The diversion efficiency during the growing period is estimated to be 56% for semi-technical irrigation development grade and 64% for technical irrigation development grade. While, the efficiency during the growing period of polowijo is also estimated to be 60% taking into account of irrigation practices under upland condition.

The calculation on irrigation water requirement is made by 10-day basis from 1975 to 1979 as shown in Fig. 5.4.1, on the basis of meteorological records and the proposed cropping patterns. The maximum unit diversion requirement of 1.26 l/sec/ha is estimated on late January, 1978. The details are given in ANNEX-II, CHAPTER IV.

5.4.3 Intake Requirement

To clarify the shortage of irrigation water and to estimate the supplemental intake requirement from the Langkemme and Sero rivers, a balanced calculation is annualy made by 10-day basis from 1975 to 1979 between the water resources dependable on the respective rivers and the seasonal irrigation requirement for the proposed cropping. The Maximum intake discharge on the Langkemme river is estimated at about 3.6 m^3/sec., and the maximum on the Sero river, about 5.5 m^3/sec. But both discharges have occurred only once recent five years respectively. In due consideration of the frequency of the canal operation, the maximum discharge of 2.5 m^3/sec. would be offtaken at the Langkemme and Sero rivers, respectively. The seasonal fluctuation of water resources dependable on the respective rivers is illustrated in Fig. 5.4.2, together with the diversion requirement.

5.5 PROPOSED PROJECT WORKS

The proposed works would be segmented into three work divisions in view of the construction plan as discussed in the following section.

i) Work Division - I

The Desa irrigation area of about 2,900 ha still remaining under non-technical level would be up-graded to semi-technical level taking into account of the dependable water resources in the tributaries. The major works in this work division would comprise the rehabilitation and integration of the existing intake weirs and the up-grading of tertiary system from non-technical level to semi-technical level.

ii) Work Division - II

The Desa irrigation area of 4,500 ha in total, 1,600 ha of the existing semi-technical level plus 2,900 ha up-graded in the Work Division-I would be projected. In this work division, the supplemental water resources for the paddy field of 4,500 ha would be developed in the Langkemme river system. The major works consist of the construction of the Langkemme irrigation canal system and the tertiary development works for the up-grading from semi-technical level to technical level.

iii) Work Division - III

Three DPU semi-technical areas of 1,900 ha would be projected, the irrigation water resources of which are presently dependent on the tributaries of the Walanae river. In this work division, further supplemental irrigation water resources development would be made in the Sero river system for the area of 1,900 ha. The major works in this work division would comprise the construction of the Sero diversion canal system and the tertiary development works for the up-grading from semi-technical level to technical level.

5.5.1 Work Division - I

Each Desa irrigation scheme is incorporated into the Langkemme irrigation system as a tertiary irrigation block after the completion of the whole project works and then, each existing main canal aligned in Desa irrigation scheme functions a tertiary irrigation canal. An alternative study is made on the rehabilitation of the existing intake structures and link (secondary) canal system in due consideration of the Langkemme irrigation canal which is constructed at the Work Division-II. Basically two alternatives are examined as mentioned below in view of construction cost, water management, effective use of water resources and land acquisition:

Alternative-1	Existing intake structures would be rehabilitated with masonry works. The irrigation water is directly released into natural tributaries from the Langkemme main canal which is constructed at the Work Division-II. No link canal is aligned in principle. The released water is diverted into tertiary blocks by the rehabilitated intakes of respective tertiary blocks.
Alternative-2	Irrigation water is distributed into tertiary blocks through the link canals which is newly constructed to join the Langkemme main canal with the respective tertiary blocks. Instead, most of the existing intakes are not rehabilitated.

The Alternative-2 is superior to the Alternative-1 in view of the better water management and the land acquisition, and vice-versa in view of the effective use of water resources and the construction cost. A combined system of the Alternative-1 and -2 is studied to attain both better management and effective use of water resources, and the system proposed for the optimum secondary system. In this system, special attention is also paid on the savings of construction cost. The proposed system is schematically illustrated in Fig. 5.5.1. The details of the study are given in the ANNEX II, CHAPTER IV.

The proposed project works in the Work Division-I are shown in Fig. 5.5.2.

(1) Rehabilitation and integration of intake structures

To reduce the length of link canal, some intakes located remote from the Langkemme main canal route would be respectively rehabilitated without integration of irrigation blocks. While, some intakes located near the main canal route would be integrated and be joined with the link canal. Most of the integrated weirs are to be constructed in rapids, the gradient of which are steeper than 1/100. Tirol type intake weir would be recommended, taking into account of high magnitude of probable flood. As regards the intake weirs to be constructed along the Belo and Laja rivers, ordinary type intake weir with a sand sluice would be proposed since considerable amount of bed-loads might rush and deposit on the riverbed. All of the intake weirs are constructed with cobble wet masonry.

(2) Link canal

Link canals would be constructed to join the inlet of integrated intake structures to the respective commanded tertiary blocks. The link canal would be aligned in due consideration of the alignment of the main canal which is constructed at the Work Division-II. The conveyance capacity of proposed link canals ranges from about 80 l/sec to 500 l/sec. The total length of the proposed link canals extends to approximate 30 km. All of the link canals would be trapezoidal and unlined.

(3) Tertiary development

The existing Desa irrigation schemes are given a function of tertiary block after completion of the whole project works. Most of the canal systems networked in the Desa irrigation scheme still remain non-technical level. Quarternary division boxes with water measuring devices would be installed as required on the existing tertiary canals. Some amount of desilting works also would be made on the deteriorated section of the tertiary canals.

The main features and quantities of the major works to be implemented within the Work Division-I are as summarized below:

Work Items	Main Features
i) Integration and rehabilitation of existing weir	- 19 Nos. of Tirol type weir and 3 Nos. of fixed type weir with scouring sluice, - Design discharge ranging between 0.1 m^3/s and 0.9 m^3/s.
ii) Link canal	- Total length of approx. 34 km - 27 Nos. of turnout and 222 Nos. of drop, and - Design discharge ranging between 0.1 m^3/s and 0.5 m^3/s.
iii) Up-grading of tertiary system (to Semi-technical level)	- 2,900 ha net irrigable areas, - Installation of division boxes with regulating and measuring devices

5.5.2 Work Division-II

(1) Langkemme intake weir

A comparative study on three alternative sites of the Langkemme intake weir is made in connection with the alignment of the Langkemme main canal. The study concludes that the site locating about 500 m upstream of the existing intake weir of Cennae DPU semi-technical scheme is optimal from technical and economic view points. The details of the study are given in ANNEX II, CHAPTER IV.

The catchment area at the site extends to about 100 km^2. About 800 m^3/sec of flooding discharge with 100-year recurrence are estimated at the site through hydrological analysis. Topographic survey and geological investigation are made at the selected site. The base rock bedded with weakly cemented sediments discloses at some part of the river bed and banks in the vicinity of the site. Geologically, the site is much favourable for the foundation of the intake weir to be proposed.

The feasibility level design of the weir is made on the basis of the surveys and studies on topography, geology, hydrology and river hydraulics at the proposed weir site. The intake capacity of 5.0 m^3/sec is given on the basis of the diversion requirement from the Langkemme river and, furthermore, in due consideration of the seasonally unstable river flow in both the Sero and the Langkemme river systems. Control regulators are installed remote from the intake site on account of the topographic condition. A side spillway is installed on the head reach. Excess water diverted into the head reach returns to the main reach of the Langkemme river through the side spillway. The intake weir and structure would be constructed with cobble wet masonry and the head reach would be also lined with rubble wet masonry. The sand sluice of the weir and the control regulator would be equipped with steel slide gate. The general features of the Langkemme intake weir are presented in Table 5.5.1.

(2) Langkemme main canal

The Langkemme main irrigation canal of about 30 km long extends from the Langkemme intake to the east along the Langkemme river and the provincial road to Takalala. At the alignment of about 10 km from the intake, the main canal traverses hilly ranges by disposition of a tunnel of about 700 m long. After passing through the hilly area, the main canal follows its trace northwards along the skirt of the hilly range extending westwards and finally debouches into the Belo river.

The main canal is aligned across the seven tributaries of the Walanae river. An aqueduct and six inverted siphons would be disposed on the junction of the tributaries. As shown in Fig. 5.5.1, the main canal releases some amount of irrigation water into the five tributaries to supplement irrigation water for the remote Desa irrigation schemes. Fifteen (15) turnouts would be proposed along the main canal to distribute irrigation water into the link canals already constructed at the Work Division-I and the secondary canals to be aligned at the Work Division-II.

The main canal would be basically unlined with a trapezoidal section. Some canal sections aligned on excessively weathered and cracky rocks would be partially lined with wet rubble masonry. The section of the main canal is classified into three typical cross sections according to topographic and geological conditions as shown in ANNEX-IV.

(3) Link canal

The link canals of about 30 km long in total would be constructed at the Work Division-I to supply irrigation water into the Desa irrigation schemes. The link canals of about two km long would be additionally proposed to connect the main canal with the Desa irrigation scheme newly up-graded at the Work Division-II. The link canal would be aligned along riverside to network with the intakes of existing semi-technical Desa irrigation schemes, as shown in Fig. 5.5.3.

All of the link canals are unlined with a trapezoidal cross section. The conveyance capacity of the canals ranges from about 80 l/sec to 250 l/sec. All the related structures would be constructed with wetted rubble masonry.

(4) Tertiary development

As shown in Table 4.5.2, the existing canal density in each Desa irrigation scheme is clarified through the field inspection undertaken in the course of this study. It widely ranges from 10 m per ha to 100 m per ha. The existing density would be increased up to about 70 m per ha, making reference to the canal density of the tertiary blocks under the Sadang and Bantimurung irrigation projects which have already developed to technical level at present and following the suggestions offered by the Design Unit of DPU South Sulawesi. All of the tertiary and quaternary canals to be newly proposed at the Work Division-II would be provided with distributing, regulating and water measuring devices for better water management.

The main features and quantities of the major works to be implemented within the Work Division-II are as summarized below:

Work Items	Main Features
i) Langkeme intake weir	- Fixed type weir of cobble masonry, - 2 bays of scoring sluice with 2 m in width, - Crest length of 37.5 m, and - Design intake discharge of 2.5 m^3/s with EL.170.0 m.
ii) Langkeme main canal	- Total length of approx. 30 km, - Design discharge ranging between 5.0 m^3/s and 0.80 m^3/s.

Work Items	Main Features
iii) Link canal	- Total length of approx. 2 km, - Design discharge ranging between 0.1 m^3/s and 0.9 m^3/s, and - 14 Nos. of drop and 4 Nos. of turnout.
iv) Tunnel	- Total length of 720 m with gradient of 1 to 1500, - 2R-horseshoe type section (R = 1.25 m), and - Design discharge of approx. 4.8 m^3/s.
v) Related structures	
a) Aqueduct	- 1 No., Reinforced concrete box barrel with a section of 3.0 m x 1.5 m, - Design discharge of approx. 3.0 m^3/s.
b) Inverted syphon	- 3 Nos., Reinforced concrete box barrel with a section of 1.4 m x 1.4 m or 1.2 m x 1.2 m, - 3 Nos., Reinforced concrete pipe with a diameter ranging between 0.8 m and 1.2 m, and - Design discharge ranging between 2.9 m^3/s and 0.8 m^3/s.
c) Turnout	- 15 Nos., - Four types, combined with a waste way, a release, or no other structure - A slide gate and a measuring device, installed - Design diversion discharge ranging between 0.06 m^3/s and 0.4 m^3/s.
d) Others	- Culverts, spillways, checks and release structures on the main canal, - Cross drains provided for runoff passing under the main canal.
vi) Up-grading work (to technical level)	- 4,500 ha of net irrigable area, - Increment of canal density from 30 m/ha to 70 m/ha.

5.5.3 Work Division-III

(1) Jupang intake weir

The Jupang intake weir is proposed at about eight km upstream from the confluence of the Jupang and Pising rivers, the tributaries of the Sero river. The catchment area at the site extends to about 230 km^2. About 1,250 m^3/sec of flooding discharge are estimated at the site with 100-year recurrences. The site is bedded with relatively hard Andesites on which about two m thick of sediment materials are deposited; it is geologically much favourable for foundation of the weir construction.

Tirol typed intake weir would be proposed in due consideration of intensive probable flooding discharge, the extremely depleted drought discharge, the riverbed condition covered with cobbles and pebbles and cost savings. A sand-settling basin would be provided with the head reach of the diversion canal since no sand sluice is installed in the Tirol type weir. The intake discharge is regulated by the sluice gates remotely installed at the tail of the head reach. Out of the maximum discharge of 2.5 m/sec proposed for the Sero diversion canal system, a discharge of about 2.0 m^3/sec would be diverted at this intake.

(2) Unyi intake

The Unyi river, a small tributary of the Jupang river, confluences about one km downstream of the Jupang intake weir. The Unyi intake weir is proposed about half km upstream from the confluence of the Jupang river. The catchment area at the weir site is planimetered to be about 30 km^2. The flood discharge of about 400 m^3/sec is estimated at the Unyi intake site with 100-year recurrence. The river bed at the intake site is covered with cobbles and pebbles. In due consideration of the anticipated flood discharge and the diversion discharge of about 0.5 m^3/sec, a gabion weir would be proposed. An offtake channel would be aligned to convey the intaked water into the Sero diversion canal. A confluence structure would be installed at the tail of the offtake channel. All of the structures related to the intake would be constructed with cobble wet masonry.

(3) Pising intake

The river flow in the Pising river, a tributary of the Sero river, would be diverted into the Sero diversion system in the vicinity of the Kampung Limpotengae. The Pising intake site is selected about three km upstream from the confluence of the Jupang river. The catchment area at the proposed intake site extends to 40 km^2. The flood discharge of 500 m^3/sec is estimated at the intake site with 100-year recurrence. Geologically, the intake site is composed of hard limestone which crops out in the riverbed and both river banks.

About 0.5 m^3/sec in maximum would be diverted at the Pising intake into the Sero diversion system. A gabion weir would be proposed in due consideration of the anticipated flood discharge, the maximum intake discharge and the geological condition. A offtake channel of about 0.5 km long is also aligned to divert the intaked water into the Sero diversion channel. A confluence structure would be also provided for the offtake channel as well as the Unyi intake. The general features of the Jupang, Unyi, and Pising intake weirs are presented in Table 5.5.2.

(4) <u>Sero diversion canal</u>

The Sero diversion canal would be aligned between the Jupang intake and the Langkemme intake, as shown in Fig. 5.5.4, to divert water resources developed in the Sero river system into the Langkemme main canal. The diversion canal originates at the Jupang intake and takes its trace from south to north along the skirt of steep hilly ranges. Excessively weathered Andesite and coral limestone are cropping out here and there along the proposed route of the diversion canal.

The diversion canal lies across rivulets and many shallow dried vales. Three aqueducts would be spanned for the diversion canal to traverse the Unyi and Pising rivers and a small rivulet. In addition, 13 cross drains would be disposed under the diversion canal so as to release runoff from shallow vales during rainy season. An inverted syphon would be proposed to traverse the wide spanned Langkemme river; it is laid under the Langkemme intake weir.

The maximum discharge of 2.5 m^3/sec. would be proposed on the basis of the analysis of diversion requirement. Topographic survey and geological and soil mechanic investigations are made along the proposed route of the diversion canal. Considerable amount of weathered and/or hard rock excavation is anticipated in the course of the construction of the diversion canal. In principle, the diversion canal is unlined with a trapezoidal cross section. Canal body composed of weathered, cracky and pervious rocks would be lined with wetted masonry as required. The main features and quantities of the major works to be constructed within the Work Division-III are summarized as follows:

Work Items	Main Features
i) Jupang intake weir	- Tirol type weir of cobble masonry, - Crest length of 38 m in total, and - Design intake discharge of 1.9 m^3/s with EL. of 176.6 m.
ii) Unyi intake weir	- Gabion weir, - Crest length of 29 m, and - Design intake discharge of approx. 0.5 m^3/s with EL. of 176.3 m.

iii) Pising intake weir	- Gabion weir, - Crest length of 25 m, and - Design intake discharge of 0.5 m^3/s with EL. of 174.7 m
iv) Sero diversion canal	- Total length of 14.9 km, - Design discharge of 2.5 m^3/s.
v) Related structure	
a) Aqueduct	- 3 Nos., Reinforced concrete box barrel with a section of 2.0 m x 1.5 m, - Design discharge ranging between 1.92 m^3/s and 2.5 m^3/s.
b) Others	- Culvert provided for road crossing, - Cross drains provided for runoff passing under the canal, and - Offtakes for water supply to the indirect areas scattered along diversion canal.
vi) Up-grading work (to technical level)	- 1,900 ha of net irrigable area, - Increment of canal density from 30 m/ha to 70 m/ha
vii) Link canal	- Total length of 3.6 km

The Langkemme Irrigation Project mainly depends its water resources during rainy season on the tributaries and the Langkemme river; the full water supply from the Sero diversion system is not substantially necessitated during rainy season. The Sero diversion canal can afford to supply considerable amount of irrigation water for the scattered paddy fields of about 100 ha along the diversion canal route during rainy season. Small scaled offtakes equipped with gates would be proposed along the diversion canal to supplement irrigation water for the said area. The water supply during rainy season remarkably contributes to the stabilization of the cultivation of rainy season paddy in the scattered area. Nevertheless, the irrigation benefits accrued from the area would not be taken into account in the economic analysis of the project. The major structures proposed in the project are laid out as presented in ANNEX-IV.

5.6 CONSTRUCTION PLAN

5.6.1 Work Shcedule

About five years of total construction period would be required for the Langkemme Irrigation Project in due consideration of the scale of the project works, availability of construction machinery, project economy, etc. The whole project works are broadly divided into three work divisions as described hereinafter.

The major works in the Work Division-I mainly comprise the construction of intake weirs in the tributaries, the construction of link canals and up-grading works of the Desa irrigation schemes covering about 2,900 ha. The major works in the Work Division-II consist of the construction of the Langkemme irrigation system and the amendment works of the Desa irrigation schemes covering 4,500 ha, inclusive of 2,900 ha up-graded at the Work Division-I. The major works assigned in the Work Division-III comprise the construction of the Sero diversion canal system and the amendment works of the DPU schemes covering 1,900 ha. The Work Division-I and -II are further subdivided into three work blocks, respectively, and the Work Division-III, into two work blocks. (See Fig. 5.6.1)

The Work Division-I and -II would almost simultaneously commence at the beginning of dry season, 1983, keeping pace with the relevant engineering works. The construction works under the Work Division-I last about two years and will complete by the end of dry season, 1985; the construction works under the Work Division-II will necessitate about three years and will have terminated by the end of 1986. At the time of the completion of the whole works under the Work Division-I, the construction works of the Langkemme irrigation canal system under the Work Division-II have already extended to the junction of the Laja river and is steadily nearing to the junction of the Labempa river. The Work Division-III will commence in 1984, keeping pace with the completion of the major portion under the Work Division-I and -II and will have completed simultaneously with the Work Division-II by the end of 1986. The construction works under the Work Division-III would be implemented from the tail of the diversion canal to the divert the irrigation water from the Sero river as early as possible. The construction schedule of the whole project is barcharted as presented in Fig. 5.6.2 in due consideration of capability of available construction equipment, workable days, quantities of construction works, etc. Furthermore, an arrow diagram is networked by critical path method, as shown in Fig. 5.6.3.

Workable days of 252 per annum are estimated for execution of earth work, masonry work, and concrete work on the basis of rainfall data around the project area. The workable days for river works, such as weir, intake structures, and siphon are confined within five months of drought season from June to November.

Major works such as weir, intake structure and crossing structures would be carried out mainly by heavy construction machines. The remaining minor works such as link canal and tertiary irrigation canal system and its related structures would be undertaken by manpower so as to increase the employment opportunity in and around the project area. The whole project works are assumed to be executed by contract basis. The Langkemme irrigation canal and Sero diversion canal systems are constructed by international contractors and the minor systems, by local contractors. The quaternary canal networks in the tertiary block would be constructed by farmers themselves under the guidance of the local government.

5.6.2 Construction Materials

Embankment materials obtainable in the project area are classified into i) alluvial fan deposits, ii) diluvial terrace deposits, iii) talus deposits, and iv) residual deposits. Most of these materials usually contain considerable amount of gravels and cobbles, which should be excluded to attain necessary impermeability of embankment. In the natural condition, most of them have relatively high water content. The reduction of water content should be made by airing to get 95% of maximum dry density. Thus, the embankment keeps considerably high resistance against sliding, shrinkage and swelling.

The riverbeds of the seven tributaries are thickly covered with sands and gravels suitable for concrete aggregates. Water absorption and specific gravity are tested on the samples of sands and grvels obtained from the said riverbeds. The results on both tests fulfil the standard requirements for concrete aggregates. The quantities of concrete aggregates estimated in the tributaries are sufficient for the concrete works proposed along the main canal system. The proposed intake sites of the Langkemme and Sero rivers are rather graced with cobble materials. The materials suitable for concrete aggregates basically lack around the construction sites of these intake weirs. In view of availability of construction materials, masonry work is much favourable for the intake weirs of the Langkemme and Sero rivers.

5.7 COST ESTIMATE

5.7.1 Project Cost

The project cost mainly comprises direct construction cost and engineering and administration costs. All of the costs are estimated at 1980 price level. A price contingency in the cost estimate is assumed at 7% per annum for foreign currency portion and 10% per annum for local currency portion, making reference to the feasibility reports recently prepared in Indonesia and on the basis of the estimated price escalation in the South Sulawesi in recent years.

The direct construction cost is estimated on the detailed unit price analysis and quantity takings of the project works. The cost of the imported equipments and materials such as gates, steel, etc. is estimated based on the current international price level. The cost for heavy construction machinery to be required for the project is estimated on the basis of the depreciation to be caused throughout the construction works. The local costs such as materials and labour wage are estimated on reference to the data obtained in the local markets and construction materials published in the South Sulawesi. The project cost is brokendown into foreign and local currency components. The local construction materials available in and around the project area would be utilized to the maximum extent.

The project cost for the implementation of the project is thus estimated to be US$34.6 million by financial basis, consisting of US$14.5 million of foreign currency and US$20.1 million equivalence of local currency as shown in Table 5.7.1.

5.7.2 Replacement Cost

Among the proposed irrigation equipments, gates and their attachments, metal works, wooden materials and gabions would be periodically replaced. The durable period of the gates and their attachments is assumed to be 25 years on an average, and that of all the remaining materials, to be 10 years.

The gates and their attachments would be replaced only once during the entire period of the project life and the total cost for the whole project is estimated to be approximately US$0.12 million, deducting salvage value, 10% equivalence of the total procurement cost. The remaining materials would be replaced four times during the entire period of the project life, and the total costs to be once replaced for the whole project are estimated to be approximate US$0.15 million. Each replacement cost is brokendown in Table 5.7.2.

5.7.3 Operation/Maintenance Cost

Operation and maintenance cost comprises personnel cost, depreciation cost of O/M equipment, vehicle, office equipment and quarter, and consumable expenses. According to the proposed organization as shown in Fig. 6.2.1, the operation and maintenance cost of the project is estimated including 15% physical contingency. The cost amounts to approximate US$0.52 million per annum on financial basis, 1.4% equivalence of the direct construction cost. The O/M cost is brokendown in Table 5.7.2.

CHAPTER VI ORGANIZATION AND MANAGEMENT

6.1 ORGANIZATION FOR THE PROJECT EXECUTION

The Directorate General of Water Resources Development (DGWRD), the Ministry of Public Works, would be given the function of the executing body for the Langkemme Irrigation Project. The Directorate General would be responsible for both the engineering works and the construction works of the project, and it would coordinate all activities of the relevant government agencies and regional administrative organizations in connection with the project execution.

The Directorate of Irrigation under the Directorate General of Water Resources Development, would assume direct responsibility of the project execution. The Provincial Office of Public Works, South Sulawesi, would coordinate the construction of the project at the provincial level on behalf of the Directorate of Irrigation.

To smoothly execute the project, a project office for the Langkemme Irrigation Project would be set up in the Provincial Public Works, South Sulawesi. The project office would operate all the field works such as additional survey and investigation, settlement of field quater, land acquisition, the detailed design and construction supervision. To effectively undertake the substantial field investigations and construction supervision, a base camp would be settled in the project site. The overall organization of the project execution would be recommended as shown in Fig. 6.1.1.

6.2 ORGANIZATION FOR OPERATION AND MAINTENANCE

With completion of all construction works of the Langkemme Irrigation Project, an operation and maintenance office would be reorganized under the Regional Irrigation Office Watan Soppeng. The office would bear the responsibility of the operation and maintenance of the major Langkemme irrigation system such as intakes and canal networks down to tertiary turnouts.

The office would be composed of one head office and the Sero and Langkemme Branch Offices; the former would be settled in the Kampung Limpotengae on the way of the Sero diversion canal and the later, in the Kampung Cennae near the Langkemme intake weir. Three field outposts would be attached to the Langkemme Branch Office in due consideration of lengthy irrigation canal system. The head office would be responsible for the overall activities necessary for the equitable distribution and optimum use of irrigation water, including preparation of annual operation/maintenance program, design and supervision of repair works, budgeting, training of staff, etc.

The Sero Branch Office would be responsible for the O/M of all of the Sero diversion canal system. The Langkemme Branch Office would be responsible for the O/M of the intake weir, the main canal and link canal of the Langkemme irrigation system and the relevant integrated intake weirs in the tributaries. One field outpost under the Langkemme Branch Office would operate and maintain the intake weir and the main canal, and the other two field outposts, each covering about 3,000 ha, would operate and maintain canal networks down to tertiary turnouts on the link canal and relevant integrated weirs in the tributaries.

These field outposts would also collect the necessary information and field data on water distribution program prepared by the O/M office. A wireless system would be proposed for communication between the head office and two branch offices. The proposed organization for the operation/maintenance is as shown in Fig. 6.2.1. Total number of staff required for the proposed organization is estimated at 35 persons for the head office and two branch offices, and about 30 persons for the field outposts.

6.3 FARMERS' ASSOCIATION

Existing Desa and DPU irrigation schemes would retain a function of tertiary block in the proposed irrigation system. All of the existing schemes are being operated by water distributor, so called "Ulu Ulu" 1/. To attain better water management at onfarm level, the existing water master system would be reorganized into water users' association, so called "P3A" which is composed of the representatives of the beneficiary farmers nominated by respective quaternary blocks.

The executing body of the association would be composed of a distribution supervisor (chief), a liaison and gate keepers. The supervisor would be democratically elected by the representatives of the beneficiary farmers. The substantial water distribution would be executed by the supervisor under guidance of the O/M office of the Langkemme Irrigation Project.

In principle, the association would be organized at tertiary block level. But, in the large scaled tertiary block exceeding 150 ha, the association would be organized at sub-tertiary block level. Sub-supervisor elected by the respective sub-tertiary block would execute water distribution under the supervisor of the whole tertiary block. The supervisor would mainly cover the following functions:

i) To plan year-roundly effective use of irrigation water based on the irrigation schedule prepared by the O/M office,

ii) To debate the water supply schedule with the representatives of beneficiary farmers,

iii) To assist extension workers for introduction of advanced water application,

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1/: also called "Manteri Air" in South Sulawesi region

iv) To execute desilting works of tertiary and quaternary canals and repairing works of onfarm facilities in collaboration with the farmers concerned,

v) To bear the responsibility for the maintenance of all irrigation facilities under the tertiary block concerned,

vi) To record the data on water distribution reported by the representatives of farmers, and

vii) To cooperate with the O/M office as for emergency problems occurring in the field.

The proposed organization for farmers' association is illustrated in Fig. 6.3.1, together with the commanding and the coordinating organizations.

CHAPTER VII ECONOMIC AND FINANCIAL EVALUATION

7.1 GENERAL

The economic feasibility of the Langkeme Irrigation Project is evaluated by internal rate of return (IRR). Sensitivity analysis is also made corresponding to changes in accrued benefits, build-up period and project costs. The financial evaluation is also carried out by analyzing typical farm budget of average size farmer and by preparing financial statement of the project as a whole. The farmer budget analysis is made for assessment of the project from the farmer's viewpoint. The analysis of financial statement is made to evaluate the repayment capacity of the project on the basis of the estimated fund requirement with assumed financial terms of the anticipated loan and the expected revenue from the project.

7.2 IRRIGATION BENEFITS

7.2.1 Increased Crop Production

The irrigation benefits of the Langkemme Irrigation Project primarily accrue from the increased crop production due to stable irrigation water supplies. These benefits are estimated as the difference of the annual net crop production values under future with- and without- the-project conditions. The crop production gradually increases after commencement of the partial operation of the project. The second paddy in non-technical area of 370 ha will be firstly benefited with the implementation of the project and some amount of benefits will initially accrue in 1984. The irrigation development for the whole project area will be ended in 1987. After the completion of the irrigation development, about 10 years of build-up period are taken into account. The full development stage will be, thus, attained in 1996. The increased crop production value at the full development stage is estimated at Rp.4,091 million per annum (Details are given in Table 7.2.1).

7.2.2 Crop Yield Reduction caused by Occasional Shortage of Irrigation Water

Owing to the uncertainty of annual rainfall and also its erratic distribution during the year, it is anticipated that, even after completion of the project, the shortage of irrigation water for the crops designed in the proposed cropping pattern might occasionally occur and cause the reduction of crop yields to some extent. This kind of loss, therefore, should be conservatively deducted from the net crop production values with the project. The net production value without project condition has been calculated on the basis of actual yields and production data in the past five years from 1975 to 1979; it is, therefore, considered that the estimated net production value without project already excludes such crop losses in its calculation.

The estimate of the yield reduction caused by the occasional water shortage is made as follows: when any water shortage for polowijo crops occurs, the estimate of yield reduction for these crops is made by reducing the harvesting areas and then estimate the losses of crops arising from the reduced area of harvest. In this estimate, period of water deficit is disregarded and only rate of total water deficit to total water requirement is used. For paddies, the estimate of yield reduction is made by following the relationship of water shortage and crop yield (see Fig. 7.2.1). The yield reduction of each crop is thus estimated and shown in ANNEX-1, CHAPTER II. The annual average crop losses are estimated at about Rp.275 million in total.

7.2.3 Direct Benefits

The primary increased production value is previously estimated at about Rp.4,091 million in total (US$1,023/ha) per annum. This is a gross benefit, because there is crop yield reduction that should be deducted from the net production value with the project. Table 7.2.2 shows the calculation of the annual direct irrigation benefits. The annual direct benefits amount to about Rp.3,816 million (US$954/ha) at the full development stage of the whole project.

7.3 ECONOMIC COST

The financial costs for construction works, replacement of various equipment, and operation/maintenance of the project are estimated at 1980 price level as mentioned in CHAPTER V; these include some amount of transfer payment such as direct/indirect taxes and profits of local contractors and dealers. The transfer payment is assumed to be equivalent to 10% of the direct construction cost, replacement cost and O/M cost, and 2% of engineering and administration costs. The economic cost of the project is obtained by deducting the transfer payment from the financial costs. Price contingency would not be incorporated in the economic cost.

The total economic cost of the project is estimated to be US$21.7 million (Rp. 13,563 million), consisting of US$10.0 million of foreign currency component and Rp.7,313 million, US$11.7 million equivalence of local currency component. The economic replacement cost of gates and other wood/metal works installed in the proposed system are estimated to be US$105,000 (Rp. 65.6 million) per annum and US$138,000 (Rp. 86.3 million) per annum, respectively, by deducting the transfer payment from the financial replacement cost given hereinbefore. The economic O/M cost of the project is also estimated to be US$472,000 (Rp. 295 million) per annum at the full development stage by deducting the transfer payment from the financial O/M cost discussed in CHAPTER V.

7.4 ECONOMIC EVALUATION

The economic evaluation is made on the assumption that:

i) Project life is 50 years from the year of 1982 to 2031,

ii) Total economic costs are Rp.13,563 million (US$21.7 million),

iii) Annual net incremental benefits are Rp.3,816 million (US$6.1 million) at the full development stage of the project,

iv) Construction period is 5 years including about one year for the engineering works; the constructions will commence in 1982 and complete in 1987, and

v) Anticipated irrigation benefits partially will come out in 1984 and increase year by year and will attain the maximum level in 1996; the build-up period of 10 years will conservatively requires to attain the full benefit. (Table 7.4.1 and 7.4.2, to be referred)

The economic internal rate of return (IRR) of the project is estimated at 14.7% as shown in Fig. 7.4.1, under the assumptions mentioned above. This internal rate of return testifys that the Langkemme irrigation project is economically feasible.

Sensitivity analysis is also made in respect to changes in annual irrigation benefits, project costs and over-run of build-up period. As summarized in Fig. 7.4.1, five cases to be anticipated in the future are selected for sensitivity tests of the Project. The lowest IRR is estimated at 10.6% in case of 20% decreases of the anticipated benefit, and, in addition, 20% increases of the estimated costs. The project is much insensitive for the changes anticipated in the future. The details are given in ANNEX-III, CHAPTER X.

7.5 FARM BUDGET ANALYSIS AND PAYMENT CAPACITY

Payment capacity is an ability of farmers to bear the expenses required for development of irrigation facilities. Such capacity is measured by the increase of net income which the benefited farmers can earn annually from the project. In order to assess the payment capacity of the farmers, the farm budget analysis is made on the average size farm under future with- and without-project conditions as shown in Table 7.5.1.

With the completion of the project, the net reserve or the payment capacity of the average farmers will increases from Rp.1,800 to Rp.197,600 per annum (US$632/ha/annum) at the full development stage. The increased net reserve would offer incentives for further development to the farmers, and the substantial payment capacity would enable the farmers to pay some charges for irrigation water.

7.6 FUND REQUIREMENT AND REPAYMENT CAPACITY

7.6.1 Water Charge

It is generally recognized that the water charge, which is used for repayment of the project capitals as well as operatin and maintenance of the project facilities, should be basically borne by the project-benefit farmers. As mentioned in CHAPTER-V, the annual O/M cost is estimated at about US$0.52 million which is equivalent to about US$80 per ha. The annual equivalence to repayment of the capital cost is estimated at about US$258 per ha under the condition of anticipated loan. The total annual costs are therefore about US$338 per ha. This corresponds to about 53% of the payment capacity of the project-benefited farmers.

Although the payment capacity is large enough for covering all the annual cost required for the project, the Government has the policy that the water charges to the project-benefited farmers are free in order to offer incentives to the farmers. The farmers bear only the O/M cost of the tertiary irrigation blocks which have to be voluntarily maintained by the farmers themselves. It amounts to about Rp.30,000 (US$43) per ha which nearly double the present water charge in the Desa irrigation system, and correspond to only 8% of the payment capacity.

7.6.2 Fund Requirement and Repayment

Fund requirement for the project implementation is equivalent to the financial construction cost of the project as mentioned in CHAPTER-V. The annual disbursement schedule of the construction cost is prepared on the basis of construction schedule. The fund requirement of the project is arranged under the following conditions for analysis of repayment capacity:

i) Total amount of the foreign currency portion plus about 31% of the local currency portion (equivalence to 30% of total loan amount) are financed by international financing agencies, with an interest rate of 3.5% per annum. The repayment period is 27 years including 7 years of grace period.

ii) The remaining 69% of local currency portion is financed by the budget allocation of the Government.

The cash flow statement is prepared under the above assumption, as shown in Table 7.6.1. The annual loan repayment amounts to US$1,650,000; the total amount would be subsidized by the Government since the project revenue such as water charge would not be expected for the time being. According to the current Government policy, the O/M cost of US$523,000 per annum would be also covered by the annual Government budget, and, in addition, the replacement cost for gates and other equipments would be periodically borne by the Government.

The Government subsidy is, however, compensated through the increased tax income, and saving of foreign exchange for import of rice. The increased tax income mainly comes from increased crop production. The increase of IPEDA tax (production tax) is expected to be about US$130,000 per annum. The saving of foreign exchange amounts to about US$4,420,000 per annum. Such indirect revenues could cover the amount of the government subsidy for the project.

7.7 SOCIO-ECONOMIC IMPACTS

Various socio-economic impacts are expected from the implementation of the project. They are:

(1) Foreign exchange saving

The rice production in Indonesia is still insufficient to meet the demand. It is reported that annual average import of rice has reached about 1.4 million tons in recent 5 years. With the completion of the Langkemme Irrigation Project, paddy production would increase to about 77,000 tons of dry stalk paddy per annum from present annual production of about 48,000 tons. The expected annual increment of paddy production would be 29,000 tons. Out of this increased production, it is expected that the marketable rice would be about 23,000 tons per annum after deducting the increased local consumption of rice. The estimated foreign exchange saving would amount to about US$4,420,000 per annum for substitution of imported rice.

(2) Demonstration effects

As already mentioned, the Langkemme Irrigation Project has been given a leading role of pioneer among 9 viable projects proposed in the Master Plan. The successful implementation of the project certainly leads to easier realization of other projects because of technical knowledge and skills to be accumulated through the project implementation. With the completion of the project, the farmers in the surrounding areas, as well as those in the project area, become familiar with modern irrigation practices and their incentives for irrigation practices are much enhanced. In the succeeding projects, therefore, the build-up period is possibly shortened.

(3) Increase of employment opportunity

It is expected that the present unemployment in and around the project area is much improved by the project implementation. After completion of the project, the more intensive land use, resulting from a new year-round irrigation system, surely increases the employment opportunity. In addition, the people gains more experience, technical know-how and skillfulness in the various working fields. These up-graded human resources provide motive power for the future development in the South Sulawesi region.

(4) Improvement of farm products

The present quality of polowijo crops like maize, groundnuts, soybeans and greenbeans are remarkably inferior owing to traditional farming technique under rainfed condition. Such low quality is much improved through the introduction of improved farming techniques with the construction of irrigation facilities. The quality of rice is also much improved through sufficient irrigation water supplies which enable the crop damages minimize and assure the even maturing of rice. Such improved quality would increase the marketability of farm products.

(5) Potential for fishery development

The proposed main canals of 30 km can be used for fishery development. Although further studies would be required for use of non-toxic agro-chemicals, the fish culture in the paddy field has a future possibility for additional farm income. The fishery development would contribute to the local supplies of animal protein.

(6) Environmental effects

The implementation of the project works would certainly leads to changes in rural economy. The domestic water supplies would be much improved through year-round supply of fresh water from the irrigation canals. The local transportation system would also be improved. This would contribute to the improvement of rural economic activities. For land and water conservation, it is recommended that reforestation work should be promoted in the relevant watersheds. The effects of reforestation would be mainfold. It would contribute to stabilization of river flow, control of seasonal floods, prevention of soil erosion, etc. The increased crop production in the project area would stimulate the improvement of marketing system and also of agricultural support services.

(7) Supplementary irrigation water supply to the scattered areas along the Sero diversion canal

There exist about 100 ha of paddy fields along the Sero diversion canal. These paddy strips are topographically irrigable by the Sero diversion canal but would not be incorporated in the direct beneficiary area in this project. But the Sero diversion canal can afford to supply irrigation water for the strips in the limited season when the river flow is relatively abundant. This remarkably contributes to stabilization of wet season paddy cultivation in these paddy strips.

(8) Improvement of operation and maintenance of existing Desa irrigation schemes

Owing to temporary irrigation structures in the existing schemes, the farmers spend about five days annually for the improvement and replacement of the facilities. After the completion of the project, all these existing facilities would be changed into parennial structures, and the farmers would be released from such laborious works. The labour force thus saved can be utilized for another productive work.

CHAPTER VIII RECOMMENDATION

(1) In 1973, a JICA team initially arrived in the South Sulawesi to survey the comprehensive development for Central South Sulawesi region. Since then, about seven years have already passed and the people concerned have much longed for the early implementation of the development works in this region. The Master Plan study implemented in 1978/79 fiscal year provides the Langkemme Irrigation Project an important role of pioneer for the rural development in this region. According to the conclusion of the Master Plan study, the feasibility study is made herewith on the Langkemme Irrigation Project. The study concludes that this pioneer project is technically sound and economically feasible. With such a background, it is strongly recommended that the project should be implemented as early as possible.

(2) For the successful implementation of the project, a considerable volume of additional field survey and investigation will be required in the detailed design stage of the proposed project works. The major field works comprise additional test drilling at the proposed intakes sites, soil mechanical tests of foundation and construction materials for the main and secondary canals and major related structures, topographic survey of the proposed canal route and major related structures, and hydraulic model test of the proposed intake weirs if necessary. In order to ensure the early commencement of the project construction, these field works have to be carried out as early as possible.

(3) The water sources for the project are the Langkemme river, the Sero river and seven tributaries of the Walanae river. The total watershed of these rivers is about 540 km^2, out of which only about 35% of the area is covered with forest and has been gradually depleted by unrestricted shifting cultivation and over-grazing of domestic animals. Such being the situation, it is strongly recommended that reforestation work should be promoted for conservation of land and water resources. The reforestation would mainly contribute to stabilization of river flow, control of seasonal floods and prevention of soil erosion. The reforestation work should be carried out under close coordination with "Pembinaan Reboisasi dan Penghijauan Daerah Aliran Sungai". The details of the reforestation work are given in ANNEX-III, CHAPTER IX. The topographic maps of 1/5000 scale are not available for these watersheds. The detailed topographic maps with a proper scale should be prepared for study on watershed management including reforestation and construction of erosion control works.

(4) Quite a few reliable data on meteoro-hydrological observation are available in and around the project area, due mainly to shortage of number of gauging station. In order to supplement the data for detailed design works, operation and maintenance of the project and further development of water resources, the present network for meteoro-hydrological observation have to be urgently improved through the establishment of new gauging stations in and around the project area including the watersheds.

(5) In due consideration of present agricultural economy which is rather matured, a triple cropping, paddy - polowijo - paddy, has been proposed for future cropping pattern to be adopted under the project. The proposed pattern will require modern farming techniques together with careful water management. It means that the present irrigation and farming practices have to be drastically changed for successful introduction of the proposed cropping pattern. With this in view, it is highly recommended that a pilot farm be established within the project area. The proposed plan of pilot farm is given in ATTACHMENT-I.

(6) In order to facilitate the intensive farming practices, farm roads well networked are essential. About 67 km of the inspection roads would be constructed under the project along the Langkemme main and secondary canals. The road networks in the project area are much improved with the Langkemme Irrigation Project, viz., the road density increases from 17 m/ha to 26 m/ha. But the increased density is still low for general standards of agricultural infrastructures, and about 70% of the existing roads are still unpaved. Further development of the road networks might be essential in the future in accordance with the gradual change of the regional economic structure in the project area. Then, special funds for rural development should be prepared for this work. The improvement plan of the road network is given in ATTACHMENT-II.

(7) In order to exploit the full potential for agricultural development, the present institutions for agricultural support services have to be strengthened through increase of staff and budget allocation. In particular, cooperative movement has to be enchanged through effective extension services. The "INSUS" (Intensifikasi-Khusus) program which has been launched since 1979, aims at collective farming of voluntarily organized farmers group under intensive guidance of the field extension workers. The results of the INSUS program have been so significant showing the average paddy field of more than 7 tons per ha in 1979/80. It is recommended that the INSUS program be encouraged in the irrigated paddy fields under the project.

(8) All of the existing Desa irrigation schemes are incorporated in the project as they are. The existing "Ulu-Ulu" system operating the Desa scheme is also reorganized into an advanced water users' association, so called P3A. Effective use of the limited water resources is essential for the project operation. The modernized water users' association should be set up in advance of the commencement of the operation of the project.

(9) In due consideration of the government policy for crop diversification, polowijo crops have been included in the proposed cropping pattern. Although the polowijo crops are promising in the project area, agronomic research on cultivation techniques of irrigated polowijo crops is required for further improvement. The recommendable farming practices including new varieties of polowijo have to be propagated to the farmers through the existing extension channels.

(10) Although the present capacity of rice mills is sufficient for processing the increased crop production, most of the existing milling facilities are of one-pass system which simultaneously carry out two processes of husking and whitening and produce a lot of broken rice. The improvement of these facilities has to be gradually made, together with improvement of drying practices, for attainment of better marketability.

(11) It seems that there is remarkable possibility for introduction of fish culture in the project area. The main canal and the river water dammed up by the intake weirs can be used for this purpose. The fish culture provides the farmers with good opportunity to enlarge their farm business. The fish culture in the paddy field seems to be difficult at present due to various technical reasons like field drying practices for paddy cultivation, use of agro-chemicals and difference of optimum water depth for fish and paddy. However, in order to make full use of development potential for fish culture, more detailed investigation and studies are required.

(12) Development of Hydropower in the Canal System

The proposed irrigation canal system has a favourable hydraulic head for micro hydropower generation, because the proposed main canal route is aligned across hilly area. To fully use the available potential head, a preliminary study is made on hydropower generation in the proposed canal system. A hydropower station with the maximum output of about 300 kW is proposed in the vicinity of the junction of the Langkemme irrigation canal and the Baruttunge river. The hydropower newly generated would surely contribute to processing, mechanized farming, irrigation, etc. Therefore, the construction of the hydropower station should be possibly inplemented as an associated project in the near future. The development plan of the micro hydropower is given in ATTACHMENT-III and the further details are compiled in ANNEX-III, CHAPTER VIII.

(13) The tail end of the Akampeng-II DPU semi-technical scheme is habitually subject to inundation, due mainly to backflow from the Walanae river and overflows of numerious creeks developed in and around the area. It occurs in May or June and usually lasts about two weeks enduring the inundation depth of about 1.5 m. The habitual waterlogged area lays lower than 12 meters above MSL and is estimated to be about 300 ha. The farmers thereabout always pay attention to their cropping calender to avoid the habitual inundation. The inundation damages in the limited area are negligible as compared with the damages caused by shortage of irrigation water prevailing over the whole project area, and it would be surely eliminated in the future by the Walanae flood control project formulated in the Master Plan.

TABLES

Table 4.5.1 Existing Irrigation Scheme

Inventory of Scheme	Name of Scheme	Grade of System	Net Irrigable Area (ha)	Canal Density (m/ha)	Inventory of Intake Structure	Grade of Intake Structure
2.	Cennae	Semi-Technical	210	20	2	C
3.	(Madenra-I)	Non-Technical	9	50	3	C
4.	(Madenra kanan)	Non-Technical	23	50	3,4	C
5.	Madenra	Non-Technical	26	30	4	C
6.	(Tokebbeng kiri)	Non-Technical	14	40	5,6	C
7.	Tokebbeng	Non-Technical	106	20	5,8	C
8.	(Congko I)	Non-Technical	61	10	7,9	C
9.	(Congko II)	Non-Technical	37	20	10	C
10.	(Pakkali kanan)	Non-Technical	50	30	11,12,13,15	A(11), C(12,13,15)
11.	Pakkali	Semi-Technical	65	100	11,14,16,17	A(11), C(14,16,17)
12.	(Labessi kanan)	Non-Technical	45	20	18	C
13.	Labessi-I	Semi-Technical	186	50	19,20,23	A(20,23), C(19)
14.	Latasi	Semi-Technical	43	50	20,21,22	A(22), C(20,21)
15.	Kadeppe	Non-Technical	54	50	33	C
17.	Timusu	Non-Technical	131	60	34,35	C
18.	Tenga Padange-I	Non-Technical	70	50	36,37	C
19.	Tenga Padange-II	Non-Technical	204	30	38	C
20.	Kalempang	Non-Technical	113	40	39	C
21.	Attebunge	Non-Technical	156	40	40	C
22.	Labessi-II	Semi-Technical	118	20	24,26	A(24, Aqueduct), C(26)
23.	(Kalempang-I)	Non-Technical	18	30	41	C
24.	(Jawi-Jawie)	Non-Technical	86	40	42,43,44	C
25.	(Pattojo)	Non-Technical	29	90	45	A
26.	Toasiabeng	Non-Technical	97	30	50	C
27.	Latana	Non-Technical	236	30	48,49,51,52	C
28.	Lamogo	Semi-Technical	478	30	54	A
29.	Ompo Pattojo	Semi-Technical	175	10	46,47	C
30.	Rompe Cadung	Semi-Technical	90	30	53	C
31.	Cenrannae	Semi-Technical	41	20	28,29	C
32.	(Lamanggarae)	Non-Technical	26	20	30	C
33.	Togigi	Non-Technical	60	50	55	C
34.	(Kubba kanan)	Non-Technical	93	30	56	C
35.	Kubba	Non-Technical	46	20	57	C
36.	Talagae	Non-Technical	60	80	58	C
37.	Maccope-I	Non-Technical	377	20	60,64	C
38.	Maccope-II	Non-Technical	24	40	60	C
39.	Passammeng	Non-Technical	64	40	61,65	C
40.	Talagae	Non-Technical	196	20	58	C
41.	Mattimpajoe	Non-Technical	180	10	32	C
42.	Akampeng-I	Semi-Technical	80	70	67	C
43.	Belo	Semi-Technical	82	50	59	A
44.	(Soppeng)	Non-Technical	48	60	63	C
45.	(Passammeng kiri)	Non-Technical	72	30	62	C
50.	Akampeng-II	Semi-Technical	868	30	68	A
51.	Lalange	Semi-Technical	700	20	25,27	A(27), B(25)
52.	Cangadi	Non-Technical	60	10	-	-
53.	Lagarigi	Semi-Technical	332	20	31	A
55.	Malanroe	Non-Technical	46	60	66	C

Summary

	Scheme	Grade of System	Nos. of Scheme	Net Irrigable Area
1.	Desa Irrigation	Non-Technical	34	2,900
		Semi-Technical	10	1,400
	(Sub-Total)		44	4,300
2.	DPU Irrigation	Semi-Technical	4	2,100
	(Total)		48	6,400

Table 4.5.2 Canal Density under the Existing Irrigation Scheme

Inventory of Scheme	Name of Scheme	Irrigation Area	Tertiary Canal Length	Quarternary Canal Length	Total Canal Length	Canal Density
		(ha)	(m)	(m)	(m)	(m/ha)
2.	Cennae	210	1,140	3,060	4,200	20
3.	(Madenra I)	9	420	0	420	50
4.	(Madenra Kanan)	23	1,240	0	1,240	50
5.	Madenra	26	770	0	770	30
6.	(Tokebbeng kiri)	14	580	0	580	40
7.	Tokebbeng	106	2,510	0	2,510	20
8.	(Congko I)	61	340	520	860	10
9.	(Congko II)	37	820	0	820	20
10.	(Pakkali Kanan)	50	240	1,200	1,440	30
11.	Pakkali	65	4,550	2,070	6,620	100
12.	(Labessi kanan)	45	670	170	840	20
13.	Labessi-I	186	3,380	5,670	9,050	50
14.	Latasi	43	1,740	360	2,100	50
15.	Kadeppe	54	880	1,700	2,580	50
17.	Timusu	131	5,600	1,960	7,560	60
18.	Tenga Padange-I	70	3,320	0	3,320	50
19.	Tenga Padange-II	204	2,720	3,350	6,070	30
20.	Kalempang	113	3,700	620	4,320	40
21.	Attebunge	156	3,010	2,700	5,710	40
22.	Labessi-II	118	2,400	120	2,520	20
23.	(Kalempang I)	18	600	0	600	30
24.	(Jawi-Jawie)	86	2,100	1,530	3,630	40
25.	(Pattojo)	29	2,170	280	2,450	90
26.	Tossiabeng	97	1,970	750	2,720	30
27.	Latana	236	6,570	920	7,490	30
38.	Lamogo	478	1,080	13,400	14,480	30
29.	Ompo Pattojo	175	1,120	180	1,300	10
30.	Rompe Gading	90	2,510	140	2,650	30
31.	Cenranae	41	630	0	630	20
32.	(Lamanggarae)	26	420	110	530	20
33.	Togigi	60	2,950	0	2,950	50
34.	(Kubba kanan)	93	870	1,980	2,850	30
35.	Kubba	46	340	530	870	20
36.	Talagae	60	3,650	880	4,530	80
37.	Maccope-I	377	6,580	1,540	8,120	20
38.	Maccope-II	24	1,050	0	1,050	40
39.	Passammeng	64	2,820	0	2,820	40
40.	Talagae	196	3,470	190	3,660	20
41.	Mattimpajoe	180	1,870	540	2,410	10
42.	Akampeng-I	80	1,500	4,080	5,580	70
43.	Belo	82	2,640	1,630	4,270	50
44.	(Soppeng)	48	2,660	230	2,890	60
45.	(Passammeng kiri)	72	1,830	320	2,150	30
50.	Akampeng-II	868	6,330	8,500	14,830	30
51.	Lalange	700	2,720	3,210	5,930	20
52.	Cangadi	60	190	200	390	10
53.	Lagarigi	332	4,330	1,960	6,290	20
55.	Malanroe	46	1,210	1,490	2,700	60

Table 4.6.1 Paddy Production in Past 5 Years in the Project Area (6,400 ha)

Year	Desa Non-technical Area			Desa Semi-technical Area			D.P.U. Semi-technical Area			Total		
	Planted Area (ha)	Unit Yield (ton/ha)	Production (ton)	Planted Area (ha)	Unit Yield (ton/ha)	Production (ton)	Planted Area (ha)	Unit Yield (ton/ha)	Production (ton)	Planted Area (ha)	Unit Yield (ton/ha)	Production (ton)
Wet Season Paddy												
1975	2,830	4.00	11,320	1,360	4.00	5,440	1,990	4.09	8,140	6,180	4.03	24,900
1976	2,830	4.19	11,860	1,050	4.29	4,500	2,020	4.85	9,790	5,900	4.42	26,150
1977	2,880	4.45	12,820	1,330	4.50	5,980	2,040	4.50	9,180	6,250	4.48	27,980
1978	2,900	4.77	13,830	1,400	4.77	6,680	2,100	4.75	9,980	6,400	4.76	30,490
1979	2,650	5.49	14,550	1,290	5.44	7,020	2,020	5.09	10,280	5,960	5.36	31,850
Average	2,818	4.57	12,880	1,286	4.59	5,930	2,034	4.64	9,470	6,138	4.60	28,280
Dry Season Paddy												
1975	2,260	4.78	10,800	1,170	4.86	5,690	1,410	5.33	7,510	4,840	4.95	24,000
1976	2,190	4.01	8,780	1,050	4.12	4,330	1,490	4.84	7,210	4,730	4.28	20,320
1977	1,870	4.38	8,190	870	4.51	3,920	1,220	5.12	6,250	3,960	4.62	18,360
1978	1,430	4.88	6,980	430	4.98	2,140	1,070	5.25	5,620	2,930	5.02	14,740
1979	1,890	5.18	9,790	1,020	5.18	5,280	1,400	4.54	6,360	4,310	4.99	21,430
Average	1,928	4.62	8,910	907	4.71	4,770	1,318	5.00	6,590	4,153	4.75	19,770
Total	4,746	-	21,790	2,193	-	10,200	3,352	-	16,060	10,291	-	48,050

Source: Agriculture Office, Kab. Soppeng and Kecamatan Office, Liliriaja, Lalabata, Marioriwawo and Lilirilau

Table 4.6.2 Results of Paddy Yield Survey (Wet Season Paddy)

	Variety	Sampling Place (Kampung/Desa)	Nos. of Hills per m^2	Nos. of Panicles per Hill	Nos. of Grains per Panicle	1000 Grain Weight	% of Ripened Grains	Unit Yield/1 (paddy)	Unit Yield/2 (Dry Stalk Paddy)
			(Nos)	(Nos)	(Nos)	(gr.)	(%)	(ton/ha)	(ton/ha)
1.	IR36	Timparaja/Pattojo	21.0	22.8	52.6	22.8	72.0	4.13	5.40
2.	IR36	Tengngapa/Pattojo	22.3	18.0	96.2	23.7	80.6	7.38	9.65
3.	IR36	Janpu/Jampu	16.0	22.3	84.1	22.8	65.6	4.49	5.87
4.	IR26	Akampeng/Maccile	21.0	14.3	99.0	24.1	83.4	6.33	8.27
5.	C4-63	Kallanroe/Maccile	18.7	15.0	111.3	25.1	58.0	4.54	5.93
6.	IR30	Belo/Belo	16.3	25.9	93.5	21.8	66.0	5.68	7.44
7.	IR36	Launga/Calung	20.7	16.3	101.4	21.5	64.8	4.77	6.24
8.	Local	Kubba/Lalabatarilau	14.7	8.0	168.1	26.0	68.7	3.53	4.61
9.	IR36	Lawara/Pattojo	20.3	18.8	71.6	24.0	77.3	5.07	6.63
10.	IR36	Awo/Jennae	20.3	20.0	86.6	21.4	53.9	4.21	5.50
11.	IR36	Tokebbeng/Watu	20.7	20.2	109.2	21.7	73.6	7.29	9.53
12.	IR36	Tokebbeng/Watu	20.3	22.0	77.8	21.3	77.8	5.76	7.53
13.	IR36	Toddalobo/Pattojo	18.7	20.3	58.5	20.1	78.7	3.51	5.59
14.	IR26	Makuntung/Botto	19.7	13.4	93.7	21.4	60.8	3.22	4.21
15.	Local	Malaka/Ompo	12.4	7.2	185.3	22.5	76.9	2.86	3.74
16.	Local	Salokaraja/Ompo	15.1	7.3	172.4	26.5	60.0	3.02	3.95
17.	IR36	Cangadi/Ompo	22.0	27.8	61.9	20.8	61.9	4.87	6.37
18.	C4-63	Centana/Ompo	15.3	12.6	66.4	30.5	85.1	3.32	4.34
19.	Citarum	Paoe/Ompo	11.3	25.7	89.1	26.7	69.8	5.16	6.77
20.	IR36	Pattojo/Pattojo	21.7	15.3	81.1	22.0	68.0	4.03	5.27
21.	IR38	Mallanroe/Maccile	16.6	17.5	94.6	21.2	62.9	3.66	4.78
22.	IR36	Mallanroe/Maccile	17.3	23.5	85.2	21.2	68.2	4.98	6.51

/1 : Unit Yield (Paddy) = Nos. of hills per m^2 x Nos. of panicles per hill x Nos. of grains per panicle x % of ripened grains x 1,000 grain weight ÷ 1,000 x 10,000 m^2

/2 : Conversion rate of paddy / Dry stalk paddy = 76.5/100

Table 4.6.3 Results of Paddy Yield Survey (Dry Season Paddy)

	Variety	Sampling Place (Desa/Kecamatan)	Nos.of Hills per m^2	Nos.of Panicles per Hill	Nos.of Grains per Panicle	1000 Grain Weight	% of Ripened Grains	Unit Yield /1 (paddy)	Unit Yield /2 (Dry Stalk Paddy)
			(Nos)	(Nos)	(Nos)	(gr.)	(%)	(ton/ha)	(ton/ha)
1.	C4 - 63	Baru/Lalabata	15.2	10	61.4	21.5	69.2	1.39	1.62
2.	IR - 30	Labessi/Marioriwawo	20.0	22	57.7	24.7	53.9	3.38	4.42
3.	IR - 30	Calung/Liliriaja	17.3	26	115.9	21.1	73.6	8.12	10.61
4.	IR - 32	Otting/Dua Pitue	18.8	20	75.8	23.7	77.6	5.23	6.84
5.	Local 46	Otting/Dua Pitue	15.3	14	120.4	22.5	75.0	4.40	5.75
6.	IR - 32	Lanairang/Dua Pitue	15.3	23	90.6	24.3	80.3	6.22	8.13
7.	IR - 26	Baru/Lalabata	16.0	20	114.6	21.3	64.5	5.03	6.57
8.	IR - 26	Baru/Lalabata	16.0	17	99.8	20.8	73.7	4.17	5.45
9.	IR - 5	Patangkai/Lappariaja	13.4	21	67.3	21.9	77.0	3.21	4.20
10.	IR - 5	Samaenre/Lappariaja	21.0	15	65.6	22.7	76.5	3.59	4.69
11.	C4 - 63	Maddumpa/Lalabata	16.0	15	63.1	22.1	70.4	2.35	3.07
12.	IR - 26	Attangsolo/Marioriawa	21.8	26	104.8	21.0	66.4	8.29	10.48
13.	IR - 5	Jenreng Palie/Lappariaja	16.0	16	105.1	26.8	76.2	5.49	7.18

/1 : Unit Yield = Nos.of hills per m^2 x Nos.of panicles per hill x Nos.of grains per panicle x % of ripened grains x 1,000 grain weight ÷ 1,000 x 10,000 m^2

/2 : Conversion rate of paddy / Dry stalk paddy = 76.5/100

Source : Supporting Report (volume 2) of Master Plan for The Central South Sulawesi Water Resources Development Project, March 1980

Table 4.6.4 Farm Budget of Average Size Farmer under Present Condition

Total Farm Land : 1.03 ha
- Paddy field : 0.61
- Up-land field : 0.42

Family Size : 5.53 persons

	(Rp)
1. Gross Farm Income	
Wet season paddy	231,400
Dry season paddy	172,400
Polowijo crops	1,600
Up-land crops	19,900
Non-farm income	20,200
Sub-total	445,500
2. Gross Out-go	
Farming expenses	
Paddy	68,800
Polowijo crops /1	100
Up-land crops	1,700
Irrigation expenses	11,800
IPEDA tax, others	4,200
Sub-total	86,600
3. Net Farm Income	
(1 - 2)	358,900
4. Family Living Expenses	
Food	208,700
Residence	46,900
Clothing	38,300
Luxury	22,900
Education	18,600
Social-expenses	15,800
Miscellaneous	6,800
Sub-total	358,000
5. Net Reserve	
(3 - 4)	900

/1 : Polowijo crops planted after harvest of wet season paddy

Table 5.3.1. Design Criteria of Proposed Farming for Paddy

1.	Varieties	IR-28/IR-36
2.	Growing Period	105-110 days
3.	Amount of Seed	30 kg/ha
4.	Nursery Period	15 - 20 days
5.	Area of Nursery Bed	1/20 of paddy field
6.	Land Preparation	One time of ploughing and 2 time hallowing/puddling
7.	Planting Method	Transplanting
8.	Planting Density	30 cm x 15 cm, 3 seedlings/hill
9.	Planting Depth	3 cm from the surface
10.	Fertilization	
	- Nursery bed	5 kg or Urea
	- Paddy field	195 kg of Urea/ha 50 kg of TSP/ha 50 kg of KCl/ha
	Time in Paddy Field	
	All TSP and KCl	Basic dressing at land preparation time
	35% Urea	Basic dressing at land preparation time
	35% Urea	First top dressing at 15 days after transplanting time
	30% Urea	2nd top dressing in the late period of a young panicle formation stage
11.	Weeding	at 15th, 30th and 50th day after transplanting
12.	Application of Chemicals	Insecticide 3 lt/ha Fungicide 1 lt/hr Rodenticide 100 gr/ha
13.	Water Control	
	. Transplanting to rooting period	Deep water depth
	. Most tillering period	Shallow water depth with intermitted irrigation
	. Neck-node differentiation period upto panicle formation period	Drying method
	. Full ripening period to harvested	Water drained
14.	Harvesting	By sickle

Note : This table compiled on the basis of data obtained from Central Research Institute for Agriculture, Bogor and Agriculture Office in Kab. Soppeng.

Table 5.3.2. Design Criteria of Proposed Farming for Polowijo Crops

	Maize	Groundnuts	Greenbeans	Soybeans
1. Varieties	BAKU BAKU, IMPA IMPA KURETEK KUNING, MENADO KUNING	GAJAH SWARCH	BAKTI B - 129 SIWALIK	ORBA DAVROS RINGGIT
2. Growing Period	75 - 90 days	85 - 100 days	65 - 75 days	80 - 95 days
3. Amount of Seed	30 - 50 kg/ha	80 - 100 kg/ha	25 - 30 kg/ha	40 - 50 kg/ha
4. Land Preparation	2 times of Ploughing and Hallowing			
5. Planting Method	Direct seeding			
6. Planting Density	50 cm x 100 cm	25 cm x 25 cm	30 cm x 50 cm	30 cm x 50 cm
7. Fertilization Basic dressing	100 kg/ha of Urea 100 kg/ha of TSP	50 kg/ha of Urea 100 kg/ha of TSP	50 kg/ha of Urea 100 kg/ha of TSP	50 kg/ha of Urea 100 kg/ha of TSP
Top dressing	150 kg/ha of Urea	25 kg/ha of Urea	50 kg/ha of Urea	50 kg/ha of Urea
8. Weeding	at 10th, 30th and 60th day after seeding			
9. Application of Chemicals Insecticide Rodenticide	2 lt/ha 100 gr/h	2 lt/ha 100 gr/ha	2 lt/ha 100 gr/ha	2 lt/ha 100 gr/ha
10. Water Control	Intermittent Irrigation (5 - 10 day Interval)			

Note : This table compiled on the basis of data obtained from Central Research Institute for Agriculture, Bogor and Agriculture Office in Kab. Soppeng.

Table 5.3.3 Unit Yields of Paddy in and around the Project Area

(1975 - 1979)

Unit : dry stalk paddy (tons/ha)

Kec./Desa	Wet Season Paddy						Dry Season Paddy					
	1975	1976	1977	1978	1979	Ave.	1974/75	75/76	76/77	77/78	78/79	Ave.
Lalabata												
Maccile	3.85	3.65	4.85	5.11	5.25	4.54	3.15	3.15	3.74	3.73	4.56	3.67
Lalabatarilau	3.75	3.49	4.67	4.95	5.16	4.40	3.04	3.62	3.62	3.73	4.43	3.69
Lilirilau												
Pajalesang	4.30	3.80	4.64	5.58	5.85	4.83	4.90	5.07	5.30	5.38	3.42	4.41
Macanre	-	-	3.04	4.08	4.35	3.82	-	-	-	-	-	-
Liliriaja												
Ganra	3.29	4.98	4.33	4.62	4.62	4.37	5.56	4.37	5.01	5.19	5.02	5.03
Belo	3.79	4.98	4.33	4.62	4.62	4.47	5.26	4.57	5.01	5.11	5.02	4.99
Galung	4.72	4.98	4.53	4.62	4.86	4.74	5.26	5.17	5.01	5.19	5.15	5.16
Pattojo	3.99	4.98	4.53	4.62	5.03	4.43	5.46	4.37	5.01	5.19	5.21	5.05
Jennae	3.99	5.18	4.93	4.79	5.03	4.79	5.54	4.97	5.51	5.53	5.21	5.35
Marioriwawo												
Labessi	3.29	2.68	3.96	4.78	5.93	3.47	3.73	3.39	4.43	4.88	5.98	4.48
Tet. rarae	3.59	2.10	3.95	4.32	6.54	4.12	5.22	3.11	4.02	4.79	6.67	4.79
Watu	3.69	3.02	3.02	4.88	7.06	4.44	5.32	3.59	3.59	4.78	7.06	4.98
Goarie	3.60	2.68	3.96	4.71	6.96	4.26	5.23	3.39	4.43	4.79	7.06	4.84
Average	3.82	3.88	4.21	4.74	5.48	4.43	4.81	4.06	4.56	4.86	5.40	4.74

Source : Agriculture Office, Kab. Soppeng and Kecamatan Offices: Liliriaja, Lalabata, Marioriwawo and Lilirilau.

Table 5.3.4 Annual Paddy Production without and with Project (6,400 ha)

	Without Project			With Project			Increment		
	W.S.P./1	D.S.P./2	Total	W.S.P./1	D.S.P./2	Total	W.S.P./1	D.S.P./2	Total
1. Planted Area (ha)									
- Desa non-tech. irri. area	2,818	1,928	4,746	2,900	2,900	5,800	82	972	1,054
- Desa semi-tech. irri. area	1,286	907	2,193	1,400	1,400	2,800	114	593	707
- D.P.U. semi-tech. irri. area	2,034	1,318	3,352	2,100	2,100	4,200	66	682	748
Total	6,138	4,153	10,291	6,400	6,400	12,800	262	2,247	2,509
2. Unit Yield (ton/ha)/3									
- Desa non-tech. irri. area	4.57	4.62	-	6.0	6.0	-	1.43	1.38	-
- Desa semi-tech. irri. area	4.59	4.71	-	6.0	6.0	-	1.41	1.29	-
- D.P.U. semi-tech. irri. area	4.64	5.00	-	6.0	6.0	-	1.36	1.00	-
3. Production (ton)/3									
- Desa non-tech. irri. area	12,900	8,900	21,800	17,400	17,400	34,800	4,500	8,500	13,000
- Desa semi-tech. irri. area	5,900	4,300	10,200	8,400	8,400	16,800	2,500	4,100	6,600
- D.P.U. semi-tech. irri. area	9,400	6,500	15,900	12,600	12,600	25,200	3,200	6,100	9,300
Total	28,200	19,700	47,900	38,400	38,400	76,800	10,200	18,700	28,900

/1 : Wet Season Paddy

/2 : Dry Season Paddy

/3 : Dry Stalk Paddy

Table 5.3.5 Economic Price of Dry Stalk Paddy in the Project Area

- Import substitution price -

(Unit : Rp/ton)

1.	International Market Price (F.O.B. Bangkok)/1 US$368	230,000
2.	External Transportation Cost (Bangkok - Ujung Pandang)	8,125
3.	Port Handling Charge and Storing Cost (including cost of sacks)/2	5,290
4.	Inland Transportation Cost (Ujung Pandang - Watan Soppeng)	4,000
5.	Selling Price of Rice at Ex-mill Gate	247,415
6.	Conversion to the Price of Dry Stalk Paddy (0.52)	128,656
7.	Milling Charge	- 6,000
8.	Handling and Transportation Cost (Farm gate to mill)	- 2,700
9.	Economic Farm Gate Price of Dry Stalk Paddy	119,956 ≒ 120,000

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

Projected price to 1985 in 1977 constant US dollars.

/2 : Handling charge at harbor 30 Rp/ton

Storing charge 7 Rp/ton/day x 180 days

Cost of sacks 4000 Rp/ton

Table 5.3.6 Total Production Costs without and with Project

	Without Project			With Project			Increment of Total Production Cost
	Planted area	Unit Production Cost	Total Production Cost	Planted Area	Unit Production Cost	Total Production Cost	
	(ha)	(Rp/ha)	(10^6Rp)	(ha)	(Rp/ha)	(10^6Rp)	(10^6Rp)
1. Wet Season Paddy							
- technical area	-	-	-	6,400	191,000	1,222.4	1,222.4
- semi-technical area	3,320	183,000	607.5	-	-	-	-607.5
- non-technical area	2,818	150,000	422.7	-	-	-	-422.7
Sub-total	6,138	-	1,030.2	6,400	-	1,222.4	192.2
2. Dry Season Paddy							
- technical area	-	-	-	6,400	199,000	1,273.6	1,273.6
- semi-technical area	2,225	192,000	427.2	-	-	-	-427.2
- non-technical area	1,928	162,000	312.3	-	-	-	-312.3
Sub-total	4,153	-	739.5	6,400	-	1,273.6	534.1
3. Polowijo Crops - maize - groundnuts - soybeans	350	72,500	25.4	6,400	124,500	796.9	771.5
Total (1+2+3)	10,641	-	1,795.1	19,200	-	3,292.9	1,497.8
Production cost per ha per year	-	280,500	-	-	514,500	-	234,000 (83.4%)
Production cost per ha per crop	-	168,700	-	-	171,500	-	2,800 (1.7%)

Table 5.5.1 General Features of Langkemme Intake Weir

Location	2.5 Km upstream of the confluence of the Sero river
Geology (observation)	Clay stone breccia
Riverbed Elevation	168.4 m
Weir Type	Fixed type Weir of Stone masonry
Crest EL.	170.0 m
Max. Weir Height	4.2 m
Crest Length	37.5 m
Scouring Sluice	2 m width x 2 nos.
Intake	2 m width x 2 nos.
Inverted Syphon	- Barrel type of reinforced concrete barrel - Barrel length of 46 m - Barrel section of 1.2 m x 1.2 m (1.8 m x 1.8m)

Table 5.5.2 Features of Intake Weirs on the Sero Diversion Canal

	Jupang	Unyi	Pising
Location	7.5 Km upstream of the confluence of the Pising river	0.5 Km upstream of the confluence of the Jupang river	3 Km upstream of the confluence of the Jupang river
Geology (observation)	breccia	breccia	breccia
Riverbed Elevation	176.2 m	175.4 m	172.8 m
Weir Type	tirol type weir	gabion weir	gabion weir
Crest Elevation	176.6 m	176.3 m	174.7 m
Crest Length	38 m	29 m	25 m
Intake	-	1 m x 2 nos.	1 m x 2 nos.

Table 5.7.1 Financial Cost of the Project

(US$)

Work Item	Local Currency	Foreign Currency	Total
I. Construction Cost			
(Work Division I)			
Preparation	260,000	-	260,000
Weir in Tributeries	417,000	100,000	517,000
Link Canal in NT Area	1,266,000	240,000	1,506,000
Tertiary Development	412,000	-	412,000
Land Aquisition	163,000	-	163,000
Sub-total	2,518,000	340,000	2,858,000
(Work Division II)			
Preparation	803,000	-	803,000
Langkemme Intake Weir	195,000	99,000	294,000
Langkemme Canal	1,875,000	3,631,000	5,506,000
Link Canal in ST Area	85,000	23,000	108,000
Tertiary Development	1,702,000	-	1,702,000
Land Aquisition	415,000	-	415,000
Sub-total	5,075,000	3,753,000	8,828,000
(Work Division III)			
Preparation	440,000	-	440,000
Sero Intake Weirs	108,000	26,000	134,000
Sero Diversion Canal	1,062,000	2,014,000	3,076,000
Link Canal in DPU Area	126,000	27,000	153,000
Tertiary Development	889,000	-	889,000
Land Aquisition	149,000	-	149,000
Sub-total	2,774,000	2,067,000	4,841,000
Total	10,367,000	6,160,000	16,527,000
II. Engineering Service	464,000	3,238,000	3,702,000
III. Administration Cost	384,000	-	384,000
IV. Physical Contingency (15%)	1,682,000	1,410,000	3,092,000
V. Price Contingency (L-10%, F-7%)	7,162,000	3,708,000	10,870,000
Grand Total	20,059,000	14,516,000	34,575,000

Table 5.7.2 (Financial) Replacement and O/M Costs

Item	Amount (x 10^3 US$)		
	L/C	F/C	Total
I. Replacement Cost			
1) Gate incl. 15% of physical contingency (Durable period: 25 years)	39	78	117
2) Wooden bar, Gabion, Screen & Metal Works incl. 15% of physical contingency (Durable period: 10 years)	119	34	153
II. O/M Cost			
1) Personnel Costs	189	-	189
2) Depreciation Cost of O/M Equipment			
- Vehicle	30		
- O/M Equipment	103	-	
Sub-Total	133		133
3) Maintenance Cost for Facilities	22	-	22
4) Office & General Expenses			
- Gasoline	64		
- Office	15	-	
- General Expenses	32		
Sub-Total	111		111
5) Physical Contingency (15%)	68	-	68
Total	523	-	523

Note: Replacement cost above is amount per one replacement.

Table 7.2.1 Net Production Value without and with Project Condition

	Without Project			With Project			Increment		
	Paddy		Polowijo Crops	Paddy		Polowijo Crops	Paddy		Polowijo Crops
	W.S.P. /1	D.S.P. /2		W.S.P. /1	D.S.P. /2		W.S.P. /1	D.S.P. /2	
1. Planted Area (ha)	6,138	4,153	350	6,400	6,400	6,400	262	2,247	6,050
2. Gross Production Value ($\times 10^6$Rp)	3,386.3	2,362.3	81.0	4,608.0	4,608.0	2,193.2	1,221.7	2,235.9	2,112.2
3. Total Production Cost ($\times 10^6$Rp)	1,030.2	739.5	25.4	1,222.4	1,273.6	777.9	192.2	534.1	752.5
4. Net Production Value ($\times 10^6$Rp)	2,356.1	1,632.8	55.6	3,385.6	3,334.4	1,415.3	1,029.5	1,701.6	1,359.7
5. Annual Net Production Value ($\times 10^6$Rp)		4,044.5			8,135.3			4,090.8	
6. Proportion of Net Production Value by Each Crop (%)	58.4	40.4	1.3	41.6	41.0	17.4	25.2	41.6	33.2

/1 : Wet Season Paddy

/2 : Dry Season Paddy

Table 7.2.2 Irrigation Benefits

Description	W/O Project	W/Project	Increment
1. Planted Area (ha)			
- Wet season paddy	6,138	6,400	262
- Dry season paddy	4,153	6,400	2,247
- Polowijo crops	350	6,400	6,050
2. Unit Yield (ton/ha)			
- Wet season paddy			
non-technical irri. area	4.57	6.0	1.43
semi-technical irri. area	4.59	6.0	1.41
D.P.U. semi-tech. irri. area	4.64	6.0	1.36
- Dry season paddy			
non-technical irri. area	4.62	6.0	1.38
semi-technical irri. area	4.71	6.0	1.29
D.P.U. semi-tech. irri. area	5.00	6.0	1.00
- Polowijo crops			
maize	0.79	2.0	1.21
groundnuts	0.81	1.2	0.39
greenbeans	0.83	1.2	0.37
soybeans	0.67	1.2	0.53
3. Projected Prices of Paddy and Polowijo Crops (Rp/ha)			
- Dry stalk paddy	120,000	120,000	-
- Polowijo crops			
maize	92,000	92,000	-
groundnuts	351,000	351,000	-
greenbeans	310,000	310,000	-
soybeans	328,000	328,000	-
4. Unit Production Cost (Rp/ha)			
- Wet season paddy			
non-technical irri. area	150,000	191,000	41,000
semi-technical irri. area	183,000	191,000	8,000
- Dry season paddy			
non-technical irri. area	162,000	199,000	37,000
semi-technical irri. area	192,000	199,000	7,000
- Polowijo crops			
maize	34,000	113,000	79,000
groundnuts	96,000	142,000	46,000
greenbeans	80,000	122,000	42,000
soybeans	80,000	121,000	41,000
5. Gross Production Value ($x10^6$Rp) (1 x 2 x 3)	5,839.6	11,409.2	5,569.6
- Wet season paddy	3,386.3	4,608.0	1,221.7
- Dry season paddy	2,362.3	4,608.0	2,235.7
- Polowijo crops	81.0	2,193.2	2,112.2
6. Total Production Cost ($x10^6$Rp) (1 x 4)	1,795.1	3,273.9	1,478.8
- Wet season paddy	1,030.2	1,222.4	192.2
- Dry season paddy	739.5	1,273.6	534.1
- Polowijo crops	25.4	777.9	752.5
7. Net Production Value ($x10^6$Rp) (5 - 6)	4,044.5	8,135.3	4,090.8
- Wet season paddy	2,356.1	3,385.6	1,029.5
- Dry season paddy	1,632.8	3,334.4	1,701.6
- Polowijo crops	55.6	1,415.3	1,359.7
8. Crop Damages Due to Water Shortage ($x10^6$Rp)	0	274.8	274.8
- Wet season paddy	0	19.3	19.3
- Dry season paddy	0	47.5	47.5
- Polowijo crops	0	208.0	208.0
9. Adjusted Net Production Value (7 - 8) ($x10^6$Rp)	4,044.5	7,860.5	3,816.0
- Wet season paddy	2,356.1	3,366.3	1,010.2
- Dry season paddy	1,632.8	3,286.9	1,654.1
- Polowijo crops	55.6	1,207.3	1,151.7

Table 7.4.1 Annual Costs and Benefits Flow

(x 10^3 US$)

Year	Economic Project Cost	O & M Cost	Replacement Cost	Total Cost (A)	Benefits (B)	Balance (B) - (A)
1982	1,022	-	-	1,022	-	-1,022
1983	4,461	-	-	4,461	-	-4,461
1984	5,851	94	-	5,945	9	-5,936
1985	4,981	189	-	5,170	162	-5,008
1986	5,192	283	-	5,475	478	-4,997
1987	205	378	-	583	1,246	663
1988	-	472	-	472	2,292	1,820
1989	-	472	-	472	3,319	2,847
1990	-	472	-	472	4,230	3,758
1991	-	472	-	472	5,115	4,643
1992	-	472	138	610	5,475	4,865
1993	-	472	-	472	5,660	5,188
1994	-	472	-	472	5,844	5,372
1995	-	472	-	472	6,003	5,531
1996	-	472	-	472	6,106	5,634
.	.	.	.	.	.	.
.	.	.	.	.	.	.
2002	-	472	138	610	6,106	5,496
2003	-	472	-	472	6,106	5,634
.	.	.	.	.	.	.
.	.	.	.	.	.	.
2007	-	472	105	577	6,106	5,529
2008	-	472	-	472	6,106	5,634
.	.	.	.	.	.	.
.	.	.	.	.	.	.
2012	-	472	138	610	6,106	5,496
2013	-	472	-	472	6,106	5,634
.	.	.	.	.	.	.
.	.	.	.	.	.	.
2022	-	472	138	610	6,106	5,496
2023	-	472	-	472	6,106	5,634
.	.	.	.	.	.	.
.	.	.	.	.	.	.
2031	-	472	-	472	6,106	5,634
Total	21,712	21,712	657	44,081	259,649	215,568

Table 7.4.2 Economic Benefit Flow

	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
A. Planted Area (ha)														
Desa non-technical irrigation area														
Wet season paddy	-	370	1,640	2,900	2,900	2,900	2,900	2,900	2,900	2,900	2,900	2,900	2,900	2,900
Dry season paddy	370	1,640	2,900	2,900	2,900	2,900	2,900	2,900	2,900	2,900	2,900	2,900	2,900	2,900
Polowijo crops	-	-	900	2,900	2,900	2,900	2,900	2,900	2,900	2,900	2,900	2,900	2,900	2,900
Desa semi-technical irrigation area														
Wet season paddy	-	-	-	-	1,400	1,400	1,400	1,400	1,400	1,400	1,400	1,400	1,400	1,400
Dry season paddy	-	-	-	1,400	1,400	1,400	1,400	1,400	1,400	1,400	1,400	1,400	1,400	1,400
Polowijo crops	-	-	-	-	1,400	1,400	1,400	1,400	1,400	1,400	1,400	1,400	1,400	1,400
D.P.U. semi-technical irrigation area														
Wet season paddy	-	-	-	-	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100
Dry season paddy	-	-	-	200	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100
Polowijo crops	-	-	-	-	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100
B. Direct Benefit by Crop (x10[6]Rp)														
Desa non-technical irrigation area														
Wet season paddy	-	0.8	25.7	100.9	176.1	262.0	341.8	397.3	402.7	402.7	402.7	402.7	402.7	402.7
Dry season paddy	-	5.1	60.1	132.4	276.7	423.3	564.8	656.4	730.6	732.8	732.8	732.8	732.8	732.8
Polowijo crops	-	-	15.4	65.2	117.7	170.3	222.9	275.4	328.0	380.4	433.0	485.5	522.6	525.4
Desa semi-technical irrigation area														
Wet season paddy	-	-	-	-	52.7	105.4	158.0	210.7	263.4	263.4	263.4	263.4	263.4	263.4
Dry season paddy	-	-	-	-	75.0	151.1	227.2	303.3	379.4	380.5	380.5	380.5	380.5	380.5
Polowijo crops	-	-	-	-	24.5	49.1	73.6	99.5	124.0	148.6	173.1	197.6	222.2	245.3
D.P.U. semi-technical irrigation area														
Wet season paddy	-	-	-	-	5.7	74.6	143.4	212.3	281.1	344.3	344.3	344.3	344.3	344.3
Dry season paddy	-	-	-	-	12.2	120.4	228.5	336.7	444.8	540.8	540.8	540.8	540.8	540.8
Polowijo crops	-	-	-	-	38.1	76.2	114.3	152.3	190.4	228.5	266.6	304.7	342.7	380.8
C. Annual Direct Benefits (x10[6]Rp)														
Desa non-technical irrigation area	-	5.9	101.2	298.5	570.5	855.6	1,129.5	1,329.1	1,461.3	1,515.9	1,568.5	1,621.0	1,658.1	1,660.9
Desa semi-technical irrigation area	-	-	-	-	152.2	305.6	458.8	613.5	766.8	792.5	817.0	841.5	866.1	889.2
D.P.U. semi-technical irrigation area	-	-	-	-	56.0	271.2	486.2	701.3	916.3	1,113.6	1,151.7	1,189.8	1,227.8	1,265.9
Total		5.9	101.2	298.5	778.7	1,432.4	2,074.5	2,643.9	3,144.4	3,422.0	3,537.2	3,652.3	3,752.0	3,816.0

Table 7.5.1 Farm Budget of Average Size Farmer without Project and with Project

Total Farm Land : 1.03 ha
- Paddy field : 0.61/1
- Up-land field : 0.42

Family Size : 5.53 persons

(Rp)

	Without Project	With Project	Increment
1. Gross Farm Income			
Wet season paddy	285,300	369,200	
Dry season paddy	212,500	356,300	
Polowijo crops/2	2,500	216,100	
Up-land crops	30,500	30,500	
Non-farm income	28,400	10,400	
Sub-total	559,200	982,500	423,300
2. Gross Out-go			
Farming expenses			
Paddy	90,200	147,600	
Polowijo crops	200	32,700	
Up-land crops	2,400	2,400	
Irrigation expenses	15,300	15,300	
IPEDA tax, others	5,300	9,700	
Sub-total	113,400	207,700	94,300
3. Net Farm Income			
(1 - 2)	445,800	774,800	329,000
4. Family Living Expenses			
Food	258,900	336,500	
Residence	58,200	75,600	
Clothing	47,500	61,800	
Luxury	28,400	36,900	
Education	23,100	30,000	
Social-expenses	19,500	25,400	
Miscellaneous	8,400	11,000	
Sub-total	444,000	577,200	133,200
5. Net Reserve			
(3 - 4)	1,800	197,600	195,800

/1 : Out of 0.61 ha of paddy field, 0.50 ha will be put under the project

/2 : Polowijo crops planted after harvest of wet season paddy

Table 7.6.1 Cash Flow Statement

(x 10³ US$)

Year	Cash Outflow: Project Cost	Cash Outflow: O/M Replacement Cost	Cash Outflow: Loan Repayment	Total Outflow (A)	Cash Inflow: Foreign Loan	Cash Inflow: Government Budget	Cash Inflow: Government Subsidy/1	Total Inflow (B)	Balance (B) - (A)
1982	1,206	-	-	1,206	1,042	164	-	1,206	0
1983	6,189	-	-	6,189	3,745	2,444	-	6,189	0
1984	8,984	-	-	8,984	5,303	3,681	-	8,984	0
1985	8,210	-	-	8,210	5,356	2,854	-	8,210	0
1986	9,576	87	-	9,663	5,104	4,559	-	9,663	0
1987	410	174	-	584	187	397	-	584	0
1988		262	-	262	(23,413)/2	262	-	262	0
1989		349	1,650	1,999		349	1,650	1,999	0
1990		436	1,650	2,086		436	1,650	2,086	0
1991		523	1,650	2,173		523	1,650	2,173	0
1992		676	1,650	2,326		676	1,650	2,326	0
1993		523	1,650	2,173		523	1,650	2,173	0
1994		523	1,650	2,173		523	1,650	2,173	0
1995		523	1,650	2,173		523	1,650	2,173	0
1996		523	1,650	2,173		523	1,650	2,173	0
1997		523	1,650	2,173		523	1,650	2,173	0
1998		523	1,650	2,173		523	1,650	2,173	0
1999		523	1,650	2,173		523	1,650	2,173	0
2000		523	1,650	2,173		523	1,650	2,173	0
2001		523	1,650	2,173		523	1,650	2,173	0
2002		676	1,650	2,326		676	1,650	2,326	0
2003		523	1,650	2,173		523	1,650	2,173	0
2004		523	1,650	2,173		523	1,650	2,173	0
2005		523	1,650	2,173		523	1,650	2,173	0
2006		523	1,650	2,173		523	1,650	2,173	0
2007		640	1,650	2,290		640	1,650	2,290	0
2008		523	1,576	2,099		523	1,576	2,099	0
2009		523		523		523		523	0
2010		523		523		523		523	0

/1 : Government subsidy to be allocated for the repayment

/2 : Accumulated foreign loan including 3.5% of interest per annum within 7 years of grace period

FIGURES

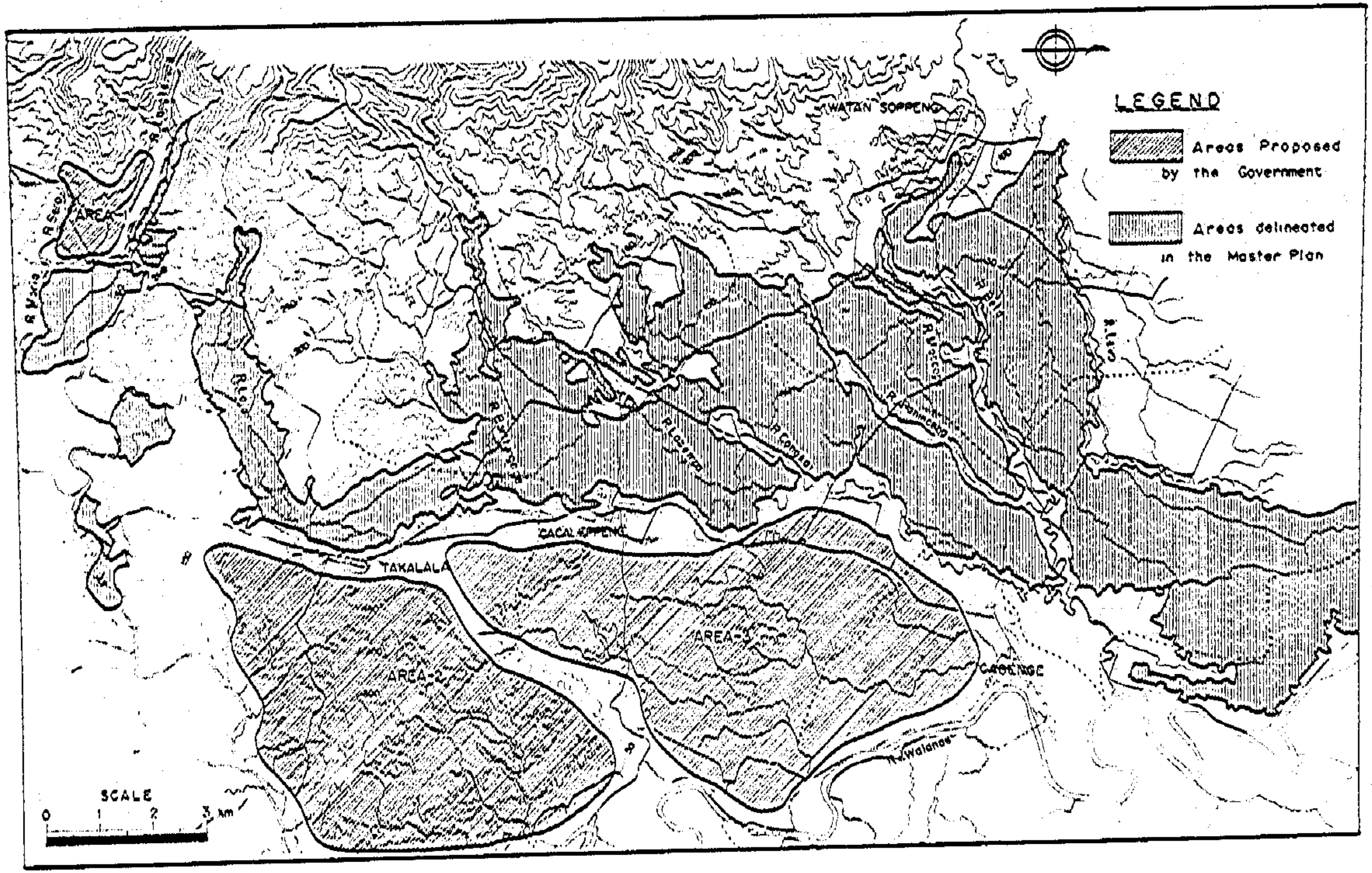


Fig. 3.1 STUDY AREA

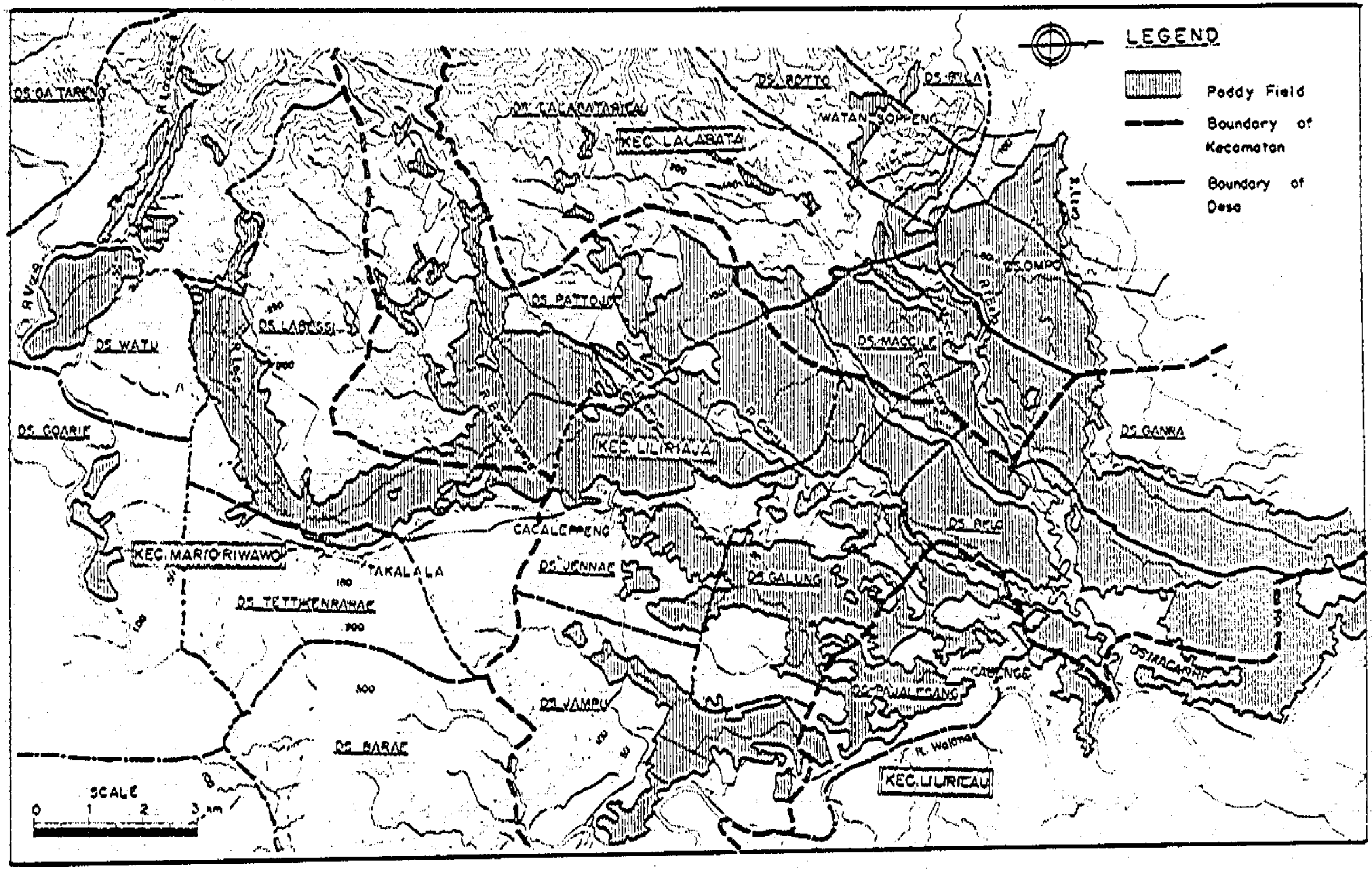


Fig. 4.1.1 ADMINISTRATIVE BOUNDARIES IN THE PROJECT AREA

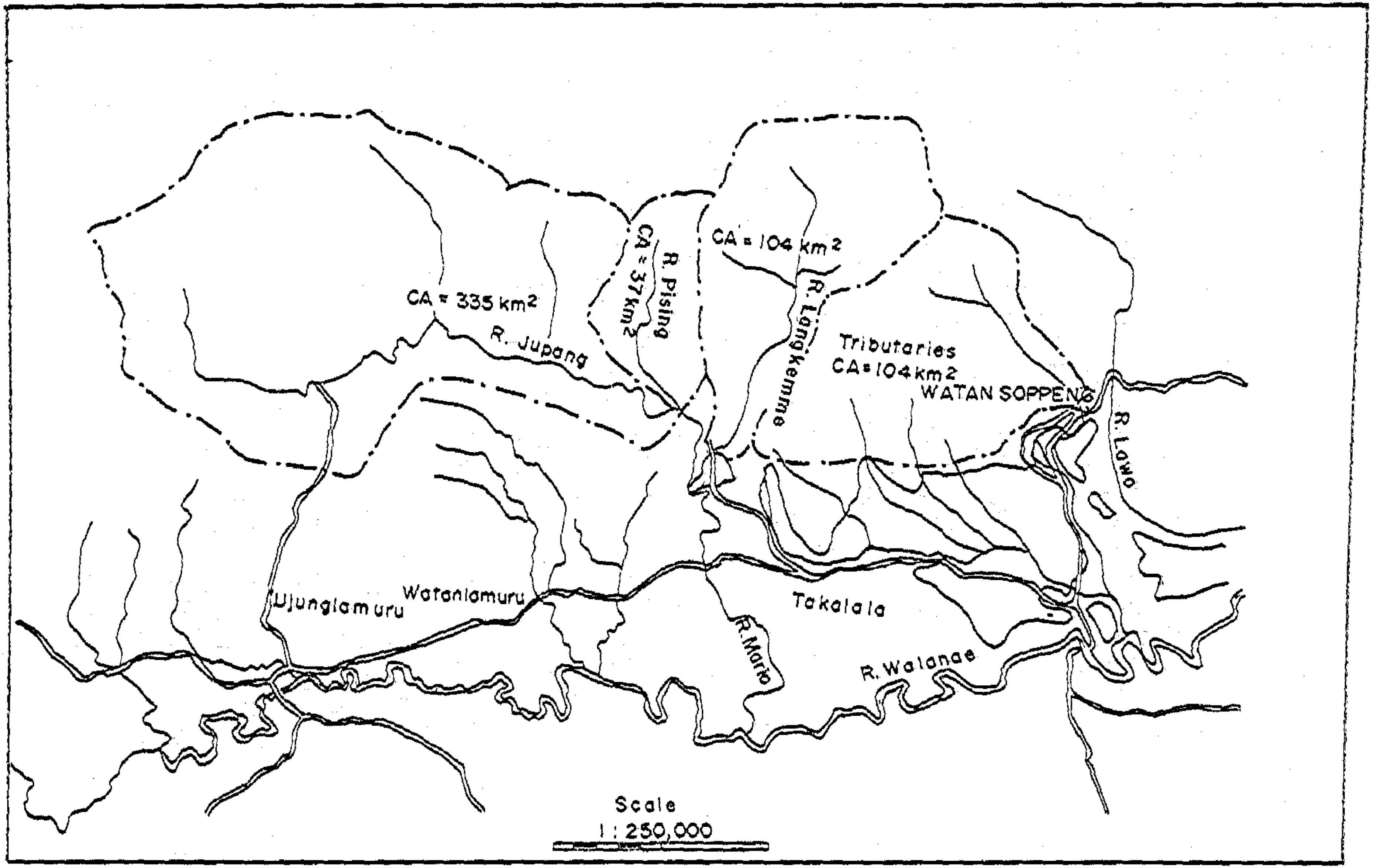


Fig.4.3.1 BASIN MAP OF MAIN RIVERS

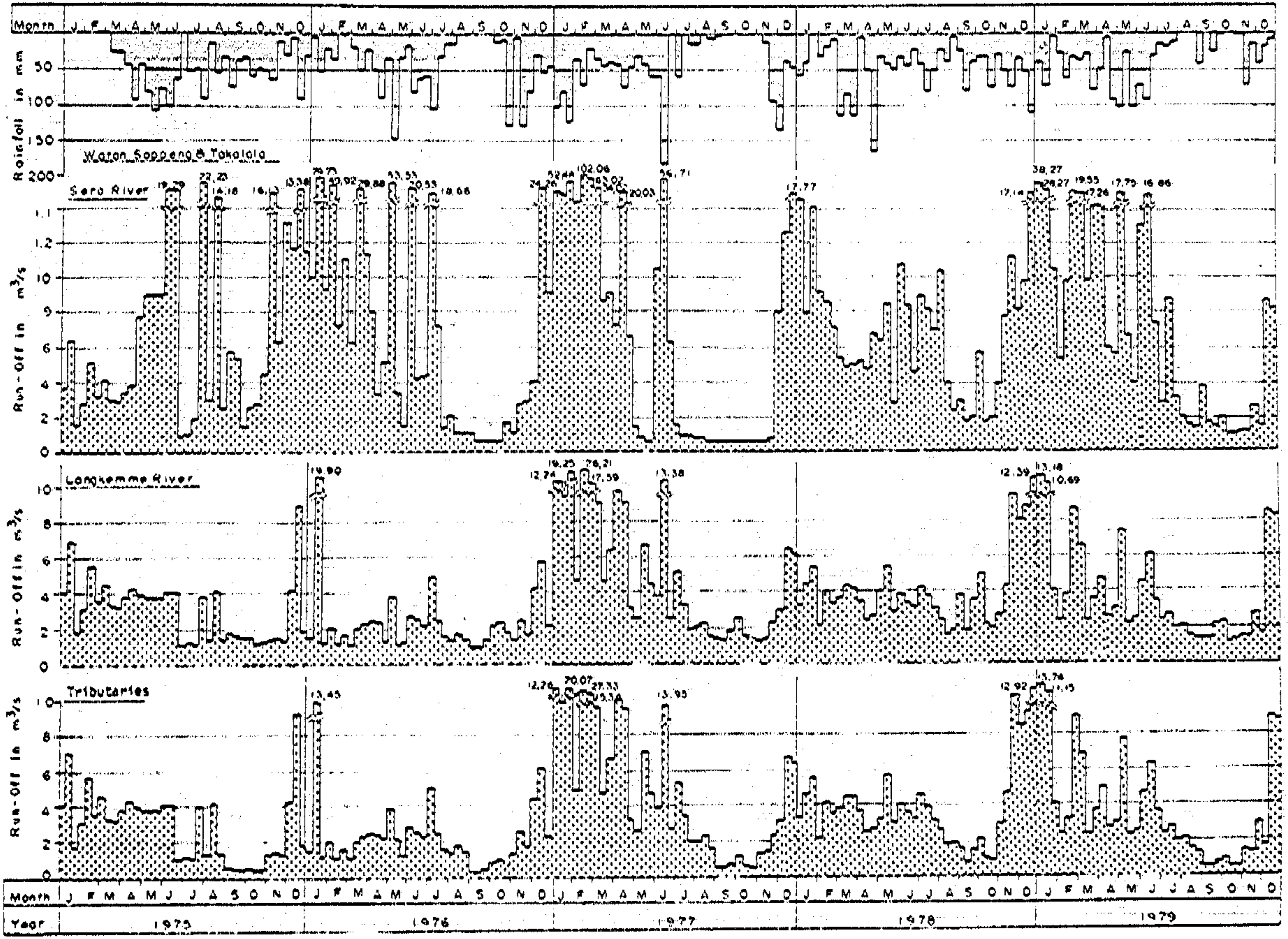


Fig. 4.3.2 ANNUAL RUN-OFF BY 10-DAY BASIS

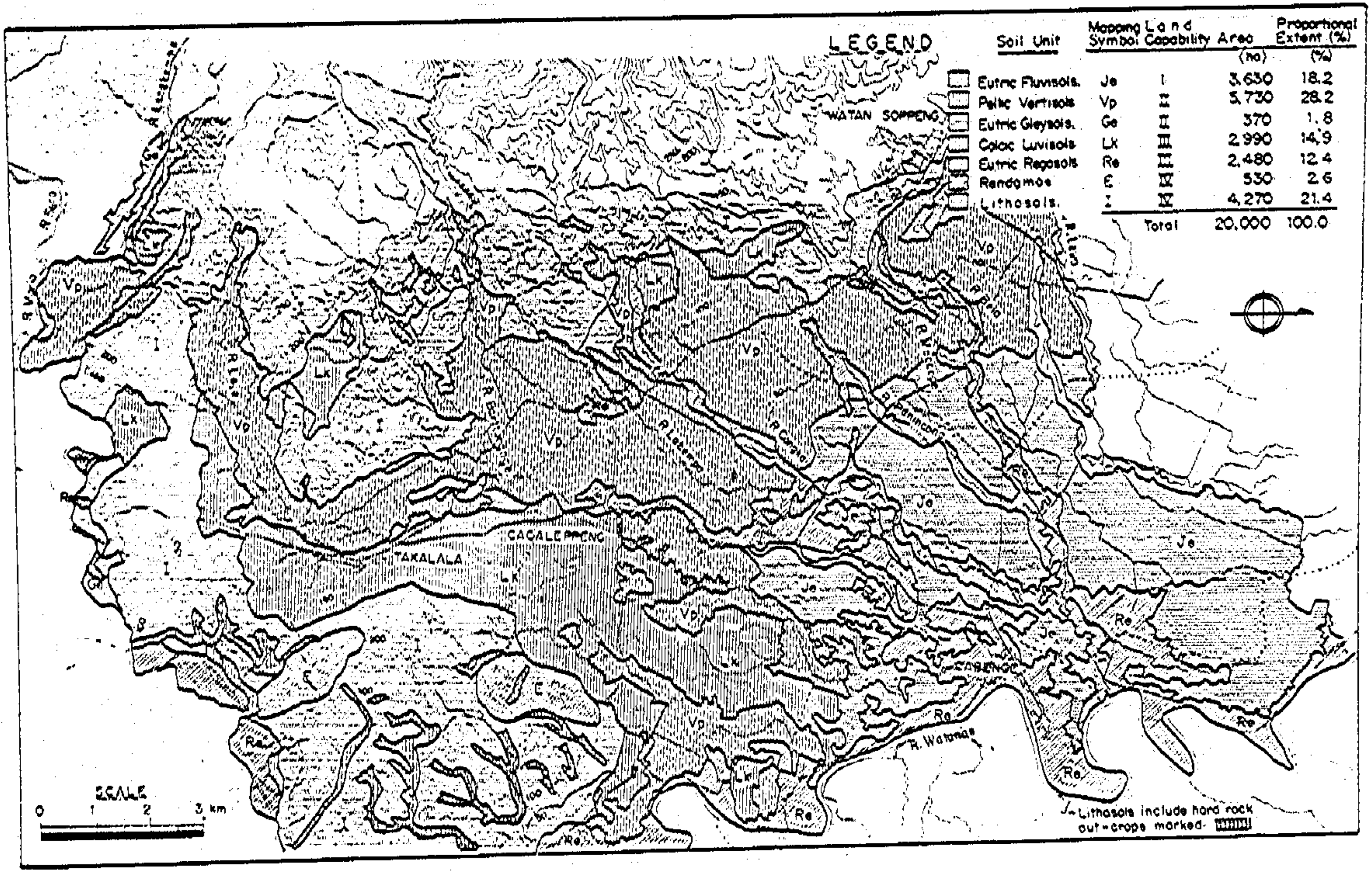


Fig. 4.4.1 SOIL MAP

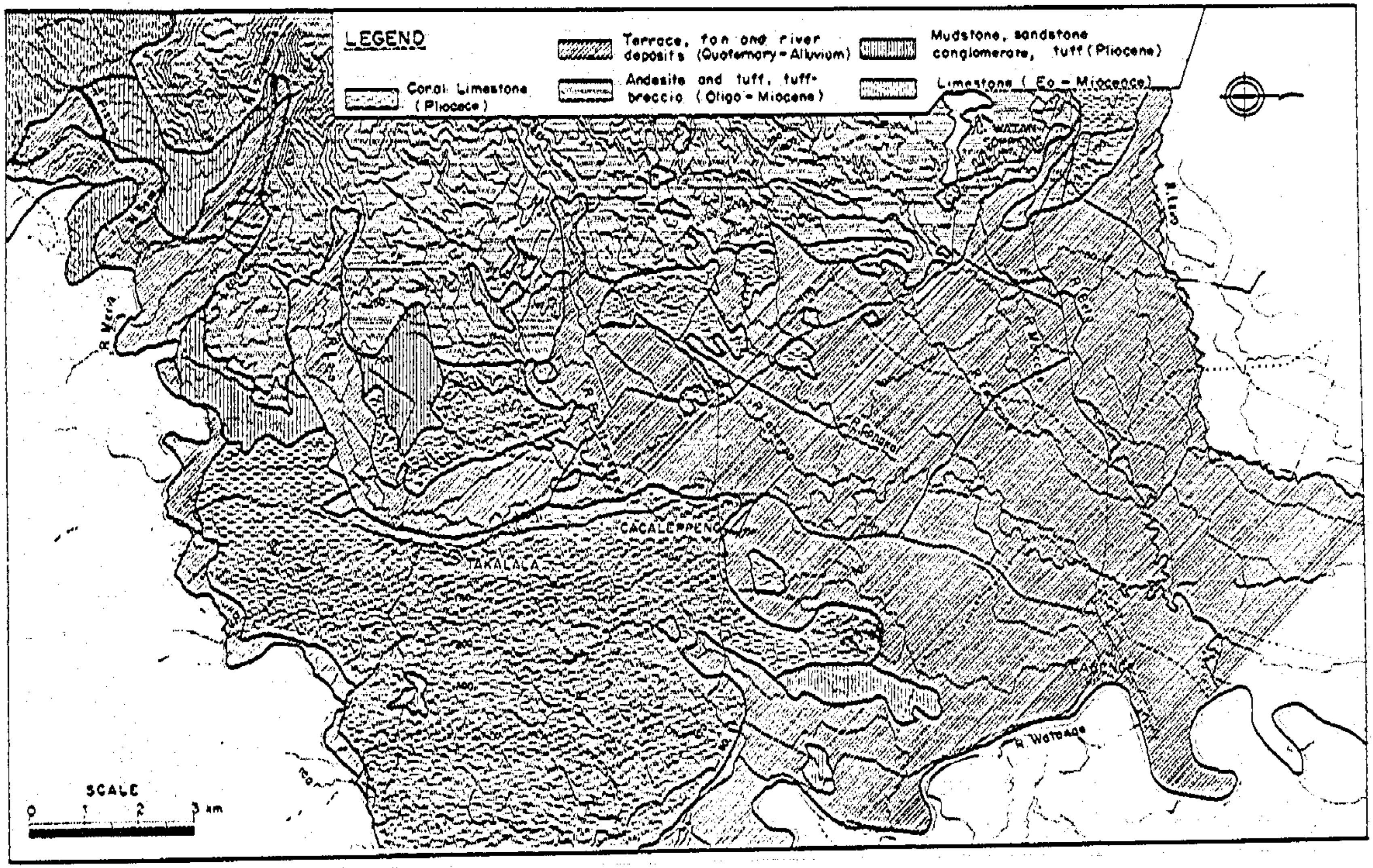


Fig. 4.4.2 GEOLOGICAL MAP

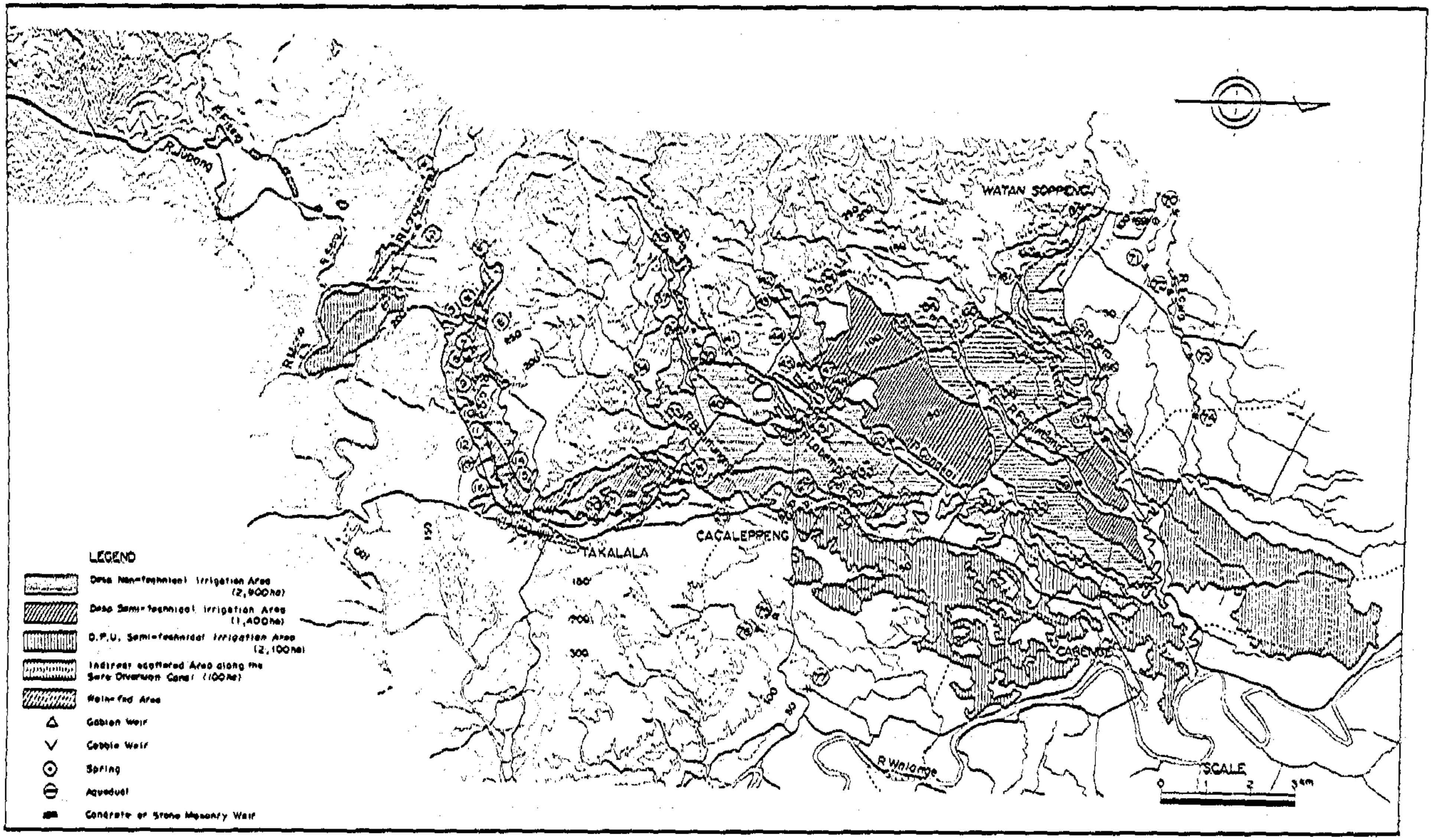
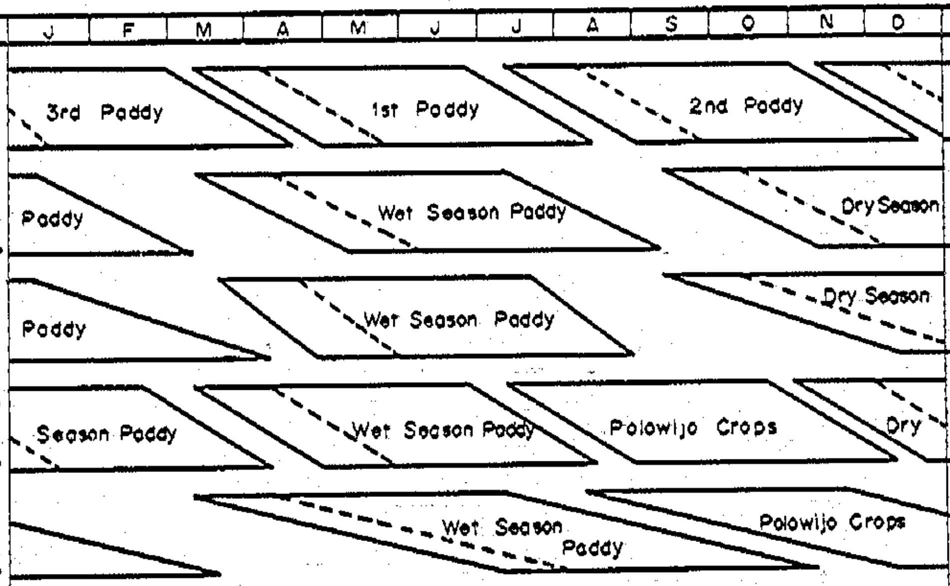


Fig. 4.5.1 EXISTING IRRIGATION SYSTEM



Pattern	Area (ha)	Area (%)
I. Paddy - Paddy - Paddy (3 crops a year) Cropping Intensity : 260-300%	70	1.0
II. Paddy - Paddy (2 crops a year) Cropping Intensity : 180-200%	2,080	32.5
III. Paddy - Paddy (2 crops a year) Cropping Intensity : 130-180%	3,370	52.7
IV. Paddy - Polowijo Crops - Paddy (3 crops a year) Cropping Intensity : 260-300%	140	2.2
V. Paddy - Polowijo Crops (2 crops a year) Cropping Intensity : 100-120%	740	11.6
	(6,400)	(100.0)

Month	J	F	M	A	M	J	J	A	S	O	N	D	Area
Mean Temperature (Sengkang) (°C)	27.9	28.0	27.7	27.6	27.4	26.5	26.1	26.3	26.7	28.2	27.9	27.6	
Rainfall (Sengkang) (mm)	86	95	121	188	267	210	142	87	57	80	122	97	1,552
(Watan Soppeng)	119	67	138	203	173	161	135	47	82	98	117	139	1,479
(Takalala)	145	97	177	158	210	211	125	37	70	86	155	189	1,660
(Cabenge)	143	78	100	167	181	124	108	77	74	121	48	108	1,329

Fig.4.6.1 PRESENT CROPPING PATTERNS IN THE PROJECT AREA

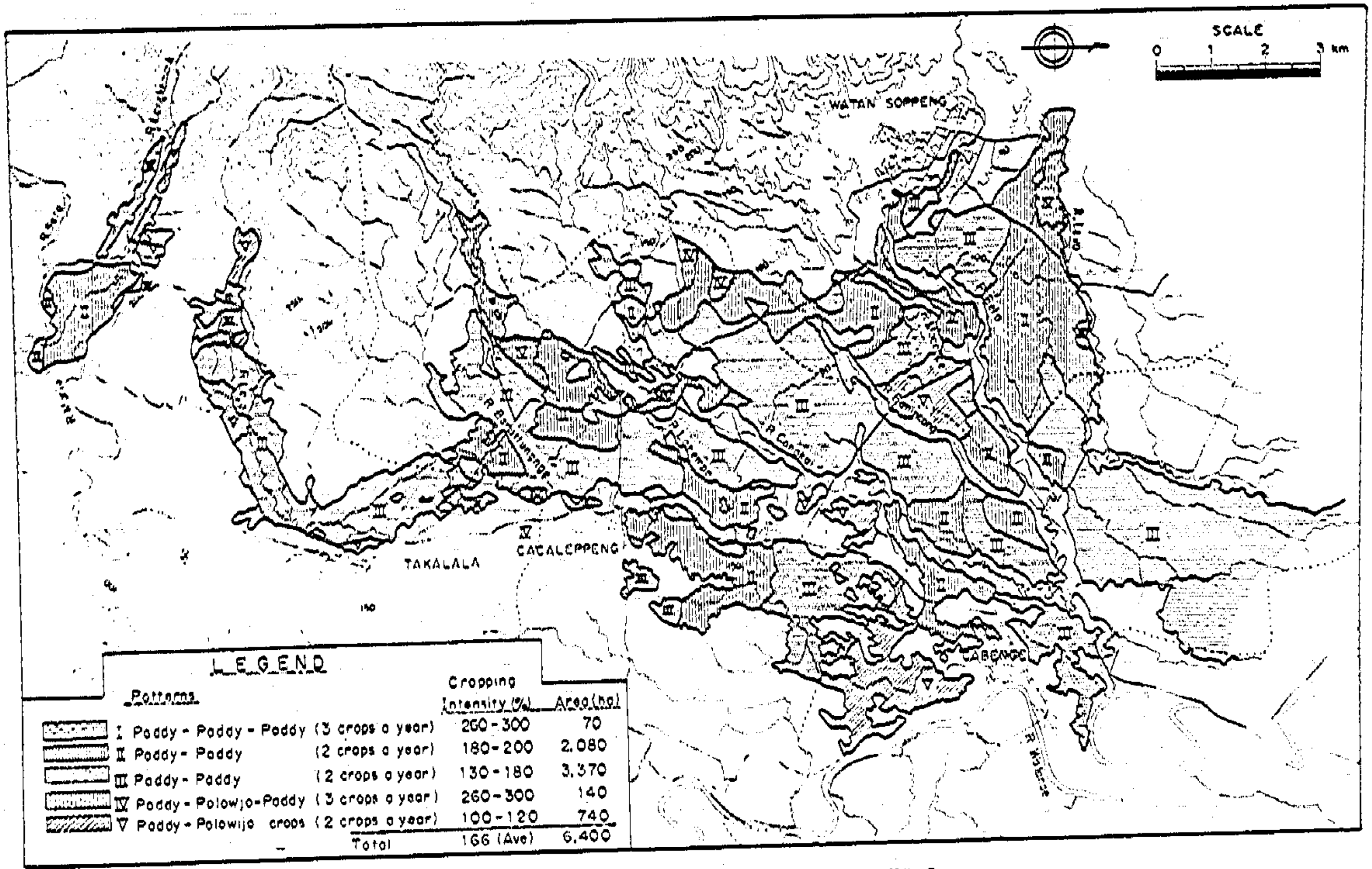


Fig. 4.6.2 PRESENT LAND USE PATTERNS IN THE EXISTING PADDY FIELDS

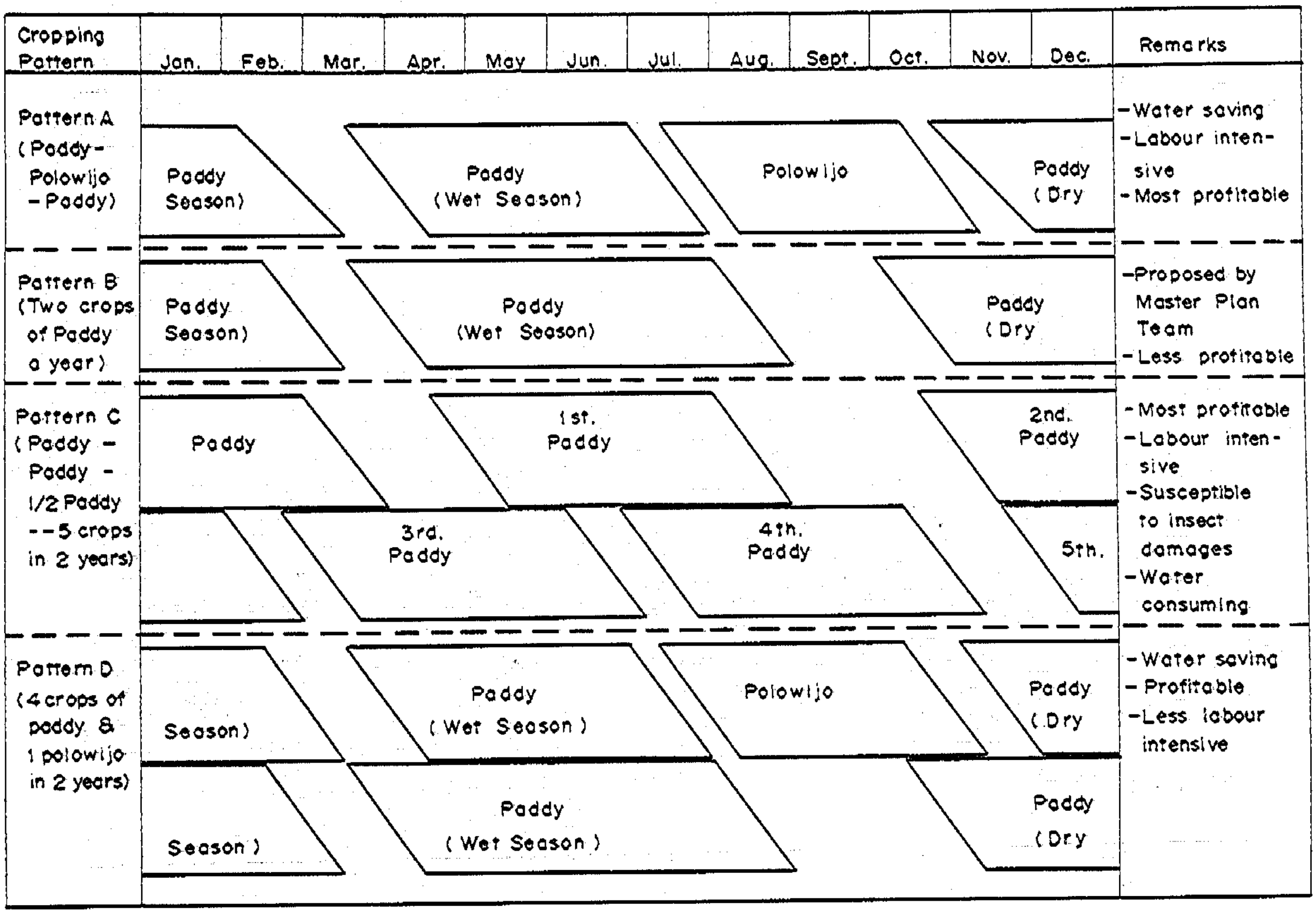


Fig.5.3.1 ALTERNATIVE CROPPING PATTERNS

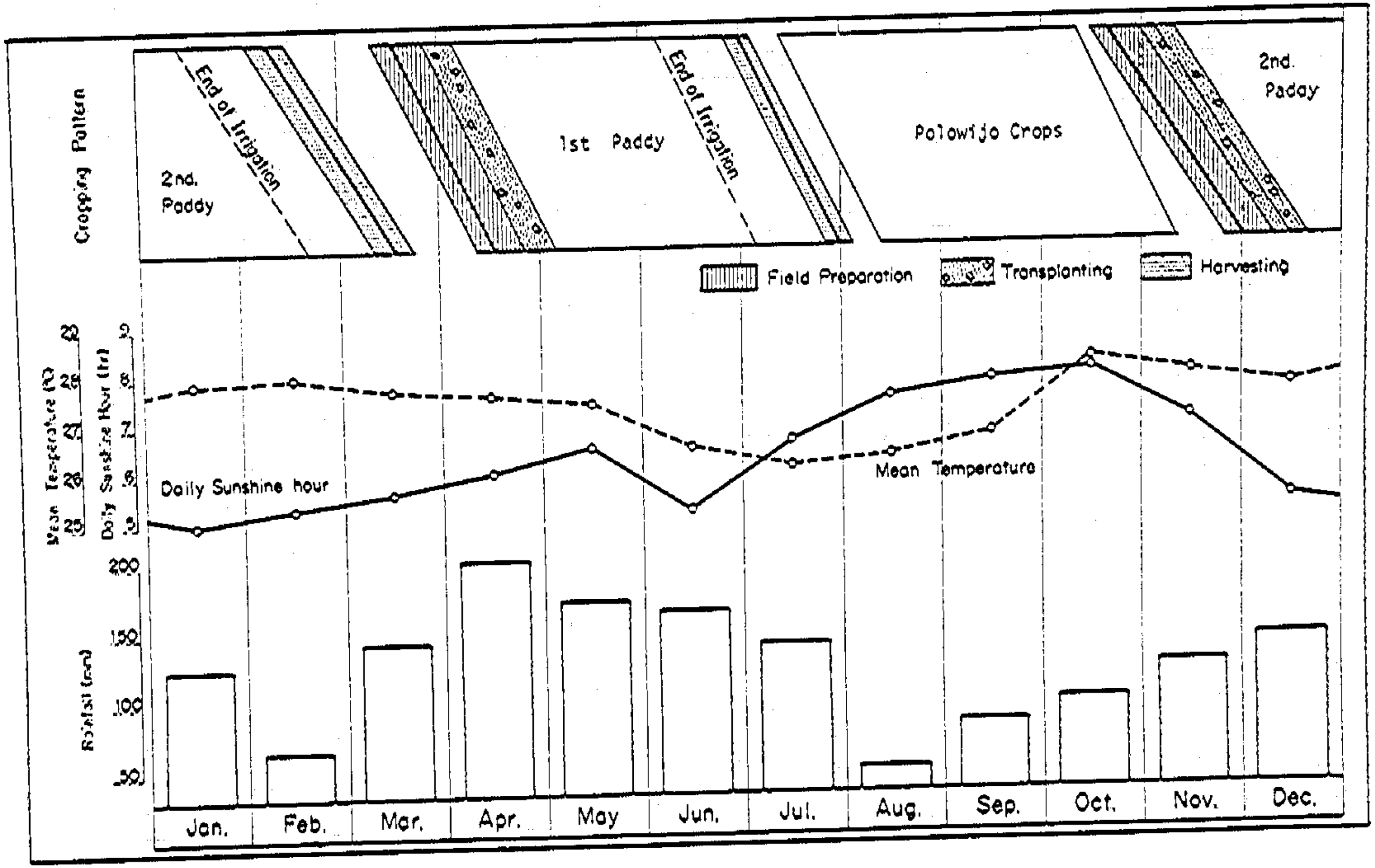


Fig. 5.3.2 PROPOSED CROPPING PATTERN (PATTERN A)

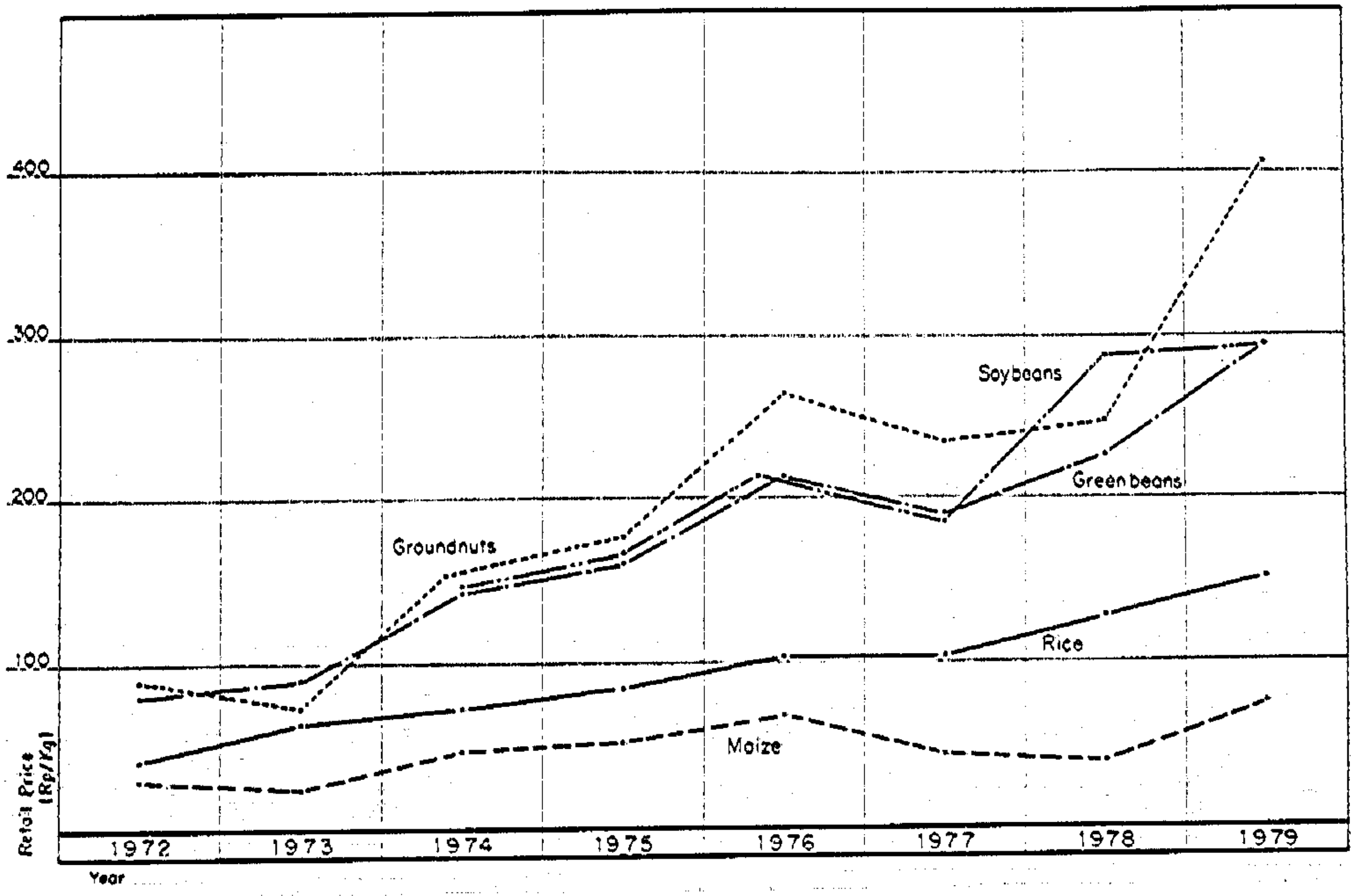


Fig. 5.3.3 RETAIL PRICES OF FARM PRODUCTS IN KAB. SOPPENG

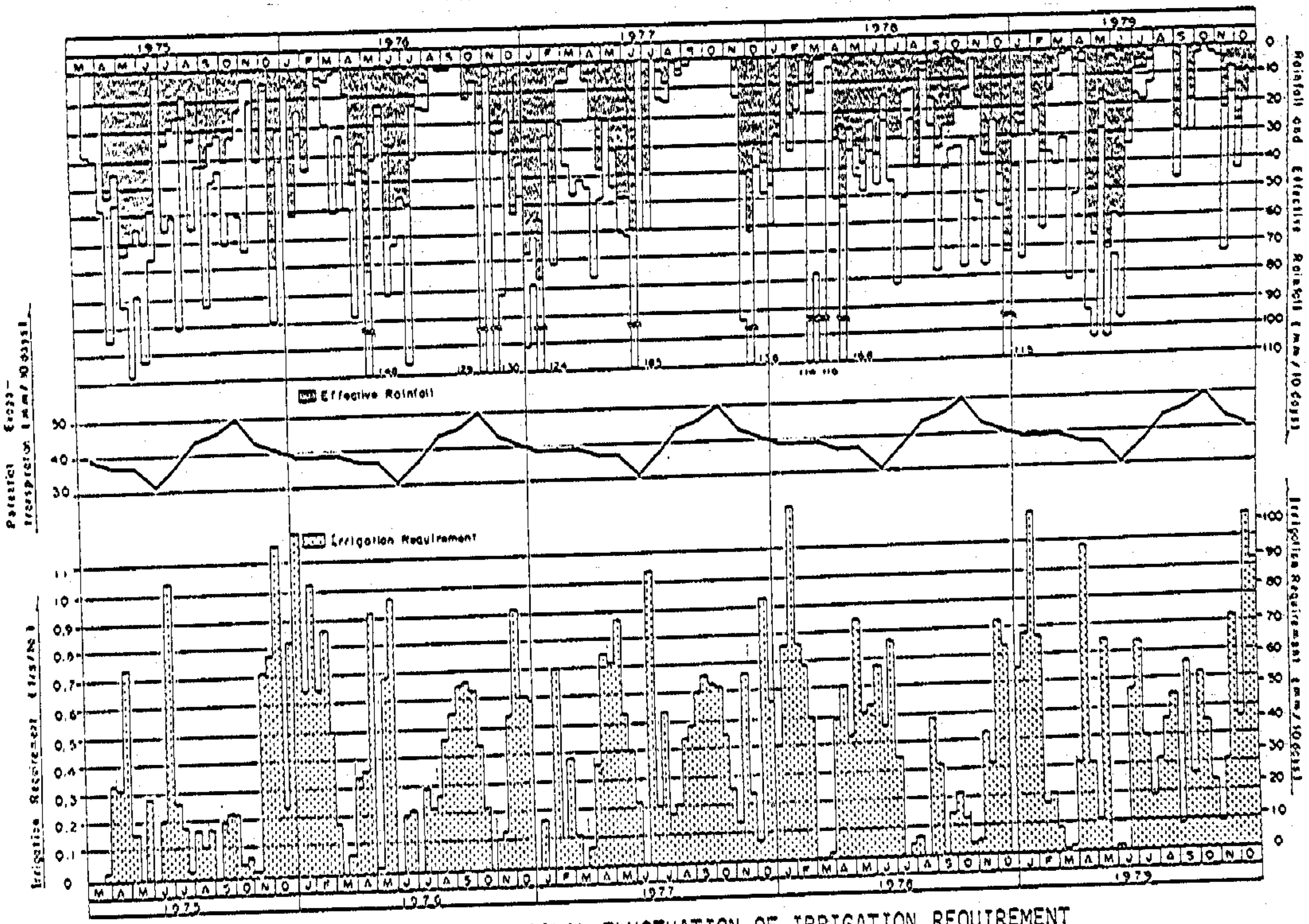


Fig. 5.4.1 SEASONAL FLUCTUATION OF IRRIGATION REQUIREMENT

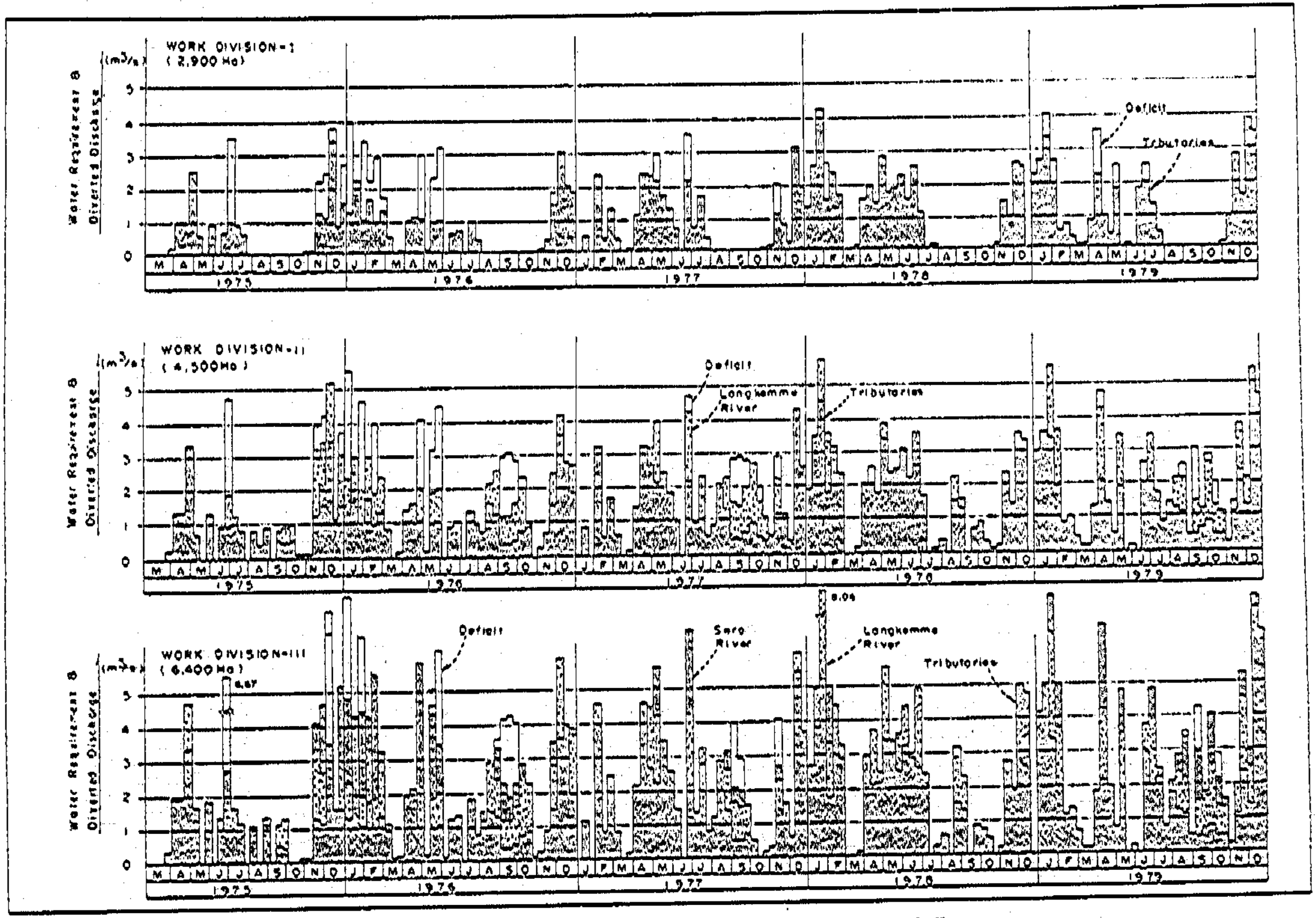


Fig. 5.4.2 SEASONAL FLUCTUATION OF DIVERSION REQUIREMENT AND INTAKE DISCHARGE

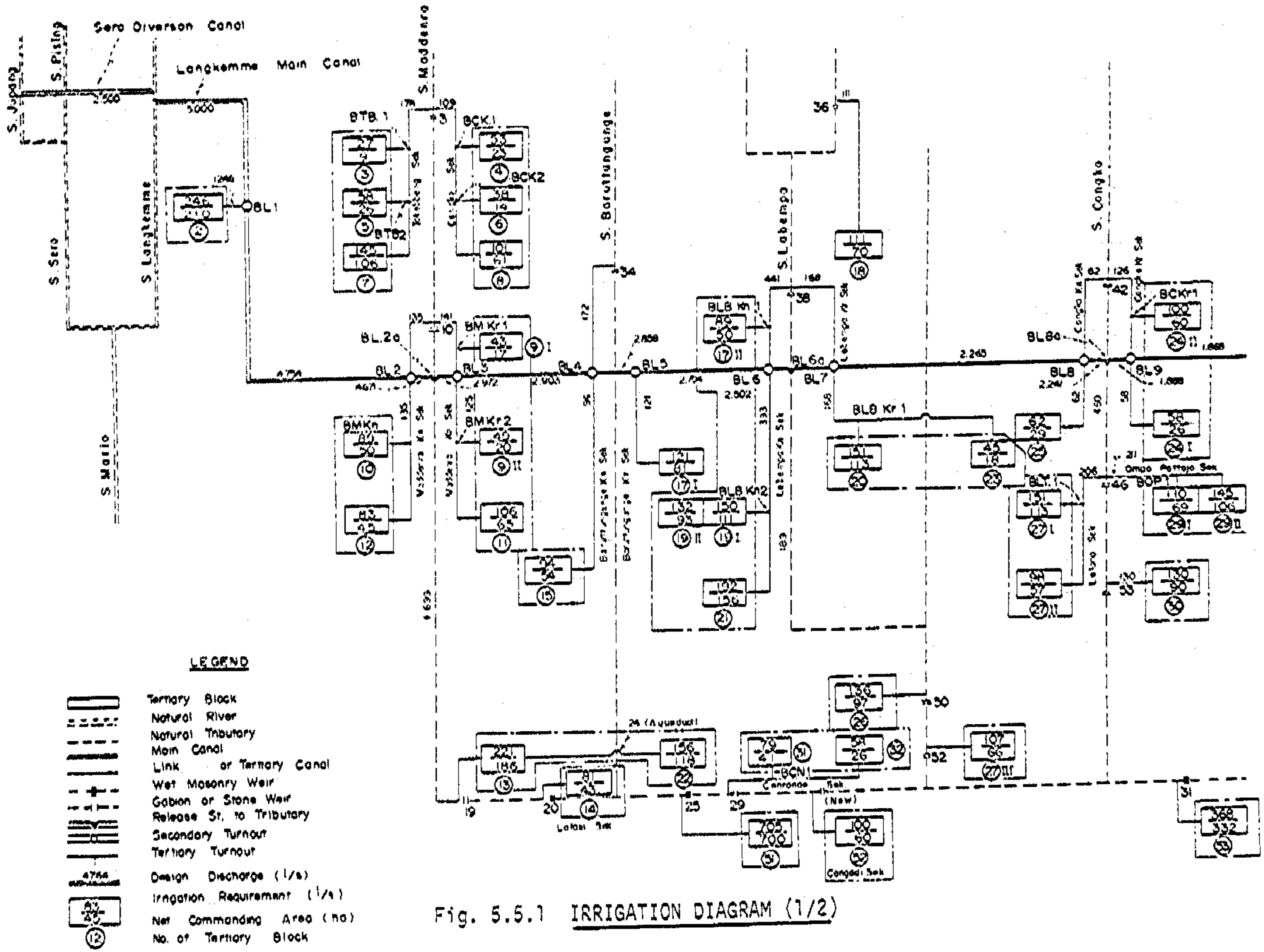


Fig. 5.5.1 IRRIGATION DIAGRAM (1/2)

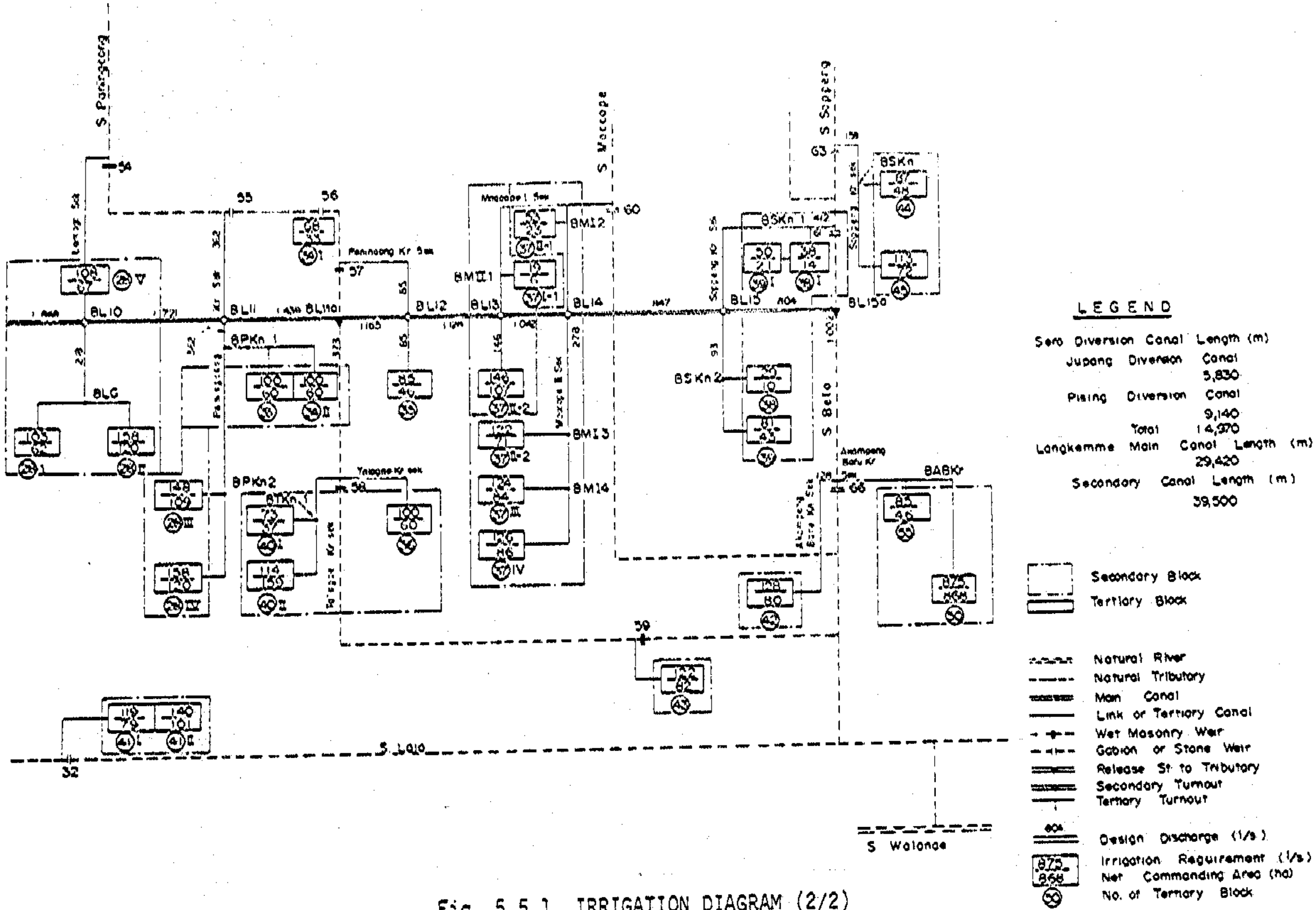


Fig. 5.5.1 IRRIGATION DIAGRAM (2/2)

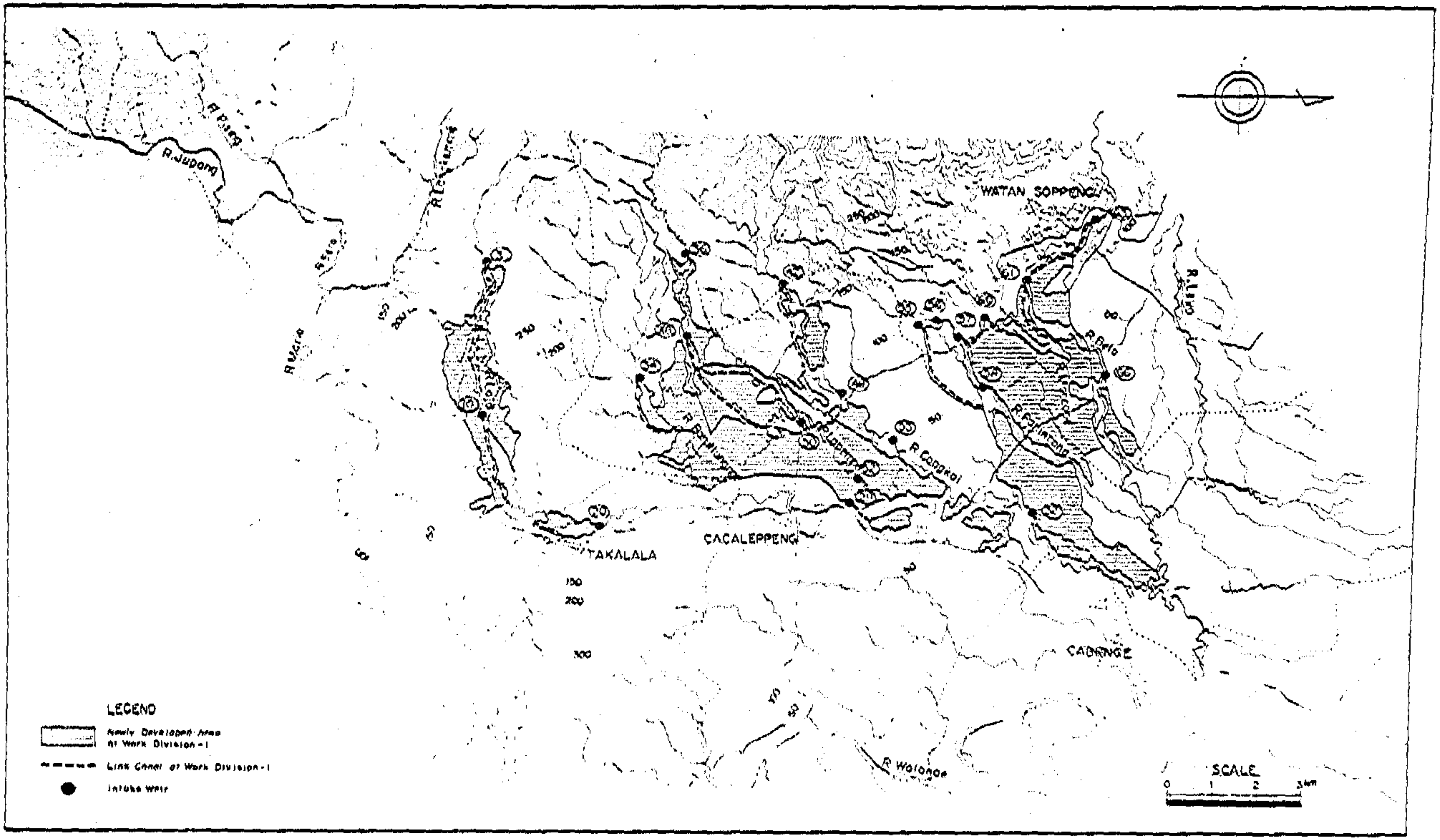


Fig. 5.5.2 PROJECT WORKS, WORK DIVISION-I

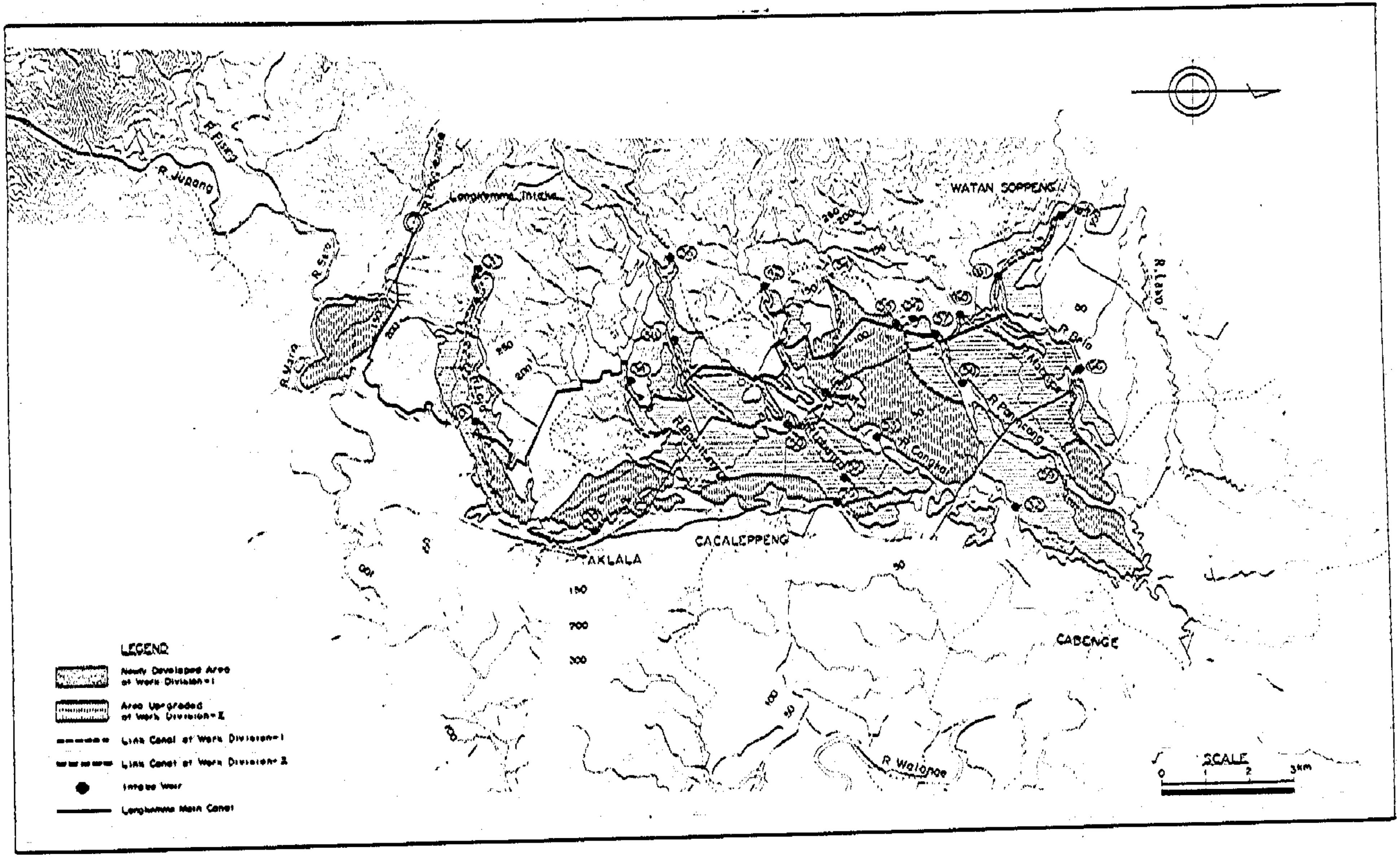


Fig. 5.5.3 PROJECT WORKS,WORK DIVISION-II

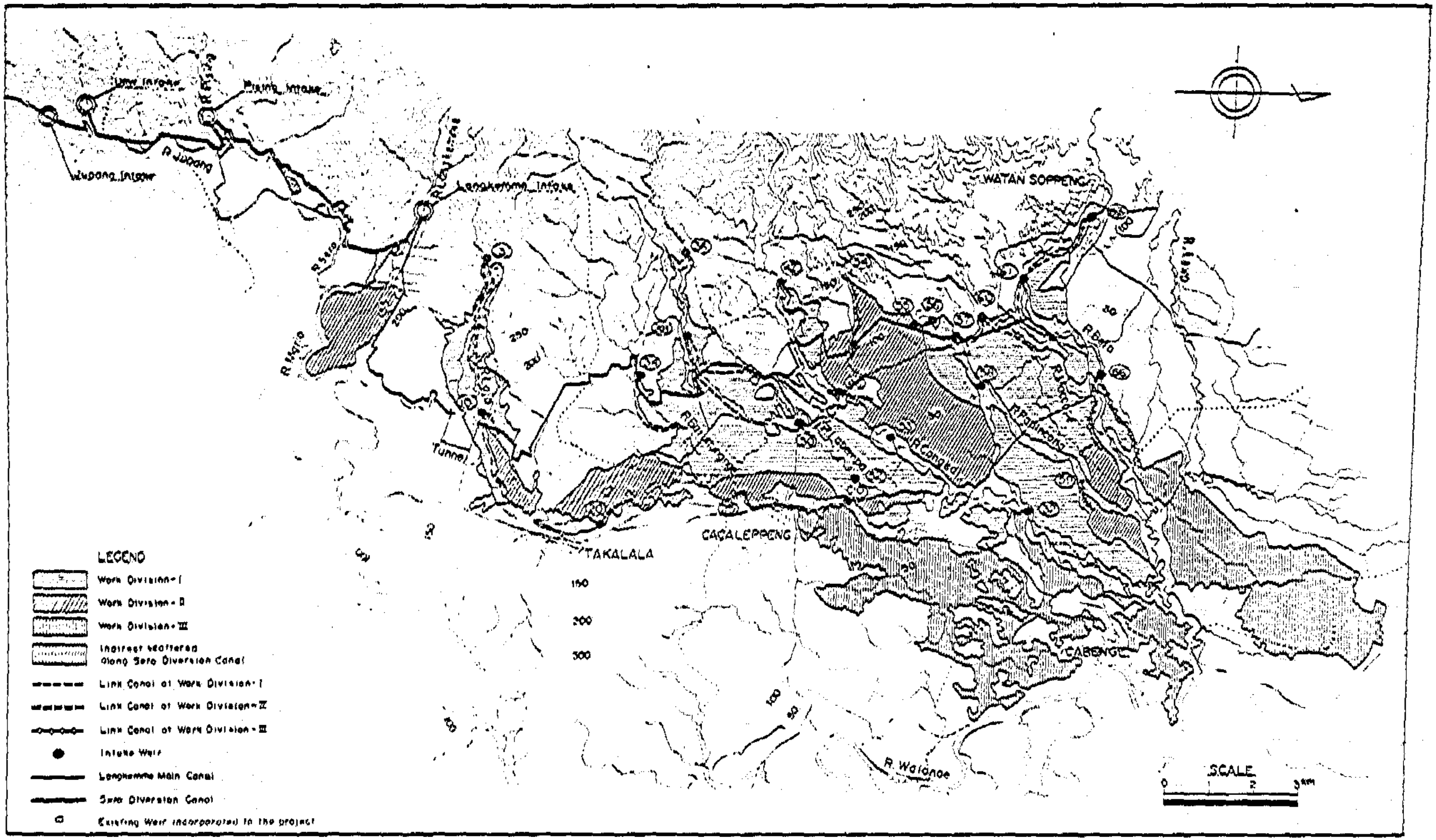


Fig. 5.5.4 IRRIGATION DEVELOPMENT PLAN (WORK DIVISION-III)

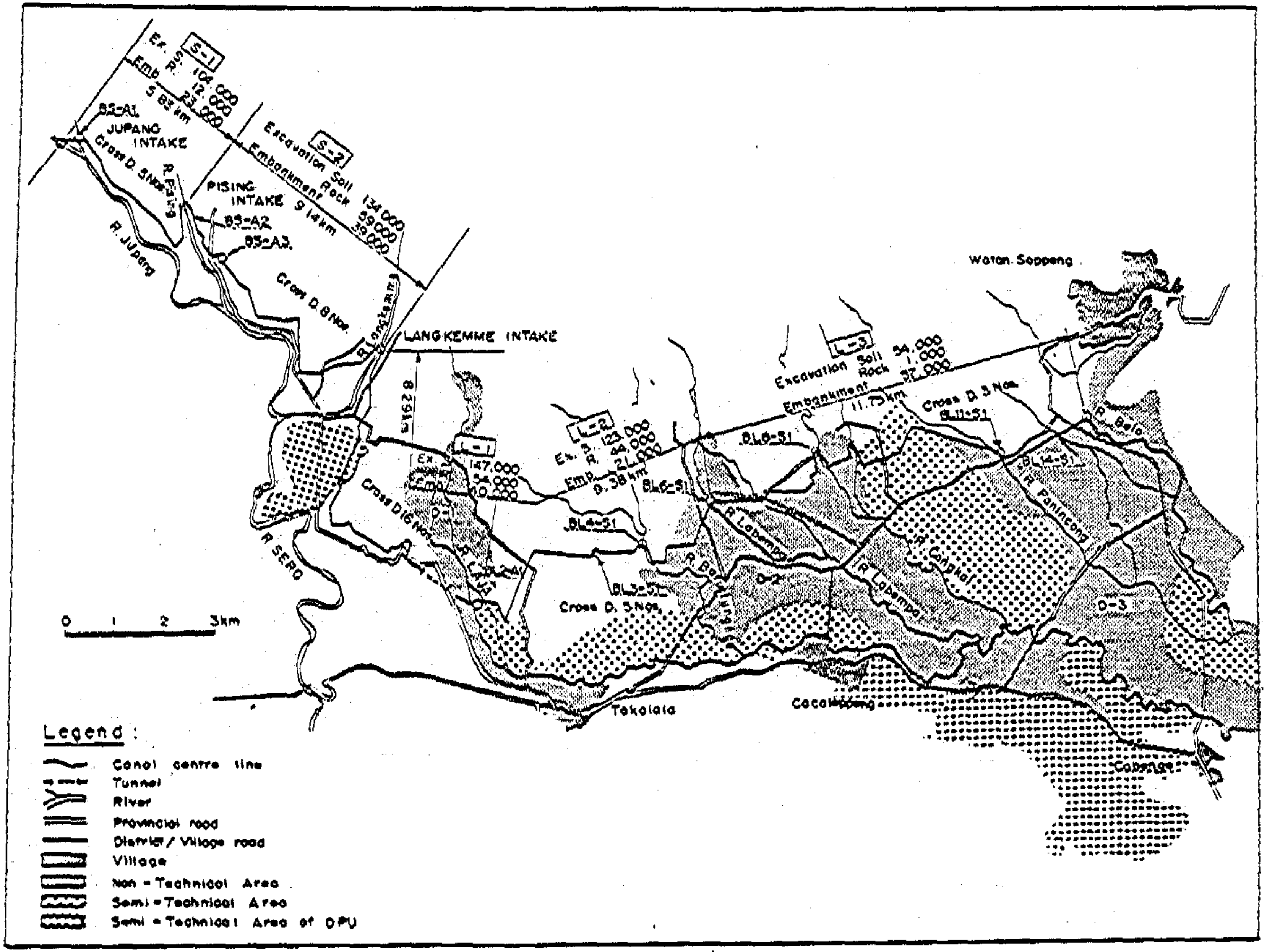


Fig.5.6.1 GENERAL MAP FOR CONSTRUCTION PLANNING

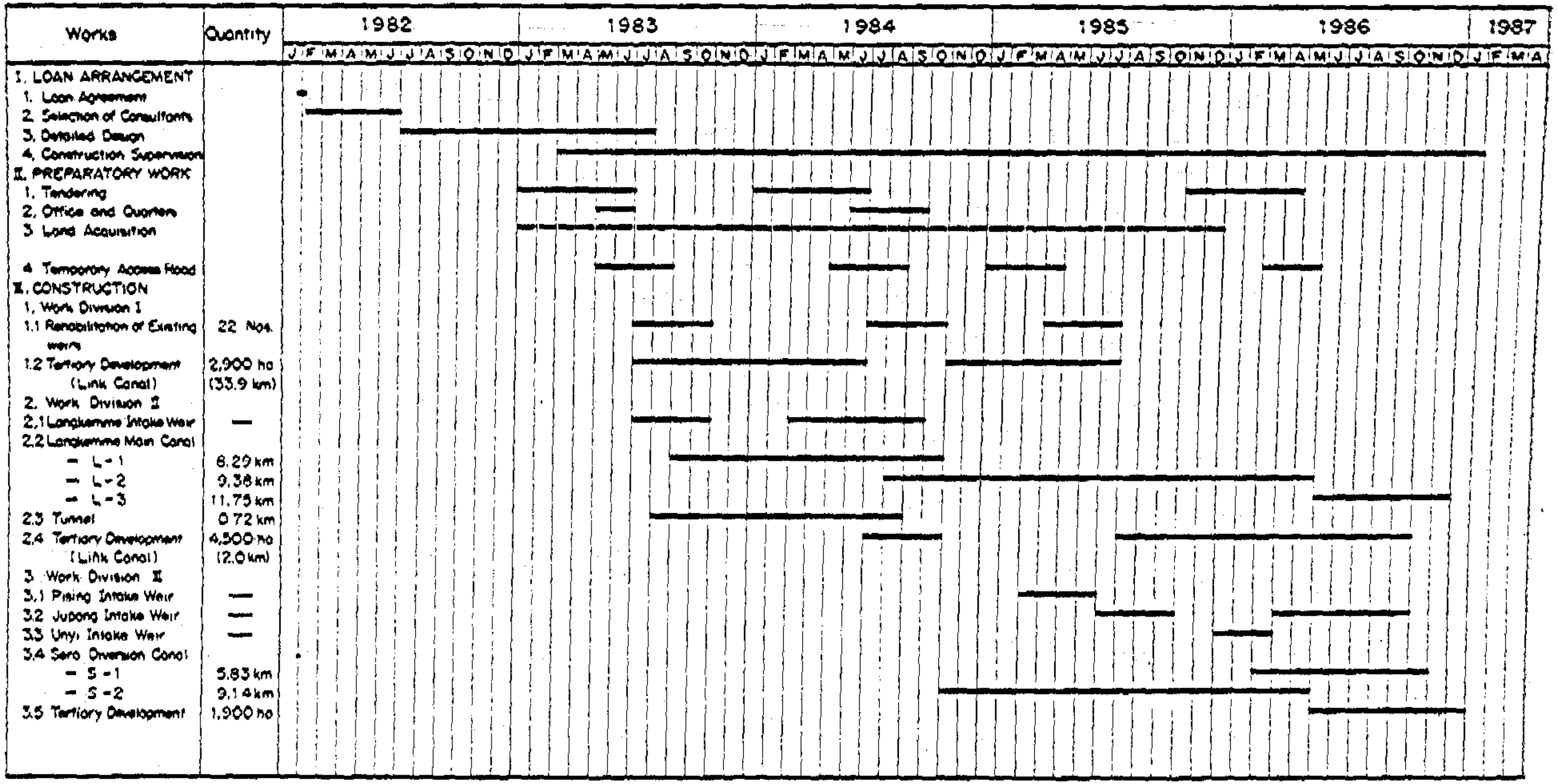


Fig.5.6.2 CONSTRUCTION TIME SCHEDULE

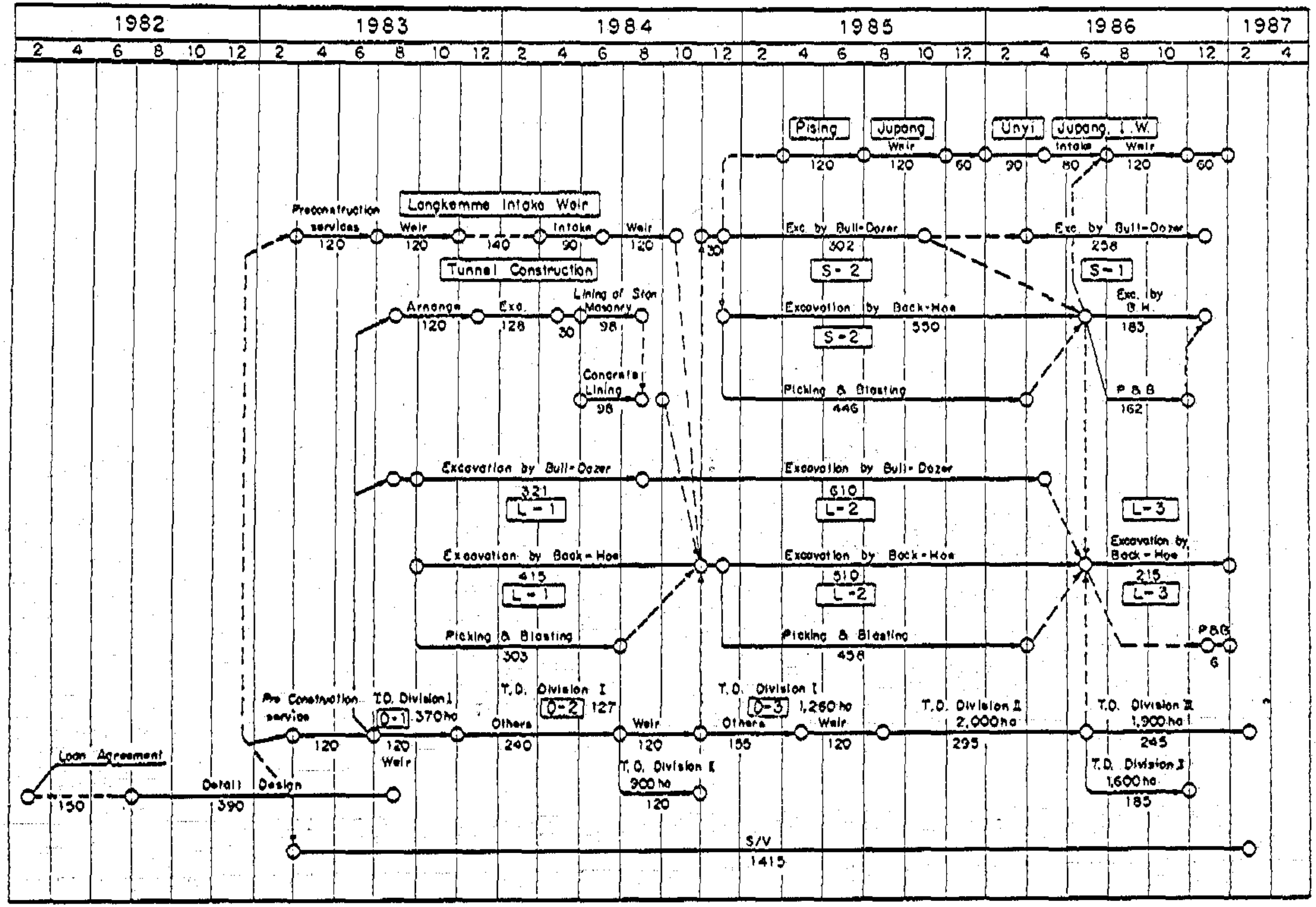


Fig. 5.6.3 IMPLEMENTATION SCHEDULE OF LANGKEMME IRRIGATION PROJECT

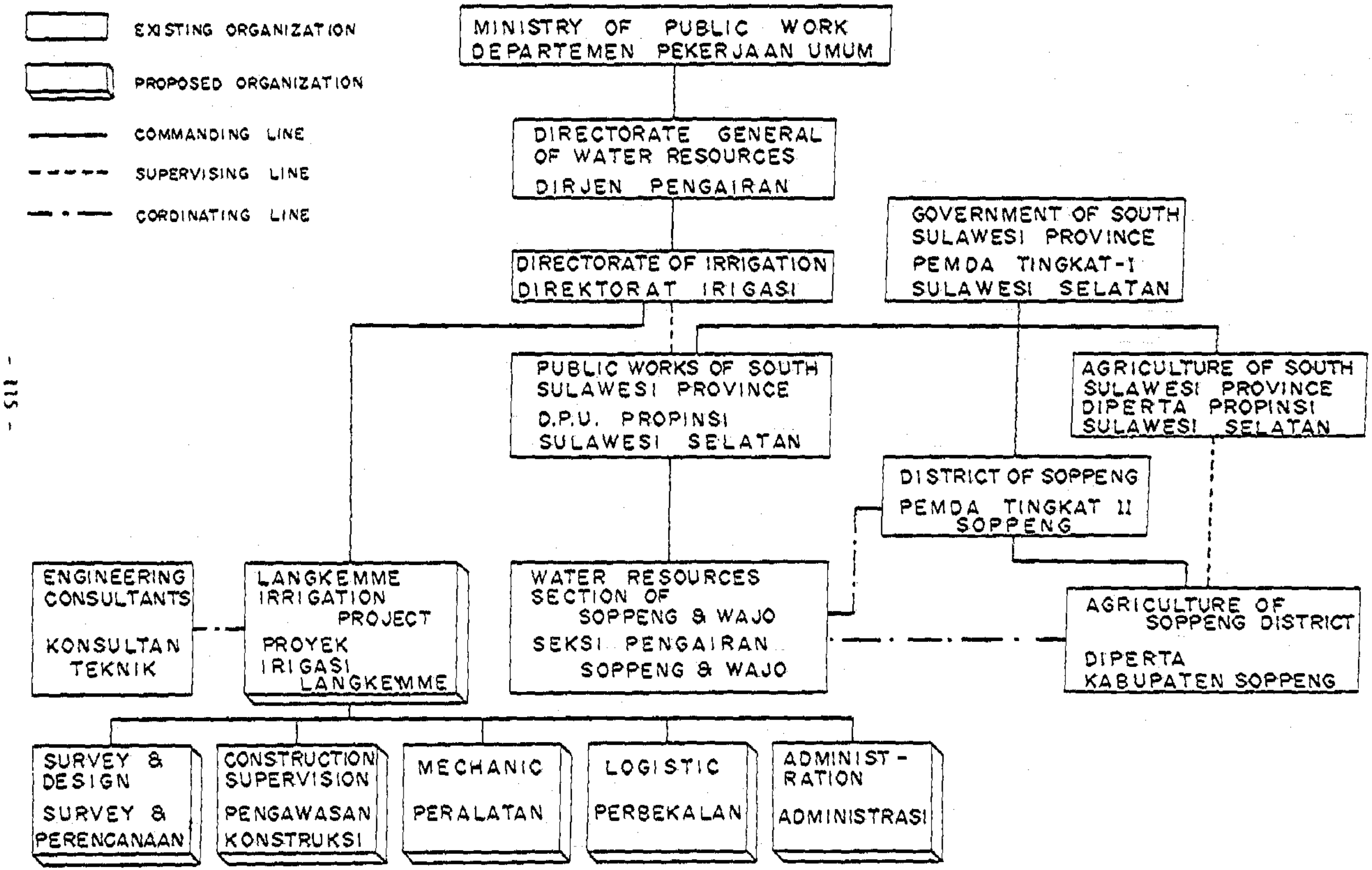


Fig.6.1.1 ORGANIZATION FOR PROJECT EXECUTION

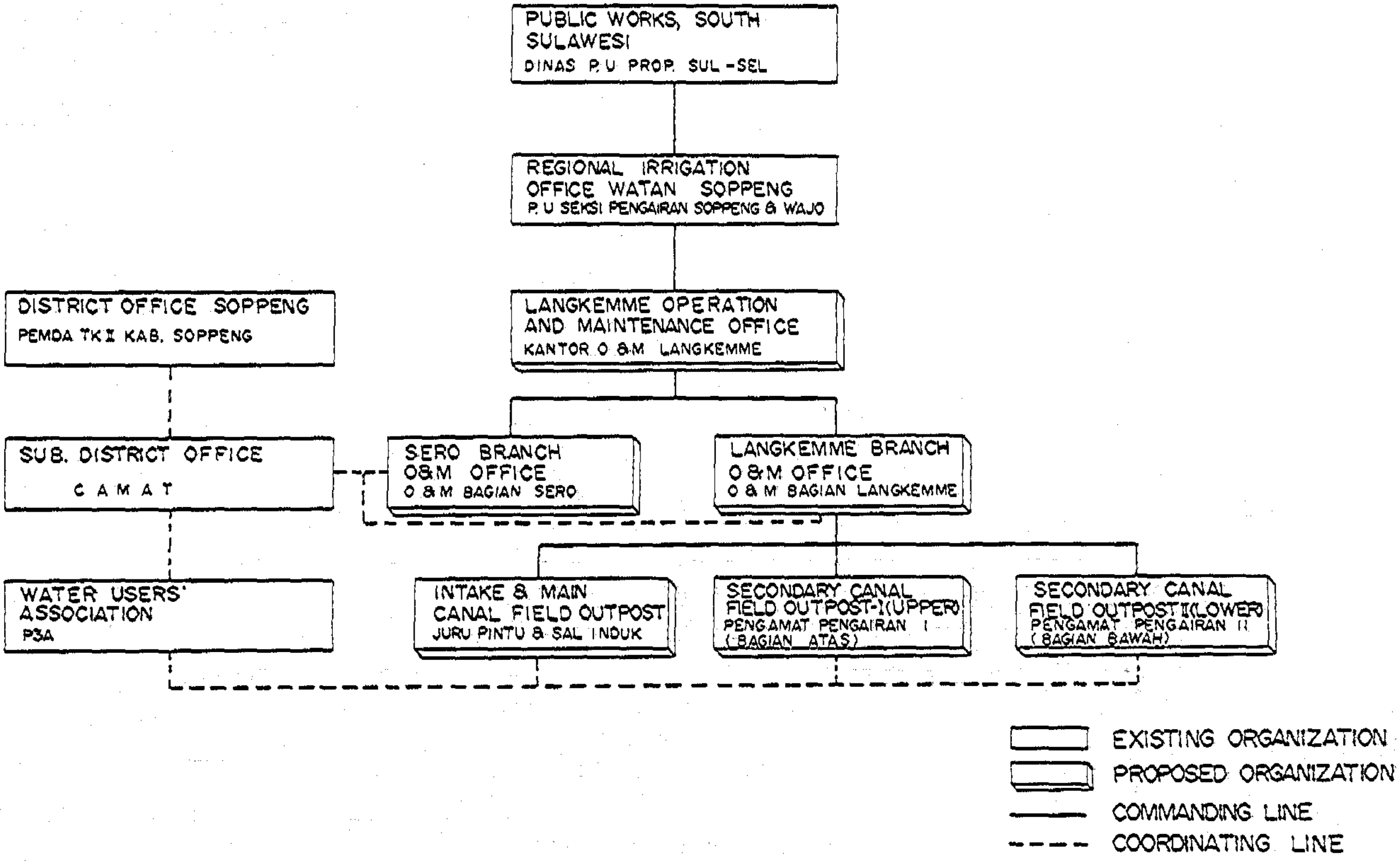


Fig.6.2.1 ORGANIZATION FOR OPERATION & MAINTENANCE

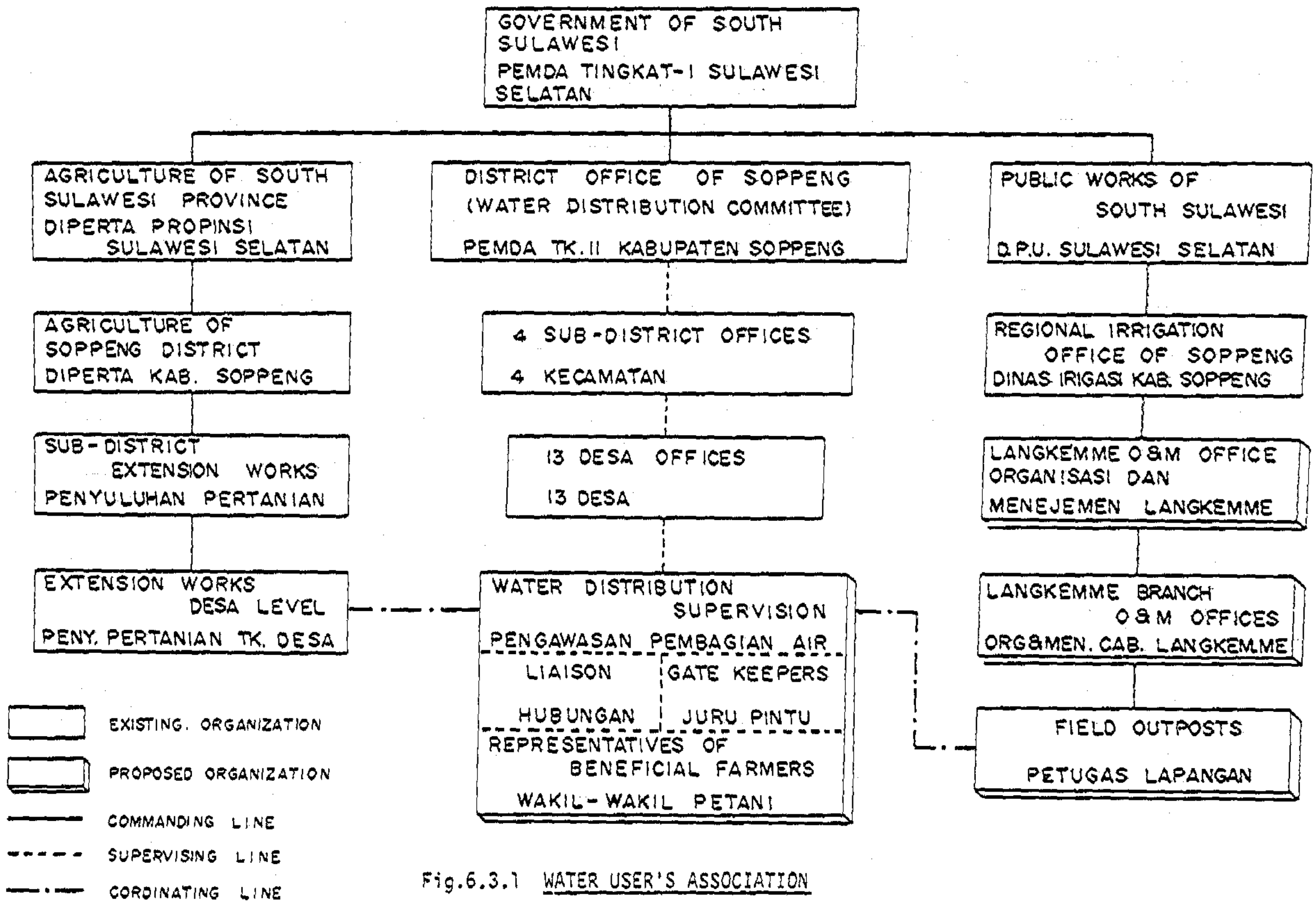
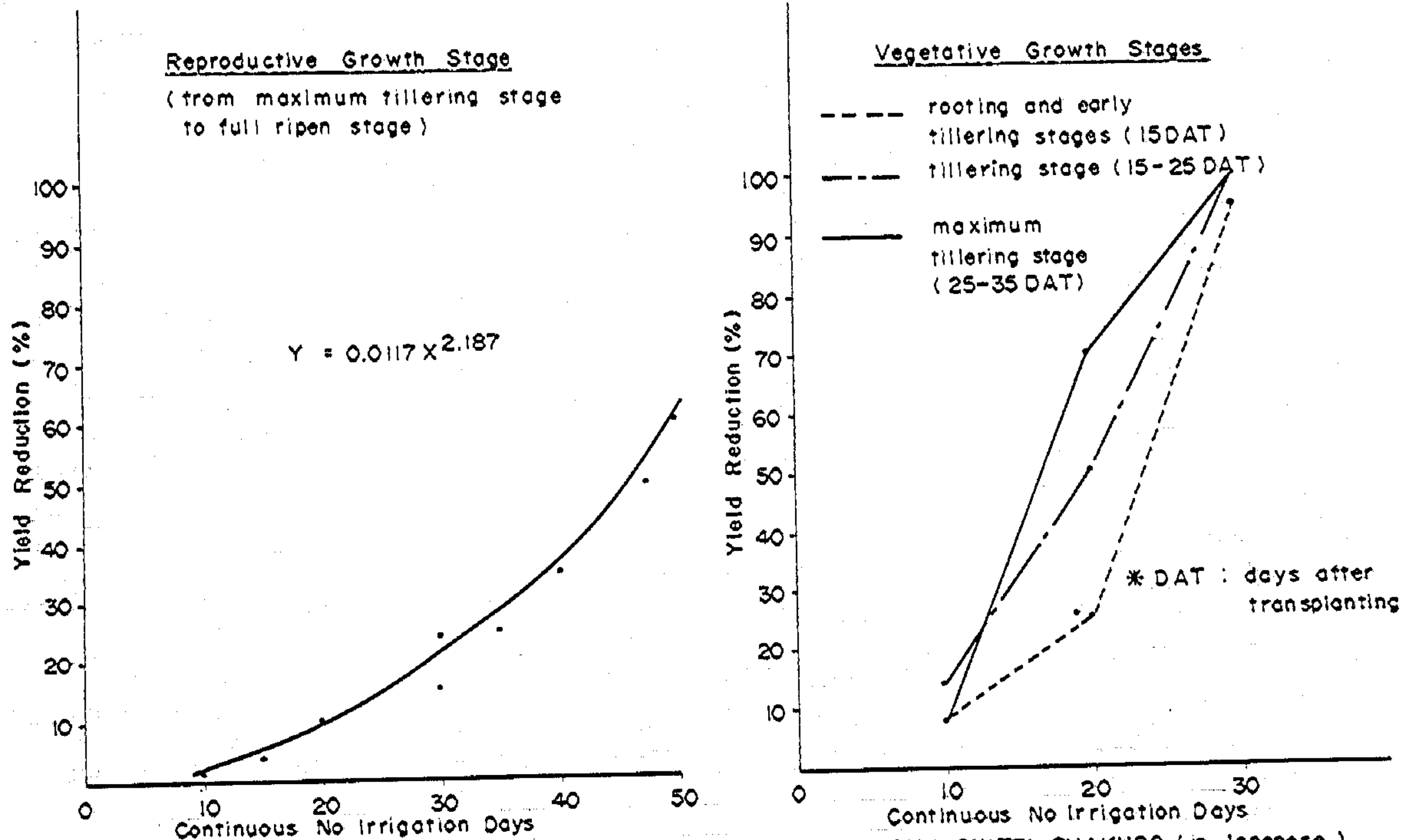


Fig.6.3.1 WATER USER'S ASSOCIATION



Source : NATSUSAKU GENSYU SUITEI SHAKUDO (in Japanese)
Ministry of Agriculture and Forestry, Japan, 1975.

Fig.7.2.1 PADDY YIELD REDUCTION VS. CONTINUOUS NO IRRIGATION DAYS

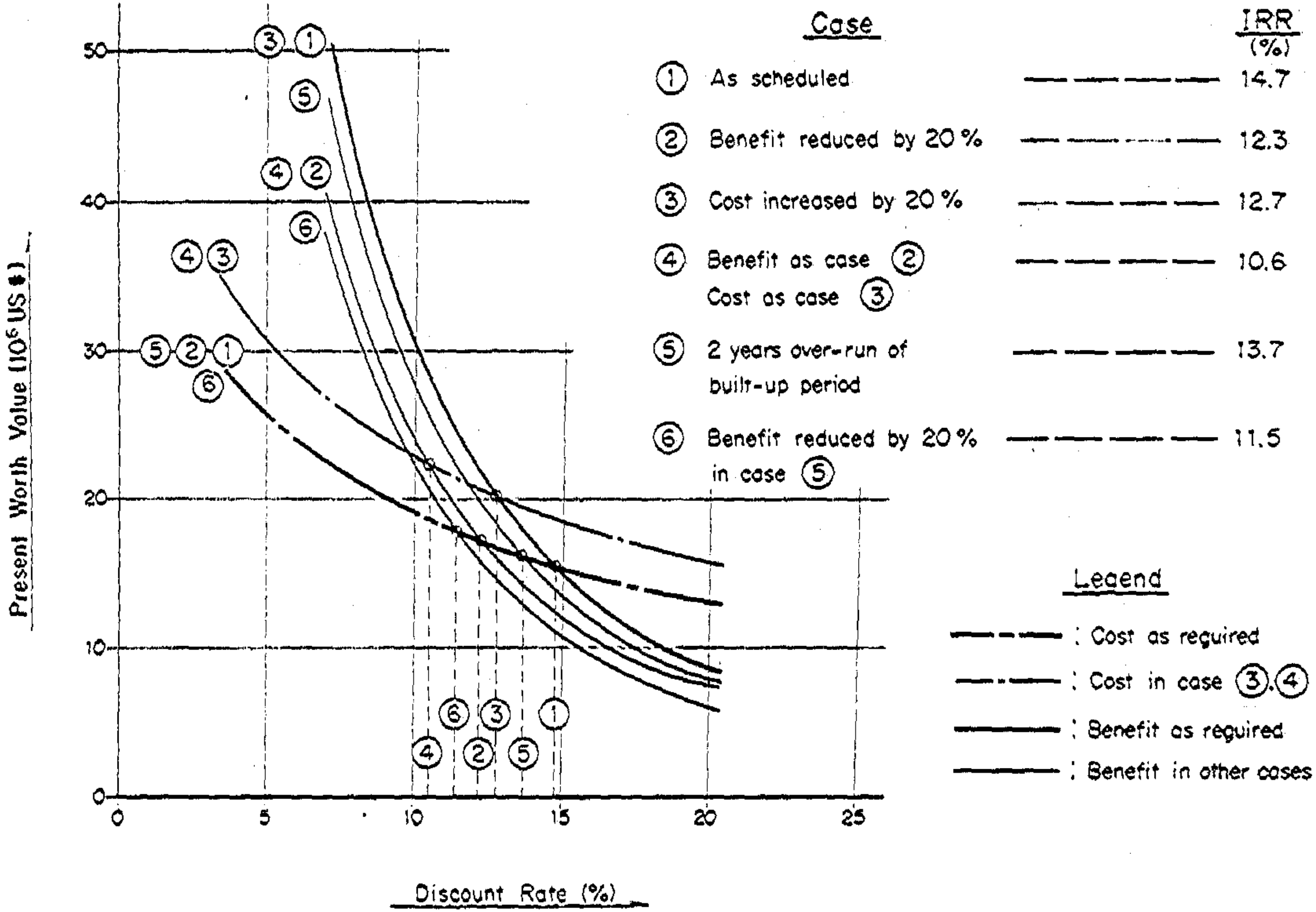


Fig. 7.4.1 SENSITIVITY ANALYSIS

ATTACHMENTS

ATTACHMENT-I PILOT FARM

1.1 OBJECTIVES

The project area is covered with 48 small scale Desa Irrigation schemes which are severally being operated. Most of the schemes still remain non-technical level; the canal density networked in the schemes is low and the canal facilities therein are poorly maintained. Despite the habitual shortage of irrigation water resources, the water management in the respective schemes has not been fully improved yet.

With the completion of the project, the existing schemes would be incorporated in the Langkemme Irrigation system and given a function of the tertiary irrigation block under the new system. Irrigation water is systematically and equitably distributed in the respective tertiary blocks through the newly developed system.

In the most of the project area, double cropping of paddy is practiced at present. Polowijo crops are planted in the very limited area after harvesting the 1st paddy. The farming practices for the polowijo crops are still primitive and their yields are very low.

As compared with the present cropping pattern, rather intensive and diversified cropping pattern has been proposed. The cropping calender comprises paddy-polowijo-paddy; the polowijo crops are planted in the paddy field immediately after reaping the 1st paddy and harvested before planting the 2nd paddy.

In accordance with the anticipated drastic changes of agriculture in future days, the present irrigation and farming practices must be highly improved in the project area. In this view, a pilot farm is essential for the success of the project and would mainly aim at

i) Guidance of better water management at tertiary, quaternary and onfarm level, and

ii) Guidance of proper irrigation and farming practices for polowijo crops as well as paddy.

Very limited farm mechanization has been introduced to the project area so far due mainly to undulating topography, lack of farm road networks, relatively small plot of paddy field, sufficient family labour and low income level of farmers. But some of such constraints would be eliminated in future and the basis for agricultural mechanization would be created in the project area with the implementation of the project. Mechanized farming practices also would be demonstrated in the pilot farm for future days.

1.2 SELECTION OF PILOT FARM

In advance of the selection of site for the pilot farm, four selection criteria are set up according to the objectives of the pilot farm.

(1) Size

One tertiary irrigation block should be selected for guidance of water management practices, a primary objectives of the pilot farm. Tertiary block greater than 100 ha would be eligible for the objectives.

(2) Location

The pilot farm must be stably supplied irrigation water throughout year. In this view, the pilot farm should be located in the vicinity of the upper reach of main canal as far as possible.

(3) Access

Due attention should be paid on the access from trunk road to the farm. The better access brings forth rapid extension of the advanced practices demonstrated in the farm.

(4) Topography

The pilot farm should be provided with relatively flat and gentle topography for the demonstration of mechanized farming practices.

Taking into account of the four selection criteria mentioned above, Labessi-I tertiary block, semi-technical level Desa irrigation scheme at present, is selected for the development of the pilot farm. The Labessi-I of about 180 ha is located at the left bank of upper reach of the Laja river and close to Takalala. The intake structure of the block would be rehabilitated about 2 km downstream from the BL2a, through which irrigation water would be released into the Laja river. The access from Takalala to the block is much easy even at present. The topography of the block is relatively gentle. The location of the pilot tertiary block, Labessi-I is shown in ANNEX-IV.

ATTACHMENT-II ROAD NETWORKS

2.1 EXISTING ROAD NETWORKS

Three provincial roads skirt along the northern, eastern and southern boundaries of the project area. A paved district road traverses the project area northward to southward and furthermore, unpaved district roads are also networked across the paddy field in the project area. In addition, the limited farm roads stretch out from the district roads to facilitate paddy cultivation in the project area. The existing roads extend to about 140 km and the density of the roads is estimated at about 17 m per ha. In the light of the standards of agricultural infrastructures, the density is considerably low for paddy cultivation. The length and density of the existing roads are summarized as follows;

Classification	Length and its Ratio				
	Paved		Unpaved		Total
	m	(%)	m	(%)	(m)
i. Provincial Road	36,100	(95)	2,100	(5)	38,200
ii. District Road	10,300	(13)	67,600	(87)	77,900
iii. Farm Road	0	(0)	24,600	(100)	24,600
Total	46,400	(33)	94,300	(67)	140,700

2.2 FUTURE DEVELOPMENT OF ROAD NETWORKS

The inspection roads of about 67 km would be constructed along the Langkemme main and secondary canals. No additional on-farm road would be proposed in the Langkemme irrigation project in due consideration of current agricultural structure and excessively small land holding size in the project area. After all, with the completion of the project, the total length of the roads would increase to about 208 km, and the density of 26 m per ha would be attained. The inspection roads to be constructed with the project are not connected each other but terminated at tertiary turnouts.

The agricultural structures in the project area might be changed in the future through introduction of mechanized farming and advanced cultivation techniques. Then, farm roads, a major agricultural infrastructure, must be organically networked according to the extension of agricultural mechanization. About 75 km of the road would be additionally extended to fully network the proposed inspection roads; the density of road increases to about 35 m/ha, which sufficiently facilitate advanced mechanized farming. The proposed length and density of the road are summarized as:

Developed Road Length

Stage	Length Paved (m)	Length Unpaved (m)	Total (m)
i. Project Stage	-	67,200	67,200
ii. Future Stage	75,600	-	75,600
Total			142,800

Road Density

Stage	Extended Length (m)	Cross Area (ha)	Density m/ha
i. Existing	140,700		17
ii. Project Stage	207,900	(8,100)	26
iii. Future Stage	283,500		35

The proposed roads at respective stage are skeletonized together with the existing roads networks as shown in ANNEX-IV.

ATTACHMENT-III HYDROPOWER DEVELOPMENT IN THE CANAL SYSTEM

3.1 AVAILABLE HYDRAULIC HEAD

A site potential for hydropower generation is selected in the vicinity of the junction of the Langkemme main canal and the Baruttunge river, where a chute structure is proposed in the scope of the Langkemme Irrigation Project to dissipate excess energy. Based on the detailed topographic survey, it is clarified that about 11 m of hydraulic head are available for power generation at the selected site.

3.2 AVAILABLE DISCHARGE

The monthly fluctuation of the discharge in the main canal is clarified at the proposed site, consequent on the analyses of hydrology and irrigation plan. The available monthly discharge widely ranges from 3.6 m^3/sec on December to 1.3 m^3/sec on September, corresponding to the seasonal fluctuation of the irrigation water requirement in the project area. While, the daily maximum discharge available for power generation is also estimated at about 3.9 m^3/sec.

3.3 DEVELOPMENT PLAN

3.3.1 Output

The generating plant to be installed in the station is given a capacity for peak power generation in due consideration of the fluctuation of irrigation water supply, because no additional water is allocated to the power generating. The generating output ranges by-monthly from 289 kW on December to 83 kW on September; the daily maximum output of 315 kW is expectable at the maximum daily discharge of 3.9 m^3/sec. Annual energy product at the proposed station amounts to about 2,000 MWh per annum.

3.3.2 Preliminary Design

(1) Turbine

The hydraulic turbine to be installed is tubular type with a draft tube. The main features of the turbine are:

i) Speed 500 rpm
ii) Output 315 kW
iii) Draft Head 1 m

(2) Generator

The generator to be installed is horizontal shaft coupled with speed increaser, having 1,000 rpm and being rated at 400 kVA, 320-220 V, 3-phase synchronous generator, 50 Hz and 0.8 power factor.

(3) Transformer

The step-up transformer to be installed is rated at 400 kVA, 50 Hz, 3-phase two windings, 380-220 V delta to 6 kV star connected outdoor, self-cooled type.

(4) Distribution

A single circuit 6 kV distribution line of 8 km is proposed together with step-down transformers and connected to the existing 6 kV distribution line near Takalala.

3.4 INSTALLATION COST

The total cost of the generating equipment and power transmitting facilities is estimated at about US$ 1.21 million, comprising the foreign currency portion of US$ 0.66 million and the local currency portion of US$ 0.55 equivalence.

3.5 ANTICIPATED BENEFIT

The value of the proposed hydropower is measured on the basis of the cost required for the production of the equivalent energy by the least cost alternative means. Two units of diesel engine-generator with a capacity of 320 kW are equivalent to the alternative of the proposed hydropower plant; one unit is considered for stand-by. The capacity value and the energy value are estimated respectively as compiled in ANNEX-III, CHAPTER VIII. Based on the both values, the annual benefit accrued from the proposed hydropower station is estimated at about US$ 0.11 million.

ATTACHMENT-IV WATERSHED MANAGEMENT

4.1 BASIC MEASURE

The watershed of the Langkemme river is relatively well-covered with forests and bushes. There is almost no problem on land and soil conservation in the Langkemme watershed. The watersheds of the Sero river and the seven tributaries of the Walanae river have been progressively reclaimed for shifting cultivation. The forest resources endowed in these watersheds have recently been depleted year by year. In addition to the lumbering by local people, over-grazing of linestock animals has exerted an aggravating influence on the land and soil conservations in these watershed.

Watershed management works mainly comprise reforestation work, erosion control works, and construction of Sabo dam. Reforestation works are much effective for water conservation. The erosion control works and construction of Sabo dam are rather preferable for land conservation. To stabilize the water resources in the both rivers, reforestation work would be given the first priority for the measure of watershed management.

4.2 REFORESTATION PLAN

4.2.1 Recommendable Species

The species of trees for reforestation have to fulfil the following conditions at least:

i) seedlings are easily multiplicated and low-costed
ii) seedlings are multiplicated in short-term, and
iii) seedlings are easily growable under unfavourable natural conditions

In due consideration of these basic conditions, various leguminous trees and Pinus morkusii (Indonesian pine tree) would be selected for the reforestation in the watershed. The leguminous trees would be mainly planted in the periphery of agricultural lands. The Pinus merkusii would be planted in the hilly and mountainous area covered with shallow and infertile soils; it is easily growable even in high altitude area.

4.2.2 Reforestation Area

Area greater than about 70% of entire watershed would be conserved with reforestation works. As above mentioned, the reforestation works would be envisaged in the watershed of the Sero river and the seven tributaries. The area selected for reforestation works amounts to about 18,000 ha, comprising 14,300 ha under the Sero watershed and 3,700 ha under the seven tributaries watershed.

4.3 PRELIMINARY COST ESTIMATE

On the basis of the data and past experiences of DAS projects, the cost estimate is roughly made for the reforestation works of the envisaged 18,000 ha. It amounts to Rp. 575 million (US$ 920,000 equivalence) and the per-hectar cost is about Rp. 320,000 (US$ 510).

4.4 ORGANIZATION FOR IMPLEMENTATION

The reforestation works envisaged herewith should be carried out as the DAS project which is enforced by the Presidential Degree No.8 in 1976. The DAS project aims at reforestation of about 40 million ha of disclosed lands extending all over the territory of Indonesia.

In the South Sulawesi Province, there are three branch offices of the DAS project, namely Jeneberang, Sadang, and Bila-Walanae. These branch offices envisage reforestation works of about 600,000 ha at present. The proposed works would be implemented under this program. The reforestation area under study would be managed by the Bila-Walanae branch office. Further detailed studies on land and soil conservations are given in ANNEX-III, CHAPTER IX.

ATTACHMENT-V MEMBER OF ADVISORY GROUP, SURVEY TEAM AND COUNTERPART

(A) Advisory Comittee

1. Leader	Mr. Katsuhiko Kimura	(Kinki Regional Administration Office, Ministry of Agriculture, Forestry and Fisheries)
2. Irrigation/Drainage	Mr. Jyuzo Wakisaka	(Agricultural Structure Improvement Bureau, Ministry of Agriculture, Forestry and Fisheries)
3. Agro-Economy	Mr. Kunio Tanaka	(Tohoku Regional Administration Office, Ministry of Agriculture, Forestry and Fisheries)
4. Agriculture	Mr. Saburo Negayama	(Agricultural Structure Improvement Bureau, Ministry of Agriculture, Forestry and Fisheries)
5. Economic Evaluation	Mr. Kuniyasu Kadowaki	(The Overseas Economic Cooperation Fund, Japan)

(B) Survey Team and Counterparts

1. Team Leader	Mr. Hiroshi Yamamoto	Ir. Syamsul Arida
2. Irrigation Planning Engineer	Mr. Kuninobu Noda	Mr. Suharman
3. Irrigation Design Engr.	Mr. Kiyotaka Mizushima	Mr. Islamuddin M.
4. Pedologist	Mr. Naoki Ariga	Ir. Hanurung
5. Hydrologist	Mr. Tomeo Ohta	Mr. Syarifuddin Mr. Singkir Alam
6. Agronomist/Agro-Economist	Mr. Fumihiro Nagao	Ir. Iskandar Drs. Syafiuddin M. Drs. Suwardy AP. Mr. Gazaly Nurdin
7. Soil Mechanical Engr./Construction Materials Expert	Mr. Michimasa Menjyo	Mr. Hasbi Tuanaya
8. Construction Planning Expert	Mr. Yoshimitsu Yukawa	Mr. Rasyid Baeda Mr. Kamrin
9. Electric Engineer	Mr. Kunio Ando	Ir. Edy Warhyono Mr. Nur Alim
10. Geologist	Mr. Takao Nishio	Mr. Sriyatno Mr. Syamsul Qamar
11. Survey/Design Engineer	Mr. Masahiko Iwama Mr. Takashi Seki	Mr. Amar Asmara Mr. Ramli M. Nur BE. Mr. Abd. Rasyid M. AR. Mr. Abd. Wahab Th. Mr. Abd. Rauf CH. Mr. Abrau Mr. Arifin
12. Environmental Assessment Expert	Mr. Seiji Ando	Ir. Parijo
13. Administration		Mr. A.P. Ridwan Mr. Badjras

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