hourly equipment Local	P.O.L.
						(M$)	(M$)	year	hour				*10-6	(M$)	(M$)	(M$)	(M$)
(1)	(2)		(3)	(4)	(5)	(6)	(7)		(8)	(9)	(10)	(11)	(12)	(13)	(14)x0.80	(15)x0.20	(16)
44	Vibrating roller	4-ton	8.00	4	27	89,300	89,940	12	600	90%	30%	5%	250	22.49	17.99	4.50	3.0
45	Vibrating roller	0.5-0.6 t	2.00	1	10	23,370	23,530	10	600	90%	35%	5%	292	6.87	5.50	1.37	1.1
46	Vibrating compactor	90-Kg	0.50	0	4	4,400	4,440	6	115	90%	30%	5%	2,174	9.65	7.72	1.93	D 6.8
47	Macadam roller	10-12ton	30.00	10	73	270,000	272,400	14	750	90%	35%	5%	186	50.67	40.54	10.13	5.5
48	Motor grader	3.7-m	63.00	8	140	330,000	335,040	12	850	90%	35%	5%	181	60.64	48.51	12.13	9.9
49	Portable air compressor	17-m3/min	22.00	3	157	111,960	113,720	12	110	90%	35%	5%	1,402	159.44	127.55	31.89	D 174.6
50	Portable air compressor	13.5m3/min	19.00	3	145	106,920	108,440	12	110	90%	35%	5%	1,402	152.03	121.62	30.41	D 161.2
51	Portable air compressor	10.5m3/min	15.00	2	106	94,140	95,340	12	110	90%	35%	5%	1,402	133.67	106.94	26.73	D 117.9
52	Portable air compressor	7-m3/min	12.00	14	79	49,400	50,360	12	110	90%	35%	5%	1,402	70.60	56.48	14.12	D 87.8
53	Concrete plant,tilting type	0.7-m3*2	180.00	45	50kw	520,000	534,400	12	9,000	90%	50%	5%	222	118.64	94.91	23.73	
54	Concrete plant,tilting type	1.0-m3*2	200.00	52	73kw	580,000	596,000	12	9,000	90%	50%	5%	222	132.31	105.85	26.46	
55	Concrete plant,tilting type	1.5-m3*2	210.00	60	145kw	760,000	776,800	14	10,000	90%	50%	5%	210	163.13	130.50	32.63	
56	Tower crane,radious 60m	9.5-ton	3,000.00	310	180kw	1,290,000	1,530,000	14	13,200	90%	20%	5%	136	208.08	166.46	41.62	
57	Jib crane (movable)	9-ton	1,000.00	155	160kw	1,200,000	1,280,000	14	13,200	90%	20%	5%	136	174.08	139.26	34.82	
58	Concrete pump car	55-60m3/hr	48.00	10	175	360,000	363,840	8	1,100	90%	55%	5%	210	76.41	61.13	15.28	9.8
59	Concrete mixer	0.2-m3	3.00	0	3.7kw	8,360	8,600	10	750	90%	40%	5%	240	2.06	1.65	0.41	
60	Concrete vibrator	0.79-kw	0.20	0	0.79kw	2,940	2,956	6	120	90%	20%	5%	1,944	5.75	4.60	1.15	
61	Crushing plant	150-t/hr	1,000.00	250	450kw	1,600,000	1,680,000	18	1,000	90%	50%	5%	128	215.04	172.03	43.01	
62	Filter plant	150-t/hr	130.00	32	95kw	320,000	330,400	16	9,000	90%	75%	5%	17	5.62	4.50	1.12	
63	Asphalt plant	60-80t/hr	80.00	105	259kw	1,030,000	1,036,400	12	850	90%	45%	5%	191	197.95	158.36	39.59	
64	Asphalt finisher	2.4-5m	40.00	10	43	346,800	350,000	14	550	90%	35%	5%	253	88.55	70.84	17.71	4.6
65	Asphalt distributor	4000l	10.00	3	154	340,000	340,800	12	530	90%	25%	5%	275	93.72	74.98	18.74	9.2
66	Asphalt kettle	4000l	0.50	2		129,600	129,640	12	530	90%	25%	5%	275	35.65	28.52	7.13	
67	Boring machine	5.5-kw	1.50	1	5.5kw	39,060	39,180	12	120	90%	35%	5%	1,285	50.35	40.28	10.07	
68	Boring machine	11-kw	2.50	1	11kw	69,660	69,860	12	120	90%	35%	5%	1,285	89.77	71.82	17.95	
69	Grout pump	3.7-kw	0.60	0	3.7	14,360	14,408	12	85	90%	40%	5%	1,863	26.84	21.47	5.37	
70	Grout pump	7.5-kw	1.10	0	7.5	20,900	20,988	12	85	90%	40%	5%	1,863	39.10	31.28	7.82	
71	Grout mixer vertical	200 l*2	1.80	0	2.2kw	10,560	10,704	12	85	90%	40%	5%	1,863	19.94	15.95	3.99	
72	Grout mixer horizontal	300 l*2	2.30	0	3.7kw	12,600	12,784	12	85	90%	40%	5%	1,863	23.82	19.06	4.76	
73	Agitator truck	4.5-m3	66.00	10	280	155,160	160,440	10	950	90%	30%	5%	179	28.72	22.98	5.74	10.9
74	Agitator truck	3-m3	59.00	7	220	112,860	117,580	10	950	90%	30%	5%	179	21.05	16.84	4.21	8.6
75	Concrete spray gun	4-6m3/hr	1.50	2	30	212,500	212,620	10	900	90%	45%	5%	206	43.80	35.04	8.76	3.6
76	Grout data processor		0.10	0	0	25,740	25,748	14	600	90%	15%	5%	208	5.36	4.29	1.07	
77	Water tanker	8-kl	50.00	8	270	120,060	124,060	10	1,000	90%	35%	5%	175	21.71	17.37	4.34	7.8
78	Water tanker	6-kl	44.00	5	180	95,760	99,280	10	1,000	90%	35%	5%	175	17.37	13.90	3.47	5.2
79	Fuel tanker	6-kl	44.00	5	180	95,760	99,280	10	1,000	90%	35%	5%	175	17.37	13.90	3.47	5.2
80	Cement silo	300-ton	66.00	22	0.75kw	128,340	133,620	16	2,000	90%	15%	5%	58	7.75	6.20	1.55	
81	Cement silo	400-ton	90.00	30	0.75kw	172,080	179,280	16	2,000	90%	15%	5%	58	10.40	8.32	2.08	
82	Water pump	50-mm	0.05	0	1.5kw	1,960	1,964	10	120	90%	95%	5%	1,958	3.85	3.08	0.77	
83	Water pump	100-mm	0.05	0	7.5kw	5,580	5,584	10	120	90%	95%	5%	1,958	10.93	8.74	2.19	
84	Water pump	150-mm	0.25	0	11kw	8,160	8,160	10	120	90%	95%	5%	1,958	16.02	12.82	3.20	
85	Water pump	200-mm	0.50	0	19kw	13,900	13,940	10	120	90%	95%	5%	1,958	27.29	21.83	5.46	
86	Diesel generator	75-KVA	5.00	2	93	55,620	56,020	12	130	90%	20%	5%	1,090	61.06	48.85	12.21	10.9
87	Diesel generator	100-KVA	5.00	2	121	56,700	57,100	12	130	90%	20%	5%	1,090	62.24	49.79	12.45	14.2
88	Diesel generator	150-KVA	8.00	3	185	90,000	90,640	14	130	90%	25%	5%	1,016	92.09	73.67	18.42	21.6

Table VIII.3.3 Hourly Equipment Cost (3/4)

No.	Description		M/T	W/T	HP	CIF Kuala Lumpur	Delivery cost at site	Life	Time	Dep	Rep	Admin	Rate	Total cost	Hourly equipment Foreign	Hourly equipment Local	P.O.L.
(1)	(2)		(3)	(4)	(5)	(M$) (6)	(M$) (7)	year	hour (8)	(9)	(10)	(11)	*10-6 (12)	(M$) (13)	(M$) (14)x0.80	(M$) (15)x0.20	(M$) (16)
89	Dredger	1350-ton	200.00	150	1,350	3,172,671	3,188,671	14	3,060	90%	50%	5%	49	156.24	124.99	31.25	300.0
90	Dredger	650-ton	100.00		650	1,137,500	1,145,500	14	2,520	90%	50%	5%	60	68.73	54.98	13.75	140.0
91	Anchor boat	40-ton	40.00		500	304,405	307,605	28	1,980	90%	120%	5%	63	19.38	15.50	3.88	80.0
92	Anchor boat	20-ton	20.00		250	177,659	179,259	28	1,980	90%	120%	5%	63	11.29	9.03	2.26	40.0
93	Dragline	0.6-m3	37.00	27	105	382,500	385,460	14	850	90%	45%	5%	172	66.30	53.04	13.26	13.5
94	Cramshell	0.6-m3	37.00	20	105	300,900	303,860	10	1,000	90%	30%	5%	170	51.66	41.33	10.33	13.5
95	Diesel pile hammer	3.5-ton	25.00	8	0	177,480	179,480	8	800	90%	45%	5%	273	49.00	39.20	9.80	
96	Vibrating pile	30-kw	4.00	3	0	86,760	87,080	8	800	90%	45%	5%	273	23.77	19.02	4.75	
97	Motor grader	2.5-m	55.00	7	76	280,000	284,400	12	850	90%	35%	5%	181	51.48	41.18	10.30	5.4
98	Diesel generator	20-KVA	2.00	1	28	33,060	33,220	12	130	90%	20%	5%	1,090	36.21	28.97	7.24	3.3
99	Hydraulic jack	200-ton	2.00	0	0	10,880	11,040	10	140	90%	45%	5%	1,321	14.58	11.66	2.92	
100	Gantry crane	10-ton	10.00	1	12kw	266,900	267,700	16	120	90%	20%	5%	990	265.02	212.02	53.00	
101	Micro-bus		20.00	3	110	300,900	301,600	10	900	90%	45%	5%	206	62.13	49.70	12.43	4.8
102	ARC welder	300-A	0.20	0	0	3,060	3,076	14	160	90%	35%	5%	871	2.68	2.14	0.54	
103	Drill jumbo rail	50-m2	82.00	7	30kw*2	705,500	712,060	10	600	90%	25%	5%	275	195.82	156.66	39.16	
104	Crawler jumbo	2-B	20.00	17	30kw*2	1,094,400	1,096,000	10	600	90%	25%	5%	275	301.40	241.12	60.28	
105	Crawler jumbo	3-B	30.00	29	30kw*3	1,648,000	1,650,400	10	600	90%	25%	5%	275	453.86	363.09	90.77	
106	Drifter	*30-kg	0.02	0	0	4,680	4,682	4	120	90%	10%	5%	2,500	11.70	9.36	2.34	
107	Drifter	80-kg	0.02	0	0	21,280	21,282	4	120	90%	10%	5%	2,500	53.20	42.56	10.64	
108	Guide cell	2.5m/30kg	0.20	0	0	9,500	9,516	4	120	90%	15%	5%	2,604	24.78	19.82	4.96	
109	Guide cell	2.5m/60kg	0.20	0	0	13,300	13,316	4	120	90%	15%	5%	2,604	34.67	27.74	6.93	
110	Concrete pump stationary	60-65m3/hr	15.00	4	66	260,000	261,200	8	750	90%	30%	5%	267	69.74	55.79	13.95	
111	Air compressor stationary	27-m3/hr	25.00	4	150	340,000	342,000	12	2,500	90%	30%	5%	60	20.52	16.42	4.10	
112	Air compressor stationary	30-m3/hr	30.00	6	150	268,600	271,000	12	2,500	90%	30%	5%	60	16.26	13.01	3.25	
113	Air compressor stationary	70-m3/hr	40.00	10	150*2	560,000	563,200	12	2,500	90%	30%	5%	60	33.79	27.03	6.76	
114	Vent fan tunnel	150-m3/hr	1.40	1	5.5kw*	560,000	560,112	12	170	90%	20%	5%	833	466.57	373.26	93.31	
115	Vent fan tunnel	400-m3/hr	1.60	1	15kw*2	56,430	56,558	12	170	90%	20%	5%	833	47.11	37.69	9.42	
116	Vent fan tunnel	500-m3/hr	2.10	1	30kw*2	67,070	67,238	12	170	90%	20%	5%	833	56.01	44.81	11.20	
117	Turn table	8-ton	24.00	9	2	100,800	102,720	10	210	90%	35%	5%	833	85.57	68.46	17.11	
118	Turn table	121-ton	29.00	10	2	111,600	113,920	10	210	90%	35%	5%	833	94.90	75.92	18.98	
119	Raise climber	10-HP	20.00	5	10	413,100	414,700	10	400	90%	30%	5%	425	176.25	141.00	35.25	
120	Muck car	4.5-m3	12.00	3		21,850	22,810	10	140	90%	30%	5%	1,214	27.69	22.15	5.54	
121	Belt conveyor	750*20	14.00		7.5kw	72,010	73,130	6	140	90%	15%	5%	1,607	117.52	94.02	23.50	
122	Cement screw		8.00	1	7.5kw	18,360	19,000	8	12,000	90%	10%	5%	15	0.29	0.23	0.06	
123	Bucket elevator		45.00	8	22kw	64,220	67,820	8	12,000	90%	10%	5%	15	1.02	0.82	0.20	
124	Rod mill		25.00	71	260kw	1,137,600	1,139,600	9	20,000	90%	40%	5%	10	11.40	9.12	2.28	
125	Vibro-dozer	0.3-m3	10.00	8	57	221,000	221,800	9	6,750	90%	90%	5%	37	8.21	6.57	1.64	7.4
126	Concrete bucket	1.5-m3	2.00	1		20,710	20,870	10	70	90%	40%	5%	2,571	53.66	42.93	10.73	
127	Chain saw	50-cm	0.50	0	55cc	3,380	3,420	8	90	90%	70%	5%	2,778	9.50	7.60	1.90	
128	Soil compactor	20-ton	60.00	21	210	471,240	476,040	10	1,600	90%	60%	5%	125	59.51	47.61	11.90	25.0
129	Concrete bucket	0.75*1	10.00	3	7.5kw	56,810	57,610	10	750	90%	40%	5%	240	13.83	11.06	2.77	
130	Concrete mixer	0.1-m3	1.00	0		1,120	1,200	5	750	90%	40%	5%	413	0.50	0.40	0.10	
131	Floater	4.5*0.9m	5.00			8,480	8,880	6	180	90%	10%	5%	1,204	10.69	8.55	2.14	
132	Discharge pipe	6.0*0.41m	2.00			1,680	1,840	6	180	90%	10%	5%	1,204	2.22	1.78	0.44	
133	Rubber joint	0.9*0.41m	0.30			3,220	3,244	6	180	90%	10%	5%	1,204	3.91	3.13	0.78	
134	Valve	0.4*0.41m	0.10			7,400	7,408	6	180	90%	10%	5%	1,204	8.92	7.14	1.78	

Table VIII.3.3 Hourly Equipment Cost (4/4)

No.	Description		M/T	W/T	HP	CIF Kuala Lumpur	Delivery cost at site	Life	Time	Dep	Rep	Admin	Rate	Total cost	Hourly equipment foreign	Hourly equipment Local	P.O.L.
(1)	(2)		(3)	(4)	(5)	(M$) (6)	(M$) (7)	year	hour (8)	(9)	(10)	(11)	*10-6 (12)	(M$) (13)	(M$) (14)x0.80	(M$) (15)x0.20	(M$) (16)
135	Bend pipe		0.10			1,080	1,088	6	180	90%	10%	5%	1,204	1.31	1.05	0.26	
136	Branch pipe		0.10			1,400	1,408	6	180	90%	10%	5%	1,204	1.70	1.36	0.34	
137	Drainage pump		10.00		120	310,000	310,800	10	120	90%	75%	5%	1,792	556.95	445.56	111.39	
138	Portable belt conveyor		2.00	0	1.0kw	3,420	3,580	4	120	90%	40%	5%	3,125	11.19	8.95	2.24	
139	Grout pump		2.00	1	11kw	26,220	26,380	12	85	90%	40%	5%	1,863	49.15	39.32	9.83	
140	Drop hammer with rig	600 g	1.00	5	PS	14,280	14,360	7	1,000	90%	70%	5%	279	4.01	3.21	0.80	6.7
141	Diesel generator		4.62	8	KVA	13,990	14,360	5	2,000	90%	65%	5%	180	2.58	2.06	0.52	2.1
142	Boat		30.00	30	PS	330,000	332,400	28	2,000	90%	120%	5%	63	20.94	16.75	4.19	7.2
143	Vibrating screen		2.00		3.7kw	56,600	56,760	28	2,000	90%	120%	5%	63	3.58	2.86	0.72	7.2
144	Cable crane	9.5 ton	30	193	425kw	3,520,000	3,522,400	14	13,200	90%	20%	5%	136	479.05	383.24	95.81	
145	Spiral classifier	14 ton	75.00		1.5 kw	71,060	77,060	9	1,000	90%	20%	5%	172	13.25	10.60	2.65	
146	Belt conveyor	10	10.00		1kw	4,680	5,480	3	1,000	90%	20%	5%	417	2.29	1.83	0.46	
147	Pontoon		150.00			368,380	380,380	12	2,000	110%	20%	5%	79	30.05	24.04	6.01	

Table VIII.3.4 Construction Cost for Lebir Dam Scheme (1/6)

Item No.	Work Item	Unit	Quantity	Unit price F.C.(M$)	Unit price L.C.(M$)	Amount F.C.(M$)	Amount L.C.(M$)	Total amount (M$)
I.	DAM WORKS COST							
1.	Access road	Km	7	185,400	114,600	1,297,800	802,200	2,100,000
2	DIVERSION TUNNEL							
2.1	Open Excavation of Inlet and Outlet							
2.1.1	Open excavation, common	m3	13,000	3.82	2.26	49,660	29,380	79,040
2.1.2	Open excavation, weathered rock	m3	24,000	5.12	3.13	122,880	75,120	198,000
2.1.3	Open excavation, hard rock	m3	68,000	10.12	6.26	688,160	425,680	1,113,840
	Sub-total					860,700	530,180	1,390,880
2.2	Concrete of Inlet and Outlet	m3	4,700	88.05	126.70	413,835	595,490	1,009,325
2.3	Tunnel Excavation	m3	230,000	40.29	41.43	9,266,700	9,528,900	18,795,600
2.4	Tunnel Concrete	m3	68,000	88.05	126.70	5,987,400	8,615,600	14,603,000
2.5	Reinforcement bar	ton	1,500	479.89	1,098.69	719,835	1,648,035	2,367,870
2.6	Plug Concrete	m3	11,680	116.28	167.32	1,358,150	1,954,298	3,312,448
2.7	Backfill Grout	m3	2,300	78.75	86.35	181,125	198,605	379,730
2.8	Consolidation Grout							
2.8.1	Drilling	m	12,000	26.80	17.79	321,600	213,480	535,080
2.8.2	Grouting	ton	600	504.54	677.06	302,724	406,236	708,960
	Sub-total					624,324	619,716	1,244,040
2.9	Curtain Grout							
2.9.1	Drilling	m	2,000	59.82	39.72	119,640	79,440	199,080
2.9.2	Grouting	ton	100	504.54	677.06	50,454	67,706	118,160
	Sub-total					170,094	147,146	317,240
2.10	Initial Cofferdam							
2.10.1	Common	m3	7,500	6.66	3.94	49,950	29,550	79,500
2.10.2	Gabion	m3	200	75.22	32.24	15,044	6,448	21,492
	Sub-total					64,994	35,998	100,992

Table VIII.3.4 Construction Cost for Lebir Dam Scheme (2/6)

Item No.	Work Item	Unit	Quantity	Unit price F.C.(M$)	Unit price L.C.(M$)	Amount F.C.(M$)	Amount L.C.(M$)	Total amount (M$)
2.11	Gate	ton	180	4,375	4,375	787,500	787,500	1,575,000
	Sub-total (Items 2.1 to 2.11)					20,434,657	24,661,468	45,096,125
2.12	Others (15%)					3,065,199	3,699,220	6,764,419
	Sub-total of Item 2					23,499,856	28,360,688	51,860,544
3	COFFER DAMS							
3.1	Excavation	m3	88,000	3.76	2.32	330,880	204,160	535,040
3.2	Embankment							
3.2.1	Embankment, core	m3	117,000	9.26	5.75	1,083,420	672,750	1,756,170
3.2.2	Embankment, filter	m3	29,000	14.71	8.64	426,590	250,560	677,150
3.2.3	Embankment, rock	m3	541,000	6.51	4.03	3,521,910	2,180,230	5,702,140
	Sub-total					5,031,920	3,103,540	8,135,460
	Sub-total (Items 3.1 and 3.2)					5,362,800	3,307,700	8,670,500
3.3	Others (15%)					804,420	496,155	1,300,575
	Sub-total of Item 3					6,167,220	3,803,855	9,971,075
4	MAIN DAM							
4.1	Excavation							
4.1.1	Excavation, common	m3	163,000	3.82	2.26	622,660	368,380	991,040
4.1.2	Excavation, weathered rock	m3	255,000	5.12	3.13	1,305,600	798,150	2,103,750
4.1.3	Excavation, hard rock	m3	109,000	10.12	6.26	1,103,080	682,340	1,785,420
	Sub-total					3,031,340	1,848,870	4,880,210
4.2	Embankment							
4.2.1	Embankment, core	m3	437,000	9.26	5.75	4,046,620	2,512,750	6,559,370
4.2.2	Embankment, filter	m3	92,000	14.83	8.71	1,364,360	801,320	2,165,680
4.2.3	Embankment, rock	m3	2,171,000	6.50	4.01	14,111,500	8,705,710	22,817,210
	Sub-total					19,522,480	12,019,780	31,542,260
4.3	Consolidation Grout							
4.3.1	Drilling	m	9,000	26.80	17.79	241,200	160,110	401,310
4.3.2	Grouting	ton	450	504.54	677.06	227,043	304,677	531,720
	Sub-total					468,243	464,787	933,030

Table VIII.3.4 Construction Cost for Lebir Dam Scheme (3/6)

Item No.	Work Item	Unit	Quantity	Unit price F.C.(M$)	Unit price L.C.(M$)	Amount F.C.(M$)	Amount L.C.(M$)	Total amount (M$)
4.4	Curtain Grout							
4.4.1	Drilling	m	34,000	59.82	39.72	2,033,880	1,350,480	3,384,360
4.4.2	Grouting	ton	1,700	504.54	677.06	857,718	1,151,002	2,008,720
	Sub-total					2,891,598	2,501,482	5,393,080
4.5	Gallery Concrete	m3	16,000	88.05	126.70	1,408,800	2,027,200	3,436,000
4.6	Reinforcement bar	ton	160	479.89	1,098.69	76,782	175,790	252,572
	Sub-total (Items 4.1 to 4.6)					27,399,243	19,037,909	46,437,152
4.7	Others (15%)					4,109,886	2,855,686	6,965,572
	Sub-total of Item 4					31,509,129	21,893,595	53,402,724
5	SPILLWAY							
5.1	Excavation							
5.1.1	Excavation, common	m3	158,000	3.75	2.33	592,500	368,140	960,640
5.1.2	Excavation, weathered rock	m3	845,000	5.20	3.05	4,394,000	2,577,250	6,971,250
5.1.3	Excavation, hard rock	m3	757,000	10.12	6.26	7,660,840	4,738,820	12,399,660
	Sub-total					12,647,340	7,684,210	20,331,550
5.2	Concrete							
5.2.1	Mass concrete	m3	12,000	90.90	110.20	1,090,800	1,322,400	2,413,200
5.2.2	Reinforced concrete	m3	91,000	88.05	126.70	8,012,550	11,529,700	19,542,250
5.2.3	Reinforcement bar	ton	3,000	479.89	1,098.69	1,439,670	3,296,070	4,735,740
	Sub-total					10,543,020	16,148,170	26,691,190
	Sub-total (Items 5.1 and 5.2)					23,190,360	23,832,380	47,022,740
5.3	Others (15%)					3,478,554	3,574,857	7,053,411
	Sub-total of Item 5					26,668,914	27,407,237	54,076,151
6	SADDLE DAMS							
6.1	Coffer Dams							
6.1.1	Excavation	m3	18,000	3.75	2.33	67,500	41,940	109,440

Table VIII.3.4 Construction Cost for Lebir Dam Scheme (4/6)

Item No.	Work Item	Unit	Quantity	Unit price F.C.(M$)	Unit price L.C.(M$)	Amount F.C.(M$)	Amount L.C.(M$)	Total amount (M$)
6.1.2	Embankment							
6.1.2.1	Embankment, core	m3	13,000	9.26	5.75	120,380	74,750	195,130
6.1.2.2	Embankment, filter	m3	4,000	14.83	8.71	59,320	34,840	94,160
6.1.2.3	Embankment, rock	m3	56,000	6.51	4.03	364,560	225,680	590,240
	Sub-total					544,260	335,270	879,530
	Sub-total (Items 6.1.1 and 6.1.2)					611,760	377,210	988,970
6.1.3	Others (15%)					91,764	56,582	148,346
	Sub-total of Item 6.1					703,524	433,792	1,137,316
6.2	Saddle Dams							
6.2.1	Excavation							
6.2.1.1	Excavation, common	m3	121,000	3.82	2.26	462,220	273,460	735,680
6.2.1.2	Excavation, weathered rock	m3	634,000	5.12	3.13	3,246,080	1,984,420	5,230,500
6.2.1.3	Excavation, hard rock	m3	46,000	10.12	6.26	465,520	287,960	753,480
	Sub-total					4,173,820	2,545,840	6,719,660
6.2.2	Embankment							
6.2.2.1	Embankment, core	m3	305,000	9.26	5.75	2,824,300	1,753,750	4,578,050
6.2.2.2	Embankment, filter	m3	66,000	14.83	8.71	978,780	574,860	1,553,640
6.2.2.3	Embankment, rock	m3	1,143,000	6.51	4.03	7,440,930	4,606,290	12,047,220
	Sub-total					11,244,010	6,934,900	18,178,910
6.2.3	Consolidation Grout							
6.2.3.1	Drilling	m	7,000	26.80	17.79	187,600	124,530	312,130
6.2.3.2	Grouting	ton	350	504.54	677.06	176,589	236,971	413,560
	Sub-total					364,189	361,501	725,690
6.2.4	Curtain Grout							
6.2.4.1	Drilling	m	40,000	59.82	39.72	2,392,800	1,588,800	3,981,600
6.2.4.2	Grouting	ton	2,000	504.54	677.06	1,009,080	1,354,120	2,363,200
	Sub-total					3,401,880	2,942,920	6,344,800
	Sub-total (Items 6.2.1 to 6.2.4)					19,183,899	12,785,161	31,969,060

Table VIII.3.4 Construction Cost for Lebir Dam Scheme (5/6)

Item No.	Work Item	Unit	Quantity	Unit price F.C.(M$)	Unit price L.C.(M$)	Amount F.C.(M$)	Amount L.C.(M$)	Total amount (M$)
6.2.5	Others (15%)					2,877,585	1,917,774	4,795,359
	Sub-total of Item 6.2					22,061,484	14,702,935	36,764,419
	Sub-total of Item 6					22,765,008	15,136,727	37,901,735
7	RIVER OUTLET WORKS							
7.1	Concrete	m3	200	82.45	118.65	16,490	23,730	40,220
7.2	Metal works	L.S.				170,000	170,000	340,000
	Sub-total (7.1+7.2)					186,490	193,730	380,220
7.3	Others (15%)					27,974	29,060	57,034
	Sub-total of Item 7					214,464	222,790	437,254
	Sub-total (Items 1 to 7)					112,122,391	97,627,092	209,749,483
	Preparatory Works (20%)	L.S.				22,424,478	19,525,418	41,949,896
	Sub-total					134,546,869	117,152,510	251,699,379
	Engineering Service and Administration	L.S.				30,203,926	7,550,981	37,754,907
	Sub-total					164,750,795	124,703,491	289,454,286
	Contingency (10%)	L.S.				16,475,080	12,470,349	28,945,429
	TOTAL OF DAM WORKS COST					181,225,875	137,173,840	318,399,715
II.	RELOCATION COST							
2.1	Road (Kuala Krai - Gua Musang)							
2.1.1	Tarmac road	km	5	645,000	645,000		3,225,000	3,225,000
2.2	Oil Palm and Rubber Plantation							
2.2.1	Plantation	ha	8,700		15,000		130,500,000	130,500,000
2.2.2	Feeder roads	km	86		150,000		12,900,000	12,900,000
	Sub-total						143,400,000	143,400,000
2.3	Forest	ha	5,300		1,300		6,890,000	6,890,000
2.4	Houses	no	165		70,000		11,550,000	11,550,000
	Sub-total (Items 2.1 to 2.4)						165,065,000	165,065,000

Table VIII.3.4 Construction Cost for Lebir Dam Scheme (6/6)

Item No.	Work Item	Unit	Quantity	Unit price F.C.(M$)	Unit price L.C.(M$)	Amount F.C.(M$)	Amount L.C.(M$)	Total amount (M$)
2.5	Contingency (10%)						16,506,500	16,506,500
	TOTAL OF RELOCATION COST						181,571,500	181,571,500
	GRAND TOTAL					181,225,875	318,745,340	499,971,215

Table VIII.3.5 Construction Cost of River Improvement Works in Urban Area

Design discharge 10,650 m3/sec

Urban area

Work item	Unit	Quantity	Unit rate F.C.(M$)	Unit rate L.C.(M$)	Amount F.C.(M$)	Amount Local (M$)	Total amount (M$)
1. Main civil works							
(1) Preparatory works.....1)	L.S.	1			2,240,600	4,657,990	6,898,590
(2) Clearing & stripping	ha	197	800.00	500.00	157,600	98,500	256,100
(3) Embankment (Transported material)	m3	668,000	11.12	6.88	7,428,160	4,595,840	12,024,000
(4) Embankment (excavated material)	m3	1,937,000	3.09	1.91	5,985,330	3,699,670	9,685,000
(5) Revetment for low channel	m2	94,400	69.00	161.00	6,513,600	15,198,400	21,712,000
(6) Revetment for high water channel	m2	12,500	31.80	74.20	397,500	927,500	1,325,000
(7) Sluice	P.C.	8			1,088,000	2,112,000	3,200,000
(8) Toe drain & ditch	m	29,100	18.30	591.70	532,530	17,218,470	17,751,000
(9) Maintenance road	m	29,100	3.30	29.70	96,030	864,270	960,300
(10) Sod facing	m2	829,000	0.25	2.25	207,250	1,865,250	2,072,500
Sub-total					24,646,600	51,237,890	75,884,490
(11) Miscellaneous works...2)	%		10.00	10.00	2,464,660	5,123,789	7,588,449
Total					27,111,260	56,361,679	83,472,939
2. Compensation							
(1) Land acquisition							
1) urban	ha	9		500,000		4,500,000	4,500,000
2) rural	ha	188		40,000		7,520,000	7,520,000
(2) House evacuation	house	170		20,000		3,400,000	3,400,000
(3) Bridge							
1) Kelantan river	plc	1				30,750,000	30,750,000
2) Tributaries	plc	1				700,000	700,000
Total					0	46,870,000	46,870,000
3. E/S & administration works..3)	L.S.				15,641,153	3,910,288	19,551,441
4. Contingency.....4)	L.S.			10.00	4,275,241	10,714,197	14,989,438
Grand total					47,027,654	117,856,164	164,883,818

Note:
1) 10% of sum of (2) to (13) civil works 1 works.
2) 10% of sum of (1) to (13) civil works 1 works.
3) 15% of 1. & 2.
4) 10% of sum 1.,2. & 3.

Table VIII.3.6 Construction Cost for Kemubu Dam Scheme (1/3)

Item No.	Work Item	Unit	Quantity	Unit price F.C.(M$)	Unit price L.C.(M$)	Amount F.C.(M$)	Amount L.C.(M$)	Total Amount (M$)
I.	DAM WORKS COST							
1.1	Access road	km	7	185,400	114,600	1,297,800	802,200	2,100,000
2	DIVERSION TUNNEL							
2.1	Open Excavation of Inlet and Outlet							
2.1.1	Open excavation, common	m3	9,600	3.82	2.26	36,672	21,696	58,368
2.1.2	Open excavation, weathered rock	m3	29,000	5.12	3.13	148,480	90,770	239,250
2.1.3	Open excavation, hard rock	m3	68,000	10.12	6.26	688,160	425,680	1,113,840
	Sub-total					873,312	538,146	1,411,458
2.2	Concrete of Inlet and Outlet	m3	2,500	88.05	126.70	220,125	316,750	536,875
2.3	Tunnel Excavation	m3	63,000	40.29	41.43	2,538,270	2,610,090	5,148,360
2.4	Tunnel Concrete	m3	17,700	88.05	126.70	1,558,485	2,242,590	3,801,075
2.5	Reinforcement bar	ton	404	479.89	1,098.69	193,876	443,871	637,747
2.6	Plug Concrete	m3	5,800	116.28	167.32	674,424	970,456	1,644,880
2.7	Backfill Grout	m3	1,000	78.75	86.35	78,750	86,350	165,100
2.8	Consolidation Grout							
2.8.1	Drilling	m	4,000	26.80	17.79	107,200	71,160	178,360
2.8.2	Grouting	ton	200	504.54	677.06	100,908	135,412	236,320
	Sub-total					208,108	206,572	414,680
2.9	Initial Cofferdam							
2.9.1	Common	m3	6,800	6.66	3.94	45,288	26,792	72,080
2.9.2	Gabion Mattress	m3	180	45.89	61.57	8,260	11,083	19,343
	Sub-total					53,548	37,875	91,423
2.10	Gate	ton	310	4,375.00	4,375.00	1,356,250	1,356,250	2,712,500
	Sub-total (Items 2.1 to 2.10)					7,755,148	8,808,950	16,564,098
2.11	Others (15%)					1,163,272	1,321,343	2,484,615
	Sub-total of Item 2					8,918,420	10,130,293	19,048,713

Table VIII.3.6 Construction Cost for Kemubu Dam Scheme (2/3)

Item No.	Work Item	Unit	Quantity	Unit price F.C.(M$)	Unit price L.C.(M$)	Amount F.C.(M$)	Amount L.C.(M$)	Total Amount (M$)
3	COFFER DAM							
3.1	Excavation	m3	21,000	3.82	2.26	80,220	47,460	127,680
3.2	Embankment							
3.2.1	Embankment, core	m3	32,000	7.46	4.63	238,720	148,160	386,880
3.2.2	Embankment, filter	m3	8,000	20.07	11.78	160,560	94,240	254,800
3.2.3	Embankment, rock	m3	148,000	12.29	7.59	1,818,920	1,123,320	2,942,240
	Sub-total					2,218,200	1,365,720	3,583,920
	Sub-total (Items 3.1 and 3.2)					2,298,420	1,413,180	3,711,600
3.3	Others (15%)					344,763	211,977	556,740
	Sub-total of Item 3					2,643,183	1,625,157	4,268,340
4	MAIN DAM AND SPILLWAY							
4.1	Excavation							
4.1.1	Excavation, common	m3	88,500	3.82	2.26	338,070	200,010	538,080
4.1.2	Excavation, weathered rock	m3	92,400	5.12	8.25	473,088	762,300	1,235,388
4.1.3	Excavation, hard rock	m3	232,600	10.12	6.26	2,353,912	1,456,076	3,809,988
	Sub-total					3,165,070	2,418,386	5,583,456
4.2	Concrete							
4.2.1	Mass concrete	m3	90,800	107.96	130.90	9,802,768	11,885,720	21,688,488
4.2.2	Reinforced concrete	m3	58,000	116.28	167.32	6,744,240	9,704,560	16,448,800
4.2.3	Reinforcement bar	ton	1,700	479.89	1,098.69	815,813	1,867,773	2,683,586
	Sub-total					17,362,821	23,458,053	40,820,874
4.3	Consolidation Grout							
4.3.1	Drilling	m	4,000	26.80	17.79	107,200	71,160	178,360
4.3.2	Grouting	Kg	200	504.54	677.06	100,908	135,412	236,320
	Sub-total					208,108	206,572	414,680

Table VIII.3.6 Construction Cost for Kemubu Dam Scheme (3/3)

Item No.	Work Item	Unit	Quantity	Unit price F.C.(M$)	Unit price L.C.(M$)	Amount F.C.(M$)	Amount L.C.(M$)	Total Amount (M$)
4.4	Curtain Grout							
4.4.1	Drilling	m	8,000	59.82	39.72	478,560	2,376	480,936
4.4.2	Grouting	ton	400	504.54	677.06	201,816	341,604	543,420
	Sub-total					680,376	343,980	1,024,356
	Sub-total (Items 4.1 to 4.6)					21,416,375	26,426,991	47,843,366
4.7	Others (15%)					3,212,456	3,964,049	7,176,505
	Sub-total of Item 4					24,628,831	30,391,040	55,019,871
	Sub-total (Items 1 to 4)					37,488,234	42,948,689	80,436,923
	Preparatory Works (20%)	L.S.				7,497,647	8,589,738	16,087,385
	Sub-total					44,985,881	51,538,427	96,524,308
	Engineering Service and Administration	L.S.				11,582,917	2,895,729	14,478,646
	Sub-total					56,568,798	54,434,156	111,002,954
	Contingency (10%)	L.S.				5,656,880	5,443,416	11,100,295
	TOTAL OF DAM WORKS COST					62,225,678	59,877,572	122,103,250
II.	RELOCATION COST							
2.1	Rough road	km	9		300,000		2,700,000	2,700,000
2.2	Railway	km	16		800,000		12,800,000	12,800,000
2.3	Oil Palm and Rubber Plantation							
2.3.1	Plantation	ha	456		15,000		6,840,000	6,840,000
2.3.2	Feeder roads	km	5		150,000		750,000	750,000
	Sub-total						7,590,000	7,590,000
2.4	Forest	ha	790		1,300		1,027,000	1,027,000
2.5	Houses	no.	1,000		70,000		70,000,000	70,000,000
	Sub-total (Items 2.1 to 2.5)						94,117,000	94,117,000
2.4	Contingency (10%)						9,411,700	9,411,700
	TOTAL OF RELOCATION COST						103,528,700	103,528,700
	GRAND TOTAL					62,225,678	163,406,272	225,631,950

Table VIII.3.7 Construction Cost of River Improvement Works in Rural Area

Design discharge 10,650 m3/sec

Rural area

Work item	Unit	Quantity	Unit rate F.L.(M$)	Unit rate L.C.(M$)	Amount F.C.(M$)	Amount L.C.(M$)	Total amount (M$)
1. Main civil works							
(1) Preparatory works.....1)	L.S.	1			6,821,668	13,596,792	20,418,460
(2) Clearing & stripping	ha	1,378	800.00	500.00	1,102,400	689,000	1,791,400
(3) Dredging	m3	2,100,000	1.66	3.84	3,486,000	8,064,000	11,550,000
(4) Embankment (Transported material)	m3	1,132,000	11.12	6.88	12,587,840	7,788,160	20,376,000
(5) Embankment (excavated material)	m3	9,503,000	3.09	1.91	29,364,270	18,150,730	47,515,000
(6) Revetment for low channel	m2	88,600	69.00	161.00	6,113,400	14,264,600	20,378,000
(7) Revetment for high water channel	m2	72,500	31.80	74.20	2,305,500	5,379,500	7,685,000
(8) Sluice	P.C.	46			10,120,000	15,180,000	25,300,000
(9) Toe drain & ditch	m	89,500	18.30	591.70	1,637,850	52,957,150	54,595,000
(10) Maintenance road	m	134,900	3.30	29.70	445,170	4,006,530	4,451,700
(11) Sod facing	m2	4,217,000	0.25	2.25	1,054,250	9,488,250	10,542,500
Sub-total					75,038,348	149,564,712	224,603,060
(12) Miscellaneous works...2)	%		10.00	10.00	7,503,835	14,956,471	22,460,306
Total					82,542,183	164,521,183	247,063,366
2. Compensation							
(1) Land acquisition							
1) rural	ha	1,378		40,000		55,120,000	55,120,000
(2) House evacuation	house	600		20,000		12,000,000	12,000,000
(3) Pumping station for irrigation	P.C.	3				8,000,000	8,000,000
(4) Bridge							
1) Tributaries	plc	4.0				2,800,000	2,800,000
Total						77,920,000	77,920,000
3. E/S & administration works..3)	L.S.				38,998,004	9,749,501	48,747,505
4. Contingency.....4)	L.S.			10.00	12,154,019	25,219,068	37,373,087
Grand total					133,694,206	277,409,752	411,103,958

Note:

1) 10% of sum of (2) to (13) civil works 1 works.
2) 10% of sum of (1) to (13) civil works 1 works.
3) 15% of 1. & 2.
4) 10% of sum 1.,2. & 3.

Table VIII.3.8 Summary of Construction Cost

(Unit : 10^3 M$)

Scheme	Lebir dam		Kemubu dam		River improvement in urban		River improvement in rural		Total amount	
No. Item	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.
1. Direct cost	134,547	117,153	44,986	51,538	27,111	56,362	82,542	164,521	289,186	389,574
2. Indirect cost Compensation, administration and engineering service	30,204	172,616	11,583	97,013	15,641	50,780	38,998	87,670	96,426	408,079
3. Physical contingency	16,475	28,977	5,657	14,855	4,275	10,714	12,154	25,219	38,561	79,765
4. Total cost (1+2+3)	181,226	318,746	62,226	163,406	47,027	117,856	133,694	-277,410	424,173	877,418

Item No.	Description	Total		1993		1994		1995		1996		1997		1998		1999	
		L.C. (M$)	F.C. (M$)	L.C. (M$)	F.C. (M$)	L.C. (M$)	F.C. (M$)	L.C. (M$)	F.C. (M$)	L.C. (M$)	F.C. (M$)	L.C. (M$)	F.C. (M$)	L.C. (M$)	F.C. (M$)	L.C. (M$)	F.C. (M$)
1.	DIRECT COST																
	(1) PREPARATORY WORKS																
	(a) Package-1	19,525,418	22,424,478	19,525,418	22,424,478												
	(b) Package-2	4,657,990	2,240,600	4,657,990	2,240,600												
	(c) Package-3	8,589,738	7,497,647														
	(d) Package-4	13,596,792	6,821,668	13,596,792	6,821,668												
	Subtotal (i)	46,369,938	38,984,393	37,780,200	31,486,746												
	(2) MAIN CONSTRUCTION WORKS																
	(a) Package-1	97,627,092	112,122,391	14,644,064	16,818,359	9,762,709	11,212,239	14,644,064	16,818,359	19,525,418	22,424,478	29,288,128	33,636,717	9,762,709	11,212,239		
	(b) Package-2	51,703,689	24,870,660	8,858,622	4,261,200	8,858,622	4,261,200	8,858,622	4,261,200	8,858,622	4,261,200	4,386,722	2,110,114	4,386,722	2,110,114	3,747,879	1,802,816
	(c) Package-3	42,948,689	37,488,234														
	(d) Package-4	150,924,391	75,720,515	2,398,494	1,327,199	2,398,494	1,327,199	2,398,494	1,327,199	2,398,494	1,327,199	6,870,394	3,478,285	6,870,394	3,478,285	7,509,237	3,785,583
	Subtotal (ii)	343,203,861	250,201,800	25,901,180	22,406,758	21,019,825	16,800,638	25,901,180	22,406,758	30,782,534	28,012,877	40,545,244	39,225,116	21,019,825	16,800,638	11,257,116	5,588,399
	Subtotal (1)=(i)+(ii)	389,573,799	289,186,193	63,681,380	53,893,504	21,019,825	16,800,638	25,901,180	22,406,758	30,782,534	28,012,877	40,545,244	39,225,116	21,019,825	16,800,638	11,257,116	5,588,399
2.	RELOCATION COST																
	(a) Package-1	165,065,000		27,510,833		27,510,833		27,510,833		27,510,833		27,510,833		27,510,833			
	(b) Package-2	46,870,000		5,858,750		5,858,750		5,858,750		5,858,750		5,858,750		5,858,750		5,858,750	
	(c) Package-3	94,117,000															
	(d) Package-4	77,920,000		4,328,889		4,328,889		4,328,889		4,328,889		4,328,889		4,328,889		4,328,889	
	Subtotal (2)	383,972,000		37,698,472		37,698,472		37,698,472		37,698,472		37,698,472		37,698,472		10,187,639	
3.	ENGINEERING SERVICES COST																
	(a) Package-1	7,550,981	30,203,926	1,132,647	4,530,589	755,098	3,020,393	1,132,647	4,530,589	1,510,196	6,040,785	2,265,294	9,061,178	755,098	3,020,393		
	(b) Package-2	3,910,288	15,641,153	586,543	2,346,173	469,235	1,876,938	469,235	1,876,938	469,235	1,876,938	469,235	1,876,938	469,235	1,876,938	469,235	1,876,938
	(c) Package-3	2,895,729	11,582,917														
	(d) Package-4	9,749,501	38,998,004	1,462,425	5,849,701	487,475	1,949,900	487,475	1,949,900	487,475	1,949,900	487,475	1,949,900	487,475	1,949,900	487,475	1,949,900
	Subtotal (3)	24,106,499	96,426,000	3,181,615	12,726,463	1,711,808	6,847,231	2,089,357	8,357,427	2,466,906	9,867,623	3,222,004	12,888,016	1,711,808	6,847,231	956,710	3,826,838
	Total (1+2+3)	797,652,298	385,612,193	104,561,467	66,619,967	60,430,105	23,647,869	65,689,009	30,764,185	70,947,912	37,880,500	81,465,720	52,113,132	60,430,105	23,647,869	22,401,465	9,415,237
4.	PHYSICAL CONTINGENCY (10% of Items 1,2 & 3 for L.C.& F.C.)																
	(a) Package-1	28,976,849	16,475,080	6,281,296	4,377,343	3,802,864	1,423,263	4,328,754	2,134,895	4,854,645	2,846,526	5,906,426	4,269,790	3,802,864	1,423,263		
	(b) Package-2	10,714,199	4,275,241	1,996,191	884,797	1,518,661	613,814	1,518,661	613,814	1,518,661	613,814	1,071,471	398,705	1,071,471	398,705	1,007,586	367,975
	(c) Package-3	14,855,115	5,656,880														
	(d) Package-4	25,219,070	12,154,021	2,178,660	1,399,857	721,486	327,710	721,486	327,710	721,486	327,710	1,168,676	542,819	1,168,676	542,819	1,232,560	573,548
	Subtotal (4)	79,765,233	38,561,222	10,456,147	6,661,997	6,043,011	2,364,787	6,568,901	3,076,419	7,094,792	3,788,050	8,146,573	5,211,314	6,043,011	2,364,787	2,240,146	941,523
5.	PROJECT COST																
	(a) Package-1	318,745,340	181,225,875	69,094,258	48,150,769	41,831,504	15,655,895	47,616,298	23,483,843	53,401,092	31,311,789	64,970,681	46,967,685	41,831,504	15,655,895	0	0
	(b) Package-2	117,856,166	47,027,654	21,958,096	9,732,770	16,705,268	6,751,952	16,705,268	6,751,952	16,705,268	6,751,952	11,786,178	4,385,757	11,786,178	4,385,757	11,083,450	4,047,729
	(c) Package-3	163,406,271	62,225,678	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	(d) Package-4	277,409,754	133,694,208	23,965,260	15,398,425	7,936,344	3,604,809	7,936,344	3,604,809	7,936,344	3,604,809	12,855,434	5,971,004	12,855,434	5,971,004	13,558,161	6,309,031
	Total (1 to 4)	877,417,531	424,173,415	115,017,614	73,281,964	66,473,116	26,012,656	72,257,910	33,840,604	78,042,704	41,668,550	89,612,293	57,324,446	66,473,116	26,012,656	24,641,611	10,356,760
	Equivalent to US$		157,101,265		27,141,468		9,634,317		12,533,557		15,432,796		21,231,276		9,634,317		3,835,837

Remarks : L.C. and F.C. mean local currency and foreign currency.

Table VIII.3.9 Disbursement Schedule of Project Cost

1997		1998		1999		200		2001		2002		2003		2004		2005		2006		
L.C. (M$)	F.C. (M$)	L.C. (M$)	F.C. (M$)	L.C. (M$)	F.C. (M$)	L.C. (M$)	F.C. (M$)	L.C. (M$)	F.C. (M$)	L.C. (M$)	F.C. (M$)	L.C. (M$)	F.C. (M$)	L.C. (M$)	F.C. (M$)	L.C. (M$)	F.C. (M$)	L.C. (M$)	F.C. (M$)	L.C. (M$)
																				8,589
																				8,589
29,288,128	33,636,717	9,762,709	11,212,239																	
4,386,722	2,110,114	4,386,722	2,110,114	3,747,879	1,802,816	3,747,879	1,802,816													10,737
6,870,394	3,478,285	6,870,394	3,478,285	7,509,237	3,785,583	7,509,237	3,785,583	11,257,116	5,588,399	11,257,116	5,588,399	11,257,116	5,588,399	11,257,116	5,588,399	11,257,116	5,588,399	11,257,116	5,588,399	11,257
40,545,244	39,225,116	21,019,825	16,800,638	11,257,116	5,588,399	11,257,116	5,588,399	11,257,116	5,588,399	11,257,116	5,588,399	11,257,116	5,588,399	11,257,116	5,588,399	11,257,116	5,588,399	11,257,116	5,588,399	21,994
40,545,244	39,225,116	21,019,825	16,800,638	11,257,116	5,588,399	11,257,116	5,588,399	11,257,116	5,588,399	11,257,116	5,588,399	11,257,116	5,588,399	11,257,116	5,588,399	11,257,116	5,588,399	11,257,116	5,588,399	30,584
27,510,833		27,510,833																		
5,858,750		5,858,750		5,858,750		5,858,750														23,529
4,328,889		4,328,889		4,328,889		4,328,889		4,328,889		4,328,889		4,328,889		4,328,889		4,328,889		4,328,889		4,328
37,698,472		37,698,472		10,187,639		10,187,639		4,328,889		4,328,889		4,328,889		4,328,889		4,328,889		4,328,889		27,858
2,265,294	9,061,178	755,098	3,020,393																	
469,235	1,876,938	469,235	1,876,938	469,235	1,876,938	508,337	2,033,350													723
487,475	1,949,900	487,475	1,949,900	487,475	1,949,900	487,475	1,949,900	487,475	1,949,900	487,475	1,949,900	487,475	1,949,900	487,475	1,949,900	487,475	1,949,900	487,475	1,949,900	487
3,222,004	12,888,016	1,711,808	6,847,231	956,710	3,826,838	995,812	3,983,250	487,475	1,949,900	487,475	1,949,900	487,475	1,949,900	487,475	1,949,900	487,475	1,949,900	487,475	1,949,900	1,211
81,465,720	52,113,132	60,430,105	23,647,869	22,401,465	9,415,237	22,440,567	9,571,649	16,073,480	7,538,299	16,073,480	7,538,299	16,073,480	7,538,299	16,073,480	7,538,299	16,073,480	7,538,299	16,073,480	7,538,299	59,653
5,906,426	4,269,790	3,802,864	1,423,263																	
1,071,471	398,705	1,071,471	398,705	1,007,586	367,975	1,011,497	383,617									0		0		4,356
1,168,676	542,819	1,168,676	542,819	1,232,560	573,548	1,232,560	573,548	1,607,348	753,830	1,607,348	753,830	1,607,348	753,830	1,607,348	753,830	1,607,348	753,830	1,607,348	753,830	1,607
8,146,573	5,211,314	6,043,011	2,364,787	2,240,146	941,523	2,244,057	957,165	1,607,348	753,830	1,607,348	753,830	1,607,348	753,830	1,607,348	753,830	1,607,348	753,830	1,607,348	753,830	5,965
64,970,681	46,967,685	41,831,504	15,655,895	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
11,786,178	4,385,757	11,786,178	4,385,757	11,083,450	4,047,729	11,126,463	4,219,783	0	0	0	0	0	0	0	0	0	0	0	0	
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	47,938
12,855,434	5,971,004	12,855,434	5,971,004	13,558,161	6,309,031	13,558,161	6,309,031	17,680,828	8,292,129	17,680,828	8,292,129	17,680,828	8,292,129	17,680,828	8,292,129	17,680,828	8,292,129	17,680,828	8,292,129	17,680
89,612,293	57,324,446	66,473,116	26,012,656	24,641,611	10,356,760	24,684,624	10,528,814	17,680,828	8,292,129	17,680,828	8,292,129	17,680,828	8,292,129	17,680,828	8,292,129	17,680,828	8,292,129	17,680,828	8,292,129	65,618
	21,231,276		9,634,317		3,835,837		3,899,561		3,071,159		3,071,159		3,071,159		3,071,159		3,071,159		3,071,159	

ement Schedule of Project Cost

01	2002		2003		2004		2005		2006		2007		2008		2009		2010	
F.C. (M$)	L.C. (M$)	F.C. (M$)	L.C. (M$)	F.C. (M$)	L.C. (M$)	F.C. (M$)	L.C. (M$)	F.C. (M$)	L.C. (M$)	F.C. (M$)	L.C. (M$)	F.C. (M$)	L.C. (M$)	F.C. (M$)	L.C. (M$)	F.C. (M$)	L.C. (M$)	F.C. (M$)
											8,589,738	7,497,647						
											8,589,738	7,497,647						
											10,737,172	9,372,059	10,737,172	9,372,059	10,737,172	9,372,059	10,737,172	9,372,059
5,588,399	11,257,116	5,588,399	11,257,116	5,588,399	11,257,116	5,588,399	11,257,116	5,588,399	11,257,116	5,588,399	11,257,116	5,588,399	11,257,116	5,588,399	11,257,116	5,588,399	11,257,116	5,588,399
5,588,399	11,257,116	5,588,399	11,257,116	5,588,399	11,257,116	5,588,399	11,257,116	5,588,399	11,257,116	5,588,399	21,994,288	14,960,458	21,994,288	14,960,458	21,994,288	14,960,458	21,994,288	14,960,458
5,588,399	11,257,116	5,588,399	11,257,116	5,588,399	11,257,116	5,588,399	11,257,116	5,588,399	11,257,116	5,588,399	30,584,026	22,458,105	21,994,288	14,960,458	21,994,288	14,960,458	21,994,288	14,960,458
											23,529,250		23,529,250		23,529,250		23,529,250	
	4,328,889		4,328,889		4,328,889		4,328,889		4,328,889		4,328,889		4,328,889		4,328,889		4,328,889	
	4,328,889		4,328,889		4,328,889		4,328,889		4,328,889		27,858,139		27,858,139		27,858,139		27,858,139	
											723,932	2,895,729	579,146	2,316,583	868,719	3,474,875	723,932	2,895,729
1,949,900	487,475	1,949,900	487,475	1,949,900	487,475	1,949,900	487,475	1,949,900	487,475	1,949,900	487,475	1,949,900	487,475	1,949,900	487,475	1,949,900	487,475	1,949,900
1,949,900	487,475	1,949,900	487,475	1,949,900	487,475	1,949,900	487,475	1,949,900	487,475	1,949,900	1,211,407	4,845,629	1,066,621	4,266,483	1,356,194	5,424,775	1,211,407	4,845,629
7,538,299	16,073,480	7,538,299	16,073,480	7,538,299	16,073,480	7,538,299	16,073,480	7,538,299	16,073,480	7,538,299	59,653,572	27,303,734	50,919,048	19,226,941	51,208,621	20,385,233	51,063,834	19,806,087
											4,358,009	1,976,544	3,484,557	1,168,864	3,513,514	1,284,693	3,499,035	1,226,779
							0		0									
753,830	1,607,348	753,830	1,607,348	753,830	1,607,348	753,830	1,607,348	753,830	1,607,348	753,830	1,607,348	753,830	1,607,348	753,830	1,607,348	753,830	1,607,348	753,830
753,830	1,607,348	753,830	1,607,348	753,830	1,607,348	753,830	1,607,348	753,830	1,607,348	753,830	5,965,357	2,730,374	5,091,905	1,922,694	5,120,862	2,038,523	5,106,383	1,980,609
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	47,938,101	21,741,979	38,330,125	12,857,506	38,648,655	14,131,627	38,489,389	13,494,567
8,292,129	17,680,828	8,292,129	17,680,828	8,292,129	17,680,828	8,292,129	17,680,828	8,292,129	17,680,828	8,292,129	17,680,828	8,292,129	17,680,828	8,292,129	17,680,828	8,292,129	17,680,828	8,292,129
8,292,129	17,680,828	8,292,129	17,680,828	8,292,129	17,680,828	8,292,129	17,680,828	8,292,129	17,680,828	8,292,129	65,618,929	30,034,108	56,010,953	21,149,635	56,329,483	22,423,756	56,170,217	21,786,696
3,071,159		3,071,159		3,071,159		3,071,159		3,071,159		3,071,159		11,123,744		7,833,198		8,305,095		8,069,147

DESCRIPTION	UNIT	Q'TY
1 PRE-FEASIBILITY STUDY		
2 FEASIBILITY STUDY		
3 FINANCING		
4 DETAILED DESIGN		
5 TENDERING		
6 MAIN CIVIL WORKS		
(1) Mobilization		
(2) Preparatory works		
(3) Diversion tunnel		
a) Excavation		
Portal	m3	105,000
Tunnel	m3	230,000
b) Concrete		
Portal	m3	4,700
Tunnel	m3	68,000
Plug	m3	11,680
c) Grout	m	14,000
d) Gate	set	1
(4) Cofferdam		
a) Excavation	m3	88,000
b) Embankment	m3	687,000
(5) Main dam		
a) Excavation		
Common	m3	163,000
Weathered rock	m3	255,000
Hard rock	m3	109,000
b) Foundation grouting	m	43,000
c) Gallery concrete	m3	16,000
d) Embankment		
Core	m3	437,000
Filter	m3	92,000
Rock	m3	2,171,000
(6) Spillway		
a) Excavation	m3	1,760,000
b) Concrete	m3	103,000
(7) River outlet works		
a) Concrete	m3	200
b) Metal works	set	
(8) Cofferdam for Saddle dams		
a) Excavation	m3	18,000
b) Embankment	m3	73,000
(9) Saddle dams		
a) Excavation	m3	801,000
b) Foundation grouting	m	47,000
c) Embankment		
Core	m3	305,000
Filter	m3	66,000
Rock	m3	1,143,000

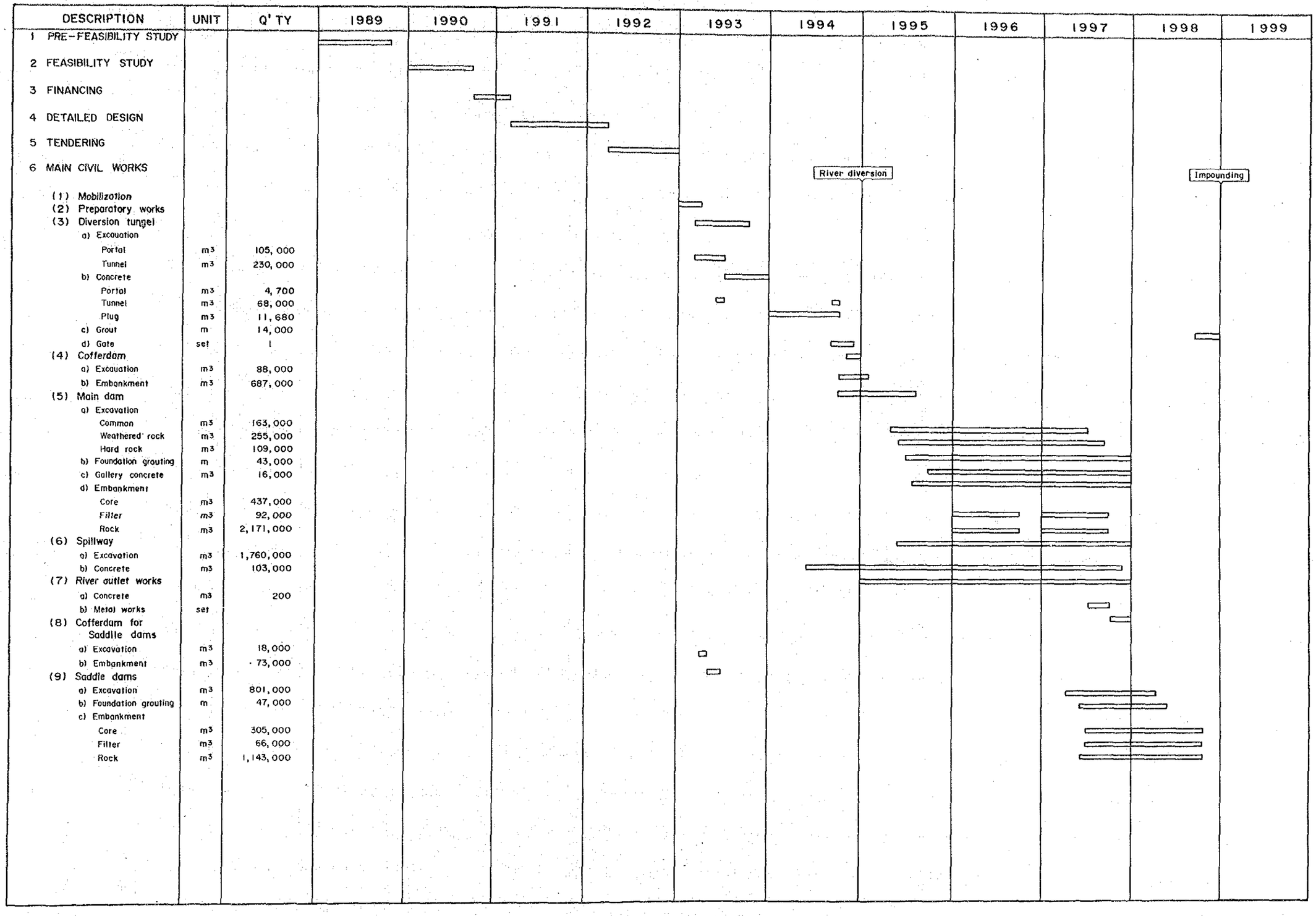


Fig.VIII.2.1 Construction Time Schedule for Lebir Dam Project

GOVERNMENT OF MALAYSIA
STUDY
ON
KELANTAN RIVER BASIN - WIDE FLOOD MITIGATION
JAPAN INTERNATIONAL COOPERATION AGENCY

DESCRIPTION	UNIT	Q'TY
Urban area		
1 PRE - FEASIBILITY STUDY		
2 FEASIBILITY STUDY		
3 FINANCING		
4 DETAILED DESIGN		
5 TENDERING		
6 CIVIL WORKS		
(1) Mobilization	L.S	
(2) Preparatory works		
(3) Clearing stripping	m²	197,000
(4) Embankment		
from borrow area	m³	1,018,000
from excavation	m³	2,605,000
(5) Revetment		
low water channel	m²	12,500
high water channel	m²	94,400
(6) Sluice	P C	10
(7) Toe drain & ditch	m	29,100
(8) Maintenance road	m	29,100
(9) Sod facing	m²	829,000
Rural area		
1 TENDERING		
2 CIVIL WORKS		
(1) Mobilization	L.S	
(2) Preparatory works		
(3) Clearing & stripping	m²	1,378,000
(4) Dredging	m³	2,100,000
(5) Embankment		
from borrow area		1,132,000
from excavation		9,503,000
(6) Revetment		
low water channel	m²	88,600
high water channel	m²	72,500
(7) Toe drain & ditch	m	89,500
(8) Maintenance road	m²	134,900
(9) Sod facing	m	4,217,000

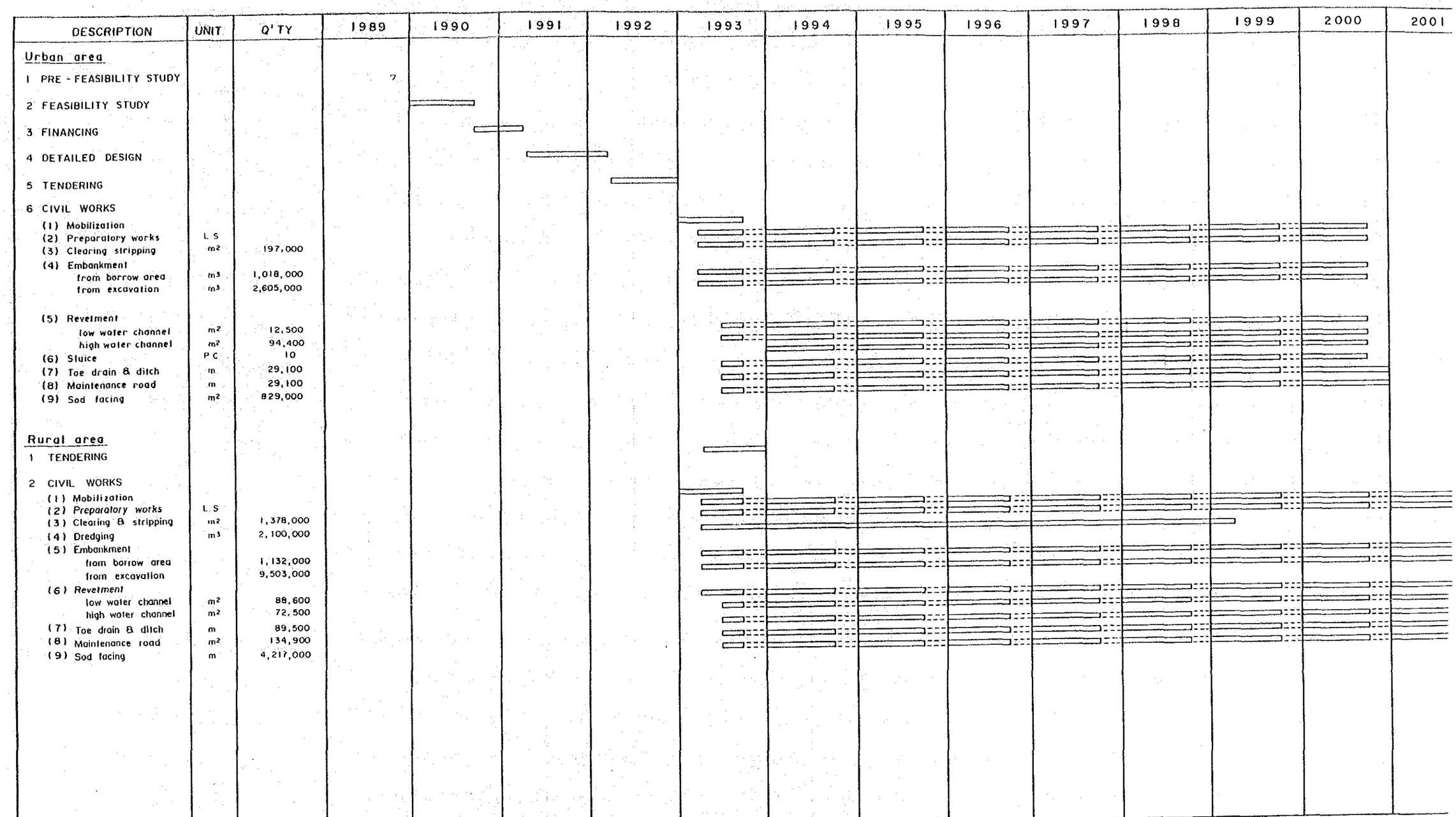
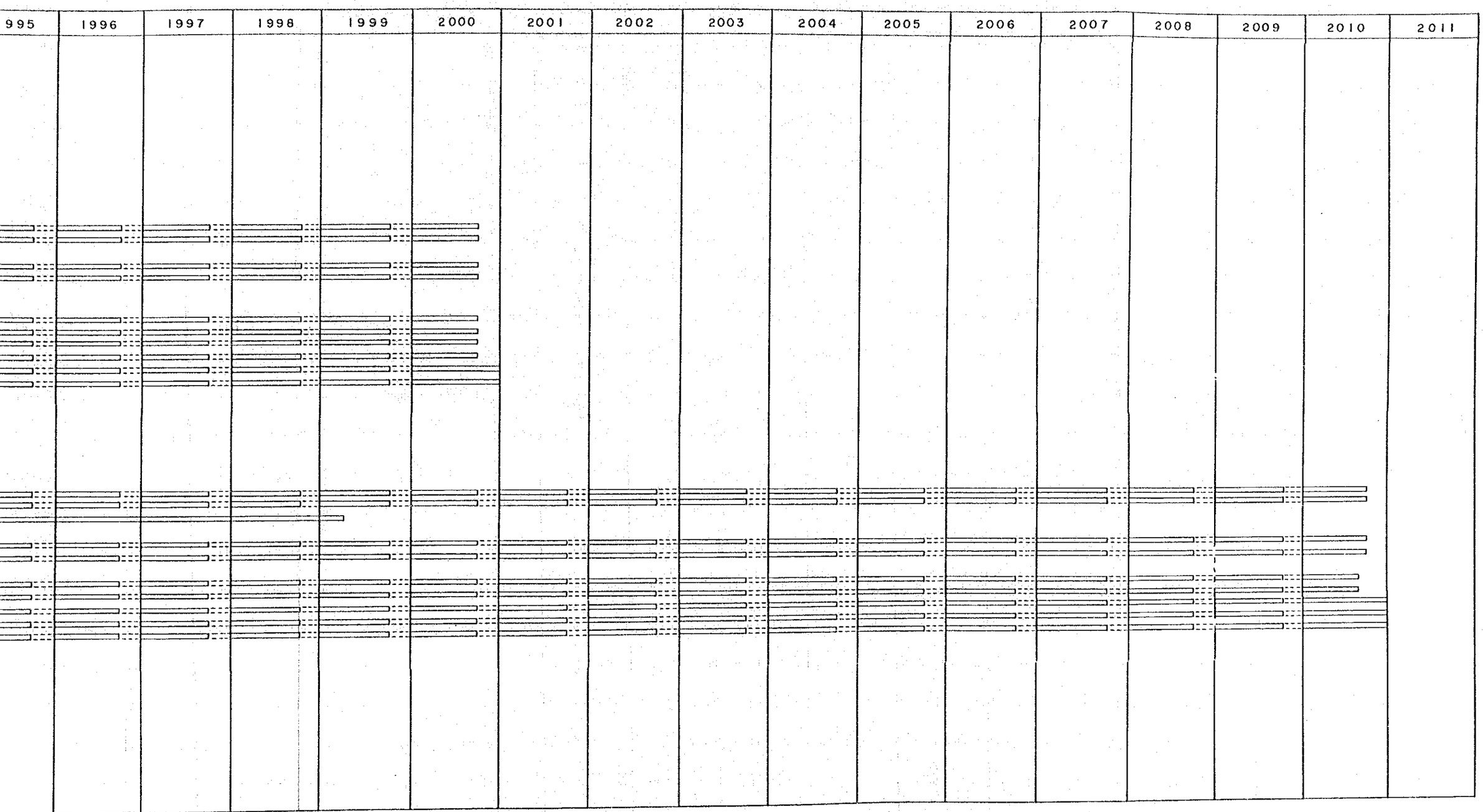


Fig.VIII.2.2 Construction Time Schedule for Kelantan River Improveme



.2 Construction Time Schedule for Kelantan River Improvement Works

GOVERNMENT OF MALAYSIA
STUDY
ON
KELANTAN RIVER BASIN - WIDE FLOOD MITIGATION
JAPAN INTERNATIONAL COOPERATION AGENCY

DESCRIPTION	UNIT	Q'TY
1 FEASIBILITY STUDY		
2 FINANCING		
3 DETAILED DESIGN		
4 TENDERING		
5 MAIN CIVIL WORKS		
(1) Mobilization		
(2) Preparatory works		
(3) Diversion tunnel		
a) Excavation		
Portal	m3	106,600
Tunnel	m3	70,000
b) Concrete		
Portal	m3	2,500
Tunnel	m3	17,700
Plug	m3	5,800
c) Grout	m	4,000
d) Gate	set	1
(4) Cofferdam		
a) Excavation	m3	21,000
b) Embankment	m3	188,000
(5) Main dam & spillway		
a) Excavation	m3	413,500
b) Concrete	m3	148,000
c) Grout	m	12,000

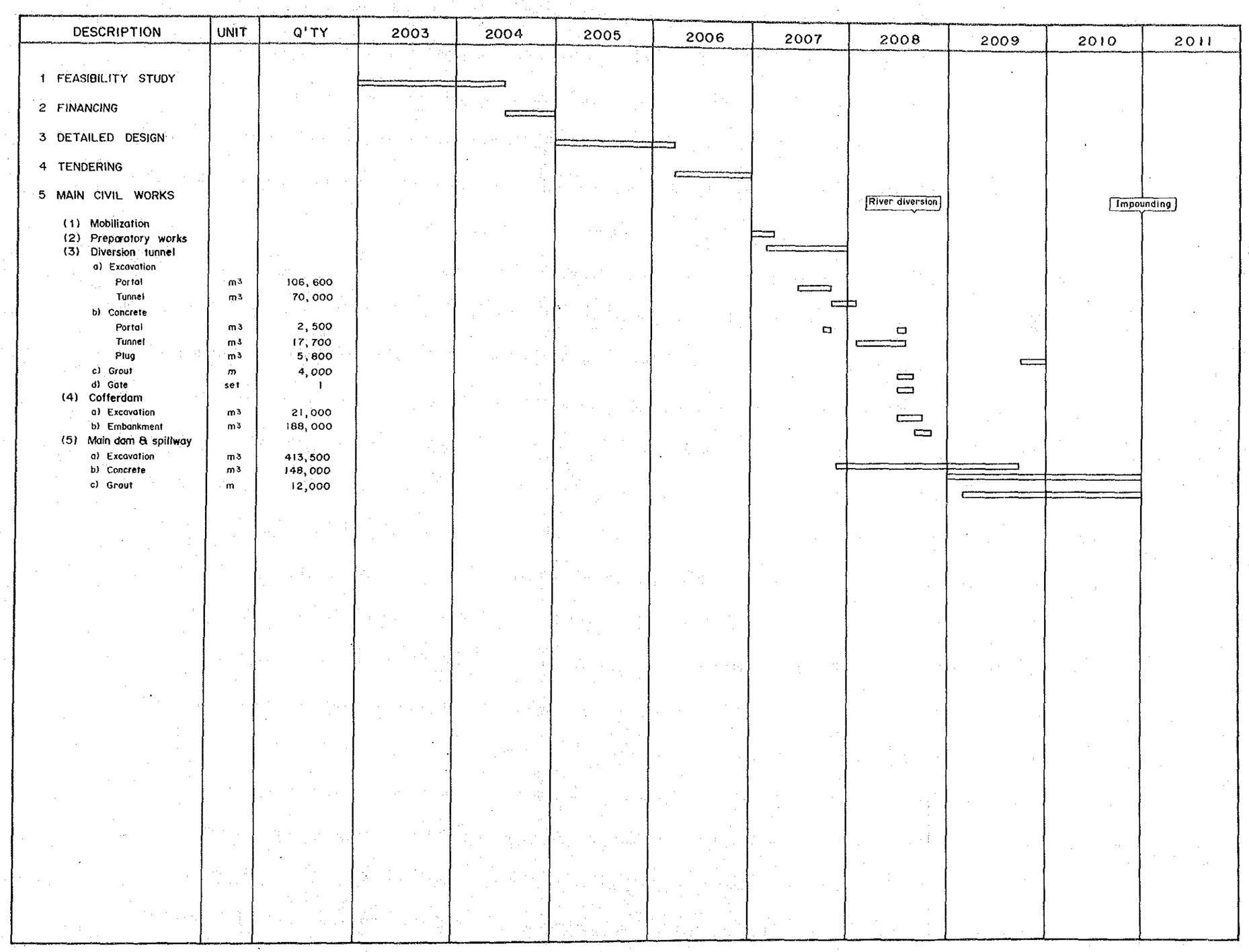


Fig.VIII.2.3 Construction Time Schedule for Kemubu Dam Project

GOVERNMENT OF MALAYSIA
STUDY
ON
KELANTAN RIVER BASIN - WIDE FLOOD MITIGATION
JAPAN INTERNATIONAL COOPERATION AGENCY