Due to soil conditions, about 1,850 ha in the Project area has been used for corn and some paddy in wet season. It is planned in this Project that in wet season 1,400 ha will be planted with corn 450 ha will be used for paddy rotated with dry season corn. In dry season new irrigation will make possible to plant peanuts on 1,000 ha area, vegetables on 400 ha area and corn on 450 ha area.

(2) Cropping Intensity

The Project area's 135% cropping intensity was derived from the total cropping hectarage of 17.560 ha against the arable area of 13,040 ha which will increase to 227% or 29,060 ha of cropping area to 12,780 ha of arable area. A substantial increase in cropping intensity is projected for the paddy area which will increase from the existing 143% to 233% under the Project, while diversified cropping will increase from 97.7% at present to 200% under the intensive farming technology.

4.3.4 Future Farm Labor Conditions

(1) Projection of Farm Household Population

According to statistics, the annual population growth rate in the Project municipalities from 1975-80 varied from 0.1% in Villaverde municipality to 2.76% in Bayombong municipality, while the average of 5 municipalities was 2.12%. These figures were all lower than the provincial level of 2.86%. This low percentage, particularly in Villaverde municipality, is due to out-flow migration of the population caused by agricultural and socio-economic conditions. The implementation of the Project will help to check further out-flow of labor by increasing employment opportunities. Therefore, the annual population growth rate of over 2.0% is expected to continue in future.

Population projection and projection of the farm household population calculated with the assumed annual growth rate of 2.0% are shown in APPENDIX I-IV.

(2) Projection of Total Number of Carabao

The increase of number of carabao in the Project area from 1976-80 was 1.73%/yr. This trend seems likely to continue in future. Projection of draft animal resources and equipment potential are the key points for planning future implementation of farm mechanization. An increase in carabao population is especially desirable.

(3) Farm Labor Balance

i) Human Resources

In the Project, the proposed annual cropped area is 29,060 ha, consisting of 12,680 ha of irrigable, and 100 ha of non-irrigable land. The cropping intensity will be raised from its present 135% to 227% with the Project. On the basis of the proposed cropping pattern and the projected farm household size, the balance of manual labor was calculated as shown in APPENDIX I-IV.

Upon completion of the Project, about 85% of the available labor force will be engaged in farm operation in the peak month of February, as opposed to 41.5% in the peak month of October before Project implementation. Therefore, with Project implementation, the employment opportunities for those engaged in farming will be more than doubled.

ii) Animal Resources

The total tractor force in the Project area is estimated to be equivalent to 32,000 carabao-days per month. However, the present number of carabaos amounting 9,700 heads in 1982 has much surplus animal labor for farming. This animal labor force is 6 times larger than the above tractor force. The animal labor balance was calculated on the basis of the estimated annual growth rate of 1.73%. During the peak month of February, the animal labor surplus rate was 24.6%. Furthermore, this percentage coupled with an assumption of zero percent annual growth rate for the present carabao population indicates as much as a 7.4%

surplus. For the farmer however, carabao are more than a mere labor source, representing property and a source of organic fertilizer.

4.3.5 Anticipated Project Production

At present, the Project area is characterized by local palay and HYV palay cultivation with a cropping intensity of 143% and an average yield of 2.4 t/ha. With the Project however, shortage of irrigation water especially during the dry season will be alleviated and cropping intensity increased to 233% including mung bean cultivation. The average yield of palay will reach 4.25 t/ha.

Paddy cultivated area will substantially increase while adjustments in corn area will be minimal. However, a significant shift in the cropping pattern will occur with the introduction of diversified crops (mung bean and peanut) totaling 4,600 ha/yr in addition to paddy and corn cultivation.

In general, corn cultivation in the Project area is mostly dependant on rainfed water supplies and this, coupled with insufficient management, results in a low average crop yield of 0.9 t/ha. In the Project area, there is a large diversified crop area, distributed along the river banks, which will be suitable for corn cultivation with improvement and further provision of irrigation facilities and the introduction of package practices. In Sta. Lucia located in the northern part of the Project area, there is a corn demonstration farm of the Ministry of Agriculture presently under the management of the Maisagana Program. Corn cultivators in its vicinity are experiencing higher corn yields. The Ministry of Agriculture reports that the potential yield of corn in Project municipalities can be categorized into three areas; (1) low potential area: 1-2 t/ha, (2) medium potential area: 3-4 t/ha, and (3) high potential area: 5 t/ha. Therefore, a corn yield of 3.0 t/ha in wet season and 3.5 t/ha during the dry season is considered a feasible target yield for the Project.

Mung bean cultivation in the Project area is not extensive. However, farmers have been familiar with the same for many years and the mung bean itself has a high domestic as well as commercial market value. In recent years, the Ministry of Agriculture has successfully bred some improved varieties of mung bean with short growth duration, high yield potential and photo-insensitivity. With optimum crop care, these varieties will have a yield potential of 1.5 t/ha.

The demand for peanuts in the Philippines has been increasing rapidly. The import of peanuts as animal feed in particular has greatly increased since 1973. The Bureau of Plant Industry of the Ministry of Agriculture has designated 44% of the entire nation's peanut production as the target for Region II in its National Legumes Production and Development Program. With adequate irrigation facilities and suitable farm management, a target yield of 1.5 t/ha in the diversified crop area of the Project is considered feasible.

4.3.6 Optimum Post Harvest Facility Size

(1) Thresher

Threshing capacity within the Project area is currently estimated at 908.4 t/day. Estimated production after Project implementation is 93,855 tons in total of both dry and wet seasons. Given an estimated threshing period of 120 days (60 days following each harvest), a threshing capacity of 782 t/day will be necessary. At 908.4 t/day, present threshing capacity in the Project area is accordingly sufficient for envisaged yields under the Project.

(2) Rice Mills

Rice mill capacity is just sufficient to process current rice production in the Project area, and will therefore not be adequate for handling the increases in rice yield envisaged under the Project. This will necessitate an increase in rice mill capacity of approximately 1.5 times the current capacity. Accordingly, capital investment from the private sector as well as a strengthening of the agricultural support system are required to ensure adequate rice mill capacity for future increases in yield.

(3) Corn Grinders

Present potential corn grinding capacity in the Project area exceeds current requirements by approximately 68%. Nevertheless, projected yield increases under the Project will slightly exceed current corn grinder capacity. The anticipated shortage in capacity however, is only 0.5 cavans/hr which may be adequately compensated by improving existing facilities and enhancing operation efficiency.

(4) Warehouses

The least developed area of post harvest facilities is warehousing. Assuming that warehouse capacity should be equivalent to 50% of production for purposes of price and quality control as well as for pest control, the current warehouse capacity of 3,900 tons represents only 1/5 of what is needed to accommodate present grain production. With projected yield increases under the Project, it will be necessary to expand current capacity 12 fold.

(5) Grain Drying System

Drying of grain after harvesting and threshing will pose problems for the wet season crop. With projected yield increases under the Project, a corresponding expansion of mechanical drier facilities will be necessary. However, as the cost for operating mechanical drier systems will have a subsequent effect on the farmers' net income, consideration should also be given to expansion of common solar drying platforms.

(6) Transportation

Potential transport capacity within the Project area is estimated at 140,000 tons/yr. This estimate is derived from the assumptions mentioned in APPENDIX I-IV based on numbers and types of vehicles registered at the Bureau of Land Transportation in Bayombong.

The balance between current transport capacity and anticipated transport requirements for farm products during the Project is estimated on the basis of the assumptions given in APPENDIX I-IV.

The total amount of agricultural products transported at full development of the Project 5 years after completion is estimated at 314,000 tons. The total amount transported for all commodities at that time is estimated at 349,000 tons as opposed to a present farm vehicle capacity of 210,000 tons within the Project area. Thus additional capacity required with the Project is 70,000 t/yr or 365 t/day (210,000 t - 140,000 t). This volume is the equivalent of approximately 90 additional 4 ton trucks.

4.3.7 Project Net Incremental Benefit

The net incremental benefit of the Project is given by the difference of the net crop production values of the area "with Project" and "without Project". The net crop production value is determined by the difference between gross crop production value and crop production cost. The net crop production value upon projected completion of the Project is estimated at 171.3 million Peso, while that for the area without Project implementation is estimated at 60.3 million Peso. Increase in agricultural labor cost is estimated at 25.1 million Peso and the net incremental benefit will therefore be 85.9 million Peso.

4.3.8 Agriculture Extension System

Two types of strategy for extension, namely, a permanent and a temporary system adaptable to the farmers' technical level were studied. Management of the latter type however, will be most important for the pilot farm of this Project due to the urgent need to achieve uniformity in farmers' technical level within the subjected period.

Under the Project, the pilot farm extension program shall cover desirably all farmers in the Project area as they themselves are beneficiaries. To satisfy the objectives of the pilot farm, there will also be several different management systems.

(1) Rotational Pilot Farm System

The pilot farm will train participants through both seminars and practical training programs, extending this service throughout the vicinity of demonstrations. In the case of permanent pilot farm facilities, however, it would take very long time to extend and demonstrate modern techniques over the entire Project area. Such permanent pilot farm would rather function as a fixed "point".

The ideal solution would be the temporary establishment of a mobile pilot farm system. This system could for example be operational for some period of the cropping season moving to new areas according to a priority sequence based on the Project area's extension blocks. The extension "point" by permanent facilities thus would actually form more of an extension "line", the mobile center rotating from one site to the next after given periods of time. The effectiveness of such a ystem could best be tested by incorporation into the Project's program.

(2) Extension Sub-Center System

In the extension blocks some extension sub-centers will be established to conduct small scale demonstration plots. Training programs in the sub-centers will use seminars and the training and visiting system (T & V System). This Sub-Center system will further spread the extention from the "line" to "plain" if combined with the above rotational pilot farm system.

(3) Combined Sub-Center and Rotational System

This approach will unify and coordinate the above mentioned two systems to spread extension effect rapidly over the entire Project area. By rotational shifting of the total system from block to block, the entire Project area will be covered.

In all of these systems, the participating farmers should be trained as nucleus leaders for their areas. These same farmers will provide continuity in the transmission of the new techniques once the pilot farm has been relocated elsewhere.

4.3.9 Irrigation Water Resources

For the Agriculture development plan, as Stage I development, the Magat Lanog and Matuno rivers have been designated as irrigation water sources.

(1) Magat River

Land use blocks 1, 2, 3 and 5, involving 11,590 ha of land, will be irrigated by the newly constructed Magat Diversion Dam at Bayombong on the Magat River. The water intake level is 273 m above sea level, and water will be distributed through the Colocol and mountain-side main canals. 188 ha of land above 270 m elevation in Uddiawan area, currently belongs to the Uddiawan CIS and will be incorperated into the new canal system. The said area will, however, be provided with separate irrigation facilities.

(2) Lanog River

In the northeastern portion of the Project area, 2,745 ha located between Murong and Sta. Lucia in Bagabag municipality at an elevation of 225-210 m have been proposed for irrigation. The irrigation water source for this area will be the supply water and flow of the mountain-side main canal extending from Magat Deversion Dam.

(3) Matuno River

At the Manamtam site, a new diversion dam will be constructed to irrigate 1,090 ha in block No. 4, including Sto. Domingo and La Torre, with an elevation range of 310-295 m.

4.3.10 Irrigation and Drainage Plan

(1) Irrigation Water Requirement

The irrigation water requirement has been calculated based on the proposed cropping pattern according to the following assumptions:

i) puddling water requirements for land preparation is estimated by required inundation depth, infiltration, period, puddling method, etc;

ii) evapotranspiration based on pan-evaporation and crop coefficient;

iii) total water requirement of crop determined by the above figures with the addition of actual measured percolation;

iv) net irrigation water requirement calculated by substraction of the effective rainfall obtained from daily water balance; and,

v) deversion water requirement determined in consideration of irrigation efficiency.

A water balance study was carried out over a 20-year period from 1957-76. Studies for a water resources plan were based on these results. The maximum unit diversion requirement used in designing irrigation facilities is designated at 2.0 ℓ/s/ha for the last day of land preparation in the dry season.

(2) <u>Design Drainage Discharge</u>

The following 2 models of drainage analysis allowing for plot storage were studied.

Analysis Method	Unit Discharge in Canal (ℓ/s/ha)	Model Condition
Plot to Plot Method	4.83	present
Toda Method	7.47	future

The Toda method has been finally adopted for the plan for the following reasons:

i) in the plot to plot method, the depth of inundation downstream is significantly greater than that upstream, while in the Toda method water depth is uniform;

ii) the Toda method is suitable for heavy rainfall minimizing potential damage; and,

iii) design drainage for the Toda method is closest to the NIA criteria (9.0 ℓ/s/ha in Northern Luzon).

The maximum 3-day continuous rainfall has been adopted in the catchment basin with probable 5-year return period. The run-off discharge from the mountainous area has been calculated on the rational formula with a 5-year return period as 24.17 ℓ/s/ha.

4.3.11 Irrigation and Drainage System

After understanding the outline of existing irrigation and drainage systems based on the maximum site investigation, data such as 1/4,000, 1/10,000 and 1/50,000 topo maps, 1/10,000 aero-photo, etc., a plan for proposed irrigation and drainage systems was prepared as shown in FIG. 9.

(1) Irrigation System

Present and proposed canal densities are tabulated below:

Canal Type	Present Density m/ha	Proposed Density m/ha
Main	1.66	7.13
Lateral	11.85	15.25
On-farm	12.35	66.00
Total	25.86	88.30

Note: subjected area is 12,680 ha

As a result, almost all the existing canals are integrated in the proposed system as follows:

Existing Canal	Proposed Canal
Main Canal (21 km) (Colocol)	utilized entirely after rehabilitation
Lateral Canal (150 km)	131 km used as proposed lateral canal remaining 19 km used as farm ditch
Farm Ditch (156 km)	maximum possible utilization

(2) Drainage System

The length of existing and proposed drainage canals according to type are listed below:

Canal Type	Present Length (m)	Proposed Improvement (m)	Newly Construction (m)	Canal Density (m/ha)
Main Canal	62,970	16,500	2,400	3.2
Lateral Canal	109,700	13,400	19,850	6.3
Farm Drain	-	-	634,000	30.8
Total	172,670	29,900	656,250	40.2

Note: subject area is 20,600 ha

4.3.12 Road Network

The inspection roads along the main and lateral irrigation canal are proposed to be constructed for appropriate operation and maintenance of irrigation facilities. These roads have substantially important roles as farm roads and as general access roads for residents of the area. In planning the required inspection roads, the existing road system is utilized as much as possible as far as available and effective.

The existing and proposed road network density is given below:

Road Type	Present (m/ha)	New Inspection Road and Hillside Development Roads (m/ha)	Total (m/ha)
Main Road (asphalt paved)	1.7	-	1.7
Branch Road (gravel)	2.6	17.7	20.3
Farm Road (un-paved)	5.0	15.4	20.4
Total	9.3	33.1	42.4

Note: subjected area is 20,600 ha

4.4 Proposed Works for Agriculture Development

4.4.1 General

In order to realize agricultural development goals of this Project, construction of new structures or improvement of existing related infrastructures such as irrigation and drainage facilities and roads, is required.

In the design of these facilities, site surveys have been extensively employed and the views of NIA counterparts, Regional and Provincial Irrigation Office, and existing Irrigators' Associations have been duly considered. NIA design manuals were also carefully studied and the design standards, criteria and standard drawings applied in the design.

The main infrastructures required for Stage I agricultural development are described hereafter.

4.4.2 Diversion Dam

Diversion dams required for stable irrigation water supply to the Project area are listed on the following list.

Diversion Dam	Intake Source	Length (m)	Height (m)	Irrigated Area (ha)
Magat Diversion Dam	Magat River	305	1.6	11,590
Manamtam Diversion Dam	Matuno River	127	2.5	1,090
Lanog Diversion Dam	Lanog River	35	1.8	(2,745)

( ): area to use return flow and diverted water from Magat Diversion Dam

(1) Magat Diversion Dam

After comparing 3 potential diversion dam sites along the Magat River, a site near the existing Colocol intake at the southern adge of Bayombong city was selected for the following reasons:

- -- economic effectiveness
- -- minimal land required for main canal
- -- comparatively stable stream of Magat River

The following probable floods have been considered in the structure design in reference with the other similar projects in Philippines:

Return Period		Design Discharge
1/20	5,200 m^3/sec	Required widths of gated and non-gated overflow weir
1/50	5,800 m^3/sec	Backwater protection bank (left bank 350 m, right bank 600 m), riverbed protection, etc.
1/100	6,300 m^3/sec	Pier height

The dam is comprised of a 13 m span roller gate for sand sluice, two 30 m span spillways (steel flap gate), and a 228 m fixed weir portion. Discharge capacity of the gates are designed to handle 500 m^3/s scale floods, which occur frequently. Accordingly, main stream of the river is led to the left bank, and eventually stabilizing the water intake.

The design diversion discharge of 21.4 m^3/s will be led to the bifurcation structure located 300 m downstream from the intake and be bifurcated to the mountain-side main canal (14.96 m^3/s) and Colocol main canal (6.44 m^3/s). Fixed wheel gates will be provided for this function to provide optimum operation and maintenance at the bifurcation structure.

(2) Manamtam Diversion Dam

The new diversion dam will be located 100 m downstream from the existing brush dam on Matuno River in consideration of river condition and the location of intake facilities.

Since the height of both banks protects the same from backwater, a fixed weir (length: 118 m) and a scouring sluice (5 m span; fixed wheel gate) have been designed. Out of 118 m length of the weir, the crest elevation of the left bank side (40 m in length) was designed 50 cm lower than the rest of the right bank to stabilize the river course to the left bank.

(3) Lanog Diversion Dam

The locations of the diversion dams have been determined according to the locations of existing diversion dams in Gannib Cabalitan CIS and Santa Cruz Careb CIS. Due to meandering of the Lanog River and the existence of several fixed weirs, small to medium-scale floods occur frequently in the middle reaches of this river. Integration of the existing CIS and improvement of the river stream have therefore been proposed in this plan.

Accordingly, the Lanog diversion dams have been equipped with movable weirs in full width of the proposed river sections. A modern rubber dam (air inflated automatic flap dam) has been adopted as it is economical and efficient.

4.4.3 Irrigation Canal System

(1) General

The proposed irrigation canal system consists of main canal, lateral or sublateral canals and farm ditches (including main and supplemental ditches).

Each canal will be provided with discharge and water level control facilities, crossing structures, etc.

(2) Irrigation Canal

The irrigation canal was designed in accordance with NIA standards and criteria for allowable velocity, roughness coefficient, proportion of depth and bedwidth, side slope, freeboard and canal gradient. Although as a general rule all canals are to be earthen, the Colocol main canal will be provided with dry masonry lining as it flows through the urban area and along the national road.

(3) Related Facilities and Structures

Required facilities and structures for appropriate water management are as follows;

i) intake and discharge measurement facilities (double orifice, partial flume and fixed proportional divisor),

ii) water level maintenance facility (check gate),

iii) drop structure (chute and vertical drop structure),

iv) canal spillway (waste water and spillway structure),

v) crossing structure (syphon, bridge and box and pipe culvert), and

vi) small-scale drainage facility (drainage inlet).

The location of each of the structures listed has been decided in accordance with design discharge and topography.

Inspection roads will be provided on the one side of canal embankment as a principle. Details will be mentioned in 4.4.5.

4.4.4 Drainage Canal System

(1) Drainage Canals

As mentioned above, the drainage system has been designed in accordance with NIA criteria. The total length of the main drainage canal is 65.37 km, including about 10 km of improvement mid-stream of the Lanog River, plus 2.4 km of new construction and 6.5 km of paetial improvement at the floodway of the Apad Creek.

The total length of lateral and sublateral canals is 129.55 km including 19.85 km of new construction and a total 13.4 km of partial improvement. The total combined length of new construction and improvement for main and lateral drainage canals is thus 52.15 km or about 27% of total drainage canal length. As there are no presently existing farm drains, the same will be constructed. All drainage canals listed above are earthen canals.

(2) Related Structures

Since the cost of all crossing structures related to irrigation canals are included in the irrigation canal system, they are not described here. Other structures required for the drainage canal system are as follows:

Drop Structure	Existing drainage slope in the Project area is about 1/300. To prevent scouring however, a 1/1,000 slope with drop structures is proposed at rehabilitated portion.
Crossing Structures	Bridges and pipe culverts are proposed. The cost of bridges is included as part of the inspection road in the irrigation canal system.

4.4.5 Roads

Excluding those in the 1,000 ha of hillside area, inspection roads along irrigation canals are the only roads to be newly constructed under this Project. 3-6 m wide roads are proposed along the main and lateral irrigation canals, with a gravel-paved width of 2-4.5 m and a 20 cm thickness.

4.4.6 On-Farm Facilities

The following on-farm facilities are proposed per each 50 ha;

main farm ditch	800 m
supplemental farm ditch	2,500 m
farm drain	2,500 m
farm road	1,250 m

4.4.7 Flood Protection Works

To protect the Project area from flooding caused by the Magat river, river embankments 13.5 km long are proposed as follows;

i) area from the proposed Magat Diversion Dam site to 700 m downstream from the Batu bridge (6.14 km), and

ii) area from Carifang to the proposed Magat Diversion Dam site (7.4 km).

The design flood discharge at Batu bridge is estimated at a probable 50-year return period (5,860 m^3/s). The banks of the river will be protected by gabion up to the freeboard height.

4.4.8 Main Component of Stage I Development

The main features of the agricultural development plan, including those dealing with flood control, are presented in TABLE 4.

4.4.9 Construction Cost

The cost for Stage I development plan, including a 10% physical contingency, is US$41.1 million. In consideration of an estimated 5% price escalation in foreign currency and 8% in domestic currency, the Project Cost for Stage I development will be US$54.1 million. Accordingly, the cost of development per ha, including that for river embankments, will be US$3,241 and US$4,276 respectively. Details of construction cost are shown in TABLE 6.

4.5 Power Development Plan

As mentioned in the Interim Report in detail, the four possible damsites were initially selected as shown in the attached FIG. 10, being named A, B1, B2 and C damsites from the upstream. But the C damsite was discarded for reason of less technical and economical soundness due to existence of solution cavities in limestone formation. Therefore, the following three alternative plans were selected for economical comparison.

Case I: A high dam at "A" damsite with a power station, and a low re-regulating dam at "B1" damsite with a power tunnel to a power station at the foothill of Bayombong plain.

Case II: A high dam at "B1" damsite with a power tunnel to a power station at the foothill of Bayombong plain.

Case III: A medium high dam at "B2" damsite with a power tunnel to a power station at the foothill of Bayombong plain.

As mentioned in the Interim Report in detail, the economic omparison made on the Case I and Case II showed the superiority of Case II to Case I. The main reason for the above is that the Case I required two separate dams and power houses which make the total construction cost considerably higher than Case II.

Then the economic comparison was made between Case II and Case III as mentioned in Appendix II-6 attached to this report. The four different dam heights for Case II and three different dam heights for Case III were selected for the detailed economic evaluation. The results shows the highest benefit-cost ratio in case of Normal High Water Level at EL. 520 m in Case II.

The benefit-cost ratio of Case III is about 12% lower than Case II mainly due to the height limit of B2 dam constrained by the topography and geology of the B2 damsite. The projected ridge on the left bank of B2 damsite has fresh rock formation at the low level, which limits the high water level at EL. 500 m at the maximum. Therefore, the annual energy output of the Case III is 394 GWh, which is about 25% smaller than that of 528 GWh in Case II (EL. 520 m).

The above economic evaluation studies suggest to adopt the B1 damsite as the best scheme.

Based on the above selection, the preliminary design was carried out taking into consideration the available river discharge, topography, geology and construction materials. The design of structures is shown in the attached drawings.

The available natural discharge at B1 damsite having a catchment area of 550 km^2 is 37.4 m^3/sec on an average for the measured hydrological data for 1957 to 1976. The maximum gross head is 220 m and the minimum is 180 m. The dead storage capacity is set at 40 million m^3 taking into consideration the 100-years silt deposit of 35 million m^3.

The annual electric energy output was calculated to be 528 GWh based on the 20-year hydrological data over 1957 to 1976, out of which 354 GWh is the firm energy output and 174 GWh is the secondary output.

The installed power generating capacity was selected to be 180 MW taking the plant factor to be 33%.

4.6 Dam and Power Facilities

4.6.1 Required Facilities

The best-suited layout and preliminary design of required structures were made considering the topographic and geologic conditions and economy as well. The results are shown in the attached drawings, of which the outline is mentioned below:

1) Dam

Type: Rockfill dam with a center core zone
Crest elevation: EL. 529 m
Height from the foundation: 147 m
Crest width: 14 m
Dam volume: 10,000,000 m^3
Upstream slope: 1 : 3.3
Downstream slope: 1 : 2.1

2) Reservoir

Normal HWL: EL. 520 m
Normal LWL: EL. 480 m
Design flood water level: EL. 524.7 m
Gross storage capacity: 137 x 10^6 m^3
Effective storage capacity: 97 x 10^6 m^3
Surface area at N.H.W.L.: 3.5 km^2

3) Diversion Tunnel

Type: Circular section, concrete-lined tunnel x 2 lanes
Inside diameter: 13.0 m
Length: No.1 Tunnel: 930 m
No.2 Tunnel: 980 m
Design flood discharge: 3,200 m^3/sec (20-years probable flood)

4) Spillway

Type: Concrete-lined open chute spillway with a stilling basin

Design flood discharge: 10,300 m^3/sec

Gates: Radial gate x 4 units

Size: 16 m (height) x 12 m (width)

5) Pressure Tunnel and Penstock

Intake: Sill elevation: EL. 461 m

Gate: 6.4 m x 6.4 m x roller gate

Pressure Tunnel: Circular section, reinforced concrete lined

Diameter: 6.4 m

Length: 5,650 m

Surge Tank: Chamber type

Diameter of riser: 11.2 m

Penstock Tunnel: 6.4 m dia. x 430 m (length)

Open Penstock: Length: 420 m

Diameter: 5.5 m - 2.8 m x 2

6) Power House

Type: Semi-underground type

Floor area: 30.5 m x 60 m

7) Generating Equipment

Turbines: Vertical shaft Francis type

Elevation of runner center: EL. 296 m

Rated speed: 277 rpm

Capacity: 92,700 kW x 2 units

Tailwater level: EL. 300 m

Generators: Vertical shaft semi-umbrella syncronous generator

Capacity: 100,000 kVA x 2 units

Power factor: 0.90

Voltage: 13.8 kV

Frequency: 60 Hz

8) Substation & Transmission Facilities

Main Transformers:	3-phase
	Voltage: 13.8 kV/230 kV
	Capacity: 100,000 kVA x 2 units
Transmission Line:	Double circuit, single conductor
	Voltage: 230 kV
	Length: 2 km
	Conductor: ACSR 795 MCM
Matuno Substation:	230 kV CB x 2 units
	Two outgoing lines
Solano Substation:	230 kV double bus,
	Two incoming lines with 1.5 CB system

9) Tailrace

Type:	Concrete conduit backfilled
Section:	Box section, 13.6 m (width) x 7.2 m (height)
Length:	933 m to Magat river

4.6.2 Dam

The rockfill type dam was selected as the most economical one after comparison with a concrete gravity dam. The concrete gravity type will cost about 20% more construction cost. As the investigation and tests on construction materials revealed that good materials for core zone, filter zone, concrete, etc. are easily obtained from the vicinity of the dam in sufficient quantity as reported in this Appendix II-4, the rockfill type dam is far economical than concrete gravity dam. (Ref. Fig.-21 and 22)

The analysis on the earthquake records suggests to adopt the horizontal seismic coefficient of 0.15 as explained in detail in Appendix II, 3.2. However the tentative dam section was designed under 0.20 for the sake of caution. Then, the upstream and downstream surface slopes were decided to take 1:3.3 and 1:2.1 as the results of the detailed stability analysis explained in Appendix II, 5.7.

The design flood was decided to be 10,300 m^3/sec which corresponds to 10,000-years probable flood as explained in Appendix II, 1.4.2. The hydraulic calculation on the proper reservoir operation shows that this design flood peak discharge will be able to be cut down to 6,800 m^3/sec as mentioned in Appendix II, 1.5, the overflow capacity of the spillway was designed to spill out the full discharge for the safety. The reservoir water level will reach to EL. 524.4 m as shown in Fig. 1-32 in the Appendix II. As shown in the calculation of free board of dam in the Appendix II-5, the dam crest is set at EL. 529 m for the safety. (Ref. Fig.-19 and 20)

Those proper gate operation is very difficult unless the advanced rainfall data is obtained and well checked at the dam control office. It is strongly recommended to provide the flood forecasting and warning system in this project. The required fund is therefore included in the estimate of the dam and hydropower project.

4.6.3 Diversion Plan

The river water diversion during the dam construction is also very important from the point of safety and economy. Taking into consideration the very rapid flood reaching time in this basin, the 20-years probable flood peak discharge is taken as the design discharge for the diversion plan. It corresponds to 3,200 m^3/sec although at the Bante gauging station, about 1 km downstream from the proposed damsite, experienced only the maximum flood of around 2,300 m^3/sec since 1957.

In order to meet the above flood peak, the two diversion tunnels are required, of 13 m inside diameter. From the topography, both tunnels will be constructed on the left bank. The gradient of tunnel was selected to be 1/300 same as the natural gradient of the river.

For the construction convenience and future outlet of reservoir water, the sill elevations of both tunnels were decided separately, namely EL. 406 m for No.1 tunnel and EL. 409.9 m for No.2 tunnel. In the dry season when the river discharge is less than 200 m^3/sec, the No.2 tunnel will have no run-off, therefore it can be used as the access tunnel for transportation. In the final stage of construction, an outlet valve will be provided in the No.2 tunnel as the permanent emergency outlet. At the same time the inlet of this tunnel is changed into a vertical elevated tower, the sill of which will have an elevation of EL. 450 m. This device will secure the safe emergency discharging operation of the reservoir water down to EL. 450 m.

As explained in detail in Appendix II, 5.6, this outlet valve can discharge 146 m^3/sec at the normal high water level of EL. 520 m and 116 m^3/sec at the normal low water level of EL. 480 m. It will be effective to lower the reservoir water level down to EL. 450 m, if so required, in cases of abnormal droughty year or for the emergency check of the dam. It will also secure the discharging of water for irrigation or any use between the dam and the tailrace outlet even when the reservoir water level is lower than the normal low water level.

4.6.4 Spillway

The spillway is of normal open chute type concrete structure with a stilling basin at the lowest end. This structure has four main components, namely 1) the gated overflow weir at the beginning point, 2) a flat open channel of about 90 m distance with 57 m width, 3) a steep chute channel of 1:0.8 slope in 140 m distance, and 4) deep stilling basin at the end to dissipate the enormous flow energy.

The detailed hydraulic design was given in Appendix II, 5.4.

4.6.5 Tailrace

The tailrace from the power house has to pass the flat field and the national highway No.5 before joining with the Magat river. The total distance is 933 m. A box section concrete conduit was designed to carry the maximum discharge of about 120 m^3/sec. This concrete conduit shall be backfilled to the original ground level. The tail water level is fixed at EL. 300 m taking into consideration the connection with the irrigation canal in future, if so required.

4.6.6 Cost Estimate on Total Investment on Hydropower Sector

The construction cost of the dam and power facilities was estimated at the price level of May 1983. The total investment cost is provided in TABLE 7 as broken down into both foreign and local currency.

The total amount will be disbursed in five years as broken down in the attached annual disbursement table.

CHAPTER V

PROJECT IMPLEMENTATION AND OPERATION

CHAPTER V

PROJECT IMPLEMENTATION AND OPERATION

5.1 Executing Agency and Coordination

The National Irrigation Administration (NIA) and the National Power Corporation (NPC) will be the executive agencies for Project Stages I and II respectively with the advice of the National Water Resources Council.

For smooth implementation, a committee will better be formed which includes Project concerned authorities and establishment of a Project office within the Project area. The Project Manager selected for direct responsibility of Project execution should have extensive technical experience as well as managerial experience with a quick and decisive character.

The main functions of the Project Construction Office can be described as follows;

i) preparation of all the tender documents for the construction works,

ii) management and supervision of all construction works,

iii) public relations and negotiations with the local beneficiaries,

iv) accounting and general management of the Project and

v) control of safety, health, security, etc. of the Project staff and local labor.

The Project Construction Office will be located at Bayombong. The existing CIS offices shall diligently maintain a close and cooperative relationship with each other.

5.2 Construction Schedule

The agricultural development plan, which includes the construction of irrigation facilities, represents Stage I of the overall development scheme (1986-90), while the hydropower plan makes up Stage II and is scheduled to take effect in 1991 for a 5 year period. The overall time schedule is shown in Fig. 13.

5.2.1 Construction Schedule for Stage I

The Proposed Schedule for Project Construction has been prepared in accordance with the scale of the Project, arrangement of construction machinery and equipment, purchase of construction materials, construction methods and work efficiency. The implementation schedule is divided into Preparation Work and Construction Work. FIG. 11-1 details the construction schedule.

(1) Preparation Work

For smooth operation of detail design, additional surveys, tendering, procurement of construction materials, management and supervision, preparation work covering a projected 12 month period is planned.

(2) Construction Work

Although an estimated 5 year period has been allotted for construction, major construction work is scheduled to be completed within 4 years. Construction has been divided into 3 general stages involving 3 water resource facilities.

Construction of the Magat Diversion Dam is scheduled to begin from the first year and will cover a 3 year period while the Lanog and Manamtam Diversion Dams are scheduled to begin from the second year and to be completed in the third year. From the third year of implementation and before completion of the Magat Diversion Dam, utilization of facilities will be possible, beginning first with upstream Colocol areas. Embankment construction is scheduled from the third year to the fifth year. Stage II of the development plan will follow completion of Stage I, beginning from the year 1991 and following the schedule shown in FIG. 12 and 13.

(3) Phasewise Implementation Plan

An alternative construction plan was studied for reference to minimize the annual financial burden to the minimum, if so required. Although the details are mentioned in APPENDIX I-XII, the outline is as follows:

Phase 1: Construction of a temporary Magat Diversion Dam and irrigation facilities in Colocol canal service area.

Phase 2: Construction of the permanent Magat Diversion Dam and flood protection embankment the flood of 10-year return period.

Phase 3: Construction of Manantan Diversion dams, Manantan irrigation facilities, development of hill area and the flood protection embankment for the design flood of 50-year return period.

It is presumed that each Phase will take three years for construction. If, therefore, the above 3 Phases are constructed in a straight series without any overlapping, the total construction period will be 9 years.

5.2.2 Construction Schedule for Stage II

All the main works will be carried out by contractors awarded by the international bidding except some special works or minor works.

The many preparatory works, such as access roads, bridges, quarters, power supply system, etc. will be carried out by local contractors as and shen so required. The flood forecasting system will be constructed under a separate contract or force account.

All the construction works will be carried out within five years including the preparatory works and the final running test of the generating facilities. The detailed construction time schedule is shown in the attached Fig. 12.

5.3 Operation and Maintenance

5.3.1 Stage I Development Plan

After completion of Project construction, the Project Construction Office will be re-organized into the Project O & M Office for operation and maintenance of irrigation facilities. (see FIG. 14)

Although initial management of the said office will necessarily be under government supervision, provision has been made for transfer of the same to local farmers upon completion of final construction.

Operation and maintenance costs have been estimated at US$290,000 per year based on NIA standards and recent practice. The above estimate, representing 0.54% of the total cost, is equivalent to US$ 23/ha (see APPENDIX I-X). This figure is also equivalent to 2.7 cabans/ha based on the supporting price of rice.

Standard irrigation fees are 2 cabans during the dry season and 3 cabans during the wet season, but in some recent projects 2.5 and 3.5 are applied respectively. Farm budget analysis shows sufficient feasibility even if this recent irrigation fee is applied to the Project.

5.3.2 Stage II Development Plan

The operation and maintenance expenses for Stage II (dam and hydropower facilities) are estimated by two parts, one O & M cost for all facilities and the other the power generation cost. The O & M cost for all facilities is estimated to be 0.2% of the total construction cost, while the power generation cost is estimated to be US$7.9/kW per annum. Thus the total annual O & M cost is to be US$1.97 million.

5.4 Administrative and Engineering Costs

Engineering and administrative expenses for Stage I of the plan include government administration, survey and investigation, the consultant's detail design and construction supervision, overseas training for government officials, test equipment, and etc. The resultant cost estimate is US$3.7 million.

Costs for Stage II, projected to be approximately 10% of total construction costs, is estimated at US$26.1 million.

Annual disbursement schedule of investment cost for both stages are tabulated in TABLES 8 and 9.

CHAPTER VI

PROJECT JUSTIFICATION

CHAPTER VI

PROJECT JUSTIFICATION

6.1 Economic Evaluation of Agricultural Development Plan

6.1.1 General

Project evaluations were made in order to ascertain the feasibility and sensitivity of the Project in view of economic, financial and socio-economic aspects. The forms of Project implementation are agricultural development including flood control and hydropower development.

The economic feasibility of the Project was evaluated in terms of the economic internal rate of return (EIRR) and the net present value (NPV). Further, sensitivity analysis was also made in order to clarify the economic viability of the Project against possible changes of costs and benefits.

The financial feasibility of agricultural development was evaluated by farm budget analysis to confirm Project viability on the farmer's side. On the other hand, hydropower development was evaluated by the financial internal rate of return (FIRR) to confirm financial feasibility. Indirect benefits and socio-economic impacts were assessed in consideration of the effects of the Project on regional development.

6.1.2 Basic Criteria

Basic criteria for economic evaluation are as follows:

i) 50-year project life from 1991 - 2040 for Stage I;

ii) 6-year construction period including detail design; (Agricultural benefits will be expected prior to completion of construction, reaching the targeted benefit 2 years after construction completion. Realization of estimated flood control benefits will be expected immediately after construction completion);

iii) calculation of Project costs and benefits based on the 1983 price level; and

iv) exchange rate between the Philippine peso and US dollar at US$/₱10.

6.1.3 Economic Indicators

In estimation of economic costs the following indicators were considered:

(1) Standard Conversion Factor (SCF)
(Adapted Standard Conversion Factor is 0.82, based on World Bank 1978 analysis.)

(2) Economic prices of farm products and farm inputs (see APPENDIX I-IV). The economic prices of farm products and inputs are estimated by the international prices forecasted by the World Bank. Domestic products in Philippines are estimated by applying the above factor, 0.82 on the market prices.

(3) Economic opportunity cost of farm labor
(Economic opportunity cost of farm labor is here set for seasonal migrant labor at 15 peso/day.)

(4) Economic opportunity cost of unskilled construction labor are heavier than farming work, 20 Peso/day is adopted.

(5) Construction Conversion Factor (CCF)
For economic analysis, the construction conversion factor is estimated as follows:

(a) Imported Component:
Accounts for about 53% of capital cost with a conversion factor of 1.00.

(b) Domestic Component and Skilled Labor:
Accounts for about 40% of capital cost with a conversion factor of 0.82.

(c) Unskilled Labor:
Accounts for about 7% of capital cost with a conversion factor 0.52.

The CCF is calculated at 0.894 using the weighted average of the above items.

6.1.4 Economic Cost

Project cost includes; (1) construction cost, (2) land acquisition and compensation cost, (3) O&M equipment procurement cost, (4) administration expenses, (5) engineering fee, (6) physical contingencies, and (7) price contingencies. Of the above, all costs except tax, land acquisition and price contingencies are counted as net capital cost to be considered in the economic evaluation. This net capital cost is converted into the economic capital cost by applying the CCF.

The economic capital cost and its annual disbursement are as shown below.

Unit: US$'000

Year	1	2	3	4	5	6	Total
Amount	1,188	3,340	9,029	9,424	8,746	3,471	35,198

The economic capital cost, operation and maintenance costs and replacement costs, and their disbursements are tabulated in Table 12.

6.1.5 Annual Operation and Maintenance and Replacement Costs

(1) Operation and Maintenance Cost

The annual O & M cost converted into economic values using the CCF are estimated at US$240,000.

(2) Relacement Cost

Relacement costs are converted into economic value using the conversion factor of 1.00 for O & M equipment (US$0.53 million per 10 years) and 0.82 for canal gates (US$2.00 million once in 25 years).

6.1.6 Project Benefits

Only the agricultural and flood control benefits are included in this evaluation. Estimated annual incremental benefit is calculated as follows:

(1) Agricultural Benefit

Agricultural benefit is evaluated as the difference of estimated net income from potential future crops between "with project" and "without project" condition. Benefits will be realized immediately after completion of Magat diversion dam construction, even before the completion of the whole Project, and reach targeted benefit within 3 years after commencement of works. The annual incremental agricultural economic benefit is US$8.59 million.

(2) Flood Control Benefit

Upon completion of the river embankment, estimated annual average economic benefit is calculated at US$0.752 million due to flood damage reduction against a 50-year return period.

(3) Total Incremental Benefit

The above two benefits total to US$9.342 million. However, during five years between Stage I and II , negative benefits of US$0.15 million in power generation in the downstream Magat Project and US$0.15 million in agriculture due to deficit of supply may be occurred. Therefore the benefit for this transition period becomes US$9.042 million.

6.1.7 Evaluation

(1) Economic Internal Rate of Return (EIRR)

Using the above estimates, cost and benefit streams are presented in TABLE 10. The EIRR is 18.9%, and thus the agricultural and flood control plan, which forms Stage I of the Project, is evaluated as economically feasible.

(2) Net Present Value (NPV)

In order to assess Project viability from an economic viewpoint, the NPV at a discount rated of 10% is calculated as US$24.9 million.

(3) Sensitivity Analysis

In order to evaluate further sensitivity of the Project to possible economic changes, a sensitivity analysis is made for the following critical conditions as an EIRR factor:

Case	EIRR (%)
1. benefit decrease by 20%	15.6%
2. cost increase by 20%	16.7%
3. delay of construction by 2 years	16.4%
4. simultaneity of above cases 1 & 2	13.3%

From the above calculations, the Project is evaluated as viable under all possible conditions discussed above. As far as economic evaluation is concerned, Stage I development is judged as feasible.

6.1.8 Economic Evaluation of Phasewise Implementation

As mentioned in 5.2.1 Paragraph (3), if the Stage I project works are implemented in three phases, the EIRR of each phase becomes as follows:

	Phase 1	Phase 2	Phase 3	Total
a) Construction Cost (US$ million)	27.72	17.09	17.61	62.4
b) Benefitted Area (ha)	8,955	9,285	12,680	-
c) EIRR (%)	20.4	13.5	17.9	18.5

The total construction cost will increase by US$8.352 million than the original plan because the total construction period is 9 years compared with 5 years for original plan. Although the above phasewise implementation can minimize the annual financial burden, still fairly high EIRR is attained. If this phasewise program is adopted, some additional investigations and design will be required for the temporary Magat Diversion Dam, etc. during the detail design period.

6.2 Economic Evaluation for Hydropower Development

6.2.1 Benefit and Cost Criteria for Hydropower Development

As for the power generation benefit, the least power cost among the alternative thermal power plants is adopted. In addition the adjusting factors for kW and kWh values are taken into consideration the different. loss rates between hydropower and thermal power plants.

As for the alternative thermal plants, oil-fired, coal-fired and gas turbine plants are selected for comparison. The power and energy cost of the thermal plant is also different according to the daily operation hours. Therefore the power cost under the same operation hours as the Matuno hydropower plant is selected for the comparison.

The power cost of thermal plant consists of the following three factors:

1) Amortization cost of the initial investment under a certain annual interest with respective economic life. (Capital recovery cost).

2) Annual fixed cost of operation.

3) Fuel cost

The criteria of the thermal power cost is selected as shown below in the price level of early 1983.

	Oil-fired	Coal-fired	Gas turbine
1. Initial investment (US$/kW)	745	990	445
2. Economic life (Year)	30	30	15
3. Amortization rate (%)	10	10	10
4. Fuel cost	34 $/Brl	62 $/t	38 $/Brl
5. Heat value of fuel (BTU/Lb)	18,300	11,540	18,400
6. Head efficiency (%)	38	37	25
7. Rate of operation cost to investment (%/Year)	3.65	5.25	2.50

Based on the above criteria, the energy cost per kWh of the above thermal plants under the plant factor of 33.3% is calculated as follows:

Oil-fired	96.90	US Mill/kWh
Coal-fired	93.04	"
Gas turbine	109.65	"

By the above comparison, it is clarified that the power cost of coal-fired plant is the lowest among others. Therefore, the power cost of the coal-fired plant was selected as the basic benefit of power generation to compare with the Matuno hydropower.

The annual amortization cost of coal-fired plant is calculated to be 105.04 US$/kW·Year and the fixed operation cost per kW is 51.98 US$/kW·Year. The fuel cost per kWh becomes 2.24 US Cent/kWh.

The adjusting factors for kW value and kWh values are estimated by the following difference of the loss rates between hydropower and coalfired plants:

	Loss rate of kW (%)				
	Transmission	Forced outage	Periodical maintenance	Self Consump.	Total
Coal-fired	2.0	5.0	14.0	9.0	27.14
Hydropower	3.0	1.0	2.7	0.3	6.84

Therefore the adjusting factor for kW value is calculated as follows:

$$\frac{1 - 0.0684}{1 - 0.2714} = 1.279$$

The loss rate of kWh is shown below:

	Transmission	Self Consump.	Total loss
Coal-fired	2.0	9.0	10.82
Hydropower	3.0	0.3	3.29

Therefore the adjusting factor for kWh value becomes as follows:

$$\frac{1 - 0.0329}{1 - 0.1082} = 1.084$$

Then the kW value of hydropower becomes 134.34 $/kW·Year, the value of fixed operation cost becomes 2.28 US Cent/kWh and the fuel cost value becomes 2.43 US Cent/kWh.

It is normally deemed that the secondary energy has only the value of fuel saving of the thermal plant and the firm energy has both the values of fixed operation cost and fuel.

The Matuno power development will generate 353 GWh of firm energy and 175 GWh of the secondary energy with the plant capacity of 180 MW. Therefore the annual total benefit (gross) will become as follows:

kW benefit:

180,000 kW x 134.34 \$/kW·Year = 24.18×10^6 \$/Year

Firm energy benefit:

0.0471 \$/kWh x 353 x 10^6 kWh/Year = 16.63×10^6 \$/Year

Secondary energy benefit:

0.0243 \$/kWh x 175 x 10^6 kWh/Year = 4.25×10^6 \$/Year

Total gross benefit: = 45.06×10^6 \$/Year

The annual operation and maintenance cost for the dam and power station was estimated to be 1.97 million US\$ equivalent as the sum of 1.42 million for power generating O&M cost and 0.55 million for O&M cost for all facilities.

Therefore the net incremental benefit is 43.09 million US\$ equivalent per annum.

6.2.2 Benefit Comparison with a Combined Thermal Power Plant of Coal-fired and Gas Turbine

In the official discussions held in Manila in December 1983 on the draft final report, the NAPOCOR asked to compare an alternative with the coal-fired plant; the alternative consisting of a combination of coal-fired and gas turbine plant. This paragraph therefore deals with the proposed alternative case.

The equivalent plant to the Matuno hydropower shall be a combined capacity of 180 MW, consisting of 80 MW coal-fired and 100 MW gas turbine plants, because the Matuno hydropower plant can produce secondary energy in the rainy season equivalent to 80 MW through a day plus 8 hrs. peak up to 180 MW.

The alternative thermal plant will cost as follows:

(1) Construction Cost

Coal-fired : 990 \$/hW x 80,000 kW = 79.2×10^6 \$

Gas turbine: 445 \$/hW x 100,000 kW = 44.5×10^6 \$

Total: 123.7×10^6 \$

(2) Fixed O & M Cost

Coal-fired :	79.2×10^6 \$ x 0.0525/year	= 4.16×10^6 \$/year
Gas turbine:	44.5×10^6 \$ x 0.025/year	= 1.11×10^6 \$/year
Total:		5.27×10^6 \$/year

(3) Fuel Cost

Coal-fired : $0.028 \text{ \$/Lb} \times \dfrac{3{,}413 \text{ BTU/kWh}}{11{,}540 \text{ BTU/Lb} \times 0.37} = 2.24 \text{ Cent/kWh}$

Gas turbine: $0.120 \text{ \$/Lb} \times \dfrac{3{,}413 \text{ BTU/kWh}}{18{,}400 \text{ BTU/Lb} \times 0.25} = 8.90 \text{ Cent/kWh}$

The average fuel cost is calculated to be 5.94 US Cent/kWh in proportion to both the installed capacity.

(4) Capital Recovery Cost

Coal-fired :	79.2×10^6 \$ x 0.1061/year	= 8.40×10^6 \$/year
Gas turbine:	44.5×10^6 \$ x 0.1315/year	= 5.85×10^6 \$/year
Total:		14.25×10^6 \$/year

The above capital recovery cost is equal to 79.17 \$/kW/year.

The adjusting factors for the kW value and kWh value for the hydropower are calculated by the difference of the loss rates and summarized below:

	For kW value	For kWh value
For coal-fired	1.279	1.084
For gas turbine	1.094	1.002

By applying the above factors on the condition of 33.3% plant factor, the equivalent benefit of hydropower becomes as follows:

(i)	Capital Recovery Value:	95.22 US\$/kW/Year
(ii)	Fixed O&M Value:	2.70 US Cent/kWh
(iii)	Fuel Value:	6.03 US Cent/kWh

The gross benefit of the Matuno hydropower station is estimated as shown below:

Capital Recovery Value:	95.22 \$/kW x 180,000 kW =	17.14×10^6 \$/Year
Value of Firm Energy :	8.73 Cent/kWh x 353 GWh=	30.82×10^6 \$/Year
Value of Second Energy:	6.03 Cent/kWh x 175 GWh=	10.55×10^6 \$/Year
Total Annual Benefit		58.51×10^6 \$/Year

The annual O&M cost of Matuno hydropower facilities is estimated to be US\$1.97 million, therefore the net annual benefit is US\$56.54 million. This net benefit is about 31% larger than that estimated from the single coal-fired plant. If the economic internal rate of return is calculated based on the net annual benefit of US\$56.54 million, the EIRR becomes 16.9% which is higher than 14.1% mentioned in 6.2.1.

As the economic evaluation shall adopt the least alternative cost as the benefit, the economic evaluation of Matuno hydropower plant shall be based on the single coal-fired plant as estimated in 6.2.1.

6.3 Economic Internal Rate of Return

The direct construction cost of 272.5 million US\$ will be disbursed in five years as shown below.

Year	F.C.	L.C.	Total
1st Year	18.4	19.2	37.6
2nd Year	25.0	12.9	37.9
3rd Year	37.2	15.9	53.1
4th Year	36.0	17.7	53.7
5th Year	64.9	25.3	90.2
Total:	181.5	91.0	272.5

From the above annual cost, the operation and maintenance cost and the power benefit, the economic internal rate of return for the economic life of 50 years was calculated to be 14.1%, which suggests that this project is economically sound. (See Fig. 15)

A sensitivity analysis on two cases was also made under the assumptions of 10% up of construction cost (Case I) and one year delay of the construction period (Case II). The Case I shows the internal rate of return to be 13.0% and Case II to be 12.6% respectively.

The above economic evaluation was made only on the benefit derived from power generation without any fringe benefits or secondary benefits, such as fresh water fishery, tourism, etc.

6.4 Financial Evaluation of Agriculture Development

6.4.1 General

The financial feasibility of the Project is evaluated from the viewpoint of farmer's economy. The study on capability of capital cost repayment has been made by preparing a cash flow table.

6.4.2 Financial Cost

Based on the current market prices and costs as of February 1983, the financial cost of Stage I development is estimated as follows:

	Foreign Currency	Local Currency	Total
Cost	211,927	161,447	373,374
Physical Contingency	21,192	16,145	37,337
Price Contingency	55,252	74,712	129,964
Total	288,371	252,304	540,675

In this estimate, the physical contingencies of 10%, and the price contingencies of 8% per annum for the local currency portion and 5% per annum for the foreign currency portion are included.

6.4.3 Capacity to Pay

In order to evaluate Project feasibility from the financial aspect of farmers, typical farm budget analyses have been made under both "with project" and "without project" conditions. The capacity to pay expected under "with project" conditions is 8,466.1 Pesos per annum for an average farm (1.64 ha), while under "without project" conditions the capacity to pay remains at 247.7 Pesos per annum. The increase in average farm surplus income would provide incentive for the farmers to participate in the Project. The Project is therefore evaluated to be financially feasible from the viewpoint of farm economy.

6.4.4 Repayment of Project Cost

Financial evaluation of this Project has been made by examining repayment capability for the capital cost of the same. Cash flow tables were evaluated using anticipated Project revenue and fund requirements as tabulated in TABLE 11.

In the examination of repayment capability, it is assumed that the capital required for Project implementation will be arranged under the following conditions:

(1) Capital for the foreign currency portion is financed by bilateral or international organizations with an interest rate of 3.5% per annum for a repayment period of 30 years including a 10-year grace period.

(2) Capital for the local currency portion is financed by Government budget allocations with no repayment.

6.5 Financial Analysis of Hydropower Development

6.5.1 Financial Projections

Financial feasibility of the Project is assessed by loan repayment capability based on net revenue from energy sale and repayment liability as outlined below.

(1) Fund Requirement

Construction cost is estimated at 1983 price levels in the preceding Chapter. Actual construction is scheduled for a 5-year period from 1991-95. Considering current worldwide inflation, a price contingency is included. The annual rates of price escalation during the construction period are set at 5% and 8% for foreign and local currency portions, respectively.

The estimated fund requirement is US$324 million, of which annual disbursement is presented on the following.

(Unit: 10^6US$)

Year	Foreign Currency			Local Currency	Total
	Civil	Electro-mechanical	Sub-total		
1	18.4	0.5	18.9	19.9	38.8
2	24.7	2.2	26.9	14.4	41.3
3	30.7	11.3	42.0	19.3	61.3
4	30.2	12.5	42.7	23.2	65.9
5	64.6	16.3	80.9	35.8	116.7
Total	168.6	42.8	211.4	112.6	324.0

Remark: excluding interest during construction

(2) Loan conditions

As the loan conditions are not settled at the moment, probable loan conditions are assumed for financial analysis of the Project as shown below:

	Foreign Currency		Local Currency
	Civil	Electro-mechanical	
Interest rate	4%	8%	12%
Grace period	7 yrs	7 yrs	7 yrs

(3) Revenue

Revenue is derived from the sale of bulk energy to customers. The current power tariff rate is rather low, nearly equivalent to ₱0.5/kWh on the average. For sound development of future power projects in the Philippines, it is worthwhile to review the current power tariff rate. In consideration of the future increase of amortization cost due to other projects, the power tariff rate in this study is set at ₱0.6/kWh. (See Table 13)

The following assumptions are made in estimating the revenue.

i) Power tariff rate: ₱0.6/kWh

ii) Loss rate (rate of unpaid energy): 10%

iii) O & M cost: US$1.97 million/annum

Accordingly, the estimated net revenue is US$26.54 million, deducting O & M cost from the total revenue.

6.5.2 Financial Internal Rate of Return (FIRR)

Based on the above conditions, the cash flow statement is prepared as shown in TABLE 20 and 21. FIRR was calculated using the Table and sensitivity tests. (See Fig. 17)

The results are as follows:

Case	FIRR (%)
1. Base case	7.2
2. Power tariff rate: ₱0.5 kWh	5.8
3. Loss Rate: 15%	6.7
4. Construction cost: +10%	6.5

With these figures, the Project is considered to be financially viable.

Upon review of the cash flow statement, the total loan including both capital and interest can be repaid in 22 years after commencement of operation of hydropower generation. This review then further underlines the financial viability of the Project. With a 50-year economic life, the financial return is estimated at US$649 million, not including interest over the life.

The above financial analysis affirms the Project's eligibility for loan investment.

A separate cash flow for only the foreign currency loan was prepared as shown in the attached TABLE 23 under the assumption that those foreign currency portion would be borrowed from some international financing sources. The revenue is estimated in proportion to the ratio between the total amounts of foreign currency to the total fund requirement.

This cash flow on foreign currency also reveals that total loan can be repaid in 22 years after completion of the Project. The maximum repayment of interest during the grace period happens in the 7th year, amounting US$16.9 million, which will have to prepare from the other source of foreign income.

The annual revenue up to the 7th year is still short for repayment, but after the 8th year it will exceed the repayment amount. Therefore the 7 years of grace period is proved to be reasonable.

The maximum outstanding loan amount will occur in the 5th and 6th year, amounting to US$211.4 million. But the amount of annual equal installment from the 11th year to 24th year will become US$11.7 million.

Based upon the above financial analysis, it is clarified that the foreign loan shall be negotiated on the conditions of grace period being 7 years and 27 years repayment period including the grace period.

6.6 Inlirect Benefits and Socio-Economic Impacts

In addition to the direct benefits stipulated in the economic evaluation, favorable but intangible indirect benefits and socioeconomic effects are expected through Project implementation.

(1) Increased Employment Opportunity

A significant increase of agricultural production is anticipated after Project implementation. In turn, corresponding increases of employment opportunities in transportation of produce, storage, rice-milling and marketing activities would also result, benefiting the local economy. Moreover, employees in the above areas would gain experience, and technical understanding and skills which could be applied to future development in the area.

(2) Expansion of Local Economy

Increased agricultural production would likewise increase the supply of production goods such as seed, fertilizer, agrochemicals, animal labor, etc., and subsequent investment in the same supply would thus be promoted expanding the scale of the local agricultural merket. Increased agricultural production also means increased wages and profits, as well as consumption and savings. Increased savings will, in turn, promote subsequent investment, and expansion of the general local economy including non-agricultural activities in the area.

(3) Contribution to Local Revenue

Expansion of the local economy will increase tax revenues, resulting in greater sources of public investment.

(4) Foreign Exchange Savings

After completion of the Project, annual rice production will be increased to 93,855 tons from the present 36,554 tons, an increase of 57,301 ton. Out of this increase, a 17,400 tons marketable surplus will remain after substraction of local consumption amounts. This marketable surplus of US$7.8 million per annum will save foreign exchange.

(5) Upon completion of the dam and hydropower station in Stage II, 528 GWh of electric energy will be newly added to the Luzon Grid. It will save annual consumption of diesel oil equivalent to 810,000 barrels which amount to US$27 million saving of foreign currency required for oil import per annum.

(6) The reservoir created by the Matuno Dam will offer the opportunity to utilize it for fresh water fishery and recreation of the local residents, although those indirect benefits are not included in the above economic evaluation.

CHAPTER VII

PRE-PROJECT

CHAPTER VII

PRE-PROJECT

7.1 Necessity for a Pre-project Stage

As described in the previous 4.1.2, it may be argued that basing the decision to commence a new project strictly on the economic appropriateness of allocation is not totally satisfactory. The Team instead submits that the "maturity" of institutions and aspirations of both benefit area residents and executive agency personnel should serve as the principal criteria for according priority to project implementation. Along this same line of thought, it may be asserted that where a project is commenced despite "immaturity" of the above mentioned institutions and aspiration, an inordinate amount of time is required to reach the point where implementation progresses smoothly, with increased danger of project failure.

As the result of consultation between Team members and concerned personnel within the Government, it was decided to establish a Preparation Stage prior to moving forward with Stage I development. This period would allow for preparations necessary to insure that all project implementation aspirations move smoothly once actual construction is commenced. The said preparation Stage is to begin immediately upon completion of F/S work, and desirably is to be supervised under the responsibility of NIA and agencies concerned within the Government.

On the basis of discussions with envisaged Project beneficiaries and experts in Nueva Vizcaya, the Team proposes that the said Preparation Stage be carried out as outlined hereinafter.

7.2 Program for Preparation Stage

Prior to commencement of the Preparation Stage, it is first necessary to clearly delineate the respective responsibilities of nothing more than executing agencies and beneficiary farmers. Achievement of abstract results during the Preparation Stage is not only meaningless but also poses the danger of inducing a loss of incentive in executing and beneficiary personnel. It is also essential that this stage not be overly long. The Team recommends that the Preparation

Stage be two years in duration and has agreed to formulate a program for action which is both specific and readily understandable.

i) Beneficiary farmers are to be briefed regarding objectives and content of the Project utilizing an abbreviated version of this Report.

ii) Residents of the Project area are to be convinced of the fact that they will clearly benefit as a result of Project implementation.

iii) Envisaged beneficiaries are to be convinced of the necessity to participate in the Project.

iv) Understanding is to be evoked in beneficiary farmers regarding the manner in which they will profit and responsibilities they will incur through participation in the Project.

Through the above measures, the interest and cooperation of Project participants is to be cultivated. Efforts will be continued until Project area residents achieve a level of awareness and concern that they respond promptly to Government actions in respect to the Project. When the instructors and instructees have achieved a concensus of thought and action, it will be considered that the Preparation Stage is over.

Of maximum importance for the Preparation Stage Program is the active participation of beneficiaries in the Project area. Accordingly, the Government must provide a formula whereby participation by area residents is readily possible. Such a formula should contain the following two areas of participation within which beneficiaries may follow a prescribed program of activities over a designated time frame. If time or physical limitations should prevent participation in both areas of activity, beneficiaries should be encouraged to take part in at least one category of activity.

i) Participation in institutional activities

ii) Participation in field activities

Rather than compulsory, participation in the above activities by beneficiaries should be encouraged on a voluntary basis. Utilization of irrigators' associations created through existing communal irrigation development would be a practical means of establishing participatory groups on an irrigation system basis.

7.3 Farmer Organizations as Principal Institutions

Through field survey, the survey Team examined the existing CIS in detail. An "institutional team" composed of three expatriate experts (one each from the sectors of agricultural economics, sociology and agronomy) joined with five NIA counterparts in visiting CIS irrigators' associations (CISIA) and presenting questionnaires. The results of this survey are compiled in section 3.6 of this report and indicate that CISIA leaders are currently faced by numerous problems related to among others distribution, water management, irrigation and drainage system, access roads and flood damage. It is also clear that area farmers are keenly desirous of improvements in living standards.

Numerous farmers expressed their willingness to participate in the Project if an adequate supply of irrigation water could be ensured. Residents of the envisaged Project area are accordingly aware that a rise in living standards is linked to needed improvements in the agriculture productive infrastructure.

Given the current living standards of farmers in the vicinity of Bayombong and Solano in Central Luzon, it would not appear difficult to organize farmers and encourage participation in the Project. Furthermore, there are 75 existing CISIA within the Project area, of which 30 are organized under a single umbrella federation. CISIA's are formally registered associations, the directors of which are elected by association members. CISIA's are actively engaged in the collection of irrigation fees. Utilization of these existing CISIA as the principal institution for carrying out participatory activities accordingly appears to be the most logical approach.

Taking into consideration the nature of existing CIS and regional administrative jurisdiction within the Project area, the said area is to be divided into 12 activity units. Each such unit is to be composed of a number of CIS. As the CIS in the Project area are currently managed, the activity units will comprise somewhat loosely constituted umbrella organizations to foster dissemination of information, facilitate seminar presentation, etc.

7.4 Activity Program Related to Institutional Aspects

Drawing on personnel primarily from NIA and Ministry of Agriculture, 3 working party teams are proposed to be created, each consisting of 3 persons including 2 institutional related personnel and 1 civil engineering personnel. These individuals will function as activity organizers and will provide active leadership during the initial stage of the Preparation Stage. The selection of appropriate, qualified staff for working parties will have a decisive influence on the success or failure of the program.

Primarily, however, it must be emphasized that the job of the working parties will not be to "instruct" or "educate" area farmers. Conventionally, government activities in this regard have consisted of speeches and seminars; however, it is not considered effective to rush forward with this type of activity from the outset. The approach envisaged by the Team is outlined below.

Step One: 4 months (1-4)

Each working party is to be responsible for 4 activity units. During the first 4-month period, each working party will visit villages and hamlets within its area of responsibility at a targeted rate of 1 activity unit/month. During their visits, working party staff will meet and talk to residents. This daily contact between working party personnel and area farmers will provide the means whereby their problems, needs and frustrations are identified, and trust is established between government staff and Project area residents. The latter is particulary important in that a certain amount of distruct may be present among some farmers simply by virtue of the fact that the working parties have been dispatched by the government. At times, dispelling of this wariness on the part of farmers cannot be accomplished through conversation alone, at which time it may be necessary on the part of working party personnel to become more actively involved in daily activities of the farmers, such as assisting at times with farm work, etc.

Step Two: 4 months (5-8)

As in Step One, working parties are targeted to visit villages and hamlets of 1 activity unit/month. At the time of visitation, working party personnel will distribute pamphlets and provide explanation pertinant to items presented under Step One. Explanatory material is to be readily understandable. Explanatory measures are to be particularly pursued until area farmers gain an understanding of the significance of the Project for area development. If a relationship of mutual trust has been established in Step One between Government staff and area residents, it may be expected that farmers will respond with interest and concern to the advice and recommendation of working party personnel. During the final portion of this Step, it is important that efforts be made to identify promising candidates as farmer leaders.

Step Three: 4 months (9-12)

During this Step, farmers' meetings are to be promoted. Ability to successfully convene meetings may be considered as already achieving a large measure of the objectives of this Step. Careful consideration must be given to the agenda for such meetings. The content of meetings must be significant to the farmers and clearly linked to enhancing their benefits. Seminar themes would be studied and prepared for consideration as follows:

i) Classification for periods of drought of paddy field into "severely affected" and "lightly affected", and survey of canal conditions, paddy field elevation, and paddy area for each classification.

ii) Same survey activities as given in i), above as relevent to conditions of flooding and drainage.

iii) Survey of potential crop yields on a unit-by-unit (activity unit) basis.

Through the above activities, participating farmers increase their understanding of farming conditions in their immediate vicinity.

Next, under the guidance of organizers, combined meetings of 4 activity groups each are held and the results of investigations carried out by each activity unit area shared with the other units. In this manner, the solidarity between farmers is strengthened and their sphere of interest and concern widened.

Other themes recommendable for consideration are:

i) Survey of member CIS

ii) Visitation of neighboring CIS to exchange opinions regarding function, problem points, operational aspects of respective CIS, as well as to foster goodwill between farmers of differing systems.

iii) Visitation of farmers producing high yields to elicit their ideas on agricultural technology, water management, etc.

iv) Investigation of means to promote acquisition of new farm management and cultivation practices. Meetings would be held to discuss pilot farm establishment.

Regarded iv) above, construction of a pilot farm on a voluntary basis by the farmers during the second year of the Preparation Stage is to be encouraged. This would be accomplished under the guidance of the aforementioned working parties with cooperation from Government research laboratory facilities and extension workers. During Step Three of the Preparation Stage, consultations would be held between area farmers and concerned government personnel to determine specifics of pilot farm site, pilot farm activities and operation, etc. Also during this Stage the following would be queried:

> Correlation of expectations by farmers regarding benefit to be derived from NIA's Matuno River Development Project. Aspirations concerning the Project would be delineated as specifically as possible.

In regards to the above, basic policy of the Government regarding the Project and the changes it will bring to the Project area are to be explained to area farmers by the organizers. Discussions would be encouraged among farmers regarding specific means by which they can cooperate to bring about early and successful implementation of the Project. Hopefully, farmers would be able to contribute in their respective areas of expertise. Their decision to do so would mark the successful conclusion of the first year of the Preparation Stage and the appropriate time to move into the specific activities of the second year.

TABLES

NIA PERSONNEL

1. COUNTERPARTS PERSONNEL

ASSIGNMENT	NAME	POSITION
Project Coordinator	Rogelio P. De La ROZA	Chief, Project Investigation Div., Project Development Dept. (PDD)
Assistant Project Coordinator	Orlando D. PASUCUAL	Head, Hydrogeology Section, PDD
Surveys & Mapping	Faustino M. GALIT	Head, Surveys and Mapping Section, PDD
Drainage Engineer	Emerson M. COLOMA	Head, Drainage Section, PDD
Drainage Engineer	Calixto M. TIMONERA	Senior Hydrologist, PDD
Flood Control Engineer	Leovino C. ALVERO	Supervising Hydrologist, PDD
Geologist	Pablito C. SUPNET	Supervising Geologist, PDD
Geophysical Engineer	Orlando C. VILLALON	Senior Hydrologist, PDD
Hydro-Power Engineer	Alberto BALUYUT	Senior Mechanical Engineer, PDD
Irrigation Engineer	Armando A. MAULAWIN	Planning Engr., Irrigation Works, PDD
Dam Engineer	Crispino CARLOS	Senior Planning Engineer, PDD
Hydrologist	Milo M. LANDICHO	Senior Hydrologist, PDD
Structure Engineer	Rogelio BARWELO	Senior Planning Engineer, PDD
Soil Engineer	Bernardo O. VALENZUELA	Supervising Soil Technologist, PDD
Economist	Socorro T. RAQUEPO	Senior Economist, PDD
Agronomist	Rogelio T. AGUINALDO	Senior Agricultural Engineer, PDD
Engineering Geologist	Ricardo DIMACULANGAN	Geologist, PDD

2. NIA PERSONNEL CONTACTED DURING STUDY

NAME	POSITION
Cesar L. TECH	Acting Administrator
Jose B. del ROSARIO, Jr.	OIC, Office of the Assistant Administrator for Project Development & Implementation
Avelino S. RIVERA	OIC, Project Development Department
Felipe G. PERDIDO	Head, Hydrography Section
Romeo POTENCIANO	OIC, Water Resources Utilization Division
Epifanio C. GACUSAN	Chief, Land Resources Utilization & Economics Division
Conrado Q. TINGZON	Head, Land Classification Section
Dominador D. PASCUA	Head, Land Use Section
Primo B. VILLANUEVA	Head, Economics Section
Isidro R. DIGAL	Chief, Plan Formulation Division
Clemente T. ALANANO	Head, Dams and Reservoir Section
Edilberto B. PUNZAL	Head, Irrigation Works Section
Abelardo Y. ARMENTIA	Head, Feasibility Studies Section
Domingo FULO	Supervising Planning Engineer
Renato M. RESUMA	Senior Planning Engineer
Arsenio A. PAGADUAN	Project Coordinator, Magat Watershed Feasibility Studies
Edilberto PAYAWAL	Division Manager, Systems Management Department
Aristeo DANAO	Provincial Irrigation Engineer, Nueva Vizcaya

NAME	POSITION
Francisco DOMANGSIL	Assistant Provincial Irrigation Engineer, Nueva Vizcaya
Reynaldo S. LIBATIQUE	Regional Director, Region II Isabela

MEMBER OF PROJECT SUPERVISORY TEAM

ASSIGNMENT	NAME	POSITION
Team Leader	Tadashi YOSHIMITSU	Director, Himi Irrigation and Drainage Project Office, Hokuriku Regional Agricultural Administration Office, Ministry of Agriculture, Forestry and Fisheries
Irrigation Engrieer	Mamoru TSUCHIMOCHI	Deputy Director, Construction, Planning and Coordination Div., Design Dept., Agril. Structure Improvement Bureau, MAFF
Rural Development	Norikazu TSUJII	Director, Project Planning Div., Planning Dept., Tokai Regional Administration Office, MAFF
Agronomy	Utsuwa FUKUMOTO	Deputy Director, Resources Div., Planning Dept., Tokai Regional Agricultural Administration Office, MAFF
Flood Control	Koichiro KATSURAGI	Deputy Director, River Planning Div., River Improvement Bureau, Ministry of Construction
Economy	Shigeru Takeda	Budgeting Div. Coordination Dept. OECF

MEMBER OF TECHNICAL ADVISER

ASSIGNMENT	NAME	POSITION
Hydropower	Kenji TAKASHIMA	Second Technical Appraisal Div. Economical Research and Technical Appraisal Dept. OECF
Hydropower	Katsuhiko OHTAKI	Nuclear Generation Div. Agency of National Resources and Energy, MITI
Hydropower	Masanori SASAKI	Hydroelectric Power Div. Agency of National Resources and Energy, MITI

MEMBERS OF THE IRRIGATION TEAM		MEMBERS OF THE HYDROPOWER TEAM	
ASSIGNMENT	NAME	ASSIGNMENT	NAME
Team Leader Irrigation Project Planner	Takashige KIMURA	Team Leader	Makoto TSUDA
		Hydropower Engineer	Iwao OHKI
Dam Engineer	Noboru YAMAGUCHI	- do -	Shunichi KIKUCHI
Dam Foundation Engineer	Tadashi OZEKI	Hydrologist	Seiichi NAKAO
Hydrologist	Yuya HIRASE	Geologist	Isao SUZUKI
Geologist	Hisao KOMURA	- do -	shuhei NISHIOKA
River Engineer	Keiji SASABE	Seismic Prospeting Specialist	Jun KANEKO
Structure Engineer	Takafumi SUZUKI	- do -	Jiro KOBAYASHI
Irrigation and Drainage	Noboru ICHIJI	Electric Engineer	Yasumasa ADAKA
Canal Engineer	Shuichi MATSUSHIMA	- do -	Saburo SUZUKI
Agronomist	Kimio SAKATA	Constuction Material Engineer	Sadao SANEKATA
Soil Engineer	Hisashi ISHIKAWA	Topo-Surver Engineer	Fusao WATANABE
Agro-Economist	Hiromitsu NIKAIDO	Economist	Toshikazu TAI
Material Engineer	Koji EGUCHI	- do -	Tetsuo OKAMOTO
Dam Structure Engineer	Shigeaki MIWA	Dam Design	Kenichi TATEISHI
		- do -	Kazuharu HASHIMOTO
Rural Development Specialist	Shigetoshi AKEDA		
Dam Design Engineer	Toshiaki MURAOKA		
Topo-survey Engineer	Kiyoji KOZAWA		

TABLE 2

PROPOSED LAND CLASSIFICATION

Unit: ha

Land Class	Lowland Area	Upland Area	Total
Arable	12,780	1,280	14,060
1R	9,510	-	9,510
2R	860	-	860
3R	-	30	30
Sub-total	10,370 1/	30	10,400
1R (2)	1,320	40	1,360
2R (2)	130	-	130
Sub-total	1,450 1/	40	1,490
2	740	-	740
3	120	110	230
Sub-total	860 1/	110	970
4 Or	100	500 2/	600
4 P	-	500 3/	500
4 F	-	100 3/	100
Non-arable	6,520	20	6,540
Class 6	4,110	-	4,110
M-land	1,440	20	1,460
Right of ways	970	-	970
Total	19,300	1,300	20,600

Note:

1/ Total 12,680ha included in the proposed Project area for lowland development

2/ 400ha is included in the proposed Project area for hill area development

3/ 600ha is included in the proposed Project area for hill area development

TABLE 3

PROPOSED LAND USE

Unit: ha

Land Use	Lowland Area	Upland Area	Total
Cultivated Land			
Paddy			
(irrigated)	10,830 1/	30	10,860
(rainfed)	-	40	40
(upland dry farming)	-	110	110
Paddy - Corn	450 1/	-	450
Corn - Peanut	1,000 1/	-	1,000
Corn - Vegetable	400 1/	-	400
Orchard	100	500 2/	600
Pasture	-	500 3/	500
Tree-farming	-	100 3/	100
Sub-total	12,780	1,280	14,060
Non-arable Land			
Class 6	4,110		4,110
Residential area	1,440	20	1,460
Right of way	970		970
Sub-total	6,520	20	6,540
Total	19,300	1,300	20,600

Note:

1/ Total 12,680ha included in the proposed Project area for lowland development

2/ 400ha is included in the proposed Project area for hill area development

3/ 600ha is included in the proposed Project area for hill area development

MAIN FEATURES OF STAGE I DEVELOPMENT

1. Gross Project Area		20,600 ha
2. Benefited Area		13,680 ha
3. Irrigation Water Requirement		21.4 m^3/s
4. Irrigation System		
4.1 Diversion Dam		
1) Magat Diversion Dam	Total width: 305m	
	Fixed weir width: 228m, height: 1.6m	
	Steel flap gate: 30m x 2 sets	
	Fixed wheel gate: 13m x 1 set	
Diversion canal	Bed width: 7m, wet masonry lining	
	Length: 250m	
Diversion structure		1 set
2) Manamtam Diversion Dam	Total width: 127m	
	Fixed weir width: 118m, height: 2.5m	
	Fixed wheel gate: 5m x 1 set	
3) Lanog Diversion Dam	Rubber dam width: 35m, height: 1.8m	
4.2 Irrigation Canal		
1) Main canal	Dry masonry lining	21.10km
	Earth lining	69.25km
2) Lateral canal	Earth lining	193.40km
3) Parshall flume		2 nos
4) Double orifice		368 nos
5) Fixed proportional divisor		24 nos
6) Check gate		370 nos
7) Chute		67 nos
8) Vertical drop		747 nos
9) Wasteway		17 nos
10) Siphon		33 nos
11) Drainage culvert		12 nos
12) Bridge		36 nos
13) Pipe road crossing		100 nos
14) Drain inlet		69 nos

5. Drainage System

Main canal	New construction: 2.4km		
	Rehabilitation: 16.5km	Total	18.9km
Lateral canaal	New construction: 19.85km		
	Rehabilitation: 13.4km	Total	33.25km

6. Inspection Road

Width	6m	(Effective width		4.5m)	14.5km
-do-	4m	(	-do-	3.0m)	273.68km
-do-	3m	(	-do-	2.3m)	55.72km

7. On-farm Development 12,680 ha

8. Hill Area Development

Farm road (width 5m, effective width 4.0m)	20km
Fence	18km
Livestock water supply	2 nos

9. Flood Embankment (Bank top width: 6.0m, River side: Gabion protection) 12.1km

10. Operation and Maintenqnce Equipment L.S.

11. Land Acquisition 386 ha

MAIN FEATURES OF STAGE II DEVELOPMENT

1.	Dam:	Type: Rockfill with a centre core zone Crest Elevation: EL. 529 m Height from foundation: 147 m Crest length: 580 m Crest width: 14 m Dam volume: 10,000,000 m^3
2.	Reservoir:	HWL: EL. 520 m LWL: EL. 480 m Surface area: 3.5 km^2 Gross storage capacity: 137 x 10^6 m^3 Dead storage capacity: 40 x 10^6 m^3 Effective storage capacity: 97 x 10^6 m^3 Maximum flood WL: EL. 524.70 m
3.	Diversion Tunnels:	Two number of concrete-lined circular tunnels Inside diameter: 13.0 m Length: No.1 Tunnel 930 m No.2 Tunnel 980 m
4.	Spillway:	Gated overflow weir and concrete-lined chute type spillway with a stilling basin Gates: Radial gates, 4 Nos Gate size: 16 m (H) x 12 m (W) Crest Elevation: EL. 504 m Design Flood Discharge: 10,300 m^3/sec
5.	Intake Structure:	Concrete vertical shaft Gate: 6.4 m x 6.4 m x 1 set with movable and fixed trash racks
6.	Pressure Tunnel:	Concrete-lined circular tunnel Diameter: 6.4 m Length: 5,650 m
7.	Surge Tank:	Chamber type concrete-lined vertical shaft

8.	Penstock Tunnel & Penstock:	
		Tunnel length: 430 m
		Open penstock pipeline: 420 m
		Diameter: 5.50 m - 2.80 m x 2 Nos.
9.	Power House:	Floor size: 30.5 m x 60.0 m
10.	Turbines:	Vertical shaft Francis turbine, 2 units
		Elevation of runner centre: EL. 296 m
		Turbine capacity: 92,700 kW x 2 units
		Rated speed: 277 rpm
		Tailwater level: EL. 300 m
		Max. gross head: 220 m
		Min. gross head: 180 m
11.	Generators:	Vertical shaft synchronous generator
		Capacity: 100,000 kVA x 2 units
		Voltage: 13.8 kV
		Frequency: 60 Hz
		Power factor: 0.90
12.	Main Transformer:	Three-phase outdoor type
		Voltage: 13.8 kV/230 kV
		Capacity: 100,000 kVA x 2 units
13.	Transmission Line:	Double circuit, single conductor
		Voltage: 230 kV
		Conductor: ACSR 795 MCM
		Length: 2.0 km
14.	Tailrace Conduit:	Concrete box culvert
		Size: 13.6 m (W) x 7.2 m (H)
		Length: 933 m

FINANCIAL CONSTRUCTION COST FOR STAGE I DEVELOPMENT
(Agriculture and Flood Protection)

(Unit: US$ '000)

Description	Foreign Cost	Local Cost	Total
1. Civil Works	18,266.7	13,830.3	32,097.0
a) Diversion Dams	4,370.0	2,751.0	7,121.0
b) Irrigation system	7,491.1	5,599.9	13,091.0
c) Drainage System	2,195.6	1,933.2	4,128.8
d) Road	1,506.5	645.7	2,152.2
e) On-farm	431.6	1,310.1	1,741.7
f) Hill Area Development	129.3	79.7	209.0
g) Flood Protection	2,142.6	1,510.7	3,653.3
2. Land Acquisition		698.4	698.4
3. O & M Facilities	530.0	300.0	830.0
4. Administration and Engineering Cost	2,396.0	1,316.0	3,712.0
Sub-total (1-4)	21,192.7	16,144.7	37,337.4
5. Physical Contingency	2,119.2	1,614.5	3,733.7
6. Price Contingency	5,525.2	7,471.2	12,996.4
Grand Total	28,837.1	25,230.4	54,067.5

FINANCIAL CONSTRUCTION COST FOR STAGE II DEVELOPMENT

(As of May, 1983)

Works		Foreign Currency (10^3 US$)	Local Currency (10^3 US$)	Total (10^3 US$)
(1)	Land Acquisition & Other Compensations	0	2,000	2,000
(2)	Preparatory Works	8,400	3,600	12,000
(3)	Diversion Tunnel	7,455	9,765	17,220
(4)	Rockfill Dam	59,000	24,000	83,000
(5)	Scillway	8,710	3,390	12,100
(6)	Spillway Gates	4,648	1,992	6.640
(7)	Intake Structure	1,357	543	1,900
(8)	Pressure Tunnel	8,264	10,736	19,000
(9)	Surge Tank	953	847	1,800
(10)	Penstock Tunnel	2,016	1,984	4,000
(11)	Penstock	8,112	2,088	10,200
(12)	Power House	5,382	1,918	7,300
(13)	Tailrace	7,882	2,818	10,700
(14)	Outlet for Irrigation Water	1,028	432	1,460
(15)	Permanent Buildings	240	360	600
(16)	Flood Forecasting System	560	140	700
(17)	Outdoor Switchyard (Civil)	73	27	100
(18)	Generating Equipment	22,720	5,680	28,400
(19)	Transmission Line	140	78	218
(20)	Substation Equipment	1,230	297	1,527
(21)	Miscellaneous Works	2,298	837	3,135
Total for Net Direct Const. Cost		150,468	73,532	224,000
(22)	Physical Contingencies	15,047	7,353	22,400
(23)	Engineering & Administration	16,700	9,400	26,100
Total for Economic Evaluation		182,215	90,285	272,500
(24)	Price Escalation	30,000	21,500	51,500
(25)	Interest During Construction	17,000	29,000	46,000
Grand Total for Financial Eval.		229,215	140,785	370,000

TABLE 8

ANNUAL DISBURSEMENT SCHEDULE OF INVESTMENT COST FOR STAGE I DEVELOPMENT

STAGE I DEVELPMENT

(Unit: US$ '000)

Description	Total			1985			1986			1987			1988			1989			1990		
	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.
1. Pre-Engineering	105.0	-	105.0	105.0	-	105.0															
2. Civil Works																					
a) Diversion Dam	7,121.0	4,370.0	2,751.0				1,031.9	807.0	224.9	2,328.0	1,387.7	940.3	2,974.1	1,730.3	1,243.8	787.0	445.0	342.0	-	-	-
b) Irrigation System	13,091.0	7,491.1	5,599.9				1,337.2	762.2	575.0	3,160.4	1,807.6	1,352.8	3,532.1	2,023.0	1,509.1	4,235.8	2,427.5	1,808.3	825.5	470.8	354.7
c) Drainage System	4,128.8	2,195.6	1,933.2				250.0	140.0	110.0	900.0	446.2	453.8	500.0	280.0	220.0	950.0	503.1	446.9	1,528.8	826.3	702.5
d) Road Network	2,152.2	1,506.5	645.7				150.7	105.5	45.2	452.0	316.4	135.6	581.1	406.7	174.4	796.3	557.4	238.9	172.1	120.5	51.6
e) On-Farm Dev't	1,741.7	431.6	1,310.1				-	-	-	478.1	118.5	359.6	490.8	121.6	369.2	677.9	168.0	509.9	94.9	23.5	71.4
f) Hill Development	209.0	129.3	79.7				-	-	-	-	-	-	-	-	-	-	-	-	209.0	129.3	79.7
g) River Embankment	3,653.3	2,142.6	1,510.7				-	-	-	836.5	490.2	346.3	1,157.5	677.1	478.4	1,157.4	679.1	478.3	501.9	294.2	207.7
Sub-Total	32,097.0	18,266.7	13,830.3				2,769.8	1,814.7	955.1	8,155.0	4,566.6	3,588.4	9,235.6	5,240.7	3,994.9	8,604.4	4,780.1	3,224.3	3,332.2	1,864.6	1,467.6
3. Land Acquisition	698.4	-	698.4				52.9	-	52.9	175.5	-	175.5	185.7	-	185.7	223.1	-	223.1	61.2	-	61.2
4. O/M Equipment	830.0	530.0	300.0				210.0	-	210.0	620.0	530.0	90.0	-	-	-	-	-	-	-	-	-
5. Administration and Engineering	3,537.0	2,326.0	1,211.0	1,103.2	990.0	113.2	483.1	364.0	119.1	604.7	324.0	280.7	572.5	270.0	302.5	493.5	216.0	277.5	280.0	162.0	118.0
6. Training	70.0	70.0	-	30.0	30.0	-	20.0	20.0	-	20.0	20.0	-	-	-	-	-	-	-	-	-	-
Total (1 - 6)	37,337.4	21,192.7	16,144.7	1,238.2	1,020.0	218.2	3,535.8	2,198.7	1,337.1	9,575.2	5440.6	4,134.6	9,993.8	5,510.7	4,483.1	9,321.0	4,796.1	4,324.9	3,673.4	2,026.6	1,646.8
7. Physical Contingency	3,733.7	2,119.2	1,614.5	123.8	102.0	21.8	353.6	219.9	133.7	957.5	544.1	413.4	979.4	551.0	448.4	932.1	499.6	432.5	367.3	202.6	164.7
Total (1 - 7)	41,071.1	23,311.9	17,759.2	1,362.0	1,122.0	240.0	3,889.4	2,418.6	1,470.8	10,532.7	5,984.7	4,548.0	10,793.2	6,061.7	4,931.5	10,253.1	5,495.7	4,757.4	4,040.7	2,229.2	1,811.5
8. Price Contingency	12,996.4	5,525.2	7,471.2	114.6	85.2	29.4	657.8	315.8	312.0	2520.3	1,114.4	1,405.9	3,529.3	1,488.3	2,041.0	4,198.6	1,691.6	2,507.0	2,007.8	831.7	1,175.9
Total	54,067.5	28,837.1	25,230.4	1,476.6	1,207.2	269.4	4,515.2	2,732.4	1,782.8	13,053.0	7,099.1	5,953.9	14,522.5	7,550.0	6,972.5	14,451.7	7,187.3	7,264.4	6,048.5	3,061.1	2,987.4

ANNUAL DISBURSEMENT SCHEDULE
FOR STAGE II DEVELOPMENT

(Unit: 10^6 US$)

Fiscal Year	1st Year	2nd Year	3rd Year	4th Year	5th Year	Total
1. Direct Construction Cost Incl. Physical Contingencies & Eng. & Administration						
1-A. Foreign Currency	18.4	25.0	37.2	36.0	64.9	181.5
1-B. Local Currency	19.2	12.9	15.9	17.7	25.3	91.0
Sub-total (Economic Cost)	37.6	37.9	53.1	53.7	90.2	272.5
2. Price Escalation						
2-A. Foreign Currency	0.4	1.9	4.8	6.7	15.8	29.6
2-B. Local Currency	0.8	1.6	3.4	5.5	10.6	21.9
Sub-total	1.2	3.5	8.2	12.2	26.4	51.5
3. Interest During Construction Period						
3-A. Foreign Currency	0.4	1.4	2.8	4.8	7.8	17.2
3-B. Local Currency	1.3	3.2	5.3	7.7	11.3	28.8
Sub-total	1.7	4.6	8.1	12.5	19.1	46.0
4. Grand Total						
4-A. Foreign Currency	19.2	28.3	44.8	47.5	88.5	228.3
4-B. Local Currency	21.3	17.7	24.6	30.9	47.2	141.7
Total (Financial Cost)	40.5	46.0	69.4	78.4	135.7	370.0

PHASEWISE ECONOMIC COST AND BENEFIT STREAM
(STAGE I)

Unit: US$ '000

Year	Year in Order	1st Phase Cost	1st Phase Benefit	2nd Phase Cost	2nd Phase Benefit	3rd Phase Cost	3rd Phase Benefit	Overall Cost	Overall Benefit
1983	1	-	-	-	-	-	-	-	-
1984	2	-	-	-	-	-	-	-	-
1985	3	1,906	-	-	-	-	-	1,906	-
1986	4	5,222	-	-	-	-	-	5,222	-
1987	5	6,795	-	-	-	-	-	6,795	-
1988	6	5,419	3,127	992	-	-	-	6,411	3,127
1989	7	160	3,608	3,560	-	-	-	3,720	3,608
1990	8	160	4,329	4,071	-	-	-	4,231	4,329
1991	9	160	4,810	1,541	-	2,174	-	3,875	4,810
1992	10	160	4,810	25	1,094	3,519	-	3,704	5,904
1993	11	160	4,810	25	1,367	3,101	-	3,286	6,177
1994	12	160	4,810	25	1,823	55	727	240	7,360
1995	13	160	4,810	25	1,823	55	1,084	240	7,717
1996	14	160	4,810	25	1,823	55	1,686	240	8,319
1997	15	160	4,810	25	1,823	55	2,409	240	9,042
1998	16	530	4,810	25	1,823	55	2,409	610	9,042
1999	17	160	4,810	25	1,823	55	2,409	240	9,042
2000	18	160	4,810	25	1,823	55	2,409	240	9,042
2001	19	160	4,810	55	1,823	55	2,409	270	9,042
2002	20	160	4,810	25	1,823	55	2,409	240	9,042
2003	21	1,110	4,810	25	1,823	185	2,409	1,320	9,042
2004	22	160	4,810	25	1,823	55	2,409	240	9,042
2005	23	160	4,810	25	1,823	55	2,409	240	9,042
2006	24	160	4,810	25	1,823	55	2,409	240	9,042
2007	25	160	4,810	25	1,823	55	2,409	240	9,042
2008	26	530	4,810	25	1,823	55	2,409	610	9,042
2009	27	160	4,810	25	1,823	55	2,409	240	9,042
2010	28	160	4,810	25	1,823	55	2,409	240	9,042
2011	29	160	4,810	55	1,823	55	2,409	270	9,042
2012	30	160	4,810	25	1,823	55	2,409	240	9,042
2013	31	160	4,810	25	1,823	185	2,409	370	9,042
2014	32	160	4,810	25	1,823	55	2,409	240	9,042
2015	33	160	4,810	25	1,823	55	2,409	240	9,042
2016	34	160	4,810	925	1,823	55	2,409	1,140	9,042
2017	35	160	4,810	25	1,823	55	2,409	240	9,042
2018	36	1,480	4,810	25	1,823	505	2,409	2,010	9,042
2019	37	160	4,810	25	1,823	55	2,409	240	9,042
2020	38	160	4,810	25	1,823	55	2,409	240	9,042
2021	39	160	4,810	55	1,823	55	2,409	270	9,042
2022	40	160	4,810	25	1,823	55	2,409	240	9,042
2023	41	160	4,810	25	1,823	185	2,409	370	9,042
2024	42	160	4,810	25	1,823	55	2,409	240	9,042
2025	43	160	4,810	25	1,823	55	2,409	240	9,042
2026	44	160	4,810	25	1,823	55	2,409	240	9,042
2027	45	160	4,810	25	1,823	55	2,409	240	9,042
2028	46	530	4,810	25	1,823	55	2,409	610	9,042
2029	47	160	4,810	25	1,823	55	2,409	240	9,042
2030	48	160	4,810	25	1,823	55	2,409	240	9,042
2031	49	160	4,810	55	1,823	55	2,409	270	9,042
2032	50	160	4,810	25	1,823	55	2,409	240	9,042
2033	51	1,110	4,810	25	1,823	185	2,409	1,320	9,042
2034	52	160	4,810	25	1,823	55	2,409	240	9,042
2035	53	160	4,810	25	1,823	55	2,409	240	9,042
2036	54	160	4,810	25	1,823	55	2,409	240	9,042
2037	55	160	4,810	25	1,823	55	2,409	240	9,042
2038	56	160	5,210	25	1,823	55	2,409	240	9,042
2039	57			25	1,823	55	2,409	80	9,042
2040	58			25	1,823	55	2,409	80	9,042
2041	59			25	1,450	55	2,409	80	9,042
2042	60					55	2,409	55	9,042
2043	61					55	2,382	55	9,042

FINANCIAL CASH FLOW STATEMENT (STAGE I)

(unit: US$ '000)

Year	Year in Order	Loan Disburse-ment	Accu-mulated Loan	O & M Cost	Cash Outflow: Repaym't of Loan Interest	Cash Outflow: Repaym't of Loan Capital	Cash Outflow: Total Outflow (A)	Cash Inflow: Project Revenue	Cash Inflow: Governm't Subsidy	Cash Inflow: Total Inflow (B)	Balance Repaymt (B)-(A)
1985	1	1,207.20	1,207.20	-	42.25	-	42.25	-	42.25	42.25	0
1986	2	2,732.40	3,939.60	-	137.89	-	137.89	-	137.89	137.89	0
1987	3	7,099.10	11,038.70	-	386.35	-	386.35	-	386.35	386.35	0
1988	4	7,550.00	18,588.70	290.00	650.60	-	940.60	290.00	650.60	940.60	0
1989	5	7,187.30	25,776.00	290.00	902.16	-	1,192.16	290.00	902.16	1,192.16	0
1990	6	3,061.10	28,837.10	290.00	1,009.30	-	1,299.30	290.00	1,009.30	1,299.30	0
1991	7	-	28,837.10	290.00	1,009.30	-	1,299.30	290.00	1,009.30	1,299.30	0
1992	8	-	28,837.10	290.00	1,009.30	-	1,299.30	290.00	1,009.30	1,299.30	0
1993	9	-	28,837.10	290.00	1,009.30	-	1,299.30	290.00	1,009.00	1,299.30	0
1994	10	-	28,837.10	290.00	1,009.30	-	1,299.30	290.00	1,009.00	1,299.30	0
1995	11	-	28,278.53	290.00	1,009.30	558.57	1,857.87	290.00	1,567.87	1,857.87	0
1996	12	-	27,700.41	290.00	989.75	578.12	1,857.87	290.00	1,567.87	1,857.87	0
1997	13	-	27,102.05	290.00	969.51	598.36	1,857.87	290.00	1,567.87	1,857.87	0
1998	14	-	26,482.75	290.00	948.57	619.30	1,857.87	290.00	1,567.87	1,857.87	0
1999	15	-	25,841.78	290.00	926.90	640.97	1,857.87	290.00	1,567.87	1,857.87	0
2000	16	-	25,178.37	290.00	904.46	663.41	1,857.87	290.00	1,567.87	1,857.87	0
2001	17	-	24,491.74	290.00	881.24	686.63	1,857.87	290.00	1,567.87	1,857.87	0
2002	18	-	23,781.08	290.00	857.21	710.66	1,857.87	290.00	1,567.87	1,857.87	0
2003	19	-	23,045.55	290.00	832.34	735.53	1,857.87	290.00	1,567.87	1,857.87	0
2004	20	-	22,284.27	290.00	806.59	761.28	1,857.87	290.00	1,567.87	1,857.87	0
2005	21	-	21,496.35	290.00	779.95	787.92	1,857.87	290.00	1,567.87	1,857.87	0
2006	22	-	20,680.85	290.00	752.37	815.50	1,857.87	290.00	1,567.87	1,857.87	0
2007	23	-	19,836.81	290.00	723.83	844.04	1,857.87	290.00	1,567.87	1,857.87	0
2008	24	-	18,963.23	290.00	694.29	873.58	1,857.87	290.00	1,567.87	1,857.87	0
2009	25	-	18,059.07	290.00	663.71	904.16	1,857.87	290.00	1,567.87	1,857.87	0
2010	26	-	17,123.27	290.00	632.07	935.80	1,857.87	290.00	1,567.87	1,857.87	0
2011	27	-	16,154.71	290.00	599.31	968.56	1,857.87	290.00	1,567.87	1,857.87	0
2012	28	-	15,152.25	290.00	565.41	1.002.46	1,857.87	290.00	1,567.87	1,857.87	0
2013	29	-	14,114.71	290.00	530.33	1,037.54	1,857.87	290.00	1,567.87	1,857.87	0
2014	30	-	13,040.85	290.00	494.01	1.073.86	1,857.87	290.00	1,567.87	1,857.87	0
2015	31	-	11,929.41	290.00	456.43	1,111.44	1,857.87	290.00	1,567.87	1,857.87	0
2016	32	-	10,779.07	290.00	417.53	1,150.34	1,857.87	290.00	1,567.87	1,857.87	0
2017	33	-	9,588.47	290.00	377.27	1,190.60	1,857.87	290.00	1,567.87	1,857.87	0
2018	34	-	8,356.20	290.00	335.60	1,232.27	1,857.87	290.00	1,567.87	1,857.87	0
2019	35	-	7,080.80	290.00	292.47	1,275.40	1,857.87	290.00	1,567.87	1,857.87	0
2020	36	-	5,760.76	290.00	247.83	1,320.04	1,857.87	290.00	1,567.87	1,857.87	0
2021	37	-	4,394.52	290.00	201.63	1,366.24	1,857.87	290.00	1,567.87	1,857.87	0
2022	38	-	2,980.46	290.00	153.81	1,414.06	1,857.87	290.00	1,567.87	1,857.87	0
2023	39	-	1,516.91	290.00	104.32	1,463.55	1,857.87	290.00	1,567.87	1,857.87	0
2024	40	-	0	290.00	53.09	1,516.91	1,857.87	290.00	1,567.87	1,857.87	0

TABLE 12

ECONOMIC COST AND BENEFIT STREAM (STAGE I)

unit: US $'000

Year	Year in Order	Cost	O & M	Replacem't Cost	Total	Benefit
1983	1					
1984	2					
1985	3	1,188	-	-	1,188	-
1986	4	3,340	-	-	3,340	-
1987	5	9,029	-	-	9,029	-
1988	6	9,424	240	-	9,664	658
1989	7	8,746	240	-	8,986	1,992
1990	8	3,471	240	-	3,711	4,473
1991	9	-	240	-	240	7,517
1992	10	-	240	-	240	8,685
1993	11	-	240	-	240	9,042
1994	12	-	240	-	240	9,042
1995	13	-	240	-	240	9,042
1996	14	-	240	-	240	9,042
1997	15	-	240	-	240	9,042
1998	16	-	240	-	240	9,042
1999	17	-	240	-	240	9,042
2000	18	-	240	530	770	9,042
2001	19	-	240	-	240	9,042
2002	20	-	240	-	240	9,042
2003	21	-	240	-	240	9,042
2004	22	-	240	-	240	9,042
2005	23	-	240	-	240	9,042
2006	24	-	240	-	240	9,042
2007	25	-	240	-	240	9,042
2008	26	-	240	-	240	9,042
2009	27	-	240	-	240	9,042
2010	28	-	240	530	770	9,042
.	33	.	240	2,000	2,240	9,042
.	38	.	240	530	770	9,042
.	48	.	240	530	770	9,042
2040	58	-	240	-	240	9,042

POWER TARIFF RATE IN LUZON GRID (NPC)

Effective July 26, 1982

UTILITIES	Unit: Peso
Demand Charge	Per Month
First 500kw of billing demand	12.00/kW
Next 19,500kw of billing demand	16.00/kW
Over 20,000kw of billing demand	22.00/kW
Energy Charge	
First 200kWh per kw of billing demand	0.4057/kWh
Next 200kWh per kw of billing demand	0.4257/kWh
Over 400kWh per kw of billing demand	0.4477/kWh
INDUSTRIES AND NON-UTILITIES	
Demand Charge	Per Month
First 1,000kw of billing demand	18.00/kW
Next 9,000kw of billing demand	19.00/kW
Over 10,000kw of billing demand	20.10/kW
Energy Charge	
First 200kWh per kw of billing demand	0.4807/kWh
Next 250kWh per kw of billing demand	0.4457/kWh
Over 450kWh per kw of billing demand	0.4157/kWh

EXISTING GENERATING PLANTS OF NPC IN LUZON GRID (AS OF JANUARY 1983)

Name of Plant		Installed Capacity Unit x No. (MW)	Installed Capacity Total (MW)	Dependable Capacity (MW)	Energy Capability GWh	Year of Comm.
Hydro Plant:						
1. Ambuklao		25 x 3	75	50.9	459	1956/57
2. Binga		25 x 4	100	85.1	610	1959
3. Angat		50x4 + 6x3	218	150.0	505	1968
4. Pantabangan		50 x 2	100	87.3	224	1977
5. Caliraya		8 x 4	32	32.1	192	1945/50
6. Botocan		8x2 + 1x1	17	15.3	60	1928
7. Barit		1.8 x 1	1.8	-	12	1957
8. Cawayan		0.4 x 1	0.4	-	3	1959
9. Masiway		12 x 1	12.0	10.8	48	1981
10. Kalayaan (Pumped Storage)		150 x 2	300	300	-	1982
Sub-Total			856.2	731.5	2,113	
Thermal Plant (Oil fired):						
1. Bataan	1	75 x 1	75	72	473	1972
	2	150 x 1	150	143	940	1977
2. Gardner	1	150 x 1	150	140	920	1968
	2	200 x 1	200	180	1,182	1970
3. Malaya	1	300 x 1	300	290	1,905	1978
	2	350 x 1	350	340	2,491	1979
4. Snyder	1	200 x 1	200	190	1,248	1971
	2	300 x 1	300	290	1,905	1972
5. Tegen	1	100 x 1	100	95	624	1965
	2	100 x 1	100	95	624	1965
6. Rockwell		60 x 3	180	150	985	1963
Sub-Total			2,105	1985	13,297	
Geothermal Plant:						
1. Tiwi	1 & 2	55 x 2	110	100	794	1979
	3 & 4	55 x 2	110	100	794	1980
	5 & 6	55 x 2	110	100	794	1982
2. Mak-Ban	1 & 2	55 x 2	110	100	794	1979
	3 & 4	55 x 2	110	100	794	1980
Sub-Total			550	500	3,970	
Total			3,511.2	3,216.5	19,380	

GROSS ENERGY PRODUCTION BY POWER PLANT IN 1982 (LUZON GRID)

Name of Plant		Installed Capacity MW	Gross Generated Energy (MWH)	Plant Factor %
Hydro Plant				
1. Ambuklao		75	312,591	47.6
2. Binga		100	430,230	44.6
3. Angat		218	494,079	25.9
4. Pantabangan		100	219,716	25.1
5. Caliraya		32	69,377	24.7
6. Botocan		17	47,502	31.9
7. Barit		1.8	11,502	73.0
8. Cawayan		0.4	1,513	43.2
9. Masiway		12.0	38,434	36.6
10. Kalayaan		300	228,628	8.7
Sub-Total		856.2	1,853,572	24.7
Thermal Plant				
1. Bataan	1	75	334,188	50.9
	2	150	1,013,373	70.7
2. Gardner	1	150	525,359	40.0
	2	200	634,736	36.2
3. Malaya	1	300	1,330,742	50.6
	2	350	1,414,019	46.1
4. Snyder	1	200	797,004	45.5
	2	300	1,219,891	46.4
5. Tegen	1	100	570,710	65.1
	2	100	649,190	74.1
6. Rockwell	1	125	6,005	0.5
	2	180	482,294	30.6
Sub-Total		2230	8,977,511	46.0
Geothermal Plant				
1. Tiwi	1 & 2	110	566,596	58.8
	3 & 4	110	708,565	73.3
	5 & 6	110	726,835	75.4
2. Mak-Ban				
	1 & 2	110	764,431	79.3
	3 & 4	110	769,506	79.9
Sub-Total		550	3,533,933	73.3
Total		3,336.2	14,136,394	48.4

HISTORICAL PEAK DEMAND AND ENERGY CONSUMPTION IN LUZON GRID

Year	Max. Generated Output (MW)	Gross Generated Energy (A) (GWh)	Load Factor (%)	Total Energy Sold (B) (GWh)	$\frac{(A)-(B)}{(A)}$ x100 (%)
1955	128	785	70.0	629	19.9
1960	287	1,884	74.9	1,596	15.3
1965	569	3,526	70.7	3,122	11.5
1970	1,111	6,155	63.2	5,486	10.9
1971	1,205	6,700	63.5	6,142	8.3
1972	1,331	7,266	62.3	6,588	9.3
1973	1,335	7,900	67.6	7,209	8.7
1974	1,379	8,260	68.4	7,275	11.9
1975	1,513	9,022	68.1	8,032	11.0
1976	1,659	9,652	66.4	8,586	11.0
1977	1,709	10,380	69.3	9,077	12.6
1978	1,780	11,222	72.0	9,688	13.7
1979	1,926	12,504	74.0	10,718	14.3
1980	2,070	13,115	72.3	11,052	15.7
1981	2,225	13,648	70.0	12,676	7.1
1982	2,364	14,365	69.4	13,081	8.9

AVERAGE ANNUAL GROWTH RATE %

1956 - 1960	17.5	19.1		20.5	
1961 - 1965	14.7	13.4		14.4	
1966 - 1970	14.3	11.8		11.9	
1971 - 1975	6.4	7.9		7.9	
1976 - 1980	6.5	7.8		6.6	
1981 - 1982	6.9	4.7		8.8	

MONTHLY PEAK DEMAND AND GROSS ENERGY PRODUCTION IN LUZON GRID IN 1982

Month	Peak Demand MW	Gross Energy Production (MWh) Hydro	Oil fired Thermal	Geothermal	Total
Jan.	2,140	163,614	629,688	265,505	1,058,807
Feb.	2,093	158,391	695,699	265,825	1,119,915
Mar.	2,178	136,568	657,781	269,849	1,064,198
Apr.	2,274	151,729	698,320	317,079	1,167,128
May	2,330	103,827	811,347	317,292	1,232,466
June	2,364	108,314	842,111	327,952	1,278,377
July	2,181	84,852	817,007	302,942	1,204,801
Aug.	2,241	168,110	777,616	314,810	1,260,536
Sept.	2,280	244,414	726,022	257,967	1,228,403
Oct.	2,330	170,005	810,279	282,152	1,262,436
Nov.	2,334	199,994	772,863	283,395	1,256,252
Dec.	2,296	163,754	738,778	329,165	1,231,697
Total	max. 2,364	1,853,572 (12.9%)	8,977,511 (62.5%)	3,533,933 (24.6%)	14,365,016 (100%)
Station Use		11,505	480,849	273,607	765,961
Pumping Energy		216,003 /1			216,003
Net Energy		1,626,064 (87.73%)	8,496,662 (94.64%)	3,260,326 (93.26%)	13,383,052 (94.67%) /2

/1 - This pumping energy is used for Kalayaan Pumping Power Station

/2 - Percentages of net energy generation to gross energy is shown in parenthesis

PROJECTED PEAK DEMAND
ENERGY IN LUZON GRID

Year	Max. Generated Output (MW)	Gross Generated Energy (A) (GWh)	Load Factor %	Energy to be Sold (B) (GWh)	$\frac{(A)-(B)}{(A)} \times 100$ %
1980	2,070	13,115	72.3	11,052	15.7
1981	2,225	13,647	70.0	12,676	7.1
1982	2,364	14,365	69.4	13,081	8.9
Forecast					
1983	2,565	16,140	71.8	14,606	9.5
1984	2,745	17,240	71.7	15,630	9.3
1985	2,940	18,420	71.5	16,725	9.2
1986	3,145	19,620	71.4	17,900	9.0
1987	3,365	21,030	71.3	19,145	9.0
1988	3,600	22,475	71.3	20,485	8.9
1989	3,850	24,020	71.2	21,920	8.7
1990	4,120	25,675	71.1	23,458	8.6

Forecasted average annual growth rate %

1981 - 85	7.3	7.0	8.6
1986 - 1990	7.0	6.9	7.0

GENERATION EXPANSION PROGRAM IN LUZON GRID

	Name of Plant	Installed Unit x No. (MW)	Cap Total (MW)	Dep Capacity (MW)	Max. Capacity (MW)	Energy Capability (MW)
1982	Existing		3,509	3,216	2,400	19,474
1983	Magat 1-4(H)	90x4				
	Rockwell (T)	-60x3				
		180	3,689	3,337	2,565	20,556
1984	Mak-Ban 5,6(G)	55x2	3,799	3,437	2,745	21,378
1985	PNPP (N)	620x1				
	Coal Thermal (C)	300x1				
		920	4,719	4,107	2,940	25,448
1986	Tiwi 7, 8 (G)	55x2				
	Tongonan 4,5 (G)	55x2				
	Tongonan 6-11(G)	55x6				
		550	5,269	4,657	3,145	31,101
1987		0	5,269	4,707	3,365	31,373
1988	Coal Thermal 2(C)	300x1	5,569	5,027	3,600	33,579
1989		0				
	To Leyte Samar	-12				
		-12	5,557	5,056	3,850	33,546
1990	San Roque	390				
	To Leyte & Samar	-6				
		384	5,941	5,339	4,120	34,659

Table 20 CASH FLOW STATEMENT STAGE II DEVELOPMENT (Foreign Currency + Local Currency)

(Unit: 10^6 US$)

Year in Order	Source of Funds: Loan	Source of Funds: Net Revenue	Source of Funds: Total	Use of Funds: Construction	Use of Funds: Interest	Use of Funds: Loan Repayment	Use of Funds: Total	Net Income	Acc. Income	Acc. Loan
1	38.8	0.0	38.8	38.8	1.7	0.0	40.5	-1.7	-1.7	38.8
2	41.3	0.0	41.3	41.3	4.7	0.0	46.0	-4.7	-6.4	80.1
3	61.3	0.0	61.3	61.3	8.1	0.0	69.4	-8.1	-14.5	141.4
4	65.9	0.0	65.9	65.9	12.5	0.0	78.4	-12.5	-27.0	207.3
5	116.7	0.0	116.7	116.7	19.0	0.0	135.7	-19.0	-46.0	324.0
6	0.0	26.5	26.5	0.0	23.7	0.0	23.7	2.9	-43.1	324.0
7	0.0	26.5	26.5	0.0	23.7	2.2	25.8	0.7	-42.4	321.8
8	0.0	26.5	26.5	0.0	23.5	4.4	28.0	-1.4	-43.8	317.4
9	0.0	26.5	26.5	0.0	23.2	7.9	31.0	-4.5	-48.3	309.5
10	0.0	26.5	26.5	0.0	22.6	11.5	34.1	-7.6	-55.9	298.0
11	0.0	26.5	26.5	0.0	21.7	18.0	39.7	-13.2	-69.1	280.0
12	0.0	26.5	26.5	0.0	20.4	18.0	38.4	-11.9	-80.9	262.0
13	0.0	26.5	26.5	0.0	19.1	18.0	37.1	-10.6	-91.5	244.0
14	0.0	26.5	26.5	0.0	17.8	18.0	35.8	-9.2	-100.7	226.0
15	0.0	26.5	26.5	0.0	16.5	18.0	34.5	-7.9	-108.6	208.0
16	0.0	26.5	26.5	0.0	15.1	18.0	33.1	-6.6	-115.2	190.0
17	0.0	26.5	26.5	0.0	13.8	18.0	31.8	-5.3	-120.5	172.0
18	0.0	26.5	26.5	0.0	12.5	18.0	30.5	-4.0	-124.5	154.0
19	0.0	26.5	26.5	0.0	11.2	18.0	29.2	-2.7	-127.2	136.0
20	0.0	26.5	26.5	0.0	9.9	18.0	27.9	-1.3	-128.5	118.0
21	0.0	26.5	26.5	0.0	8.6	18.0	26.6	0.0	-128.5	100.0
22	0.0	26.5	26.5	0.0	7.3	18.0	25.3	1.3	-127.2	82.0
23	0.0	26.5	26.5	0.0	5.9	18.0	23.9	2.6	-124.6	64.0
24	0.0	26.5	26.5	0.0	4.6	18.0	22.6	3.9	-120.7	46.0
25	0.0	26.5	26.5	0.0	3.3	15.8	19.1	7.4	-113.3	30.2
26	0.0	26.5	26.5	0.0	2.2	13.5	15.7	10.8	-102.5	16.6
27	0.0	26.5	26.5	0.0	1.2	10.1	11.3	15.2	-87.3	6.5
28	0.0	26.5	26.5	0.0	0.5	6.5	6.9	19.6	-67.7	0.0
29	0.0	26.5	26.5	0.0	0.0	0.0	0.0	26.5	-41.1	0.0
30	0.0	26.5	26.5	0.0	0.0	0.0	0.0	26.5	-14.6	0.0
31	0.0	26.5	26.5	0.0	0.0	0.0	0.0	26.5	12.0	0.0
32	0.0	26.5	26.5	0.0	0.0	0.0	0.0	26.5	38.5	0.0
33	0.0	26.5	26.5	0.0	0.0	0.0	0.0	26.5	65.0	0.0
34	0.0	26.5	26.5	0.0	0.0	0.0	0.0	26.5	91.6	0.0
35	0.0	26.5	26.5	0.0	0.0	0.0	0.0	26.5	118.1	0.0
36	0.0	26.5	26.5	0.0	0.0	0.0	0.0	26.5	144.7	0.0
37	0.0	26.5	26.5	0.0	0.0	0.0	0.0	26.5	171.2	0.0
38	0.0	26.5	26.5	0.0	0.0	0.0	0.0	26.5	197.7	0.0
39	0.0	26.5	26.5	0.0	0.0	0.0	0.0	26.5	224.3	0.0
40	0.0	26.5	26.5	0.0	0.0	0.0	0.0	26.5	250.8	0.0
41	0.0	26.5	26.5	0.0	0.0	0.0	0.0	26.5	277.4	0.0
42	0.0	26.5	26.5	0.0	0.0	0.0	0.0	26.5	303.9	0.0
43	0.0	26.5	26.5	0.0	0.0	0.0	0.0	26.5	330.5	0.0
44	0.0	26.5	26.5	0.0	0.0	0.0	0.0	26.5	357.0	0.0
45	0.0	26.5	26.5	0.0	0.0	0.0	0.0	26.5	383.5	0.0
46	0.0	26.5	26.5	0.0	0.0	0.0	0.0	26.5	410.1	0.0
47	0.0	26.5	26.5	0.0	0.0	0.0	0.0	26.5	436.6	0.0
48	0.0	26.5	26.5	0.0	0.0	0.0	0.0	26.5	463.2	0.0
49	0.0	26.5	26.5	0.0	0.0	0.0	0.0	26.5	489.7	0.0
50	0.0	26.5	26.5	0.0	0.0	0.0	0.0	26.5	516.3	0.0
51	0.0	26.5	26.5	0.0	0.0	0.0	0.0	26.5	542.8	0.0
52	0.0	26.5	26.5	0.0	0.0	0.0	0.0	26.5	569.3	0.0
53	0.0	26.5	26.5	0.0	0.0	0.0	0.0	26.5	595.9	0.0
54	0.0	26.5	26.5	0.0	0.0	0.0	0.0	26.5	622.4	0.0
55	0.0	26.5	26.5	0.0	0.0	0.0	0.0	26.5	649.0	0.0

Table 21 CASH-FLOW STATEMENT (Foreign Currency)

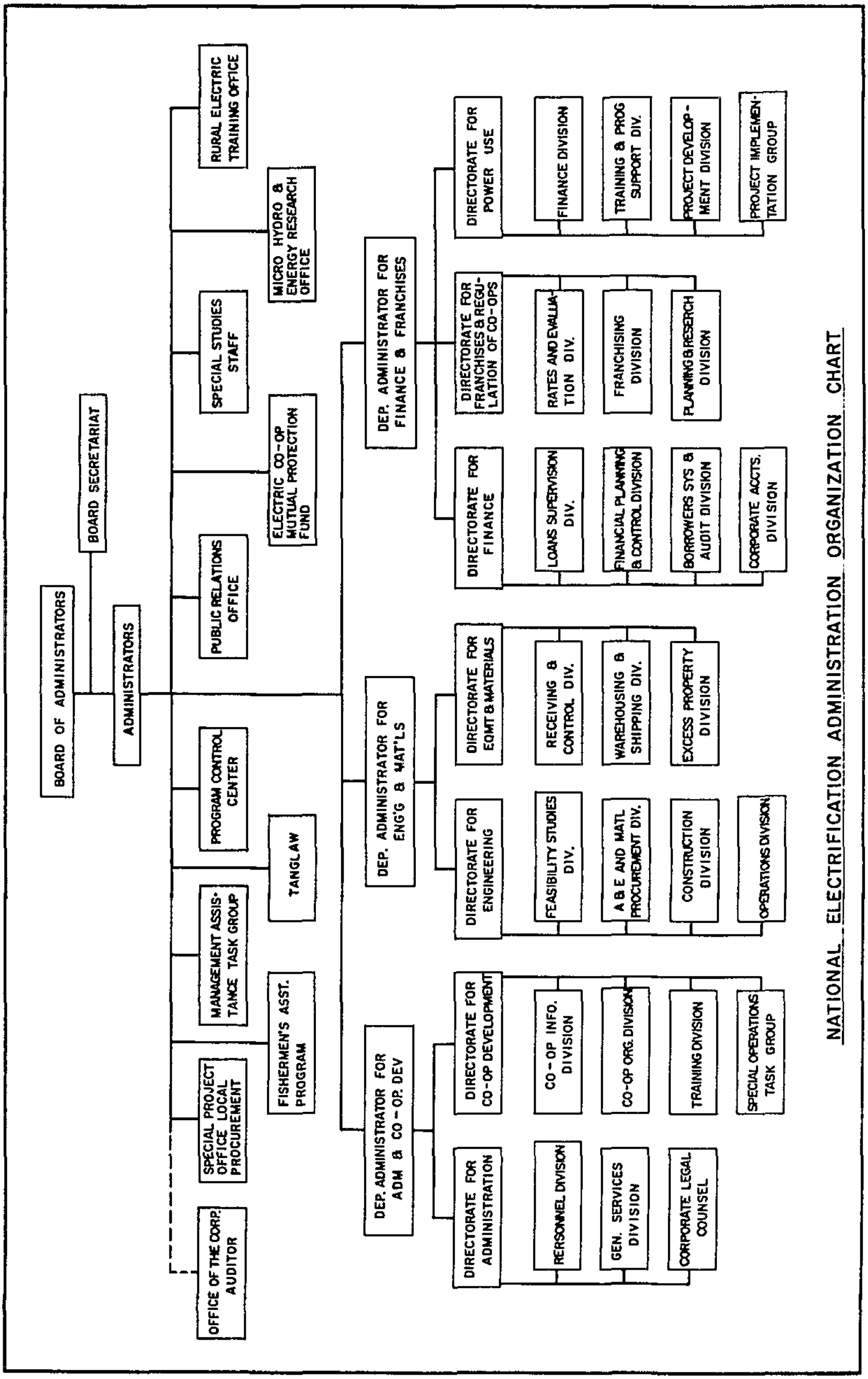
STAGE II DEVELOPMENT

(Unit: 10^6 US$)

Year in Order	Source of Funds			Use of Funds				Net Income	Acc. Income	Acc. Loan
	Loan	Net Revenue	Total	Construction	Interest	Loan Repayment	Total			
1	18.9	0.0	18.9	18.9	0.3	0.0	19.2	-0.3	-0.3	18.9
2	26.9	0.0	26.9	26.9	1.4	0.0	28.3	-1.4	-1.7	45.8
3	42.0	0.0	42.0	42.0	2.8	0.0	44.8	-2.8	-4.5	87.8
4	42.7	0.0	42.7	42.7	4.8	0.0	47.5	-4.8	-9.3	130.5
5	80.9	0.0	80.9	80.9	7.6	0.0	88.5	-7.6	-16.9	211.4
6	0.0	17.3	17.3	0.0	10.2	0.0	10.2	7.1	-9.8	211.4
7	0.0	17.3	17.3	0.0	10.2	1.0	11.2	6.1	-3.7	210.3
8	0.0	17.3	17.3	0.0	10.1	2.5	12.7	4.6	0.9	207.8
9	0.0	17.3	17.3	0.0	10.0	4.9	14.9	2.4	3.3	202.9
10	0.0	17.3	17.3	0.0	9.8	7.2	17.0	0.3	3.6	195.7
11	0.0	17.3	17.3	0.0	9.4	11.7	21.2	-3.9	-0.3	183.9
12	0.0	17.3	17.3	0.0	8.9	11.7	20.6	-3.3	-3.6	172.2
13	0.0	17.3	17.3	0.0	8.3	11.7	20.1	-2.8	-6.4	160.4
14	0.0	17.3	17.3	0.0	7.7	11.7	19.5	-2.2	-8.5	148.7
15	0.0	17.3	17.3	0.0	7.2	11.7	18.9	-1.6	-10.2	137.0
16	0.0	17.3	17.3	0.0	6.6	11.7	18.4	-1.1	-11.2	125.2
17	0.0	17.3	17.3	0.0	6.1	11.7	17.8	-0.5	-11.7	113.5
18	0.0	17.3	17.3	0.0	5.5	11.7	17.2	0.1	-11.7	101.7
19	0.0	17.3	17.3	0.0	4.9	11.7	16.7	0.6	-11.0	90.0
20	0.0	17.3	17.3	0.0	4.4	11.7	16.1	1.2	-9.8	78.2
21	0.0	17.3	17.3	0.0	3.8	11.7	15.5	1.8	-8.1	66.5
22	0.0	17.3	17.3	0.0	3.2	11.7	15.0	2.3	-5.7	54.7
23	0.0	17.3	17.3	0.0	2.7	11.7	14.4	2.9	-2.9	43.0
24	0.0	17.3	17.3	0.0	2.1	11.7	13.8	3.5	0.6	31.3
25	0.0	17.3	17.3	0.0	1.5	10.7	12.2	5.1	5.7	20.6
26	0.0	17.3	17.3	0.0	1.0	9.2	10.2	7.1	12.8	11.4
27	0.0	17.3	17.3	0.0	0.6	6.9	7.4	9.9	22.6	4.5
28	0.0	17.3	17.3	0.0	0.2	4.5	4.7	12.6	35.2	0.0
29	0.0	17.3	17.3	0.0	0.0	0.0	0.0	17.3	52.5	0.0
30	0.0	17.3	17.3	0.0	0.0	0.0	0.0	17.3	69.8	0.0
31	0.0	17.3	17.3	0.0	0.0	0.0	0.0	17.3	87.1	0.0
32	0.0	17.3	17.3	0.0	0.0	0.0	0.0	17.3	104.4	0.0
33	0.0	17.3	17.3	0.0	0.0	0.0	0.0	17.3	121.7	0.0
34	0.0	17.3	17.3	0.0	0.0	0.0	0.0	17.3	139.0	0.0
35	0.0	17.3	17.3	0.0	0.0	0.0	0.0	17.3	156.3	0.0
36	0.0	17.3	17.3	0.0	0.0	0.0	0.0	17.3	173.6	0.0
37	0.0	17.3	17.3	0.0	0.0	0.0	0.0	17.3	190.9	0.0
38	0.0	17.3	17.3	0.0	0.0	0.0	0.0	17.3	208.2	0.0
39	0.0	17.3	17.3	0.0	0.0	0.0	0.0	17.3	225.5	0.0
40	0.0	17.3	17.3	0.0	0.0	0.0	0.0	17.3	242.8	0.0
41	0.0	17.3	17.3	0.0	0.0	0.0	0.0	17.3	260.1	0.0
42	0.0	17.3	17.3	0.0	0.0	0.0	0.0	17.3	277.4	0.0
43	0.0	17.3	17.3	0.0	0.0	0.0	0.0	17.3	294.7	0.0
44	0.0	17.3	17.3	0.0	0.0	0.0	0.0	17.3	312.0	0.0
45	0.0	17.3	17.3	0.0	0.0	0.0	0.0	17.3	329.3	0.0
46	0.0	17.3	17.3	0.0	0.0	0.0	0.0	17.3	346.6	0.0
47	0.0	17.3	17.3	0.0	0.0	0.0	0.0	17.3	363.9	0.0
48	0.0	17.3	17.3	0.0	0.0	0.0	0.0	17.3	381.2	0.0
49	0.0	17.3	17.3	0.0	0.0	0.0	0.0	17.3	398.5	0.0
50	0.0	17.3	17.3	0.0	0.0	0.0	0.0	17.3	415.8	0.0
51	0.0	17.3	17.3	0.0	0.0	0.0	0.0	17.3	433.1	0.0
52	0.0	17.3	17.3	0.0	0.0	0.0	0.0	17.3	450.4	0.0
53	0.0	17.3	17.3	0.0	0.0	0.0	0.0	17.3	467.7	0.0
54	0.0	17.3	17.3	0.0	0.0	0.0	0.0	17.3	485.0	0.0
55	0.0	17.3	17.3	0.0	0.0	0.0	0.0	17.3	502.3	0.0

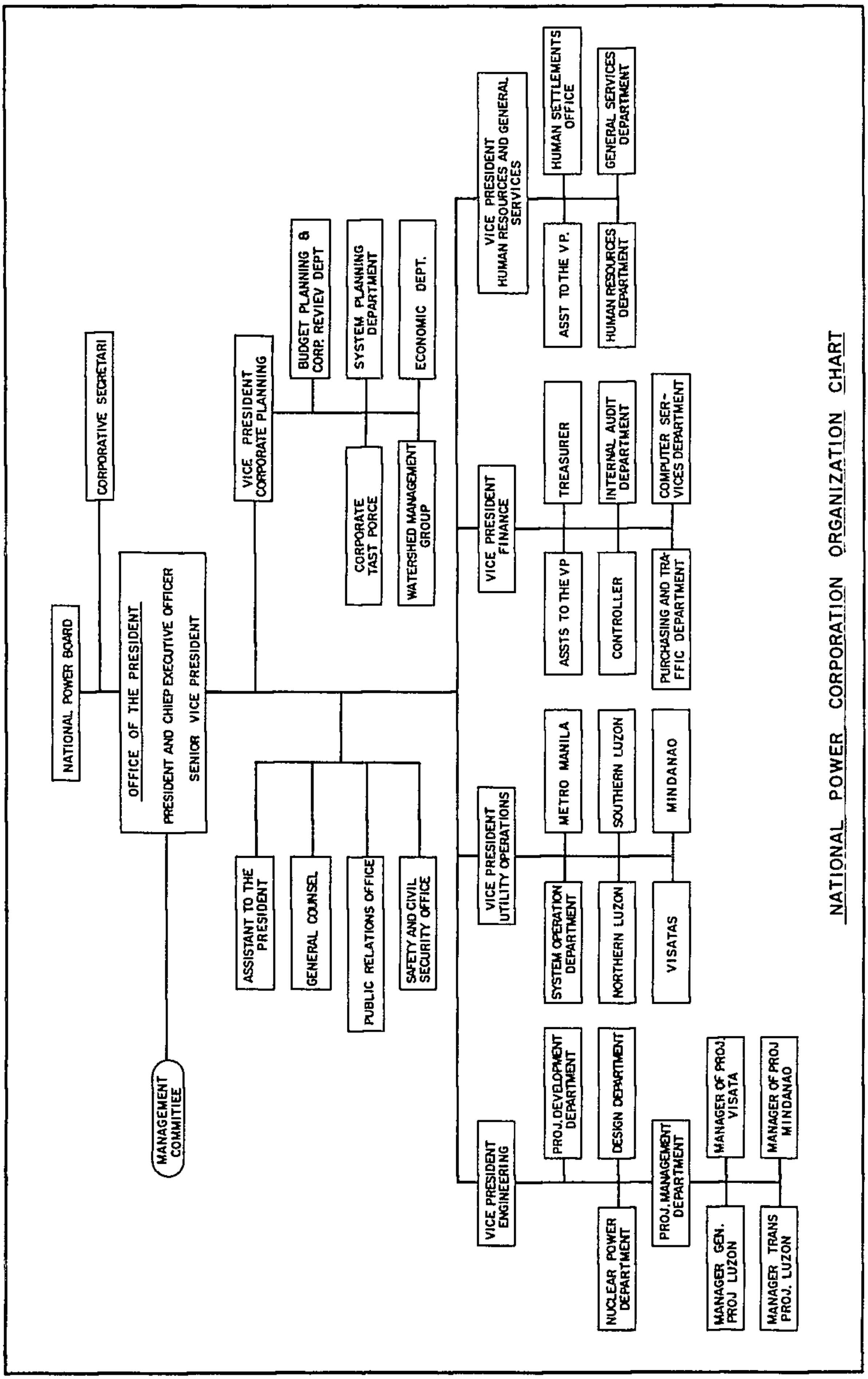
FIGURES

FIG. 1



NATIONAL ELECTRIFICATION ADMINISTRATION ORGANIZATION CHART

FIG. 2



NATIONAL POWER CORPORATION ORGANIZATION CHART

ELECTRICITY SUPPLY SYSTEM IN LUZON

LEGEND

• HYDRO	(EXISTING)	——— :	230kV LINE
○ 〃	(FUTURE)		
◉ OIL-FIRED	(EXISTING)	—·— :	115kV LINE
◎ COAL-FIRED	(FUTURE)		
▲ GEOTHEMAL	(EXISTING)	--·- :	69kV LINE
△ 〃	(FUTURE)		
⊕ NUCLEAR	(FUTURE)		
· SUBSTATION			

EXISTING GENERATING PLANTS

1. AMBUKLAO	75 MW	HYDRO
2. BINGA	100 MW	〃
3. ANGAT	218 MW	〃
4. PANTABANGAN	100 MW	〃
5. CALIRAYA	32 MW	〃
6. BOTOCAN	17 MW	〃
7. BARIT	1.8 MW	〃
8. CAWAYAN	0.4 MW	〃
9. MASIWAY	12 MW	〃
10. BATAAN	225 MW	OIL-FIRED
11. GARDNER	350 MW	〃
12. MALAYA	650 MW	〃
13. SNYDER	500 MW	〃
14. TEGEN	200 MW	〃
15. ROCKWELL	305 MW	〃
16. TIWI	220 MW	GEO.
17. MAK-BAN	220 MW	〃

GENERATING PLANTS UNDER CONSTRUCTION OR PLANNING

21. KALAYAAN	300 MW	HYDRO
22. MAGAT	540 MW	〃
23. SAN ROQUE	390 MW	〃
30. TIWI	220 MW	GEO.
31. MAK-BAN	110 MW	〃
40. THERMAL I	300 MW	COAL-FIRED
41. THERMAL II	300 MW	〃
50. PNPP	620 MW	NUCLEAR

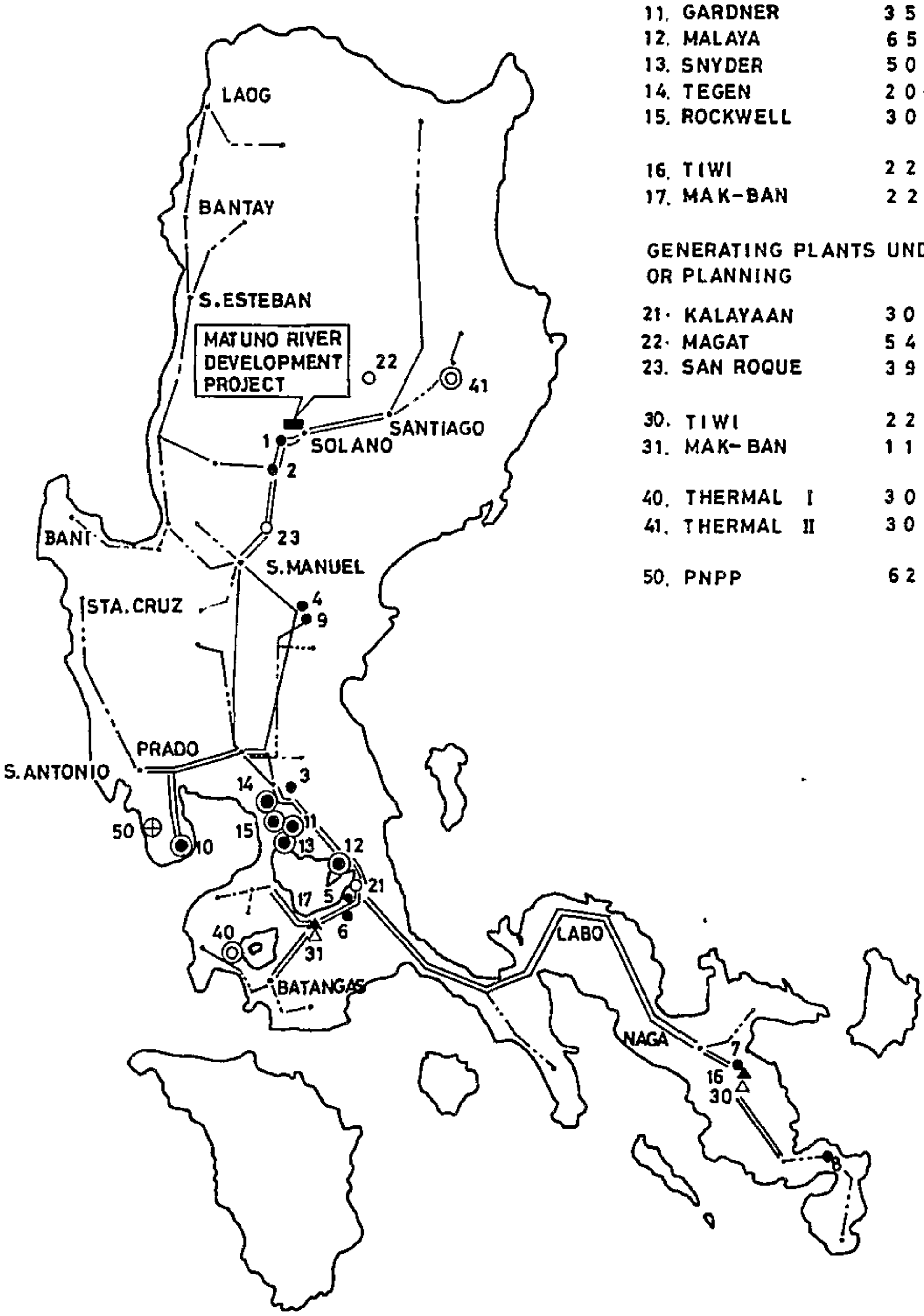


FIG. 4

TYPICAL DAILY LOAD CURVES OF LUZON GRID

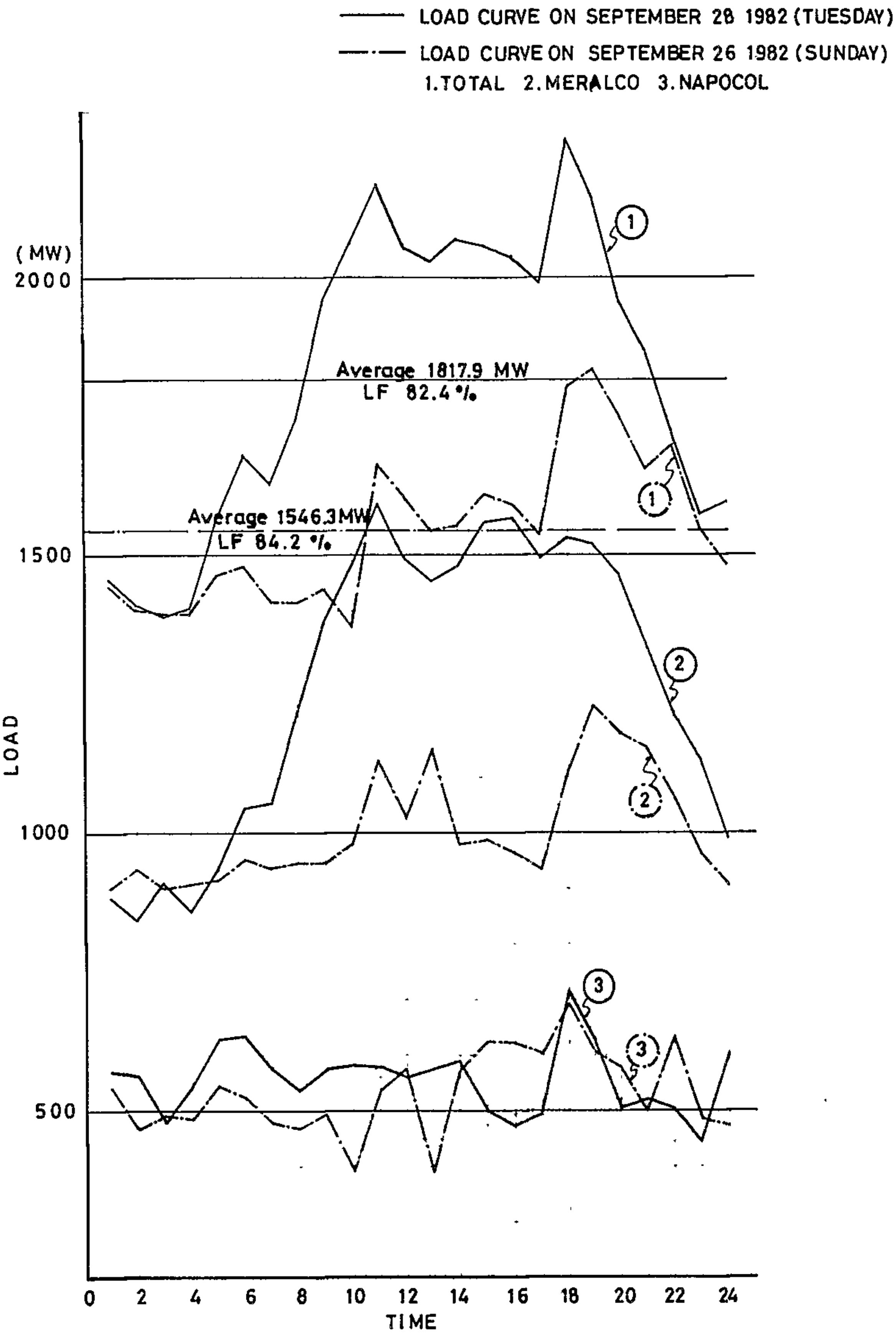
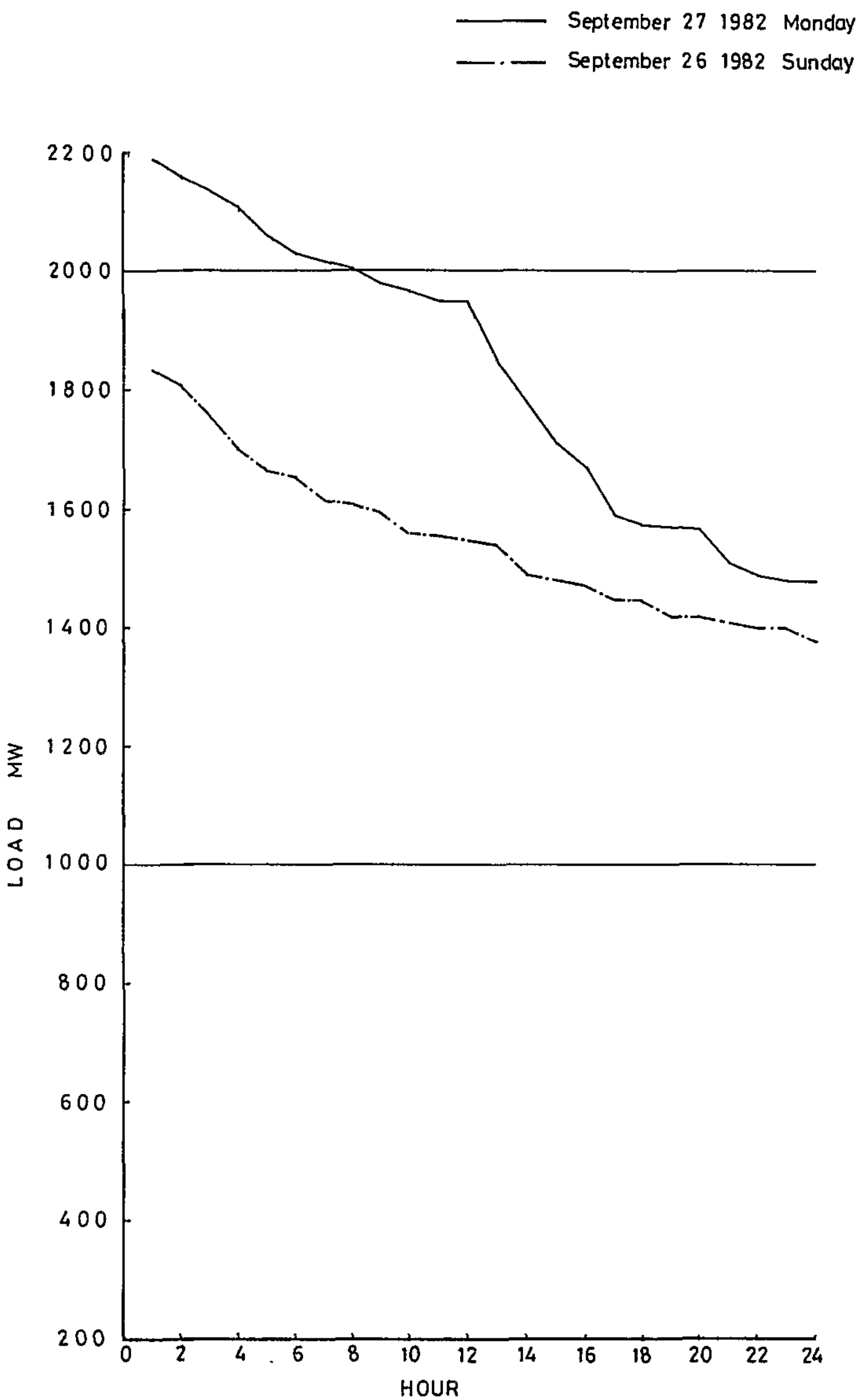
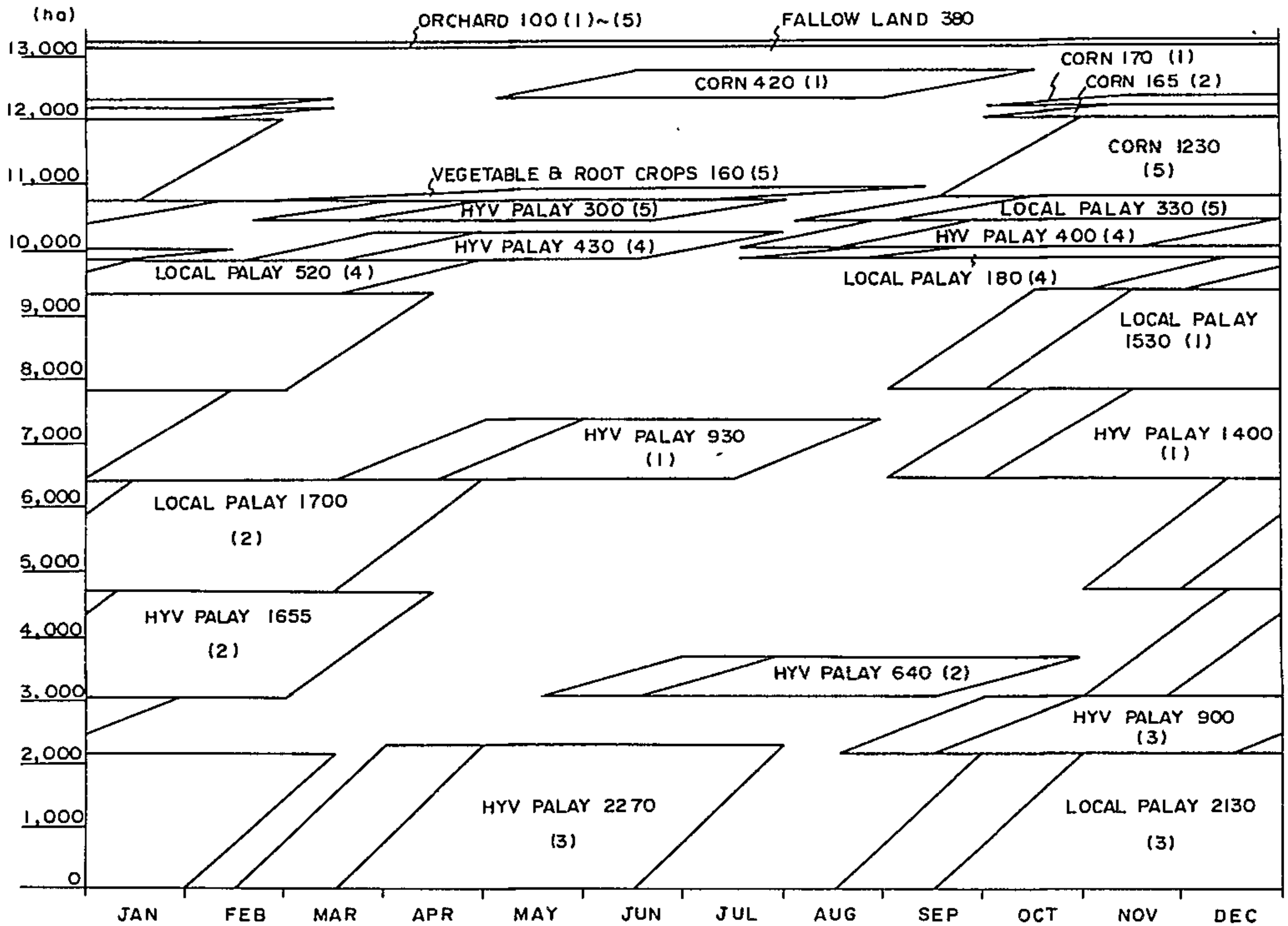


FIG. 5

TYPICAL DAILY LOAD DURATION CURVES



PRESENT CROPPING PATTERN



Land Area 13,040 ha

Cropped Area 17,560 ha

Cropping Int. . 134 7%

Note .

1. Land Area excludes area of Right of Way
2. (1) ~ (5) indicates Block number

FIG. 7

PROPOSED LAND USE BLOCK

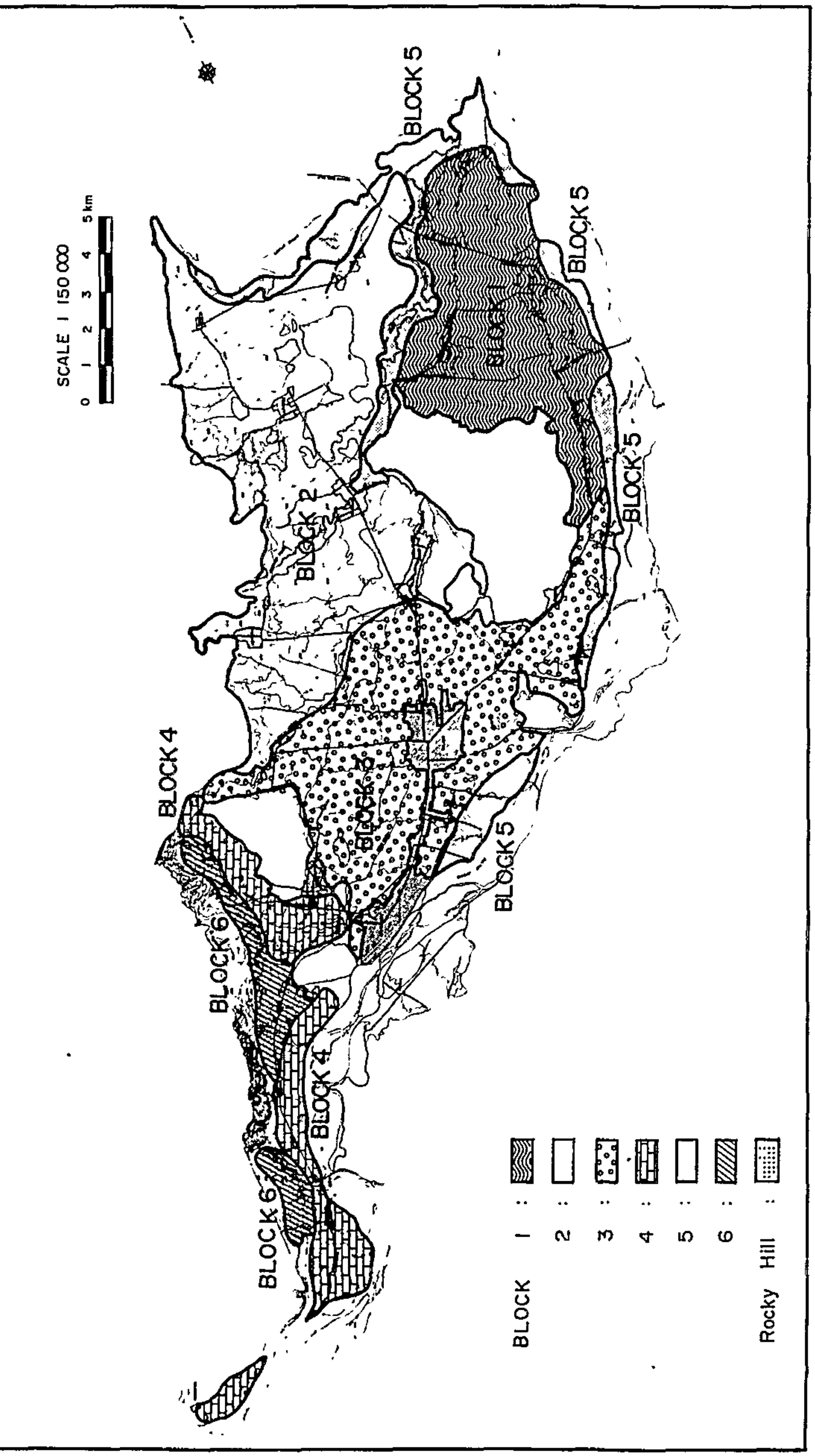
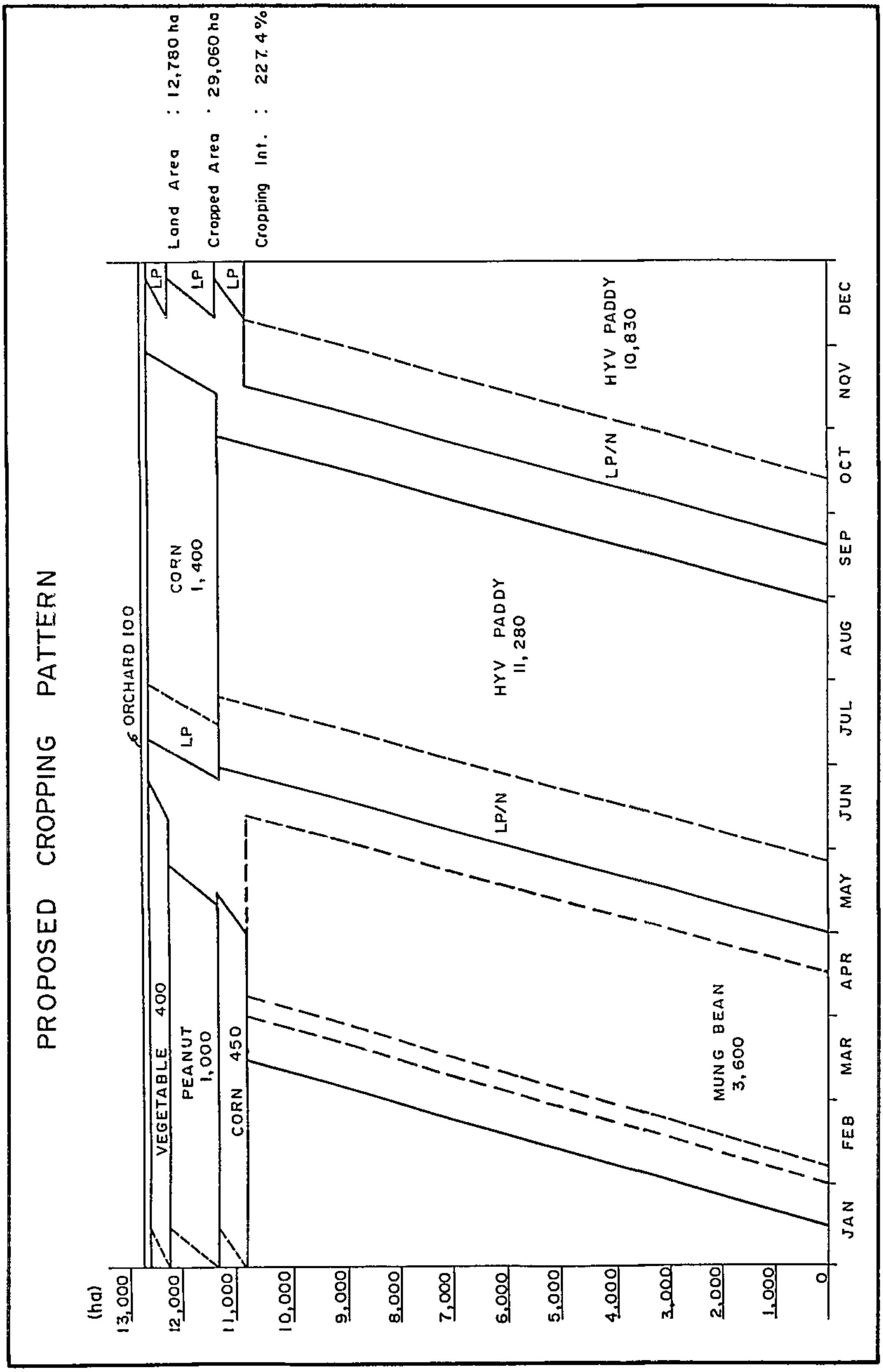
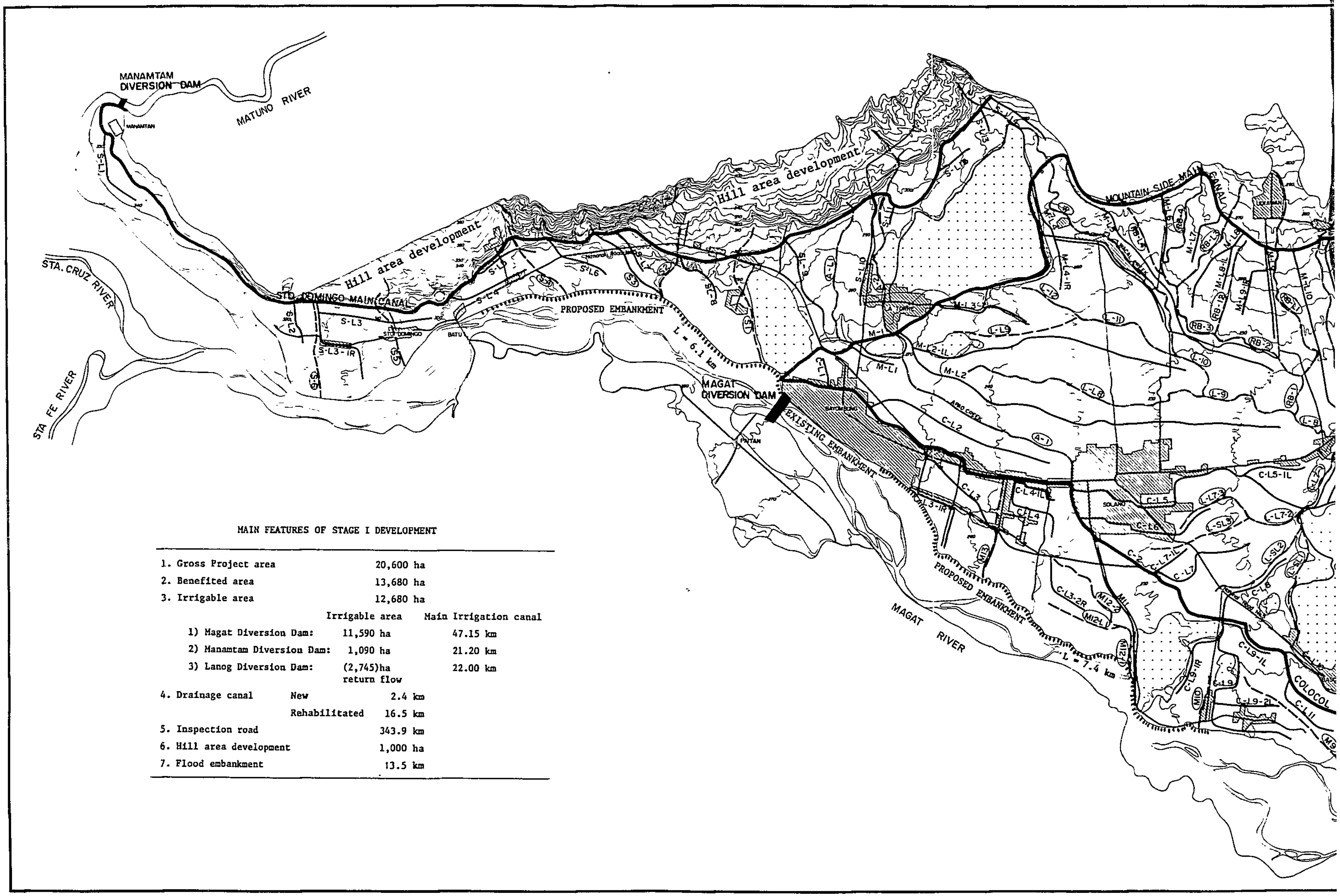


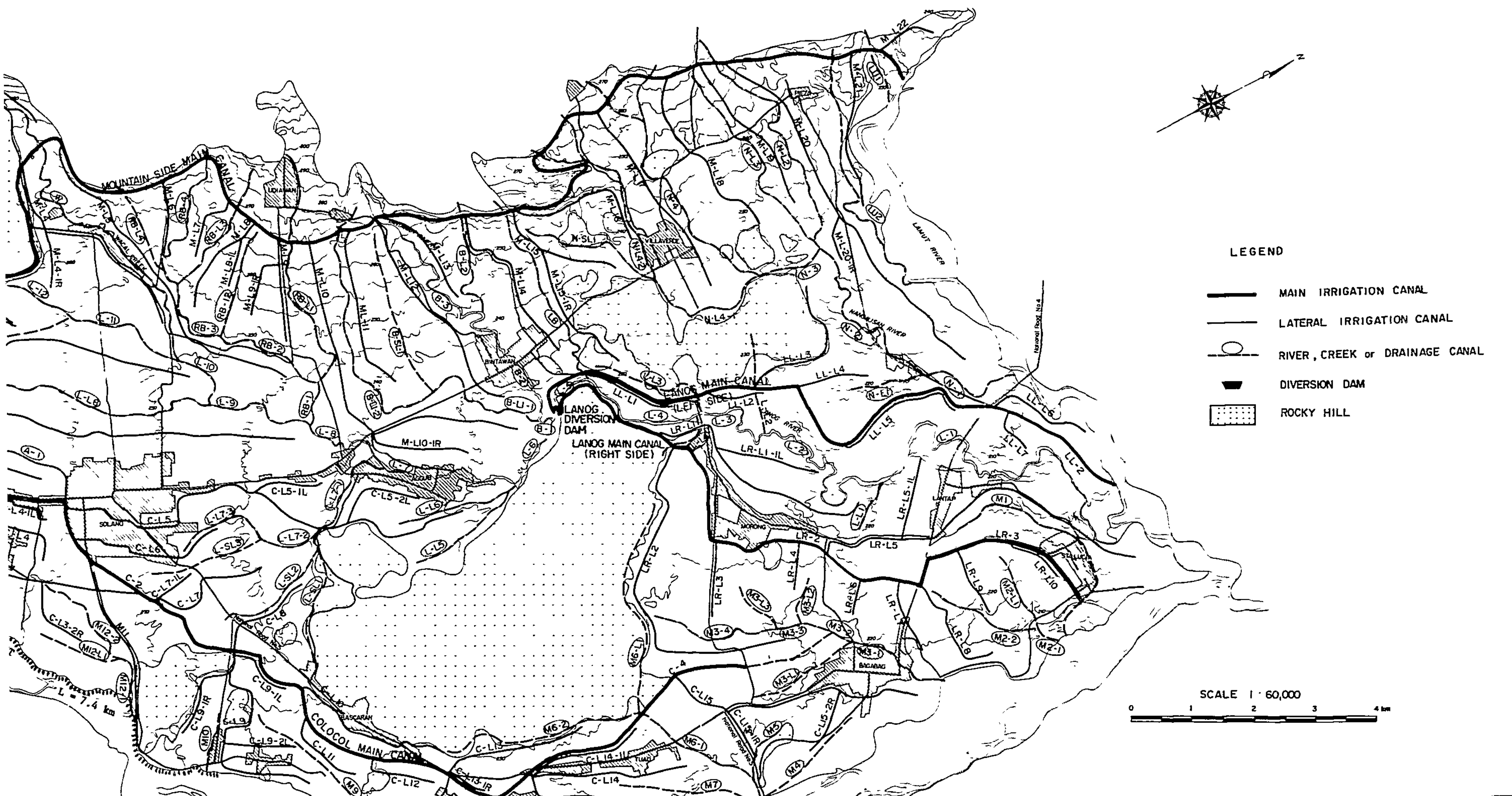
FIG. 8


PROPOSED CROPPING PATTERN
Land Area : 12,780 ha
Cropped Area : 29,060 ha
Cropping Int. : 227.4%
(ha)
13,000
12,000
11,000
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
ORCHARD 100
VEGETABLE 400
PEANUT 1,000
CORN 450
MUNG BEAN 3,600
LP
LP/N
HYV PADDY 11,280
CORN 1,400
HYV PADDY 10,830
LP/N
LP
LP
LP



MAIN FEATURES OF STAGE I DEVELOPMENT

1. Gross Project area		20,600 ha	
2. Benefited area		13,680 ha	
3. Irrigable area		12,680 ha	
		Irrigable area	Main Irrigation canal
1) Magat Diversion Dam:		11,590 ha	47.15 km
2) Manamtam Diversion Dam:		1,090 ha	21.20 km
3) Lanog Diversion Dam:		(2,745)ha return flow	22.00 km
4. Drainage canal	New	2.4 km	
	Rehabilitated	16.5 km	
5. Inspection road		343.9 km	
6. Hill area development		1,000 ha	
7. Flood embankment		13.5 km	



Republic of the Philippines
NATIONAL IRRIGATION ADMINISTRATION

MATUNO RIVER DEVELOPMENT PROJECT
NUEVA VIZCAYA

GENERAL LAYOUT

JAPAN INTERNATIOANL COOPERATION AGENCY

DWG. NO. | SHEET OF

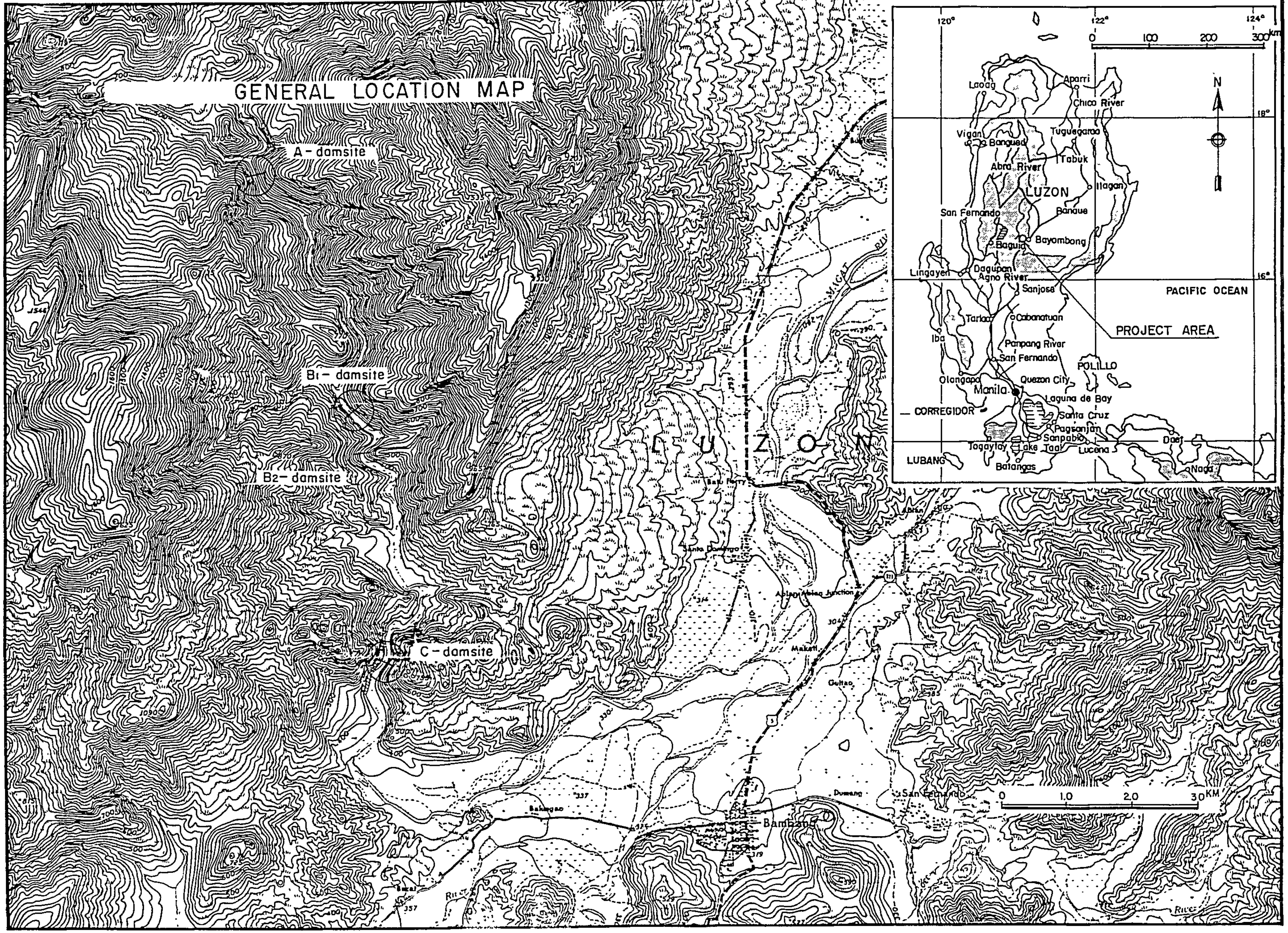

GENERAL LOCATION MAP
A-damsite
B1-damsite
B2-damsite
C-damsite
LUZON
Bambang
Santa Domingo
Aritao-Abian Junction
Dumang
San Fernando
Bakengao
Makati
0 1.0 2.0 3.0 KM
120° 122° 124°
0 100 200 300 km
N
Laoag
Aparri
Chico River
Vigan
Bangued
Tuguegarao
Abra River
Tabuk
LUZON
Ilagan
San Fernando
Banaue
Baguio
Bayombong
Lingayen
Dagupan
Agno River
Sanjose
PACIFIC OCEAN
Tarlac
Cabanatuan
PROJECT AREA
Iba
Panpang River
San Fernando
POLILLO
Olongapo
Quezon City
Manila
Laguna de Bay
CORREGIDOR
Santa Cruz
Pagsanjan
Sanpablo
Tagaytay
Lake Taal
Daet
LUBANG
Lucena
Batangas
Naga

FIG. II-I

IMPLEMENTATION SCHEDULE FOR STAGE I DEVELOPMENT

ITEMS		WORK QUANTITY	1984	1985	1986	1987	1988	1989	1990	
Pre Project Arrangement										
Diversion Dam	Magat	305 m								
	Manamtam	127 m								
	Lanog	35 m								
Colocol Irrigation System	Main	21100 m			6850 m	8050 m	6200 m			
	Lateral	60100 m			12300 m	17900 m	17550 m	12350 m		
	On-Farm	3220 ha				1568 ha	870 ha	782 ha		
Mountain Side Irrigation System	Main	26050 m				8000 m	6500 m	11550 m		
	Lateral	78100 m				26500 m	22800 m	28800 m		
	On-Farm	5625 ha				1913 ha	1696 ha	2016 ha		
Lanog Irrigation System	Main	22000 m					6600 m	15400 m		
	Lateral	37350 m					17650 m	19700 m		
	On-Farm	2745 ha					1006 ha	1739 ha		
Sto. Domingo Irrigation System	Main	21200 m						9250 m	11950 m	
	Lateral	17850 m						7600 m	10250 m	
	On-Farm	1090 ha						399 ha	691 ha	
Road		21522 m			1507 m	4520 m	5811 m	7963 m	1721 m	
Drainage	Lanog River	10000 m				4964 m		2483 m	2553 m	
	Colocol	4290 m			4290 m					
	Other Impro.	37860 m					9163 m	9163 m	9163 m	
Hill Area Development		1000 ha								
River Embankment		13.5 km				Step - 1		Step - 2		
O & M Facilities										
Training										
Engineering Service				Detailed Design		Supervision				

FIG. II-2

PROPOSED ORGANIZATION CHART FOR
PROJECT CONSTRUCTION STAGE I DEVELOPMENT

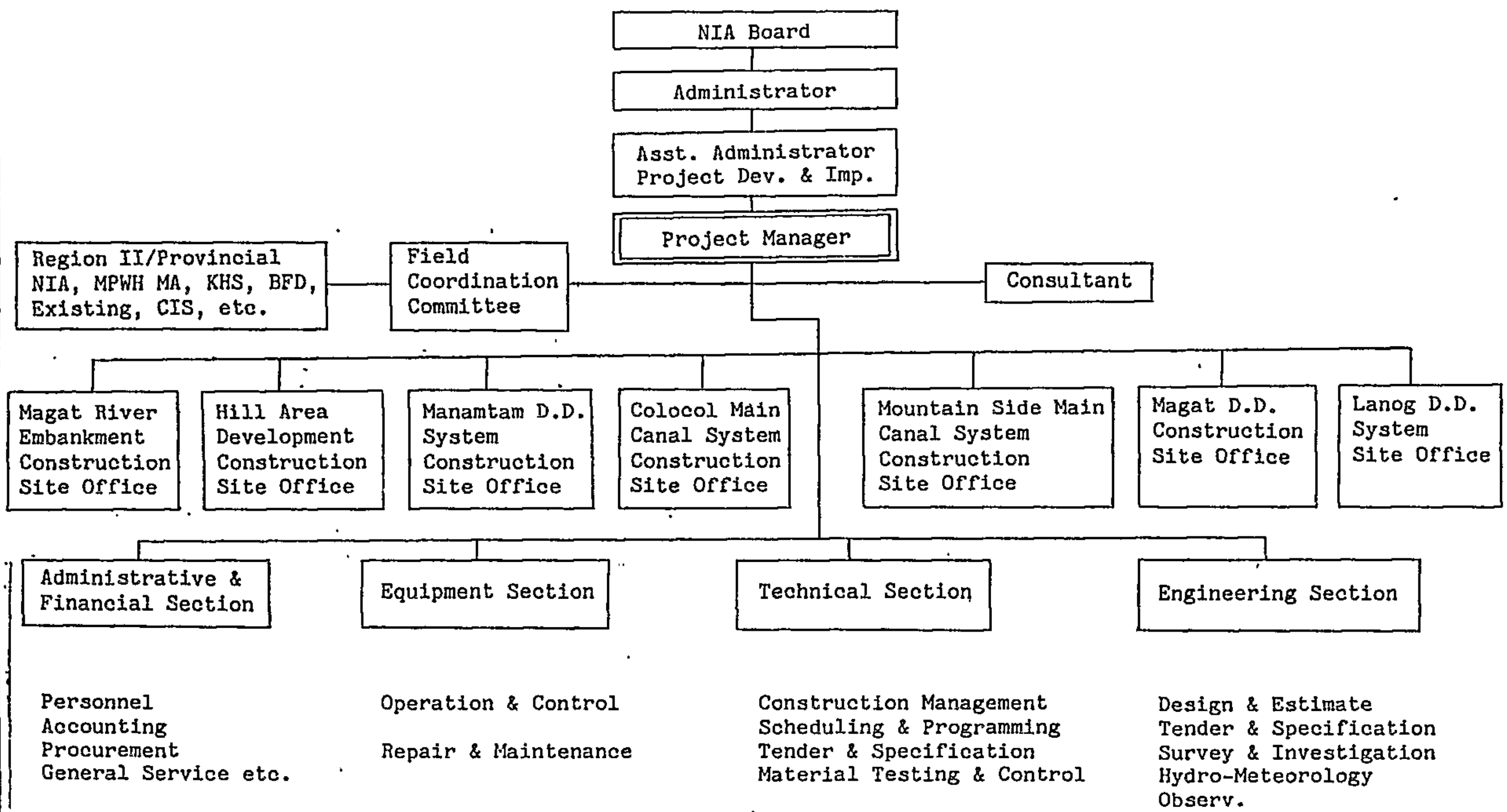
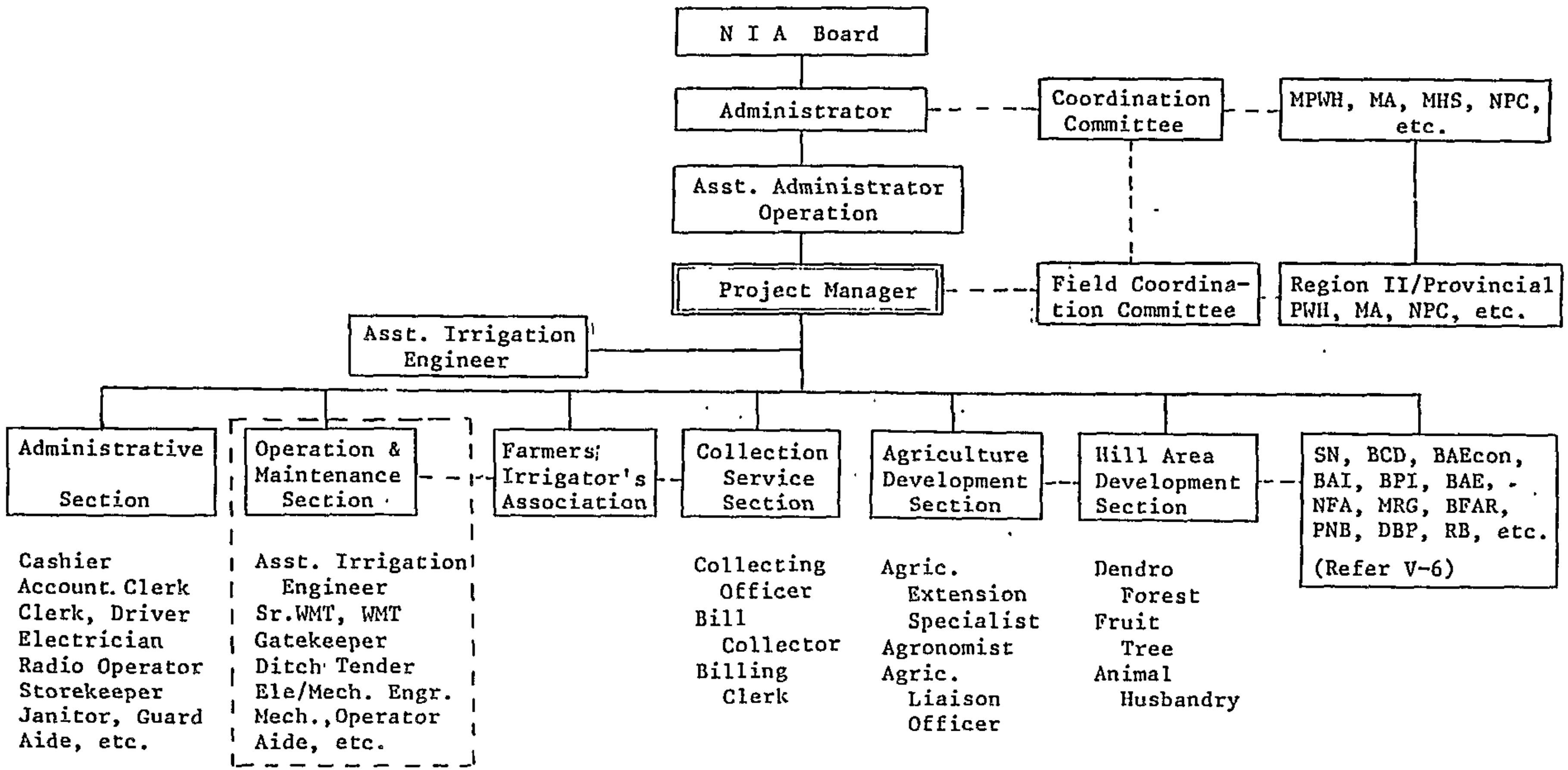


FIG. II-3

PROPOSED ORGANIZATION CHART FOR OPERATION AND MAINTENANCE
FOR
STAGE I DEVELOPMENT



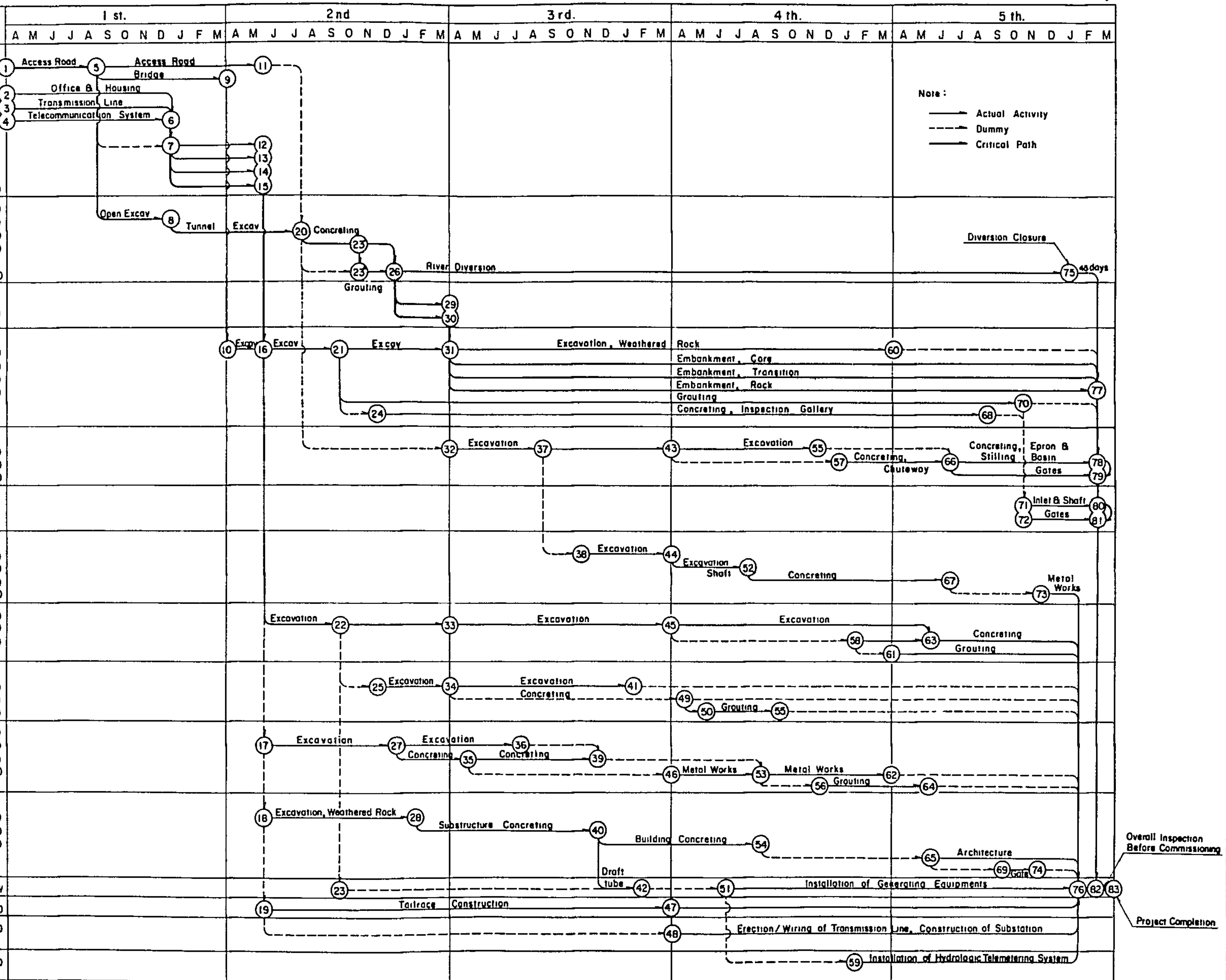
Note: -O & M for river embankment will be under MPWH, Region II
-O & M organization for Hill Area Development will further be adjusted in the detail design stage

FIG. 12

CONSTRUCTION TIME SCHEDULE OF B1 HIGH DAM AND POWER STATION ON MATUNO PROJECT

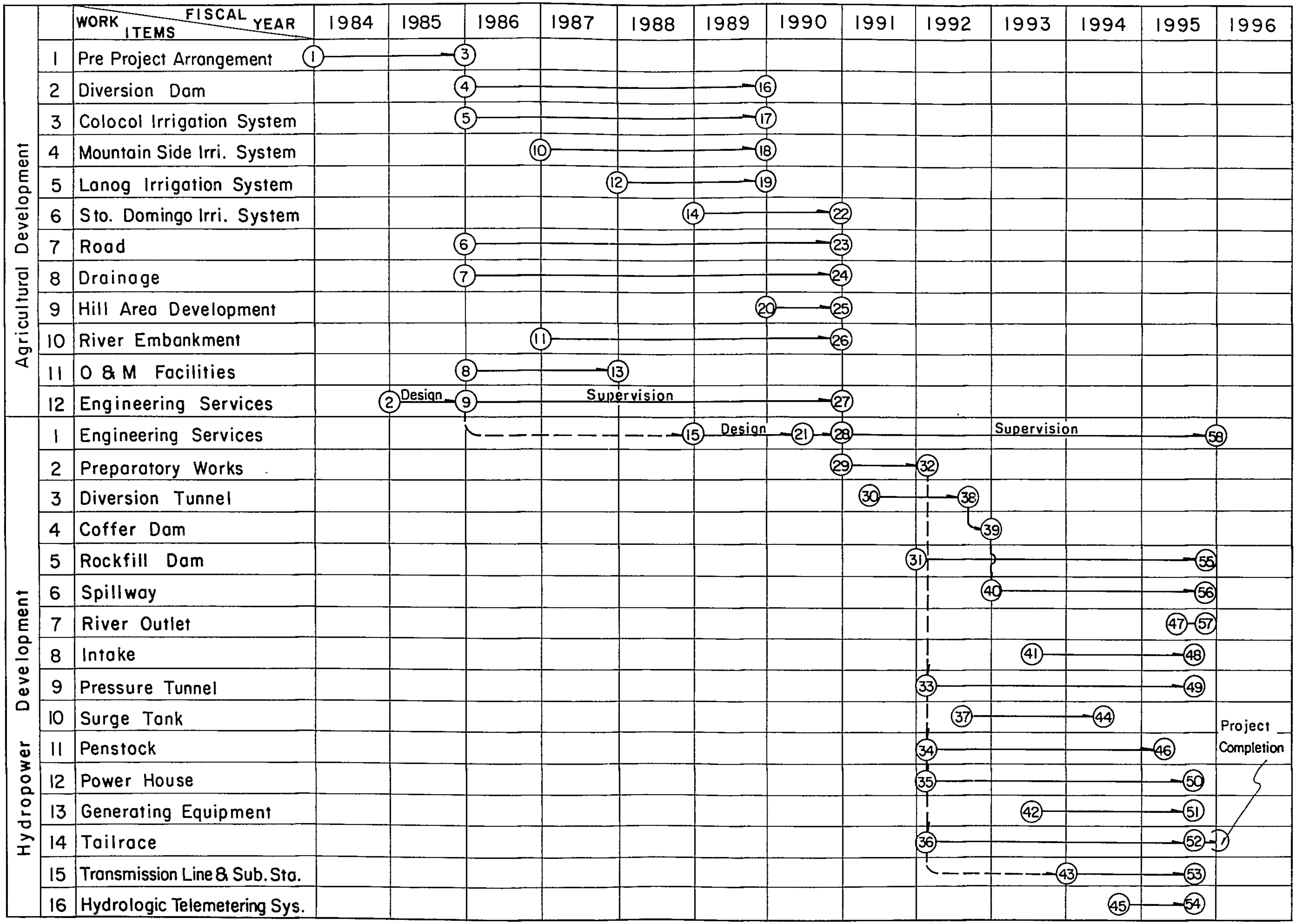
(At Price level of May 1983)

ITEMS	UNIT	WORK QUANTITY
PREPARATORY WORKS		
Access Road (Main)	KM	10.0
Bridge	M	150.0
Office, Housing	L S	
Transmission Line, Others	KM	15.0
Telecommunication System	KM	15.0
Quarry Site	L S	
Aggregate, Batcher Plant	L S.	
Quarry Site Borrow Area Stripping	L.S.	
Hauling Road to Dam Site	KM	5.0
DIVERSION TUNNEL D=13.0M	M	1,910.0
Excavation (Open)	M^3	41,000.0
Excavation (Tunnel)	M^3	330,000.0
Concrete	M^3	80,000.0
Grouting	L S	
Gates	TON	520.0
COFFER DAM		
Upstream Coffer Dam	M^3	250,000.0
Downstream Coffer Dam	M^3	
ROCKFILL DAM (H=144.0M)		
Excavation, Weathered Rock	M^3	350,000.0
Embankment, Core	M^3	1,000,000.0
Embankment, Transition	M^3	800,000.0
Embankment, Rock	M^3	6,200,000.0
Grouting	L S	
Inspection Gallery	L S	
SPILLWAY		
Excavation	M^3	2,000,000.0
Concrete	M^3	100,000.0
Gates	TON	900.0
RIVER OUTLET		
Inlet & Shaft	L S	
Gates	L. S	
INTAKE		
Excavation, Weathered	M^3	20,000.0
Excavation, Shaft	M^3	6,300.0
Concrete, Shaft etc.	M^3	2,500.0
Metal Works, Gate, Screen	TON	230.0
PRESSURE TUNNEL	M	5,650.0
Excavation in Tunnel	M^3	260,000.0
Concrete in Tunnel	M^3	80,000.0
Grouting	L.S	
SURGE TANK		
Excavation	M^3	42,100.0
Concrete	M^3	6,500.0
Drain Tunnel	M	100.0
PENSTOCK	M	850.0
Excavation	M^3	65,000.0
Concrete	M^3	26,500.0
Metal Works	TON	3,300.0
Grouting	L S.	
POWER HOUSE		
Excavation, Weathered	M^3	150,000.0
Concrete in Foundation	M^3	25,000.0
Concrete in Building	M^3	15,000.0
Super Structure	L.S.	
Tailrace Gate	L S	
GENERATING EQUIPMENT		2 x 90MW
TAILRACE	M	933.0
TRANSMISSION LINE AND SUBSTATION	KM	20
HYDROLOGIC TELEMETERING SYSTEM	UNIT	3.0

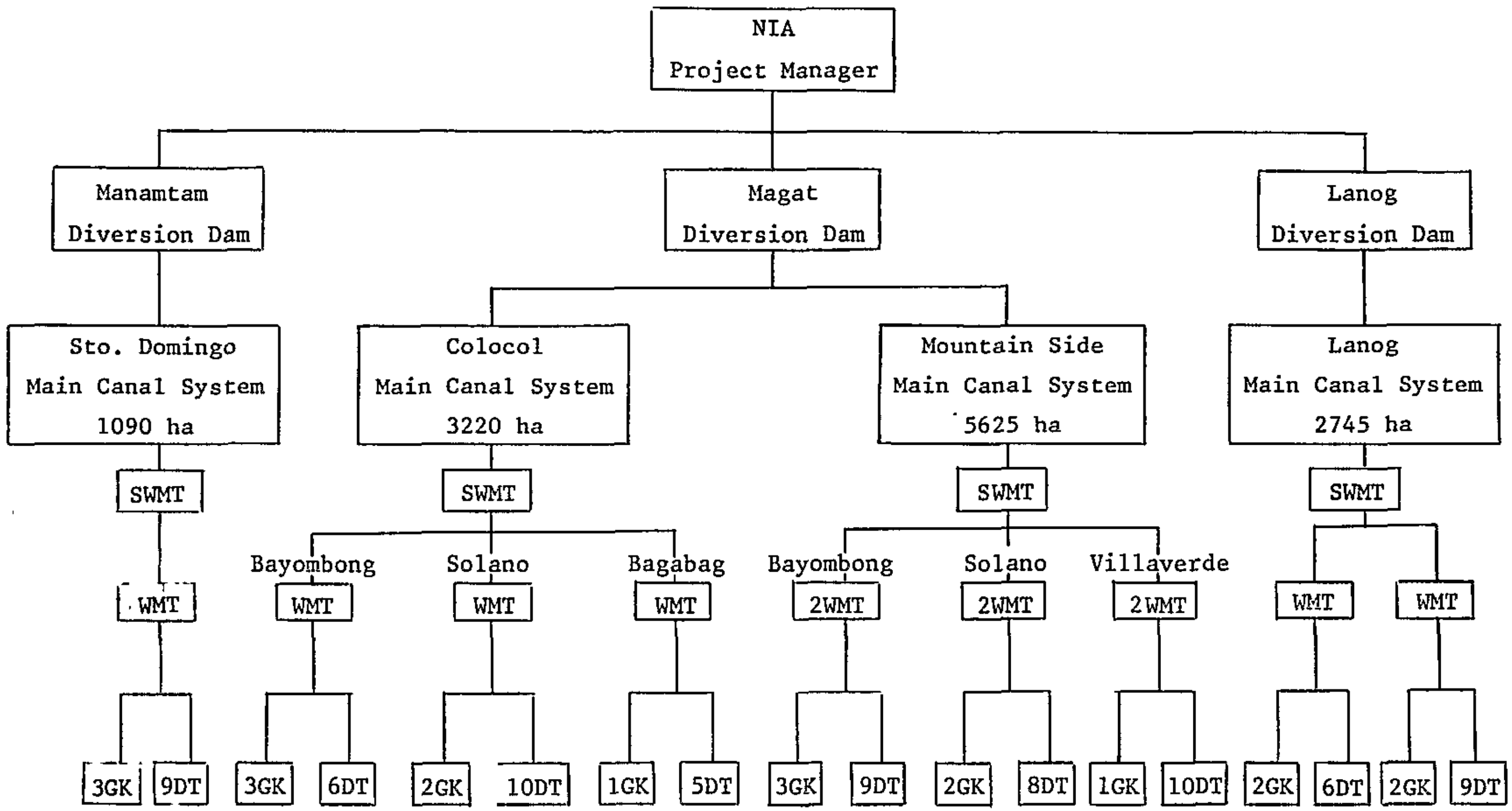


CONSTRUCTION COST	Unit	1st		2nd		3rd		4th		5th		TOTAL
	10^3US$ FOREIGN	19.2	SUB TOTAL 40.5 x10^3US$	28.3	SUB TOTAL 46.0 x10^3US$	44.8	SUB TOTAL 69.4 x10^3US$	47.5	SUB TOTAL 78.4 x10^3US$	88.5	SUB TOTAL 135.7 x10^3US$	F.L. 228.3
	10^3US$ LOCAL	21.3		17.7		24.6		30.9		47.2		L.C 141.7

CONSTRUCTION TIME SCHEDULE ON MATUNO RIVER DEVELOPMENT PROJECT

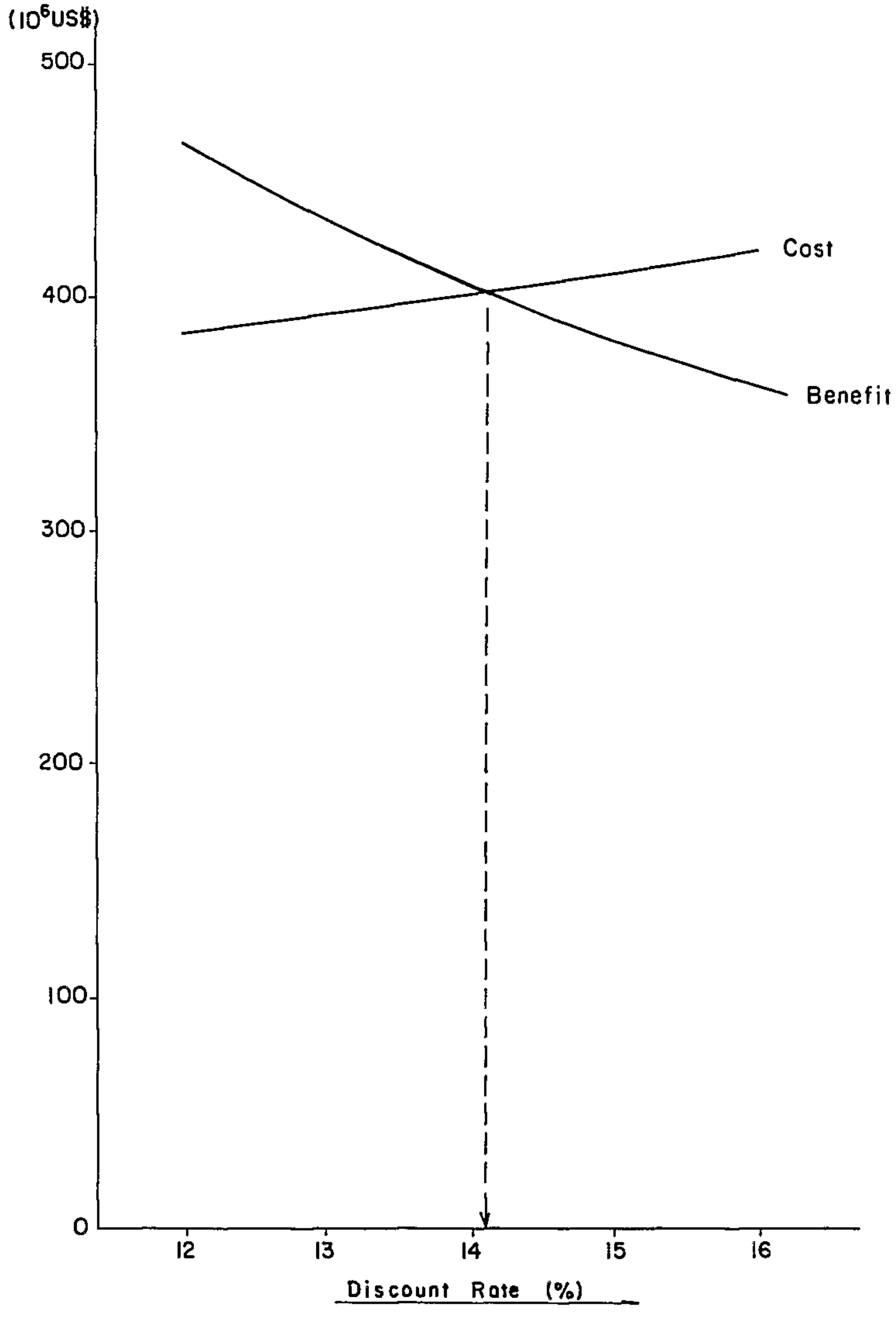


ORGANIZATION OF OPERATION AND MAINTENANCE



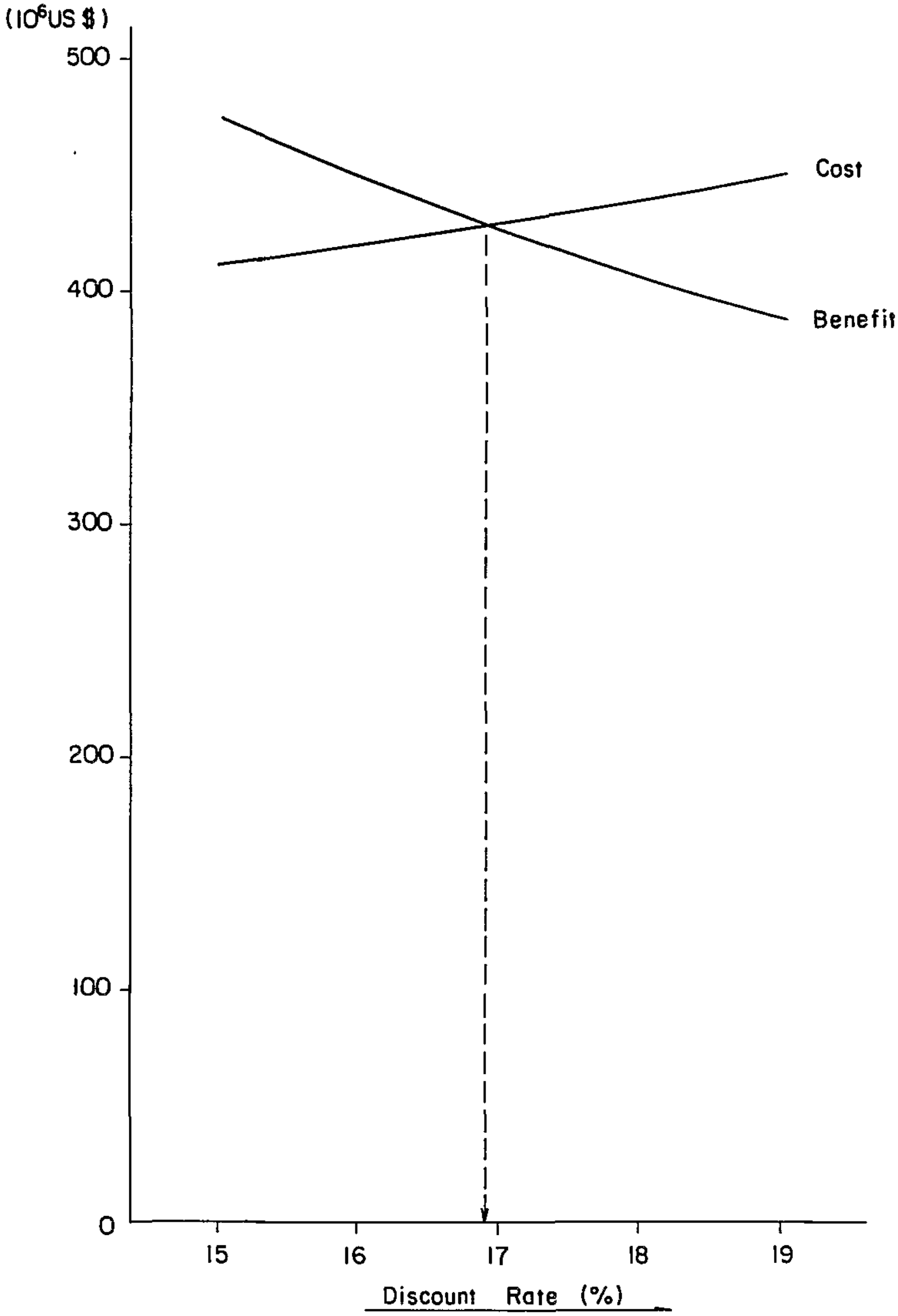
SWMT: Senior Water Management Technician
WMT: Watermaster (Water Management Technician)

2GK: 2 Gate keepers
8DT: 8 Ditch tenders



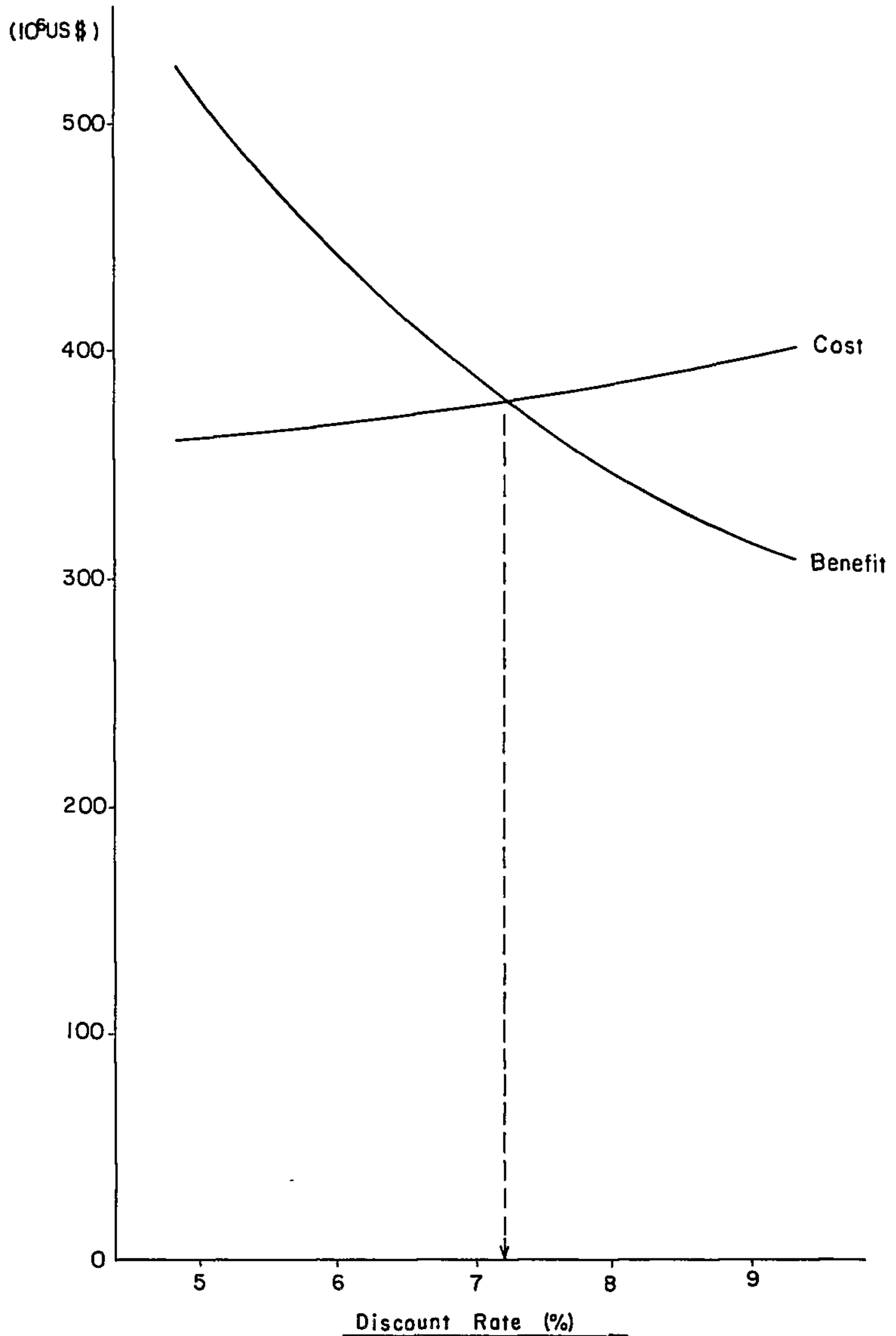
ECONOMIC INTERNAL RATE OF RETURN FOR HYDROPOWER DEVELOPMENT (Case I)

FIG. 16



ECONOMIC INTERNAL RATE OF RETURN FOR HYDROPOWER DEVELOPMENT (Case 2)

FIG. 17

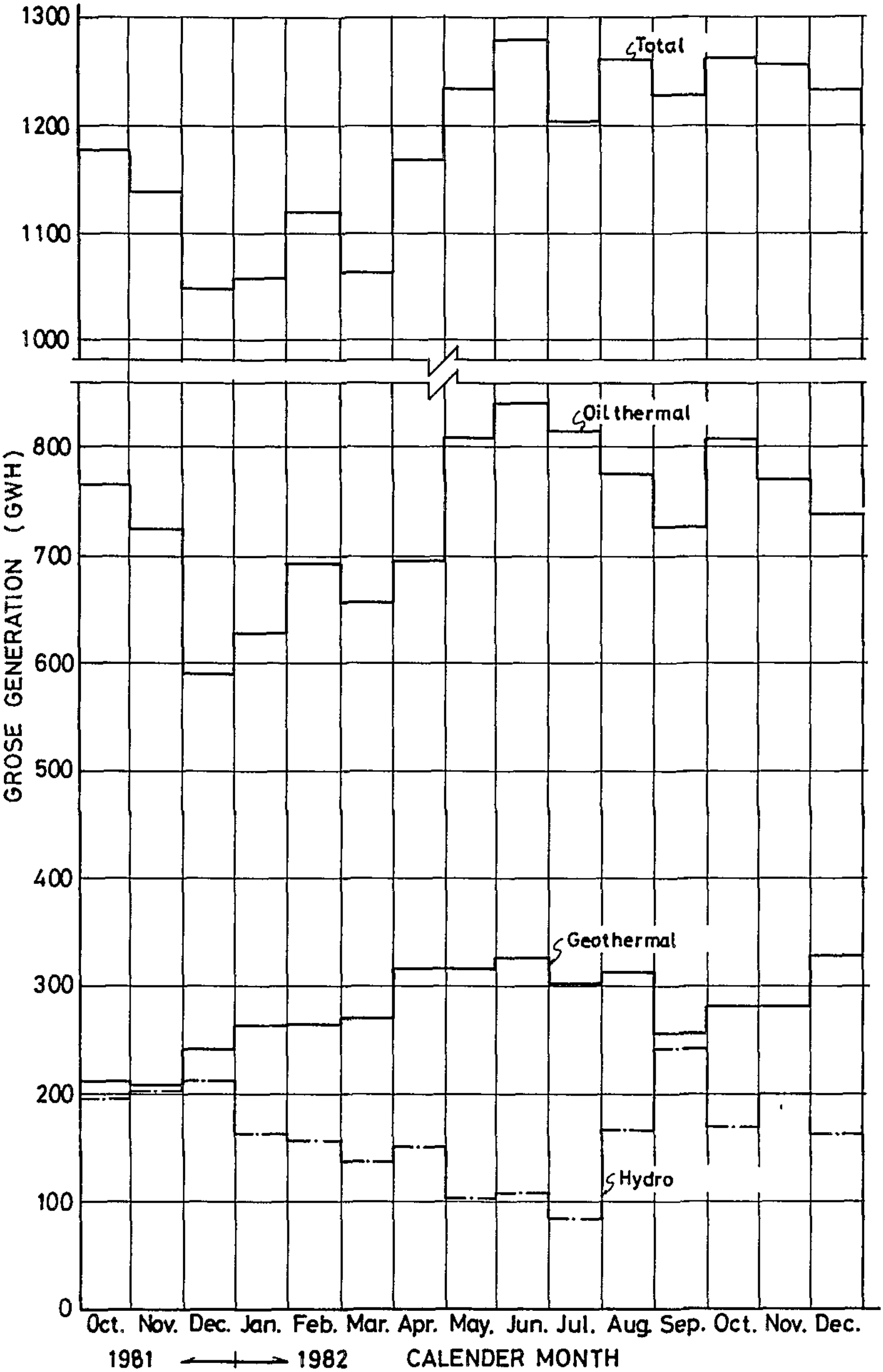


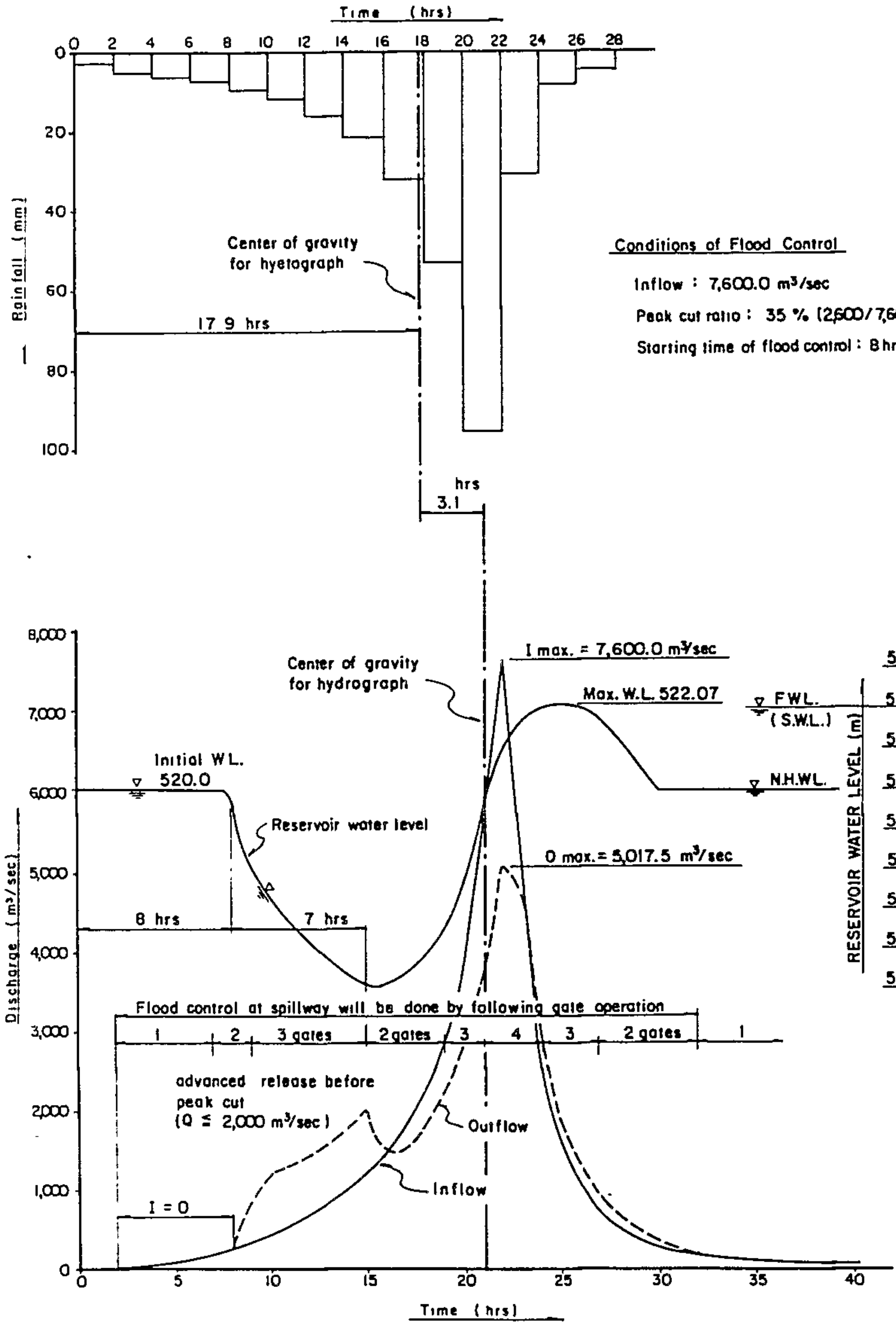
FINANCIAL INTERNAL RATE OF RETURN FOR HYDROPOWER DEVELOPMENT

FIG. 18

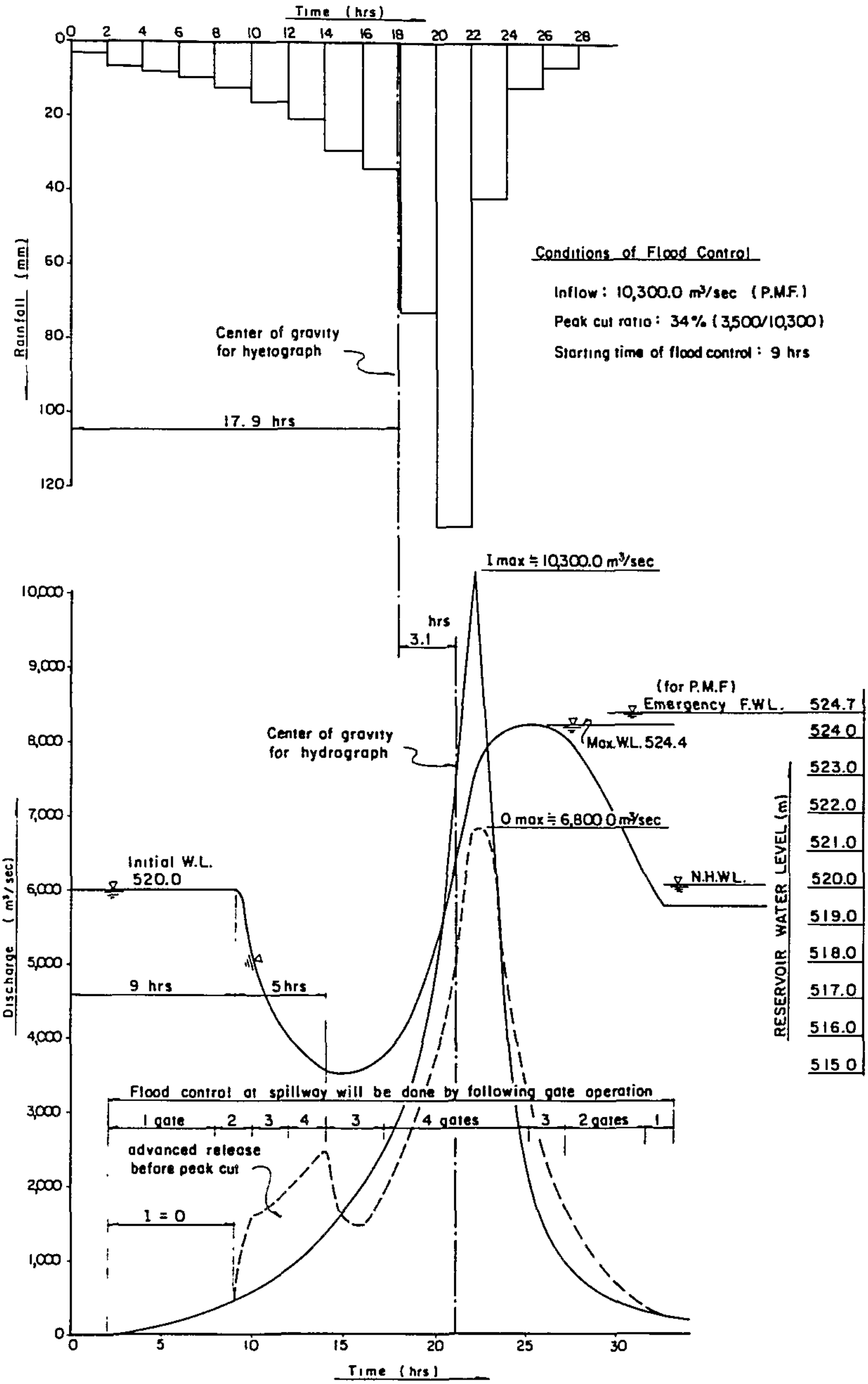
GROSS ENERGY GENERATION ON 1982 BY CATEGORY WISE

LUZON GRID

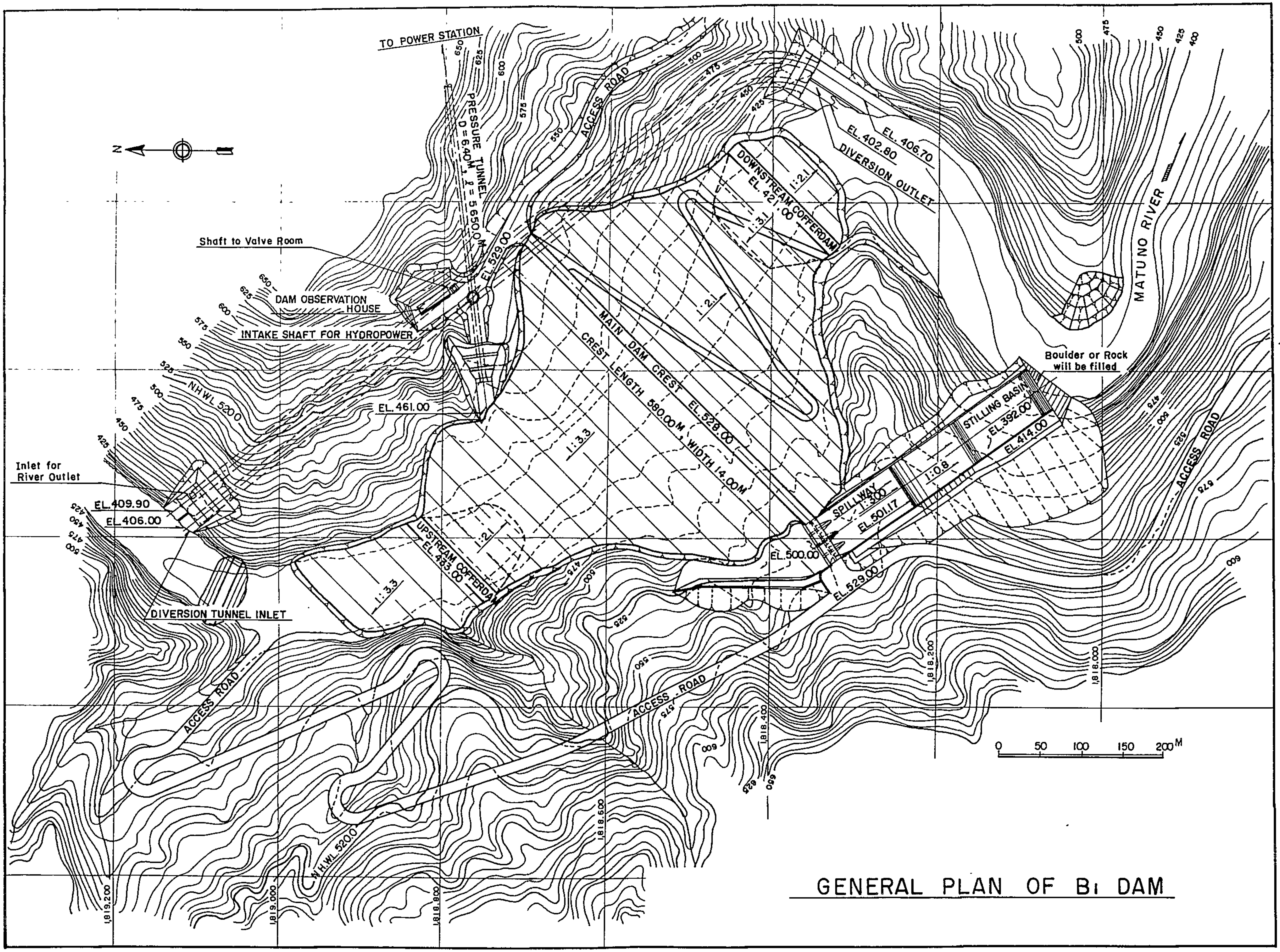




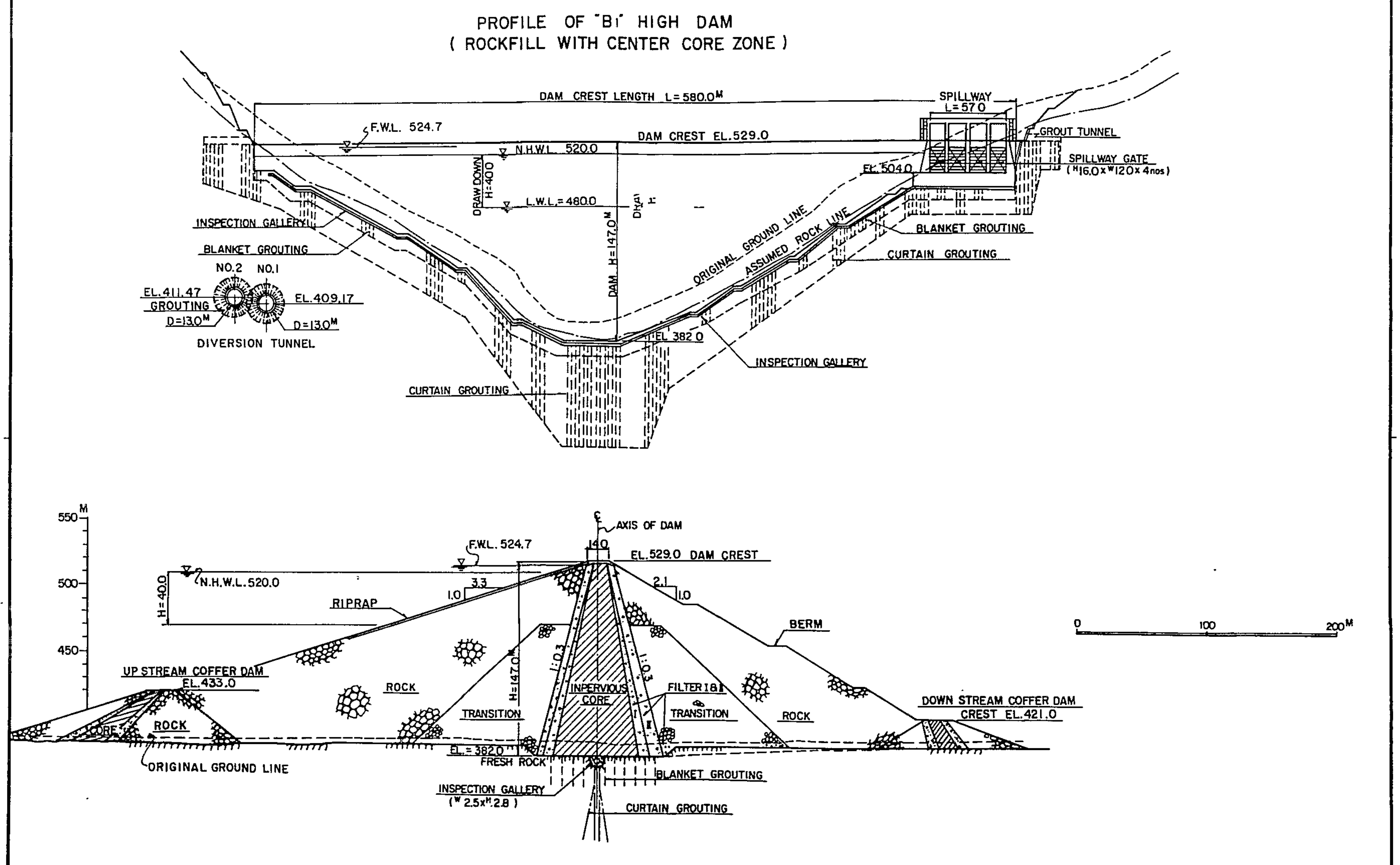
FLOOD CONTROL AT SPILLWAY OF B1 DAM RESERVOIR



FLOOD CONTROL AT SPILLWAY OF B1 DAM RESERVOIR



GENERAL PLAN OF B1 DAM



TYPICAL CROSS SECTION AND PROFILE

A2 NO 455L

JICA