REPUBLIC OF INDONESIA
Ministry of Public Works
Directorate General of Water Resources Development

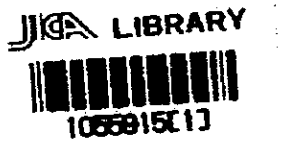
FEASIBILITY STUDY ON THE KOMERING-I IRRIGATION DEVELOPMENT PROJECT IN THE UPPER KOMERING RIVER BASIN

VOLUME I

MAIN REPORT

JUNE 1981

Japan International Cooperation Agency
Tokyo, Japan



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PREFACE

In response to a request from the Government of the Republic of Indonesia, the Government of Japan decided to provide the technical services for the feasibility study on the Upper Komering River Basin Development Project as a part of the technical cooperation of the Government of Japan from 1979 through 1982. In accordance with the Scope of Works for the feasibility study agreed upon between the Government of Indonesia and the Government of Japan, the Japan International Cooperation Agency dispatched a feasibility study team headed by Mr. S. Yano of Nippon Koei Co., Ltd. on the Komering-I Irrigation Development Project which was identified as the priority project in the Comprehensive Study previously carried out in 1979/80 fiscal year. The study team performed field investigation from July 14, 1980 to November 13, 1980.

The report is hereby presented based on the findings obtained in the field survey as well as the subsequent study in Japan. I sincerely hope that this report will substantially contribute to the implementation of this project.

Finally, I wish to express my hearty gratitude to the Government of Indonesia and other authorities concerned for their kind cooperation and assistance extended to the study team.

June, 1981

Keisuke Arita

Keisuke ARITA
President
Japan International Cooperation Agency

Mr. Keisuke ARITA
President
Japan International Cooperation Agency
Tokyo, Japan

Dear Sir,

LETTER OF TRANSMITTAL

We have the pleasure of submitting the feasibility report on the Komering-I Irrigation Development Project in the Upper Komering River Basin, the Republic of Indonesia, in accordance with the terms of reference issued by your Agency.

The project is basically formulated for the sharp increase in food production and the improvement of farmers' living standards in the Komering-I area of 36,700 ha. After implementation of the project, the increased amount of agricultural products would substantially contribute to the national economy as well as the regional economy in the South Sumatra region. We would recommend that the project will be soon implemented in line with the conclusion presented in this report.

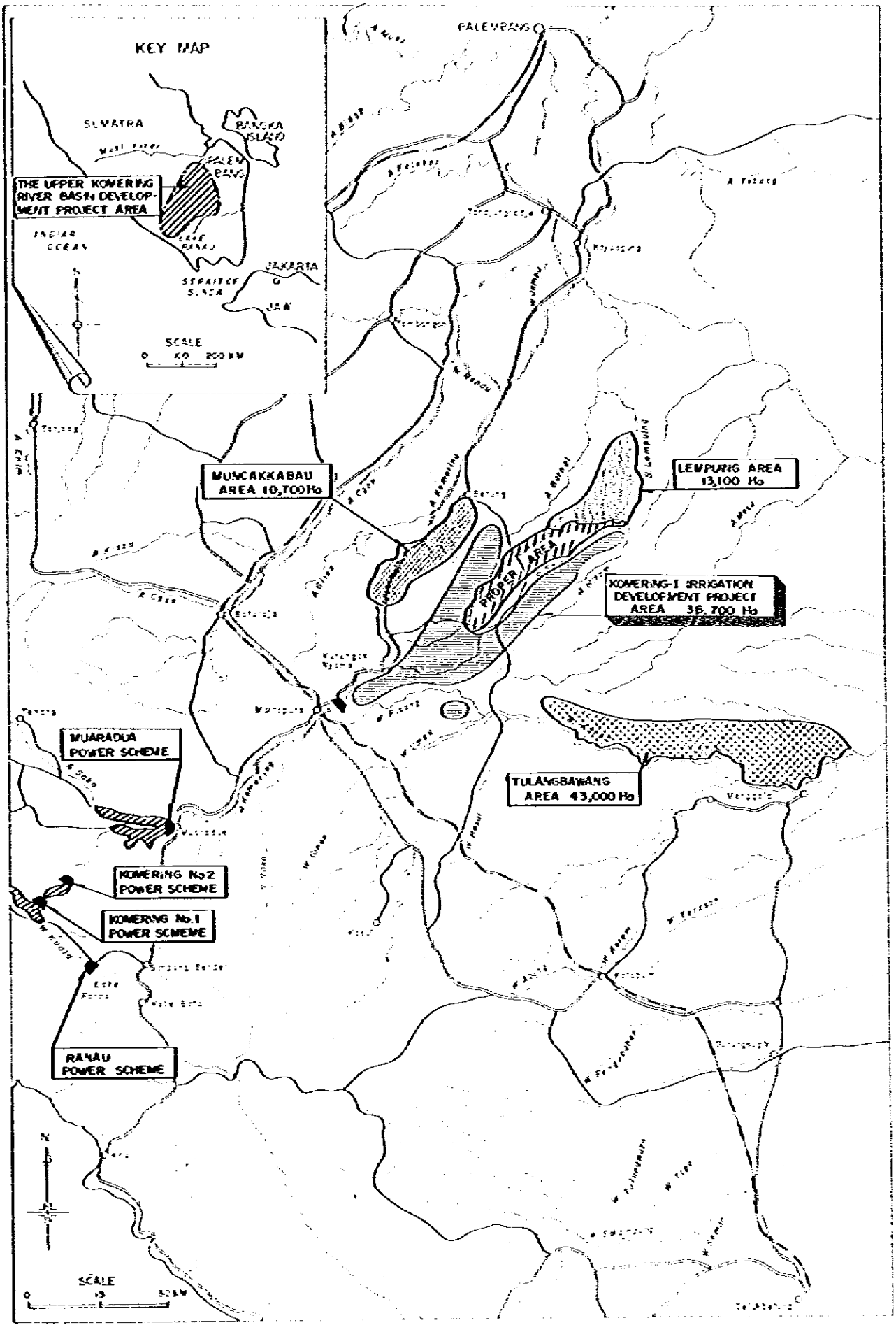
We wish to express our deep appreciation and gratitude to the personnel concerned of your Agency, the Authorities concerned of the Government of Indonesia and the Embassy of Japan in Indonesia for the courtesies and cooperation extended to us during our field survey and study period.

Sincerely yours,

S. [signature]

Shinichi YANO
Leader of the Study Team for
the Komering-I Irrigation
Development Project

LOCATION OF DEVELOPMENT PLAN



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ABBREVIATIONS AND LOCAL TERMS

Abbreviations and local terms used in this report are listed below:

A. ABBREVIATIONS

1. Length

mm	millimeter
cm	centimeter
m	meter
km	Kilometer

2. Area

cm^2	square centimeter
m^2	square meter
km^2	square kilometer
ha	hectare

3. Volume

lit (ℓ)	liter (= 1,000 cm^3)
m^3	cubic meter

4. Weight

mg	milligram
g	gram
kg	kilogram
t	ton (= 1,000 kg)

5. Time

sec	second
min	minute
hr	hour

6. Other measures

%	percent
PS	horse power
pH	scale for acidity
°C	centigrade
m^3/sec	cubic meter per second
lit/sec/ha	liter per second per hectare
cm/sec	centimeter per second
m.e/ℓ	milligram equivalent per liter
mgcal/cm^2	milligram calorie per square centimeter
t/ha	ton per hectare
ppm	part per million
EC	electric conductivity
CEC	cation exchange capacity
No. (Nos.)	number(s)

7. Technical terms

EL	elevation above mean sea level
H	height
WL	water level
HWL	heigh water level
LWL	low water level
FWL	flood water level
Q	discharge

8. Money

US$	US Dollar
Rp.	Indonesian Rupiah

(US$1.0 = Rp.625.-)

9. Other abbreviations

FAO	Food and Agriculture Organization of United Nations
UNDP	United Nations Development Program
DPU	Department Pekerjaan Umum (Department of Public Works)

P3SA	Proyek Percencanaan Pengembangan Sumber-Sumber Air
IRRI	International Rice Research Institute
JICA	Japan International Cooperation Agency
WHO	World Health Organization
BRI	Bank Rakyat Indonesia (Indonesian People's Bank)
GDP	Gross Domestic Products
GRP	Gross Regional Products

8. LOCAL TERMS

Kab.	Kabupaten (District)
Prov.	Provinsi (Province)
OKU	Kabupaten Ogan Komering Upper River Basin
OKI	Kabupaten Ogan Komering Lower River Basin
BIMAS	Mass Guidance for Self-sufficiency in Food
INMAS	Mass Intensification for Self-sufficiency in Food
CRIA	Central Research Institute for Agriculture, Bogor
PPS	Extension Specialist
PPM	Extension Supervisor
PPL	Field Extension Worker
BPP	Rural Extension Center
KUD	Village Unit Cooperative Body
DOLOG	Depot Logistic
BULOG	Board of Logistic
KIOSK	Small Shop
ADC	Agricultural Development Center
UPP	Land Development Unit
KIK	Small Investment Credit
Desa	Village
Kecamatan	Sub-district
Kontak-Tani	Key farmer or leading farmer

Ani-Ani	Small Rice Harvesting Knife
Lebak	Swamp behind river levee
Pelita (Repelita)	Five-year Development Plan
Sawah	Paddy field
Dalam Angka	Statistical data
Polowijo	Second crops, planted after harvest of rainy season paddy
Tegal	Upland field
Ladang	Shifting culture land
Alang-alang	Grass land
Ulu Ulu	Water master

CONCLUSION AND RECOMMENDATION

A. SUMMARY OF CONCLUSION

INTRODUCTION

1. This report presents the results of survey and study for feasibility study on irrigation development of the Komering-I area with about 37,300 ha of net irrigable area in the upper Komering river basin.

2. The Government of Indonesia has laid great emphasis on substantial increases in food production over a wide range of crops and promoting transmigration to outer islands in order to relieve population pressure in the densely-populated islands, through which the Government intends to raise the production of food stuff and to accelerate a more balanced economic development in the region.

3. The Government had formulated the project in 1970 and identified the agricultural and irrigation development of about 48,000 ha in the Belitang Extension Area and hydro-power development of some 128 MW in installed capacity in the upper reach of the Komering river. About 33,000 ha of flat-land extending along the Tulangbawang river was further conceived to be developed with the diversion of water from the Komering river.

4. In response to the request of the Government of Indonesia on the technical aid to carry out the feasibility study of the project, the Government of Japan decided to provide the technical services for the feasibility study on the project as a part of the technical cooperation program of the Government of Japan from 1979 through 1982.

5. In accordance with the scope of works for feasibility study on the Upper Komering River Basin Development Project agreed upon between the Government of Indonesia and the Government of Japan, the comprehen-

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sive study on the project was carried out by JICA (Japan International Cooperation Agency) in cooperation with the Government of Indonesia from September 1979 to April 1980. Following the above study, the feasibility study of the Komering-I area with about 37,300 ha identified as the first priority for irrigation development within the promising irrigation development potentials of around 104,000 ha, was carried out by JICA from July 1980 to June 1981.

GENERAL ECONOMIC AND AGRICULTURAL BACKGROUND

6. Agriculture in Indonesia has played an important role in its economy, and more than 60% of the national active population are engaged in agriculture. Production of rice, the main staple food in Indonesia, has substantially increased recently, and it is expected to attain the self-sufficiency in rice production in the near future, whereas the rice production in the South Sumatra Province still can not meet its increasing demand resulting from the rapid population growth.

7. Following the successful implementation of the First and Second Five Year Development Plans (Repelita I and II), the Government has set up the Third Five Year Development Plan (Repelita III) for 1978/80 to 1983/84. Repelita III is a continuation and enhancement of the previous plan and places the major objectives on raising living standard of the people and more equitable distribution of welfare of the whole population.

THE PROJECT AREA

8. The project area is situated at both the south-west corner of South Sumatra Province and the northern part of Lampung Province. The Komering river originates from Lake Ranau with a surface area of about 127 km^2 and about 542 m above mean sea level. Forest still covers a large area of the mountainous region but its deforestation has resulted in heavy erosion and deposition of the eroded materials in the lower reach of the Komering river. The Komering-I

area is situated within the flat land of the upper Komering basin and gently slopes from the right bank of the Komering river to the Lempuing river sandwiching the Belitang Proper Area where about 20,000 ha are provided with irrigation system of about 105 km long main and secondary canals at present. The ground elevation of the project area ranges from 25 m to 80 m.

9. Results of geological investigations reveal that the geological conditions of two alternative headworks sites are favorable in foundation of headworks to be constructed. The Ranau regulating dam site would have also favorable geological conditions. Gravel and sand for concrete are sufficiently available along the upstream reachs from Martapura in the Komering river.

10. The soils in the proposed irrigation development area are classified into eight mapping units consisting of one uniformity and seven associations. The soils comprise Podzolic Soils, Alluvial Soils, Gley Soils, Hydromorphic Soils and Andosols in the Great Soil Group. Except for some hilly and steep lands, the project area is fairly suitable for both paddy and upland crops cultivation.

11. Climate in the project area is tropical. Average annual rainfall in the project area is approximately 2,600 mm, of which about 80% fall during the rainy season from October to May. The fluctuation of mean temperature in the flat lands is rather small throughout the year ranging from 26°C to 28°C. The annual relative humidity is as high as about 80% at Belitang. The annual average sunshine hour is about 5.2 hr/day.

12. Annual average runoff of the Komering river is about 207 m^3/sec at Martapura with about 4,260 km^2 of its catchment area. The maximum monthly runoff of about 305 m^3/sec in April and the minimum of about 133 m^3/sec in August are observed. From Lake Ranau, about 18 m^3/sec of average runoff flow fairly constantly to the Komering river. The Komering river transports the considerable quantities of eroded materials to its lower reach. The annual sediment transport is roughly estimated to be about 880 m^3/km^2 on an average.

13. Population in the project area is estimated at about 114,000 in 1980, of which about 46,000 are living in the southwestern half of the project area, about 65,000 in the northeastern half of the area and about 3,000 in the Pisang Area. Average family size is estimated to be about 5.4 persons.

14. The project area covers about 51,000 ha, of which about 14,000 ha, 28.5%, are cultivated with paddy and about 12,000 ha, 24.6%, with upland and perennial crops of cassava, maize peanuts, coffee etc. Forest and Alang-Alang lands still cover about 19,000 ha, approximately 38% of the area. Average farm holding size in the southwestern half of the project area is about 1.0 ha, while that in both the northeastern half of the project area and the Pisang Area, where transmigrants settled rather recently, is about 1.75 ha.

15. Three types of cropping pattern are prevailing in the project area. Type-I pattern is predominant in 1 ha farm holding area in the upper part of the project area. Rainfed paddy covering about 64% of the area is transplanted during a period from the mid-October to December. The harvesting is made from February to May. Upland crops are planted in about 11% of the area under the rain-fed conditions. Type-II pattern prevails in the lower parts of the Belitang Extension Central Area. At present about 20% of lands are cultivated with paddy and about 21% for both upland crops and perennial crops and the remainings are still covered with forest. Type-III pattern is predominant in the Pisang Area where only 15% of the area is planted with mainly upland crops and perennial crops.

16. The present farming practices in the area are still conventional. Very limited amounts of fertilizer and chemicals are used for paddy cultivation. High yielding varieties of paddy are introduced in the very limited area owing to the lack of irrigation facilities. Upland paddy, maize, cassava, peanuts etc. are traditionally cultivated during the period of rainy season. Negligible amounts of fertilizers and chemicals are applied to both paddy and upland crops cultivation at present.

17. Present crop yields are rather low except for paddy cultivation under the BIMAS program. The average yields of crops in the project area in 1978/79 were about 2.5 t/ha of rainy season paddy, 1.0 t/ha of maize, 0.8 t/ha of peanuts, 0.7 t/ha of soybeans and 6.0 t/ha of cassava, etc. Total production of paddy and upland crops in the project area are estimated at about 43,000 tons of paddy, about 23,000 tons of cassava and about 1,100 tons of peanuts respectively.

18. Surplus of paddy produced by farmers in the project area is mostly marketed through two channels, DOLOG/KUD and itinerant grain buyers. The DOLOG/KUD market the rice for stabilization of price of rice under the Government control. The following table shows the present farm gate prices of major farm products prevailing in the project area.

	Price (Rp./kg)
Rice	175
Maize	150
Cassava	25
Soybeans	300
Peanuts	430

19. Extension services to the farmers are carried out by field extension workers (PPL) under the supervision of the Agricultural Extension Office in Kabupaten through PPS and PPM. Service area of PPL averages about 1,200 ha of paddy fields cultivated. The Belitang Seed Center is located near the project area. The stock seeds of paddy produced at the Center are distributed to the some seed growers authorized. Then the seeds produced by the seed growers are distributed to farmers through BUUD/KUD. The amount of paddy seeds is still insufficient.

THE PROJECT

20. The project is formulated with the main concepts of:

(1) increase and stabilization of yield and production of the rainy season paddy through supply of irrigation water, proper drainage improvement and introduction of improved irrigation farming,

(2) introduction of diversified cropping pattern including the rainy season paddy, dry season paddy and Polowijo through provision of year-round irrigation,

(3) increase of agricultural production by opening up new agricultural lands in the areas which have favorable physical conditions for agricultural development.

(4) Improvement of living standard and more equitable distribution of income and welfare of the people, and

(5) Successful settlement of transmigrants through irrigation and agricultural development.

21. The project area covers about 51,000 ha in gross of which about 36,700 ha of irrigation area in net are delineated taking into account the land suitability, topography, land use and the Government's policy for development. From the viewpoint of project development sequence, the project area is divided into two sub-areas. Sub-Area-I covering 18,500 ha extends over the western half of the project area and Sub-Area-II covering 18,200 ha extends over the eastern half including the Pisang Area of about 2,900 ha of net irrigable land.

22. For the proposed agricultural development in the area, five cropping patterns, i.e. two types for 1-ha farm holding area and three types for 1.5-ha farm holding area, are recommended taking into account the agro-climatic conditions and the farm holding size. The rainy season paddy will exclusively be grown in the whole project area in every cropping pattern. In order to maximize the yields and profits, improved high yields and tasty varieties will be introduced under this project. During the dry season, the whole 1-ha farm

holding area will be cultivated with paddy, but 1.5-ha farm holding area will be cultivated with paddy and Polowijo such as peanuts, soybeans and maize from the viewpoints of crops diversification and water saving.

23. After implementation of the project, the following crop yields and production are expected.

Crops	Yield (ton/ha)	Area (ha)	Production (10^3 tons)
Rainy season paddy	4.0	36,700	146.8
Dry season paddy	4.5	27,260	122.7
Peanuts	1.3	8,920	11.6
Soybeans	1.3	4,720	6.1

24. After the implementation of the project, about 24,000 ha of forest and Alang-Alang area in the Belitang Extension Central Area would be reclaimed for irrigable paddy lands. In the Pisang Area, approximately 1,700 families of transmigrants would newly be settled mostly in its northern portion where a large area is still unopened. In the northern parts of the Central Area the forest and Alang-Alang areas are rather scattered so that the transmigration program is proposed to be thoroughly assessed according as the reclamation of the areas.

25. The irrigation requirement for the project is estimated for the proposed cropping pattern. Effective rainfall with 80% probability of exceedence of the drought year is taken into account for its calculation. Canal conveyance and operation losses are estimated to be 15% and 30% of the diversion requirement respectively. The total diversion requirement for the project is estimated at 44.1 m^3/sec which include the diversion requirement for the BK-1 area of 1,300 ha in the Belitang Proper Area also.

26. Two alternative sites for the headworks, Pracak and Perjaya, were thoroughly surveyed and studied from the technical and economical viewpoints. As the results, the Perjaya site is recommendable for constructing diversion weir at an elevation of 79.3 m in its intake water level. The headreach between the settling basin and the bifurcation structure would be unlined with 1/8,000 in gradient on an average.

27. Since the irrigation water for the Lempuing and Tulangbawang Projects would be diverted from the Perjaya headworks, the development sequence of those projects was studied whether the headreach and main canals of Komering-I system should be constructed with the capacity including the discharge for those areas from the initial stage of construction, or the expansion of facilities to be co-used should be made at their respective development stage. The results of study indicate that it is rather economical to construct the headreach and main canal of the Komering-I Project for its own capacity, unless the development of the Lempuing and Tulangbawang Projects is commenced within 5 years.

28. Economic comparison on integration of intake for the Belitang Proper Area into the intake system of the Komering-I Project was made, because the large amount of sediment loads from the Komering river is deposited at the head of headreach of the Proper Area, resulting in very less discharge in the headreach. In addition, stoplogs provided at BK-I check cum turnout commanding 1,300 ha of elevated land bottleneck the flow capacity of the headreach. As the results, it is proposed to construct the headreach of the Komering-I Project at its own capacity inclusive of diversion of water to 1,300 ha of BK-I.

29. Economic comparison on integration of intake of the Muncak Kabau Project into the Komering-I system was also carried out. The result of study shows that water intake through its own intake structure near Muncak Kabau is rather economical, though certain O & M costs for desilting are required annually. Meanwhile, some hydropower generation can be made by harnessing the head difference between the canal water elevation of the Komering-I system and the intake water level of

the Muncak Kabau system, if the diversion of water for the Muncak Kabau Project is integrated into the Komering-I headreach.

30. In order to utilize efficiently the large amount of water of Lake Ranau, a regulating concrete dam will be constructed at about 2.3 km downstream from the outlet of the Lake. The salient feature of the dam is as follows:

1) Active storage capacity of lake	300 MCM
2) Design discharge (max)	50 m^3/sec
3) Dam	
Height	8 m
Length of crest	84 m
Size of gate (H x B)	1.6 m x 2.5 m
Number of gate	6 Nos.

31. The following table shows the salient features of the headworks, irrigation, drainage and road networks.

1) Headworks	
Intake water level	El. 79.3 m
Crest length of fixed weir	171.0 m
Size of gate (B x H x Nos.)	17.5 m x 5.4 m x 2 sets
Intake gates (B x H x Nos.)	7.0 m x 4.0 m x 3 sets
2) Driving channel	
Length	1.6 km
Type of canal	Trapezoidal concrete
Base width	5.0 m
Side slope	1:1.5
3) Settling basin	
Size of basin (W x L)	40 m x 35 m
Number of basin	2 Nos.
Number of gate	2 x 12 Nos.
4) Headreach	
Length	8 km
Canal slope	1/8,000

	Type of canal	Trapezoidal unlined
	Width of canal base	18 m
5)	Main irrigation canals	
	Length	134 km
	Type of canal	Trapezoidal unlined
	Related Structures	222 Nos.
6)	Secondary irrigation canals	
	Length	237 km
	Type of canal	Trapezoidal unlined
	Related Structures	774 Nos.
7)	Tertiary irrigation canals	880 km
8)	Drainage system	
	Main drains	180 km
	Secondary drains	310 km
	Tertiary drains	954 km
	Related Structures	299 Nos.
9)	Inspection roads	
	Main roads	135 km
	Secondary roads	237 km
	Tertiary roads	1,064 km

32. The project will be implemented taking the following five stages:

1) Construction of headworks and headreach including those detailed design,

2) Detailed design and implementation of Sub-area-I, 18,500 ha, and tertiary development of about 2,000 ha,

3) Implementation of tertiary development of 16,500 ha in Sub-area-II,

4) Detailed design and implementation of Sub-area-II, 18,200 ha, and tertiary development of about 2,000 ha and construction of Ranau regulating dam, and

5) Implementation of tertiary development of 16,200 ha in Sub-area-II.

The time required for the implementation of the project is estimated to be approximately nine years including the design works and preparatory works.

33. Office and quarters required for the project implementation are briefly estimated as follows:

1)	Main office	2,000 m^2
2)	Branch offices	500 m^2
3)	Repair shop	500 m^2
4)	Store house	5,000 m^2
5)	Quarters	3,100 m^2
6)	Motor pool	15,000 m^2

34. In order to implement the project successfully it is proposed to establish the Komering-I Project Office under the superintendence of the Provincial Department of Public Works. The main functions of the Project Office are as follows:

1) Financial arrangement needed for construction works and operation and maintenance of the project facilities,
2) Design and construction supervision of the construction works down to tertiary systems,
3) Assistance to farmers in construction of quaternary canals,
4) Design and construction supervision and operation of the pilot scheme, and
5) Accounting and management of the construction works.

35. In order to attain the expected crop production, more intensive agricultural support services are essential. In this context, the agricultural extension services should be strengthened. For agricultural credit services it is desired to establish a branch office of BRI within the project area. More farmers' cooperatives are organized and strengthened for proper operation of irrigation farming. In addition, it is desired to establish the water users' association for proper water management.

36. The total project costs required are estimated to be about US$321 million which comprise US$122 million equivalent of local currency and US$199 million of foreign currency, which include the physical contingency of about 10% of direct cost and the price contingency of 5% per annum for the foreign currency portion and 8% per annum for the local currency portion. The annual operation and maintenance costs are estimated to be about Rp.720 million per annum.

37. The agricultural net incremental benefit through the project is estimated to be about Rp.27,100 million per annum including the benefit to be derived from 1,300 ha of elevated land in the Belitang Proper Area.

38. The economic feasibility of the project is evaluated in terms of internal rate of return on the basis of a 50 years useful life. The calculated internal rate of return is around 16.2% as a whole, which indicates the economic soundness of the project.

B. RECOMMENDATIONS

1. The feasibility investigation and study for the project were carried out based on the following topographic maps:

1) 1/5,000 scale with 2.5 m contour intervals covering the south-western half of the irrigable area,
2) 1/50,000 scale with 2.5 m contour intervals covering the whole project area,
3) 1/50,000 scale with 20 m contour intervals covering the Lake Ranau area.

For the successful implementation of the project, a considerable supplementary topo-survey and preparation of maps in acceptable scale are required to be carried out particularly for the following stage of the detailed design works of the project. Namely,

1) topographic maps of either 1/5,000 scale with 0.5 m contour intervals or 1/2,500 scale with 0.5 m contour intervals for cadastral survey covering the entire project area, and

2) topographic maps of 1/500 scale with 0.25 m contour intervals at both headworks and settling basin sites for hydraulic model tests.

2. Hydrological analysis was carried out based on the available data provided by the Authorities concerned and supplementary investigation carried out by the Comprehensive Survey Team in 1979. Those data were rather insufficient for analysis due to certain interruption in measurement of river runoff and meteorological observation. In view of vital importance of meteoro-hydrological data on the water resources development, it is urgently needed to carry out the periodical measurement of river runoff and establishment of additional meteorological and hydrological stations to obtain the reliable data.

3. The upper basin of the Komering river has widely been developed for perennial crops cultivation and shifting culture by deforesting the lands, resulting in acceleration of considerable amount of sediment transport and unforeseen flood discharge of the river. The consolidated watershed management of the upper reach basin is indispensable. In this context, it is strongly recommended to promote the reforestation work for land conservation and water resources.

4. For the proper operation of settling basin to be constructed for the project as well as for study on reservoirs proposed for future development of the river basin, periodical measurement of sediment transport of the river at Martapura is essential.

5. Geological investigations at the headworks site and regulating dam site were carried out to a certain extent in 1980/81. Further additional test drillings at those sites including proposed settling basin site are required to be carried out in order to ensure the successful implementation of the works.

6. Based on the results of geological investigations and topographic maps prepared, hydraulic model tests of the proposed headworks and settling basin are proposed to be carried out for proper design on effective working of the structures.

7. In the estimation of irrigation water requirement for the project area, percolation rate measurement in the paddy field and intake rate measurement in the uplands were carried out to some extents. The estimation of consumptive use by crops was made based on the empirical formula. Actual field measurement of both consumptive use and additional percolation rate for paddy and intake rate measurement for uplands, particularly at the lands to be newly reclaimed, are needed to be carried out in the project area so as to obtain more reliable figures.

8. In order to exploit the full potential of the lands for agricultural development, rather intensive cropping patterns were proposed to the project, which require more improved farming technics together with careful water management. For the successful introduction of the proposed cropping pattern and its water management to the farmers in the project area, a pilot demonstration scheme is porposed to be established within the project area, for which the proposed plan is given in ANNEX-XII. Along with the above, the present institutions for agricultural support services have to be strengthened through increase of staff and budget allocation. In particular, cooperative movement is to be enhanced through effective extension services.

9. The comparative studies on irrigation water intake system between the proposed Perjaya headworks for both the Belitang Proper Project and the Muncak Kabau Irrigation Project and the present free intake system at Kurungang Nyawa for the Belitang Proper Project and the original plan of free intake at Muncak Kabau were carried out without considering the possibilities of hydro-power development. From the rough studies based on the available topographic maps and the proposed plan of Komering-I Project, it is expected to generate about 1,000 KW at Kurungan Nyawa and about 800 KW at Muncak Kabau harnessing the head between the proposed canal water level in the Komering-I System and the proposed intake water level at each said Project. In view of future rural electrification in and around the project area for raising living standard and welfare of the people as well as agro-industry development, the detailed comparative studies on such micro-hydropower development are recommended to be carried out at the time of realization of both the Lumpuing and the Muncak Kabau Projects.

1. INTRODUCTION

1.1 AUTHORITY

This report is prepared in accordance with the Article 4 (2) in the Scope of Works for Feasibility Study on the Upper Komering River Basin Development Project (hereinafter referred to as "the Komering-I project" or "the project") in the Republic of Indonesia agreed upon between the Government of the Republic of Indonesia and the Government of Japan.

This report presents the results of field survey and study for feasibility on the Komering-I Irrigation Development Project with around 37,300 ha of net irrigation area undertaken by the study team of JICA and their counterparts from the Government of Indonesia.

1.2 PROJECT HISTORY

The economic growth of Indonesia during the period of the First and Second Five-Year Development Plans (Repelita I & II) was quite impressive. The agricultural production, particularly food, however, had not kept pace with its increased demands due to increasing of population and rising of living standard of the people, resulting in import of rice, about 1.9 million tons in 1979 and other crops. In the Repelita III, substantial increases in food production over a wide range of crops are envisaged. The increase of rice production is projected at an average rate of 4.3% and the increase of other secondary crop productions at 5 to 7% per annum.

In the mean time, the Government of Indonesia has laid great emphasis on promotion of transmigration to outer islands like Sumatra in order to relieve population pressure in the densely populated islands, through which the Government intends to raise the production of food stuff and to accelerate economic development in the less densely populated areas towards a more balanced development of the regions.

Based on the above background, the development of the Komering river basin was taken up as one of the promising development plans, and the following activities have been taken so far.

(1) The Belitang Extension Project was formulated in 1970 within the framework of the Land and Water Resources Development in South Sumatra by the Government of Indonesia with the assistance of FAO/UNDP. The reconnaissance investigation for the project was carried out by FAO in 1972 and its results justified the development of 48,000 ha for irrigation in the Belitang area and 128 MW for hydro-power in the upper reach of the Komering. Meanwhile, the Government of Indonesia conceived the development of 33,000 ha in the Tulangbawang area by diverting irrigation water from the Komering river.

(2) The Government of Indonesia requested the Government of Japan to extend technical aid for the feasibility study of the above project including the Tulangbawang area. In response to the request, the Government of Japan decided to provide the technical services for the study as a part of technical cooperation program of the Government of Japan.

(3) Prior to the feasibility study, JICA despatched the Contact Mission to the site from November to December 1978 to conduct the preliminary survey and to prepare the scope of works for the feasibility study. JICA further despatched the Scope of Works Mission to Indonesia in July 1979 to exchange their views with the Government of Indonesia regarding the draft scope of works prepared by the Contact Mission.

(4) In accordance with the scope of works, JICA first despatched the aerial photo survey team to the project area from August to November 1979 to take aerial photographs on a scale of 1:20,000 over 81,000 ha of the area and to prepare topographic maps on a scale of 1:5,000 for 30,000 ha of the priority area.

(5) After the above despatch, JICA further despatched the comprehensive study team to the site from the middle of September to December 1979 for the field survey and the preparation of Interim Report which described their finding and the result of preliminary study on the project. The draft final report of the comprehensive study was submitted to the Government of Indonesia in April 1980. The study revealed that the project would provide the promising development potentials for the irrigation of around 120,000 ha and hydro-power of 216 MW. The study further revealed that around 37,300 ha would be selected as the priority area for the irrigation development, and the feasibility study would proceed to this area.

(6) In July 1980, JICA despatched the Advisory Committee Mission to Indonesia to make field inspection in the feasibility study area and to exchange their view with the Government of Indonesia regarding the extent of the feasibility study to be carried out in 1980/81. As the result, it was concluded that the feasibility study on the irrigation development of 37,300 ha in the Komering-I project area would be carried out together with the aerial photo mapping on a scale of 1:5,000 for the area of 135 km^2 extending over the western half of the northern part of the project area in 1980/81.

(7) Following the above conclusion, JICA despatched the feasibility study team to the site in the middle of July 1980 to initiate the field survey. The team had completed field survey and preliminary study by the end of October 1980, and the Interim Report was submitted to the Government of Indonesia in mid-November 1980.

(8) Immediately after the despatch of the feasibility study team; from the end of July 1980, the aerial photo mapping team was despatched to the site and the team completed the field survey by the mid-September 1980. The map was prepared and submitted to the Government of Indonesia in March 1981.

(9) The draft final report of the feasibility study on the Komering-I project was submitted to the Government of Indonesia in March 1981. Taking into account the comments on the draft report forwarded by the Government of Indonesia, the final report of the feasibility study was prepared by the team and submitted to the Government of Indonesia in June 1981.

1.3 OBJECTIVE OF THE STUDY

The objective of the study is to carry out the feasibility study on the irrigation development of the Komering-I area with about 37,300 ha in net with particular emphasis on the irrigation water supply from the Komering river and agricultural stabilization through introduction of improved irrigation farming and agricultural support services.

1.4 ACTIVITIES OF THE STUDY TEAM

The activities of the study team broadly consist of field survey and feasibility study of the project. The field survey includes;

(1) socio-economic survey,
(2) meteorological and hydrological survey,
(3) topographic survey,
(4) soil survey,
(5) geological survey,
(6) soil mechanical survey,
(7) agricultural survey,
(8) agro-economic survey,
(9) irrigation and drainage surveys, and
(10) construction material survey.

The feasibility study includes;

(1) establishment of regional agricultural development concept,
(2) formulation of development plan of the project,
(3) preliminary design of project facilities,
(4) project cost estimate,
(5) project organization and management,
(6) economic and financial evaluation of the project, and
(7) preparation of the implementation schedule for the project.

The Interim Report, which described major finding, preliminary views and provisional conclusions so far reached by the end of the field survey, was submitted to the Government of Indonesia in November 1980. The Draft Final Report was submitted in March 1981 for the review of the Government of Indonesia. The report described the development plan of the project, appropriate time schedule, preliminary estimate of investment cost and economic and financial viabilities of the proposed irrigation and agricultural development plan. The Final Report prepared taking into account the comments made by the Government of Indonesia on the Draft Final Report, was submitted in June 1981.

The team member and the counterpart personnel provided by the Government of Indonesia are listed in Table 1.1 and their activities are illustrated in Fig. 1.1.

Table 1.1 LIST OF FEASIBILITY STUDY TEAM

A. For Field Work

1. Study Team

1)	S. Yano	Team Leader
2)	T. Tomita	Irrigation & Drainage Planning Engineer
3)	H. Sekine	Irrigation & Drainage Design Engineer
4)	S. Uesugi	Structural Design Engineer
5)	M. Fujinami	Engineering Geologist
6)	T. Matsuoka	Soil Mechanical Engineer
7)	I. Koshino	Agronomist
8)	M. Matsui	Soil Chemist
9)	M. Shono	Agro-Economist
10)	F. Watanabe	Survey & Design Engineer
11)	H. Nakano	Survey & Design Engineer
12)	C. Kubota	Survey & Design Engineer

2. Counterparts

1)	Ir. H. Hasbullah Bandarnata	Advisor
2)	Ir. Hasan Nuh	Advisor
3)	Ir. Sukarno Wahab	Team Leader/Regional Planner
4)	Sulam Muchnadi BIE	Irrigation & Drainage Engineer
5)	Ir. Sahib Kadir	Irrigation & Drainage Engineer
6)	Suratno H. P. BIE	Irrigation Structure Engineer
7)	Alju Syafri	Irrigation Structure Engineer
8)	Abdi Mulya	Irrigation Structure Engineer
9)	Muslim BIE	Land Reclamation Engineer
10)	E. Praptodi Mulyo B. Sc.	Hydrologist

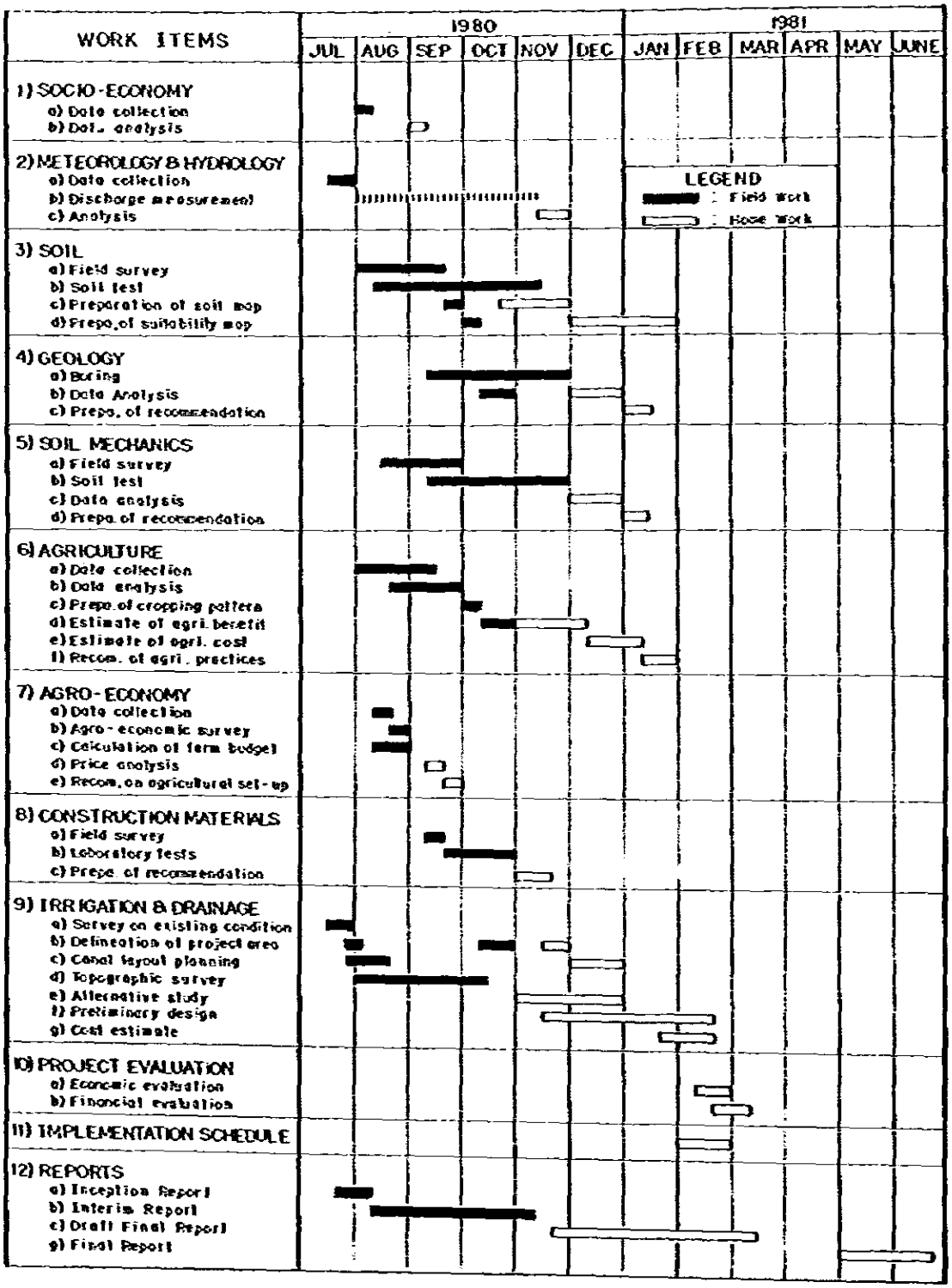
(to be continued)

11)	Ir. Syarbini Husin Alam	Geologist
12)	Ir. Abuamat HAK	Geologist
13)	Ir. Armand Sulun	Agronomist
14)	Mustafa Kamal B. Sc.	Agronomist
15)	Sri Biswarno B. Sc.	Soil Chemist
16)	Ir. Bochari Rachman M.A.D.E.	Economist
17)	Zulkarnain Iskak	Economist
18)	Kartalegawa	Soil Mechanical Engineer
19)	A. Rivai Suryanta	Topographic Surveyor
20)	Zaelani	Topographic Surveyor
21)	Ibrahim Istar	Topographic Surveyor

B. For Home Work

1)	S. Yano	Team Leader
2)	T. Tomita	Irrigation & Drainage Planning Engineer
3)	H. Sekine	Irrigation & Drainage Design Engineer
4)	S. Uesugi	Structural Engineer
5)	M. Fujinami	Geologist
6)	T. Matsuoka	Soil Mechanical Engineer
7)	I. Koshino	Agronomist
8)	M. Matsui	Pedologist
9)	M. Shono	Agro-Economist
10)	Y. Miura	Mechanical Engineer
11)	A. Takatoo	Construction Engineer
12)	F. Watanabe	Survey/Design Engineer
13)	I. Akizuki	Irrigation & Drainage Planning Engineer
14)	S. Ando	Structural Engineer
15)	Y. Nakano	Design Engineer
16)	S. Hanada	Design Engineer
17)	A. Sezaki	Construction Planning Engineer

Fig. 1.1 ACTIVITIES OF THE FEASIBILITY STUDY TEAM



2. GENERAL ECONOMIC AND AGRICULTURAL BACKGROUND

2.1 LAND AND POPULATION

The land of Indonesia covers about 2 million km^2 with more than 14,000 islands. Indonesia is comparatively well endowed with land resources, particularly in the outer islands. The greater part of the land is, however, covered by forest. Only about 18.5 million ha, about 10% of the land, are presently cultivated, of which about 8.8 million ha are planted with paddy, about 5.9 million ha with upland crops and about 3.8 million ha with perennial crops respectively.

The land of South Sumatra Province amounts to about 103,000 km^2 of which about 73% are still covered by forest. South Sumatra province is blessed with substantial resources of oil, coal and natural gas and is a significant producer of agricultural cash crops such as coffee, pepper, cassava and rubber. The cultivated land is about 720,000 ha in total of which about 55% are planted with paddy.

Population of Indonesia is estimated to be about 147 million (77 person/km^2) in 1980 of which around 91 million (691 persons/km^2) are densely populated in Java, resulting in severe population pressure. The annual growth rate is projected to be about 2% during Repelita III, so that the total population would reach about 152 million by the end of 1983. About 70% of the working population is engaged in agriculture including fishery and forestry.

Population of South Sumatra Province is estimated to be about 4.6 million (45 persons/km^2) in 1980, which is much less population pressure than that in Java. The growth rate of population in South Sumatra Province is about 2.9%, much higher than that in the whole Indonesia mainly because of substantial increase of transmigrants.

2.2 NATIONAL AND REGIONAL ECONOMIES

The economic growth of Indonesia during the past five years has been impressive. The GDP increased from Rp.10,708 x 10^9 in 1974 to Rp.21,788 x 10^9 in 1978, corresponding to about 20% of annual growth rate. The agricultural output accounted for about 31% of GDP which still played a dominant role on the economy in Indonesia. A substantial portion of the revenue came directly and indirectly from agriculture. The GDP in South Sumatra Province was about Rp.840 x 10^9 (Rp.203,000 per capita) in 1978. The general economy of South Sumatra Province is mainly dependent on agriculture and mining, followed by manufacturing.

Both export and import values of Indonesia in recent years have substantially increased as shown in the following table.

Exports and Imports in Indonesia

(Unit : US$.$10^6$)

Year	'73	'74	'75	'76	'77	'78	'79
Export	3,211	7,426	7,103	8,546	10,853	11,643	15,590
Import	2,729	3,842	4,770	5,673	6,230	6,690	7,202
Balance	482	3,584	2,333	2,873	4,623	4,953	8,388

Source: Statistik Indonesia

The export value increased at an annual rate of as high as about 30% from 1973 to 1979, while the import value increased at only about 18% of annual growth rate during the same period. The export value of crude oil has remarkably increased recently, resulting in substantial surplus of the trade balance. The export value of agricultural products amounted at about US$.3,956 x 10^6, about 25% of the total exports, in 1979, which came mainly from the wood products, rubber, coffee and palm oil. The following table shows the import of rice in recent 8 years.

Quantity of Rice Imported

(Unit : 10^3 tons)

Year	72/73	73/74	74/75	75/76	76/77	77/78	78/79	79/80
Q'ty	1,230	1,225	1,137	670	1,509	2,308	1,800	1,922

Meanwhile, the import value has increased in relatively low pace compared with that of export. The import of rice in 1979 amounted at about 8% of the total import values or 1.9 million tons in quantity.

Main export commodities of agricultural products in South Sumatra Province are estate crops such as coffee, rubber, pepper, wood, etc. and amounted to about US$.144 million (about 5% of export value of agriculture products in whole Indonesia).

The chemical industry of fertilizer production (mainly urea) in Indonesia has been put into operation by P.T. Pusri since 1963 in Palembang. At present about 1,632,000 tons of urea and about 114,000 tons of ammonium sulphate are produced annually. In 1977/78, about 410,000 tons of urea were exported to ASEAN countries and others.

2.3 AGRICULTURE

Agriculture in Indonesia has played an important role in its economy. The agricultural active population in Indonesia was about 66% of the national active population in 1978. Average farm family size and farm size excluding estates were about 5.0 persons and 0.99 ha/household respectively in 1978.

According to the Central Bureau and Repelita III for Agriculture, 1979, the production of rice in the whole Indonesia would reach about 19 million tons in 1980, which may attain the self-sufficiency of rice in the near future, while in South Sumatra Province, the rice production could not far attain to its increasing demand resulting from the rapid population growth. The rice imported internally amounted to about 190,000 tons in 1979. The following table shows the cultivated land and production of major crops in the whole Indonesia and South Sumatra Province in 1978.

Crops	Cultivated Area (10^3 ha)		Production (10^3 tons)	
	Indonesia	South Sumatra Province	Indonesia	South Sumatra Province
Rice	8,929	378.0	17,525	424.0
Maize	3,025	6.4	4,029	4.8
Cassava	1,333	20.8	12,902	204.0
Peanuts	506	5.9	446	4.7
Soybeans	733	3.4	617	2.9
Sweet Potato	301	6.0	2,033	47.3
Perennial Crops	3,536	21.8	3,370	18.4

Sources: Statistical Yearbook of Indonesia, 1977/78

Rice is the main staple food in Indonesia. The production of rice has increased at an annual rate of about 3.8% from 1970 to 1978. This rapid increase in production is considered to be attributable to the yield increase brought about by the Government intensification program on rice mainly in Java and Bali and the substantial increase in cultivation area in the outer islands.

Irrigated rice cultivation in Indonesia is a long-practiced and well-understood art. Java has more irrigated area than any other islands. Irrigated paddy land in Sumatra is only about 19% of its total paddy land in 1970, while that in Java is as high as about 65% of the total paddy land. The following table shows the paddy land area by the type of irrigation in Java and that in South Sumatra in 1977.

	1973/1			1977/2			
	Indonesia	Java		South Sumatra Province		Kab. OKU	
	(10^3ha)	(10^3ha)	(%)	(10^3ha)	(%)	(10^3ha)	(%)
Technical	1,733	1,446	42.0	17.1	6.0	5.5	9.1
Semi-technical	947	524	15.2	17.1	6.0	5.5	9.1
Non-technical	979	544	15.8	21.0	7.4		
Rain-fed	1,664	859	24.9	76.5	27.0	26.5	43.7
Tidal, etc.	273	73	2.1	152.6	53.6	23.1	38.1
Total	5,596	3,446	100.0	284.4	100.0	60.6	100.0

Data Source: /1 Directorat Irrigasi, 1973
/2 Agricultural Office in South Sumatra Province, 1978

Since 1960 the laws and regulations for land reform have been promulgated to establish the landowner system and abolish the tenancy system. According to this law, the maximum size of farm holding per household is restricted to 15 ha in paddy land and to 20 ha in upland. The tenant system is still in effect to some extent and the tenant usually pay about 50% of his farm products to his landlords as the land use fee.

2.4 TRANSPORTATION

Total length of roads in South Sumatra Province in 1978 was about 10,428 km. The trunk roads connecting Palembang, capital of the Province, to each Kabupaten capital are generally asphalt-paved, and re-alignment and widening of the pavement as well as improvement of bridge load are being undertaken to some extent, while maintenance of secondary roads is restricted to clearing plants growth along the shoulders. The Trans-Sumatra Highway linking Tanjungkarang, capital of Lampung Province, to Lubuklinggau, which is under construction, will run through the upper Komering basin.

The National Railway Network of Indonesia operates in both South Sumatra and Lampung Provinces. The main railway connecting Palembang to Tanjungkarang runs through Baturaja of Kabupaten capital and Martapura located within the upper Komering basin. The rails are single track of 1,067mm gauge with 13 tons per axle at present.

The main shipping port is Palembang. It has port facilities of general cargo wharf for ships of 15,000 DWT. The port of Panjang, about 9 km away from Tanjungkarang, has a deep sea harbour and has taken on a greater significance with the construction of roll-on roll-off wharf facilities for ferryboats plying between Java and Sumatra.

The airport in South Sumatra is available at Palembang. The air strip for Palembang can accept DC-9 aircraft.

2.5 AGRICULTURAL SUPPORT SERVICES

2.5.1 Research

The research works on agriculture are conducted through centralized networks under the direction of the Central Research Institute of Agriculture (CRIA), Ministry of Agriculture, located at Bogor, Java. There are six branch research stations conducting various agronomic research activities throughout the whole Indonesia.

Research works in South Sumatra Province are carried out within the centralized network activities under the direction of CRIA. The substation at Lahat carries out mainly the following research activities for paddy and secondary crops.

a) Fertilizer application test of high yielding and local varieties,
b) Control test on fungicides and insecticides,
c) Variety tests for paddy and secondary crops,
d) Tests on suitable cropping pattern.

One of the most important factors on the production increase is the introduction of improved seeds of crops. There exist seven seed centers in whole Indonesia, two in Sumatra, four in Java and one in Sulawesi. Out of two seed centers in Sumatra, one center is located at Belitang near the project area.

2.5.2 Extension Services

Agricultural extension services in Indonesia has been strengthened with establishment of the Agency for Agricultural Education, Training and Extension as one of the extra-ministerial bureaus under the Ministry of Agriculture. At the same time, the Government has intended to establish an Agricultural Development Center (A.D.C.) with an additional function of seed multiplication center in each province and several Rural Extension Centers (B.P.P. or R.E.C.) in rural area.

The main function of ADC is the adaptability test of new recommended agricultural techniques and in-service training for extension workers at provincial level. The REC is a kind of base camp for extension education activities with the functions of preparation of extension programs, dissemination of agricultural information and training for leading farmers at the local level.

The primary policy for this development program of Agricultural Extension Service was to promote and accelerate extension education activities on field level by separating extension activities with general agricultural administrative services. Following the basic policy, the South Sumatra Province has promoted the strengthening of Agricultural Extension Service since 1976.

The present organization of Agricultural Extension Service in South Sumatra is formed by two separate lines, namely administrative line and operational line under the supervision of inspector of Provincial Agricultural Extension Services. The Agricultural Development Center (ADC), which provides practical technical information for extension workers, has just commenced the construction works in Lahat District in 1979, but it mainly deals with upland crops.

2.5.3 Seed Multiplication and Distribution

The stock seeds of new recommended varieties of paddy in South Sumatra Province such as IR 36, IR 38, are produced at the Provincial Seed Center (KEBUN BENIH SENTRAL) located at BK 10 in Belitang in the center of the Belitang Proper area. The foundation seeds, necessary for stock seed production in this center, are provided by CRIA at Bogor. The stock seeds of paddy produced at the Center are distributed to Seed Stations (BALAI BENIH) managed by MURA and LIOT District Agricultural Offices, seed growers consisting of mostly farmers and demonstration farmers.

The extension seeds produced by these Seed Stations, seed growers and demonstration farmers, are supplied to the farmers through KUD and/or seed distributors according to the BIMAS/INMAS Program and/or requirement of the farmers.

2.5.4 Agricultural Credit

The Indonesian People's Bank (BANK RAKYAT INDONESIA - BRI) is the state bank specialized in agricultural credit covering whole country. The Bank is authorized to finance BIMAS (BIMBINGAN MASAL, Intensification Program) credit for qualified individual farmers. Besides, using own credit funds, the Bank provides the loan to farmer's group and various agricultural associations.

In order to provide loan service properly, especially BIMAS credit service, the Bank has established a broad network formed by many regional offices, branch offices and sub-branch offices so called BRI. UD (Village Unit BRI) since 1974.

In Palembang, there is a regional office of BRI which covers whole South Sumatra Province. Under the regional office, there are 9 branch offices with 71 Village Unit BRIs in whole South Sumatra Province at present.

There are three kinds of loan for agriculture in the Bank loan, i.e. short term, medium term and long term loans. The BIMAS credit is the short term production loan in category with the loan conditions of 7 months in loan term with 1% of monthly interest rate.

2.5.5 Co-operative

Supplies of agricultural inputs and processing and marketing of farm product are made through the co-operatives which have been promoted in the rural area by the Indonesian Government through the District Co-operative Offices since 1945 when the Co-operative Act in Indonesia was enacted. Inspite of the governmental efforts, the movement of co-operative has not been well developed yet mainly due to shortage of operation fund and inadequate road network in the rural area.

In order to improve such stagnant condition of the co-operative movement, the establishment of Village Unit Co-operative (KUD) has

been introduced by the Government to the area by adopting the Agricultural Intensification Program since 1973 when the Presidential Decree for Village Unit was enforced.

In the South Sumatra Province, out of 547 village units, 115 village units, 21% of total village units established BUUD/KUD by the end of 1979/80 fiscal year.

2.5.6 Transmigration Service

There are two kinds of transmigrants in the governmental transmigration, i.e. general transmigration and spontaneous transmigration. The general transmigration means that the transportation cost from original place to transmigration area and foodstuff of initial 12 months are subsidized to each household by the Government. The spontaneous transmigration has no such subsidy and all the expenses should be prepared by themselves.

In the general transmigration program, the Government firstly delineates the transmigration area and then clears the area. Road network, village yard, necessary office buildings and residences of transmigrants are also constructed by the Government. Each household of transmigrants is given 2 ha of land including 0.25 ha for home yard, 0.75 ha for upland field and 1.00 ha for paddy field at the time of transmigration. After opening the transmigration scheme, the transmigration site office takes care of every administrative aspects such as health, communication, education, village administration and agriculture, for initial 5 years under the supervision and assistance of Kabupaten Transmigration Office and Provincial Department of Transmigration.

2.5.7 Land Reclamation Service

The large scale irrigation projects in Indonesia were carried out under the responsibility of the Ministry of Public Works (DPU).

As for the construction works, the responsibility of DPU was previously limited up to the construction of secondary canal and 50 m of tertiary canal from its turnout structure. On-farm development and/or land reclamation within the tertiary irrigation block such as tertiary canal, quaternary canal, farm ditch, farm road and land reclamation for paddy field were left to the farmer's hand and constructed under the technical guidance of the Provincial Public Works and Agricultural Extension Services.

Because of the lack of fund and insufficient technique for on-farm development, the construction of on-farm development scheme was usually delayed. In order to improve such stagnant condition, Indonesian Goverment has decided that the construction of tertiary canal with irrigation facilities of quaternary canal is carried out by DPU and land development is promoted under the responsibility of the Ministry of Agriculture, since 1979 when the Repelita III was started.

2.6 THE THIRD FIVE YEAR DEVELOPMENT PLAN (REPELITA III)

Following the Second Five Year Development Plan (Repelita II) which had been successfully achieved in March 1979, the Government of Indonesia has set up the Third Five Year Development Plan (Repelita III) for 1979/80 to 1983/84.

Repelita II was to deal with the problems of expanding employment opportunities, raising level of income, a more equitable distribution of income, a more even distribution of gains of development among the various regions, provision of adequate supplies of basic human needs, improving the nutritional status of the population and enhancing the quality of life.

Repelita III is a continuation and enhancement of the previous Plan and has the following major objectives.

i) To raise the living standards and levels of knowledge of the Indonesian people.

ii) To strive for a more equitable distribution of welfare of the whole population.

iii) To lay a strong foundation for the next stage of development.

For the successful implementation of Repelita III, the Plan will pursue a balance among the three elements of the development strategy, namely, equity of welfare, high economic growth and national stability. In this context the following economic growth is expected during the five years of Repelita III.

i) Real economic growth rate of about 6.5% per annum.

ii) Per-capita gross domestic product of about 4.4% per annum.

iii) Population growth of about 2% per annum, which means that the total population is estimated to reach 151 x 10^6 in 1983.

Regarding the agricultural development sector, the Plan envisages to raise the productivity of agriculture from which this sector will provide more food for the growing population and raw materials for industry as well as foreign exchange and employment opportunities. The agriculture in Repelita III will contribute directly to improvement of the welfare of the population, promoting industrial growth and a more balanced development of the regions. In this context, the Plan envisages the substantial increase in food production over a wide range of crops. It is projected to grow rice production at an average annual rate of 3.3% and secondary crops by 5 to 7% per annum.

In order to increase the food production, the first priority in the Plan is given to the water resources development for which the following irrigation developments are contemplated:

		Area (ha)
i)	Rehabilitation and improvement of existing system	536,000
ii)	Construction of new system	700,000
iii)	Tidal swamp irrigation	400,000
iv)	Expansion and rehabilitation of tertiary system	600,000
v)	Swamp area reclamation	135,000

The transmigration program is placed on one of the major development activity in Repelita III. Through this program the Plan emphasizes the urgency of relieving population pressure in the densely populated islands as well as accelerating economic development in the less densely-populated islands areas. In Repelita III, the transmigration program aims to settle 500,000 families in 250 settlement locations in Sumatra, Sulawesi, Kalimantan and Irian Jaya.

3. THE PROJECT AREA

3.1 LOCATION

The project area is situated in both the south-eastern part of South Sumatra Province and the northern part of Lampung Province. The area, 50,600 ha in gross (36,700 ha[1] in net), extends northeastwards sandwiching the Belitang Proper Area. The boundaries between the project area and the Proper Area are the Macak river in the north and the Belitang river in the south.

The project area is broadly divided by the Pisang river into two areas; the Belitang Extension Central Area (33,800 ha in net) and the Pisang Area (2,900 ha in net). Administratively, a major part of the Central Area; except some areas in the southern part of the area which belongs to Lampung Province (Kecamatan Bahuga), belongs to South Sumatra Province; Kecamatan Martapura, Buay Madang, Belitang and Cempaka in Kabupaten OKU. The total area of Pisang Area is included in Kecamatan Bahuga in Kabupaten North Lampung of Lampung Province.

3.2 INFRASTRUCTURE

Main transport facilities linking the project area to the prospective market places of Palembang, Baturadja and Martapura are roads, railway and navigation in the Komering river. The trunk road linking Martapura to Palembang running through the project area is asphalt-paved and relatively well-maintained. Along the main canal of the Belitang Proper Area, a well maintained paved road provides an important transportation

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[1] : The project net irrigation area was originally 37,300 ha in the Scope of Works concluded between the Government of Indonesia and the Government of Japan, but reduced by 600 ha because of topographic conditions revealed in this survey period.

activities for marketing of agricultural inputs and outputs. There are several village roads connecting the trunk road to villages, and village to village within the project area, which are unpaved and often impassable due to poor maintenance.

At present, substantial quantity of farm products, particularly rice are transported to Palembang by means of navigation from Kurungan Nyawa and Betung using the Komering river mainly during the rainy season. The project area is still isolated from either rural electricity supply and telecommunication service system, though the economic and social benefits of rural electrification and telecommunication service may appear indisputable in a general sense from the village welfare and security.

Educational facilities and services for primary school in the project area are rather adequately provided at each village. The number of school illiterates has shown rapid decreasing tendency in recent years. The following table shows the number of pupils of school and its rate of attendance in five Kecamatan concerned with the project in 1979 (for details, vide ANNEX-VI).

(Unit: 10^3 pupils)

	Children (No.)	Elem. School (No.)	Elem. School (%)	Jr. H School (No.)	Sr. H. School (No.)
South Sumatra Province	797.6	576.7	72.3	80.9	41.9
Kabupaten OKU	112.9	102.5	90.7	10.5	2.5
Kecamatan concerned	63.0	49.4	78.4	5.3	0.9

Medical services in the project area are inadequate and far below desirable standard. There is an acute shortage of doctors, dentists and nurses, and health facilities and medical equipment. The ratio of population to major health facilities is extremely low.

3.3 NATURAL RESOURCES

3.3.1 Topography

The general topography of the project area is characterized by the flat alluvial plain with an average slope of 0.1% north-westwards and undulating peneplain sloping down towards the Belitang and the Macak rivers, average slope of 0.5%. The flat alluvial plain lies mainly along the right bank of the Komering river over 30 km towards downstream reach from Perjaya. The peneplain occupies more than 60% of the total area. Ground elevation of the irrigable area ranges from 25 to 80 m in the Belitang Extension Central Area and 25 to 60 m in the Pisang Area.

Maps on a scale of 1:50,000 (25 m contour interval) prepared by Indonesian Government and maps on a scale of 1:50,000 (5 m contour interval) prepared by FAO/UNDP cover the total project area. In the course of the comprehensive study in 1979, JICA took aerial photographs on a scale of 1:20,000 over 81,000 ha including the total project area and prepared the maps on a scale of 1:5,000 (2.5 m contour interval) for 30,000 ha including the southern half of the Central Area and the total Pisang Area. JICA has also prepared the maps on a scale of 1:5,000 (2.5 m contour interval) for around 13,500 ha extending over the western half of the northern part of the Central Area.

3.3.2 Geology

Geological explorations by means of core drilling and field permeability tests at the alternative headworks sites; Perjaya and Pracak, Ranau regulating dam site and along the headreach are carried out to supplement surface observation. In addition, the geology of the foundation for the main irrigation canals is also investigated by digging test pits along the canals, and mechanical tests of soil samples collected from the test pits are conducted. The results of investigation so far obtained clarify the followings (for the details, vide ANNEX-III and IV).

Geology at the Pracak headworks site: Compact and hard layers exist at the depth of 10 - 14 m from the surface of the left bank. The standard penetration test indicates the N-value of 50, and the foundation of the proposed headworks would be constructed on the abovementioned layers; sandstone and claystone. The field permeability tests show that the leakage is negligible in the said layers; 2×10^{-5} - 2×10^{-6} cm/sec.

Geology at the Perjaya headworks site: Alternating layers of sandstone and claystone are found at the depth of about 16 m from the surface of left bank of the river. These alternating layers indicate $N \geqq 50$ in standard penetration value. The field permeability tests show the permeability value of 4×10^{-4} - 2×10^{-5} cm/sec. Judging from the above results, this site would be in favorable geological condition as the foundation of the proposed headworks.

Geology at the Ranau regulating damsite: The base rock of the proposed damsite is composed of the ryolitic and welded tuff having a thickness of over 20 meters. General permeability coefficient in the base rock is between 4×10^{-4} and 3×10^{-7} cm/sec. Judging from the above survey results, this site would have favorable geological condition as the foundation of the proposed dam.

Geology along the canal routes: The project area is broadly classified into two regions of hilly area and paddy field area. The hilly area is mostly composed of cohesive soil and the paddy field area is composed of consolidated clay and unsolidified sand. The soils in both areas are considered to have sufficient bearing capacity as foundation of the related canal structures. The seepage through the wetted perimeter of canal is not serious in the hilly area and does not require any special treatment in the canal. In the paddy field area canal lining will be required in sandy zone where the seepage would be rather high.

Rock material: There is a quarry site located at Bukit Mapas, about 15-km south from Martapura, which is being used for producing materials for concrete aggregate and road metalling. The rocks available at this quarry site are blocks of andesite, which are exposed at the surface. The quality test in laboratory shows the compression strength of 462 kg/cm^2 under the moistened condition. Judging from this value, this rock can be used as concrete aggregate material and other construction purposes such as road metalling, masonry work, etc. The size of present quarry is 30 meters in width and one kilometer in length. Providing the depth of quarry to be 10 - 20 meters, the quantity of rock material available from this quarry would amount to more than 300,000 m^3 in gross.

Sand and gravel: Fine concrete aggregate will be available along every reach of the Komering river and its volume will be enough for the construction use for the project. Coarse aggregate is also available in the Komering river. Particularly the high gravel contents are found along the upstream reach from Martapura. The maximum gravel size is about 60 mm in diameter, and its shape is round. The available quantity is roughly estimated to be 400,000 m^3.

3.3.3 Soils

(1) Soil classification

The soil survey is carried out over the total area of about 90,000 ha in and around the project area. The soil classification is made in accordance with Indonesian soil classification system[/1].

The surveyed area is classified into eight mapping units consisting of one uniformity (Mapping Unit 4) and seven associations (Mapping Unit 1, 2, 3, 5, 6, 7 and 8). These mapping units further consist of 25 soil phases.

/1: Sistem Klasifikasi tanah di Balai Penyelidikan Tanah, M. Soepraptohardjo, Bogor, 1961

Mapping Unit-1 corresponds to Podzolic Soils in the Great Soil Group. This mapping unit exists extensively on the upper peneplain in the northern and southern parts of Belitang inland river basin. This area is generally free from flooding, but erosion of surface soils is in progress severely, particularly in the fallow lands after extensive reclamation like shifting culture. The soils are deep and well drained having horizon sequence of A-B-C. These soils are quite deficient in the essential plant nutrients. This unit covers about 17,500 ha or 34% of the project area.

Mapping Unit-2 corresponds to Podzolic Soils in the Great Soil Group. This mapping unit exists scatterly at the foot of the upper peneplain or on the river terraces in the northern and southern parts of Belitang inland river basin. The soils have developed on the lower peneplain, and are deep to moderately deep. The soils are well drained having horizon sequence of A-B-C. The land of this unit is flat or almost flat to gently sloping. The nutrient status of these soils is much; almost same as those of Mapping Unit 1. This unit occupies about 5,600 ha or 11% of the project area.

Mappint Unit-3 includes Gley Soils, Alluvial Soils and Hydromorphic Soils in the Great Soil Group. This mapping unit is observed locally on the river terrace between peneplain and alluvial plain. The land of this unit is almost flat with slopes of less than 2% and the ground elevation is almost same as that of natural levee in the alluvial plain. This area has developed on an alluvium deposit from the adjacent uplands and have a profile sequence with A-(B)-C horizon. These soils vary from shallow to moderately deep and from poorly to well drained. Poor contents of the essential plant nutrients commonly exist and are limiting factor against the frofitable production. This unit occupies 8,500 ha or 17% of the project area.

Mapping Unit-4 corresponds to Alluvial Soils in the Great Soil Group. This mapping unit is situated locally on the river terraces along the Hitam and the Umpu rivers. The land of this unit has rather flat topography with an escarpment at the edge of the river. Since the difference of height between the terrace surface and the river bed is about 3 meters, the areas are free from flooding. The soils have a weak profile development of A-(B)-C. These soils are shallow in depth and poorly drained. This unit extends over 1,100 ha or 2% of the project area.

Mapping Unit-5 comprises Alluvial Soils and Hydromorphic Soils in the Great Soil Group. This mapping unit is situated on the natural levees formed by the old Komering river or its branches. The lands are almost flat with slope of less than 2% and mostly used as the farmyard or the cultivation of perennial crops. The difference of height between the natural levee and the alluvial plain (flood plain) is in the range of 30 - 50 cm. The soil depth is rather deep, and these soils have the profile development with A-(B)-C horizons. In this area, external drainage is fair, while internal drainage is somewhat poor. This unit covers 1,300 ha or 3% of the project area.

Mappint Unit-6 comprises Alluvial Soils, Gley Soils and Andosols in the Great Soil Group. This mapping unit is located on the flat valley bottom among peneplains or between peneplain and alluvial plain. The soils have been developed from alluvium deposits originating from the adjacent hills. The land of this unit is flat or almost flat with slopes of less than 2% sloping down to the stream flow direction. Since these small waterways are commonly constricted by a natural levee formed by the old Komering river or its branches on the alluvial plain, sometimes by road artificially, the moisture condition of these soils tends to become more moist with time. Chemical and physical properties are similar to those of the soils on the alluvial plain. This unit covers 6,700 ha or 13% of the project area.

Mapping Unit-7 comprises Alluvial Soils and Gley Soils in the Great Soil Group. This mapping unit developes extensively on the alluvial plain of Belitang inland river basin. This alluvial plain including many natural levees was formed by the old Komering river or its branch. The alluvium sediments have been derived from the Komering river basin. The land of this unit is flat or almost flat with slope of less than 2% but some parts have depression. Groundwater table is at or near the ground surface for more than 6 months in most years and the areas are submerged during the wet season. Poor contents of the essential plant nutrients exist commonly and would be a limiting factor against the further production increase. This area covers 8,100 ha or 16% of the project area.

Mapping Unit-8 comprises Gley Soils and Organic Soils in the Great Soil Group. This area is mainly observed on a depression in the alluvial plain or constricted river basin and ox-bow in very limited scale. The lands of this unit are flat or almost flat with slope of less than 2%. Groundwater table is at or near the ground surface throughout the year. The lands have very serious limitation for the use of farming due to the deep water stagnation, very strong acid reaction, lack of mineral fraction and deficiency of essential plant nutrients. This unit covers 1,800 ha or 4% of the project area.

Table 3.1 summarizes the acreage of each mapping unit mentioned above.

(2) Land suitability

Among various systems for the evaluation of land suitability, the classification system established by FAO[/1] is considered applicable in Indonesia. In this study, therefore, the land suitability classification for the cultivation of paddy and upland crops under the irrigated condition is made referring to this system.

The land suitability of the project area is classified into three Orders, eight Classes and ten Sub-classes. These Sub-classes are grouped into seven grades by the degree of limitation against the land use for paddy cultivation as seen in Table 3.2.

/1: FAO (1976), A Framework for Land Evaluation

Among them, the lands classified into Grade-I, II and III are suitable for paddy rice cultivation. The correlation between Suitability Sub-class for the cultivation of paddy and polawijo are as follows:

Paddy Rice	Polowijo	Paddy Rice	Polowijo
S1	S3fw	Sc1t	S1
S2f	S1f	Sc2ft	S2fo
S2ft	S2ft	N1ft	S3ef
S3fw	N1fi	N2t	N2et
S3fi	N1fi		
S3ft	S2fo		

f; fertility i; inundation t; topography w; wetness
o; acidity

3.3.4 Climate

The project area is located in low latitudes and belongs to the equator climate zone. The project area is affected by tropical monsoons, having dry and rainy seasons. The rainfall data are available at 31 gauge stations in and around the area, but those observation periods vary from station to station and are often interrupted. Other meteorological data such as evaporation, relative humidity, temperature, sunshine and wind velocity are available at three stations in and around the area; Belitang, Banding Agung and Menggala. The data cover two to ten years.

Average annual rainfall in the project area is about 2,640 mm of which about 80% fall during the rainy season from October to May. The remainings fall during four months of the dry season from June to September.

The mean temperature in the flat land ranges from 26°C to 28°C with little seasonal variation. Both the daily maximum and minimum temperatures recorded at Belitang are 36.50°C and 17.0°C, respectively. The annual average relative humidity is about 80% at Belitang, where the monthly average reaches its maximum in January, approximately 83%, and the minimum occurs in August, approximately 77%. Annual average sunshine duration at Belitang is about 5.2 hr/day. The monthly average sunshine hours, however, vary from 6.3 hr/day at maximum in May and to 4.1 hr/day at minimum in January. The wind velocity is generally low. The monthly averages of wind velocity are in the range from 1.1 m/sec to 1.7 m/sec. The annual pan evaporation observed in Belitang is 1,600 mm (4.5 mm/day). The monthly average evaporation reaches its maximum in March approximately 5.1 mm/day. The minimum occurs in June, 4.2 mm/day.

Table 3.3 summarizes the main features of climate in the project area.

3.3.5 Hydrology

(1) Streamflow of the Komering river

The Komering river has a catchment area of 4,260 km^2 at Martapura. In its upper reach, Lake Ranau is located. It is the only large water body that can serve as natural reservoir and supplies water to downstream throughout the year. The water surface area is approximately 127 km^2 at water surface elevation of 542.5 m above mean sea level. The Komering river originates from this lake.

The monthly average discharge of the Komering river reaches its maximum in April; approximately 305 m^3/sec. The minimum occurs in August; approximately 133 m^3/sec. The seasonal patterns of the streamflow of the Komering river at Martapura and Lake Ranau are as follows (for details, vide ANNEX-I):

Mean Monthly Streamflow (m^3/sec)

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Average
Komering	245	263	245	305	262	195	145	133	136	150	181	230	207
Lake Ranau	18	20	19	20	20	18	17	16	15	15	17	17	18

The maximum discharge recorded at Martapura in 1977 was 1,372 m^3/sec, and the minimum discharge was 39.0 m^3/sec in October, 1972.

The flood discharge at Martapura is estimated by using the records of the maximum mean daily discharge there.

Return Period	Probability (x)	Flood Runoff
5 year	20 %	1,004 m^3/sec
10	10	1,102
20	5	1,194
50	2	1,311
100	1	1,398
200	0.5	1,484
1,000	0.1	1,684

(2) Sediment transport

The Komering river transports a considerable quantity of eroded materials, and deposition of eroded materials raises the river beds and the irrigation canal base.

In "Hydrometeorological Analysis and Evaluation" presented by Dr. Medardo Moliga G. in November 1974, the equation of sediment discharge is given. In "Belitang Extension Area Agricultural Development Project, Reconnaissance Planning Report" prepared by UNDP/FAO, the annual sediment production rate was roughly estimated at 880 m^3/km^2 on an average. Further study on sediment transport will be necessary based on the data for which collection was started from September 1979 at Martapura and Kurungan Nyawa gauging stations.

(3) Water quality

In order to check the water quality of the Komering river, water sampling was carried out at 4 locations, i.e. Kayuagung, Kangkung, Banding Agung and Tanjung Raja, in 1979. A study of the chemical properties of water showed that the water could be used for irrigation. For drinking, the water was needed to be filtered to remove evaporated residue, and be boiled thoroughly to destroy all micro-organism which may exist in the water, judging from the amount of $KMnO_4$ demand.

3.4 LAND USE AND AGRICULTURE

3.4.1 Population

The project area is administratively situated within five Kecamatans; four in OKU Kabupaten in South Sumatra Province and one in Lampung Utara, Kabupaten in Lampung Province.

Since 1937, the so called Belitang Area consisting of said five Kecamatan has played an important role on the settlement of transmigrants mainly from Java island. The following table shows the comparison of population in the Belitang area between 1971 and 1979.

Kecamatan	1971				1979			Annual Increase Rate (%)
	Area (km^2)	Population (10^3)	Family (10^3)	Density (Person/km^2)	Population (10^3)	Family (10^3)	Density (Person/km^2)	
Martapura	501	34.2	7.6	68	52.9	10.6	106	5.6
Buay Madang	1,060	112.9	22.6	106	138.9	26.0	131	2.7
Belitang	800	75.0	17.8	94	105.0	15.9	131	4.3
Cempaka	885	72.0	12.8	81	87.5	15.0	99	2.4
Bahuga	3,465	17.4	3.2	5	25.5	4.6	7	5.2
Total	6,711	311.5	64.1	46	409.8	72.1	61	3.4

As seen in above table, Kecamatans Buay Madang and Belitang are most densely populated, while the population density in Kecamatan Bahuga is extremely low. More than 90% of the population is considered to be engaged in agriculture and its related activities.

According to the field survey, total population in the project area is estimated at around 114,000 in 1980, of which about 46,000 are living in the southwestern half of the project area (1 ha farm holding area), about 65,000 in the northeastern half of the area (1.5 ha farm holding area) and about 2,800 in the Pisang area. Average family size is estimated to be 5.4 persons.

3.4.2 Land Use

The project area covering about 51,000 ha is broadly divided into three types of area from the average farm holding size and cropping pattern prevailed, i.e. 1 ha farm area, 1.5 ha farm area (in the Extension Area and Pisang Area. The following table shows the present land use in each type of area.

Present Land Use in the Project Area

Land Category	1 ha Farm Area		1.5 ha Farm Area		Pisang Area		Total Area	
	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)
Paddy field	7,250	63.5	7,130	20.7	40	0.8	14,420	28.5
Upland field	1,320	11.6	7,150	20.8	310	6.4	8,780	17.3
Ladang	0	0	2,690	7.8	150	3.1	2,840	5.6
Forest	190	1.7	7,850	22.8	3,670	76.0	11,710	23.1
Alang-Alang	50	0.4	6,960	20.2	410	8.5	7,420	14.7
Perennial	300	2.8	300	1.0	230	4.8	860	1.7
Village	1,390	12.2	1,360	4.0	20	0.4	2,770	5.5
Others	890	7.8	940	2.7	0	0	1,830	3.6
Total	11,420	100.0	34,380	100.0	4,830	100.0	50,630	100.0

(1) 1 ha farm area

The area is mostly located in the upper part of the project area, where transmigrants settled in the very early stage (more than 20 years ago). 1.75 ha of farm land had been provided for each farmer at the time of his settlement. But the lands have been inherited to their second generations dividing the land into 1.75 families on an average at present. Most of the agricultural lands comprise flat alluvial plain with the elevation ranging from about 80 to 60 m. The area is predominantly cultivated with paddy which corresponds to about 64% of the total area, where most of the farmers had been transmigrated in 1950 to 1960. The rainy season paddy is mainly planted under rainfed condition. The upland (Tegal) and shifting culture land (Ladang) are mainly cultivated with upland paddy, maize, cassava, peanut, soybean, etc. Negligible perennial crops such as coffee, rubber, etc. are planted in this area except for coconut and clove in each farm house yard.

(2) 1.5 ha farm area

The area extends over the northeast of 1.0 ha farm area mentioned above, sandwiching the Belitang proper area. The area is relatively flat, but some undulation lands extensively cover the upper parts of the area with an elevation ranging from 60 to 25 m. The area has been largely developed for settlement of the transmigrants recently. The rainfed paddy cultivation is practiced in the limited area in the lowland which occupies about 21% of the area. Tegal and Ladang occupy about 29% of the area and are mainly cultivated with upland paddy, maize, cassava, soybean, peanuts, etc. under rainfed conditions. The grass land (mainly Alang-Alang), one of the potential cultivable lands, and forest lands covered mainly by secondary forests occupy about 43% of the total area.

(3) Pisang area

The area is located in southern part of the project area sandwiched by the Pisang river and the Umpu river. The area is rather undulating topography with an elevation ranging from 60 m to 25 m. Only less than 1% of Sawah and about 10% of Tegal and Ladang are utilized for agricultural land. Rainy season paddy is cultivated on sawah, and upland crops such as upland paddy, maize, cassava, soybean, peanut, etc. are planted on the Tegal and Ladang. Perennial crops, coffee, rubber, clove, coconuts, etc. are planted in about 5% of the area. Virtually, the most of the Pisang Area is still covered with secondary forests and grasses, corresponding to about 84% of the total area.

3.4.3 Cropping Pattern

Rain-fed paddy is predominantly cultivated in the project area except for the Pisang Area. The Pisang Area is mainly cultivated with upland crops. Three types of cropping patterns are prevailing in the project area.

Type-I pattern is predominant in 1 ha farm area. Paddy is planted from the middle of October, onset of the rainy season. The planting period is extended over about 2.5 months. The harvesting paddy lasts for about 3 months from February to April depending on the varieties. The dry season paddy cultivation is practiced in very limited area where stream flow for irrigation is made available. Upland crops such as upland paddy, cassava, maize, peanuts, soybeans, etc. are planted from the beginning of rainy season, October, and harvested from June to August in the case of cassava and from February to May in the case of other cereals.

The cropping pattern Type-II prevails in 1.5 ha farm area. Out of 1.75 ha of farm lands provided by the government, about 1.4 ha are planted with rainy season paddy, upland paddy and upland crops under the rain-fed conditions. The rainy season paddy on sawah is basically cultivated as large as possible if irrigation water is available. Planting and harvesting periods of rainy season paddy are almost the same as the cropping pattern Type-I. About 0.1 ha of farm land is planted with perennial crops such as rubber, coffee, clove, coconut, etc. About 0.25 ha on an average for each farmer is still left for either Alang-Alang or forests.

Type III pattern is predominant in the Pisang Area. The farmer in the area cultivates a few rainy season paddy, upland paddy, upland crops and perennial crops at an about 67% of the total farm land provided by the Government. Substantial parts of the land are still covered with Alang-Alang and forest.

3.4.4 Farming Practices

The present farming practices in the project are still conventional, resulting in rather low yield of crops owing to the lack of effective irrigation facility. Buffaloes or bulls, though not sufficient number, are the main sources of motive power. Fertilizer application is very little, ranging from 10 to 20 kg/ha of urea and 5 to 10 kg/ha of triple super phosphates, and a little amount to agro-chemicals are used. Several local varieties of paddy are commonly planted. High yielding varieties have been recently introduced.

Upland crops such as cassava, maize, soybeans, peanuts, etc. are planted without applying any fertilizer. The cultivation practices are still conventional. Hired labourers are commonly employed for the plowing, weeding and harvesting.

Perennial cash crops and orchard are planted in some elevated lands without applying any fertilizer. The varieties of those crops seem to be unimproved.

3.4.5 Crop Yield and Production

Present yields of crops in the project area are rather low except for paddy cultivation under the BIMAS program. The following table shows the average crop yields estimated in the project area in 1977/1978 based on data obtained from the field survey and the Authorities concerned.

Crops	Yield (t/ha)	Remarks
Rainy season paddy (with BIMAS)	3.0	Dry paddy
Rainy season paddy (without BIMAS)	2.5	Dry paddy
Dry season paddy (without BIMAS)	2.5	Dry paddy
Upland paddy	1.1	Dry paddy
Cassava	6.0	Fresh roots
Maize	1.0	Grain
Peanuts	0.8	Grain
Soybeans	0.7	Grain

The present crop production of paddy and upland crops was estimated by multiplying the crop planted area by the crop yields as shown in the following table.

Crops	Area /1 (ha)	Production (tons)
Rainy season paddy (with BIMAS)	2,610	7,830
Rainy season paddy (without BIMAS)	11,810	29,530
Dry season paddy (with BIMAS)	100	300
Dry season paddy (without BIMAS)	170	430
Upland paddy	4,120	4,540
Total paddy	18,810	42,630
Maize	800	800
Cassava	3,830	22,980
Peanuts	1,350	1,080
Soybeans	505	350

/1 : Area is estimated based on land use survey and the data provided by Desa offices concerned.

3.4.6 Labor Requirement

Large parts of the work for farming are operated by the family labors in general except for transplanting and harvesting of paddy. Seasonal labors required are mainly employed from small holder farmers within the project area and to some extent from the outside. The following table shows the labor required per ha for cultivation of crops at present.

(Unit: Man-day/ha)

Work Item	Paddy	Upland Paddy	Maize	Cassava	Peanuts	Soybeans
Nursery bed	8	-	-	-	-	-
Land preparation	21	35	-	-	-	-
Transplant and sowing	25	20	7	10	7	7
Weeding	55	35	20	25	25	20
Fertilizing	3	2	-	-	-	-
Chemicals applying	2	2	-	-	-	-
Harvesting	45	30	20	30	25	20
Others	29	16	8	10	8	8
Total	188	140	55	75	65	55

3.4.7 Livestock

Livestock raising is incidental to the basic farm management in the project area at present. The livestock raised are cattle, buffalo, chicken, duck, goat, swine, etc. Cattle and buffalo are playing an important role in preparation of land and to some extent in transportation of farm outputs and inputs. The total number of cattle and buffalo count for about 13,500 heads corresponding to about 0.6 head per household in the project area, which is still insufficient to prepare the land within the limited time. Livestock raising is not an important source of income. Poultry products are primarily for home consumption and to some extent in local market.

3.4.8 Farm Budget

Based on the present farm gate prices of major farm products and inputs prevailing in the project area, the present farm budget is estimated and summarized in the following table.

Cropping Pattern	Unit	Typical Farmer Type-I	Type-II	Type-III
Family size	Nos.	5.1	5.4	6.4
Farm size	"	1.0	1.75	1.75
Gross income				
Farm income	Rps.	257,870	292,030	189,760
Livestock income	"	18,820	20,250	19,050
Miscellaneous income	"	30,000	35,000	50,000
Total		306,690	347,280	258,810
Outgo				
Farming expenses	"	23,700	39,800	28,450
Livestock expenses	"	1,880	2,030	1,910
IPEDA tax, etc.	"	6,700	1,500	1,500
Family living expenses	"	272,510	301,470	226,240
Total		304,790	344,800	258,100
Balance (Capacity to Pay)	"	1,900	2,480	710

As shown in the above table, the surplus of typical farmer is extremely low. The increase of income from the improved farming is indispensable for improvement of their living standard.

3.5 AGRICULTURAL SUPPORT SERVICES

3.5.1 Extension Services

Extension services to the farmers are carried out by field extension worker (PPL) under the supervision of the Agricultural Extension Office in Kabupaten through PPS (Penyuluh Pertanian Specialist) and PPM (Penyuluh Pertanian Madya). In the project area, 3 PPM command five Kecamatans, Martapura, Buay Madang, Belitang, Cempaka and Bahuga, in which 37 PPL provide the extension services to the farmers through 581 Kontak-Tani (Leading farmer). Service area of one PPL is about 1,200 ha of paddy field on an average. Although personal contact is more effective to stimulate the farmers to improve their farming, only limited farmer's benefit from the services due to acute shortage of trained extension worker. Reinforcement of the extension services is eagerly required.

3.5.2 Seed Multiplication

The Belitang Seed Center, one of the seven National Seed Center, is located near the project area. Foundation seeds of paddy are supplied from CRIA to this Center through the Agricultural Extension Service Office of South Sumatra Province. The stock seeds of paddy produced at the Center are supplied to two-seed growers in OKU. Some seeds are also distributed to the some seed growers authorized. Then the seeds produced by the seed growers are distributed to the BIMAS farmers as well as common farmers through BUUD/KUD (Badan Usaha Unit Desa/Koperasi Unit Desa, Village Farmers' Cooperative). The amount of paddy seeds produced is still insufficient to distribute fully to the farmers in the project area. Further efforts are required.

3.5.3 Credit

BRI (Bank Rakyat Indonesia) provides loan services to the rural sector and BIMAS credit activities through its branch and sub-branch offices. The Baturaja branch office covers the project area.

There are three kinds of loan for agriculture provided by BRI at present i.e. short term, medium term and long term loans. The BIMAS credit is the short term production loan with the conditions of 7 months in loan term and 1% of monthly interest rate.

The annual average area of paddy cultivation under the BIMAS program in recent five years was about 10,000 ha in OKU Kabupaten, which correspond only to about 14% of the total paddy land in OKU (see details in Section 3.3, ANNEX-VI).

3.5.4 Co-operative

There are 14 KUD (Koperasi Unit Desa) in the Belitang Area. These numbers correspond to only less than 10% of those of Desa in Belitang Area. Each KUD is operated under the guidance and supervision of the District Agricultural Cooperative Union concerned. The major activities of KUD are both supplying farm inputs to and purchasing farm outputs from the members on time (see details in Section 3.3, ANNEX-VI). As the KUD is playing an important role in providing various services for farmers to achieve the successful implementation of agricultural development, it is desires that the further establishment of KUD as well as strengthening of those activities is required for the successful implementation of the project.

3.5.5 Marketing, Processing and Prices

Surplus of paddy produced by farmers is mostly marketed through the two channels, DOLOG/KUD and itinerant grain buyers. The DOLOG/KUD market the rice, functioning the sabilization of price of rice under the Government control. Because of very limited storage capacity of DOLOG/KUD for rice in the project area, the share of quantity of rice purchased by DOLOG/KUD is insignificant. Furthermore, the storage capacity of rice of farmers themselves is also quite limited. Accordingly the farmers are often compelled to sell the rice to the itinerant merchants at the harvest time with comparatively low unit price. The seasonal fluctuations in farm gate price of paddy is relatively high due to inadequate marketing system, transportation and storage facilities. In this context, it is desired that DOLOG and KUD would equip with sufficient storing capacity of warehouse.

Regarding the upland crops, the farmer sells those products through either itinerant merchants or weekly market in general. Limited farmers sell chicken and other livestock products at their local markets, but those marketing amounts are insignificant.

The main processing facilities owned by KUD is rice mill. In the project area, the rice mill owned by the Village Unit Co-operative is counted at 11 with total milling capacity of about 12,500 t/year of rice. In addition, 185 small rice mills are owned by each village and private business men in the project area.

DOLOG in South Sumatra Province purchases the rice when the price comes down under the floor price and sells it when the price rises over the ceiling price at the central market in Palembang. In 1979/80, the floor price and ceiling price in South Sumatra Province are set at Rp. 156/kg and Rp. 195/kg respectively.

The seasonal fluctuation in farm gate price of farm products is relatively high due to inadequate marketing, poor transportation facilities and limited storage facilities. The following table shows the present farm gate prices of major farm products and inputs prevailing in the project area (see details in Section 3.2, ANNEX-VI).

Item	Unit Price (Rp./kg or lit.)	Remarks
Rice	175	
Paddy	100	Dry paddy
Maize	150	
Cassava	25	
Soybean	300	
Peanuts	430	
Rubber	250	
Coffee	800	
Urea	70	
TSP	70	
Farm Labour	700	

Source: 1) Agricultural office in Kab. OKU
2) Farm economy survey in the Belitang Area
3) Local market survey in Belitang

3.5.6 Transmigration

The Belitang Area has been the most conspicuous transmigration area succeeded since the beginning. Approximately 20,000 families of general transmigrants have been settled in Kabupaten OKU since 1950 of which more than 95% were in the Belitang area. They were provided with 2 ha of land including 0.25 ha of houseyard of which 1.25 ha was cleared and prepared for farm land by the Government in principle.

In the project area, particularly, the lower parts of the Central Area and the Pisang Area, certain spontaneous transmigrants have been settled individually in the scattered area.

3.6 EXISTING IRRIGATION AND DRAINAGE SYSTEM

The first activity for the irrigation development in the Upper Komering Basin is the construction of irrigation facilities in the Belitang Proper Area with a net irrigation area of 20,600 ha. The development program for this area was formulated in 1936 as a trans-migration project and its implementation was carried out from 1939 to 1942. The major works completed in this period were a head regulator, main canal up to BK-IX, secondary canals and the related structures. After seven-year suspension, the construction work was resumed from 1950 and around 66 km of main canal, 39 km of secondary canals and around 100 km of secondary drainage canals have been completed so far. Construction of the tertiary and quaternary canals are being constructed by the farmers themselves under the guidance of Cabang Belitang (Belitang Branch Office). Other than the Belitang Proper Area, there is no irrigation and drainage system in the project area.

Operation and maintenance of the Belitang Proper Project are being done by 6 Resorts of Cabang under the supervision of Baturaja Irrigation Section. Under the chief of Resort, 37 gate operators and maintenance workers (so called PP. Air) carry out daily activities of operation and maintenance of the project facilities. Since 1973, the Water Users' Association (P3A) was established in every village which has irrigation facilities. At present, however, only 6 Water Users' Associations with 285 members exist in the area.

The canal system can supply water only to 3,600 ha in the dry season (17% of the total Proper Area) and 12,000 ha in the rainy season (58% of the total Proper Area). This serious shortage of irrigation water supply is mainly due to the less capacity of the head regulator and the headreach of the canal up to BK-1, both of which are being extended so as to take a design discharge of 25 m^3/sec. In addition, the raising of water level with stoplog at BK-1; for the irrigation of the elevated lands in the Proper Area, gives less hydraulic gradient in the headreach portion and accelerates silt deposition in the canal, resulting in less discharge in the canal.

Generally no systematic irrigation rotation system is being applied at present in this project area. At the request from the farmers through gate operator, the water is released to the fields. When more requests are made by farmers at a time, those farmers are grouped into two, and three-day rotation is applied between the two groups. No water charge is collected from the farmers.

Mal-drainage, particularly along the Macak and the Belitang rivers and the inner lowlands, is another negative condition for the agricultural development. As mentioned in the above, the office has constructed around 100 km of secondary drainage canals, but these canals are not so well functioning because of absence of tertiary drainage canals.

The project office has a budget of around Rp. 50,000,000 (equivalent to US$3.9/ha) for repair and maintenance of the facilities in 1980/81. This amount seems not enough for proper maintenance of the system.

Table 3.1 ACREAGE OF EACH MAPPING UNIT IN THE PROJECT AREA

(Unit: ha)

Mapping Unit	Great Soil Group	Land Form	Belitang Extension Central Area		Pisang Area		Total	
			Surveyed Area	Gross Irrigable Area	Surveyed Area	Gross Irrigable Area	Surveyed Area	Gross Irrigable Area
1.	Podzolic Soils	Upper peneplain	38,280	16,500	7,850	1,010	46,130 (51) /1	17,510 (34)
2.	Podzolic Soils	Lower peneplain	7,110	2,360	3,710	3,270	10,820 (12)	5,630 (11)
3.	Gley Soils Alluvial Soils Hydromorphic Soils	River terrace	8,660	8,490	-	-	8,660 (10)	8,490 (17)
4.	Alluvial Soils	River terrace	1,070	900	200	200	1,270 (1)	1,100 (2)
5.	Alluvial Soils Hydromorphic Soils	Natural levee	1,390	1,330	-	-	1,390 (2)	1,330 (3)
6.	Alluvial Soils Gley Soils Andosols	Flat valley	7,950	6,500	170	170	8,120 (9)	6,670 (13)
7.	Alluvial Soils Gley Soils	Alluvial plain	8,560	7,960	160	160	8,720 (10)	8,120 (16)
8.	Gley Soils Organic Soils	Swales	4,570	1,760	20	20	4,590 (5)	1,780 (4)
			77,590	45,800	12,110	4,830	89,700 (100)	50,630 (100)

/1: Proportional extent of each mapping unit

Table 3.2 ACREAGE OF EACH LAND SUITABILITY UNIT

(Unit: ha)

Grade	Suitability Class	Suitability Sub-class	Belitang Extension Central Area				Pisang Area		Total Area	
			1.0 ha Area		1.5 ha Area					
			Surveyed Area	Gross Irrigable Area	Surveyed Area	Gross Irrigable Area	Surveyed Area	Gross Irrigable Area	Surveyed Area	Gross Irrigable Area
I	Highly suitable	S1	7,160	6,790	3,850	3,170	110	110	11,120 (12) /1	10,070 (20)
II	Moderately suitable	S2f, S2ft	5,030	2,180	6,430	7,490	250	230	11,710 (13)	9,900 (20)
III	Marginally suitable	S3fw, S3fi, S3ft	7,720	410	30,870	19,690	11,150	4,310	49,740 (55)	24,410 (48)
	Sub-total		19,910	9,380	41,150	30,350	11,510	4,650	72,570 (80)	44,380 (88)
IV	Conditionally highly suitable	Sc1t	1,500	1,270	-	-	-	-	1,500 (2)	1,270 (3)
V	Conditionally moderately suitable	Sc2ft	280	270	200	190	-	-	480 (1)	460 (1)
VI	Currently non-suitable	N1ft	2,840	260	8,510	3,440	120	120	11,470 (13)	3,820 (7)
VII	Permanently non-suitable	N2ft	1,810	240	1,390	400	480	60	3,680 (4)	700 (1)
	Sub-total		6,430	2,040	10,100	4,030	600	180	17,130 (20)	6,250 (12)
	Total		26,340	11,420	51,250	34,380	12,110	4,830	89,700 (100)	50,630 (100)

/1: Proportional extent of each grade

Table 3.3 SUMMARY TABLE OF CLIMATOLOGICAL DATA

Monthly Rainfall (mm)

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
B.K-IX	346	243	336	276	191	99	82	92	110	181	303	358	2,697
B.K-O	340	278	399	300	247	137	108	102	112	222	260	384	2,923
Martapura	350	303	337	305	214	125	102	150	120	194	269	377	2,846
Muaradua	237	216	289	265	231	114	148	118	130	191	261	300	2,500
Banding Agung	235	211	212	233	192	100	138	105	170	179	224	232	2,093
Menggala	286	329	402	165	156	111	107	64	119	170	221	331	2,461

Monthly Temperature (°C)

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual Mean
Belitang	26.3	26.9	27.2	27.8	27.7	27.7	27.5	27.6	27.6	27.3	27.1	26.9	27.3
Banding Agung	23.2	23.6	23.9	24.2	24.2	23.7	23.9	23.4	23.7	24.2	24.1	23.2	23.8
Menggala	27.3	27.3	27.3	27.8	28.1	26.9	26.3	27.1	27.2	27.4	27.4	27.4	27.3

Monthly Relative Humidity (%)

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual Mean
Belitang	83	82	82	83	82	80	78	77	77	77	80	82	80
Banding Agung	85	83	83	82	81	81	83	83	84	82	81	82	83
Menggala	76	74	70	78	86	79	76	70	69	71	71	73	73

(to be continued)

Monthly Sunshine Duration (hr)

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual Average
Belitang	4.1	4.4	4.9	5.5	6.3	5.9	5.3	6.0	5.2	5.0	5.0	4.1	5.2

Monthly Solar Radiation (mmH_2o in Belitang, Cal/cm^2 in Menggala)

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual Average
Belitang	12.0	12.5	13.8	14.0	13.0	12.1	11.6	13.1	13.1	13.5	13.0	13.0	13.0
Menggala	448.8	457.8	473.6	478.8	468.6	438.3	413.9	449.9	462.7	462.6	472.1	470.9	458.5

Monthly Wind Velocity (km/hr)

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual Average
Belitang	3.8	3.6	3.2	2.5	2.4	2.4	3.1	3.3	3.3	3.0	2.7	3.2	3.1
Banding Agung	3.1	2.6	4.4	4.6	4.5	4.2	5.6	4.5	4.8	5.1	5.5	4.2	4.4
Menggala	2.4	2.6	2.5	2.2	2.5	2.6	3.1	3.0	3.4	2.6	2.4	2.6	2.7

Monthly Evaporation (mm/day)

Belitang	4.5	4.3	5.1	4.9	4.7	4.2	4.4	4.9	4.9	4.9	4.6	4.5	4.5
Banding Agung	4.8	4.6	4.2	3.7	4.2	4.5	5.1	4.7	4.8	4.6	4.1	4.8	4.2
Menggala	5.8	5.6	7.3	5.3	4.4	3.0	3.9	4.3	4.4	5.7	5.2	5.6	5.1

4. THE PROJECT

4.1 PROJECT CONCEPTS

The Komering-I Irrigation Development Project which covers 36,700 ha of lands in net is formulated to maximize the expected project benefits. The main concepts of the project are to:

- increase and stabilize yield and production of rainy season paddy through supply of irrigation water, proper drainage improvement and introduction of improved irrigation farming,
- introduce diversified cropping pattern including the rainy season paddy, dry season paddy and polowijo through provision of year-round irrigation, and
- increase agricultural production by opening new agricultural lands in the areas which have favorable physical conditions for agricultural development.

Because of no irrigation and drainage facilities in the area except for small drainage canals constructed by farmers themselves, the existing paddy fields often suffer from long dry spell in the dry season and maldrainage in depressed lands in the rainy season. Therefore, most of the paddy fields are used only for one cropping in a year. The intensive agricultural development in the area is constrained by:

- no irrigation system,
- poor drainage conditions,
- poor road network, and
- insufficient agricultural supporting services.

In order to achieve the projected agricultural development in success, the construction of following insfrastructures and further improvement of supporting services are required:

- construction of irrigation network consisting of a regulating dam, headworks, main, secondary, tertiary and quaternary canals,
- construction of drainage network which consists of main, secondary, tertiary and quaternary drains,
- construction of road network which includes main, secondary and tertiary roads,
- reclamation of new farm lands,
- operation and maintenance of the irrigation and drainage networks, and
- further improvement of the present agricultural supporting services.

4.2 DELINEATION OF PROJECT AREA

4.2.1 Affecting Factors for Delineation of Project Area

In the delineation of the project area, the following factors are taken into consideration.

(1) Land suitability classification

Based on the evaluation of land suitability classification, the areas classified in Grade-I, II and III are taken up as the irrigable area. In this evaluation, the affecting factors for the delineation are erodability of lands, topography, flooding condition, drainability of soils, fertility, soil depth for cropping and degree of soil acidity.

(2) Present land use

The present land use and vegetation of the area are taken into consideration, because these conditions have large effects on the relative difficulty in making land reclamation for the irrigation development.

(3) Government's policy

The most important factor is the Indonesian Government's development policy. The areas which have been selected for transmigration program or irrigation development program would be given a high priority for the selection of project area.

4.2.2 Area to be Developed

The area to be developed under the proejct has 50,600 ha in gross (36,700 ha in net) and extends to the northeast direction sandwiching the Belitang Proper Area as shown in PLATE No. 1 attached to this report. The boundaries between the project area and the Proper Area are the Macak river in the North and Belitang river in the south. The area is topographically bisected by the Pisang river, i.e. 45,800 ha (gross) of the Central Area and 4,800 ha of the Pisang Area (gross).

The general topography of the project area is characterized by the flat alluvial plains and the undulating peneplains. The alluvial flat plains lie mainly along the right bank of the Komering river over 30 km towards downstream reach from Perjaya. The undulating peneplains occupy around 60% of the total area. Ground elevations of the irrigable area range from 25 to 80 meters in the Central Area and 25 to 60 meters in the Pisang Area.

In this area, particularly in the southwestern half of the Central Area, the land settlement by transmigrants was firstly commenced in 1937 and continued up to 1941, and most of the areas are cultivated with paddy and/or upland crops. As for the northeastern half of the Central Area, approximately one-third of the area has been opened up since 1953. The Pisang Area was firstly transmigrated by spontaneous

migrants in 1940's mainly along the Umpu river. According to the reconnaissance and aerial photo map taken in September 1979, around 16% of the area has been reclaimed for agricultural use. At present, this area is being opened up at high speed by spontaneous migrants.

From the viewpoint of the project development sequence, the project area is divided into two sub-areas, i.e. Sub-Area-I and Sub-Area-II. The Sub-Area-I, 18,500 ha, extends over the western half of the Central Area, and the Sub-Area-II of 18,200 ha occupies the eastern half of the Central Area and the whole Pisang Area.

4.3 AGRICULTURAL DEVELOPMENT

4.3.1 General

Though the monsoon permits the cultivation of a rainfed rice crop and upland crops, uneven distribution of rainfall during the monsoon prevents the development of intensive agriculture in spite of its favourable climate conditions in the project area. Based on the soils and land suitability surveys carried out in the area, it has been confirmed that approximately 72% of the gross command area is suitable for irrigation agricultural development.

It is evident that the introduction of perennial irrigation farming will considerably increase the yield of paddy and upland crops particularly in the dry season. It is expected that proper water supply and adequate application of inputs as well as introduction of improved varieties together with efficient extension services would result in a considerable yield increase of crops year after year, after the implementation of irrigation development.

The agricultural development in the project area is to achieve self-sufficiency in staple foods of rice in the nation, particularly in South Sumatra Province through introduction of the intensified year-round irrigation farming utilizing the abundant flow of the Komering river.

4.3.2 Proposed Cropping Pattern and Farming Practices

There are two types of farm size. One is 1 ha farm holding farmer predominating in the flat land of the upper reach of the irrigation system proposed, where farmers settled in the very early stage of the transmigration program. The other is 1.5 ha irrigable farm holding farmer prevailing on the flat to gently sloping lands located at relatively lower reach of the irrigation system proposed and the south of the Pisang river, where farmers settled recently.

Farmers in the project area fairly respond to the availability of water for particularly paddy cultivation. There is an obvious wish to increase the productivity of yield of crops to compensate for their limited land holding. In fact, the reliable experience has already been gained from the proper water management as well as introduction of sufficient inputs under the BIMAS/INMAS program.

The rice cultivation is quite common and well known to the farmers in the project area. The climate and soil conditions are also suitable for rice cultivation. Paddy will be introduced in the project area as a main crop in order to achieve self-sufficiency in food in South Sumatra Province.

Based on the agro-climatic conditions and the farm holding size, two cropping patterns are proposed for future agricultural development as shown in Fig. 4-1 and Fig. 4-2 and are briefed as follows:

Cropping pattern I; Early settled area (more than 20 years), where farmer holds around 1 ha on an average at present. Double cropping of paddy and 50% of polowijo, mainly peanuts and soybeans, will be cultivated. The crop intensity will be 2.5.

Cropping pattern II; Recently settled area,where farmer holds around 1.5 ha of irrigable land on an average. 1.5 ha of rainy season paddy, 1.0 ha of dry season paddy and 0.5 ha of polowijo, mainly peanuts and soybeans, will be cultivated. The cropping intensity for irrigated land will be 2.0.

In addition to the above, three alternative patterns are conceived in view of crop diversification and water saving, in which more cultivation of polowijo will be introduced than the proposed.

From the viewpoint of photosynthetic efficiency on the increase of yield, rainy season paddy is proposed to be transplanted from the beginning of December to the end of January and dry season paddy from the middle of April to the beginning of June. It is recommended to grow high yielding varieties such as IR-36 and IR-38 and improved local varieties like Gehar, Adil and Gata from the plant physiological viewpoint. The harvesting period would be from the middle of March to the middle of September. Polowijo crops will be grown during the period from August to November in 1.0 ha farm holding area and June to October in 1.5 ha irrigable farm holding area. Virtually rather intensified pattern for the 1.0 ha farm and diversified pattern for the 1.5 ha farm would be introduced. The cropping area and intensity for irrigated land in each pattern are shown below.

(Unit : Ha.)

	Pattern I		Pattern II		
	Area/ House	Cultivated Area	Area/ House	Cultivated Area	
				Central	Pisang
Rainy season paddy	1.0	8,400	1.5	25,400	2,900
Dry season paddy	1.0	8,400	1.0	16,940	1,930
Polowijo	0.5	4,200	0.5	8,460	970
Total		21,000		50,800	5,800
Cropping intensity		2.5		2.0	2.0

The required amount of fertilizers for paddy and polowijo per crop per ha would be about 180 kg of urea and 90 kg of triple super phosphate in total for paddy,and about 30 kg of urea and 40 kg of triple super phosphate in total for polowijo respectively. Along with proper water management and optimum fertilizer application, the control of pests and diseases through the use of agricultural chemicals is essential under the proper guidance by the extension service stuff. In as much as large number of people directly or indirectly use the canal water for drinking and other purposes, attention should be paid to the method of use of chemicals. The labour force needed for the proper farming will be mostly employed from the family labour. In the peak time of labour required such as transplanting and harvesting times, some hired labours are required. In this connection, the use of draft animals and improved farming tools and equipment is proposed to be introduced. The details for proposed farming practices for paddy are illustrated in ANNEX-V. The standard farming practices recommended for the upland crops are also illustrated in ANNEX-V.

4.3.3 Anticipated Yield and Production

With introduction of improved farming practices as well as proper water management, the crop yield is expected to increase substantially. The following table shows the target yields of major crops and production. The time required for the target yield depends on mainly progress of the agricultural support services. The anticipated build-up period after the implementation of the development varies dependent on the field conditions. In the case of 1 ha farm holding area, the crop yield would reach its expected yield in and after 5 years,while in the case of 1.5 ha farm holding area, 7 years would be required to reach its anticipated yield.

Anticipated Yield of Major Crops and Production

Crops	Yield (t/ha)	Production (10^3t)	Remarks
Rainy season paddy	4.0	146.8	Dry paddy
Dry season paddy	4.5	122.7	Dry paddy
Peanuts	1.3	11.6	
Soybeans	1.3	6.1	

4.3.4 Transmigration

After the implementation of the project, about 24,000 ha of forest and Alang-Alang areas in the Belitang Extension Central Area particularly lower reach of the area will be reclaimed for paddy lands. These areas are considered to be accepted for certain transmigration but rather scattered,so that the transmigration program is proposed to be thoroughly assessed according to the local circumstances. In the Pisang Area, certain large area in the upper portion of the area are still unopened, where general transmigration of approximately 1,700 families may be accepted.

4.4 IRRIGATION AND DRAINAGE PLANS

4.4.1 Water Resources

In the study area, there flow four major rivers, i.e. the Komering, Macak, Belitang and the Pisang. Among them, the Komering river gives an ample perennial flow,and its water stage can cover the elevations up to 80 meters, below which most of the fertile flat lands exist. Accordingly, only the Komering river is taken as an irrigation water resources in the study.

4.4.2 Irrigation Water Requirements

The irrigation water requirements are calculated for each proposed cropping pattern taking the effective rainfall with a 80% probability of exceedence of the drought year, which was obtained by calculating the daily balance between rainfall and consumptive use of water for 17 years.

Canal conveyance and operation losses are estimated to be 15% and 30% of the diversion requirements respectively. The peak water requirements for each cropping pattern, and total diversion requirements are shown below (for the details, vide ANNEX-VII). The Fig. 4-3 shows the irrigation flow diagram.

(1) Peak unit water requirement

- for cropping pattern - I ; 1.28 lit/sec/ha
- for cropping pattern - II; 1.12 lit/sec/ha

(2) Total diversion requirement; 44.1 m^3/sec/1

4.4.3 Drainage Water Requirement

For the design of suitable drainage improvement plan within a feasible range, the study is made to estimate the drainage requirements for the areas where the drainage improvement could be practiced economically by gravity. The study is made taking into account the various factors such as topographic conditions, present drainage conditions, soils, groundwater tables, etc., which vary from area to area.

The proposed drainage requirement is estimated for 3-day consecutive rainfall with a 10-year return period. Thus, the design drainage requirements are estimated to be 7.5 lit/sec/ha for all the project area (for the details, vide ANNEX-VII).

/1; This figure includes the diversion requirement for the BK-I area of 1,300 ha in the Belitang Proper Area.

4.4.4 Alternative Study on Diversion Works

During the comprehensive study period in the last year, there found two attractive sites for the construction of headworks, i.e. at Pracak and Perjaya as shown in PLATE NO.1 attached hereto. In the comprehensive report prepared by JICA in March 1980, a rough comparative study was made between these two sites for the construction of headworks and gave a very preliminary conclusion that the Pracak site might be justified for the project. But, this comparative study was made without detailed technical data and information such as topography and geology, and accordingly it was remarked in the report that before a final design was made, however, elaborate technical and economical comparisons should be made based on the detailed topographical and geological survey results to be obtained in the coming feasibility study time.

In accordance with the abovementioned recommendation, further detailed alternative study with more technical information, topographic survey, geological investigation by means of core drilling and water pressure tests and hydrological analysis on the Komering river are carried out during this survey period.

Through the reconnaissance and detailed survey and investigation so far carried out, the advantages and disadvantages are compared between the Pracak and the Perjaya sites as follows:

- The river width is more narrow at Pracak site (130 m) than the Perjaya site (170 m).
- Both sites provide favorable geological conditions for the construction of headworks.
- The hydrological conditions are almost same at both sites.
- The length of driving channel from the intake structure to the settling basin in the Pracak case is longer than the Perjaya case, if natural flushing-out system is considered at the settling basin.

- A long and deep-cut headreach, around 8 km of upper reach out of total length of about 18 km, is required in case of the Pracak site. Whereas, a shallow-cut headreach with a length of 8 km is required in Perjaya case.
- If the Pracak site is selected, the canal water level can be maintained by 4 - 6 meters higher than the Perjaya case. This difference of canal water level can increase the irrigable area in the order of 500 - 1,000 ha.
- The Perjaya site provides more favorable access for the construction and O & M purposes.

These advantages and disadvantages as well as the technical data and information draw many alternatives even at the respective site also. The alternative cases to be compared are established based on the following major influencing factors.

(1) Intake water level at the headworks site

Higher intake water level can irrigate more farmlands and decrease the excavation cost of the headreach, but more construction cost for the headworks is required.

(2) Lining of the headreach

If the headreach is lined with concrete or masonry, the canal section will become smaller and excavation volume will be reduced to great extent, though lining cost would be higher than the unlined case. In general, the lined canal will have a steeper slope than the unlined canal from the economical and technical viewpoints, which results in the reduction of irrigable area because of lower canal water level at the end of headreach as compared with the unlined case. The O & M cost in the lined case is cheaper than that in the unlined case.

(3) Gradient of the headreach

Although the steep gradient of canal will economize the construction of canal, the irrigable area will decrease because of lowered canal water level at the end of headreach.

Understanding the above merits and demerits of each case, the alternative study is made on various combinations of these influencing factors. As the result, the followings are recommended as the most attractive diversion plan for the project (for details, vide ANNEX-VII).

- Headworks site	;	Perjaya
- Intake water level at headworks site	;	EL.79.3 m
- Lining of headreach	;	unlined
- Gradient of headreach	;	1/8,000
- Irrigable area	;	36,700 ha

4.4.5 Development Sequence of Lempuing and Tulangbawang Projects

According to the comprehensive development plan recommended in the JICA report (1980), the development of the Lempuing and Tulangbawang Projects will follow the realization of the Komering-I Project. Therefore, it is worthy to study whether the headworks and the headreach of the Komering-I Project have to be constructed with the increased capacities after inclusion of the irrigation water required for these two projects from the initial construction stage, or expansion of their capacities should be made at their respective development stage. In this content, the following alternative cases are established.

(1) Lempuing Project

The Lempuing Project area extends over the northeast of the Komering-I area. The irrigation water for this project area will be diverted through the Perjaya headworks, the headreach and the North Main Canal of the Komering-I irrigation system. Therefore, the following cases are compared.

Case-1 : Joint construction of the related facilities with an increased capacity after inclusion of water for the Lempuing area.

Case-2 : Future expansion of the capacity of the related facilities at the implementation stage of the Lempuing area.

(2) Tulangbawang Project

The irrigation water of the Tulangbawang Project area will be diverted from the South Main Canal. Similarly to the Lempuing area, the following alternative cases are compared:

Case-1 : Joint construction of the related facilities with an increased capacity after inclusion of water for the Tulangbawang area.

Case-2 : Future expansion of the related facilities at the implementation stage of the Tulangbawang area.

According to the cost estimated for the above cases, the Case-1 is much economical in terms of the initial investment for both the Lempuing and Tulangbawang Projects. However, the pre-invested capital does not become effective until the respective irrigation project has been realized. For the choice of the economical construction sequence between the above-mentioned alternative cases, the economic comparison by means of internal rate of return (IRR) is made by assuming the different length of time span from the start of the Komering-I Project works to the realization of the Lempuing and Tulangbawang Projects.

In both cases of the Lempuing and the Tulangbawang Projects, the IRR for the case of the joint construction is higher than that of the expansion works only within the time of three to four years after the start of the Komering-I Project works. This indicates that it is not economical to construct the headworks and headreach of the Komering-I Project with the increased capacities to meet the development of the Lempuing and the Tulangbawang Projects, if such

projects are not realized within 5 years after the start of the Komering-I Project.

Consequently, since the development of the Lempuing and the Tulangbawang Projects is unlikely to be realized within 5 years after the start of the Komering-I Project, it is proposed that the Perjaya headworks and headreach should be constructed with the capacity only for the Komering-I Project Area at the initial stage.

4.4.6 Economic Comparison on Integration of Intake for the Belitang Proper Area

The water level in the headreach portion of the existing Belitang Irrigation Canal is being raised by stoplogs provided at BK-I to irrigate the elevated lands of around 1,300 ha in the Proper Area. This raising of water level gives less hydraulic gradient in the headreach portion and results in less discharge in the headreach.

In addition, since there is no provision of a settling basin in the BK-0, a large amount of the sediment loads are deposited in the headreach. It is estimated at about 30,000 m^3 per year. The maintenance is needed by means of dredging annually.

The above-mentioned unfavourable conditions in Proper Area will be improved with the following countermeasures to be taken upon implementation of the Komering-I Project.

Case-1 : Water supply to the high elevated area from the Komering-I system

According to the results of the field investigation and hydraulic analysis of the headreach, the present proper headreach can convey the water required for the irrigation of whole Belitang Proper Area, if the hydraulic gradient of the headreach is improved by removing the stoplog provided at BK-I. In this case, the elevated lands of 1,300 ha will be covered by the Komering-I system.

Case-2 : Diversion of irrigation water required in the Proper Area from the Komering-I system

The North Marin Canal of the Komering-I system will cross over the headreach of the Proper Area and the irrigation water for the Proper Area can be diverted from the Komering-I system at the crossing point. In this case, the maintenance cost of the headreach of Belitang Irrigation Canal, particularly for the dredging of sediments in the headreach, would be decreased to much extent because of less sediment loads in the water from the Komering-I system than that from the Kurungan Nyawa. The inclusion of the Proper Area into the Komering-I system, however, will increase the construction costs of the headworks, headreach and the North Main Canal of the Komering-I system, because their design capacity has to be increased by 25 m^3/sec. In this case, the micro-hydropower generation in the order of 1,000 kW can be conceived at the inlet point from the Komering-I system harnessing the head difference between the Belitang Irrigation Canal and the Komering North Main Canal, but this benefit is not counted in this comparative study.

In order to determine the economical plan to solve the hydraulic constraint of the Proper Area, the economic comparison is made for the above two cases. According to the cost estimates for the above two cases, the Case-1 is more economical than the Case-2.

Consequently, the headworks, headreach and North Main Canal and the related canal structures of the Komering-I Project will be constructed with the increased capacities to be able to supply water only for the elevated area of 1,300 ha in the Proper Area.

4.4.7 Economic Comparison on Integration of Intake of the Muncak Kabau Project Area

In the previous study, the intake structure for Muncak Kabau Project was contemplated on the right bank of the Komering river in the vicinity of the village Muncak Kabau. No diversion weir is

planned to be constructed because of considerable costs for its construction. Since there is no adequate difference in water level between the river and canal, the removal of sediment loads from the canal will have to be conducted by means of dredging. In consideration of the ground level of the Muncak Kabau Project Area and the water level of the Komering-I North Main Canal, the diversion of water to the Muncak Kabau from the Komering-I system is easily made with provision of short length of a connecting channel. Before determining the irrigation system capacity of the Komering-I system, the economic comparison on integration of the intake structure of the Muncak Kabau Project into the Komering-I system is needed. For the comparison, the following two cases are considered.

Case-1 : Water intake through its own intake near Muncak Kabau

The relating costs to the comparison are the construction costs of intake structure, settling basin and headreach, and the annual O & M costs for the related facilities and dredging.

Case-2 : Diversion of water from Komering-I system

The comparative costs concerned are the allocated construction costs of the headworks, headreach and North Main Canal, the construction cost of the connecting channel, and the annual O & M costs for the related facilities.

The detailed cost estimate and comparison for the above case are made in ANNEX-VII. This cost estimate indicate that, the Case-1 is more economical than the Case-2 in terms of the annual cost. The irrigation system of the Komering-I Project will therefore be constructed without inclusion of the diversion requirement for the Muncak Kabau Project.

4.5 PROPOSED PROJECT WORKS

4.5.1 General

The central feature of the Komering-I Irrigation Development Projects is to supply irrigation water of 44.1 m^3/sec to the project area from the Komering river. The facilities required for the project include a regulating dam, headworks, headreach, canals and their relevant structures, drainage facilities and farm roads.

The basis for determining the facility requirements for each function is that enough project facilities be provided in the most effective and economical manner so that each function can be combined with and fully compatible with the other farming operations required at each stage of development. Based on the above requirements, the following planning and preliminary design of project facilities are prepared.

4.5.2 Ranau Regulating Dam

The main function of the Ranau regulating dam is to regulate the discharge from Lake Ranau. The lake is located in the upmost of the Komering river. It has 127 km^2 of water surface area at 542.5 m above the mean sea water level and about 508 km^2 of catchment area. Active storage capacity of the lake will be around 300 million m^3 using 2.5 m of the operating depth.

In order to utilize this large water body efficiently for irrigation and other purposes, the present outflow pattern of the lake should be regulated to the following pattern as mentioned in the comprehensive study made by JICA in 1980.

(Unit : m^3/sec)

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
12	12	12	12	12	30	50	20	15	12	12	12

Based on the plane table survey and river cross section survey along the Selabung river (the upper reach of the Komering river), the construction site is selected at about 2.3-km downstream from the outlet of Lake Ranau.

The river flow at the dam site, average runoff of 17.6 m^3/sec is quite stable throughout the year ranging from 15 m^3/sec to 20 m^3/sec, because of regulating action of the lake.

The base rock of the proposed dam site is composed of the ryolitic and welded tuff having a thickness of over 20 meters. General permeability coefficient in the base rock is between 4×10^{-4} and 3×10^{-7} cm/sec.

The regulating dam consists of concrete dam portion, gated weir and stilling basin. In order to give the design capacity of 50 m^3/sec to the Selabung river at the design low water level, EL. 539.0 m (at dam site), the deepening of the river is required particularly between the outlet of Lake Ranau and the rapid located at 0.6-km downstream from the dam site. The bottom width of the deepened river is 18 meters.

Since there exists good rock foundation at the dam site, the dam is of concrete gravity type supported by rock foundation. The dam crest is one-meter higher than the design high water level of EL. 543.0 m. The gated weir portion is of overflow type, and has the length of 18 meters partitioned into six by piers. Six sets of manually operated steel gates, 1.6-m high and 2.-5m wide for each, will be installed in between the piers. The details are shown below and further in PLATE No. 2 attached hereto.

- Design discharge ; 50 m^3/sec

- Design water level

  high water level; EL. 543.0 m
  low water level ; EL. 539.0 m

- Concrete dam portion

  type of dam ; concrete gravity type
  crest elevation; EL. 544.0 m
  dam height ; 8.0 m
  length of crest; 84.0 m

- Gated weir portion

  type of weir ; overflow type
  crest elevation; EL. 537.5 m
  crest length ; 18 m
  type of gate ; manually operated roller gate
  size of gate
  (H x B) ; 1.6 m x 2.5 m x 6 Nos.

4.5.3 Headworks

The alternative study made in the section 4.3 hereof concluded that the Perjaya site would be the most suitable site for the construction of headworks from both economical and technical viewpoints. The Perjaya site is located at about 3-km downstream of Hartapura.

The design flood discharge at the site is estimated to be 1,398 m^3/sec for the 100-year return period. The flood water level comes up to EL. 81.5 m, where the river has 170-m width, river bed elevation of 74.0 m, right bank elevation of 95 m and left bank elevation of 88 m.

Alternating layers of sandstone and claystone are found at the depth of about 16 meters from the surface of left bank. The alternating layers indicate $N \geq 50$ in standard penetration value. The field permeability tests show the permeability value of 4×10^{-4} - 2×10^{-5} cm/sec.

The headworks consist of various components such as a fixed weir, movable weir, intake, miscellaneous structures, operating facilities, driving channel and a settling basin. For the well functioning as the headworks, each component should be combined with and fully compatible with each other.

(1) Design conditions

Design flood discharge: The flood with a 100-year return period, 1,398 m^3/sec, is taken as the design flood discharge.

Design flood water level: By adding 0.3 meter of back-water affection to the water level of the design flood discharge, the design flood water is obtained to be EL. 81.8 meters, which will not give any damages to the houses, bridges and farmlands along the upstream of the Komering river.

Design intake discharge: The design intake discharge is taken to be the peak diversion requirement of 44.1 m^3/sec for the Komering-I area and the BK-I area of 1,300 ha in the Proper Area.

Design intake water level: Following the result of the alternative study of diversion works mentioned in the section 4.4.4 hereof, the design intake water level is determined to be EL. 79.30 meters.

(2) Preliminary design

Fixed weir: In order to maintain the design intake water level to be EL. 79.3 meters even in the low flow season, the crest elevation of the fixed weir is taken to be the same as the design intake water level. The highest portion of the weir is 5.3 meters from the river bed. The length of weir is determined to be 171 meters considering the river width at the site. The shape of the weir is hydraulically favourable for the overflow of floods.

Movable weir: The movable weir consisting of flood way and a scouring sluice will be constructed in the right side of the river section. The structure is designed for super critical flow in order to flush out the bed loads. Net width of the movable weir is so determined as to keep the back-water level below the design flood water level. The top elevation of gates for the movable weir has an allowance of around 10 cm above the design intake water level. The gate width and number for the flood way and the scouring sluice are determined to be 17.5 meter for both facilities after economic comparison and further taking into consideration the passing of drift wood between the gate piers. The gates will be operated by motor considering the weight of gates and frequency of operation.

River bed protection works: An apron will be provided downstream of the weir to protect the river bed against the erosion and to increase the creep length. The required length of apron is 25 meters. In addition, concrete blocks and gabion works will be provided immediately upstream of the weir and downstream of the said apron.

Raft way: A raft way will be provided between the fixed and movable weirs for raft passing. This facility is of chute type having a width of 8 meters and flow depth of 1 meter.

Intake structure: An intake structure will be constructed on the right bank of the river. The net width of the intake structure is determined to be 21 meters for the design discharge of 44.1 m^3/sec and design flow velocity of 0.7 m/sec in the structure. The structure will be equipped with three steel slide gates; 4.0-m high and 7.0-m wide, which can be operated manually or by motor. The bottom floor of the intake structure will be raised for 1.5-meters from the river bed to prevent the river bed loads from flowing into the structure.

Driving channel: The concrete-lined driving channel, 1.6 km, will be constructed between the intake structure and the settling basin with 1/4,000 gradient. The channel has trapezoidal section formed with the bottom width of 5.0 meters and the side slope of 1:1.5. The water depth in the channel is 3.0 meters.

Settling basin: A settling basin will be constructed at the end of the driving channel. This structure is divided into two units from the standpoints of operation and maintenance. The design discharge for one unit is 22 m^3/sec. The length and width of the basin are designed to be 35 meters and 40 meters respectively for the maximum particle size of sediment loads of 0.3 mm. The loads settled in the basin will be flushed out to the Komering river with gravity flow within four hours.

Foundation works: The foundation of gated piers is of floating type supported by piles. Particular foundation treatment is not needed for the construction of apron. The foundation of intake structure is independent from those of other structures.

The salient features of the headworks is shown below and further in PLATE No. 3 attached hereto.

- Intake water level : EL. 79.30 m
- Design flood water level : EL. 81.80 m
- Fixed weir
  - crest elevation : EL. 79.30 m
  - length : 171 m
  - height (max.) : 5.3 m
- Movable weir
  - type of gate : roller gate
  - size of gate (B x H): 17.5 m x 5.4 m, 2 sets
  - gate operation : operated by motor
- Intake structure
  - size of gate (B x H): 7.0 m x 4.0 m, 3 sets
  - gate operation : operated by motor or manually

- Driving channel

type of canal	:	trapezoidal
lining material	:	concrete
base width	:	5.0 m
side slope of canal	:	1:1.5
length	:	1.6 km

- Settling basin

type of desilting	:	gravitationally flushing-out
size of basin (W x L)	:	40 m x 35 m
No. of basin	:	2 nos.
No. of gate	:	2 x 12 sets
gate operation	:	manual operation

- Operation bridge

type	:	girder type
width	:	5 m
length	:	244 m

- Operation facilities

operation house	:	340 m^2
electric facilities	:	diesel generator, 42 kVA x 2 sets

4.5.4 Irrigation Canal System

Irrigation canal system in the project area includes headreach, main canals, secondary canals, tertiary canals and quaternary canals. The layout planning of these canals is done after understanding their respective function and requirement. The proposed layouts of the canals down to the secondary canals are shown in PLATE NO. 1 attached hereto.

(1) Headreach

A headreach with an approximate length of 8 km is constructed between the settling basin and a bifurcation structure to lead the diverted water of 44.1 m^3/sec in peak time to North and South Main Canals.

The canal has a trapezoidal section with an inside slope of 1:1.5, and has a 18-m wide bottom and 2.5 m water depth. The design water levels at the head and the end of the canal are determined to be EL. 78.3 m and EL. 77.0 m respectively taking into account the design water level at the heads of the main canals, EL. 74.7 m and the head loss at the bifurcation structure. The longitudinal gradient of the canal base is 1/8,000.

(2) Main canals

In the project area, three main canals, i.e. South Main Canal, North Main Canal and Pisang Main Canal, are required to deliver irrigation water from the headreach to the development area in the shortest or in the most economical way.

The North Main Canal, 50 km, will be constructed for the irrigation of the Sub-Area-I, 18,500 ha, which includes around 3,300 ha of the command area of the headreach. This canal will cross the existing Belitang Irrigation Canal at 4-km point of the canal. This canal is designed for the discharge of 19.2 m^3/sec at its head including 1.6 m^3/sec for 1,300 ha in the Proper Area.

The South Main Canal will run for around 71 km to irrigate the Sub-Area-II of 18,200 ha. On its way, the water will be diverted to the Pisang Main Canal at 13-km point. The design discharge at the head of the canal is around 22 m^3/sec which include the irrigation water for the Pisang Area (4 m^3/sec).

The Pisang Main Canal will be branched off from the South Main Canal and runs for about 14 km for the irrigation of 2,900 ha in the Pisang Area. At its 3-km point, the canal will cross over the Pisang river.

All the main canals mentioned above will basically be unlined and trapezoidal. The raised portions will be lined with concrete.

(3) Secondary canal

These canals will be branched off from the abovementioned main canals to distribute water to the secondary units of which size will vary from 500 ha to 2,000 ha depending on the topography. Around 70 secondary canals with a total length of 250 km will be constructed in the project area. These canal will be principally unlined, but the raised canal portion will be lined with concrete.

The number and the total length of the main and secondary canals and the number of their related structures are tabulated below:

	North	South	Pisang	Total
Main canal				
- canal length (km)	50	71	13	134
- related structure				
turnout (nos.)	35	45	9	89
check gate (nos.)	15	19	4	38
spillway (nos.)	7	9	2	18
crossdrain (nos.)	37	28	4	69
bridge (nos.)	2	3	1	6
aqueduct (nos.)	1	-	1	2

	Sub-area-I	Sub-area-II	Total
Secondary canal			
- canal length (km)	108	129	237
- related structure			
turnout (nos.)	188	221	409
check gate (nos.)	82	95	177
spillway (nos.)	30	40	70
crossdrain (nos.)	10	16	26
drop (nos.)	37	55	92

4.5.5 Drainage Canal Network

(1) Main drains

The location of main drain is dominated by natural streams and rivers crisscrossing in the development area. Among these streams and rivers, the Belitang river and the Macak river will be used as the main drains. These rivers will be improved for 110 km in total to allow the design discharge to flow down smoothly (see PLATE NO. 1 attached hereto).

(2) Secondary drains

These drains will be designed to collect water from quaternary drains and tertiary drains and to transport collected water to main drains or rivers. Depressed areas or old stream beds will be used for location of the secondary drains. For the project, around 70 secondary drains with a total length of 150 km will be excavated.

The following table shows the total required canal length and the number of their related structures.

	Sub-area-I	Sub-area-II	Total
Main drain			
- canal length (km)	180	-	180
- related structure			
bridge (nos.)	2	-	2
Secondary drain			
- canal length (km)	118	191	309
- related structure			
drainage culvert (nos.)	38	59	97
drainage drop (nos.)	76	124	200

4.5.6 Tertiary Development

The tertiary development program will be prepared for every tertiary block to be irrigated by tertiary system. The tertiary system will consist of tertiary canal, sub-tertiary canals and quaternary canals which will respectively cover the tertiary block (50 - 150 ha), sub-tertiary blocks and quaternary blocks (10 - 15 ha). In tertiary blocks, tertiary drains and quaternary drains will also be required to evacuate excess water from the blocks.

The typical canal layouts in two representative blocks are as shown in Fig. 4-4 and 4-5. The following table shows the total required canal length.

		Sub-area-I	Sub-area-II	Total
Tertiary canal	(km)	407	473	880
Tertiary drain	(km)	444	510	954
Quaternary canal	(km)	1,110	1,150	2,260
Quaternary drain	(km)	250	230	480
Tertiary inspection road	(km)	518	546	1,064

4.5.7 Inspection Road

For the proper operation and maintenance of project facilities, well arranged inspection roads are vital importance. Since these roads will also be used as village roads and farm roads after the project implementation, the arrangement of the inspection roads should be made considering the existing and planned road networks.

In the project area, the following three types of inspection roads will be provided:

- Main inspection roads along the main canals, 7-meter wide and metalled with gravel.
- Secondary inspection roads along the secondary canals, 5-meter wide and metalled with laterite soil.

- Tertiary inspection roads along the tertiary canals, 3-meter wide and non-metalled.

The detailed layout planning is prepared considering the existing farm and village road networks and future canal layouts, and proposed road network is shown in the map attached to VOLUME-3 (DRAWINGS).

The following table shows the respective road length.

	Sub-Area-I	Sub-Area-II	Total
Main inspection road (km)	50	85	135
Secondary inspection road (km)	108	129	237
Tertiary inspection road (km)	518	546	1,064

4.5.8 Land Reclamation

The total areas to be reclaimed for paddy fields are around 27,700 ha in gross. The land clearing works for forest are carried out by the farmers themselves under the transmigration program of the Indonesian Government. Therefore, the cutting work of trees is not included in the project work. For the reclamation of the shrub land, the clearing work is made and followed by firing. Uprooting work is made after firing. Finally the rough levelling work is carried out. The final levelling work and construction of quaternary canals and border ridges are practiced by the farmers themselves.

4.5.9 Office and Quarters

Office and quarters are required for the persons to be engaged in the project implementation and in the operation and maintenance of the project facilities. The location of these facilities is proposed at Martapura. The required number and space of these facilities are briefly estimated as follows:

(1) Main office : 2,000 m^2
(2) Branch office : 500 m^2
(3) Repair shop : 500 m^2
(4) Store house : 5,000 m^2
(5) Quarters : 3,100 m^2
(6) Motor pool : 15,000 m^2

4.5.10 O & M Equipment

The O & M equipment shown in Table 4.1 will be required during the project operation period.

4.6 CONSTRUCTION SCHEDULE

The project will be implemented taking the following five stages in consideration of the large scale of the project:

(1) detailed design and construction of headworks and headreach,

(2) detailed design and implementation of Sub-area-I of 18,500 ha which includes the commanding areas of North Main Canal, including tertiary development of 2,000 ha,

(3) implementation of tertiary development, 16,500 ha in Sub-area-I,

(4) detailed design and implementation of Sub-area-II of 18,200 ha which includes the commanding areas of South Main Canal and the Pisang Area, and the Ranau regulating dam, including tertiary development of 2,000 ha, and

(5) implementation of tertiary development, 16,200 ha in Sub-area-II.

The time required for the implementation of the whole project works is estimated to be nine years, including the project mobilization and the preparatory works, from 1983 to 1991.

Large-scaled civil works such as headworks, regulating dam, headreach, main canals and main drains, etc. will be carried out mainly by using heavy construction machinery. The civil works for secondary canals, secondary drains and tertiary development will be carried out mainly by man-power with small construction equipment in order to maximize the employment opportunity in and around the project area. It is assumed that all the works would be executed on the contract basis.

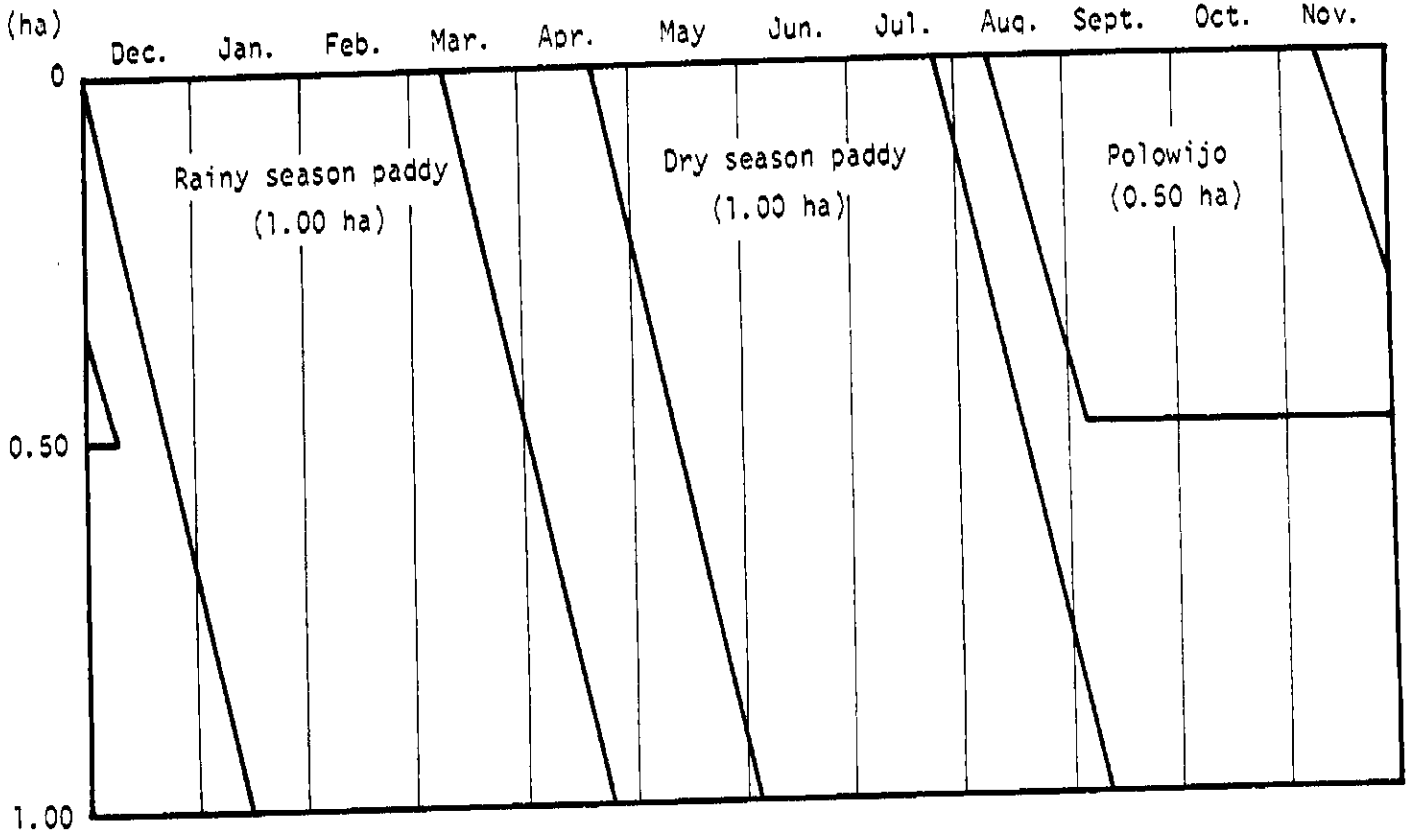
The quaternary networks within the tertiary blocks will be constructed by farmers themselves under the guidance of the project office.

The proposed implementation schedule is shown in Fig. 4-6 (for the details, vide ANNEX-VIII).

Table 4.1 REQUIRED NUMBER OF MAJOR EQUIPMENT FOR OPERATION AND MAINTENANCE

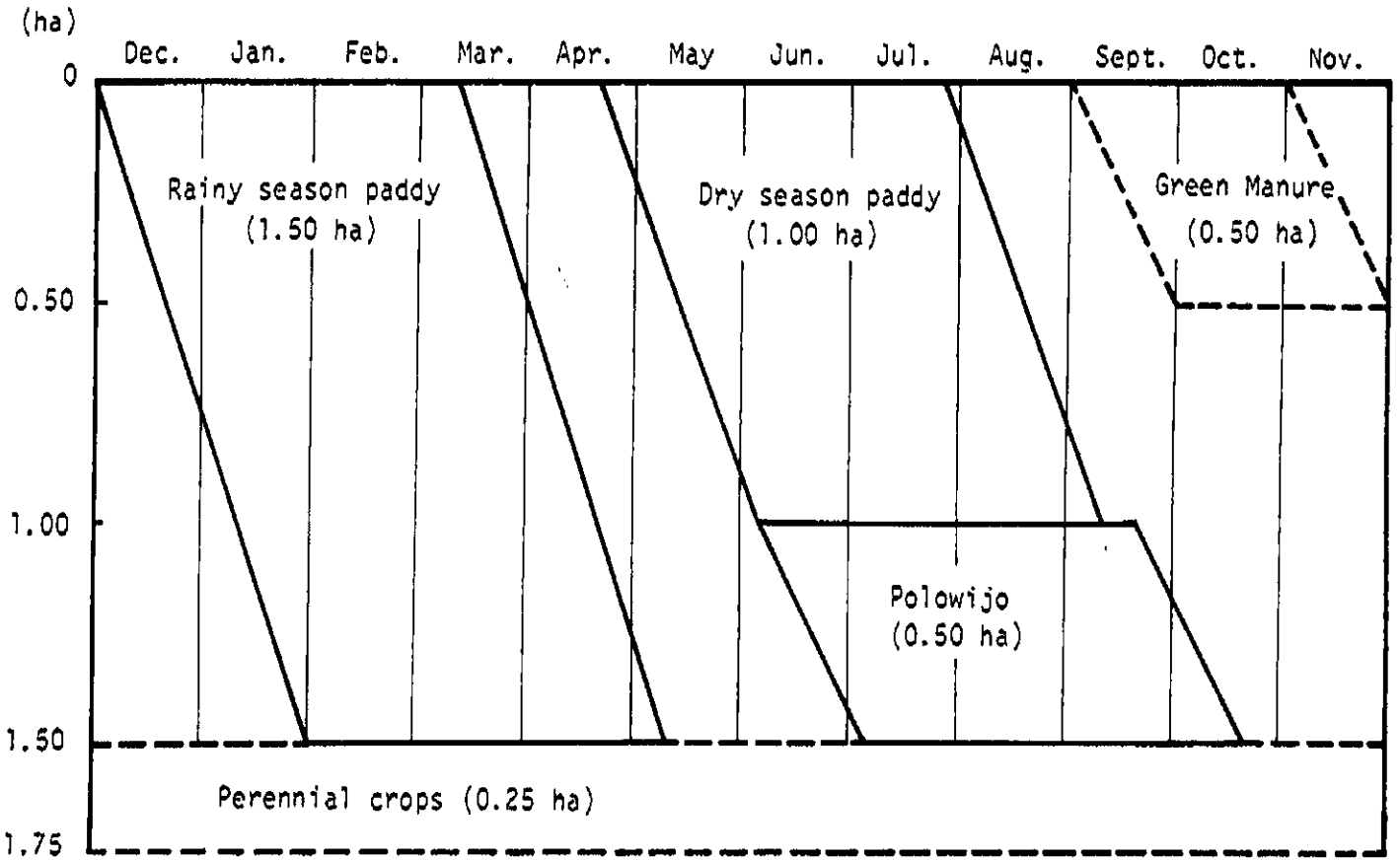
Item No.	Equipment	Required No.
A.	VEHICLE AND EQUIPMENT	
1.	Dragline, 0.8 m^3	2
2.	Backhoe, 0.6 m^3	6
3.	Backhoe, 0.3 m^3	4
4.	Bulldozer, 21 ton	2
5.	Bulldozer, 11 ton	4
6.	Dozer shovel, 1.4 m^3	2
7.	Wheel loader, 1.0 m^3	2
8.	Motor grader, 11 ton	2
9.	Water tanker, 5 m^3	3
10.	Tire roller, 8 - 10 ton	2
11.	Tamper, 80 kg	10
12.	Soil compactor, 90 kg	10
13.	Portable concrete mixer, 0.2 m^2	3
14.	Concrete vibrator, ϕ 45	6
15.	Submersible pump, ϕ 150	5
16.	Generator, 10 kw	4
17.	Trailer truck, 30 ton	2
18.	Dump truck, 11 ton	4
19.	Dump truck, 2 ton	6
20.	Cargo truck w/crane, 8 ton	4
21.	Cargo truck w/crane, 2 ton	6
22.	Ordinary truck, 6 ton	3
23.	Truck, 1 ton pick-up type	10
24.	Jeep, four wheel drive	10
25.	Sedan, 6 persons	3
26.	Repair shop tools	LS
27.	Spareparts (20% of the above)	LS
B.	TELECOMMUNICATION SYSTEM	1 set

Fig. 4.1 PROPOSED CROPPING PATTERN TYPE I (1.0 ha)



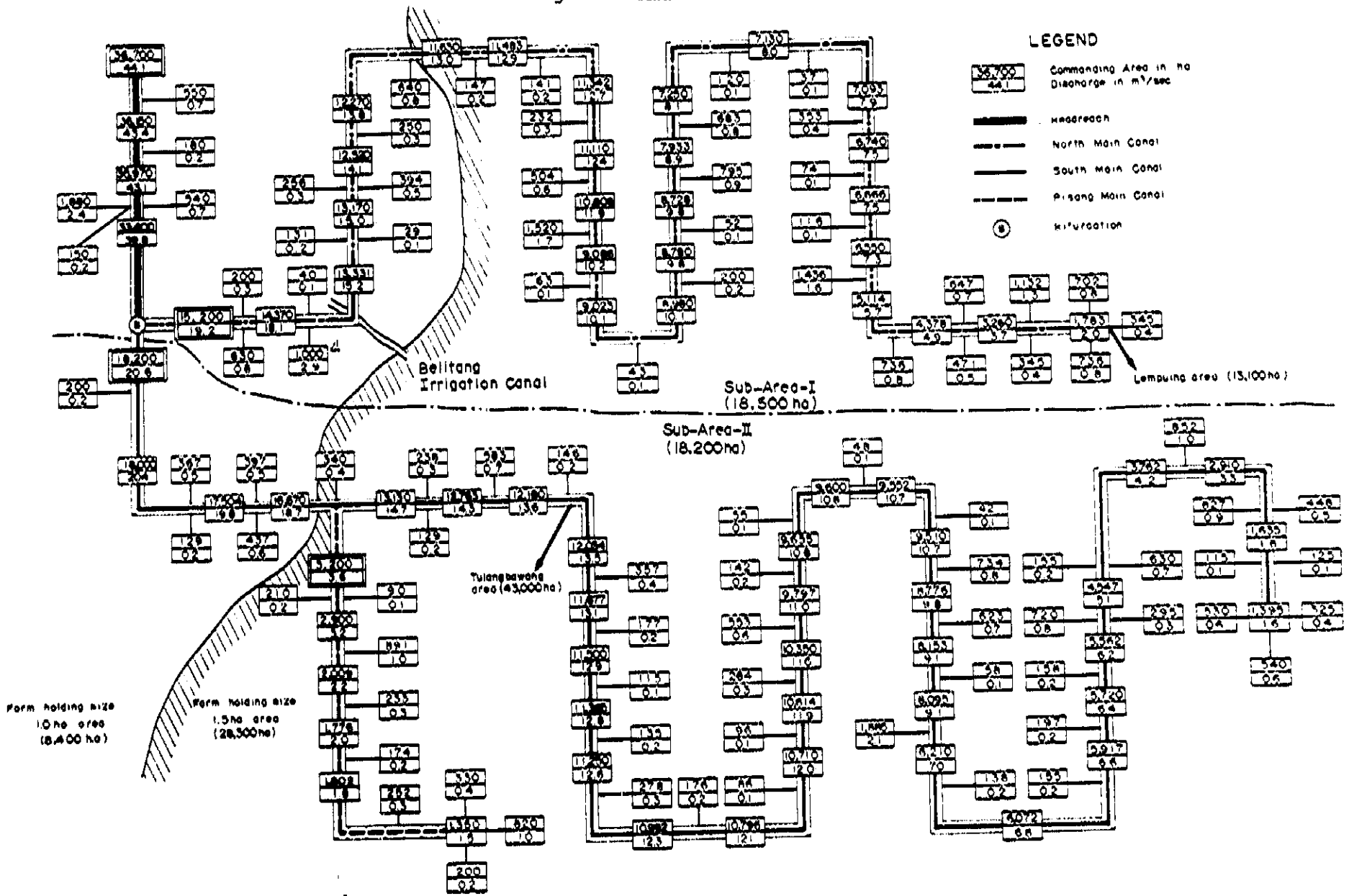
Crop Intensity: 2.50

Fig. 4.2 PROPOSED CROPPING PATTERN TYPE II (1.50 ha)



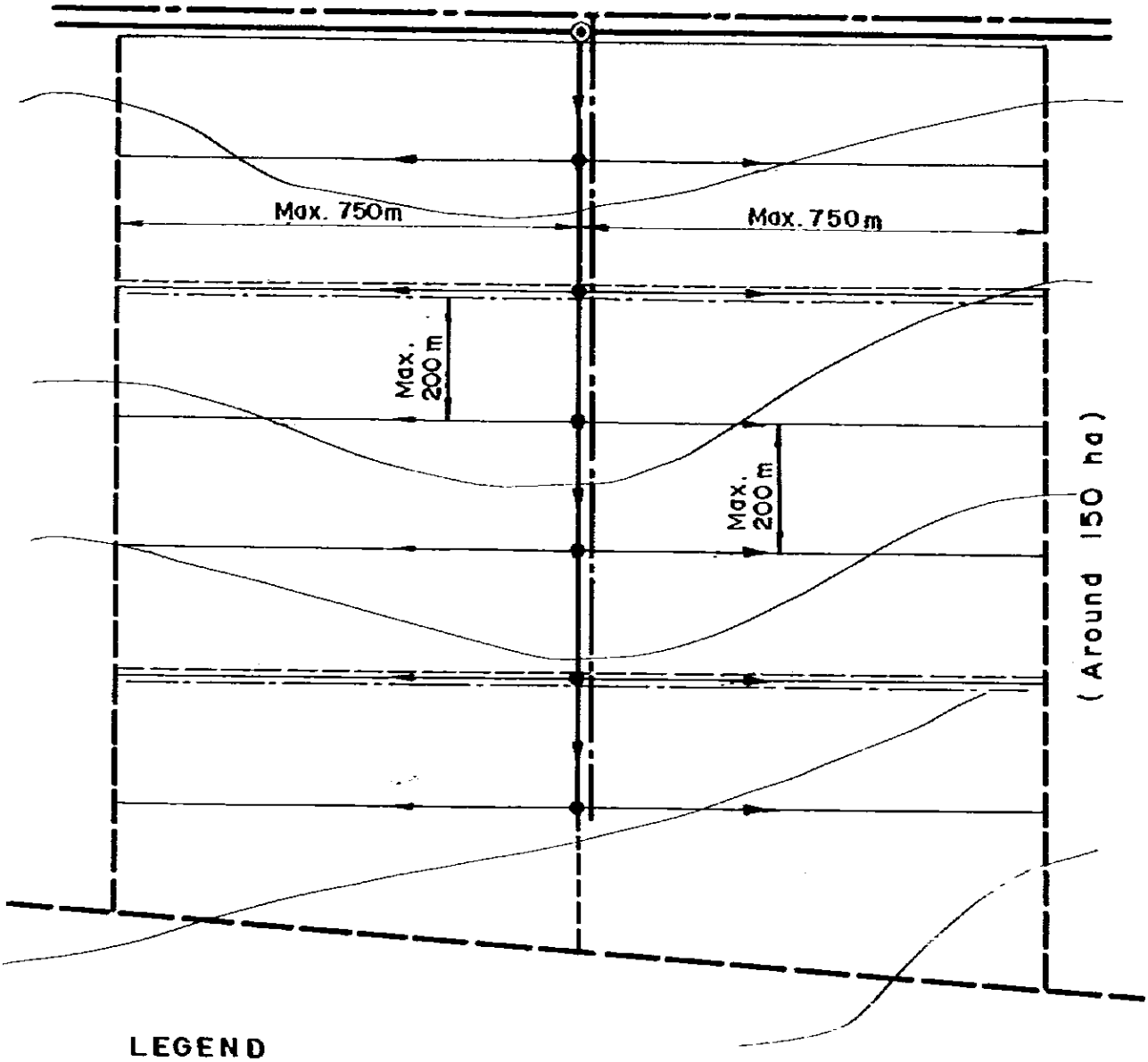
Crop Intensity: 2.00 (Except 0.50 ha of Green Manure and 0.25 ha of Perennial crops)
Perennial crops are excluded from economic evaluation, because these crops are not benefited by irrigation.

Fig. 4.3 IRRIGATION DIAGRAM



Note, ⚠ : Including the water requirement of 1.6 m³/sec for 8.5 thousand ha in Belitang Proper area.

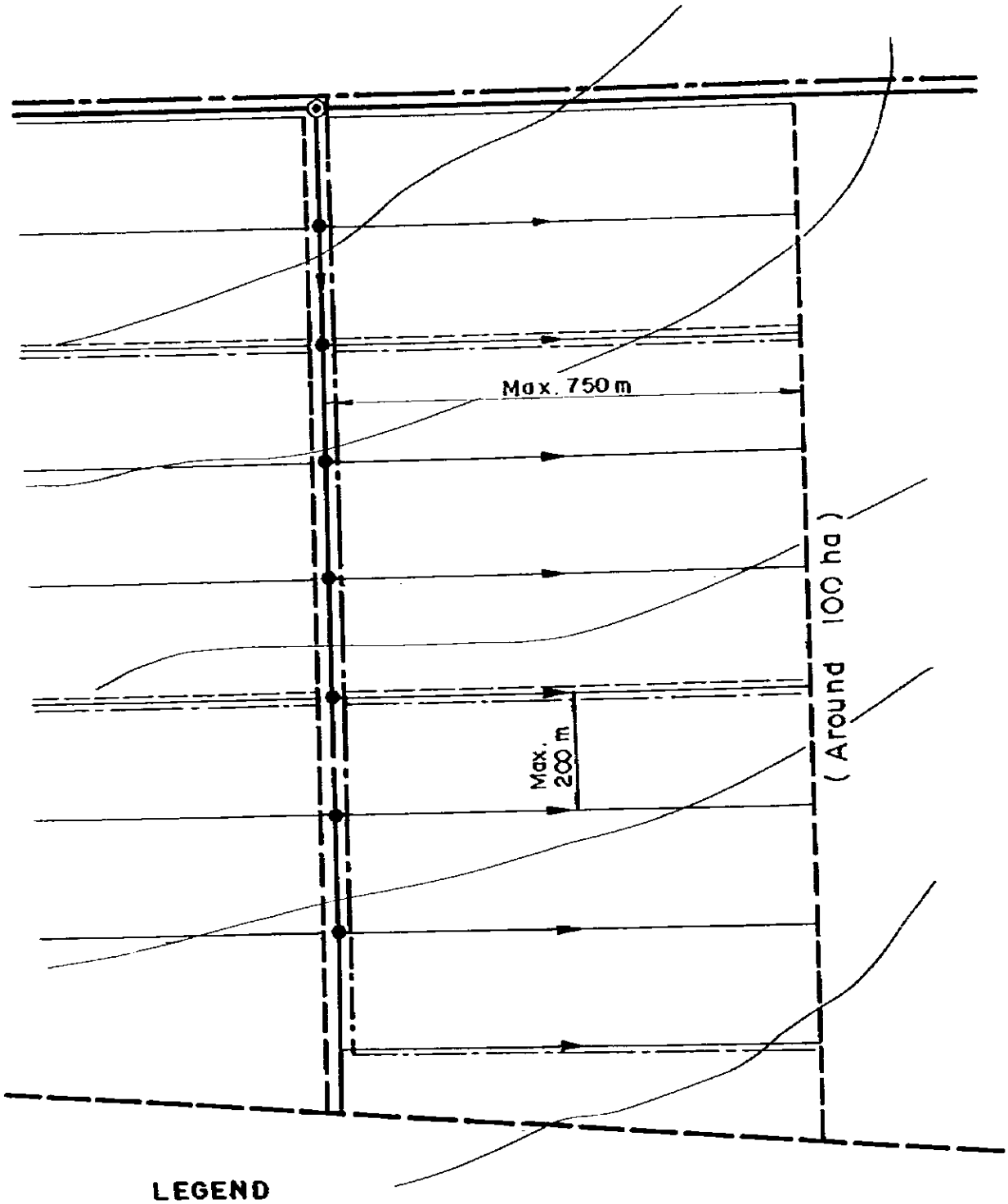
Fig. 4.4 TYPICAL LAYOUT OF TERTIARY SYSTEM (1)



LEGEND

- Main or Secondary Canal
- Tertiary Canal
- Quaternary Canal
- Main or Secondary Drain
- Tertiary Drain
- Quaternary Drain
- Main or Secondary Inspection Road
- Tertiary Inspection Road
- Farm Operation Road
- Turnout for Tertiary Canal
- Tertiary Division Box

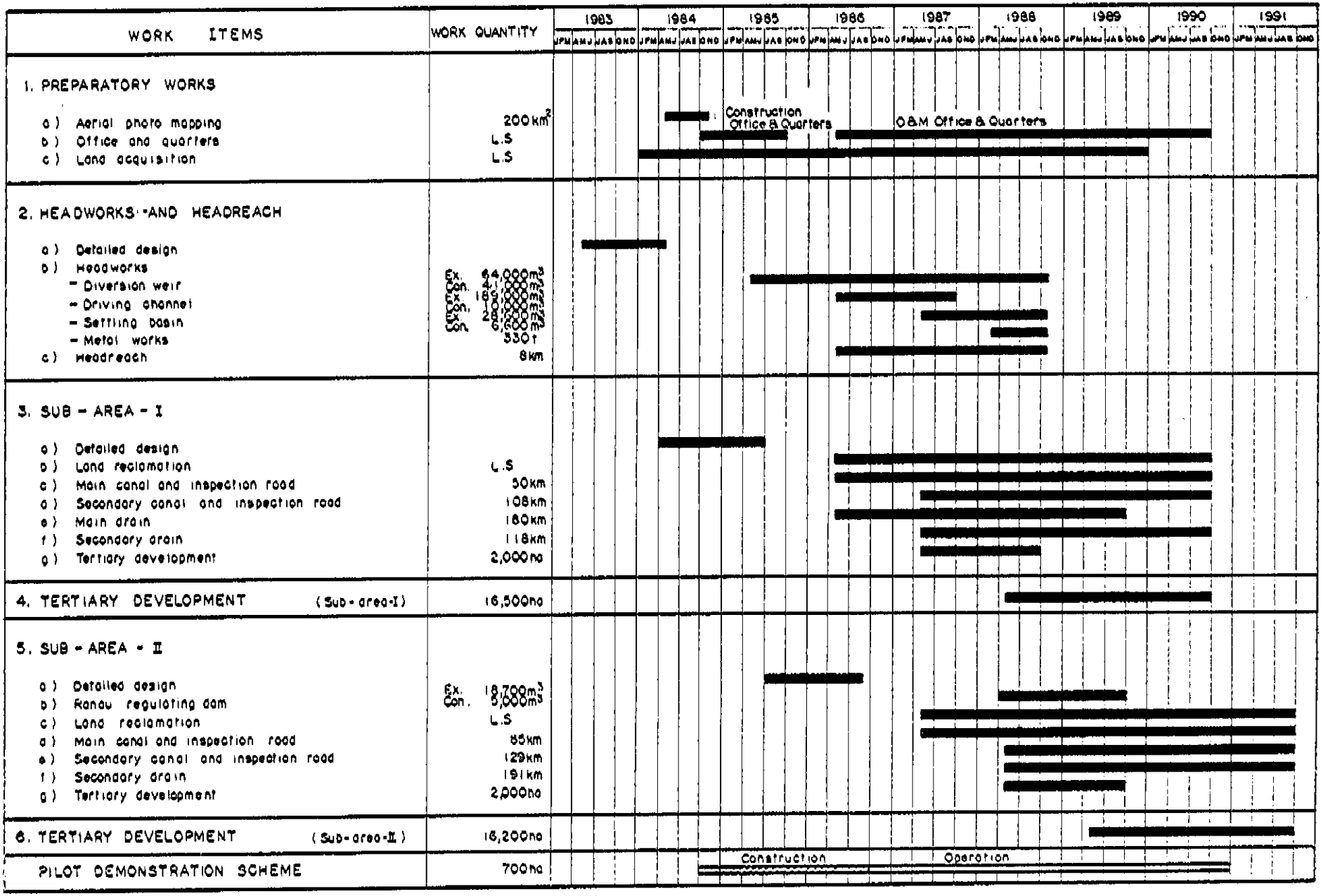
Fig. 4.5 TYPICAL LAYOUT OF TERTIARY SYSTEM (2)



LEGEND

- Main or Secondary Canal
- Tertiary Canal
- Quaternary Canal
- Main or Secondary Drain
- Tertiary Drain
- Quaternary Drain
- Main or Secondary Inspection Road
- Tertiary Inspection Rord
- Farm Operation Road
- Turnout for Tertiary Canal
- Tertiary Division Box

Fig. 4.6 PROJECT IMPLEMENTATION SCHEDULE



5. ORGANIZATION AND MANAGEMENT

5.1 ORGANIZATION FOR THE PROJECT IMPLEMENTATION

The Directorate General of Water Resources Development, the Ministry of Public Works, will be the executing agency for the implementation of the project. The Directorate of Irrigation under the said Directorate General of Water Resources Development will have direct responsibility for the project implementation. The Provincial Department of Public Works, South Sumatra, will be responsible for the implementation at the provincial level. In order to implement the project successfully, however, it is proposed to establish the Komering-I Project Office under the superintendence of the Provincial Department of Public Works (for the details of organization, vide ANNEX-IX).

The main functions of the Project Office are as follows:

(1) financial arrangement needed for construction of irrigation, drainage and road networks, and operation and maintenance of the project facilities,

(2) design and construction supervision of all the construction activities down to tertiary systems,

(3) assistance to farmers in construction of quaternary canals,

(4) planning, design, construction supervision and operation of the pilot demonstration scheme, and

(5) accounting and management of construction works.

The Project Office will consist of one main office and five branch offices. It is proposed to establish the main office at Martapura before getting into the major construction works of the project. The branch offices will be established at Perjaya, Bumiharjo, Sukaharjo, Rejodadi and Muarahazu, in keeping pace with the progress of the project construction works. Total number of the staff required for the Project Office would be around 220 at maximum.

5.2 ORGANIZATION FOR OPERATION AND MAINTENANCE OF THE PROJECT

After completion of the construction work, the Komering-I Project Office will be re-organized into the Project Operation and Maintenance Office under the Provincial Department of Public Works. The Project O & M Office will be responsible for operation and maintenance of all the project facilities down to inlets of tertiary blocks. The operation and maintenance of the tertiary blocks down to terminal facilities will be entrusted to the water users' associations and farmers themselves.

The O & M Office will consist of one head office and five sub-offices. The main office and the branch offices established in the construction stage will be used as the project O & M Office after completion of the project construction work. The O & M Office will consist of two working divisions, i.e. Technical Division and Administrative Division. The Technical Division will have four sections; Design Section, Operation Section, Maintenance Section and Mechanical Section. The Administrative Division will also have four sections, i.e. Accounting Section, Financing Section, Personnel Management Section and Store Section.

The main office will be responsible for the overall activities necessary for proper operation and maintenance of all the project facilities including preparation of overall O & M program, design and construction of repairing and rehabilitation works, budgeting, training of the O & M staff. The duties of each section are described in detail in ANNEX-IX. The communication between the main office and four sub-offices will be made using telephone system.

Total number of the O & M staff required in full operation stage would be around 200 persons including the staff for the main office and all the sub-offices.

5.3 AGRICULTURAL SUPPORT SERVICES

5.3.1 General

In order to attain the expected crop production through the introduction of double cropping a year with irrigation and drainage improvement, it is essential to provide more intensive agricultural support services, in addition to proper operation and maintenance of the project facilities.

For this purpose, further improvement of the present support services will be required, particularly for extension services, agricultural cooperative, credit and research works. In addition, it is recommended to establish the water users' association for proper water management under the guidance of the Project O & M Office.

5.3.2 Agricultural Extension Services

The number of the existing field extension workers in the project are insufficient for the proper guidance of crop cultivation techniques to the farmers. Especially, in the case of "With Project" it will become important to up-grade farmers' knowledge on crop cultivation techniques such as introduction of new high yield varieties, improvement of fertilizer application system and control of insects and diseases, guidance of demonstration farm with Kontak Tani (key farmer), etc.

In the project area, each PPL (field extension worker) is dealing with about 1,700 farmers with 1,200 ha of paddy field on an average.

The present agricultural extension service is insufficient for proper guidance on application of improved irrigation farming techniques mainly because of short of PPL, lack of equipment and material for extension activities, and shortage of budget. It is desired to increase number of PPL and strengthen their technical knowledge in order to spread evenly the improved farming techniques to the individual farmer. Appropriate command area per PPL would be about 500 ha of paddy field. In order to maintain prospective crop production throughout the project operation, the training of farmers is required to be constantly carried out through Kontak Tani. Group meeting of the voluntary organization, such rural youth club and farmers' activity group, will also be held from time to time with the assistance of the Kontak Tani and PPL.

Further improvement would also be required for equipment and instruments necessary for PPL's activities such as vehicles, soil testing apparatus, visual aids, etc.

5.3.3 Agricultural Credits

The most important agricultural credits in Indonesia is the BIMAS/INMAS credits which operations were commenced from 1965. For the introduction of the BIMAS/INMAS programs, particularly for paddy cultivation, one of the prerequisites is that the field to be applied has to be basically provided with the technical or semi-technical irrigation system.

There are three kinds of loan for agriculture by the Bank Rakyat Indonesia, i.e. short term, medium term and long term loans. The BIMAS/INMAS credit for paddy production loan is short loan with 7-month loan term with monthly interest rate of 1%.

In order to extend the BIMAS/INMAS program area, it is desired to establish a branch office of BRI in the project area after fulfillment of the abovementioned prerequisite through the project.

5.3.4 Co-operative

The establishment of Village Unit Co-operatives (KUD) was scheduled to be completed for about 21% of total Village Units in South Sumatra Province by the end of 1979/80. In the project area, 14 KUDs out of 65 village units have been organized, but membership is less than 10% of total member of farmers. Much effort should be paid to establishment of such farmers' co-operatives for proper operation or irrigation farming by means of strong guidance of the government through governmental regional offices.

In addition, more rice mills,paddy drying yards, warehouses,agro-equipment and tools, etc. should also be sufficiently provided to the BUUD/KUD organizations in the project area so as to deal with smoothly farm outputs and inputs.

5.3.5 Water Users' Association

Operation and maintenance of the irrigation and drainage facilities in the tertiary block will be done by farmers themselves. Before completion of the construction work of the project facilities, the water users' association should be established in each village under the initiation of a village chief, Camat and Bupati with guidance of the Project O & M Office and the agricultural office as explained in detail in ANNEX-IX. In particular, the Project O & M Office will provide full technical guidance and advice for water supply management and maintenance of the facilities through the resort of the O & M sub-office.

The water users' association will have a Board which will be staffed by a chairman, treasurer and farmers' representatives. The village chief will, in general, be the chairman and will manage the association. One Ulu Ulu (water master) will be posted in each tertiary block and will carry out water management including preparation of irrigation calender, handling of canal structures, diverting of scheduled amount of water to the quaternary canals, and supervision of maintenance works. A farmers' leader will be selected in each quaternary block as an assistant of the Ulu Ulu.

The activities of the Ulu Ulu and the farmers' leader are important for proper water management at farm level and for the project as well. In order to fulfill their missions, they would have a full knowledge for water supply management of the project as well as at farm level. They will therefore be trained by the staff of the Project O & M Office.

5.3.6 Research

The present farming practices in the project area are still primitive and the farmers are not familiar with irrigation farming of which knowledge would become essential for the proposed agricultural development. Other constraints observed in the project area are shortage of qualified field extension workers, insufficient facilities for seed multiplication and its distribution system, and weakness of applied agricultural research. In order to attain the projected target of the agricultural development in the area, a systematic program of adaptation test and selection of crops proposed is essential. In this context, the present Belitang seed center should be extended and strengthened in staff, facilities, equipment, field, etc.

5.3.7 Pilot Demonstration Scheme for Water Management

Except for the Belitang Proper Area, no systematic irrigation water management is practiced in the upper Komering river basin. Even in the Proper Area with a net irrigable area of 20,600 ha, the present irrigated area is only about 3,600 ha in the dry season and about 12,000 ha in the rainy season mainly due to less capacity of headreach of the main canal and inadequate water management in on-farm level. In the project area, the farmers are entirely not familiar with irrigation farming. Besides, no Ulu Ulu and farmers' leader trained on water management are actually made available.

In view of above constraints and circumstances, it is recommended to establish a pilot demonstration scheme for water management in advance to the implementation of the project. The major purposes of the scheme are as follows:

1) tertiary and quaternary development through construction of the irrigation and drainage facilities as well as road network, as the model of future development;

2) training of Ulu Ulu and leading farmers and incentive farmers on water management; and

3) tests on optimum irrigation water supply to various crops and determination of the irrigation requirements.

The selection of the scheme area is made taking into account the administrative boundaries (village boundaries), availability of irrigation water, drainability of the area, soil conditions, accessibility for transportation and communication, future layouts of irrigation and drainage facilities of the project and demonstration effects to the project area. As the result, the Kurungan Nyawa area is proposed for the scheme.

The selected area covers about 900 ha of land in gross, of which around 700 ha are selected as a net irrigable area. This area extends over two villages; 400 ha in Kurungan Nyawa and 300 ha in Tebat Jaya. All the part of area is being cultivated with paddy. The northern boundary of the area is formed by the asphalt-paved road constructed along the Belitang Irrigation Canal. Other than this trunk road, village road network, all of which are unmetalled, are well developed in the scheme area.

The irrigation water for the scheme will be pumped up from the Komering river; around 1-km upstream from the existing intake structure for the Belitang Proper Area, and distributed to the farm plots through the tertiary and quaternary canals. The excess water from the fields will be drained out through the quaternary drains and tertiary drains to the outside of the area. In addition to these facilities, some buildings such as office, storehouses and staff quarters will be constructed for the operation of the scheme (for the details, vide ANNEX-XII).

5.4 EXPATRIATE ASSISTANCE WORKS

Large civil engineering works on the water resources development project require experienced professional manpower at all levels of the responsible organization as a whole. For the successful prosecution of the project, appropriate expatriate assistance is proposed to be introduced.

A vital part of the functions of expatriate assistance would be the training of the local professional and sub-professional manpower on management of supervision of the construction works and the provision of substantial experience and techniques to the project. The details are explained in ANNEX-IX.

6. COST ESTIMATE

6.1 PROJECT COST

6.1.1 Conditions

The project cost is estimated based on the following conditions:

(1) The exchange rate used in the estimate is;
US$1 = Rp. 625

(2) All the civil engineering works are to be carried on the contract basis using contractor's own machinery.

(3) All the unit rates for civil work items are estimated using the current prices as of the end of 1980.

(4) The project cost comprises foreign and local currency portions. Each currency portion includes the following items:

Local currency portion

- labor force,
- sand, gravel and wooden materials,
- fuel, oil, etc.,
- inland transportation costs,
- government's administration expenses during the construction period,
- contractors' general expenses and profit,
- expenses of engineering services for local consultant, and
- minor works.

Foreign currency portion

- reinforcement bar and other structural steel,
- cement,
- steel gates, diesel generators, motor and other metal works,
- depreciation costs for construction machinery,
- vehicles to be required for the construction supervision and O & M equipment,
- foreign contractors' general expenses and profit, and
- expenses and fees of engineering services for foreign consultant.

(5) Cost for jungle clearing is not included in the estimate.

(6) The physical contingency of around 10% of direct cost and the price contingency of 5% per annum for the foreign currency portion and 8% per annum for the local currency portion are included in the estimate.

(7) The associated costs to be financed by the Government, such as the costs for strengthening the extension services, facilities of the water users' association, and improvement of the social infrastructures are not included in the estimate.

6.1.2 Estimate

The total project costs are estimated at US$321 million, which comprise US$122 million equivalent of local currency and US$199 million of foreign currency. The summary of the cost estimate is as shown in Table 6.1 (for the details, vide ANNEX-X).

6.1.3 Annual Disbursement Schedule

The annual disbursement schedule is worked out based on the construction time schedule. The summary of the disbursement schedule is as shown below:

(Unit; 10^3US$)

Year	Foreign Currency Portion	Local Currency Portion	Total
1983	2,229	763	2,992
1984	7,212	3,056	10,268
1985	9,292	3,229	12,521
1986	17,743	9,509	27,252
1987	30,695	17,847	48,542
1988	46,360	25,808	72,168
1989	38,715	26,378	65,093
1990	30,217	21,051	51,268
1991	16,899	14,246	31,145
Total	199,362	121,887	321,249

6.2 ANNUAL OPERATION AND MAINTENANCE COSTS

The annual operation and maintenance costs include the salaries of project administrative and water control staffs, the materials and labor costs for repair and maintenance of project facilities, the costs for operation, repair and maintenance of O & M equipment, and the running costs of project facilities including diesel generators. The estimated costs are Rp. 720 million per annum in total which correspond to US$31.4 US$/ha/year (for details, vide ANNEX-X).

6.3 REPLACEMENT COSTS

Some of the facilities, especially mechanical and electrical works have shorter useful life than the civil works, and require replacement at a certain time within the project useful life. The replacement costs and the useful lives of these facilities are listed in Table 6.2.

Table 6.1 SUMMARY OF CONSTRUCTION COST

	Item	Total	Foreign Currency	Local Currency
		(10^3US$)	(10^3US$)	(10^6Rp.)
1.	Preparatory Works	10,979	7,993	1,866
2.	Ranau Regulation Dam	1,832	1,229	377
3.	Headworks and Headreach	18,854	15,294	2,225
4.	Irrigation Canals and Inspection Roads	64,038	42,584	13,409
5.	Drainage Canals	10,985	6,294	2,932
6.	Tertiary Development	26,684	17,097	5,992
7.	Land Reclamation	31,173	21,235	6,211
8.	Office and Quarters	1,816	-	1,135
	Sub-total	166,361	111,726	34,147
9.	Land Acquisition	3,431	-	2,144
10.	O & M Equipment	4,888	4,490	249
11.	Administration Expenses	2,534	-	1,584
12.	Engineering Services	16,072	14,318	1,096
13.	Physical Contingency	15,379	11,173	3,629
	Sub-total	43,904	29,981	8,702
	Total	210,265	141,706	42,849
14.	Price Contingency	110,984	57,656	33,330
	GRAND TOTAL	321,249	199,362	76,179

Table 6.2 REPLACEMENT COST AND USEFUL LIFE

Item	Useful Life	Replacement Cost
	(years)	
1. O & M Equipment	10	4,888,000
2. Project Facilities		
2.1 Gates in Ranau regulating dam	25	202,000
2.2 Headworks		
- Gate	25	3,079,000
- Electric facilities	20	441,000
2.3 Gates in irrigation facilities	25	6,736,000

7. PROJECT EVALUATION

7.1 GENERAL

The project evaluations are made in order to ascertain the feasibility of the project in view of economic, financial and socio-economic aspects.

The economic feasibility of the project is evaluated in terms of the internal rate of return. Further, sensitivity analysis is also made with respect to change in the economic project cost, market price of paddy and yield of paddy. In the calculation, the economic costs and benefits are estimated based on the study results in Chapter 4 and 6 hereof.

The financial aspect is evaluated by calculating the capacity to pay and by preparing the repayment schedule of the project capital cost. The calculation of capacity to pay is made to confirm the soundness of the project from the farmers' viewpoint. The repayment schedule is prepared to estimate the annual scale of the subsidy to be paid by the Government based on the estimated fund requirements with the assumed financial terms of the conceivable loan and the expected revenue from the project.

Intangible socio-economic impacts of the project are also briefly studied in due consideration of the effect of the project on the regional development.

7.2 ECONOMIC EVALUATION

7.2.1 Economic Cost

The economic cost for the implementation of the project includes costs for (1) preparatory works, (2) construction of project facilities, (3) procurement of O & M equipment (first procurement only), (4) administration expenses, (5) engineering services and (6) physical contingency of 10% for the direct cost. In addition to the above costs,

the construction cost for the on-farm development works and the cost for jungle clearing, both of which are estimated using the opportunity cost for labor, are counted in the economic cost.

The annual disbursement of the economic costs is summarized as follows (for the details, vide ANNEX-XI):

1983	2,672 x 10^3 US$
1984	8,592 "
1985	9,629 "
1986	19,756 "
1987	33,937 "
1988	47,889 "
1989	40,849 "
1990	30,808 "
1991	16,417 "
Total	210,549 x 10^3 US$

7.2.2 Annual Operation and Maintenance Costs

In addition to the O & M costs estimated in Chapter 6, the O & M costs of Rp. 26 x 10^6 to be required in the elevated lands (1,300 ha) in the Belitang Proper Area, which will be benefited by the Komering-I project facilities, are taken into account in the evaluation.

7.2.3 Replacement Costs

The replacement cost shown in Table 6.2 in the preceding chapter is assumed to be required at the intervals of the economic useful life of each facility.

7.2.4 Project Benefit

The agricultural benefit through the project is estimated for the cases of "with project" and "without project" to know the net incremental benefit in the full operation stage of the project. The benefit will come out immediately after the completion of land reclamation, even before the completion of the total construction works. The benefit is expected to take linear increase, and the full benefit will be attained during the build-up period of five years for the 1.0-ha area and seven years for the 1.5-ha area in the Belitang Extension Central Area and the Pisang Area.

The following table summarizes the annual net incremental benefit in the full development stage.

Development Area	Area (ha)	Annual Net Incremental Benefit (10^6 Rp.)
Belitang Extension Central Area		
- 1.0-ha area	8,400	6,408
- 1.5 ha area	25,400	17,661
Pisang Area	2,900	2,330

In addition to the above, the benefit to be derived from the elevated land of 1,300 ha in the Belitang Proper Area; Rp. 746 x 10^6, is counted in the evaluation.

7.2.5 Evaluation

For the economic evaluation of the project, the cost and benefit streams are firstly prepared, then, the internal rate of return is calculated. The calculated internal rate of return is around 16.2% as a whole, which indicates the economic soundness of the project.

In order to evaluate further the soundness of the project to the possible changes of economic conditions in future, sensitivity analysis is made with respect to changes in the project cost, market price of paddy and paddy yield also by calculating the internal rate of return. The calculated results are shown in the following table.

Internal Rate of Return (%)

	Benefit Decrease		
Cost Increase	0	-10%	-20%
0	16.2	14.7	13.2
+10%	14.9	13.5	12.1
+20%	13.8	12.5	11.2

From the above calculated results, it can be said that the project would be still sound even in the worst case, i.e. 20% increase of the cost and 20% decrease of the benefit.

7.3 FINANCIAL EVALUATION

7.3.1 Fund Requirement for Project Implementation

All the project cost estimated in Chapter 6 is taken as the fund requirement for the project implementation. The annual disbursement schedule of the fund is also shown in Chapter 6.

7.3.2 Capacity to Pay

For the evaluation of the project feasibility from the viewpoint of farmer's economy, farm budget analyses are made on three typical farms; 1.0-ha farm and 1.5-ha farm in the Belitang Extension Central Area and 1.5-ha farm in the Pisang Area as stated in Chapter 4.

With the completion of the project, the annual net reserve or capacity to pay would increase remarkably. The capacity to pay estimated under the "with project" condition is Rp. 214,500 (US$342.0) for the 1.0-ha farm and Rp. 362,700 (US$580.0) for the 1.5-ha farm in the Belitang Extension Central Area and Rp. 231,800 (US$371.0) for the 1.5-ha farm in the Pisang Area respectively.

7.3.3 Water Charge

It is generally understood that the water charge is imposed to the water users, and the water charge thus collected is spent for the payment of O & M expenditures incurred to the project and for the repayment of the capital cost of the project. In Indonesia, however, the farmers traditionally do not pay any water charge directly, but contribute indirectly by paying the IPEDA tax.

As estimated in Chapter 6, the annual operation and maintenance costs required for the project would be Rp. 720 x 10^6; equivalent to about 31.4 US$/ha. This corresponds to about 9.1% of the capacity to pay for 1.0-ha farm and 8.1% for the 1.5-ha farm in the Belitang Extension Central Area and 12.7% for the 1.5-ha farm in the Pisang Area. On the other hand, the annual scale of repayment amount for the capital cost is estimated to be about 270 US$/ha for the foreign currency portion and 163 US$/ha for the local currency portion. These repayment amounts can not be covered by the capacity to pay from the viewpoint of the farmer's economy.

The water charge to be collected from the water users should be within a reasonable range in the capacity to pay that could still give sufficient incentive to the farmers. With this view, the reasonable water charge is recommended to be 19,700 Rp./ha/annum, i.e. the required annual O & M cost. This recommended water charge will be the project revenue in the financial evaluation of the project. In addition to the above, water distribution fee of either 30 kg of paddy per hectare per crop in kind or about 3,000 Rp./ha in cash will be charged from the farmers benefited for the payment to the Water Users' Association.

7.3.4 Repayment of Project Cost

The financial evaluation of the project is made by examining the repayment capacity for the capital cost of the project. For the examination, the cash flow table using the anticipated project revenue and the fund requirement according to the disbursement schedule is prepared as shown in Table 7.1.

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

(1) For the foreign currency portion, the capital is financed by bilateral or international organizations with an interest of 2.5% per annum for a repayment period of 30 years including 10-year grace period.

(2) For the local currency portion, the capital is financed by the budget allocation of the Government with no repayment.

Based on the above conditions, the repayment schedule for the foreign currency portion is prepared as shown in Table 7.1. This table indicates that the direct revenue from the water charge can not cover the annual repayment of the fund, except for the O & M cost, and the repayment of the fund has to be made by the subsidy of the Government.

7.4 INDIRECT BENEFITS AND SOCIO-ECONOMIC IMPACTS

In addition to the direct benefits stipulated in the economic evaluation, substantial secondary direct benefits steming from the project outputs and induced by project inputs and favourable intangible socio-economic impacts are expected from the implementation of the project.

7.4.1 Foreign Exchange Saving

Under the project implementation, paddy production will increase to about 269,500 tons per annum from the present production of 51,700 tons. Out of this increased production, it is expected that the marketable rice would amount to about 160 x 10^3 tons after deducting the local consumption. This surplus would reduce the annual amount of imported rice, resulting in the saving of foreign exchange amounting to about US$60.2 x 10^6 per annum at the rate of US$376 per ton in economic price.

7.4.2 Increase of Employment Opportunity to Local People

Employment opportunity to the local people will be increased by the project implementation, and a favourable impact will be given to the national economy. Furthermore, the employee will be able to gain more experience, technical know-how, skillfulness in the various working fields. These accumulations would be applied to the future development in South Sumatra Province.

7.4.3 Improvement of Local Transportation

The local transportation will be improved much by the construction of the operation and maintenance roads along the irrigation canals. The expanded road system will not only enhance the economic activity in and around the project area but also contribute to inter-regional accessibility and communication.

7.4.4 Improvement of Environmental Sanitation

The construction of the project works would have a possitive effect on the overall ecology of the project area. The health and sanitary conditions would become better with drainage improvement as well as supply of fresh water through the irrigation canals.

Table 7.1 FINANCIAL CASH FLOW STATEMENT

Unit: US$10^3

Year	Loan Disbursement	Accumulated Loan	Cash Outflow: O & M Cost	Cash Outflow: Repayment of Loan Interest	Cash Outflow: Repayment of Loan Capital [1]	Cash Outflow: Total Outflow(A)	Cash Inflow: Project Revenue	Cash Inflow: Government Subsidy	Cash Inflow: Total Inflow(B)	Balance of Payment (B) - (A)
1983	2,229	2,229	-	55.7	-	55.7	-	55.7	55.7	0
1984	7,212	9,441	-	236.0	-	236.0	-	236.0	236.0	0
1985	9,292	18,733	-	468.3	-	468.3	-	468.3	468.3	0
1986	17,743	36,476	-	911.9	-	911.9	-	911.9	911.9	0
1987	30,695	67,171	-	1,679.3	-	1,679.3	-	1,679.3	1,679.3	0
1988	46,360	113,531	-	2,838.3	-	2,838.3	-	2,838.3	2,838.3	0
1989	38,715	152,246	758	3,806.2	-	4,564.2	758	3,806.2	4,564.2	0
1990	30,217	182,463	933	4,561.6	-	5,494.6	933	4,561.6	5,494.6	0
1991	16,899	199,362	1,084	4,984.1	-	6,068.1	1,084	4,984.1	6,068.1	0
1992		199,362	1,152	4,984.1	1,795.4	7,931.5	1,152	6,779.5	7,931.5	0
1993		197,566.6	1,152	4,939.2	4,566.9	10,658.1	1,152	9,506.1	10,658.1	0
1994		192,999.7	1,152	4,825.0	8,530.4	14,507.4	1,152	13,355.4	14,507.4	0
1995		184,469.3	1,152	4,611.7	8,530.4	14,294.1	1,152	13,142.1	14,294.1	0
1996		175,938.9	1,152	4,398.5	8,530.4	14,080.9	1,152	12,928.9	14,080.9	0
1997		167,408.5	1,152	4,185.2	9,195.6	14,532.8	1,152	13,380.8	14,532.8	0
1998		158,212.9	1,152	3,955.3	9,968.1	15,075.4	1,152	13,923.4	15,075.4	0
1999		148,244.8	1,152	3,706.1	9,968.1	14,826.2	1,152	13,674.2	14,826.2	0
2000		138,276.7	1,152	3,456.9	9,968.1	14,577.0	1,152	13,425.0	14,577.0	0
2001		128,308.6	1,152	3,207.7	9,968.1	14,327.8	1,152	13,175.8	14,327.8	0
2002		118,340.5	1,152	2,958.5	9,968.1	14,078.6	1,152	12,926.6	14,078.6	0
2003		108,372.4	1,152	2,709.3	9,968.1	13,829.4	1,152	12,677.4	13,829.4	0
2004		98,404.3	1,152	2,460.1	9,968.1	13,580.2	1,152	12,428.2	13,580.2	0
2005		88,436.2	1,152	2,210.9	9,968.1	13,331.0	1,152	12,179.0	13,331.0	0
2006		78,468.1	1,152	1,961.7	9,968.1	13,081.8	1,152	11,929.8	13,081.8	0
2007		68,500.0	1,152	1,712.5	9,968.1	12,832.6	1,152	11,680.6	12,832.6	0
2008		58,531.9	1,152	1,463.3	9,968.1	12,583.4	1,152	11,431.4	12,583.4	0
2009		48,563.8	1,152	1,214.9	9,968.1	12,335.0	1,152	11,183.0	12,335.0	0
2010		38,595.7	1,152	964.9	9,968.1	12,085.0	1,152	10,933.0	12,085.0	0
2011		28,627.6	1,152	715.7	9,968.1	11,835.8	1,152	10,683.8	11,835.8	0
2012		18,659.5	1,152	466.5	8,172.7	9,791.2	1,152	8,639.2	9,791.2	0
2013		10,486.8	1,152	262.2	5,401.3	6,815.5	1,152	5,663.5	6,815.5	0
2014		5,085.5	1,152	127.1	1,437.8	2,716.9	1,152	1,564.9	2,716.9	0
2015		3,647.7	1,152	91.2	1,437.8	2,681.0	1,152	1,529.0	2,681.0	0
2016		2,209.9	1,152	55.2	1,437.8	2,645.0	1,152	1,493.0	2,645.0	0
2017		772.5	1,152	19.3	772.5	1,943.8	1,152	791.8	1,943.8	0
2018		0	1,152	0	0	1,152.0	1,152	0	1,152.0	0

[1] : The figures in this column are the accumulation of the repayment for five loans having the different repayment periods.

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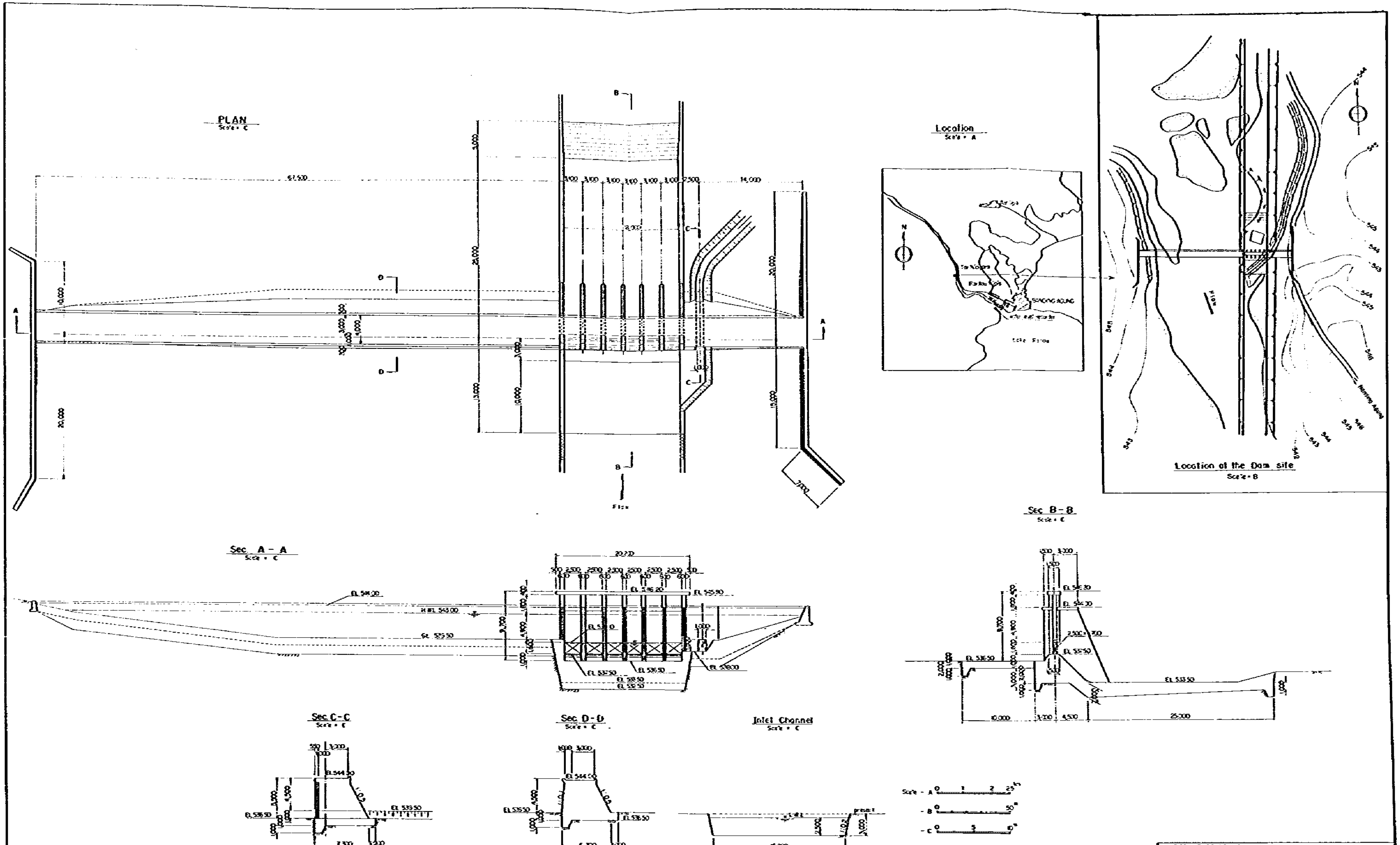
GENERAL LAYOUT MAP



DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT

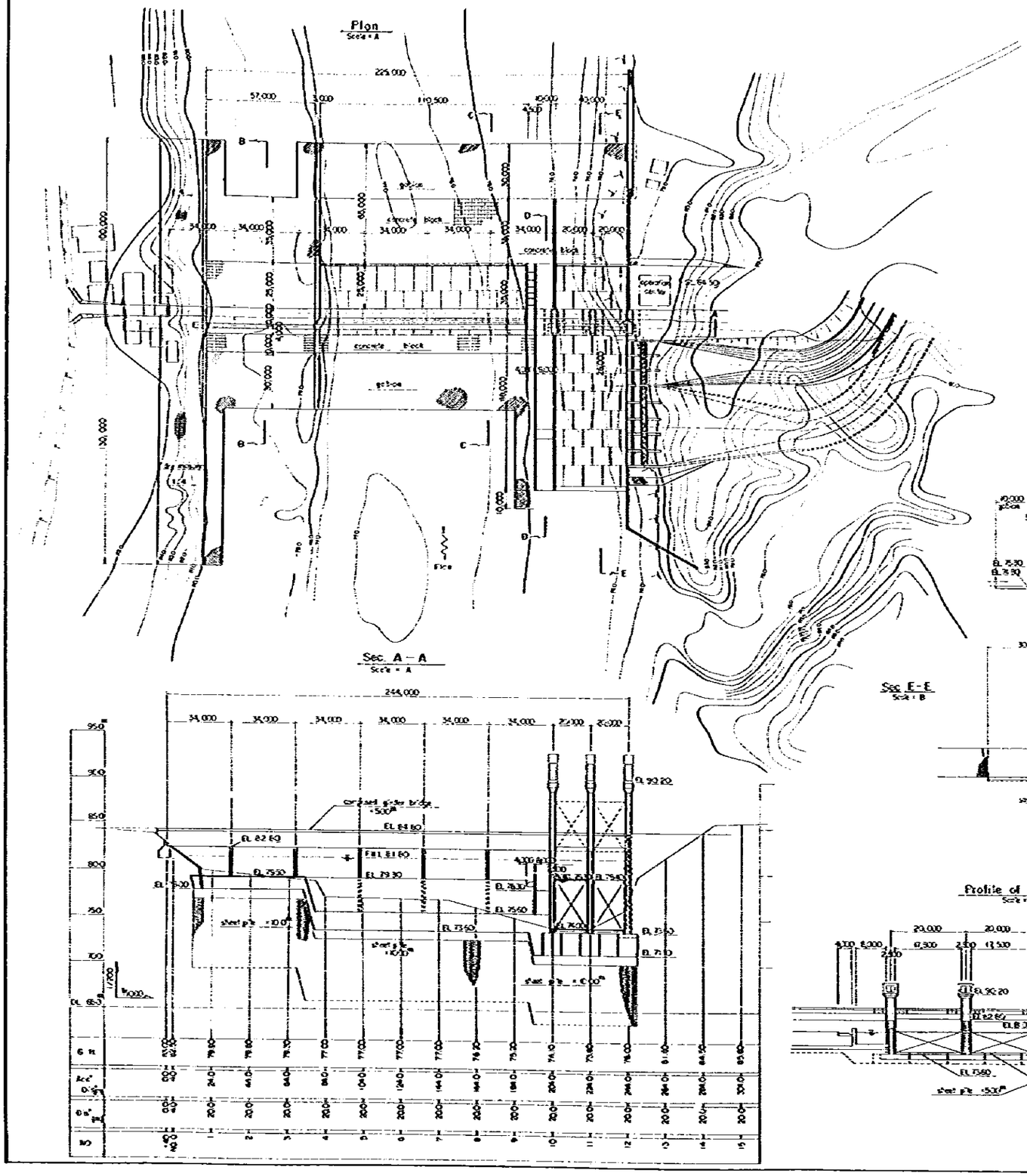
KOMERING-I IRRIGATION DEVELOPMENT PROJECT

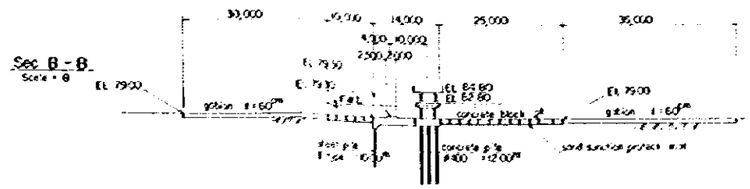
TITLE OF DRAWING

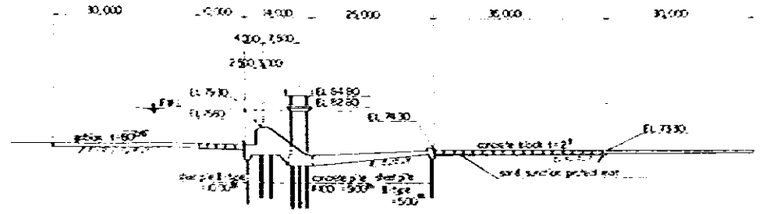
RANAU REGULATING DAM

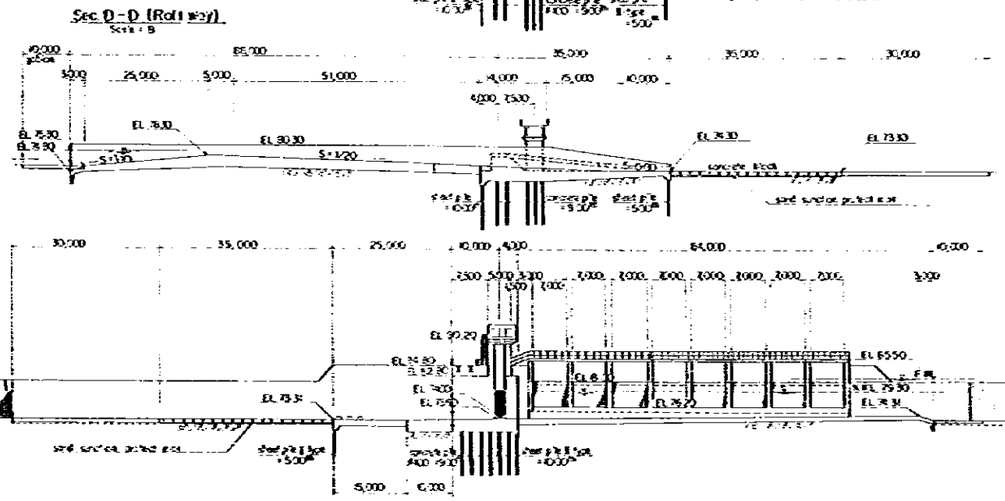
JAPAN INTERNATIONAL COOPERATION AGENCY
TOKYO

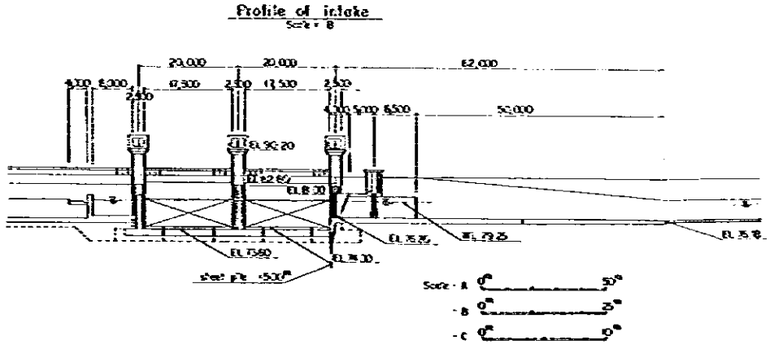
PLATE
NO. 2

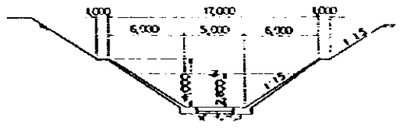












Scale : A
B
C

DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT

KOMERING-I IRRIGATION DEVELOPMENT PROJECT

TITLE OF DRAWING

HEADWORKS (PERJAYA)

JAPAN INTERNATIONAL COOPERATION AGENCY
TOKYO

PLATE NO. 3