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LAMPUNG BRACKISH WATER POND PROJECT

FEASIBILITY STUDY

CHECCHI AND COMPANY
1730 Rhode Island Avenue, N. W.
Washington, D. C. 20036

November, 1976

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PART ONE

INTRODUCTION AND SUMMARY

PART ONE: INTRODUCTION AND SUMMARY

A. INTRODUCTION

On June 9, 1976 the United States Agency for International Development signed a contract with Checchi and Company to conduct a feasibility study of a pilot brackish water fisheries project in Indonesia. The venture was to be located on about 3,000 hectares of land in Lampung Province on the eastern coast of Sumatra and immediately south of the Sekampung River. If the area south of the Sekampung River did not prove satisfactory for fish culture, then adjacent areas were to be investigated and their potential for a feasible venture assessed.

The contract called for specialist services in determining the technical, economic, and social feasibility of the Lampung project. Among the issues to be addressed were site suitability, recommended technology, construction labor and input availability, marketing prospects and mechanics, and training and extension programs. In addition, land development and water management plans were to be prepared. Estimates of construction and operating costs of the recommended system were to be used to calculate the internal rate of return on investment on a social return basis as well as cash flow projections for individual project participants.

This report documents the findings of the specialists who participated in the study. It is presented in three parts and five appendices. Part One provides a brief synopsis of the proposed project, and summarizes the team's key findings and recommendations regarding the development of brackish water fisheries on the sites selected for investigation in this study as well as elsewhere on the Sumatran coast. Parts Two and Three contain analyses of the technical and economic/social feasibility of the project respectively. Included are discussions of the site, the appropriate fish culture technology, project design, project management, and social and environmental considerations, along with an evaluation of the project's economic viability from both societal and individual points of view. These analyses are supported by more detailed reports prepared by the five specialists on the study team, which are attached on the following appendices:

Appendix A	Aquaculture Specialist Report
Appendix B	Engineering Report
Appendix C	Social Soundness Analysis
Appendix D	Economic and Marketing Analysis
Appendix E	Tidal Hydraulics

B. PROJECT DESCRIPTION

The proposed project is part of a fisheries development plan envisioned by the Indonesian Directorate General of Fisheries to supply infrastructural, financial and organizational support to tambak (milkfish) farmers currently living in Java, where production is limited by their inability to obtain the inputs needed to practice improved fish cultural technology. The Government (GOI) would provide incentives for them to relocate to other areas of the country, where the land and technology they require to attain higher productivity levels could be made available.

In order to realize this plan, the GOI has requested the U.S. Agency for International Development to assist with the design and implementation of a brackish water fishfarm project in Lampung Province, which would serve as a model for subsequent developments throughout Indonesia. USAID would make loan and grant funds available for construction and technical assistance. Indonesian Governmental agencies would assume responsibility for resettling project participants, constructing local infrastructure and demonstration ponds and supplying operating loans to farmers.

The proposed Lampung fisheries project was designed to provide transmigrant fish farmers with more extensive areas for cultivation, technical and financial assistance from governmental and banking institutions, infrastructure facilities, and housing. In addition to increased family earnings and improved standards of living, anticipated benefits included:

- The transfer of improved technology for brackish water fish culture;

- An increase in the contribution of brackish water ponds to national fish production;

- An increase in per capita fish consumption; and

- Development of the potential of milkfish as an export product.

It was anticipated that the project objectives could best be achieved by converting 3,200 hectares of unused swampland to tambak production, and by providing 1,200 poor, fishfarm families with 2.5 hectare production units each.

C. KEY FINDINGS AND RECOMMENDATIONS

The team's principal findings and recommendations are as follows:

- Project Technical Feasibility

  - The two sites identified for investigation by the project team are not suitable for tambak operations. The site on the southern side of the Sekampung River is of insufficient size to accommodate more than 1,800 hectares of fishponds. The site to the north of the river is characterized by uneven ground surfaces, which would be too expensive to level and develop.

- Provided that a suitable site can be located, climatological and hydrological conditions prevailing in Lampung Province and its coastal waters are considered favorable for tambak farming. However, tidal amplitudes along the cost of the Java Sea are generally too low to permit technical water management by gravity flow. Pumping is a feasible alternative where waters fluctuate between -0.25 meters below and +1.5 meters above sea level, and where storm waters can be diverted to separate canals.

- The technology recommended for the Lampung project is based on three production cycles per year. As long as adequate fry supply, pesticides fertilizers, and financial and marketing support can be made available to the project farmers, it should be possible to increase fish production from current levels of 300 to 400 kilograms per hectare to 900 kilograms per hectare on an annual basis.

Economic and Social Feasibility

- Project investment costs in current prices range from a low of Rp. 3,072,748 (US$7,413,000) to Rp. 3,877,666 (US$9,356,000), based on whether 2.5 or 5.0-hectare ponds are developed, and on whether hand labor or machine methods predominate in the construction of the dikes and canals. The least-cost alternative is that which provides for the construction of five-hectare ponds by machine methods. However, this alternative will accommodate only half as many families. The projected inflation of 15 percent annually will of course increase both cost and revenue estimates.

- Project economic rates of return, which treat family labor as a benefit rather than as a cost, vary from 10.9 to 13.0 percent, with the most favorable return generated by investment in five-hectare farms constructed by machine methods.

- When wages to family labor are deducted from net surplus flows, internal rates of return decline. In order for these returns to compare favorably with the opportunity cost of capital in Indonesia, and for the project participants to earn an adequate living from their activities, the farms must be a minimum of five hectares in size, and the project will be able to accommodate no more than 580 pond operators and 25 technicians and their families.

- When employment benefits arising from the project, but external to net surplus flows, are taken into account, rates of return increase to between 19.5 and 22.9 percent, depending on project investment costs.

- The resettlement of project participants must be closely programmed and monitored to ensure that the rate of transmigration does not exceed the absorptive capacity of the infrastructure, and that the transmigrants are included in the project development and management process.

PART TWO

TECHNICAL ANALYSIS

PART TWO: TECHNICAL ANALYSIS

A. SITE CONSIDERATIONS

The site originally proposed for study by the project team is located south of the Sekampung River, extending approximately eight miles along the coast of the Java Sea and about one kilometer inland from the coast. However, information obtained during field and air reconnaissance surveys of this site indicated that no more than 1,800 hectares were available for fishpond development. In view of the anticipated size of the project, which calls for a production area of 3,200 hectares, it was decided to concentrate site investigations on the northern side of the river, which was found to have an area large enough to accommodate the ponds and human settlements. A further advantage of the more northern location was its accessibility to the site of proposed infrastructure facilities in Maringgai.

The selection of the study site was made without the benefit of information on its physical and environmental characteristics. This information was subsequently collected and evaluated by members of the project team, whose findings are summarized below.

1. Site Characteristics

From available literature, observations and tests conducted on site, conclusions have been drawn regarding the physical and environmental conditions existing in the project area. Details of these analyses are found in Appendices A and E to this report. A synopsis is provided below:

a. Topography

Along the coast and extending inland for about one-half kilometer the topography of the proposed site appears generally flat and slightly above sea level. This area comprises the project greenbelt, which is to be reserved for purposes of coastal and environmental protection. Beyond the greenbelt, the project area slopes rapidly downward and forms a series of bowls, the bottoms of which are up to 4.75 meters below mean sea level. In some areas, the slope is as much as four meters per kilometer downwards. These low elevations, combined with the uneven nature of the ground surface, indicate that the site investigated north of the Sekampung River is unsuitable for aquaculture.

A major portion of the project site is covered by heavy vegetation with scattered thickly wooded areas. Big trees are difficult and expensive to remove, and may delay completion of the project. However, the local Public Works Office has verbally expressed its willingness to allocate monies from its forthcoming budget to cover part of the clearing costs. It is also possible that the sale of logs taken from the site may offset the cost of clearing to stumping, although a logging contractor who will agree to this arrangement has yet to be found.

b. Plankton

Analysis of plankton samples collected from four representative stations on the coast of the Java Sea and close to the project site reveal a normal plankton population typical of estuarine conditions, consisting of both marine and fresh water forms. The Sekampung River brings the fresh water plankton to the coastal region where they intermix with marine varieties, producing a heterogenous mixture of rich plant and animal materials needed for the nutrition of fish. The ecological conditions in estuarine environments favor all forms of biological activity including spawning. Thus, milkfish by nature come to spawn in coastal waters.

c. Soil

Soil samples obtained from the proposed site reveal a combination of sandy-muddy and clay-loam in various sampling areas with clay-loam predominating. The percolation loss through clay soil is assumed to be one mm per day. [1/] Such soil is the ideal type for fish pond development due to its high water holding capacity. As the site is on virgin land, there is no doubt that the upper ground layers contain large amounts of organic nutrients.

d. Climate

An examination of climatological data for Lampung Province covering the project site indicates that the climate is relatively stable and, therefore, conducive to the development of plankton in a fishpond environment. Interviews with long-time residents of the area reveal that floods, typhoons and other natural cataclysms are a rare occurrence in this part of Lampung Province. There are no records to indicate the extent of periodic flooding of the Sekampung River, the only river close to the project site.

e. Hydrology

Averages from water quality sampling tests made during the months of July and August indicate that values for dissolved oxygen, pH, turbidity, water temperature, and air temperature fall within the optimal ranges for the normal development of milkfish during the period of growth in brackish water ponds. These values also favor growth of benthic algae, plankton, diatoms and some of the higher filamentous forms, which constitute the principal food of milkfish.

1/ "Design criteria, Irrigation and Drainage" - Engineering Consultants, Inc. The Citanduy River Basin Development Project, Banjar, 1976.

Salinity measurements taken near the site of the proposed inlet channels to the project ranged from 25 to 31 ppt, indicating the diluting effect of the Sekampung River as far as 20 kilometers from its mouth. This salinity range is acceptable for brackish water fish culture. Surface water salinities in the Sekampung River adjacent to the project area run from 4 ppt upstream to about 9 ppt at Sekampung on an ebbing tide, which are too low for use in filling fish ponds.

Groundwater levels in the project area appear to range from zero to one meter below ground level. The groundwater in shallow wells in the project area is slightly saline. Domestic water supply is obtained from shallow (1-2 meters) wells where possible, but in many cases the groundwater salinity is too high and fresh water must be imported from inland.

f. Tides

The tidal prism in the Sekampung River extends to well above the project area. The tide is mainly diurnal with an average tidal amplitude of 60 + 5 cm. Coastal tidal currents are northward during the ebbing period of the river.

Tide gauge readings taken in July, 1976, indicate that tidal amplitudes in the project area are too small to permit efficient filling and draining of a large number of fish ponds by gravity. Pumping will therefore be necessary if more than 5 ha of fish ponds are to be filled and drained per canal.

2. Implications for Project Feasibility and Design

Both sites investigated by the project team were found to be unsuitable for brackish water fisheries development. The site to the south of the Sekampung River was rejected because of insufficient area suitable to a venture of the size specified by the GOI and USAID. A larger area to the north of the river was then examined but had to be ruled out because the topography proved to be unsuitable.

An examination of climatological and hydrological data for Lampung Province and its coastal waters indicates that such conditions are favorable to tambak culture, provided that a more suitable site can be found. Before additional sites are considered for development, however, information on ground elevations and tidal fluctuations should be collected and carefully assessed. The following physical and environmental parameters should also be kept in mind:

- Gravity aquaculture projects operated with tidal fluctuations of less than 1.5 meters are marginal because they make proper water management difficult. Areas with fluctuations of less than one meter are not recommended unless an input-output pumping system is included in the project design.

- Pumping is a feasible alternative to gravity where waters fluctuate between -0.25 meters below and +1.5 meters above sea level. However, the use of pumps for drainage is not appropriate if storm waters cannot be diverted to separate canals.

- Where the salinity of river waters falls below 15 ppt, ponds should be filled by means of canals running inland from the coast. Care must be taken when constructing and operating such canals to remove mud deposits in canal inlets.

- Level terrain is most conducive to fishpond development because it requires a minimum of digging and excavation work, and thereby limits the amount of fertile top soil that must be removed. Open areas with sparse vegetation are less expensive to clear and prepare for pond construction.

- Swamp lands, marshes, tidal flats and mangrove areas are considered good sites for the construction of nursery pond systems. In these areas an abundance of microscopic flora and fauna are found which serve as the natural feed for milkfish fry. Mangrove trees also form good protection for dikes because they act as buffers to minimize the destructive effects of wave action.

B. PRODUCTION CHARACTERISTICS AND CONSTRAINTS

Through visits to selected tambak facilities and analysis of the findings of an IBRD fisheries project supervision mission to Indonesia in 1975, [1/] the team assessed existing levels of fish production technology in the Lampung area and identified a number of factors limiting the potential for increased yields and higher farmer incomes. A summary of the most significant of these constraints is provided below, along with recommended steps to reduce their impact on the proposed project. Additional details on technological guidelines and practices that should be adopted by the project farmers may be found in Appendix A to this report.

1. Characteristics of Existing Tambak Production Technology

Private fishponds in Java and Lampung generally range from 0.8 to about 3 hectares. The small size of individual holdings coupled with the fact that the majority of fish farmers practice inefficient methods of tide water stocking and crude pond management procedures result in annual yields that are consistently low, averaging about 300 to 400 kg. per hectare. Productivity is further inhibited by understocking of ponds, which is inevitable in view of the limited availability of fry and fingerling stock.

A large majority of Indonesian fish farmers still cling to antiquated methods of farming. Fertilizers, pesticides, and supplemental feeds are rarely used. Those who depend entirely on natural stocking have stocking rates that are far too low, in part because tidal waters bring into the ponds large numbers of fish predators which devour the young fry and compete with the bigger ones for food and space.

1/ Appraisal Mission and Fisheries Project Supervision Mission to Indonesia, Aquaculture Specialist Report to IBRD, 1975.

Low tidal fluctuations, such as occur along the coast of Lampung Province, make it difficult for farmers to institute efficient water management practices needed to avoid abrupt changes in the chemical and physical conditions in the pond which may lead to mass killing of fish. Also, low tidal fluctuations do not permit complete pond drainage, an operation necessary for pest and predator control as well as for the growth of benthic algae. While mechanical pumps can be used to drain and refill the ponds, small fish farmers generally do not have the resources to purchase this type of equipment. Most also lack an understanding of the importance of scientific water quality analysis in maintaining normal physical and chemical standards in brackish water habitats.

The cultivation of small pond holdings yields barely enough income for a farmer to maintain his family, let alone the capital to expand and modernize his facilities. Even where credit financing is available, the small operator may be reluctant to institute any innovation or improvements in view of the scarcity of inputs (fertilizers, supplementary feeds, fry) and the fact that he has little chance of increasing the size of his holdings.

Fish farmer incomes are further reduced by the 15 to 20 percent wastage that occurs between harvesting and final sale. This relatively high wastage factor results from the use of chunk ice, the absence of so-called "cold chain" facilities (refrigerated cold storage and transport, ice plants, chill rooms) in the prevailing marketing system, and the consequent deterioration in the quality and price of the fish. 1/

A final factor limiting the potential of small pond operations in Indonesia is a shortage of trained personnel to assist fish farmers in adopting

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1/ Appendix E includes a detailed discussion of the significance of the wastage factor in the Indonesian fish marketing system.

modern aquacultural practices. Fisheries schools, the only source of such technical manpower, are few in number and produce graduates who are immediately employed in sensitive jobs requiring expertise and seasoned judgments.

2. Implications for Project Feasibility and Design

In order to remove the constraints to improvements in productivity levels and incomes outlined above, the project farmers must have access to inputs heretofore unavailable to the typical fishpond operator in Indonesia. These inputs include adequate fry stock, pond facilities, fertilizers, pesticides, training, and financial and marketing support, as discussed in the following subsections.

a. Fry-Fingerling Supply

Stocking rates vary according to pond location, level of technology, and environmental conditions in the ponds, as well as with the availability of fish seeds. The normal stocking rate for fry in nursery ponds ranges from 20,000 to 30,000 per hectare. In meticulously prepared nurseries where all conditions are optimum and food is abundant, the rate may be as high as 40,000 to 50,000 fry per hectare. Heavy stocking of nurseries is resorted to when there is a heavy demand for fingerlings and fry fishing is good.

The normal stocking rate of fingerlings (five to six inch size) is 2,000 to 3,000 per hectare. If the market demand is for milkfish 12 to 14 inches in size, pond operators may choose to overstock, fertilize the ponds, and harvest after four months. More typically, however, crops are harvested twice a year. Under normal conditions survival rates for fry to fingerlings range from five to ten percent; for fingerlings to marketable size fish from 80 to 90 percent. Under improved pond management procedures, more than 50 percent of fry may survive to fingerling stage, and around 95 percent of fingerlings to marketable size.

As stated in Section B.1 above, the low productivity of existing tambak culture operations is due in part to the inability of farmers to obtain enough fry and fingerlings to stock their ponds at optimum levels. This has serious implication for the proposed project, as there is no assurance of an adequate fry-fingerling source in Lampung Province to meet the estimated demand. Results of the preliminary fry survey conducted by the Jepara Brackish-Water Research Station reveal the extreme poverty of milkfish and shrimp fry in the coastal waters of the Java Sea from Maringgai in the north to Ketapang in the south. (See Tables 5 to 8, Appendix A). However, the research was conducted between October, 1975, and January, 1976, which is the low season for fry fishing in this portion of the Java Sea. Surveys on seasonal occurrence, distribution and abundance of milkfish and shrimp fry are still in progress. Until the results of these studies become available, the existence of a nearby source of fry and fingerlings cannot be ascertained.

Records of the Directorate General of Fisheries indicate a number of possible sources of imported fry and fingerlings (See Table 4, Appendix A), among which D.I. Aceh and Sumatra Utara would be preferred in view of their proximity to the project site. If further investigations show that neither of these locations contain sufficient fry to support a continued brackish water fisheries operation, then other areas will have to be explored as alternate sources of supply.

For the project to be profitable, the cost of fry delivered to the site must not exceed 7 to 8 rupiah each. The landed cost of fry and fingerlings airlifted from the sources cited by the Directorate General of Fisheries to Jakarta ranges from 8 to 9 rupiah. A similar range would apply to the cost of air transport to Lampung.

A project of the dimensions envisioned for Lampung Province will require a fry-fingerling bank large enough to meet all stocking requirements. Ten percent of the total pond area would be adequate for the nurseries if fry are stocked on a continuing basis to replenish fingerlings which have been transferred to the rearing ponds.

b. Pond Size

One reason for the low returns generated by most existing fishpond holdings is their limited size. An allotment of two and one-half hectares to each fish farmer is not sufficient to attain the income goals of the proposed project, especially if they are to be operated as individual holdings. A minimum of five hectares per family is therefore recommended. The economic rationale behind this recommendation will be discussed in Part Three (Section A 2) of this report.

c. Fertilization, Pest Control, and Supplementary Feeding

Fertilizers, pesticides, and sometimes supplementary feeds are used to maintain high levels of pond productivity. Fertilizer is required to stimulate the growth and multiplication of algae and plankton diatoms as well as to replenish used-up nutrients in the soil. Two types of fertilizers, inorganic (urea and TSP) and organic (rice bran, copra cake and cow dung) have been found to be appropriate for use in ponds under certain environmental conditions, depending primarily on water quality and rate of growth. Before fertilizers are applied on a large scale in project ponds, experiments should be conducted to determine their effectiveness. In this regard, it should be borne in mind that conditions existing in two adjacent ponds are not always identical, necessitating the use of more than one type of fertilizer.

The initial preparation process removes about 90 percent of the pests and predators from the ponds. As most of these organisms find their way into the ponds through tidal waters, their subsequent entrance can be prevented by constructing a special screening system consisting of small meshed nylon nets placed outside the main-gate, one on the entrance side and another on the exit side, with smaller screens fitted to the secondary and tertiary gates.

For eliminating organisms that remain present in pond waters, two pesticides, brestan and derris, have been found to be effective under existing conditions in Java and South Sulawesi. Brestan, applied at the rate of 1 kg/ha/yr, has been used for snail control. Derris, applied in amounts of 4 kg per hectare for one application, controls nearly all types of animal pests and predators. Tobacco dust is another material which is commonly used in fish ponds in amounts of 300 kg per hectare per application. All of these materials are inexpensive and easily available. They are also biodegradable.

Supplemental feeding is an option open to farmers engaged in intensive fishpond cultivation. Feed selection and use is determined by the stage of development of the fish. During periods of maximum growth, they may require additional protein. Preparatory to harvesting, they are often given supplements that are rich in carbohydrates in order to increase their weight and improve their form and appearance. Feeds may be produced and processed locally, or obtained from by-products of food processing establishments. In many cases, however, the costs of supplemental feeding outweigh the benefits of increased revenues to fish farmers.

Small pond operators should be entitled to the benefits of the government's input (fertilizer) subsidy schemes, which are currently available only to farmers of agricultural products. Studies to identify additional sources of low-cost supplemental feed and fertilizer should also be undertaken. The feasibility of rendering readily available and inexpensive raw materials into pellets, meal or cakes should be investigated, as these forms facilitate dispensation and have a longer storage life. Sources of cheap organic fertilizers may include by-products of food establishments and processing plants as these waste materials are generally obtainable free or at nominal cost. Thorough chemical analyses should be performed to determine their effect on plankton and fish growth before they are actually applied in the commercial rearing of fish, however.

d. Training

Specialized training programs are required to strengthen management capabilities and to instruct the farmers in fish cultural technology. To provide such training, specialists can be brought to the project site from any of four training stations: the Brackish Water Research and Development Project (Jepara), the Inland Fresh Water Research Institute (Bogor), the University Faculty of Fisheries (Bogor), the Inland Fisheries Training Institute (Sukabumi, West Java), and from the Directorate of Fisheries in Jakarta. Alternatively, a designated number of fish farmers can be selected to participate in live-in courses at the training stations themselves.

Training at the project site should take the demonstration farm approach. In conjunction with its expanded fisheries development program, the Directorate General of Fisheries is constructing about 45 demonstration fish farms throughout Indonesia with loan funds provided by the International Bank for Reconstruction and Development. One of these stations is now under construction close to the proposed location of the project. When completed it will serve farmers throughout the Lampung area. However, it is recommended that priority be given to establishing an additional five-hectare demonstration pond on site for use in training transmigrant pond operators directly associated with the project.

Demonstration training programs should provide farmers with an understanding of the aquatic ecosystem as it operates in a fish pond environment and a familiarity with the basic equipment and simple field instruments used in fish culture work, such as thermometers, oxygen and pH determination kits, salinometers, turbidity meters and plankton nets. Periodic workshops and seminars should be offered by fisheries extension and demonstration personnel, as well as by the field extension officers of the recently created Agency for Education Training and Extension, on topics including:

- Collection of milkfish (and shrimp)[1/] fry for rearing in nursery ponds;
- Pond preparation;
- Pond water management;
- Periodic monitoring of water quality;
- Repair and improvement of dikes and gates;
- Eradication and control of fish pond pests and predators;
- Fertilization of pond waters;
- Preparation and administration of supplementary feed; and
- Stocking techniques

Lectures and demonstrations should be supported by simple charts and instruction sheets printed in the local language.

Overseas training in fishpond management and mariculture for employees connected with the proposed project would improve the technical knowledge and capabilities of the extension personnel who would train the project farmers. Such training is available in the Philippines, Thailand, and Taiwan, for periods of from six to eight months. Criteria for applicant selection are included in Appendix A.

It is also strongly recommended that a minimum of three foreign technical advisors be contracted during the various stages of project

1/ According to technicians from the Directorate of Fisheries, the culture of milkfish and shrimp in the same pond has been successful in Java and South Sulawesi. Studies and experiments should be conducted on the economic feasibility of instituting a similar operation at Lampung.

implementation. These specialists would furnish technical assistance in pond construction, administration and management, organization of the village settlements, and installation of infrastructure facilities respectively.

e. Financing

Fishpond operators have been reluctant to take pond improvement loans because of the strict financial terms imposed by rural banks. It is recommended that liberalized credit financing be made available. The PRP for the Lampung project states that Bank Rakyat Indonesia will provide operating loans to farmers on convenient terms.

f. Marketing

As the proposed project will need to market portions of its production in both Lampung Province and Java, its marketing strategy must deal effectively with the existing collection and distribution networks, while minimizing losses due to fish wastage. The Maringgai fish auction provides a natural and well-located outlet for supplying the local (Lampung) market. In marketing milkfish in Java, project management can make one of several alternative arrangements. The simplest arrangement would be to join the Pekalongan fisheries project as a ninth satellite. [1/]. As such the Lampung project would receive regular payments for the fish shipped at prices free alongside (FAS) the Pekalongan refrigerated boats at Maringgai.

Alternatively, the Lampung project management could develop independent working relationships with Java wholesalers capable of handling the excess volume of milkfish. In this case, either the wholesalers (or their agents) would buy milkfish directly at the project site and provide for their own interisland transportation, or the project management would arrange for transportation and delivery of the fish to the wholesalers at designated harbors or landing places in Java.

1/ The Pekalongan fisheries project, and the Indonesian fish marketing structure, are described in Appendix E.

Both methods require that the fish be iced if they are to reach Java markets in a condition fresh enough to obtain a fair price. Refrigerated boats suitable for transportating the fish are not presently available and careful attention must be paid to providing for this important link in the marketing chain. In addition, a cold storage plant will have to be built at Maringgai for receiving and icing milkfish from the ponds, and equipment for loading them onto boats for shipment to Java will have to be purchased. Improvements to the Maringgai harbor will also be required. For purposes of this study, it is assumed that all necessary storage and transport facilities will be developed independently of the Lampung project.

C. PROJECT DESIGN

This section of the report summarizes the design approach recommended for the development of a 3,200-hectare brackish water fisheries operation in Lampung Province. Detailed specifications and cost estimates are provided in Appendix B. Cost assumptions used in preparing the project economic analysis are described in Part Three, Section A I.

With minor modifications, the suggested approach can be adapted to field conditions prevailing in any number of potential sites in the lower Sekampung River area, provided that the site is characterized by a relatively flat, sea level topography, and contains clay-loam soils that are high in organic matter. Key design parameters are as follows:

- To maximize production, fry nursery, holding and starting pond operations are to be separated from the fish rearing ponds;

- To the extent possible, ponds are to be located on sparsely vegetated terrain in order to minimize land development costs;

- Water supply is to be of tidal origin and unpolluted;

- Milkfish raised in waters with low salinity bring low market prices. The salt content of the pond waters should range between 15 and 25 parts per thousand. Provisions are to be made for diluting or adding sea water as necessary;

- Tidal fluctuations should be from 1.5 to 2.5 meters to permit water management by gravity. Otherwise a pumping system is required;

- Ponds are to be drained and rehabilitated on an annual basis;

- Production is to be planned to ensure harvest of a constant volume of fish throughout the year.

- Depth of rearing pond waters is to be maintained at approximately 40 cm; and

- The planned size of each family unit pond is 2.5 hectares.

The recommended site layout, water management facilities, and project works were developed in accordance with these design parameters. Each is described in turn below.

1. Site Layout

While there are no firm rules for the preparation of pond layouts, top consideration is given to attaining ease and efficiency in water management. Small ponds are generally easiest to prepare stock, and manage. Large ponds, on the other hand, cost proportionately less to construct and allow more rearing space, which reduces predation and encourages faster growth.

Figure 2 in Appendix B illustrates the proposed layout of ponds and roads for the Lampung site north of the Sekampung River. The site is divided into a series of plots generally consisting of two 50-hectare modules (one square kilometer) which are served by two pumping plants. Each module includes 18 rearing ponds and two nursery ponds, for a total of 20 ponds of 2.5 hectares a piece. 1/ Variations of this scheme are permissible, such as the inclusion of 2.5 hectare ponds at the end of a pump canal or the use of 1½ sq. kilometer plots. However, the installation of a pumping plant to serve plots of less than 50 hectares is likely to be uneconomical.

2. Water Management

The water management plan for the project provides for a combined fill and drain system. Mechanisms for diluting or adding sea water and removing rain water are also included. The modular aspects of the design makes it possible to schedule stocking of fish and the ensuing harvest in such a manner that 50 hectare units can be harvested each month of the year provided a minimum area of 600 hectares is under production. This feature is necessary in order to stabilize the marketing of fish.

Because of the small tidal amplitudes prevailing along the Lampung coast, pumping facilities will be necessary to convey sufficient quantities of saline water (about 120 m^3/day/ha.) through the canals to the fishponds. Several pumping plant designs and arrangements for supplying water were investigated. The one selected consists of a reinforced concrete structure flanked by stone masonry inlet and outlet transitions. A separate bridge across each pump canal downstream of the pump location can be provided where necessary to permit vehicular access to the ponds and pumps. A traditional gate is to be installed in each pond to permit drainage as required. The gate essentially consists of two rows of stop-logs packed with earth to make it water tight.

1/ Subsequent financial and economic analyses of project feasibility revealed 5-hectare rearing ponds to yield higher rates of return.

Two types of pumps are available: a horizontal centrifugal type with foot-valve and strainer; and a turbine type with a trash rack or strainer. Selection should be made on the basis of competitive bidding. Either pump can be connected through gear boxes to diesel engines, which are recommended because they are generally more reliable and have a longer life than gasoline engines.

Pumping capacity requirements are estimated at 130 litres per second, based on the maximum difference in water levels between the sea channel and the pump canal. While the actual pumping head will vary with the stage of the tide, the setting of the pump house, and the level of the land, the range used for estimating purposes was between 25 centimeters below to 2 meters elevation above mean sea level. If deep percolation varies greatly from the assumed 1 mm per day, pump capacity may need to be increased.

The capacity of each pumping plant is based on the assumptions that 20 ponds will be filled over each 30-day period and that the pumps will be used 16 hours per day. The pumps will need to operate about 800 hours a year to fill the ponds and to supply water to compensate for seepage and evaporation. Additional pumping will be required to control pond salinity which to a large degree is influenced by precipitation and seepage. Weekly start-up will be necessary during periods when the pumps would normally be shut down to maintain the pumps and motors in good working order. The running time at each such start-up should be from 20 to 30 minutes.

The pumping plant and bridge designs shown in Appendix B, Figures 4 and 5, were used in estimating quantities. The actual designs, however, depend on individual site conditions and the type of pump selected.

3. Project Works

a. Canals and Dikes

The arrangement of nursery and rearing ponds, pump plants, dikes, and supply canals on each square kilometer module is diagrammed in Appendix B, Figure 3. Sea water is pumped through the sea channel to a supply canal serving the ponds in each 50-hectare plot. Division and/or road dikes border each plot, within which interior dikes separate the individual ponds. The elevation of the water in the supply canal has been set to maintain a depth of 40 cm in the fishponds.

The volume of earthwork required to construct the channels and dikes was calculated in accordance with the typical sections shown in Appendix B, Figure 6, with a 20 percent allowance for shrinkage. Normally, excavation from the sea channel would provide sufficient earth to build the dikes along its length. Likewise, the pump channel and the adjacent pond ditch would furnish the earth for the dikes along that channel, with the remainder of the earth required taken from the perimeter ditches bordering each pond, the ditch along the roadway, and the bottom of the ponds. In the case of the site investigated, however, the finding that much of the area is below sea level makes a larger volume of dike material necessary, and this may prove to be unavailable except at too high a cost.

Where there are streams flowing into the site, these will have to be routed to pass through the project layout. Cross drainage channels may also have to be planned. For the study site, excavation amounting to about 250,000 cubic meters would be required for this purpose of canalization of streams and ditches.

To admit saline water to the fishponds and to drain superfluous rain water, canals must also be dug through the greenbelt extending from the coast to the project area. These canals will have to be flushed and dredged periodically to prevent silting up from sediment transport. 1/

b. Gates and Screens

Traditional Indonesian pond inlet structures consist of a treated timber box placed in the pond dike bordering the water supply canal, usually with a bamboo fish screen to keep predators out and fish in. These structures have a life of five years or less. For this reason, the project design replaces the traditional screen with a brick masonry and reinforced concrete structure which should last throughout the life of the project.

c. Domestic Water Supply

At present, some villages on the East Lampung coast must import domestic water due to salt penetration of groundwater aquifers. Others obtain their water from hand-dug wells, about 1-1.5 meters deep. Water consumption varies from about 20 lcd to about 50 lcd. 2/ Excreta is usually disposed into a nearby canal or stream.

Contaminated water is the principal agent in the transmission of typhoid, cholera and dysentery (shigellosis). To avoid contamination hazards at the project site, 6-10 meter deep wells should be driven and cased. The top should be fitted with a hand pump and sealed. Each hydrant yields between 5-8000 lpd and supplies 100-200 persons. Water treatment is rarely necessary.

Excreta disposal should be by pit latrines. These are usually dug by hand and should be sealed with earth when nearly full.

1/ Design information on the required stabilization structures is contained in Technical Report No. 4, C.E.R.C., U.S. Army Corps of Engineers, 1966.

2/ Libby, A.W. "Sumatra Regional Planning Study," R.R. Nathan Assoc., Inc., Wash. D.C., 1975.

D. PROJECT IMPLEMENTATION, MANAGEMENT, AND OPERATIONS

1. Project Implementation

The first phase of the project includes construction of the fishpond facilities and the infrastructure and superstructure for the human settlement. The detail design and construction will be performed by competent architects, engineers and other specialists under contract to the GOI and USAID. These contractors will be guided by a general feasibility plan.

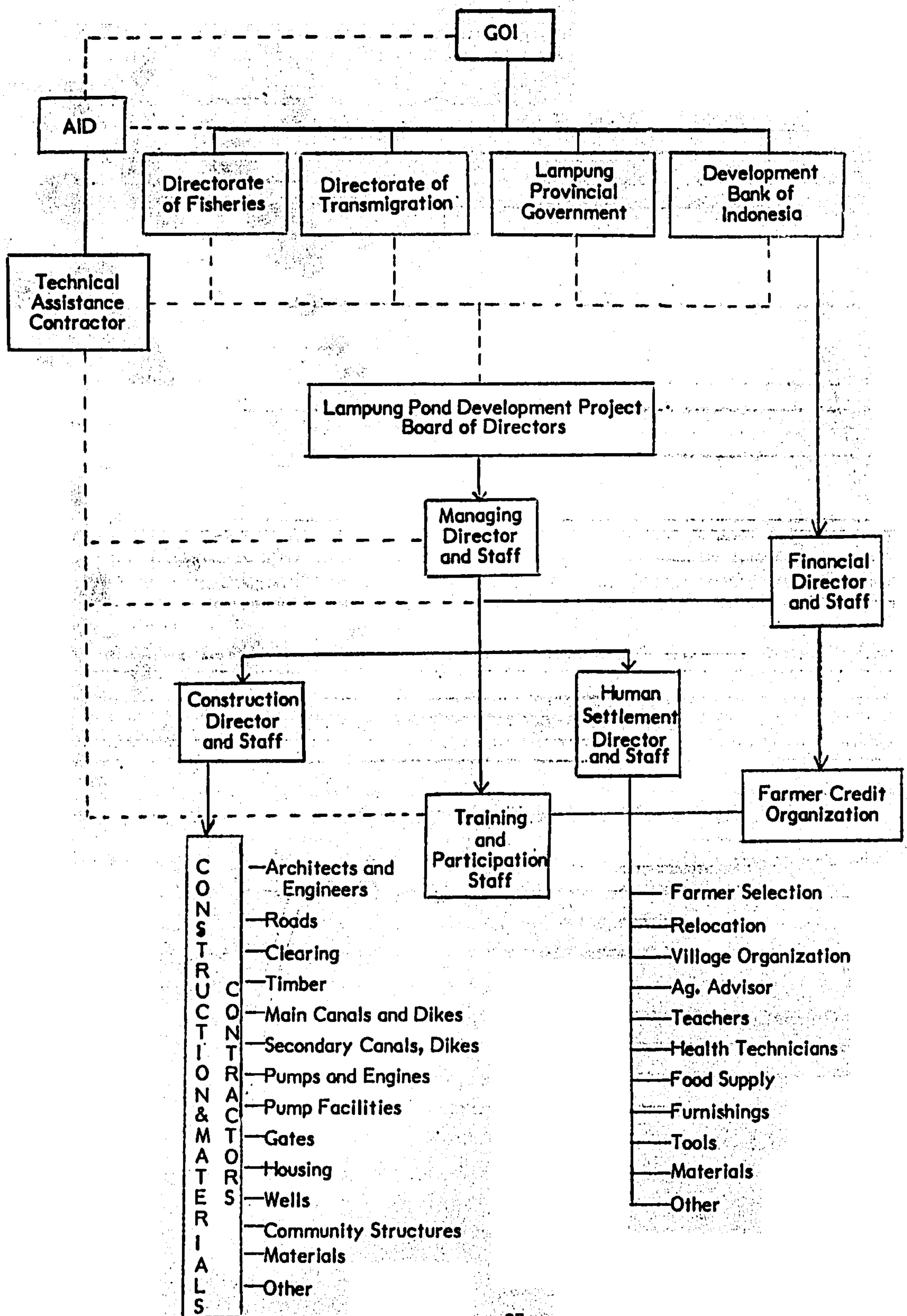
A second and parallel phase involves the relocation of fish farmer families, creation of their social organization, training, and provision of financial support during at least the first year in the new location. These activities will be provided for and supervised by agencies of the GOI and USAID, or their subcontractors.

Funding and staffing requirements for first and second phase activities will be met from loans, grants and budgetary sources. The GOI Directorate General of Fisheries, Directorate General of Transmigration, Lampung Provincial Government, USAID and others can each be expected to contribute their negotiated portion of the total funding and personnel required. However, the fact that each participating agency will be interested in retaining as much freedom of action as possible is likely to lead to the inevitable delays as jurisdictional, funding and staffing problems arise and must be resolved.

Given the magnitude of the Lampung development, and the diversity of the entities involved, a single executing agency or government corporation should be established to coordinate and manage the development. A suggested organization chart for such an entity is provided in Exhibit I.

EXHIBIT I

ORGANIZATION CHART FOR CONSTRUCTION AND HUMAN SETTLEMENT PHASES OF THE LAMPUNG BRACKISH WATER POND PROJECT



Sufficient authority and recognition must be given to this entity so that its director can carry out his responsibilities, using staff assigned full time from each participating agency as well as competent personnel selected by his Board of Directors. Financial controls will be of particular importance, requiring specialists well trained and experienced in all aspects of financial management. To provide this expertise, it is recommended that the Indonesian Development Bank be included as a participating agency.

2. Project Management

The third phase of the project is the commercial operation of the fishponds. Traditionally, Indonesian fish farmers have managed and made decisions on their own following patterns long established in their locations. However, the advanced technology and intensified production cycle envisioned for the Lampung project cannot be applied without a centralized management organization to program the rotational activities required for drying and preparation, fry and fingerling stocking, and harvesting of nearly 1,200 ponds, as well as to provide for water management, training, and other inputs. The recommended operating guidelines management system, and management structure for this organization are described below.

a. Operating Principles and Procedures

This feasibility study is based on a fishpond operation of 3,200 hectares, as specified in the scope of work. A project of this magnitude is likely to present considerable managerial, organizational and operational difficulties at least in its initial years. These difficulties could be minimized by adopting a phased approach, with development concentrated in an 800 to 1,000 hectare area during the first phase. 800 hectares of productive pond surface could be allocated among nursery and rearing operations as follows:

- 32 nursery pond units (15 fry ponds, 10 fingerling ponds, 7 stunting or holding ponds) @ 2.5 hectares = 80 hectares

- 144 rearing pond units @ 5 hectares = 720 hectares

Additional 800-hectare parcels could be developed at future dates, depending on the availability of inputs, markets, and financial support. Regardless of whether the area under production is 800 hectares or some mutiple thereof, similar proportions of nursery to rearing ponds, and similar operating principles and procedures, apply.

To maximize productivity and income levels, all stocking, rearing, and harvesting should be performed cyclically and in accordance with a fixed schedule. Once established, the recommended schedule will allow for continuous harvests of fish on a daily basis.

The success of this cyclical approach depends on the availability of uniform-size fingerlings to replace marketable fish as they are withdrawn from the rearing ponds. Thus, all units in the nursery pond system must be fully stocked at all times. Optimum stocking rates will range from 30,000 to 50,000 fry per hectare in fry ponds, 5,000 to 10,000 fingerling per hectare in holding or stunting ponds, and 2,000 to 5,000 fingerling per hectare in rearing ponds. If there is an abundance of fry, overstocking may be resorted to, with the holding and stunting ponds used to accommodate the excess supply.

Such an intensive production system requires that measures be taken to minimize mortality rates and to optimize growth. Fry must be properly handled and transported to arrive in healthy condition, and should be acclimatized prior to stocking. Routine activities, such as pond preparation, fertilization, pest and predator control, water quality testing, dike and gate repair, and supplementary feeding (where necessary to replenish natural food supplies), must be carried out by trained personnel on a regular basis.

Growth must be monitored and correlated with water quality, and immediate remedial steps taken where required to avoid abrupt changes in the pond environment.

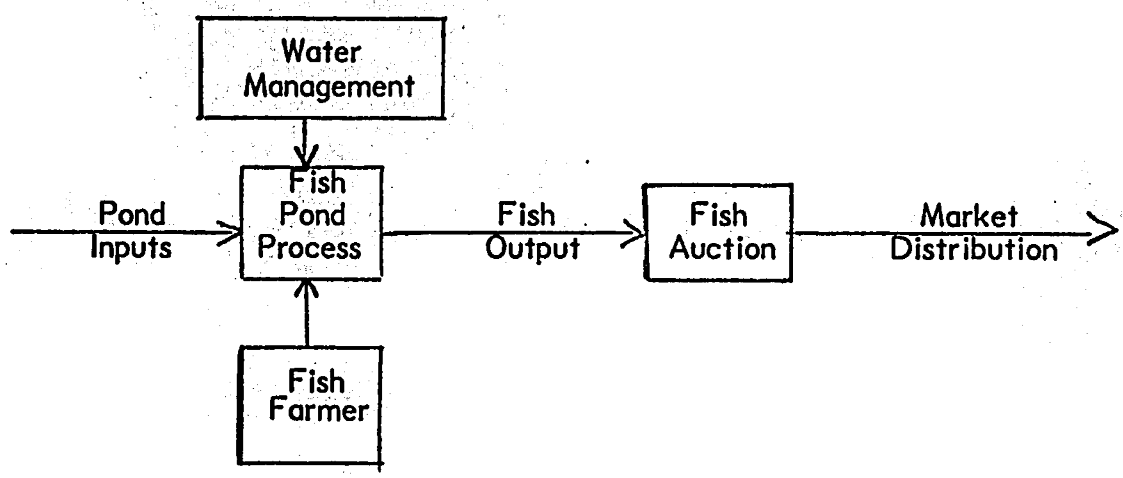
The size of harvestable fish depends to a large extent on the market, which generally demands three to four pieces of fish per kilogram. Inspection and quality control and proper handling and storage also contribute to marketability. Trained fish inspectors should employ on-the-spot sampling techniques to confiscate spoiled fish. Refrigeration, cold storage, and quick freezing facilities must be accessible in order to reduce wastage and ensure maximum returns to pond operators.

The recommended operating cycle permits each pond to be harvested three times a year, provided that a constant supply of fingerlings is available throughout this period. Ponds are prepared annually during the dry season. Fry are planted in nursery ponds on a continuing basis, where they grow to fingerling size in six to eight weeks. From there, they are moved to transition or stunting ponds to be held for stocking in the rearing ponds as required. Once in the rearing ponds, fingerlings grow to marketable size fish in three to four months.

The rearing ponds are stocked with fingerlings on successive days, in a manner such that the second pond, or group of ponds, may be harvested and restocked the day after the first, and so on until all ponds in the system have been harvested and immediately replenished with fingerlings. In this way, the first pond is once again ready for harvest when operations in the last pond have been completed, and the cycle can begin again.

b. Operations Management

The introduction of modern technology to fishpond operations requires a far more sophisticated system of management than that with which the majority of Indonesian fish farmers are now familiar. For most existing pond operators, the management process is as shown in the diagram which follows:



This relatively simple system of production and marketing milkfish is not, however, sufficient for a project with a targetted annual yield of 900 kilos per hectare. In order to reach this target, fish fry nurseries must be maintained to supply the fish rearing ponds. A pumping system to sustain optimum water conditions must be provided, and all pond operations must be performed according to schedule. The principal functions involved in managing the proposed technology include:

- Scheduling

  Careful scheduling is a critical element of the intensified production system recommended for Lampung, where 2,900 hectares of rearing pond surface must be programmed for preparation, stocking, harvesting, and restocking in a manner that will yield an adequate supply of marketable fish on a daily basis. Schedules must also be developed for rearing pond operators, to ensure that fingerlings are available for the rearing ponds as required.

- <u>Fish Management</u>

Fish management provides the technical supervision needed to make sure that all scheduled dates for each pond are met. It also includes responsibility for (1) purchasing, receiving and distributing fish fry to the nursery ponds; (2) overseeing the growth of the fry to fingerling stage; (3) supervising the transfer of fingerlings to rearing ponds; and (4) overseeing the rearing of fingerlings into marketable fish sizes.

- <u>Water Control</u>

The Lampung project design calls for a comprehensive pumping system to control water depths and salinity in the ponds at all times. Each pumping plant is intended to serve a management sub-unit totalling 50 hectares of pond surface with as many as twenty 2½ hectare ponds. Pump operations must be carefully supervised to ensure that water is removed from or added to a sub-unit according to schedule.

- <u>Materials Management</u>

Materials management involves purchasing, receiving, and distributing fertilizer and pesticides according to the established pond preparation schedule, as well as overseeing the proper applications of these inputs. It also includes purchasing, storing and distributing maintenance supplies, such as pump engine fuel, oil and spare parts, as required by maintenance management.

- <u>Maintenance</u>

Those involved in maintenance management are responsible for keeping water pumps, engines, and structures in good working order, as well as for assisting the fish farmers with maintaining their pond gates, screens and dikes In addition, they cooperate with other management staff in the dredging and removal of silt from the sea canals as necessary.

The flow of physical inputs, controls,and information encompassed within these five key management functions is diagrammed in Exhibit 2. A sixth function of .management, supervision of the flow and distribution of revenues, is discussed in the next subsection.

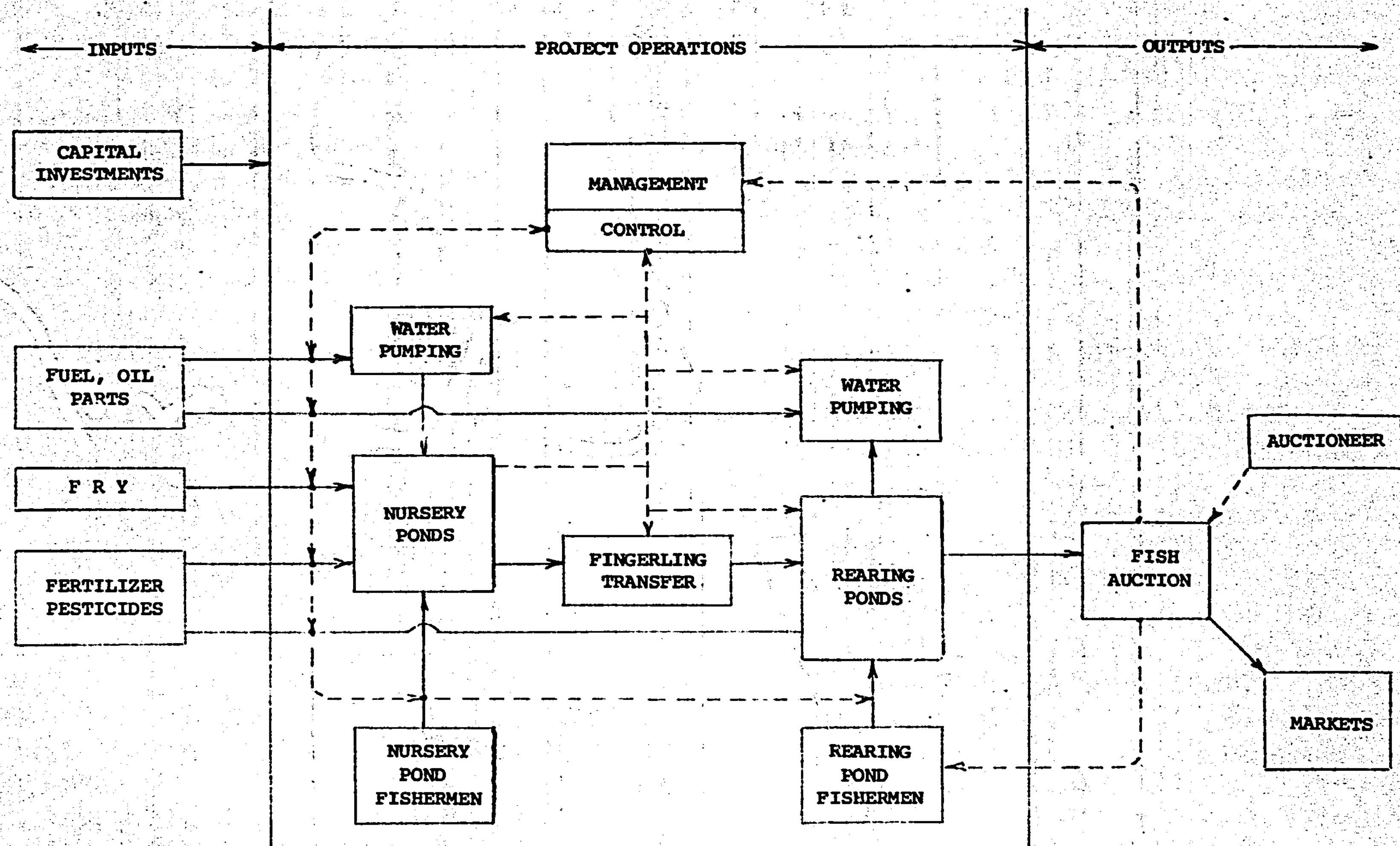
c. Revenue Accountability

An important responsibility of project management is the supervision and control of funds received and expended by the project farmers, as well as by its own staff in the performance of the functions outlined above. Under the system recommended for the Lampung project, central management costs are to be deducted from fish sale proceeds before the balance is distributed among participating farmers. The source of funds flow is the point where the fish are sold at auction. Prices, quantities and funds transfers are recorded on original documents by the cooperative auctioneer and his staff. These funds are then apportioned among three principal groups: (1) the marketing cooperative which receives a commission on sales; (2) the project management; and (3) the farmers who deliver the fish to the auction floor.

Project management uses its share of the proceeds to cover the costs of pond inputs (fry, fertilizer, pesticides, maintenance supplies, etc.), payroll, and amortization payments. From their gross receipts, the rearing pond farmers must deduct operating costs, including the purchase of fingerlings from nursery pond operators and such items as nets, buckets, skiffs (small boats), etc

EXHIBIT 2

MANAGEMENT OPERATIONS DIAGRAM



—> Fish and materials flow
--> Feedback information and/or control

The integrity of this system of revenue and cost apportionment is maintained by keeping records of fry received, fingerlings transferred, and fish sold at auction. If discrepancies are found to result from unauthorized sales or transfers, the water supply to offending pond operators can be cut off if so ordered by management.

A model of the flow and distribution of revenues to the Lampung project is provided in Exhibit 3. The example percentage data are based on revenue and cost assumptions set forth in Part Three (Economic Analysis) of this report.

d. Management Structure

A Central Management Organization (CMO) will be charged with managing the Lampung project. The recommended structure of this organization is shown in Exhibit 4, and may be summarized as follows:

- The Provincial Fisheries Office in Lampung Province will provide technical and administrative guidance to the Central Management Organization.

- The Fisheries Demonstrators and Field Extension Officers assigned to the government demonstration fish farms in Way Sekampung and at Maringgai will serve as technical assistants and conduct periodic demonstrations and workshops on scheduled dates, or as often as necessary, to the fish farmers operating the project.

- The Mayors of Villages I and II will form a Coordinating Council on the care, operation and maintenance of the entire project. This Council will function as a policy-making body,

EXHIBIT 3

FLOW AND DISTRIBUTION OF REVENUES

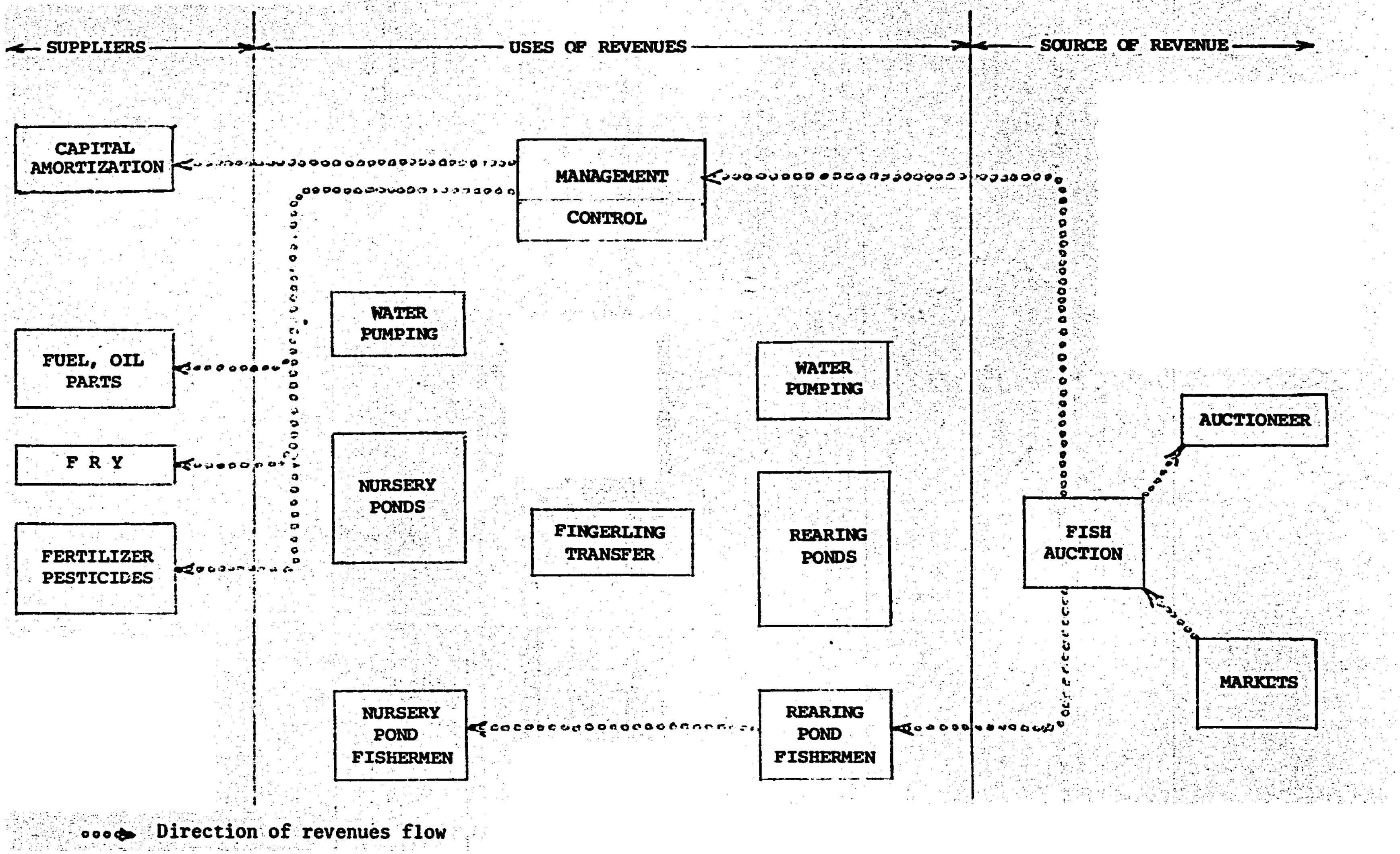
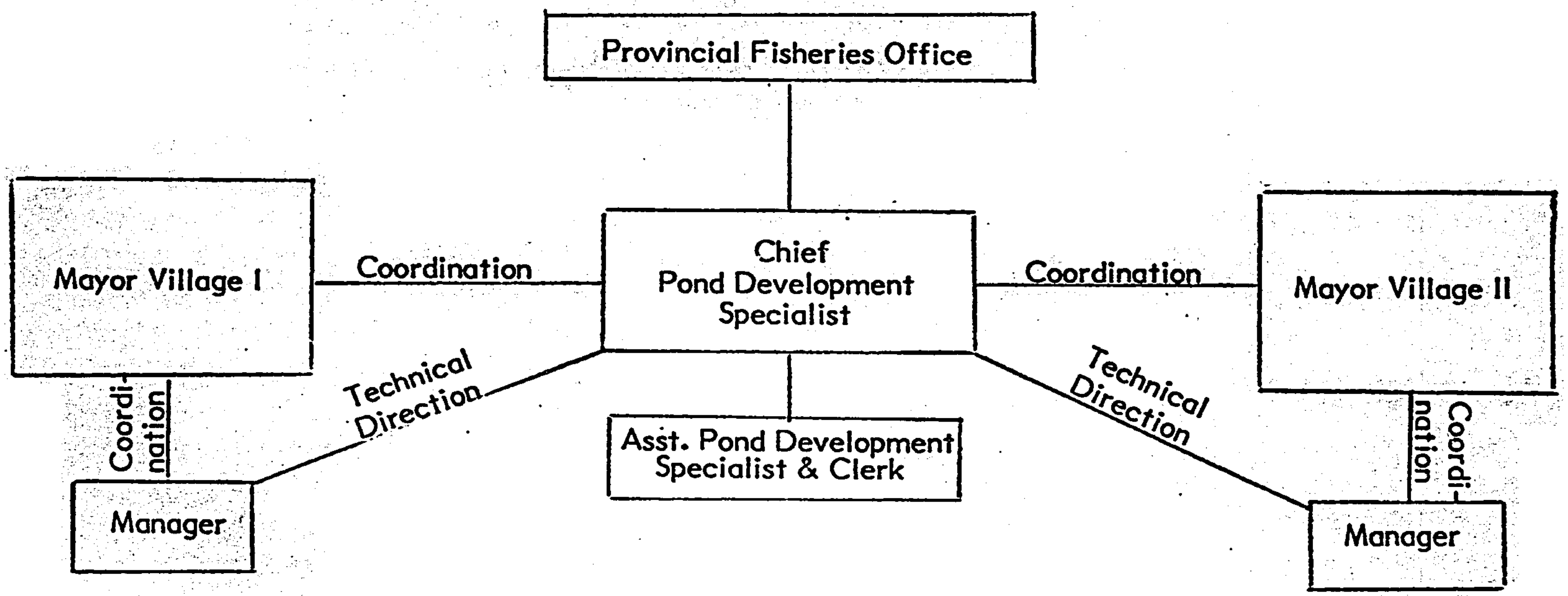


EXHIBIT 4

STRUCTURE OF THE CENTRAL MANAGEMENT ORGANIZATION



1 Asst. Manager
2 Pump Operators/Water Overseer
2 Asst. Pump Operators
4 Asst. Fish Pond Specialists
1 Mechanic
1 Mechanic Helper
2 Fish Pond Caretakers/Security Guards

1 Asst. Manager
2 Pump Operators/Water Overseer
2 Asst. Pump Operators
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1 Mechanic
1 Mechanic Helper
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with the two mayors as Chairman and Vice Chairman respectively. Its membership will include the village managers, assistant managers, and the pond development specialists.

- The Chief Pond Development Specialist and his Assistant will have supervisory responsibility for all technical activities associated with the project. The Managers and Assistant Managers for each village will serve in an administrative capacity, with responsibilities for budgeting and finance, accounting, and general services. The functions and duties of other project staff are listed in Appendix A.

PART THREE

ECONOMIC AND SOCIAL/ENVIRONMENTAL ANALYSIS

PART THREE: ECONOMIC AND SOCIAL/ ENVIRONMENTAL ANALYSIS

A. ECONOMIC ANALYSIS

1. Key Assumptions

This analysis makes a number of assumptions related to the site, level of technology, design, cost, and operating performance of the Lampung project, based on the findings and recommendations of the five specialists on the study team. The most important of these assumptions are outlined below. They are treated in more detail in Part Two, and in Appendices A through E of this report.

a. Technical and Design Assumptions

A basic assumption of the analysis is that a site can be found which is suitable for water management by pumps. A minimum of 4,200 hectares will be required, allowing 950 hectares for a green-belt between the ponds and the Java Sea, 350 hectares for dikes, roads, and village areas, and 2,900 hectares for nursery and rearing ponds.

The site is to be divided into 50-hectare plots, each served by one pumping plant. Each plot can contain between 10 and 20 ponds, depending on whether 5.0 or 2.5-hectare pond farms are constructed. Regardless of size, the farms will be allocated to project participants on the basis of one per family.

Project participants will receive training in modern fish production techniques. With an adequate supply of fry, and efficient pond management procedures, they should be able to complete three production cycles each year. Production will be planned to ensure harvest of a constant volume of fish throughout the year.

b. Supply and Demand Assumptions

Pond construction will extend over a period of 60 months, with the first three 50-hectare modules ready for stocking at the end of the twentieth month. Thereafter ponds will be completed at the rate of 100 hectares every two months. At full production, the ponds can be expected to yield 465 metric tons at the end of each four-month cycle, or 2,610 metric tons per year. Estimated daily production of marketable fish is 8.7 metric tons.

It is anticipated that 820 metric tons of annual production will be absorbed by the local (Lampung Province) market, and that the balance will be shipped on refrigerated boats to Java. In both cases, the landing place auction price received by the fisherman is calculated at US$0.60 per kilogram.

c. Investment Cost Assumptions

Capital investment in the Lampung project ranges from a low of Rp. 3,072,748 (US$7,413,000) to a high of Rp. 3,877,666 (US$9,356,000) depending on whether the 2,900 hectares of pond surface area are divided into 2.5-hectare or 5.0-hectare farms, and on whether hand labor or machine methods predominate in the construction of the dikes and canals. Investment costs for alternative construction designs are summarized in Exhibit 5.

As the totals indicate, doubling the size of each farm from 2.5 to 5.0 hectares reduces pond construction costs by about 14 percent, and housing costs by nearly 50 percent. Whereas Cases A and C maximize the use of common labor, Cases B and D utilize machinery to complement the labor force in a cost-effective manner and so reduce total costs by an average of 7 percent. The least-cost alternative is that which provides for the construction of five-hectare farms with machine methods.

EXHIBIT 5

PROJECT INVESTMENT COSTS SUMMARY

Case	Farm Size (ha)	Construction Method	Costs (Rp 000) Pond Facilities	Costs (Rp 000) Human Settlement	Technical Assistance a/	Fees b/	Total
A	2.5	hand	2,125	506	505	741	3,877
B	2.5	machine	1,989	506	505	200	3,700
C	5.0	hand	1,840	292	505	613	3,250
D	5.0	machine	1,204	292	505	572	3,073

a/ Includes costs of relocation and training.

b/ Includes engineering and contingency fees.

Source: Appendix D, Exhibit D-7.

d. <u>Operating Assumptions</u>

At full production of 2,610 tons, and an auction price of US$0.60 per kilogram, annual project revenues are estimated at US$1,566,000 in current prices. Revenue flows enter the system when milkfish are sold at auction. A four-percent auction fee, plus the costs of operating supplies and materials, are deducted from gross receipts. The balance is available for (1) distribution to project fishermen, and (2) management and amortization costs.

Exhibit D-13 (Appendix D) summarizes the projected annual operating performance of the Lampung project at full production. The statement shows an operating income of $771,000, or 49 percent of sales. Assumptions regarding quantities and costs of operating supplies and materials are listed in Appendix D, Exhibit D-12.

2. <u>Rate of Return Analysis</u>

The internal rate of return on investment (IRR) measure was used to evaluate the Lampung project in three ways. First, alternative project economic rates of return (PERR) were derived by computing surplus flows from inputs and outputs valued at current market prices, adjusting for wages to unskilled construction labor, and treating the cost of family labor as a benefit. Second, benefits to project participants were assessed by calculating internal rates of return under varying levels of family income. Finally, certain forward linkage effects generated by the project activity were taken into account by use of sector benefit measurement (SBM) approach to quantifying external, or indirect, employment benefits. The results of these analyses, which were prepared for the four alternative construction design cases illustrated in Exhibit 5, are summarized below.

a. Project Economic Rates of Return (PERR)

Exhibit D-14 in Appendix D shows the input and output values used to calculate returns on public capital invested in the Lampung project. The life of the project is assumed to be 50 years. Returns vary with investment costs of alternative construction designs as follows:

Case	Farm Size (ha)	Construction Method	PERR (%)
A	2.5	hand	10.9
B	2.5	machine	11.1
C	5.0	hand	12.7
D	5.0	machine	13.0

The sensitivity of these rates of return to changes in investment and operating costs and project revenues was tested for the following assumptions:

- Investment costs: A ten percent change in total project investment cost will alter the rate of return by 10.7 percent,
- Operating costs: A ten percent variation in pond expenses will change the rate by 9.7 percent,
- Revenues: A ten percent increase or decrease in project revenues will result in a 17.6 percent change in the rate.

The overall impact of such changes can be illustrated for Case D, where if total costs were ten percent lower, and revenues ten percent higher, the rate of return would rise from 13 percent to 17.8 percent.

b. Farmer Income Benefits

The potential of the Lampung project for generating adequate incomes for the families operating the ponds depends to a major extent on the number and size of farms that are established, and to a lesser extent on the types of construction methods used. If the Government's objective is to maximize individual farmer income levels, then the costs of construction, the number of farms, and consequently the number of families participating in the project, will have to be reduced. If, on the other hand, the priority is to resettle as many families as possible, then the farms should be smaller in size and more numerous, and family incomes held relatively low.

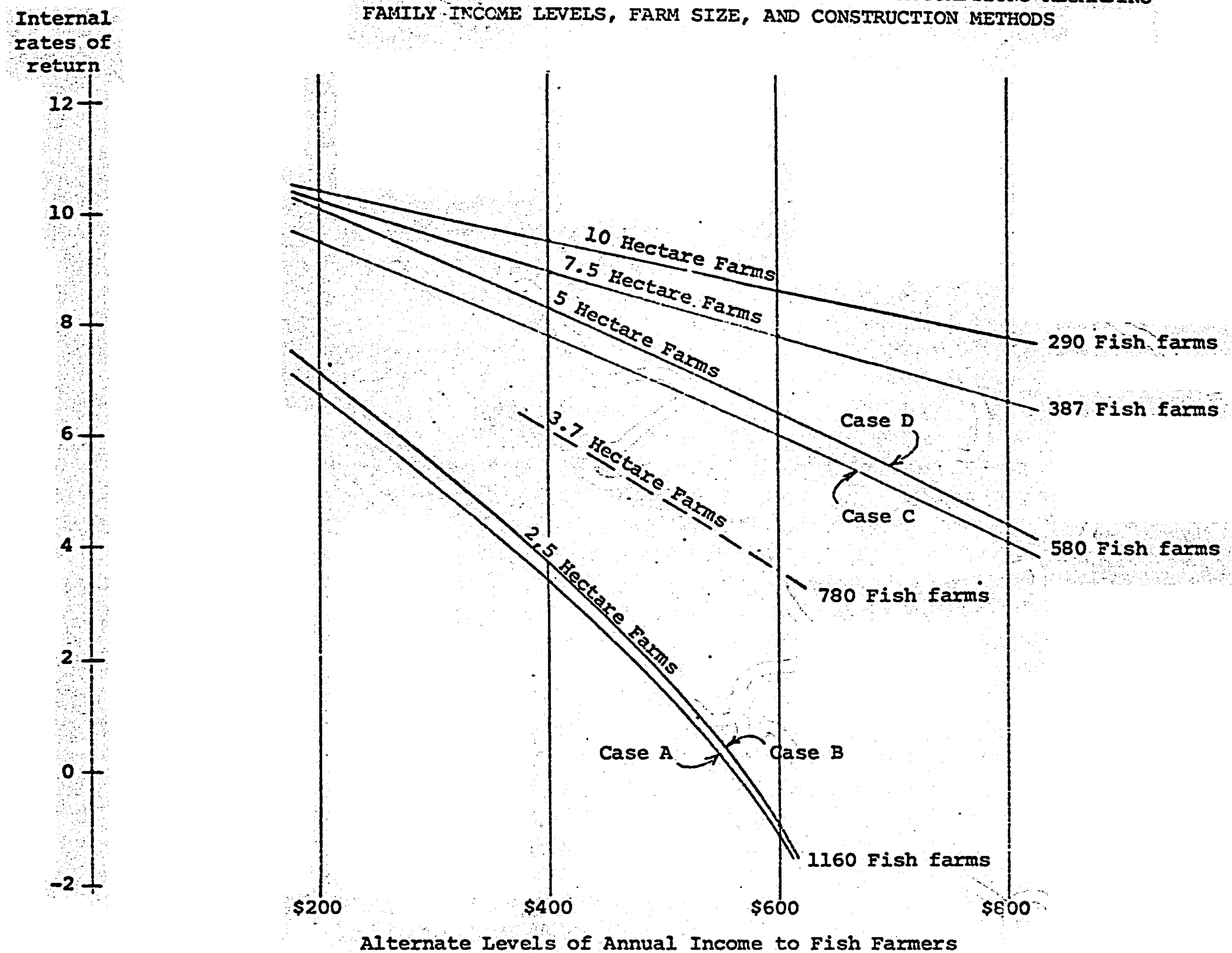
Exhibit 6 illustrates the sensitivity of internal rates of return to capital invested in the project to variations in farm size, construction methods, and family income levels. Internal rates of return were calculated after deducting annual family incomes of between $200 and $800 from surplus flows. The results indicate that, in order for the return to compare favorably with an opportunity cost of capital of between five and nine percent, 1/ and for the project participants to earn an adequate living from their activities, 2/ the farms must be a minimum of five hectares in size, and the project can accommodate no more than 580 pond operators and their families.

1/ Current savings interest rates in Indonesia are between 20 and 24 percent. The rate of inflation is in the 15 percent per year range.

2/ Average per capita incomes in Indonesia are between $80 and $120 per year, or $400 to $600 per family of five.

EXHIBIT 6

ACHIEVABLE INTERNAL RATES OF RETURN UNDER ALTERNATE ASSUMPTIONS REGARDING FAMILY INCOME LEVELS, FARM SIZE, AND CONSTRUCTION METHODS



c. Sector Benefit Rate of Return (SBRR)

The sector benefit measurement (SBM) approach was used to quantify employment benefits arising from the project but external to project net surplus flows. These benefits accrue to those in the fisheries sector who are involved in the marketing and distribution of fish produced by the Lampung farmers. They are defined as the wage portion of the value added to Lampung fish production between the time it is first sold at auction and the point of final sale. A full discussion of the methodology for sector benefit measurement, and its advantages over more traditional approaches to estimating external project benefits, is provided in Appendix D, Section F.

When these external sector benefits are taken into account in calculating internal rates of return, the Lampung project becomes an increasingly attractive investment from the standpoint of the national economy. Computed sector benefit rates of return are as follows:

Case	Farm Size (ha)	Construction Method	SBRR (%)
A	2.5	hand	19.5
B	2.5	machine	20.0
C	5.0	hand	22.3
D	5.0	machine	22.9

B. SOCIAL AND ENVIRONMENTAL ANALYSIS

1. Sociocultural Considerations

A report prepared by the team sociologist regarding the social soundness of the proposed project is attached as Appendix C. Included in the report is a discussion of the project's sociocultural feasibility in terms of the capacity of its farmer participants to develop and manage the ponds in a manner that will optimize productivity and incomes, an analysis of potential roles for women in the project, and an assessment of the adequacy of plans for the resettlement of farmers at the site. Findings and recommendations concerning each of these issues are summarized below.

a. Sociocultural Feasibility

The development of the proposed project site into 2.5 hectare fishponds will provide employment opportunities for an estimated 1,160 operators and 25 resident technical advisors. It is assumed that a minimum of two new village units will have to be created to accommodate these workers and their families, nearly all of whom will be migrating to Lampung Province from congested areas of Central Java. Transmigrants are generally faced with a variety of adjustment problems of a sociocultural, environmental, and economic nature. Major structural changes must be made in their systems of land tenure, marketing, and self-government. New social infrastructure will have to be provided along with training and incentives that will give them a vested interest in the future of the Lampung project.

In order for potential transmigrants to adapt to the practices and procedures required to make the new tambaks operate as planned, an extensive training program will be required. Subsistence will have to be provided project participants until the project is operating at planned levels, which may take several years. Otherwise, project participants will be forced to engage in subsistence agriculture - for which they will be totally unequipped.

Project participants will be willing to incur debt for activities perceived to benefit them if there is a reasonable assurance that the costs will not be too high. It is unlikely that any investment of resources will be made if there is no clear chance of benefitting directly from the investment. Land tenure arrangements currently under consideration that do not vest the farmers with title to the land and its improvements will inhibit investment for such purposes. Although uncommon in Central Java and Lampung, land holdings in North Sumatra are by certificate and (at least in Aceh), where community land holdings are the rule, land use is by letters of use, which are reported as being acceptable to banks for collateral purposes. Tambak operations in this system are subject to expropriation of their ponds but compensated for surface improvements. A similar approach to the problem of land tenure might be adapted for the proposed project.

Operation and management of the project water system requires close supervision and collaboration by project participants. Spontaneous organization by the settlers to accomplish this task will not occur, yet participant involvement in government and management is essential to the success of the endeavor. Consequently, plans for project management and community government must be developed in combination. Technical assistance in this area must be provided until project production goals have been reached and sustained for a period of time.

One important environmental difference between Central Java, (where participants would be recruited) and the project site in Lampung is that malaria is endemic in Lampung. Estimates of the death rate among transmigrants due to this disease run as high as fifteen percent. Permanent dehabilitation among the survivors is common. An intensive campaign should be mounted in the target area to eradicate this disease.

b. Role of Women in Project Development and Management

To the extent that no effort has yet been made to involve potential participants in project planning, an excellent opportunity exists to enhance the degree and nature of the participation of transmigrant women. Participation in project development must not be limited to the project population: involvement of men and women already on the site is also required to eliminate potential hostilities and inequities among current residents and transmigrant groups.

c. Resettlement Plans

The preliminary settlement plan calls for the creation of two villages of approximately 600 families (3,000 individuals) each, to be established sequentially as the physical facilities (such as housing and water supply) are completed. Planning for these villages should take into account that the actual number of individuals likely to be involved in any move sponsored by the transmigration authority will exceed the number of individuals being directly supported by that agency. This planning should allow for the provisions of all tools and inputs necessary for tambak developments, household construction and small scale agricultural activities. Food should be provided in quantities large enough to support the entire site population until the fishponds are producing at targeted levels. This will eliminate the need for settlers to devote their time to subsistence farming instead of tambak operation.

Village infrastructure and superstructure (primary school, clinic, warehouse, village meeting place, religious structure, marketplace, administrative service center and roads) should be constructed by the appropriate government agencies for the first 600 families, and subsequent village sites located accordingly. These families will then become the responsibility of the provincial government in Lampung. Markets will likewise be subsidized by the government to protect the settlers from the ingenuity of unscrupulous entrepreneurs.

Although potential transmigrants are likely to be familiar with a system of production tied to a cash economy, they will be unfamiliar with the high degree of coordination required for the operation of the project as planned. They will bring with them only a rudimentary form of social organization and will have to rely on the emergence of an autochthonous one after arrival. The provincial government structure will extend downward to the village level and it is probable, though not certain, that community leadership and government authority will be vested in the same individuals.

The conventional governmental structure is to be supplemented by a "Central Management Organization," (CMO) responsible for coordinating all activities required for the successful operation of the fishfarming industry. No precedent for such an organization has been observed locally. However, there is a well-developed tradition of demonstration stations, intensification agents and voluntary associations of farmers which provide promising models for local governments.

The manner in which the CMO will gain the farmers' voluntary compliance with the unusual and unfamiliar technical demands of the Lampung project is not clear nor has any mechanism been proposed for resolving conflicts that might emerge between social and economic priorities. One way to encourage community participation in addressing problems associated with social change is to subordinate the CMO to the village government by placing CMO technical experts under municipal authority. Under this arrangement, the technicians would receive their training, certification, and base salaries from the Department of Fisheries, but would also be eligible for incentive pay based on local productivity.

Individual housing units should be laid out on lots of 0.25 hectares, according to statements made by Transmigration officials in Jakarta and Semarang. Some additional land should be made available for agricultural development, part of which might be used for support of work animals, cows, and other domestic livestock.

A schedule should be developed to assure that the rate of transmigration does not exceed the absorptive capacity of the infrastructure. Resettlement should not begin until public health facilities are constructed and the staff on site, for example. Succeeding units of migration should not be undertaken until neighborhood and mutual assistance associations have been formed.

The entire sequence of social development should be closely programmed and monitored. Present residents - as well as potential transmigrants -should be incorporated in the project planning process. This involvement should extend upward through local community leaders as well as downward from the provincial government.

2. Environmental Considerations

Typically in Indonesia, fishponds have been built one at a time, and their effect on the environment has consequently been slow and gradual. In the case of the proposed project, however, more than 3,000 ha. will be developed over a relatively short period of time, and the impact on the land, water resources, flora, and fauna is likely to be sudden and considerable. Cleared land, subdivisions and fishponds will replace jungle and grasslands. The expansion in water surface area as well as the reduced amount of greenery will affect the micro-climate. Wind, humidity, and ground temperatures will all increase. Drainage of surrounding swamplands may be necessary to control mosquito breeding.

Birdlife is now plentiful in the area. As trees are removed, many birds will lose their nesting sites. Those that remain risk being hunted to extinction. Tigers, elephants, crododiles, and monkeys are similarly threatened.

With the expected increase in boat traffic to Palas and Sekampung, the Sekampung River will become an important transportation artery. Undoubtedly, this will have an impact on its bank as settlements grow up along the river. Sekampung itself is likely to become an important town and trading center, however undesirable this may be in view of its lack of potable water and high saline groundwater characteristics.

Along the coast canal inlets will be constructed and seawater withdrawn, affecting longshore sediment transport and resulting in erosion and the formation of deposition patterns. Careful soil management procedures also need be established to avoid washing soils from denuded areas into the Sea of Java.

While drainage of fishponds and swamplands will add nutrients to the coastal waters, and thus should enhance coastal fishing, herbicides and pesticides must be applied to the ponds in such a manner that pond waters can safely be discharged into the coastal environment.

To minimize any potential negative impacts on the natural environment the project design incorporates the following features:

- Greenbelts will be preserved along the coast and between the fishpond sections. These will act as wind breaks and provide shade for humans and wildlife.

- An alternative source of firewood should be made available to prevent trees within the greenbelt areas from being cut for firewood.

- All trees and other vegetation cleared during site construction will be disposed of in a manner that will not cause undue harm to existing plant and animal life. The use of explosives, defoliants, chemicals, and grassfires will be avoided.

Excavated soil will be utilized in the building of dikes rather than removed from the site.

Care will be taken to ensure that no plant or animal species in the area are endangered as a result of project operations. The National Wildlife Conservation Agency is to be apprised of the proposed development so that it can initiate necessary conservation measures. This Agency should make provisions for transferring wild animals to forest reserves and wildlife sanctuaries as necessary.

LAMPUNG
BRACKISH WATER POND
PROJECT

APPENDICES

LAMPUNG

BRACKISH WATER POND PROJECT

APPENDICES

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APPENDIX B	Engineering Report September 1976
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APPENDIX A

AQUACULTURE SPECIALIST REPORT

LAMPUNG PILOT BRACKISH WATER

POND DEVELOPMENT

AQUACULTURE SPECIALIST REPORT

BY

Dr. S.V. BERSAMIN

PREPARED FOR
THE UNITED STATES
AGENCY FOR INTERNATIONAL DEVELOPMENT
WASHINGTON, D.C.

SEPT., 1976

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This document, Report Number 1, is one of five which, together fulfill all the requisites assigned to Checchi and Co. in Contract No. AID/afr-C-1141, Work Order No.12, Project No. 497-11-995-249 executed with the Government of the United States of America represented by the Contracting Officer, Office of Central Management, Central Operation Division, Washington, D.C. as part of a general work plan described in Office Memorandum dated June 11, 1976 to Dr. Silvestre V. Bersamin from Mr. Harvey Lerner.

Subject: Terms of Reference

Lampung Brackish Water Pond Development

Scope of services:

The contractor shall provide the services of five specialists hereinafter specified in Section VII of the contract:

1. Brackish Water Development Specialist
2. Water Resource Engineer
3. Fishery Economist/Marketing Specialist
4. Tidal Hydraulics Engineer
5. Sociologist

The Team composed of five specialists shall conduct the following feasibility studies:

1. Technical Feasibility

a. Examine the proposed project area and assess its suitability for tambak culture. Examination of the area will include interpretation of aerial photographs, topographic maps, soil analysis, water analysis, determination of available waterheads for fish culture, etc. On the basis of this examination, determine whether or not the selected site is suitable for tambak development. If the selected site is unsuitable, examine alternative sites in the immediate vicinity and attempt to find one that is suitable.

b. Inspect representative tambak areas in localities to be selected by USAID and/or DGF, for the purpose of observing existing levels of technology. Utilizing local knowledge gained in the inspection, recommend the manner and means of tambak technology best suited to intensive culture of 2.5 ha plots situated in Lampung.

c. Develop a plan for land clearing and development to include canal, dike, and gate design, individual fish farm design, village site locations, road sites, dewatering pump sites and sizes (if needed), and cost estimates. All designs should indicate where more detailed work is required before moving to construction design. Plans should also include sufficient identification, or specifications, of any equipment which may be recommended.

In making plans for site development, contractor will also consider and make recommendations on the following:

1) width of "green belt" to be left on sea front of site.
2) trade-offs between construction machinery and hand labor in land clearing, canal digging, etc.
3) availability of labor necessary for site development.

d. Site and infrastructure development will be undertaken by GOI, with on-farm development by farmers using hand labor and bank credit as necessary. Contractor will evaluate this method on the basis of overall economic feasibility, financial attractiveness to farmer considering cash flow and magnitude/duration of debt incurred, period of time for full project development, etc., and make recommendations concerning proposed credit programs to be instituted.

e. Assess adequacy of plans for transmigration of tambak farmers into the area and make recommendations concerning criteria for selecting transmigrants, land allocations, and initial outfitting of farms.

f. Verify the availability and economic cost of inputs necessary for the tambak technology recommended, e.g., fry and/or fingerlings, fertilizers, pesticides, etc., and recommend a scheme for timely, economic supply. In this connection, contractor will review and comment on the fry survey being conducted in the Lampung area.

g. Conduct a local market survey to assess marketability of harvested fish in surrounding communities, Javanese population centers, and other markets in Indonesia. Evaluate and comment on the viability of becoming a satellite, producing area for Jakarta. Recommend improvements in transportation, ice availability, and other facilities necessary to assure linkage of the project with its markets.

h. Make recommendations concerning an aquaculture extension program and related training programs to assist project farmers to understand, accept, and apply intensive tambak technology. Recommend possible requirements for overseas training for extension personnel and for foreign technical advisors to assist the extension program and/or management.

i. Assess and make recommendations concerning plans for overall project management that will assure timely completion of all development activities and effective coordination between cognizant agencies.

j. Prepare the outline of a water management plan which will detail structure and functions, operation and management, and a method of ascertaining, assessing, and collecting user fees.

Tools and instruments such as pH meters, transits, levels, etc. will be available on a loan basis from the GOI.

2. Economic and Social Feasibility

a. Evaluate the economic feasibility of the project, using the internal rate of return on investment (IRR) as the criterion. IRRs shall be calculated on a social return basis, applying shadow prices that reflect the true economic value of factor inputs and project outputs, and on a business basis, using prices prevailing locally. Contractor will also evaluate the sensitivity of the IRRs to variations in land clearing and development costs, price of productive inputs, such as fingerlings, fertilizer etc., handling and transport cost of harvested fish to market, and price received for fish. The IRRs will be compared with the opportunity cost of capital prevailing in Indonesia and returns to public capital investment in tidal rice development projects.

b. Prepare cash-flow projections for project farmers, demonstrating the attractiveness, or lack of it, for their participation in the project and the potential for improving individual farmer's incomes and standards of living.

c. Assess the sociocultural feasibility of the proposed project; in general, following the guidance for such assessments provided in AID Handbook #3 (Project Assistance). In project-specific terms, the contractor should assess motivating and inhibiting factors for Javanese tambak farmers to migrate to Lampung province; adaptability of these potential transmigrants to improved technologies, and factors determining their willingness to invest and incur debt for such improvements; capacity and readiness of such farmers to organize themselves for effective on-farm development, and operation and management of water systems. Contractor should also investigate possible climatic, environmental differences between Java and the Lampung area that might make adaptation difficult for the Javanese.

d. Determine the degree and nature of participation by transmigrant women in project development and management of tambak ponds and recommend ways in which this participation might be enhanced.

Introduction

The brackish water areas in Lampung Province, Southern Sumatra, include an abundance of marshes, swamps and a few estuarine bays whose potential productive capacities have never before been assessed. The brackish water pond fisheries in this part of the country is relatively a young industry. Most of the existing fish ponds have been developed from virgin lands and methods of construction and pond management are crude and poorly planned. The average annual production is miserably low-about 300 to 400 kg for one growing season which usually lasts from six to eight months.

The cost of clearing heavily covered areas is immensely high and this has discouraged the transmigrants to engage in fish farming. The development of tidal flats into fish ponds where the clearing and construction costs are much lower should be looked into by transmigrating fish farmers.

Sumatra has, for the past decade, been considered a haven for transmigrants from various parts of the Indonesian Archipelago. To relieve population pressures in Java, improve the family income and standard of living of the farmers, the Government has financed several transmigration projects from various regions of Java to selected sites in Sumatra. It has provided these transmigrants financial and organizational support and infrastructure facilities to enable them to start a new life with better opportunities. It has openly encouraged other prospective settlers to resettle in this land to take advantage of the many benefits which its virgin lands have to offer.

The Lampung Brackish Water Fisheries Development Project is the first of its kind to be undertaken jointly by the Government of Indonesia with technical and financial assistance from the United States Agency for International Development. Various government agencies on the national and provincial levels have indicated their cooperation by providing some logistical support which is necessary in the assessment of feasibility.

This project will provide the transmigrant fish farmers a much wider area for cultivation than their old pond holding in their place or origin, technical and financial assistance from government and banking institutions, infrastructure facilities and housing. Other benefits besides increasing the family earnings and improving the standard of living of the fish farmer are:

- It will bring improved technology of brackish water fish culture to the new place.
- Increase the contribution of inland brackish water ponds to the national annual fish production.

- Increase the per capita fish consumption of the people.
- Increase the nation's storehouse of protein.
- Develop the potentialities of milkfish as an export product.

Reasons for shifting from the south side of Sekampung River to the north side

The south side of the Sekampung River is not adequate for 3,200 hectares as envisioned in the project review paper.

It was necessary to get the rest on the north side of the river which appeared to provide the area adequate for the purpose.

There was around 1800 hectares in the south side which is of a character that may be suitable for fish pond development if provided with the right kind of water, but to concentrate the project site on one side of the river would be more advantageous from the point of view of management and construction costs.

The north side appeared to have more areas which are less heavily covered with vegetation.

There has been a rapid increase in agricultural farmer's villages in the south side of Sekampung River during the last few years. The present squatter situation may pose a serious problem to the development of the new villages and management of the fish ponds.

Nearness and accessibility of the project site to the future development of infrastructure facilities proposed for the Meringgai area such as a fishing port, rural electrification and ice plants.

From the air reconnaissance survey it appeared that the south side of Sekampung river may be of a lower ground elevation than the north side.

With these reasons the Team made a decision to concentrate its studies on the north side of the river.

Assessment of technical feasibility

The Site

A major portion of the selected project site is under heavy cover of vegetation with scattering of thickly wooded areas. Big trees are difficult to remove, incur huge expense in clearing and stumping and delays the completion of the project. However, the local Public Works Office has verbally expressed its willingness to help the project by allocating a certain amount of money in its forthcoming budget to cover part of the clearing cost. It was also revealed that the cost of the logs taken from the site may offset the cost of clearing to stumping. They have yet to locate a logging contractor who will agree to this condition. Another solution would be to credit an estimated amount of 300,000 dollars from timber sales to be applied to the cost of clearing and stumping. To save further on costs, this part of the job could be undertaken by the local Public Works Office with the use of appropriate machinery.

The site is not a tidal flat, swamp or marsh but a forested area remote from tidal inundations. The only solution to this unfavorable situation is the construction of channels from the sea to the Project. These are open channels about two kilometers long and 10 to 15 meters wide.

An overland survey of the project site reveals certain areas with undulating terrain. These areas require heavy excavation which removes thick layers of earth including top soil which contains organic and inorganic nutrients necessary for growth of algae. However, if pumps will be used to bring in tide water into the ponds there will be no unnecessary deepening of the pond bottom.

Narrow range of tidal fluctuation

Actual tide measurements reveal that the tidal range in the project site is around 60 cm. This narrow tidal range does not permit efficient water management in fish ponds which depend on tides as the source of pond water for fish culture. This situation has ruled out the principle of gravitational flow in filling and draining the ponds and the best solution is the use of appropriate water pumps to bring in sea water.

The water direct from the sea could be used but water from tidal streams are more suitable for the rearing of fry. It is good management policy for the ponds to be capable of drainage at any time desired even under ordinary tide conditions. It is essential to drain the ponds during the preparation for stocking to eliminate all predators, to change the water and flush the ponds when there is threat of pollution and control of water level during the process of catching fish.

A tidal range of around 100 cm. may allow natural drainage but only to a limited extent. A wide range of tidal variation is necessary to attain the proper water management operations.

Water quality

The averages of water quality sampling tests taken during the months of July and August reveal the following range of values for the different chemical and physical environmental factors:

1.	Dissolved oxygen	5.92	- 7.04	ppm
2.	pH	7.0	- 7.2	
3.	Salinity	25	- 31	ppt
4.	Turbidity	22	- 42	cm
5.	Water temperature	28	- 30	°C
6.	Air temperature	27.5	- 28	°C

Morning and afternoon sampling tests were made every Monday of the week at 5 stations in the coast of Java Sea close to the project site particularly near the proposed site of the channel inlet which supplies sea water to the fish ponds.

All the values taken fall within the optimal ranges for the normal growth and development of milkfish during the period of growth in brackish water ponds. These values also favor growth of benthic algae, plankton, diatoms and some higher filamentous forms. The coastal region is fairly stable with regard to these factors.

The salinity measurements taken near the site of the proposed inlet of the channels ranged from 20 to 29 ppt which indicate the freshening effect of Sekampung River as far as 20 kilometers away from the mouth. This salinity range is acceptable for brackish water fish culture. This condition is fairly stable throughout the day.

Milkfish fry can tolerate a wide range of salinity from 15 to 32 parts per thousand. Mortality could be decreased significantly if this range of salinity in the pond could be maintained. Adult milkfish could tolerate higher levels of salinity although recent experiments done in Laguna Lake in the Philippines have proven that milkfish could adjust very well in fresh water and demonstrated a better rate of growth compared with brackish water conditions. Fish pens are now being constructed in the lake for milkfish rearing. This indicates that milkfish in captivity can develop very efficient body adjusting mechanisms to changing external environmental factors.

Plankton

Analysis of plankton samples collected from four representative stations in the coast of the Java Sea close to the proposed site of the channel inlet reveal a plankton population typically normal in estuarine conditions, an intermixing of marine and fresh water forms. Sekampung River brings the fresh water forms to the coastal region close to the project site and intermix with the marine plankton producing a heterogenous mixture of rich plant and animal materials needed for fish nutrition. This explains the richness of estuarine areas in supporting a variety of forms. The ecological conditions in estuarine environments favor all forms of biological activity including spawning. Thus the mature milkfish come to spawn in coastal areas.

Soil

The principal sources of nutrients for the algae, plankton and fish in a fish pond environment are soil and water. While water could be changed periodically and circulated in the pond, soil is a fixed factor. However, both could be fertilized to replace the nutrients which have been used by the fish and plankton. Certain types of soils possess large amounts of organic nutrients which are gradually released into the water.

Others possess a high capacity for holding water. These are 2 properties of soil which are desirable for fish pond purposes. The clay loam type of soil has these 2 properties. Soil samples obtained from the proposed site reveal a combination of sandy - muddy and clay-loam soil in various sampling areas. Percolation loss of clay soil has been assumed to be 1 mm per day.* Comparing this data with the water evaporation rate for the Lampung area which is 3 to 4 mm per day, clay loam soil, would be the ideal type for fish pond development due to its high water holding capacity. Considering that the site is virgin land, there is no doubt that the upper ground layers contain large amounts of organic nutrients.

Assessment of Climatologic and Hydrologic data

An examination of the climatologic and hydrologic data in Lampung Province covering the project site indicate that they are conducive to the development of plankton in the coastal areas and the stabilization of ecological factors in the fish pond environment.

* Design Criteria, Irrigation and Drainage "Engineering Consultants, Inc. The Citanduy River Basin Development Project, Banjar, 1976

Following is a summary of the annual climatological data for Lampung Province.*

Factor	Lowest	Highest	Average
Air temperature, °C	25.8 (Jan.)	28.2 (Oct.)	26.9
Relative humidity, %	56 (Oct.)	65 (June & Feb.)	62
Sunshine, hrs/day	2.8 (Dec.)	4.7 (Oct. & Apr.)	3.7
Evaporation, mm/day	3.4 (Feb.)	5.4 (Oct.)	4.2
Rainfall, mm/mo	67 (July)	391 (Jan.)	214
Wind run, km/d	120 (May)	198 (Sept.)	156
Wind direction	NE to NW (Jan.-Apr.)	SE to SW (May-July)	E to SE (Aug.-Nov.)

Effect of climatologic and hydrologic factors on plankton population**

An analysis of the hydrologic and climatologic factors operating in a fish pond environment is a necessary approach in determining the varying degrees of biological productivity in the pond or its capacity to produce organic matter for the fish populations found therein. This important activity is determined by the amount of phytoplankton organisms which play an important

* Hydrological Network, Lampung Province, H. Humphrey's and Sons, London, 1975, Part 2, Vol. 2

** Bersamin, S.V., 1957. Fluctuations in the Planktonic Population of the Estuaries of Navotas and Malabon, Phil. Jour. of Sc., Vol. 86, No.4, Dec. 1957, pp. 339 - 357/

role in the nutritional scheme of aquatic life.

Plankton populations fluctuate in abundance, they appear and disappear, they migrate with ocean currents to other places, occur in blooms during peaks of reproduction and their diurnal migrations are correlated to rainfall, salinity, pH, cloud coverage, humidity, light intensity, temperature and wind velocity. Variability of these factors affect plankton physiology and their stability favor increases in plankton production.

Ocean currents which cause a faster rate of water replacement adversely affect plankton production. Rising tides result in decrease in plankton numbers. The pH which favors best plankton growth is toward the alkaline side. Water temperatures from 29°C to 30°C are considered optimal and could support a rapid rate of plankton reproduction. Maximum growth and multiplication of plankton has been observed during days of sunshine with intermittent cloudiness. The occurrences of occasional cloudiness is a factor in speeding up the chemical process of organic synthesis in the plankton organism. Organic production is directly associated with the amount of chlorophyll present in the phytoplankton.

The average number of daily sunshine hours for the year in Lampung Province is from 2.8 (Dec.) to 4.7 (Oct. and April).

This condition favors rapid chlorophyll production in phytoplankton. The relative humidity recorded for the year is from 56% (Oct.) to 65% (June and Feb.). These readings are also ideal for plankton production. A very high relative humidity of about 87 percent has been found to cause a tremendous decrease in plankton numbers.

Strong winds and rainfall are inimical to plankton production and distribution. Very low salinities cause big slashes in plankton populations. Copious rainfall causes swelling of estuaries and increases the rate of run-off thereby washing away a great bulk of surface plankton. Excessive rains increase turbidity of water and decrease the rate of light penetration and the rate of photosynthetic activity of the phytoplankton and algae.

Occurrences of floods and typhoons

Results of interviews with experienced men belonging to the older generation and have lived in the area for long periods of time reveal that floods, typhoons and other natural cataclysms are a rare occurrence in the region. In fact there are no available records in the locality to show these events. There are also no records to indicate periodic flooding of Sekampung River, the biggest and only river close to the project site. These phenomena are detrimental to fish pond management. They cause great losses to fish farmers. Areas that are periodically flooded are avoided because fish under cultivation may be washed away during the occurrences of these natural catastrophies. Under this situation the perimeter dikes of fish ponds in the area must have to be constructed at least about 12 to 15 inches above the highest flood waters recorded to prevent the destructive effects of floods on the fish ponds and that these dikes must be constructed such that they do not obstruct the flow of rivers. Flood protection costs will not be an additional item to the project.

<u>Assessment of the Fry-Fingerling Supply</u>

At this stage there is no assurance of an adequate fry-fingerling source in Lampung Province to service the requirements of the proposed project. Results of the preliminary fry survey conducted by the personnel of the Jepara Brackish-Water Research Station assisted by the fisheries officers of the Lampung Regional Station reveal the extreme poverty of milk-fish and shrimp fry in the coastal waters of the Java Sea from Maringgai in the north to Ketapang in the south. (Tables 5 to 8)

This survey was conducted from October, 1975 to January, 1976, the low season for fry fishing in this portion of the Java Sea. Fisheries personnel estimate that the fry season starts in April and lasts until July. The survey on seasonal occurrence, distribution and abundance of milkfish and shrimp fry is still in progress. Subject to the results of these surveys conducted by DGF teams, a nearby source cannot yet be ascertained.

Records from the Directorate General of Fisheries indicate the following places as possible sources of fry and fingerlings for the project: (Table 4)

1. D.I.Aceh
2. Sumatera Utara

3. Jawa Barat

4. Jawa Tengah

5. Jawa Timur

6. Sulawesi Selatan

7. Bali

8. Nusa Tenggara Barat

9. Daerah Lain

During the height of the fry season in Aceh, the fry enter the water canals with the tides, are caught in these places by fry fishermen and marketed. During this season the average catch per man, per fishing hour is about 2000 fry. Fry fishing is done intensively from April to July each year. D.I.Aceh and Sumatera Utara would be the best sources for the much-needed fry considering their nearness to the project site.

If further investigations show that the portion of the Java Sea close to the project site does not contain sufficient fry to support a continued operation of the project, then other areas must be tapped and explored as alternate sources of fry. A project of these dimensions require a fry-fingerling bank which will serve as the reservoir for the stocking requirements of the rearing ponds. Ten percent of the total pond area would constitute the adequate size for the nurseries if fry stocking is on a continued basis to provide immediate replenishment of fingerlings which have been transferred to the rearing ponds.

At least 100 of the fish farmers should be trained and their activities concentrated on the proper handling, care and rearing of milkfish and shrimp fry. Their nurseries should always be fully stocked to insure a continued operation of the project. Importation of fry and fingerlings, if economically feasible will solve this obstacle. They could be bought from North Sumatera, Aceh, Kalimantan, South Sulawesi and Java and transported by boat or plane to the site at costs economically feasible to the project. For the project to be profitable, the cost of fry delivered to the nursery site must not be more than 7 to 8 rupiah apiece. The landed cost of fry and fingerlings airlifted from the places mentioned above to Jakarta is around 8 to 9 rupiah. Price of fry from the fry fishermen is 1 to 1.5 rupiah apiece. It would cost about the same price to bring the fry and fingerlings to Lampung by the some type of transport.

Recommendations:

1. Development of the five principal phases of the milkfish industry.

Development of the five principal phases of the milkfish industry should be given all the logistical support it needs. These divisions of the industry, namely: (a) fry fishing, (b) fingerling production, (c) rearing pond operation, (d) marketing, transport and distribution, and (e) utilization, processing and preservation are interdependent with each other and failure of one phase could cause the decline of the whole system. The first phase of the project would be to build up a large fry-fingerling bank to supply the stocking requirements of the project.

2. The mixed culture of milkfish and shrimp, a successful operation in Java and South Sulawesi.

The culture of milkfish and shrimp in the same pond has been proven to be a successful operation in Java and South Sulawesi as reported by technicians from the Directorate of Fisheries. Studies and experiments should be conducted regarding the possible benefits of mixed culture of shrimp and milkfish. These two species are compatible for joint culture.

3. Intensification of fry survey.

A more intensive fry survey on the coastal areas of Java from Maringgai to Ketapang on a year 'round basis should be conducted to establish a nearby source of milkfish fry. There was no evidence of fry fishing during the time of the survey trip which was the last week of June to first week of July. Records from the Directorate General of Fisheries indicate that the months of November to January are very poor in fry. (table nos. 5-8) Other areas in Southern and northern Sumatra should be intensively explored.

4. Importation of fry and fingerlings from nearby fry producing areas

Consider the possibilities of importing fry and fingerlings from northern Sumatra, Aceh, Kalimantan, South Sulawesi and Java. A 3000 hectare project in order to be viable and economically sound must have adequate nurseries which are always fully stocked to provide a continued source of fry and fingerlings to meet the stocking requirements of the fish farmers. Intensive cultivation would not be feasible without a guaranteed fingerling supply.

5. Continuing exploration of more suitable areas for brackish water-pond development.

There should be a continuing and intensive exploration of more suitable areas for brackish water pond development like tidal flats with scanty vegetation, marshes and swamps which are not densely covered and flat terrains which could easily be reached by tidal action. These areas incur lesser costs in clearing and in pond construction. Future transmigrants who want to engage in brackish water pond culture will find this information useful. It will encourage others to engage in this activity. The ecological and hydrobiological conditions in these places favor the growth and development of micro- and macro-benthic algae and plankton organisms - the natural food of fish.

6. Site development on the incremental plan.

Development of the site should be on the incremental plan. It is strongly recommended to start with an economically, socially and technically feasible module - 600 to 800 hectares.

7. Liberalized financing of credit by rural banks made available to fish farmers.

Liberalized financing of credit by rural banks should be made available to fish farmers. The PRP provides that Bank Rakyat Indonesia will provide loan funds to the fish farmers for operating expenses on convenient terms.

Fish farmers are reluctant to incur credit for fish pond improvement due to strict terms imposed by banks.

8. Periodic training programs for fish farmers.

Periodic training programs for fish farmers should be conducted to update them on the latest techniques on improved technology of fish culture. The live-in type of training have been found to be most effective for those who do not have any or much basic training and formal education in fisheries.

9. Site clearing and excavation should be a thorough operation.

Site clearing and excavation must be properly and thoroughly executed. After all the trees and other forms of vegetation have been cut and removed from the site, the strumps and root systems extracted from the ground, the next step is locating the pond bottom. Over excavation is a bad practice because it removes thick layers of top soil which is essentially humus and other organic material deposited in the upper ground layers. This material contains organic and inorganic nutrients which are needed by the benthic algae and plankton organisms including diatoms during the process of growth and/development. These organisms constitute the natural food of fish. The nutrients also support vital body activities of the fish. They participate in various cycles in water. These are illustrated by food chain interrelationships. A flat terrain is always preferred to the undulating type because of the minimum of excavation involved. Tidal flats are good examples.

10. Maintenance of normal stocking rates

It is essential to maintain normal stocking rates in the fish ponds if all the environmental factors are optimal. This condition could be determined by a periodic monitoring of water quality. When some of the environmental factors are not within the normal levels, remedial measures should be instituted without delay. The Fish Pond Specialist should supervise all these types of activities.

11. Decomposition processes cause fish kills

Root systems of all types of vegetation must be uprooted after the plants have been removed from the site. Some fish pond operators leave them untouched underneath the soil to rot and decompose. Decomposition is an oxygen-consuming reaction of long duration. While it may not cause mass death because the fish have the capacity to develop certain degrees of tolerance a low dissolved oxygen content of the water certainly affects the vital physiological processes in the body of the fish. In extremely advanced cases of rapid decomposition, fish kills may result. An abundance of plant life in water replenishes most of the oxygen consumed during decomposition activities and uses up the carbon dioxide generated during the process. A balance of plant and animal life in the fish pond restores the normal gas exchange in an aquatic environment. The benthic algae and plankton diatoms represent the flora while the fish and zooplankton represent the fauna in this typical biotic interrelationship.

12. Stump removal should be a thorough operation

Stump removal should be thorough and complete. This is an expensive operation in fish pond construction. They are usually left to decay and decompose in the ponds and gradually extracted with crude implements. This long process causes the pond water to become acidic to the extent of becoming deleterious to fish life. Under this situation, it becomes necessary to apply some liming procedures to restore the normal and optimal pH of 7.2 to 8.6. Normally, some fish ponds soils are acidic due to the high content of organic acids, of which the most common is tannic acid. Liming is recommended to remedy this condition.

13. More studies on artificial feed formulation for milkfish

Undertake more studies on artificial feed formulation for fry, fingerling and post adult milkfish to increase the present rate of growth with natural feeding. Local raw materials which are easily available and cheap should be utilized in the study and investigation of protein sources for fish feed. They could be rendered into pellets, meal or cake form for easy dispensing and longer storage life. There are also some local sources of a carbohydrate type of food which could be used for feeding prior to harvesting to increase the weight and round up the body of the fish. This will raise the market value of the harvested fish. Some good sources of cheap organic fertilizers which should be looked into are by-products of food establishments and processing plants. These waste materials which are usually disposed of could be obtained free or with a nominal cost. They should be thoroughly analyzed chemically and their effect on plankton and fish growth properly evaluated before they are actually applied in the commercial rearing of fish.

14. Establishment of a quality control laboratory

The establishment of a water quality control laboratory equipped with basic equipment to monitor periodically the physical, chemical and biological properties of the water is essential to obtain the optimal conditions which support fish growth. The fish farmers should be taught on how to handle and operate these equipment so that they can perform their own tests and measurements. The laboratory supervisor should set up schedules on the use of the various equipment available for fish pond use.

15. Improvement of fish pond devices and structures

As part of a continuing program of pond improvement, the fish farmer should devise and construct more effective screen filters which can prevent the entrance of predators and fish pests in various stages of development into the ponds. Predator control decreases significantly the mortality of milkfish in the ponds. There is always plenty of room for improving the major structural components of fish ponds like gates, dikes, doors and reinforcements with respect to materials, design and workmanship. Permanent structures save more on costs, increase efficiency in management and operation. and produce higher yield for the fish farmer.

16. Intensify search for suitable sites for fish pond development in various regions in Sumatra

In implementing the expanded fisheries development program of the country, the Directorate General of Fisheries should undertake a continuing search for new areas suitable for fish pond development. Before requesting for technical and financial assistance in the development of new areas for fish pond projects, it is essential that a thorough investigative study be conducted by professional aquaculturists and fish pond engineers to determine the suitability of the site for fish culture purposes.

Swamp lands, marshes, tidal flats and mangrove areas are considered good sites for the construction of nursery pond systems. In these areas are found an abundance of microscopic flora and fauna which form the stock of the desired benthic algae which serve as the natural starter feed for fry. Under optimal conditions of the aquatic environment this stock continue to generate rapidly sometimes causing the production of blooms or population explosions as in the case of certain forms of diatoms and plankton algae.

A flat terrain would be most conducive for fish pond development because this type of topography entails the minimum of digging and excavation work. This process removes the upper layers of the soil which usually constitute the most fertile portion of the pond bottom. Open areas with scanty vegetation definitely will incur lesser expense in clearing and preparing the site for pond construction. The mangrove trees form good protection for dikes because they act as buffers to minimize the destructive effects of wave action.

Survey of existing brackish water fish ponds close to the project site

One of the fish ponds visited during the survey is owned by Mr.Wasta, one of the early immigrants who came to Lampung Province in search of better opportunities and to practice his main occupation, fish farming. His ponds are located on the north side of the mouth of the Sekampung River in the village of Belukang. They constitute one of the better developed ponds in the area but has the appearance of being neglected.

There is practically no water management techniques employed, no evidences of pond improvement, care and maintenance. The owner claims that his annual production is half a ton per hectare and that this includes all the edible resources found in the pond. The growing season is six months.

A random sampling by cast net near the fish pond gate in the main water canal contained the following organisms:

Species	Number
1. Mullet (Mugil)	13
2. Sea catfish (Arius)	2
3. Metapenaeus	2
4. Macrobrachium	3
5. Milkfish (Chanos chanos)	0

6. A puffer 1

The absence of milkfish in any stage of development was quite revealing. The pond owner explained that the milkfish fry season has just ended. There were, however, some concentrations of milkfish fry in some portions of a pond.

From the interview, it was gathered that:

1. Mr. Wasta holds no permit nor lease agreement issued by any government agency to construct and develop fish ponds in the area. Fisheries personnel revealed later that it is the same for all the fish pond developers in the region.
2. He is, therefore, squatting on public domain.
3. The construction of his ponds has been under advisement from personnel of the regional fisheries office in Lampung.
4. The total area of his ponds is 16 hectares and only 4 to 5 hectares are being developed.
5. He has no plans at the present to develop the 11 hectares.

His reluctance to develop the rest of his area is due to:

1. The natural stock of milkfish and shrimp fry in the region is quite low and this limits his production.
2. He can only resort to traditional or wild stocking and tide water brings in large numbers of pests and predators which eat up the fewer milkfish and shrimp fry.

3. Fry survival is very low under the above situation.
4. There is no available fry-fingerling market in Lampung where he could purchase the seeds necessary to stock his ponds.
5. He can't institute pond improvements because of lack of funds.
6. Limited tidal variations restrict proper water management and no pond preparation methods are employed.
7. He cannot practice water quality control methods due to lack of equipment and training.
8. He claims that there are no government incentives to help him develop and improve his ponds.

Mr. Wasta has a family of about eight members, which include in-laws, and they live together in a hut built in fromt of the pond. He cannot support his family from fish pond production alone so he engages himself in sea and river fishing and vegetable and fruit raising. The rest of his family assist him in these supplementary occupations. They fish for small shrimp near the mouth of the river with the use of fine meshed nets, which are sun-dried and sold to local markets. Coconut and pineapple are planted on the fish pond dikes.

The case of Mr.Wasta may be a typical example of all the other fish pond developers in Lampung. The state and condition of his ponds, the level of production and his occupational and personal problems are, in many ways, similar to the rest of the fish farmers in the area.

Production constraints in existing tambak areas*

In a survey of representative tambak areas in Java and Lampung Province for the purpose of observing the present levels of technology being practiced, several production constraints have been identified:

1. Limited area of individual pond holdings

The average area of a private fish pond in Java and Lampung range from 0.8 to about 3 hectares. Where these small pond holdings are concentrated, there is not much room for expansion. Under this situation, and coupled by the fact that majority of the fish farmers still practice inefficient methods of tide water stocking and crude pond management procedures, the production is consistently low. Limited size of pond holdings prevents a high return from investment. The amount of yield is not commensurate with the input. The annual production per hectare has been consistently maintained at an average of about 300 to 400 kg.

2. Narrow range of tidal fluctuation

The average tidal fluctuation in Lampung area is about 60 cm, more or less. Low tidal fluctuations are not conducive

* Appraisal Mission and Fisheries Project Supervision Mission to Indonesia, Aquaculture Specialist Report to IBRD, 1975.

to efficient water management and environmental manipulation and control. It prevents fish farmers from instituting proper regulatory measures to avoid abrupt changes in the chemical and physical conditions in the pond which may lead to mass killing of fish. Low tidal fluctuations do not permit complete drainage of the ponds, an operation which is necessary for pest and predator control and growing of benthic algae, the natural food of the fish. The recommended solution to this situation would be the use of mechanical pumps which could drain a pond completely or fill it with water to the desired depth. Small fish farmers may not be able to purchase this equipment due to its high cost. They could pool their resources to enable them to purchase a pump and schedule its use among themselves.

3. Inadequacy of fry to attain optimal stocking rates

A critical item in pond management which is considered the key to increased production is an adequate and continuous supply of fry and fingerling to insure normal stocking rates. One of the reasons for the low production in majority of the ponds surveyed is the fact that they are under-stocked due to limited supply of fry and fingerlings. The milkfish industry in this country can prosper only if all its important segments are ameliorated, including:

a) The fry fishing industry
b) The fingerlingling industry (raising fry to fingerling size)
c) The rearing pond industry (raising milkfish to marketable size)
d) Handling, transport and marketing of milkfish
e) Milkfish processing and utilization

Surveys for new fry fishing grounds should be intensified. Fluctuations in the size of the natural stocks, their seasonal distribution and abundance must be investigated. All Indonesian coastal waters should be studied for this purpose. Fragmentary work has been accomplished along this line.

The milkfish fry industry is a distinct and viable industry and, if given the proper impetus, will service another equally important segment of the milkfish industry the fingerling producers. With the development of the fry and fingerling industries, the traditonal method of pond layout with nurseries, transition and stunting ponds will be eliminated. The fish farmers will maintain rearing ponds only. With advanced technology, they can make two to three harvests a year. Indonesian techniques have a long way to go in this regard. The production target of the Lampung Project is to at least double if not treble the present average annual production of about 500 kg. This is a realistic goal if all problems affecting proper pond management will be surmounted.

4. Low productivity destroys incentives of fish farmers

The cultivation of small pond holdings yield very limited income. The fish farmers average annual income is hardly enough to maintain his family. Under this situation, he has no means to increase his effort and capital to his investment except with the aid of financing institutions.

Credit financing may not be profitable for small holdings. The average fish farmer is not desirous of credit to finance his operation because he believes that it is not a paying venture for the following reasons:

a) He cannot increase his productive area

b) The supply of fry and fingerling is limited

c) Fertilizers and commercially prepared supplementary feeds are not available most of the time.

5. Majority of the ponds are neglected need more pond improvement

A large majority of Indonesian fish farmers still cling to the antiquated methods of fish farming. Those who depend entirely on natural stocking have stocking rates that are far too low and tidal waters bring into the ponds big numbers of fish predators which devour the young fry and compete with the bigger ones for food and space. Under this situation the general rule is mixed farming of shrimp and milkfish.

The above mentioned factors have discouraged many of the farmers to institute pond improvement measures and their ponds appear neglected. The fisheries extension and demonstration personnel, as well as the field extension officers of the recently created Agency for Education Training and Extension, should give more drive in their campaign for increased fish pond productivity by holding periodic demonstration and workshop seminars.

Some suggested areas which need more emphasis are the following:

a) collection of milkfish and shrimp fry for growing in nursery ponds

b) rearing of fry to 10 to 15 cm fingerhings before stocking

c) pond preparation for growth of benthic algae

d) water management in ponds to obtain optimal conditions

e) periodic monitoring of water quality

f) repair and improvement of dikes and gates

g) eradication and control of fish pond pests and predators

h) fertilization of pond water to enhance the growth of benthic and plankton algae

i) supplementary feeding of cultured fish to accelerate growth, especially before harvesting, and to prevent overgrazing on the plankton algae.

6. Lack of qualified, competent technically trained manpower

This situation has been observed in all levels of organi-- zation from the top echelon to the lowest ranks. Majority of the appointees are not equipped with proper qualifications. Fisheries technical schools, the only source of technical man-power, are few in number and produce a limited number of gra-duates who are employed immediately without any previous ex-perience to handle sensitive jobs requiring expertise and seasoned judgments. There is lack of a standard description and qualifications guide for civil service employees. There is urgent need for a Wage and Position Classification Bureau.

7. Government subsidies and liberalized financing un-available to fish farmers

Interviews with pond owners and Directorate of Fisheries personnel revealed that the small fish farmers do not benefit from government subsidized fertilizers. Agricultural farmers benefit largely from this program. The government scheme of providing assistance to smallfarms should be reorganized so that fertilizers can also be channeled to fish farmers.
Fish farmers need assistance not only in the form of technical knowledge but also materials for pond improvement.

8. Water quality assessment practically nonexistent

Majority of the fish farmers do not understand the optimal ecological requirements of milkfish and shrimp. They use experience as a guide in the determination of water quality. This is inaccurate and unsound and must be supported by scientific analysis. The more advanced farmers who have had some degree of training in improved fish pond management understand the normal values for the physical and chemical environment. The normal values should be set as standards for representative regions.

Farm Ownership

In Lampung Province, there is no organized system of granting lease permits by the Government to prospective fish pond developers. All the fish ponds visited were virtually squatting on government property without the benefit of a government lease or a permit to operate.

The Director General of Fisherries favors granting long-term government leases to fish farmers involved in the project*. This will solve the present dilemma in Java of "diminishing family properties" caused by division of these properties by inheritance. If the fish pond is leased to the fish farmer, he cannot subdivide it and award portions to his children as inheritance. The property remains intact and he can use it indefinitely because the lease agreement will provide that the fish farmer can renew the lease as long as the terms and conditions have been satisfactorily complied with.

Eligibility of fish farmer for renewal of lease agreement will be based on:

a) successful fish pond management throughout the duration of the first lease period,

* Personal interview with the Director General of Fisheries, June, 1976.

b) that there are no encumbrances on the property,

c) all permit fees and annual dues paid up-to-date,

d) fish production up to standard, and

e) fish farmer must be physically capable to continue operations.

Technical Procedures*

1. Preparation of the nurseries

In areas where there is no defined dry and wet season, the process of pond preparation could be done at any time during the year. Where there are distinct dry and wet seasons, the ponds are usually prepared during summer. This initial step in improved pond management is essential as it prepares the ponds for the growth of benthic algae commonly called pond scum, a heterogenous mixture of plant and animal complex consisting of blue-green algae, green algae, larval organisms, eggs, protozoans, rotifers, bacteria, and other micro-organisms and organic detritus. This material constitutes an important food item during the growing stages in the development of the milkfish.

Pond preparation provides a starter stock of benthic algae which, under favorable conditions, spreads throughout the bottom of the whole pond and insures a continuous supply of natural food for milkfish and shrimp. The intensity of growth is influenced by the amounts of organic and inorganic nutrients present in the soil and water. When these nutrients are used up by the growing benthic algae and plankton, it becomes

* Part reference, Tech. Bull. Phil. Fish. Com.

necessary to replace them by the application of the proper kinds of fertilizer to enhance algae growth. Fertilizer application must be supervised by a professional aquaculturist.

2. Provisions for better water renewal and circulation

Nursery ponds require an effective water renewal and circulation system to provide good water for normal growth and development of the fry. They should be constructed as close as possible to the main water canal for ease in obtaining their water requirements. If they are located far from the water source, a secondary water canal should be constructed leading to the main water canal where it receives new supply of water whenever necessary.

One catching pond could serve two or more nurseries and is conducive to better water circulation. The usual practice is to make a temporary cut at the extremity of the middle partition gate so that if water is let in through one gate and let out through the other, a complete renewal of water is permitted.

Another method of providing the ponds with fresh tide water is by constructing a head pond that is deep enough to store water which could be used when tidal water is turbid and polluted.

A transition pond which is not in use may also serve this purpose.

3. Leveling and cultivation of the pond bottom

The ponds are drained during the low tide. This is attained by manipulating water levels in the pond and the water supply canal. If this is not feasible an appropriate water pump must be used. The nurseries are cleaned of the old stock of fish. The pests and predators are killed and exterminated during this process. If necessary a concentrated solution of derris may be applied (10 cc to 1 cu. m. of fish pond water), allowed to stay in the pond until all the organisms die and float on the surface of the water. Flush the pond twice with clean tidal water to neutralize the toxic effects of the derris solution. Dispose of all dead animals properly. The bigger forms of vegetation which grew in the pond during the rearing period are uprooted and disposed of. The pond bottom is stirred with shovel or rake to bring the nutrients in the subsurface layers available to the surface.

After the mud is loosened, the soil is meticulously leveled with a wooden rake attached to a bamboo or wooden pole. The purpose of leveling is to make the bottom topography slope from the farthest end of the pond toward the gate which should be the deepest portion of the pond. All the depressions, elevations and holes are leveled off.

Another good practice is to construct a canal which runs diagonal from one corner of the pond gradually sloping and deepening toward the gate. This internal canal system provides a good refuge for fingerlings during hot days and makes the process of catching easier. The slope of the bottom should be gradual so that the water is fairly distributed throughout the pond. After the ponds have been well leveled and cultivated they appear like well-tended garden plots.

4. Draining and drying the pond

The ponds are exposed to dryness for two to three days after which a little water is let in to induce the burrowing predators like the mudfish (Ophicephalus) and the eel to come to the surface where they are caught and exterminated. Then the pond bottom is allowed to dry until the soil cakes and cracks. This process may take around six to eight weeks depending on the intensity of sunlight. It eradicates completely the fish enemies and competitors of the milkfish fingerlings. This process also hastens the organic decomposition going on in the soil.

5. Inspection of leaks and seepage in dikes

Before the ponds are planted with fingerlings, they are cleaned and repaired. Grasses and overgrown vegetation on the dikes are trimmed or uprooted. All the eroded portions of dikes are patched. A good method of detecting leakages in the nursery ponds is done by allowing water to enter the pond during an incoming high tide until the highest level is reached. The gates are closed and water outside the nurseries is drained. The leakages could be repaired immediately. For big leaks and seepage, the solution is to construct a puddle trench about 30 to 50 cm wide running along the dike on one side. The same is done on the other side until the whole area is covered. The trench is then filled with hard blocks of clay which is compressed by hitting with heavy wooden blocks until the sealed portion is sufficiently settled. If dikes are badly damaged throughout the whole length, it may be more economical to replace them with new ones.

6. Screening the gates

Bamboo screens are the most common in the Indo-Pacific region because bamboo is easily available, cheap and last long if well matured when cut. The screens are installed after the ponds have been thoroughly dried and cleaned, water let in and the benthic algae, microflora and fauna and plankton organisms have started to grow. The screens are covered with fine meshed cloth made of abaca, jute fiber or nylon material to prevent the escape of the milkfish fry.

7. Water management before stocking the ponds with fry

After the bottom soil is thoroughly dried up, allow gradually about three inches of fresh tidal water to enter the pond. After three to five days, a thin layer of greenish brown scum starts to grow at the bottom of the pond. As the growth becomes thicker, gradually increase the depth of the water by allowing new tide water into the pond. After about four to six weeks, this material will have developed into a thick slimy mass of pond scum covering the entire pond bottom.

By this time the pond is ready for stocking fry or fingerlings. It is good practice to flush the pond once with new and clean tide water before stocking. Fry must be stocked in eight to ten inches of water and for fingerlings, in 10-12 inches of water. The depth of the water is gradually increased as the fish grow in size.

The pond scum is a heterogenous mixture of different forms of bacteria, filamentous and unicellular blue-green algae, diatoms, various forms of protozoans, ostracods, copepods and round worms. This "micro-benthic biological complex" constitutes the natural food of milkfish.

8. Nature of soil

The kind of soil best fitted for fish pond is clay-loan, This soil contains the essential organic and inorganic nutrients which are needed by the algae for their growth. The maintenance and replenishment of this benthic algae depends on the amount of nutrients found in the soil and water. Clay soil has a good capacity for holding water. The rate of evaporation of pond water is much faster than percolation of water in clay soil.

9. Depth of Water

The "micro benthic biological complex" grow best in very shallow waters. A large portion of this material is made up of plants which require solar energy for effective photosynthesis. A depth of about 10 to 15 cm allows a complete penetration of light from the surface to the bottom and does not allow the growth of bigger forms of filamentous algae which is not yet needed by the fry.

When the fry develops into the fingerling stage the depth of the water could be increased to more than 20 cm. At this depth the bigger filamentous forms of green algae start to grow toward the surface of the water. These plants provide part of the food of the fingerlings and form a habitat conducive to the rapid development of plankton diatoms. An overgrowth of these more complex plants crowd up the benthic forms. It is good practice to thin down these plants when they cover the whole pond surface.

10. Salinity

The micro-benthic algae have efficient powers of tolerating wide ranges in salinity from brackish to marine conditions, from 10 to 40 parts per thousand. However, the best range of salinity for optimal growth is from 26 to 31 parts per thousand.

11. Turbidity

Turbidity caused by large amounts of suspended soil particles in water is detrimental to algae and plankton productivity. They interfere with light penetration decreasing the amount of solar energy necessary in organic production. On the other hand, a high turbidity measurement may also be caused by an abundance of plankton algae and diatoms suspended and floating on the water surface. This type of turbidity is beneficial.

The stirring action of winds, waves and currents produce turbid waters which not only decrease effective light rays for photosynthesis but suspended sediments destroy the flotation properties of plankton organisms. This destructive effect could be minimized by planting mangrove trees and other effective wind barriers along the perimeter dikes.

12. Control of predators, fish pond enemies and overgrown vegetation

Most common of the fish pond enemies are crabs, mullets, snails, eels, sea snakes and other marine fishes. They scour the bottom, cause turbidity, feed on the algae, hinder their growth and compete with the milkfish for food and space. These enemies should be exterminated as soon as they are noticed.

An overgrowth of benthic algae can cause death of fry. In some instances big patches of algae lose their foothold at the bottom and float on the surface. The fry which jump over them get entangled with the filaments and die. Overstocking is one method of controlling the overgrowth of algae. Higher forms of vegetation may also grow in the pond and outgrow the algae. These plants should be collected and disposed of. The excess benthic algae are also collected, dried and later used as artificial feed to the fingerlings.

13. Stocking the nursery ponds

Fry fishermen fish in coastal areas, beaches and estuaries. They place their catch in unglazed earthen containers, big melon rinds or other appropriate containers and brought to the fingerling growers. The fry are sorted, the dead ones and other juvenile forms are removed and the numbers are estimated by using glazed white porcelain cups or with the palms cupped to hold a certain number of fry. Experienced persons are fairly accurate in this method of counting. It is important that all other juvenile forms must be weeded out to prevent undue losses caused by fish pond predators.

Stocking of the fry is best done in the early morning or late in the afternoon when the temperatures are lower. To prevent undue mortality the temperature and salinity of the water in the jar and in the pond must be about the same. If there are significant differences, efforts must be made to have these factors approximate each other. Abrupt changes in the physical and chemical environmental factors are common causes of fish kills.

After all these factors have been controlled, the jars are brought near the fish pond gates which is the deepest portion of the pond. They are immersed below the surface of the water and tilted toward one side to allow the pond water to get into the jar. The jar is held under water for about 15 to 20 minutes to give ample time for acclimatization to the new environment. This procedure is repeated until all the fry have been stocked in nursery ponds.

14. Stocking rates

Well prepared nursery ponds with good growth of benthic algae can be stocked with 300,000 to 500,000 fry or at the rate of 30 to 50 fry per square meter. In practice nursery operators tend to overstock their ponds to provide for an excess or reserve to be used in case of a big demand. The excess fingerlings are maintained in stunting ponds where their growth is retarded but are kept in good health. Understocked nursery ponds result in a waste of space and variations in the rate of growth of the fry. Rearing pond operators prefer uniform sized fingerlings. Nurseries require the same amount of care whether they are understocked or overstocked.

15. Water management

After the fry are stocked it is best to keep the water level at around 10 cm to maintain a good growth of the bottom algae needed by the fry for food. This will also prevent the growth of the bigger forms of filamentous algae which is not needed by the fry. Occasional freshening of the nursery ponds with new tide water keeps the fry healthy. Spring tides provide good water but neap tides bring in semi-turbid and partly contaminated water. During heavy rainfall and occurrences of floods, the water level should be increased to prevent sudden changes in salinity and temperature. Nursery operations require constant surveillance to prevent drying up of the ponds killing all the fish stocked. The ponds should be guarded against leaks and seepage which are common causes of the reduction in pond water leading to the drying up of the entire nursery.

16. Fry maintenance and care

The normal activities of fingerlings consist of swimming and feeding. Healthy and well-fed fingerlings are active and swim in groups. The under-nourished ones could be detected by their slow and weak body movements. The growth is disproportionate, the head is overly large and the trunk and tail much too compressed. There is another indication of starvation, the appearance of a deep black color on their backs and a shiny luster at the base of the fins caused by protrusion of the bones at the region. Starved fingerlings are susceptible to diseases.

As the fry grow to fingerling-size, overstocking becomes evident. At this stage the usual practice is to transfer them to adjacent nurseries by making a break through the partition dike and allowing the fingerlings to spread in the other pond. Some could be caught and sold to rearing pond operators. Thinning could also be accomplished by transfering fingerlings to transition ponds.

As growth continuous the benthic algae decreases in abundance. The fingerlings graze on them and the capacity of the pond to replenish the stock of algae depends on the amount of nutrients found in the soil and water. When these nutrients become exhausted then the situation necessitates the use of fertilizers and artificial feeds. On the other hand, if there is an excess of algae which the fry could not consume due to rapid growth and multiplication of the algae, this excess algae could be gathered, dried and stored, and can be broadcasted in the pond when needed.

To keep the fingerlings healthy and well nourished, fine rice bran could be used as supplementary feed. The usual practice is to broadcast the rice bran once in the morning and another in the afternoon. The amount of rice bran depends on the number of fish in the pond. A one hectare pond stocked with 200,000 to 300,000 fry may need 5 to 12 kg of rice bran a day. The fish could be trained to feed at certain times of the day and in certain areas of the pond. The nurseries should always keep a continuous stock of fingerlings until a new stock of fry becomes available.

17. Mortality in nurseries

There are 4 principal causes of mortality in nursery ponds, namely:

a) In overstocked ponds it is not unusual to find a certain percent of mortality in the morning due to the excessive use of oxygen at night and lack of the compensating supply of oxygen from photosynthesis. The oxygen-carbon dioxide balance is altered and the fish suffer from oxygen deficiency.

b) Inadequate nutrition makes the fish weak and vulnerable to diseases. Abnormal growth is also an indication of poor nutrition.

c) The entrance of polluted waters into the pond and the decomposing action of uneaten food which accumulate at the bottom of the pond resulting in low oxygen levels cause death of the fish by asphyxiation.

d) Sudden changes in physical and chemical factors of the environment like temperature, pH, salinity and dissolved oxygen content.

18. Predators, pests and diseases

Predators, fish pond pests and diseases can cause heavy mortality to fry and fingerlings. Fish predators gain access into the ponds through the gates with the incoming water during their larval stages. The fry of ten pounders and tarpoons are strikingly similar to the milkfish fry which makes it difficult to sort out during stocking. Other fish predators include the mudfish, climbing persch, sea basses, groupers, crevalles, eels, catfishes, gobies, and snappers.

Predatory snakes, lizards and amphibians are pugnacious feeders and could cause considerable damage to the fish stocks. Birds visit fish ponds singly or in flocks and prey on the milk-fish fry. Parasitic infestation of flatworms and round worms and external infestation of crustacean parasites have been reported.

19. Methods of catching fingerlings

The period of rearing fry to fingerling stage is from 1½ to 2 months. They could be kept in the ponds for a longer period if there are no orders from rearing pond operators. There are 2 common methods of catching the fingerlings.

The first method utilizes a natural tendency of milfish to go against the current. The nursery pond is partially emptied of its water during preceding low tide. During the next incoming high tide, new tide water is allowed to enter the nursery pond. The fingerlings will swim toward the water coming in. They are either caught near the gate or inside a catching pond which is located near the gate. A net is used to round them up after which they are scooped into appropriate transport containers.

The other method is to make them go with the current. The nursery pond is drained until the pond floor is exposed leaving water only in the canals and in the catching pond where the fish congregate. Reserve water from an adjoining pond is allowed to flow into the other pond. The fingerlings are caught in the catching pond.

The fingerlings are then transported to the rearing pond areas where they are first stocked in transition ponds at the rate of 1 to 15 fingerlings per square meter. These ponds have been prepared for stocking following the procedure discussed earlier.

Training Centers

Specialized training programs for the fish farmers should be given all the necessary logistic support and encouragement. These programs strengthen their capabilities and update them on the latest developments on improved fish culture. There are two ways of accomplishing this activity; first, by bringing to the project site experts and specialists from any of the four training stations and agencies, namely, the Brackish Water Research and Development Project at Jepara, the Inland Fresh Water Research Institute in Bogor, the Faculty of Fisheries, University of Bogor, the Inland Fisheries Training Institute at Sukabumi, West Java, and qualified technical personnel from the Directorate of Fisheries, Jakarta and second, by bringing to these stations a designated number of fish farmers on scheduled dates to participate in a live-in training course.

The Directorate of Fisheries should include as a high priority project in its expanded fisheries development programs the construction of an additional five-hectare training-demonstration fish pond in the project site to serve the needs of fish farmers involved in the project.

Training programs for fish farmers should include providing familiarity with very basic equipment used in fish culture work, descriptions, methods of operation and care and suppliers. A majority of the fish farmers in Java and South Sulawesi still rely on experience as indices for fish pond productivity. This is due to the lack of adequate laboratory facilities to supplement lecture instructions in the training stations mentioned above. These fish farmers should be taught to develop confidence in laboratory and field instruments to increase the credibility of their work.

Training programs should emphasize the basic concept in fisheries biology expressed in simple layman's language to give the fish farmers a clear understanding of an aquatic ecosystem as it operates in a fish pond. Some of them are the following:

1. Effect of environmental variations on fish growth
2. Environmental control measures
3. Standards for water quality and test methods
4. Organic production in a fish pond
5. Energy cycles and conservation

The farmers are not ready for the highly sophisticated, expensive and intricate technology. Simple instruments with clearcut results are more convincing and they take to these methods more readily.

The need of a continous monitoring of environmental suitability must be stressed and this phase of fish culture activity needs some instruments which can easily be manipulated like; thermometers, oxygen and pH determination kits, salinometers, turbidity meters and plankton nets.

The demonstration pond must have, among others, charts on indices of pond productivity translated in Indonesian language for immediate reference such as the normal values of the physical, chemical and biological factors of the aquatic environment which are optimal to fish growth. Technical information on the improvement and repair of dikes, gates and water canals, maintenance of proper water levels and emergency measures in cases of mass death of fish caused by abrupt changes in environmental conditions can be channelled to the fish farmers in the form of popular leaflets and hand-outs readable and in a language which can easily be understood.

Special Training Programs for Fry Fishermen, Fingerling Raisers and Rearing Pond Operators

1. Construction and method of operation of improved fishing gear for fry (The Jepara model).
2. Identification of milkfish and shrimp fry.
3. Techniques in counting and estimating fry numbers.
4. Packing fry for transport.
5. Fry acclimatization prior to planting in nurseries.
6. Locating schools of fry.
7. Search for new and richer fry grounds.
8. Improvement in the construction of dikes, gates, doors and screens.
9. Water quality determination with the use of scientific equipment.
10. Techniques in the stocking of fish.
11. Predator and pest control.
12. Fertilization of ponds.
13. Preparation and administration of supplemental feed.
14. Pond preparation.
15. Repair of dikes, gates and doors.

Program of activities in government demonstration fish ponds

A. Improvement in pond construction

The lay out, design and specifications of fish ponds vary and are influenced by several factors, namely:

1. Kind of organisms that are being cultured
2. Availability of land
3. Hydrographical and ecological conditions existing in the surrounding coastal waters, estuary or river
4. The kind of technology to be applied
5. Availability of funds
6. Terrain of the site for development
7. Climatic conditions in the locality and others

There are no hard and fast rules in the preparation of pond lay outs but top consideration should be given to the attainment of ease and efficiency in water management. Standard designs have been prepared for 2.5 and 5 hectare ponds. For ease in management and operation and to insure better growth, smaller sized ponds are recommended. The best size for nurseries range from 1000 to 5000 square meters, for transition and stunting ponds from 5000 to 10,000 square meters and for rearing ponds from 10,000 to 50,000 square meters.

The advantages of small sized ponds over the extremely big ones are:

1. They are more manageable. Operations like pest control, feeding, fertilization could be done with ease.
2. Water control is easier in small ponds.
3. Harvesting takes a shorter time.

Smaller ponds are easier to prepare and stock. Clearing, levelling of pond bottom and dike building entail lesser costs than big sized ponds. There are also several disadvantages of overly small ponds:

1. There is so much space wasted. The many dikes surrounding the small compartments could be made available to the fish thereby increasing the rearing space.
2. The fish can evade their enemies who prey on them better in a wide space than in small narrow compartments.
3. Maintenance expenses are greater in small ponds than in bigger ponds.
4. Fish stocked in big ponds grow faster whereas fish stocked in small ponds have the tendency to stunt after a certain period.

Dike construction may follow as close as practicable the following recommended sizes:

Principal dike surrounding main water canal - 6x4x3.5 meters (base X slope X crown)

Perimeter dike - 5x3x2.5 meters

Secondary dike - 3x2x2.5 meters

Tertiary dike - 2x1½x1 meters

The principal and perimeter dike should be built on strong foundation. Low and narrow dikes which are poorly constructed are vulnerable to the effect of dike borers. Dike repair is an expensive undertaking and interferes with various activities in pond management. Leaks and seepages need immediate repair to prevent the escape of fish and fertilizers and the entrance of undesirable organisms into the pond.

The pond bottom must be leveled and deepened to allow sufficient amounts of water for the growth of benthic algae. Clay-loam soil has a good capacity for holding water and also contains the necessary nutrients for the growth of plankton algae and benthic organisms which make up the natural food of fish.

The sluice gates and screens must also be of strong materials, predator-proof, and watertight when closed, and easily controlled to regulate the flow of water into and out of the pond.

The main water canal must be deep and wide enough to contain adequate water to meet the requirements of the ponds at all times. There should be a daily monitoring of the physical and chemical properties of the water for fish pond suitability, examination and weeding out of fishpond pests and predators. It is essential that all the ponds be designed so that they can be drained of water whenever necessary. If this is not possible with gravity flow, because the bottom elevation and water levels do not permit, then mechanical pumps must be made available for this purpose.

B. Fertilization

Increased production necessitates the application of suitable fertilizers to provide a continuous source of natural food (algae and plankton) in the pond at all times. As the fish grow, their food intake increases proportionately. To maintain the balance of life in the pond and insure normal growth of the fish, the rate of replenishment of the food consumed must keep pace with the feeding habits of the fish.

Overgrazing by the fish may deplete the benthic and planktonic algae found in the pond. When this happens, growth and reproduction of the algae can be stimulated by the use of appropriate fertilizers. Fertilization supplies essential nutrients to enhance the growth and multiplication of algae and plankton diatoms and also replenishes the used-up nutrients in the soil. Two types of fertilizers, inorganic (urea and TSP) and organic (rice bran, copra cake and cow dung) have been found to be effective under certain environmental conditions. The efficacy of the fertilizers applied must be correlated with water quality and rate of growth. It will be necessary to apply the fertilizers in small experimental scale before they are used in large scale operations. It should also be borne in mind that conditions existing in two adjacent ponds may not be the same so while a certain fertilizer is effective in one pond, it may not elicit the same result in the nearby pond.

C. Predator and pest control

Initial pond preparation removes about 90 percent of the pests and predators originally existing in the area before the start of construction - Majority of the fish pond enemies find their way into the ponds through the tidal water - This could be prevented by constructing a special screening system made up of small meshed nylon nets placed outside the main gate, one on the entrance side and another on the exit side. Smaller screens could also be used to fit the secondary and tertiary gates. These screens provide an adequate and effective means of preventing the entrance of unwanted fish and other organisms into the pond. A more effective screen filter could be devised for the demonstration fish ponds of the Directorate of Fisheries. It should be tried under different tide conditions and its efficiency assessed. If found effective, it could be recommended for use in the project.

Two pesticides have been found to be effective under existing conditions in Java and South Sulawesi, namely: brestan and derris. Brestan applied at the rate of 1 kg/ha/yr has been found to be good for snail elimination and derris applied in amounts of 4 kg per hectare for one application could kill almost all types of animal organisms in the pond. Tobacco dust is another material which is commonly used to kill fish pond predators and is used in amounts of 300 kg per hectare for one application. These materials are cheap and easily available. They are also biodegradable.

D. Supplemental feeding

Supplemental feeding is considered an important feature in intensive cultivation. This process of feeding to be economically wise, must be dispensed in suitable form, like powder, granules, meal, cakes, pellets and in appropriate holding containers or devices to prevent wastage. In the absence of a pelleting machine, powered and granular meal could be mixed with clay soil, molded and dried. They are placed in wire baskets and suspended in one corner of the pond. Feeding could be done at the same place in the same manner and at periodic intervals. Conditioned feeding saves time, energy and prevents wastage.

The cost of the feed supplements must not offset the normal productive cost-benefit ratio. They must be cheap and highly digestible and provide the necessary nutrients needed by the growing fish. Selection of feeds must be correlated with the growth stage of the fish under cultivation. During the period of maximum growth, the fish needs more protein supplements. Preparatory to harvesting the fish, their bodies could be rounded off to increase the weight and improve the form by giving carbohydrate - rich supplements. These feed supplements could be produced and processed locally or obtained from by-products of food processing establishments..

Overfeeding should be avoided as feeds left unconsumed decompose and may cause the water to become acidic. Decomposition is also an oxygen-consuming activity and endangers the life of the fishes.

E. Stocking rates

Stocking rates vary according to the locality, technology applied, environmental conditions existing in the ponds and availability of fish seeds. The normal stocking rate for fry in nursery ponds range from 200 to 300,000 per hectare. In meticulously prepared nurseries where all conditions are at the optimum and food is abundant, the rate is 400 to 500,000 fry per hectare. Heavy stocking of nurseries is resorted to when there is a big demand for fingerlings and fry fishing is good.

The normal stocking rate of fingerlings (five to six inch size) is 2,000 to 3,000 per hectare. If the market demand for milkfish is for the 12 to 14 inch size, fish pond operators have the tendency to overstock, fertilize the ponds and harvest after four months. Normally, crops are harvested twice a year. The survival rates that are expected under normal environmental conditions are: fry to fingerlings - five to ten percent; fingerlings to marketable size - 80 to 90 percent. Under improved pond management the survival rates of fry to the fingerling stage could be increased to more than 50 percent and of fingerlings to the marketable size fish to around 95 percent.

Need of an overseas training program and foreign advisors

An overseas training program for government technical employees servicing the project will bring into the country the latest trends on improved pond technology. Strengthening the capabilities of technical management staff will redown to the benefit of the project and will greatly enhance the attainment of the national goals and objectives. These trained personnel will act as trainors for the fish farmers upon completion of their overseas training programs.

Requirements for an overseas training program for demonstration/extension field personnel are:

(a) He must be a graduate of a University Faculty of Fisheries or a Fisheries Vocational High School, major in Fish Culture,

(b) Have at least two years experience in Fish Pond Management in a government or privately owned fish pond,

(c) He must be presently employed as Fisheries Demonstrator and Field Extension Officer in the regional office which has jurisdiction over the project area, and,

(d) Be willing to serve the project three years for every year or fraction thereof of training abroad.

Place of training: Philippines, Thailand, or Taiwan

Subject of Training: Fish Pond Management and Mariculture

Duration of training: Six to eight months

It is strongly recommended that at least three foreign technical advisors will be contracted during the various stages of the project implementation phase. These specialists will furnish technical assistance in the construction, administration and management of the fish ponds and in the organization of the village settlements and installation of infrastructure facilities.

Environmental Impact

Effect on the flora and fauna of the region

The green belt, which is a strip of mangrove area about half a kilometer wide and possibly more than 20 kilometers long, will be left untouched. Mangrove vegetation constitute a natural barrier to protect coastal areas from the disastrous effects of tidal waves, storms, typhoons and other atmospheric and hydrologic cataclysms. The mangrove plant, due to its anatomical characteristics and habits, is provided with natural resistance against the various strong forces of nature. These trees provide protection to the vast assemblage of animals inhabiting estuarine bays, sheltered coves, lagoons and tidal creeks. The ecological factors operating in these brackish water units are conducive to normal growth and development. Besides fish, crustaceans and mollusks abound in mangrove areas. They provide supplementary food to people living in the coastal regions. To preserve the green belt, conservation laws should be promulgated regulating the cutting of mangrove trees for firewood.

Effect on land and water.

Conversion of land which is practically virgin to cleared land for village site subdivision, fish pond and infrastructure development will change the biotic environment in the area. With intensive development, the change will be immediate and sudden. Environmental impact will be felt more by the wild-life existing in the locality, both the animal and plant populations. They will be driven out from the area and emigrate to other places.

Man, greatest factor in depletion of water resources

Human settlements will increase especially near the river bank. Villages will grow in number and size. There will be more people to engage in sea and river fishing due to increase in population. Because of necessity and ignorance of conser-vation, the people catch juvenile forms of fishes, crabs, shrimps and lobsters. If this method of irrational exploitation is allowed to continue, the economic aquatic resources in these regions are in danger of depletion. The Directorate of Fisheries should promulgate proper conservation measures to protect the resources from depletion and allow these naturally reproducing populations to provide a continuing resource for exploitation.

Threat of pollution

Increase in the number of villages near the river's bank will also increase boat traffic in Sekampung River. Likewise, there will also be an increase in marine traffic in the coast of Java from Maringgai to Ketapang if Maringgai becomes a port and a business center. The last few years saw a rapid increase in agricultural holdings in Lampung Province close to the project site. This means more insecticides and herbicides which eventually find their way to recipient aquatic units. These three factors may contribute to a threat of pollution resulting in the despoilment of the biological environment of man and wanton destruction of natural resources.

Activities in the project site will be supervised

All trees and other vegetation cut down during the site clearing will be removed, utilized and disposed properly without causing undue damage or harm to the existing plant and animal life in the locality.

There will be no burning of plant cover in the area nor the incineration of disposable materials to the extent of causing forest or grass fires.

There will be no defoliation processes to be used in tree clearing, no explosives to be used in excavation, no chemicals will be used in any operation which harm or kill the endemic flora and fauna in the region.

Soil will not be carted away from the site but will be utilized in the building of dikes for the project.

No plant or animal species in the area will be endangered as a result of the various project operations, nor will the present water and land environment be despoiled for the use of both men and animals. Conservation measures will be promulgated to protect the biotic environment from the scrupulous activities of man.

Protection of wildlife in the project area

The National Wildlife Conservation Agency should be apprised of the proposed project development so that it can initiate the necessary conservation measures to protect the wildlife existing in the area. This Agency should make the provisions for the trapping, crating and transporting of wild animals to be transferred to forest reserves and wildlife sanctuaries. The surveyors who made the survey for ground elevations reported the presence of elephants and crocodiles in the project area.

<u>Functions and responsibilities of the Central Management Organization</u>

The Provincial Fisheries Office in Lampung Province will provide technical and administrative guidance to the Central Management staff..

The Fisheries Demonstrators and Field Extension Officers assigned to the government demonstration fish farms located in Way Sekampung and at Maringgai will provide technical assistance and conduct periodic demonstrations and workshops on scheduled dates or as often as necessary to the fish farmers operating the project.

The Mayors of Villages I and II will form a Coordinating Council on the Care, Operation and Maintenance of the whole fish pond project. This Council is a policy making body. The two mayors will be Council Chairman and Vice Chairman respectively. The members of the Council will include:

1. Chief Pond Development Specialist
2. Assistant Pond Development Specialist
3. Manager, Village I
4. Manager, Village II
5. Assistant Manager, Village I
6. Assistant Manager, Village II

The Council members are advisory and recommendatory in function.

The Chief Pond Development Specialist and Assistant are in charge of the following:

1. Supervision of all technical activities in the project
2. Control, coordinate and formulate regulatory instruction regarding:
    a. Fish pond fertilization
    b. Use of supplementary feeds
    c. Use of pesticides
    d. Pond preparation and stocking
    e. Harvesting of marketable fish
    f. Fish auctions, sales and marketing
3. Schedule and coordinate
    a. Workshop seminars - invite foreign and local experts and specialists on brackish water pond culture.
    b. Training centers - senior technical personnel from the Directorate of Fisheries shall manage this activity.
    c. Demonstration and extension work - the demonstration and extension officers of the regional offices of the Directorate of Fisheries and the Agency for Education, Training and Extension are charged with this function.

4. Establish security measures.
5. Prepare informative brochures for use of fish farmers.
6. Liason with government and private industry.

The Managers and Assistant Managers shall perform the following:

1. All administrative functions with regard to fish pond management.
    a. Budgeting and finance
    b. Accounting
    c. Disbursements
    d. General services

The Assistant Fish Pond Specialists will execute all technical instructions from the Chief Pond Development Specialist regarding:

1. Fish pond fertilization
2. Use of supplementary feeds
3. Use of pesticides
4. Pond preparation and stocking
5. Harvesting of marketable fish
6. Fish auctions, sales and marketing

The Pump Operators and Assistants/Water Overseers are in charge of the following:

1. Water Management
   a. Supply water requirements of fish ponds.
   b. Oversee dike and gate operations in relation to filling and draining of ponds.
   c. Control pump operation and maintenance.
   d. Set schedules for pump use by fish pond operators.

The Mechanics and Helpers will perform the following functions:

1. Installation, operation, maintenance and repair of all mechanical equipment owned by the project.
2. Prepare periodic reports on status of machinery and other equipment including fuel consumption.
3. Prepare orders for new machinery and equipment needed by the project.

The Fish Pond Caretakers/Security Guards are in charge of the following:

1. Provide security and protection of all fish ponds in the project.
2. Maintain peace and order in the whole project area.
3. Report immediately all abnormal occurrences in the fish ponds
4. Reprimand or apprehend all violators of law and order.

Table-1
Data on Milkfish and Shrimp Fry Catches from Kuala Sekampung Palas (South Lampung)*

No.	Location	Date	Hour	Wind Direction	Character Of Bottom (coast)	Weather	Number Of Milkfish Fry	Number Of Shrimp Fry	Description
1.	Palau Mundu	17-25 Nov. 1975	9:00 A.M. & 4:00 P.M.	Northwest	Sandy	Good	35	0	Fingerling size 5-10 cm
2.	Pantai Belok	26-30 Nov. 1975	7:00 A.M. & 2:00 P.M.	East	Sandy muddy	Clear	15	0	Fingerling size 5-10 cm
3.	Kuala Sekampung	1-10 Dec. 1975	8:00 A.M. & 2:00 P.M.	South	Sandy muddy	Good	17	0	Fingerling size 5-10 cm
4.	Kuala Sekampung	11-17 Dec. 1975	8:00 A.M. & 3:00 P.M.	East	Sandy muddy	Clear	21	0	Fingerling size 5-10 cm
5.	Way Ketibung	18-24 Dec. 1975	8:00 A.M. & 4:00 P.M.	East	Sandy muddy	Good	12	0	Fingerling size 5-10 cm
6.	Pantai Belok	27-31 Dec. 1975	9:00 A.M. & 3:00 P.M.	East	Sandy muddy	Clear	10	0	Fingerling size 5-10 cm
7.	Kuala Sekampung	1-10 Jan. 1976	7:00 A.M. & 2:00 P.M.	South	Sandy muddy	Good	20	0	Fingerling size 5-10 cm
8.	Way Ketibung	11-23 Jan. 1976	10:00 A.M. & 3:00 P.M.	East	Sandy muddy	Rainy	15	0	Fingerling size 5-10 cm
9.	Kuala Sekampung	24-30 Jan. 1976	8:00 A.M. & 2:00 P.M.	East	Sandy muddy	Good	25	0	Fingerling size 5-10 cm

* Source: Directorate of Fisheries, Jakarta

Table-2

Data on Milkfish and Shrimp Fry Catches from Kuala Sekampung Palas *

(South Lampung)

No.	Location	Date	Hour	Wind Direction	Character Of Bottom (coast)	Weather	Number Of Milkfish Fry	Number Of Shrimp Fry	Description
1.	Palau Mundu	1-7 Feb. 1976	9:00 A.M. & 4:30 P.M.	Northwest	Sandy	Clear	13	0	Fingerlings 5-10 cm
2.	Pantai Belok	8-20 Feb. 1976	10:00 A.M. & 4:00 P.M.	East	Muddy-Sandy	Good	23	0	Fingerlings 5-10 cm
3.	Kuala Sekampung	21-29 Feb. 1976	8:00 A.M. & 3:00 P.M.	East	Muddy-Sandy	Clear	14	0	Fingerlings 5-10 cm
4.	Kuala Sekampung	1-7 Mar. 1976	9:00 A.M. & 5:00 P.M.	Southeast	Sandy-Muddy	Bad	150 80	0	Fingerlings 2-5 cm
5.	Belok	8-15 Mar. 1976	10:00 A.M. & 2:00 P.M.	Southeast	Sandy-Muddy	Clear	215 200	0	Fingerlings 2-5 cm
6.	Ketapang	16-23 Mar. 1976	9:00 A.M. & 3:00 P.M.	Southwest	Sandy	Bad	240 310	0	Fingerlings 2-5 cm
7.	Belok	24-31 Mar. 1976	9:00 A.M. & 2:00 P.M.	Southeast	Sandy-Muddy	Good	200 275	0	Fingerlings 2-5 cm
8.	Kuala Sekampung	1-7 Apr. 1976	9:00 A.M. & 4:00 P.M.	East Northeast	Sandy-Muddy	Clear	50 35	0	Fingerlings 1-2 cm
9.	Belok	8-15 Apr. 1976	10:00 A.M. & 2:00 P.M.	East	Sandy-Muddy	Bad	75 95	0	Fingerlings 1-2 cm
10.	Ketapang	16-23 Apr. 1976	9:00 A.M. & 3:00 P.M.	East Northeast	Sandy	Clear	115 25	0	Fingerlings 2-3 cm
11.	Palau Mundu	24-30 Apr. 1976	10:00 A.M. & 2:00 P.M.	East	Sandy	Bad	30 150	0	Fingerlings 1-2 cm

* Directorate of Fisheries, Jakarta

Table-3

Prices of Milkfish Fry During the Catching Season *

No.	Province	Peak Season Month	Peak Season Price (Rp/Pc.)	Low Season Month	Low Season Price (Rp/Pc.)	Mean Price (Rp/Pc.)	Remarks
1.	D.I. Aceh	Sept. to Oct.	2.00	March to July	2.50	2.25	Prices taken from direct buyers
2.	North Sumatera	-	-	-	-	-	no data available
3.	West Java	Oct. to Dec.	3.70	April to May	4.00	3.21	
4.	Central Java	Oct. to Dec.	2.40	April to May	4.01	3.95	
5.	East Java	Oct. to Dec.	-	April to May	-	1.00	
6.	South Sulawesi	-	-	-	-	-	no data available
7.	Bali	-	0.64	-	0.82	0.73	
8.	West Nusatenggara	Oct. to Dec.	-	April to June	-	0.53	
9.	Other places	-	-	-	-	-	no data available

* Source: Directorate of Fisheries, Jakarta

Table-4

Production of Fry in Indonesia *
(Production x 1000)

No.	Province	1967 Produc-tion	1967 Decrease Increase %	1968 Produc-tion	1968 Decrease Increase %	1969 Produc-tion	1969 Decrease Increase %	1970 Produc-tion	1970 Decrease Increase %	1971 Produc-tion	1971 Decrease Increase %	1972 Produc-tion	1972 Decrease Increase %	1973 Produc-tion	1973 Decrease Increase %
1.	D.I. Aceh	58,236	-	34,980	-40	30,537	-13	41,220	+38	22,348	-46	19,160	-14	N.D.	-
2.	North Sumatera	N.D.	-	N.D.	-	N.D.	-	N.D.	-	N.D.	-	N.D.	-	N.D.	-
3.	West Java	443	-	3,276	+641	9,474	+189	23,684	+150	2,344	-90	8,938	+281	2,396	-732
4.	Central Java	3,912	-	9,142	+134	19,867	+117	10,065	-49	6,255	-38	7,547	+21	N.D.	-
5.	East Java	270,248	-	40,585	-85	136,938	+237	173,958	+27	43,395	-75	138,641	+219	57,347++	-58
6.	South Sulawesi	60,000	-	69,940	+17	105,290	+51	117,473	+12	117,868	+0.3	107,868	-8	117,900	+9
7.	Bali	5,083	-	2,001	-61	5,583	+179	4,052	-27	4,235	+5	5,252	+24	N.D.	-
8.	West Nusatenggara	N.D.	-	N.D.	-	188	-	328	+74	1,987	+560	2,312	+16	N.D.	-
9.	Other places	N.D.	-	N.D.	-	N.D.	-	2,069	-	69,540	+3,260	70,000++	+0.7	N.D.	-
	Total	397,921	-	159,924	-60	307,877	+48	372,849	+21	267,972	-28	359,718	+34	117,643	

* Source: Directorate of Fisheries, Jakarta
N.D. - No Data Available
++ - provisional data

Table - 5

Survey of Milkfish and Shrimp Fry Potential
Conducted by
The Central Research Station for Milkfish & Shrimp, Jepara

Date October 1975	Location of fishing fround	Catching time Morning	Catching time Afternoon	Milkfish AM	Milkfish PM	Shrimp	Remarks
20	Muara Uncal	9:00-11:00		15	10	-	
20	Kuala Nibung		2:00-3:00	-	-	-	
21	Kuala lbh. Maringgai	9:00-11:00		5	-	-	
22	-"-	9:00-11:00		20	-	-	
23	-"-	8:00-10:00		4	-	-	
23	Kuala Nibung	11:00-12:00		10	5	-	
23	Kuala Sekampung		2:00-3:00	-	-	-	
24	Kuala lbh.Maring-gai	9:00-11:00		5	5	-	
25	-"-		2:00-3:00	-	-	-	
26	-"-	9:00-11:00		4	2	-	
27	-"-		2:00-3:00	-	-	-	
28	Muara Uncal	9:00-11:00		3	-	-	
29	Kuala Lbh. Maringgai	9:00-11:00		5	2	-	

Table - 6

Survey of Milkfish and Shrimp Fry Potential
Conducted by
The Central Research Station for Milkfish & Shrimp, Jepara

Date November 1975	Location of fishing ground	Catching time		Milkfish		Shrimp	Remarks
		Morning	Afternoon	AM	PM		
1	Kuala lbh. Meringgai	9:00-11:00		1	-	-	
2	-"-	9:00-11:00		3	-	-	
3	-"-		3:00-4:00	-	-	-	
4	-"-	9:00-11:00		7	5	-	
5	-"-		3:00-4:00	-	-	-	
6	-"-		2:00-3:00	-	-	-	
7	-"-	9:00-11:00		5	3	-	
8	-"-	9:00-11:00		4	-	-	
9	-"-	9:00-11:00		5	-	-	
10	-"-		3:00-4:00	-	-	-	
11	-"-	9:00-11:00		2	7	-	
12	-"-	9:00-11:00		1	-	-	
13	-"-		2:00-3:00	-	-	-	
14	-"-	9:00-11:00		3	2	-	
15	-"-	9:00-11:00		2	-	-	
16	-"-	9:00-11:00		4	-	-	
17	-"-	8:00-11:00		6	-	-	
18	-"-		3:00-4:00	-	3	-	
19	-"-		2:00-4:00	-	5	-	
20	-"-		2:00-4:00	-	6	-	
21	-"-		2:00-4:00	-	5	-	
22	-"-		2:00-4:00	6	-	-	
23	-"-		2:00-4:00	-	3	-	
24	-"-	8:00-11:00		-	5	-	
25	-"-	8:00-11:00		-	6	-	
26	-"-	8:00-11:00		-	5	-	
27	-"-	8:00-11:00		-	4	-	
28	-"-	8:00-11:00		-	7	-	
29	-"-	8:00-11:00		8	-	-	

Table - 7

Survey of Milkfish and Shrimp Fry Potential
Conducted by
The Central Research Station for Milkfish & Shrimp, Jepara

Date December 1975	Location of fishing ground	Catching time		Milkfish		Shrimp	Remarks
		Morning	Afternoon	AM	PM		
1	Kuala lbh Maringgai	8:00-11:00		9	-	-	
2	-"-	8:00-11:00		7	-	-	
3	-"-	8:00-11:00		5	-	-	
4	-"-	8:00-11:00		3	-	-	
5	-"-	8:00-11:00		6	-	-	
6	Kuala Sekampung		2:00-3:00	-	-	-	
7	Pantai Belok		2:00-4:00	-	-	-	
8	Pulau Mundu	8:00-11:00		-	-	-	
9	Kuala Sekampung	8:00-11:00		-	-	-	
10	Muara Uncal		2:00-3:00	-	-	-	
11	Labuhan Maringgai	8:00-11:00		-	-	-	
12	Kuala Penet	9:00-12:00		19	-	-	
13	Labuhan Maringgai		2:00-3:00	-	10	-	
14	-"-		2:00-4:00	-	15	-	
15	-"-		2:00-4:00	-	10	-	
16	-"-		2:00-4:00	-	17	-	
17	-"-		2:00-4:00	-	13	-	
18	-"-		2:00-4:00	-	8	-	
19	-"-		2:00-4:00	-	5	-	
20	-"-	8:00-11:00		9	-	-	
21	-"-	8:00-11:00		11	-	-	
22	-"-	8:00-11:00		10	-	-	
23	-"-	8:00-11:00		5	-	-	
24	-"-	8:00-11:00		-	-	-	
25	-"-	8:00-11:00		-	-	-	
26	-"-		2:00-3:00	-	-	-	
27	-"-		2:00-3:00	-	-	-	
28	-"-		2:00-3:00	-	-	-	
29	-"-		2:00-3:00	-	-	-	
30	-"-		2:00-3:00	-	-	-	

Survey of Milkfish and Shrimp Fry Potential
Conducted by
The Central Research Station for Milkfish & Shrimp, Jepara *

Date January 1976	Location of fishing ground	Catching time Morning	Catching time Afternoon	Milkfish AM	Milkfish PM	Shrimp	Remarks
1	Labuhan Maringgai	8:00-11:00		-	-	-	
2	"	8:00-11:00		-	-	-	
3	"		2:00-4:00	-	-	-	
4	"		2:00-4:00	-	-	-	
5	"		2:00-4:00	-	-	-	
6	"	8:00-11.30		-	-	-	
7	"	8:00-11.30		-	-	-	
8	"		3:00-4:00	-	-	-	
9	"		2:00-4:00	-	-	-	
10	"	9:00-11:00		-	-	-	
11	"	9:00-11:00		-	-	-	
12	"		3:00-4:00	-	-	-	
13	"		3:00-4:00	-	-	-	
14	"		2:00-4:00	-	-	-	
15	"		3:00-4:00	-	-	-	
16	"	9:00-11:00		-	-	-	
17	"	9:00-11:00		-	-	-	
18	"		3:00-5:00	-	-	-	
19	"		3:00-4:00	-	-	-	
20	"		3:00-4:00	-	-	-	
21	"	8:00-11:00		-	-	-	
22	"	9:00-11:00		-	-	-	
23	"		2:00-4:00	-	-	-	
24	"	9:00-11:00		-	-	-	
25	"		3:00-4:00	-	-	-	
26	"		2:00-4:00	-	-	-	
27	"		2:00-4:00	-	-	-	
28	"	8:00-11:00		-	-	-	
29	"	8:00-11:00		-	-	-	
30	"		3:00-5:00	-	-	-	
31	"		2:00-3:00	-	-	-	

* Source: Tables to were supplied by the Regional Office, Directorate of Fisheries, Tanjung Karang.

Table-9

CURRICULUM FOR JOB TRAINING ON BRACKISH WATER POND CULTURE TECHNIQUE*

No.	SUBJECT	EXPLANATION	Lecture (hours)	Practical work (hours)	Field Work (days)
1.	Introduction to Pond Culture	The role of brackish water pond culture in Indonesia and South East Asia	1		
2.	Brackish water ecology	Tide, salinity, rainfall, natural food, etc.	2	12	
3.	Cultivated fishes	Fish, shrimp etc, - distinguishing features of various stages of life history, biological notes etc.	2	18	
4.	Food and feeding habits of shrimp and fish	Food and feeding habits of various stages of the life history of fish and shrimp.	2	18	
5.	Predators and undesirable fish	Distinguishing characters at different stages, occurence and its abundance.	1	12	
6.	Pond site and pond construction	Soil, tide fluctuation, dykes, canals ditches and levelling of pond bottom.	4		5
7.	The function and properties of water and soil	Method of controlling water and soil quality for the benefit of culture	2	24	2
8.	Shrimp and milkfish fry collection	Method of collection, identification of fry, handling, transportation	4	30	8

*Source: Directorate of Fisheries, Jakarta, Indonesia

9.	Hatchery of shrimp	Breeding and hatching technique of shrimp in captivity, nursery technique of the hatching, preparing technique of feed materials etc.	4	18	8
10.	Pond management	Technique of manuring, erradication of pests, controlling water conditions, propagation of natural food, stocking methods etc.	4	6	8
11.	Intensive culture technique	Monoculture technique, mixculture technique, manipulation stocking	4		8
12.	Water pollution	Water pollution control, pesticide selection for pond use, toxicology, etc	2	18	
13.	Pond culture economy	Economical aspect of pond culture	4		
14.	Extension service methodology	Methods for extension service in pond culture	4		

Table-10

Water Quality Survey of the Coast of Java Sea Near Project Site, Maringgai to Kuala Sekampung

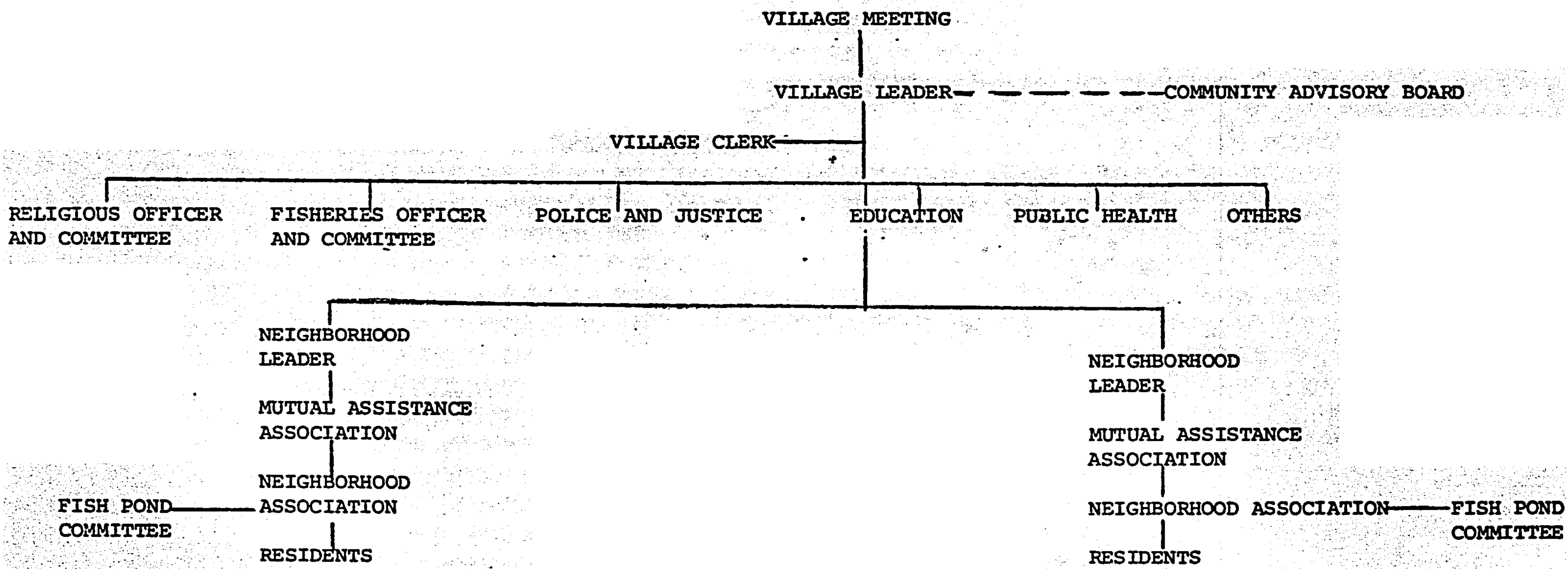
Stations	I		II		III		IV		I		II		III		IV	
Date, 1976	8/3		8/3		8/3		8/3		8/3		8/3		8/3		8/3	
	LT	HT	LT	HT	LT	HT	LT	HT	LT	HT	LT	HT	LT	HT	LT	HT
Water temperature, °C	27.3	25.4	27.5	24.8	28.2	25.8	28.2	24.4	24.5	25.2	25.2	26.3	25.3	25.8	28.4	25.7
Air temperature, °C	30.5	27.2	29.8	26.5	29.9	25.6	30.2	26.8	26.3	27.5	26.8	27.8	27.0	27.6	26.8	27.3
Salinity, °/oo	30.6	30.1	31.2	30.4	30.8	29.8	31.2	30.4	29.2	30.2	30.1	31.3	30.4	31.6	28.9	30.2
pH	7.0	7.0	7.2	6.9	7.4	7.2	6.9	6.8	6.8	7.1	6.7	6.9	7.1	7.3	7.1	6.9
Turbidity, Cm	24	-	31	-	37	-	28	-	-	-	-	-	-	-	-	-
Dissolved Oxygen, ppm	5.06	4.25	6.12	4.83	5.93	5.23	4.92	4.65	4.26	5.36	5.18	6.13	4.85	5.64	4.88	5.12
Time of sampling	14:00	23:00	14:50	23:35	14:30	23:20	14:00	23:00	4:00	10:00	4:35	10:40	4:05	10:45	3:30	10:10

The stations are chosen sites of the proposed channel inlets from the coast of Java Sea to the project. They are about 4 km. apart. Station I is located at a point which is 7 km from Maringgai and Station IV is located near the mouth of Sekampung River.

Continuation of Table-10

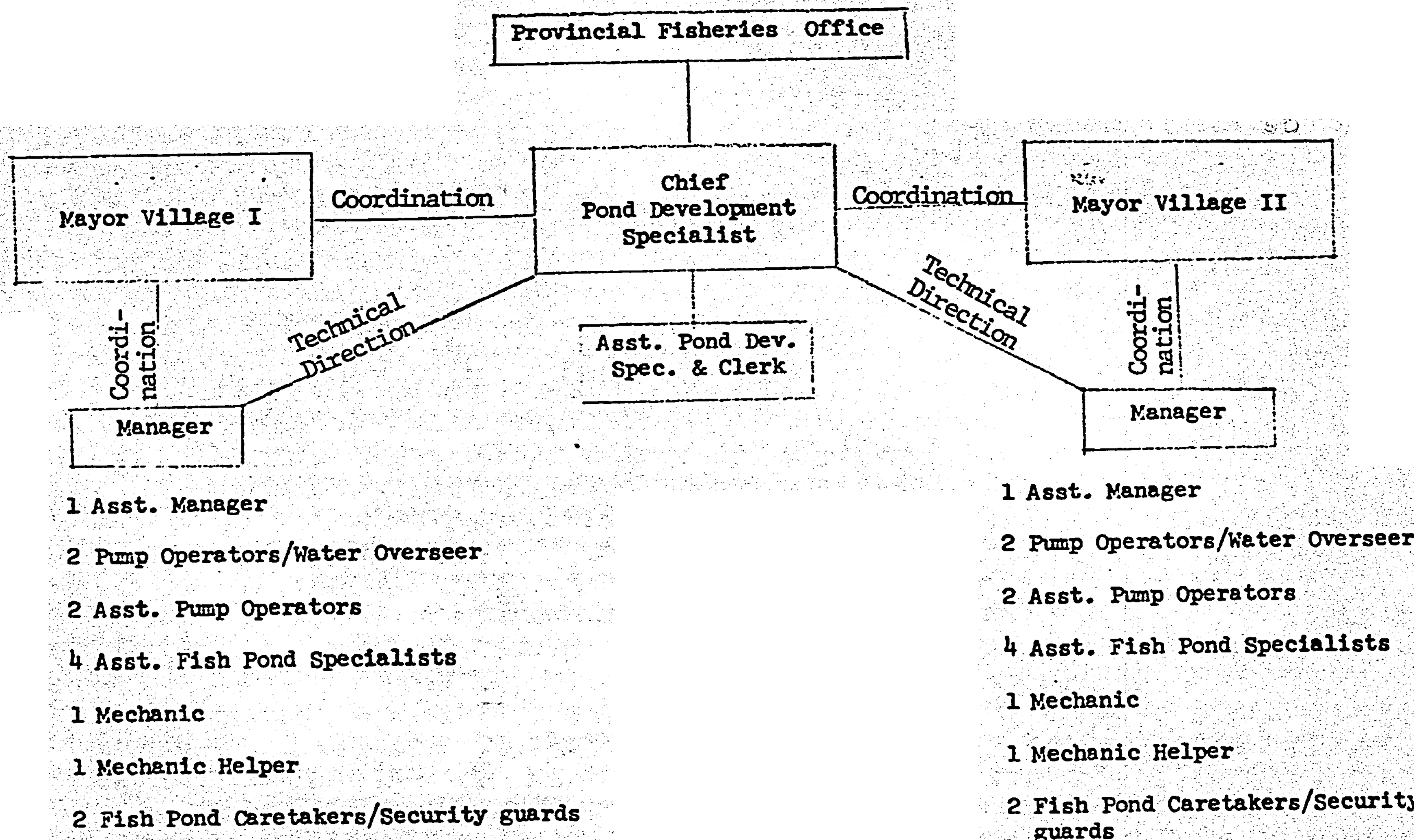
Stations	I		II		III		IV		I	II	III	IV
Date, 1976	8/17		8/17		8/17		8/17		7/27	7/27	7/27	7/27
	LT	HT	LT	HT	LT	HT	LT	HT				
Water temperature, °C	26.4	28.4	28.8	25.3	25.3	25.2	25.6	24.8	30.0	29.5	30.0	29.0
Air temperature, °C	29.6	27.8	28.4	27.4	29.8	28.6	28.9	27.7	28	27.5	27.5	27.0
Salinity, °/oo	30.1	28.3	31.0	30.6	31.3	31.2	30.6	30.4	31	30.5	30	25
pH	7.1	7.3	7.2	6.9	7.1	7.1	6.9	7.2	7.1	7.2	7.0	7.1
Turbidity, Cm	26	-	34	-	36	-	28	-	22	42	35	27
Dissolved Oxygen, ppm	4.96	6.27	5.08	6.18	5.36	5.86	4.86	5.93	5.92	7.04	6.08	6.27
Time of sampling	13:10	22:10	14:05	23:15	13:55	23:10	13:20	22:30	14:00	15:00	16:10	16:10

Figure-1



Structure of the Village Unit Organization

Figure 2



Structure of the Central Management Organization

APPENDIX B

ENGINEERING REPORT

LAMPUNG PILOT BRACKISH WATER POND DEVELOPMENT

ENGINEERING REPORT
by:

FRED LOCHER

PREPARED FOR
THE UNITED STATES
AGENCY FOR INTERNATIONAL DEVELOPMENT
WASHINGTON, D. C.

SEPTEMBER, 1976

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2. CONCLUSIONS AND RECOMMENDATIONS

a. Pumping to supply aquaculture projects is feasible if the range for pumping falls between minus 25 centimeters below mean sea level and + 2.0 meters above mean sea level water to water.

b. Pumping for the drainage of aquaculture projects will generally not be feasible if the removal of storm water is involved.

c. Gravity aquaculture projects operated with tidal fluctuations of less than 1.5 meters are marginal because proper project water management becomes difficult. Areas with fluctuations less than one meter are not recommended.

d. Site topography and its relation to mean sea level and the tidal fluctuation should be a prerequisite to a decision to consider any area for project development.

e. Projects of less than 600 hectares in isolated areas are not sufficiently large to produce the volumes of fish required to attract buyers.

f. The project under consideration is not feasible because of adverse topographic conditions and the related excessive costs for development.

3. PROJECT DEVELOPMENT

a. Background

On June 9, 1976 U.S. Aid Washington signed a contract with Checchi and Company of Washington D.C. for a feasibility study of an aquaculture venture on 3000 hectares of land located on the eastern coast of Sumatra and immediately south of the Sekampung River. The contract further stated that if the area south of the Sekampung River did not prove satisfactory adjacent areas were to be investigated and that a feasibility determination be made of the then selected area.

The Checchi team of experts arrived in Jakarta the evening of June 18, 1976. After meetings with government and AID officials and an unavoidable delay due to administrative details a visit to the project site was made during the period from June 28 to July 2, 1976.

Information obtained during the site visit and a concurrent study of available maps indicated that the desired area of 3000 hectares was not available on the south side of the Sekampung River. An overflight by plane the following week confirmed this finding. It also revealed a large vacant land area of similar character north of the Sekampung River. However, no ground elevations or topography was available for either area.

The site visit also served to destroy of the myth of a 1.5 meter tidal variation. We installed a gage in the estuary of the Sekampung River and from the limited readings obtained there and from correlations with a station on Java having similar characteristics we estimated that the average tidal fluctuation was 60 centimeters with a maximum of 100 centimeters and a minimum 30 centimeters. Later and more extensive data from a gage installed at Maringgai in the Java Sea indicates even lower readings. With this information and from visual observations of the land elevation along the coast, it appeared that a gravity system for delivering water to an aquaculture development in both the areas north or south of the Sekampung River was not practical. If either of the areas were to be used for this purpose pumping the water to the desired elevation would be necessary.

A result of the overflight on July 7, 1976 in which 4 members of the Checchi team and several Mission members participated, was a request from the Mission to shift the study to the area north of the Sekampung River. We agreed and immediately requested the Mission to contract for the necessary site information which would make it possible to determine the topographic suitability of the area. After a delay caused by factors outside ours or the Mission's control a contract with 24 day completion time was let on July 23. The contractor was on the site by July 26 and had until Aug. 19, to complete the work.

The proposed project area is shown on figure 1. It is accessable by an 8 kilometer foot path from Maringgai or from the sea by a very small boat. It is inhabited by elephants, deer, leopards and the vicious Sumatra bear.

Our contract with AID required us to make a feasibility finding and report to AID within 2 months after our arrival in Jakarta. This made August 20, 1976 the target date. The combination of circumstances presented a problem. Complete field data would not be available before August 19, 1976 and a feasibility determination was required by August 20, 1976.

After several trial runs and arrangements of fish-ponds it became apparent that a basic modular design dependent on pumping - a gravity system was ruled out because the small tidal amplitude - could be designed which with minor alternations could be fitted to a variety of field conditions. The project cost for the basic design could be done in detail and modifications to fit actual field conditions could be made quickly when such data became available and was within the limits of the design. The basic quantities used in formulating the estimate would also be segregated according to structure, type and component parts for easy modification later if necessary.

Concurrent preliminary financial and economic studies indicated that with 2.5 hectare plots the project financial appraisal was marginal but that the added value was very favorable. With 5 hectare plots both the financial appraisal and the added value studies were favorable.

The modular approach to the project design made it possible to set up a range of conditions where the pumping could vary from 25 centimeters below mean sea level to 3 meters above sea mean sea level. The pump houses were designed for either pump in, pump out or both. Bridges at the pumphouses were adjacent to but separate from the pumphouse structure to permit elimination when not needed for vehicular access to the project. Topography could vary from 25 centimeters below sea level to about two meters above sea level. Land surfaces had to be uniform, either sloping greatly upward and away from the coast, level or a combination of level and gently sloping terrain.

The design and estimated project cost employing the above principles was worked out in detail and is presented in the following sections. The more detailed financial and economic studies were based on the cost estimates derived in this manner.

4. PROJECT DESIGN

a. General Requirements

The culture of milkfish is not an exact science and there are about as many opinions on the proper management of fish ponds as there are experts and each one influences project design either through structure design or the scheduling of water deliveries. The design is further complicated by the lack of existing knowledge which would enable the designer to quantify the benefits of project features as they relate to production. In this project analysis it was decided to list those features which contribute to maximum production, and incorporate into the project as many of them as judgement indicated would significantly increase production. The list without regard to importance is as follows:

i. Nursery, holding and stunting pond operations should be separated from the rearing of salable fish.

ii. Pond location should be on sparsely vegetated lands, as heavily timbered land increases construction costs enormously.

iii. Water supply is to be of tidal origin and unpolluted.

iv. The salt content of the water in the fish ponds should be kept between 15 and 25 parts per thousand.

v. Tidal fluctuations of 1.5 to 2.5 meters are required to permit successful management of the water supply by gravity provided the land of the pond area is at an elevation which will permit inundation of 50 centimeter or more at high tide and drainage on the ebb tide. Topographic features must be reasonably uniform in elevation.

vi. Average tidal fluctuations of less than one meter are not conductive to efficient water management and environmental manipulation and control by gravity.

vii. Fish ponds should be drained and rehabilitated once each year.

viii. Production in the various ponds should be spaced so that a nearly constant volume of fish are harvested throughout the year.

ix. Soils should be the clay loam type and high in organic matter.

x. During the rearing period the depth of the ponds should be about 40 cm.

xi. The design must provide for dilution or increasing the salinity as required to maintain the desired salt content of the pond water.

xii. A pre-determined area of 2.5 hectares was arbitrarily established as the size of a family unit.

The project design provides for separate nursery and stunting ponds thus providing a year round supply of fry to stock the rearing ponds.

The project area is located on both heavily timbered and sparsely timbered areas. Out of a total of 3200 hectares 1267 are covered with heavy forest. This greatly enhanced the project costs.

The water supply is taken directly from the ocean where the salinity is about 29 parts per thousand and the temperature is about 30 degrees celsius. Precipitation during the rainy season will soon reduce the pond salinity below 25 parts per thousand.

The average tidal fluctuation at the project site is less than 60 cm and in general high tide does not appear to inundate the project area let alone cover it to a depth of 50 cm. If the area is to be used for aquaculture it will be necessary to pump to the required elevation.

The first trial design provided separate systems for filing and draining the ponds. Such a system has many advantages in terms of water management. It is costly and the advantages did not justify the additional expense.

The project plan provides for a combined fill and drain system. Features for dilution or adding sea water as required are also included, however they require careful management for accomplishment.

The modular approach of the design makes it possible to space stocking and the ensuing harvesting in such a manner that units of 50 hectares can be harvested each month of the year provided a minimum area of 600 hectares is in production. This feature was necessary to stabilize the market for fish.

The soils in the project area appear suitable. In general they are clay loans.

The elevation of the water in the supply canals has been set to provide the desired 40 cm depth in the fish ponds.

The provision of pumping makes it possible to maximize the benefits of good water management even though certain constraints are imposed by the choice of a combination filling and drainage system.

There was no ground control available for this area but from visual observations along the sea it appeared that the land was on the average about 50 cm above high tide and sloped upward in the inland direction. With only this meager information available it became a problem as to how the system could be designed and laid out with a minimum of revision if and when some ground control became available. The modular approach as shown on figure 2 was adopted. Each module consists of two 50 hectare plots (i.e. one kilometer sq) served by two pumping plants. One for each 50 net hectares of fish pond area. There are 18 rearing ponds and 2 nursery ponds all of 2.5 hectares each served by one pumping plant. In general these modules were fitted into the designated project area and the layout was made accordingly. This is shown diagramatically on figure 3. Some variations such as adding 2.5 hectare plots at the end of a pump canal or using $1\frac{1}{2}$ modules to better accomodate the project area are permissable with this plan. Areas of less than 50 hectares served by one pumping plant would normally be overly costly to develop.

b. Pumping Plants

Several designs of pumping plants and arrangements for supplying water were investigated. The chosen one consists of a reinforced concrete structure flanked by stone masonry inlet and outlet transitions. A separate bridge across the pump canal downstream of the pumping plant is provided where necessary to permit vehicular access to the plants. A traditional gate was installed to enable drainage of the ponds when required. The gate is essentially two rows of stop-logs packed with earth to make it water tight. The gate is cumbersome to operate but considering that the ponds will be drained only once each year, necessitating full gate operation only annually, the selection is the most practical.

There are two types of pump available. The horizontal centrifugal with foot-valve and strainer on the turbine type with a trash rack or strainer. The type selected would be influenced by comparing prices obtained from alternate competitive bidding. In either case the pumps should be direct connected through gear boxes to the diesel engines. Diesel engines are recommended because they are generally more reliable and have a longer life.

The capacity of the pums is related to the marketing requirement of a uniform supply of fish throughout the year, precipitation, deep percolation and the need for stabilizing salinity in the ponds. Pump capacity is estimated at 130 litres per second at the maximum difference in water level between that in the sea chnnel and the pump canal. The actual pumping head will vary with the stage of the tide and the setting of the pump house, and the level of the land. The range used for estimating purposes was between 25 centimeters below to 2 meters elevation above mean sea level. If deep percolation varies greatly from the assumed 1 mm per day, pump capacity will need to be increased.*

* Deep percolation of 1 mm/day is used in estimating water requirements for rice culture. Soil conditions in the fish ponds appears similar so the 1 mm/day was used.

The pump capacity was based on filling 20 ponds over a 30 day period with 16 hours operation per day. The 30 day period was chosen to coincide with the marketing requirement mentioned earlier. The estimated minimum operating time including filling of the ponds and supplying make-up water resulting from seepage and evaporation is about 800 hours per year. Additional pumping will be required to control pond salinity which to a large degree is influenced by precipitation and actual seepage. Weekly operation will be required during periods when the pumps would normally be shut down to prevent excessive deterioration of the pumps and motors. The running time should be from 20 to 30 minutes.

The pumping plant and bridge shown on figure 4 & 5 were used to estimate quantities. The actual design will vary according to individual site conditions and the type of pump selected.

c. Project Earthwork - Channels and Dikes

The volume of earthwork was calculated in accordance with the typical sections shown on figure 6 with 20 % added for shrinkage. Excavation from the sea channel will provide sufficient earth of build the dikes along that channel. The pump channel and the adjacent pond ditch will furnish the earth for the dikes along the channel. The remainder of the earth required will have to be taken from the perimeter ditches around each pond, the ditch along the roadway and such additional material as can be taken from the bottom of the ponds.

d. Conveyance Channels for Cross Drainage

From the maps and aereal photographs it appears that there are three minor streams flowing into the project area. These will have to be rerouted to fit the project layout. In addition it is expected that two additional cross drainage channels will be required. In all 5 strips each 50 meters wide extending across the project area were provided for this purpose. Excavation amounting to about 250,000 cubic meters for canalization of the streams and ditches was included in the project cost estimate.

e. Fishpond gate structure - Inlets

The traditional pond inlet structure consists of a treated timber box placed in one of the pond dikes. It has the traditional gate and usually a bamboo fish screen to keep predators out and fish in. These structures have a life of 5 years or less and are in various states of disrepair during that period.

The project design replaces the traditional structure with a brick masonry and reinforced concrete structure which should last throughout the life of the project. It is furnished with a traditional gate and a new type of fish screen. Details of the pond inlet are shown on figure 7.

f. Fish Screens

Fish screens as now constructed consist of a bamboo frame and vertical strips of split bamboo with an occasional cross brace. The vertical strips are from $1\frac{1}{2}$ cm to 2 cm wide and spaced 5 to 8 mm apart in accordance with the desires of the pond operator. The screen is in the form of a V or a half circle and placed on the pond side of the inlet gate. The V or half circle shapes are used to provide a larger water entrance area and thus reduce the hydraulic head less through the screen. These screens are totally unacceptable from a hydraulic point of view. It is estimated that less than 1/6 of the screen area is effective for passing water. The resulting head losses through the screen are considerable. They also have a rather limited life.

The fish screen proposed for this project consists of a wooden frame slightly larger than the gate opening and the full height of the inlet structure. It will be cross braced at 1/3 and 2/3 of its height. On this frame monofilament line of about 30 kilogram test will be strung vertically through holes drilled in the frame to the proper spacing. This screen will have good hydraulic properties and will not need to be larger than the opening in the pond inlet structure. A diagramatic sketch of the proposed fish screen is shown on figure 8.

5. UNIT PRICES

a. Housing

Transmigration was contacted concerning current costs of housing being furnished to settlers by their organization. For a house 6 x 5.5 meters and depending on location the cost of a house at 1975/76 prices varied between 200,000 and 314,000 rupiahs. A cost of 331,600 rupiahs per house was used in the estimate.

b. Clearing and Grubbing

About 1267 hectares of the project area is heavily timbered. According to the Lampung Department of Forestry contracts can be let to contractors for selective cutting of timber and the earnings from the sale of the timber can be applied to the costs for clearing and grubbing. A credit of 124,200,000 rupiahs was entered in the estimate for the sale of timber.

Clearing costs were furnished by Caterpillar Tractor Co.

from their experience with similar types of ground cover. Their prices include depreciation as well as operating expenses. The clearing costs as used in the estimate assume that the Public Works Department will execute the work with machines furnished by the project. If the work is done by private contractors the costs could be considerably higher because contractors in this area expect margins of 200 percent or more.

c. Pumps and Engines

The pumps must be designed for seawater service and will be more costly than normal. The units costs used here are quoted U.S. prices plus installation. If foreign made pumps and engines are furnished the purchase price probably will reduce by about 30%. The plan is to have the engine directly connected to the pumps through gear reduction units. The use of belt driven units is considered impractical though the initial cost is less.

d. Excavation

All earthwork except the underwater excavation, and the sea channels was considered hand labor. It is estimated that a considerable savings could be made if the pump channel excavation was also included as machine work. This would increase the total volume of machine work and tend reduce the unit price. The unit price of machine excavation includes an amount for forming the dikes from the machine excavation earth.

The sea channels are approximately 2 meters deep. It was considered impractical to hand excavate to this depth.

e. Other unit prices were obtained from various sources. The ones used in this estimate were primarily based on data furnished by the Public Works Department adjusted upwards to reflect current conditions. For example the Public Works unit prices were based on labor at 340 rupiahs per day whereas the current rate is 600. A tabulation of the unit prices are shown on Table 1.

6. ESTIMATE OF PROJECT COST.

The project cost is estimated at $8,105,793 without the auxilliary costs of trainees, technical assistance, relocation costs, etc. The auxilliary costs have been set at $1,250,000 by the Mission. If these are added, the project cost then becomes $9,355,793.

The estimate includes a contigency factor of 20% on constructed items and 10% for engineering on all items except housing, wells, schools, clinics and government offices. The 20% contigency factor is justified by the paucity of field data presently available. Ten percent for engineering would normally be high but the project construction will be spread over a period of 5 years and overhead costs will necessarily be high.

Details of the estimate are shown on table II.

Reductions in total cost can be affected by increasing the amount of machine excavation, increasing the size of farm ponds and worldwide bidding for the pumps and engines. These combinations have been costed and included in the alternative economic analysis. Construction fund requirements by years over the 5 year construction period are also shown in the economic section.

7. CONSTRUCTION LABOR FORCE

The labor force at the peak of construction is estimated at 1011 men. The bulk of them will be engaged in excavating earth. They will be employed full time over the estimated construction period of 5 years. The crew of carpenters helpers etc. engaged in housing and building construction will be required for at least a 4 year period. They will be required to finish one house every working day for 4 years. Labor distribution is estimated as follows:

Excavation	800
Access & Project Road	75
Housing	50
Pump houses	30
Machine Excavation	2
Inst. Pumps + Engines	4
Selective cutting timber	20
Clearing and Grubbing by machine	15
Pond inlet structures	15
T o t a l	1011

The marshalling of a labor force of this size in a labor short area will no doubt have a disruptive effect on the local economy. Food prices and other supporting facilities will escalate considerably. Labor costs will also escalate and project costs will increase as result. No allowances have been made in the project estimate for these price increases.

8. PROJECT OPERATING COSTS

Project operating costs consist of two parts, the cost of pump operation, and the project personnel costs:

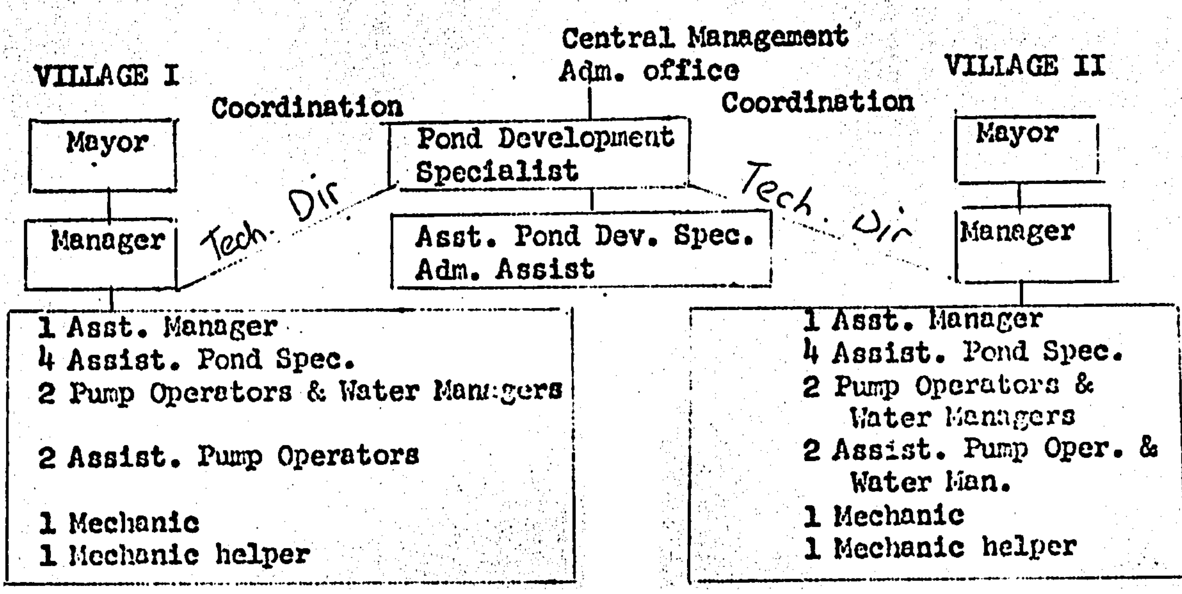
(a) Pump Operation

Total Running Time of 58 pumps = 58 x 800 = 46400 hrs.

Fuel consumption = 3 liters per hour; cost 50 rupiahs/liter

Fuel cost = 3 x 46,400 x 50	= Rp.	6,960,000
Add 10% running time for salinity control	=	696,000
Total Fuel Cost	=	7,656,000
Oil Change every 50 hrs Operation	=	765,990
Repairs & Maint. of 10% Equipment Cost	=	24,041,000
Total Running Cost per year	= Rp.	32,462,990

We assume that the project inhabitants will occupy two villages each under the control of the headman. Project operating personnel will be divided between two villages. They will report administratively through a manager, who while administratively reporting to the village chief, will be technically responsible to a Project Development Specialist appointed and paid by a central government organization. The organization pattern is shown below:



The estimated cost of this staff exclusive of the village mayor is estimated at 15,840,000 rupiahs. This added to the pump and engine operating cost makes a total annual cost of 48,302,990 rupiahs. This amount will have to be provided annually and the government will need to decide how and by whom it should be paid.

9. HYDROLOGY

a. Precipitation

There are 16 years of precipitation data available at Maringgai, a station located eight kilometers north of the project area. The maximum recorded precipitation was about 15 centimeters in 24 hours. No other data on intensity was available.

b. Evaporation

Pond evaporation was considered equal to pan evaporation as no conversion coefficients were available.

c. Deep percolation

Deep percolation for rice culture in Indonesia is assumed to be one millimeter per day. The project soils are similar to those in rice areas so the same rate was used in our analysis. Table III shows average annual precipitation for two stations located near the project. The table also lists pan evaporation by months and net precipitation over evaporation and deep percolation referred to data from the Maringgai station.

d. Tidal Fluctuations

Tidal information along the coast where the project is located was nonexistent. We gathered such information as is now available by installing a tide gauge in the estuary of the Sekampung River and later another at Maringgai. Initial readings at Sekampung were taken over a 24 hour period and correlated with a station on Java. The data from this study is given inMMr. Glenne's paper*. Further data at this location was obtained hourly on July 12, 13 and 14, 1976. We did not attempt to relate the tidal information to land elevations as such do not exist.

When the project area was shifted north of the Sekampung River a new gauge was installed at Maringgai. Readings were taken every hour from 1600 hours on July 28 to 2400 hours on July 31. A tabulation of these readings reduced to project datum is shown on Table IV. Mean sea level was calculated at elevation 7.76 meters project datum.

10. <u>POND SALT BALANCE</u>

* "Tidal Hydraulics" - Bard Glenne

Aquaculture specialists generally agree that a fish pond salt balance in the 15 to 25 parts per thousand range is very desirable for growing milkfish. The following tabulation shows the variation in salinity over a twelve month period with no artificial controls on salinity and a constant pond elevation of 40 centimeters. It was also assumed that excess precipitation spilling from the ponds was 25 percent effective volume wise in removing salt from the pond, i.e. the effluent resulting from precipitation was 75 percent less saline than the pond water. The pond is assumed full on Jan. 1 with sea water at 29 parts per thousand.

Jan. 1	29. PPT	Aug. 1	11.82 PPT
Feb. 1	25.4 "	Sept. 1	14.41 "
Mar. 1	15.88 "	Oct. 1	18.13 "
Apr. 1	14.10 "	Nov. 1	24.64 "
May 1	14.50 "	Dec. 1	24.14 "
June 1	13.9 "	Jan. 1	21.45 "
July 1	12.37 "		

To maintain salinity above 15 parts per thousand at all times it would be necessary to draw the ponds down and additional sea water as required to raise the salinity above 15 parts per thousand.

11. TOPOGRAPHY

Land surfaces suitable for aquaculture should be relatively plane surfaces either level or sloping gently upward and away from the source of the water. Areas which slope downward from the water source will be either difficult or impossible to drain.

The topography of the proposed site is generally level along the coast and slightly above sea level. This are extends inland about one half kilometer and comprises the project greenbelt-an area reserved for coasted protection and ecological reasons. Inland from the green-belt, the project area slopes rapidly downward and forms a series of bowls, the bottoms of which are up to 4.75 meters below mean sea level. In some areas the slope is as much as 4 meters per kilometer downwards.

Obviously the elevations in the project area and the uneven nature of the ground surface cause the project parameters to fall outside the limits established by the design for feasibility. In fact the topographic features are so unfavourable that it is doubtful that a workable project could be designed for the area regardless of cost.

Because the topographic features are so unfavourable we have recommended that this project site should not be considered for aquaculture development.

Topographic features and elevations are shown on figures 9, 10, 11 and 12. Elevations and distance of cross sections taken every two kilometers along the length of the project are shown on tables V, VI, VII and VIII.

TABLE I

UNIT PRICE for ESTIMATING COSTS

	Rupiahs	Units
Access Roads	2,302,000	Km.
Project Roads	2,302,000	Km.
Structure Excavation (wet)	1,200	M3
Reinforced Concrete	80,000	M3
Stone Masonry	26,000	M3
Brick Masonry	22,000	M3
Heavy Clearing and Grubbing	239,600	Ha.
Light Clearing and Grubbing	41,400	Ha.
Housing	331,600	Per house
Wells (Complete with hand pump)	45,000	Each
Schools, Clinics, Government Offices	44,712,000	Lumpsum
Excavation dikes	820	M3
Pumps and engines	5,389,000	Each
Pond screens	8,280	Each
Gates Pond inlet structures	4,140	Each
Gates Pump House	20,000	Each
Excavation inlet channel from sea (by machine)	600	M3
Rig Rap	4,140	M3
Underwater Excavation	1,200	M3
Selected Cutting (Credit)	124,350,000	Lump Sum

TABLE II

COST ESTIMATE

Description	Unit		Cost per Unit (000) Rupiahs	Total (000) Rupiahs		
Access Road	4.5	Km.	2,302.0	10,359		
Project Road	17	Km	2,302.0	39,134		
Structure Exc.	17258	M3	1.2	20,709		
Reinforced Concrete	1879	M3	80.0	150,320		
Stone Masonry	3596	M3	26.0	93,495		
Brick Masonry	4640	M3	22.0	102,080		
Excavation Dikes	1,170,318	M3	.82	959,660		
Pumps and Engines	58	ea	5,389	312,562		
Pond Screen	1,140	ea	8.28	9,439		
Gates - Pond Inlets	1,140	ea	4.14	4,720		
Gates - Pump Houses	58	ea	20.0	1,160		
Rip Rap	883	M3	4.14	3,656		
Heavy Clearing & Grubbing	1,267	Ha	239.6	303,573		
Clearing Light	1,933	Ha	41.4	80,026		
Sea Channel Exc. (Machine	250,200	M3	.60	150,120		
5-Cross Drainage Channels	57,600	M3	.80	46,080		
Under Water Exc.	9,600	M3	1.20	11,520		
			Total		2,298,613	
			Less Credit		124,200	
					2,174,413	
Housing	1,200	ea	331.2	397,440		
Water Wells	48	ea	45.0	2,160		
Schools, Clinics, Offices	Lump sum			44,712		
Sub Total				444,312	444,312	
			Sub Total		2,618,725	
Eng. 10% of 2,174,413					217,441	
Cont. 20% of 2,618,425					523,685	
			TOTAL		3,359,551	=$8,105,793
Mission and Other Costs						1,250,000
						$9,355,793

Table II

TABLE III

AVERAGE
MONTHLY PRECIPITATION
and
EVAPORATION AND SEEPAGE

Month	Evap. mm/Mo.	Deep Per. mm/Mo.	Precipitation: Metro mm/Mo.	Precipitation: Labuan Maringgai mm/Mo.	Evap. Seepage mm/Mo.	Net gain or loss* mm/Mo.
Jan.	114.7	30	338	229	144.7	+ 84.3
Feb.	95.2	28	264	247	123.2	+ 123.8
Mar.	114.7	31	267	211	145.7	+ 65.3
Apr.	132.0	30	170	142	162.0	- 20.0
May	114.7	31	134	181	145.7	+ 35.3
June	111.0	30	126	173	141.0	+ 32.0
July	102.0	31	118	131	133.0	- 2.0
Aug.	136.4	31	96	118	167.4	- 49.4
Sept.	147.0	30	88	124	177.0	- 53.0
Oct.	167.4	31	96	88	198.4	- 110.4
Nov.	153.0	30	231	163	183.0	- 20.0
Dec.	127.1	31	277	211	158.1	+ 52.9
Total	1,400.5	365	2,205	2,018	1,879.2	138.8

* Pond evaporation was considered equal to pan evaporation. Numbers are based on precipitation at Labuan Maringgai.

Note: Plus numbers indicate fishpond spills; minus numbers indicate make-up water by pumping.

All figures are averages of 16 years or more of record.

TABLE IV

TIDAL OBSERVATIONS
MARINGGAI LAMPUNG

Number	Time	Water Level			
		7/28/76	7/29/76	7/30/76	7/31/76
1	1600	7.562 L	-	7.524	7.570
2	1700	7.612	-	7.594	7.625
3	1800	7.692	-	7.650	7.769
4	1900	7.772	-	7.800	7.755
5	2000	7.880	-	7.837	7.820
6	2100	7.942	-	7.916	7.906
7	2200	7.956 H	-	7.945 H	7.995 H
8	2300	7.885	-	7.925	7.953
9	2400	7.892	-	7.968	7.918
10	2100	-	7.767	7.842	7.835
11	0200	-	7.650	7.672	7.708
12	0300	-	7.693	7.550	7.563
13	0400	-	7.575	7.562	7.557
14	0500	-	7.543	7.547	7.535 L
15	0600	-	7.532	7.529	7.540
16	0700	-	7.505	7.528 L	7.546
17	0800	-	7.590	7.555	7.578
18	0900	-	7.492 L	7.608	7.615
19	1000	-	7.490	7.596	7.640
20	1100	-	7.484	7.613	7.659
21	1200	-	7.493	7.632	7.652
22	1300	-	7.504	7.624	7.644
23	1400	-	7.499	7.595	7.655
24	1500	-	7.502	7.592	7.619

Note: Tidal Elevations are referenced to project datum.

TABLE V

Cross Sections PR1 and PR2

PR1			PR2		
Point No.	Distance Meters	Elevation	Point No.	Distance	Elevation
1	0	2.86	1	0	5.56
2	95	5.29	2	23	6.14
3	133	3.62	3	49	5.90
4	200	5.40	4	75	5.52
5	215.5	4.93	5	85	6.02
6	290.5	6.96	6	104	5.70
7	528.5	3.66	7	119.5	5.70
8	533.5	3.67	8	134	5.83
9	655.5	3.57	9	155.5	6.04
10	696.5	3.67	10	189.5	5.93
11	733.5	3.55	11	235.5	6.04
12	786.5	3.65	12	386.5	5.71
13	817.5	3.55	13	527.5	5.92
14	863.5	3.20	14	708.5	5.33
15	922.5	3.67	15	816.5	5.61
16	984.5	3.15	16	1022.5	5.81
17	1051.5	3.71	17	1195.5	5.44
18	1174.5	3.10	18	1453.5	5.19
19	1205.5	3.10	19	1645.5	6.12
20	1296.5	3.00	20	1818.5	7.25
21	1356.5	3.30	21	2050.5	8.02
22	1437.5	3.27	22	2258.0	8.22
23	1557.5	3.18	23	2388.5	7.03
24	1665.5	3.35			
25	1775.5	3.48			
26	1837.5	7.02			
27	1907.5	7.23			
28	2028	7.92			
29	2142	7.87			
30	2304	6.02			

Note: Elevations in meters project datum
mean Sea Level = 7.76 project datum

TABLE VI

Cross Sections PR3 and PR4

PR3			PR4		
Point No.	Distance	Elevation	Point No.	Distance	Elevation
1	0	5.01	1	0	2.88
2	132	5.41	2	148	3.03
3	380	4.77	3	325	2.62
4	553	4.30	4	458	3.10
5	663	3.89	5	610	3.17
6	813	3.96	6	768	3.44
7	1000	4.81	7	830	3.86
8	1149	3.99	8	974	3.77
9	1285	4.72	9	1265	4.01
10	1417	5.37	10	1473	3.86
11	1574	5.94	11	1593	4.32
12	1694	5.86	12	1749	5.24
13	1896	5.97	13	1842	6.21
14	2014	5.73	14	1936	6.73
15	2227	6.40	15	2088	7.18
16	2369	6.94	16	2229	6.41
17	2467	8.11	17	2377	7.73
18	2597	7.98	18	2605	7.84
19	2768	7.94	19	2835	8.02
20	2956	7.82	20	2901	7.63
21	3148	8.08			
22	3335	8.14			
23	3478	7.68			

Note: Elevations in Meters Project Datum
Mean Sea Level = 7.76 Project Datum

TABLE VII

Cross Sections PR5 and PR6

PR5			PR6		
Point No.	Distance	Elevation	Point No.	Distance	Elevation
1	0	5.76	1	0	6.19
2	134	5.48	2	166	6.03
3	300	5.35	3	250	5.92
4	485	5.35	4	426	6.19
5	616	5.69	5	606	5.82
6	717	5.91	6	833	6.14
7	921	6.01	7	1060	5.71
8	1100	5.89	8	1159	5.83
9	1248	5.89	9	1337	5.95
10	1421	5.89	10	1604	5.74
11	1676	6.11	11	1609	7.98
12	1912	6.25	12	1624	8.12
13	1924	7.95	13	1843	6.17
14	2184	8.03	14	2035	5.41
15	2203	6.25	15	2045	8.20
16	2448	6.13	16	2286	8.13
17	2462	8.01	17	2481	5.71
18	2664	7.99	18	2665	5.93
19	2699	6.24	19	2675	7.85
20	2885	6.24	20	2812	8.00
21	2896	7.82	21	2827	5.92
22	3052	5.29	22	3044	5.37

Note: Elevations in meters project datum
Mean Sea Level = 7.76 project datum

TABLE VIII

Cross Sections PR7 and PR8

PR7

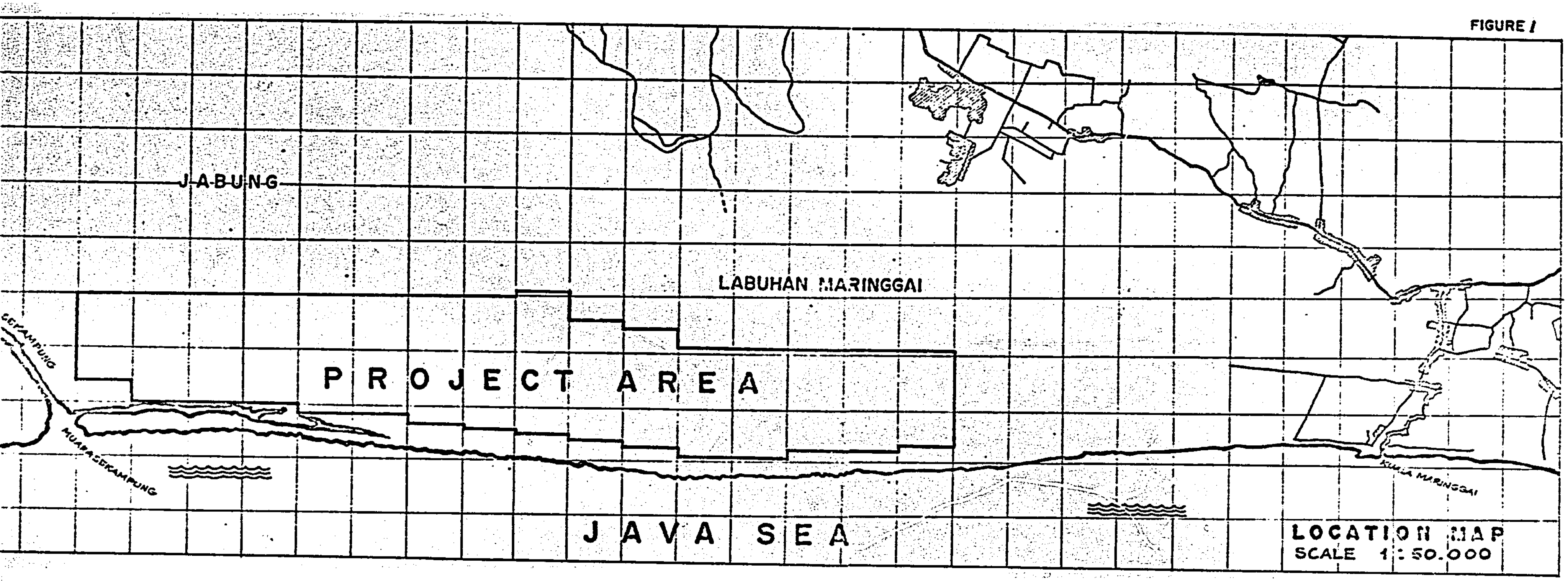
Point No.	Distance	Elevation
1	0	5.55
2	59	5.77
3	121	5.49
4	196	5.78
5	277	6.97
6	336	6.84
7	405	7.12
8	526	7.04
9	583	7.64
10	675	7.28
11	762	7.73
12	860	5.89
13	954	5.42
14	1080	5.66
15	1184	5.90
16	1271	6.79
17	1342	6.82
18	1414	6.90
19	1529	6.91
20	1609	7.54
21	1702	7.60
22	1847	8.54
23	1959	8.05
24	2058	7.56
25	2150	5.61
26	2257	7.51
27	2392	7.54
28	2556	7.52
29	2708	6.73

PR8

Point No.	Distance	Elevation
1	0	6.39
2	168	6.18
3	297	6.21
4	390	6.46
5	566	6.71
6	750	8.24
7	922	8.34
8	1081	7.61
9	1279	7.70
10	1442	8.72
11	1626	7.83
12	1803	8.54
13	1994	8.05
14	2150	5.57
15	2309	7.75
16	2483	7.24
17	2600	7.11
18	2801	5.93

Note: Elevations in Meters project datum
Mean Sea Level = 7.76 project datum.

FIGURE 1

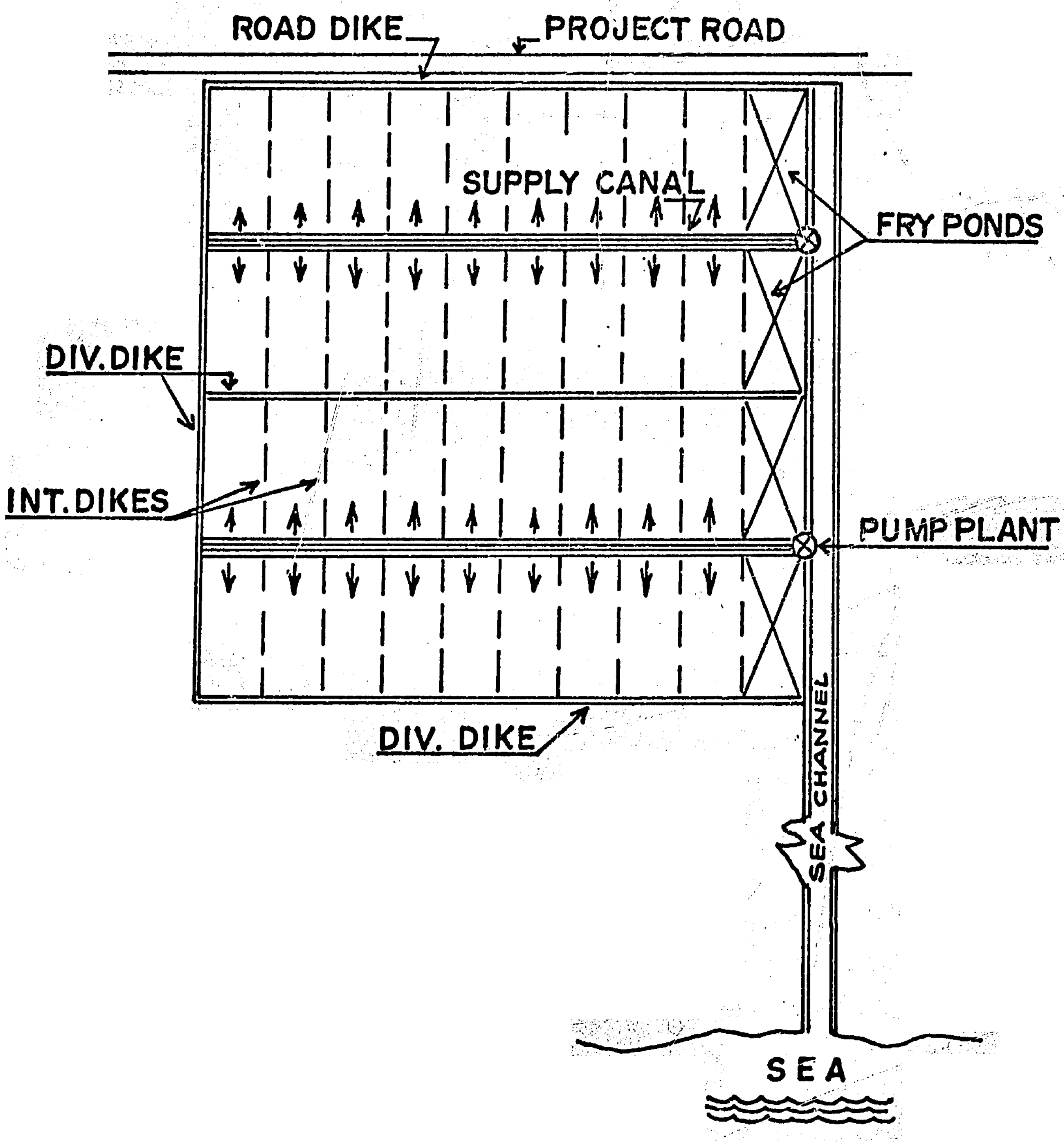


LOCATION MAP
SCALE 1 : 50.000

FIGURE 2

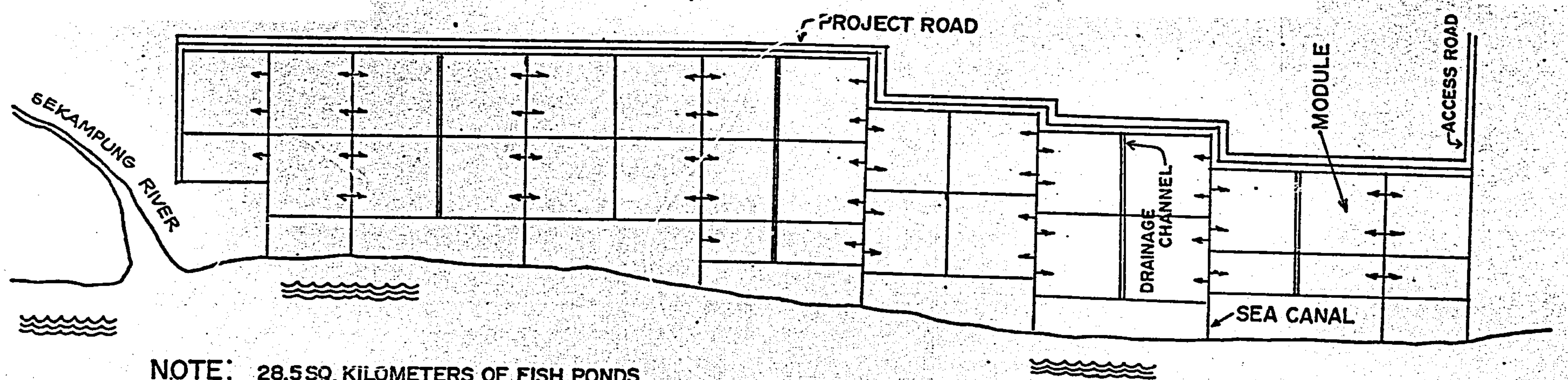
SCHEMATIC ARRANGEMENT OF FISHPONDS

ONE KILOMETER SQUARE



LAMPUNG FISHERIES PROJECT

FIGURE 3



NOTE: 28.5 SQ. KILOMETERS OF FISH PONDS
58 PUMPING PLANTS. EACH CONTAINING
1 PUMP OF 130 LITERS /Sec.

SCALE: APPROX. 2.5cm. = 1 kilometer.

SCHEMATIC ARRANGEMENT OF ONE KILOMETER SQUARE
AND ONE-HALF KILOMETER SQUARE MODULES

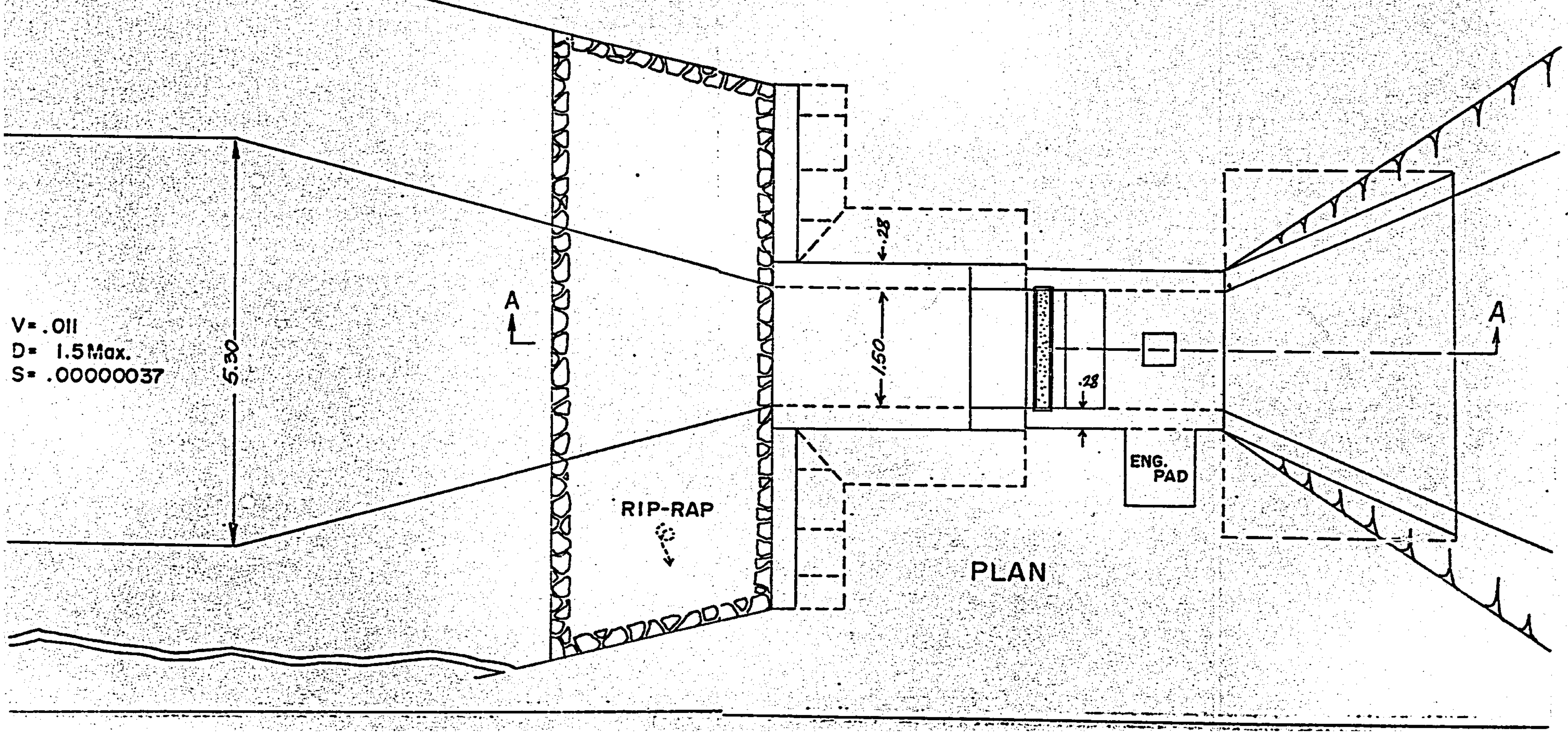
Drawn by F.L.
CHECCHI and Co.

Traced by:
WASHINGTON D.C.

PLAN OF PUMP HOUSE AND BRIDGE

Scale 254cm. = 1 Meter

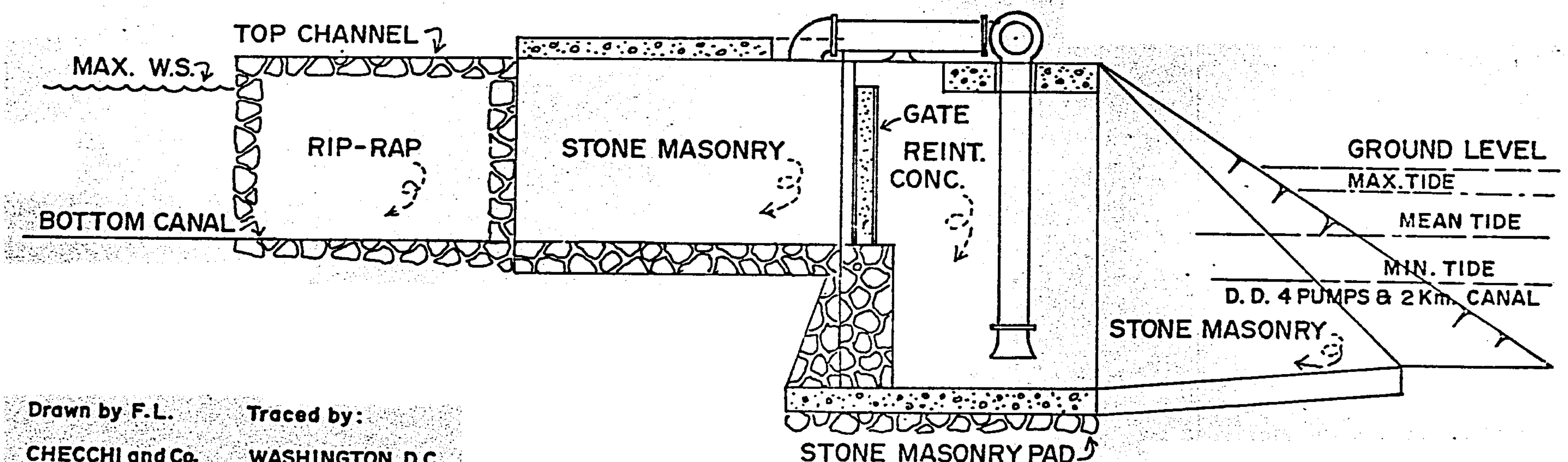
FIGURE 4



LAMPUNG FISHERIES PROJECT

PUMPING PLANT AND BRIDGE

FIGURE 5



Section A-A

Drawn by F.L. CHECCHI and Co.

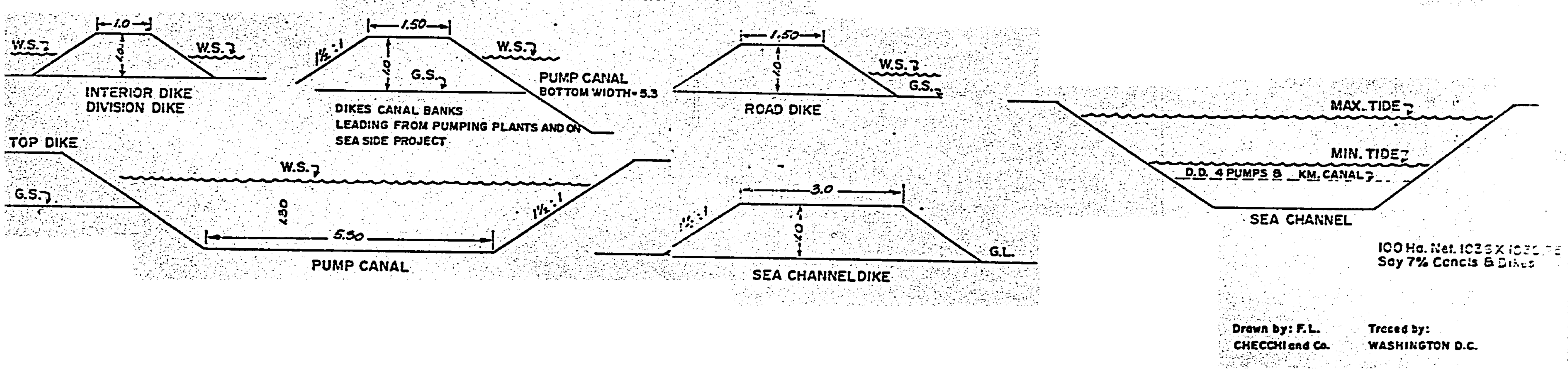
Traced by: WASHINGTON D.C.

LAMPUNG FISHERIES PROJECT

TYPICAL SECTIONS

Scale: 2.54 cm. = 1 meter

FIGURE 6



FISHPOND INLET STRUCTURE

FIGURE 7

Scale: 2.54cm = 1 meter

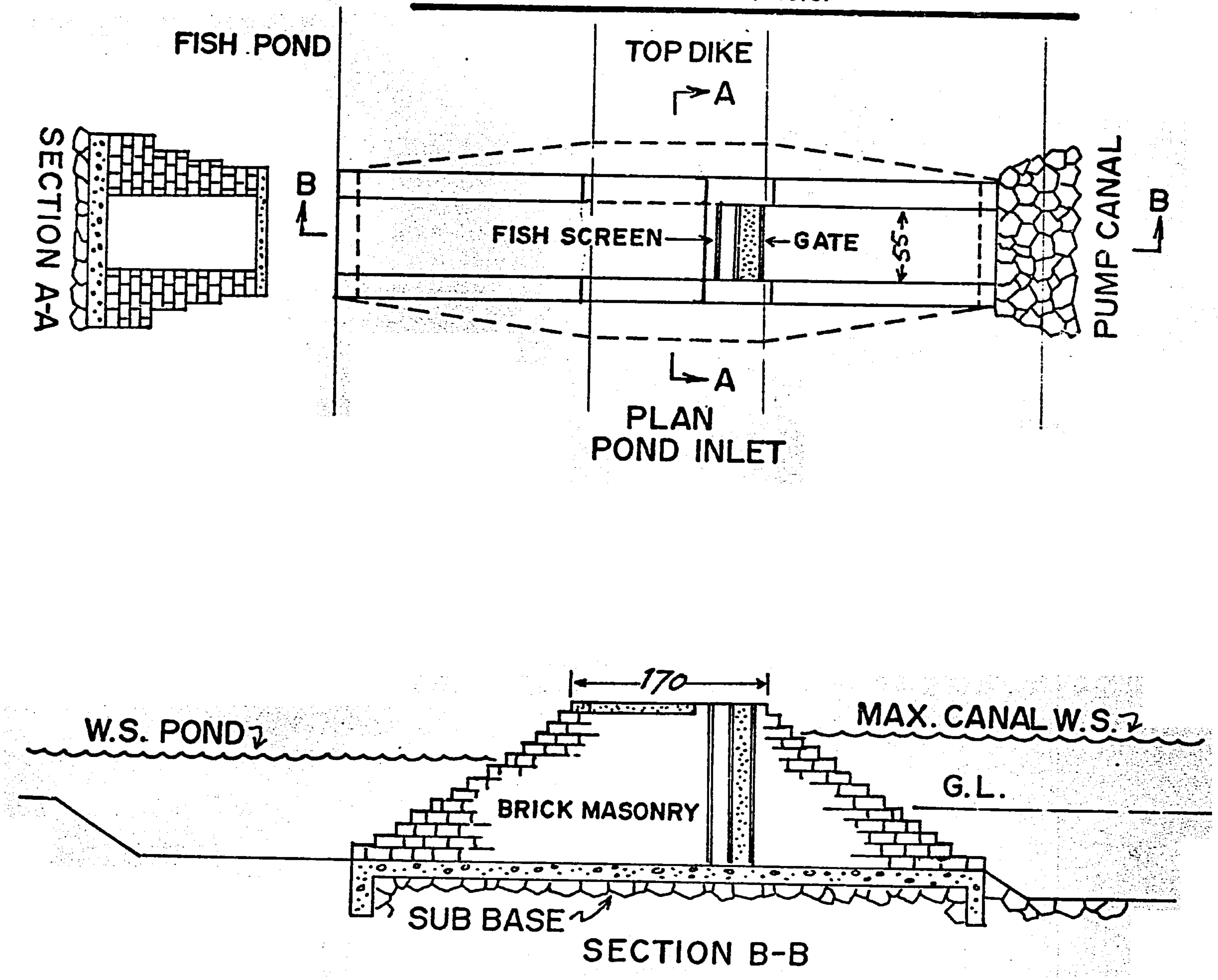
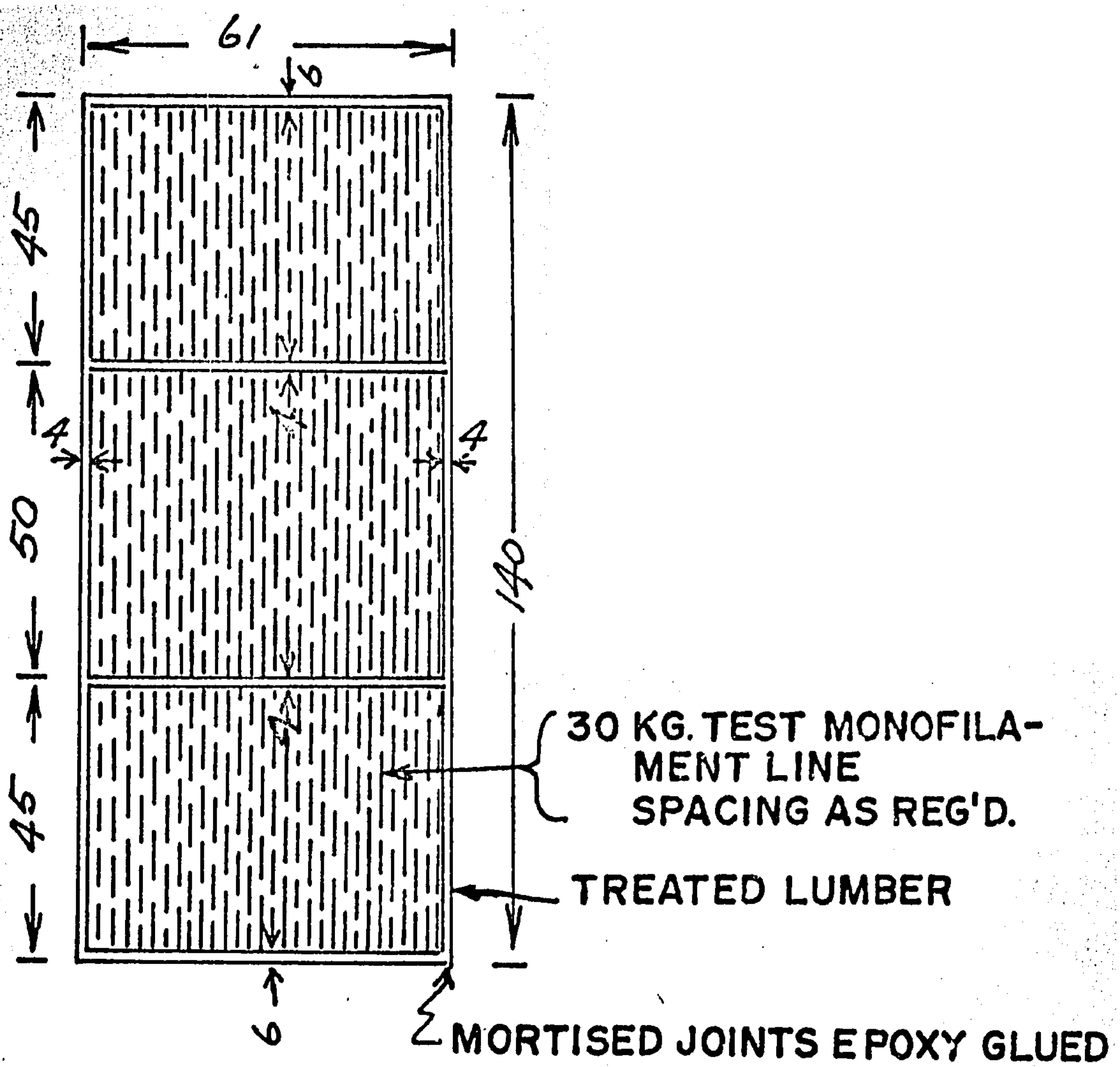


FIGURE 8



FISHPOND SCREEN

DIAGRAMATIC - NOT TO SCALE
DIMENSIONS IN CENTIMETERS

LAMPUNG FISHERIES PROJECT
FISHPOND SCREEN

Drawn by F. L. Traced by :

CHECCHI and Co. WASHINGTON D.C.

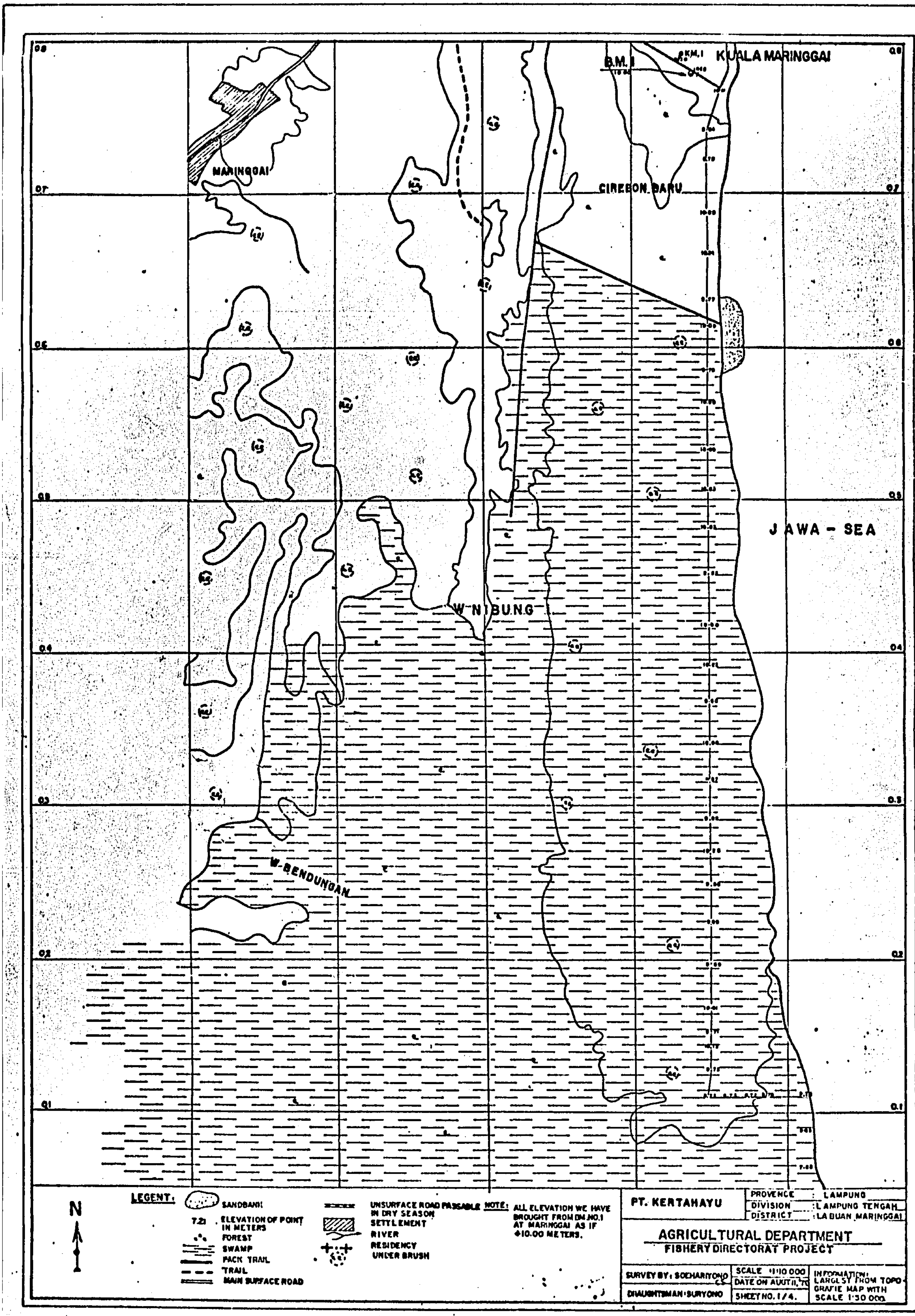

KUALA MARINGGAI
B.M.I
MARINGGAI
CIREBON BARU
JAWA - SEA
W. NIBUNG
W. BENDUNGAN
N
LEGENT:
SANDBANK
7.21 ELEVATION OF POINT IN METERS
FOREST
SWAMP
PACK TRAIL
TRAIL
MAIN SURFACE ROAD
UNSURFACE ROAD PASSABLE IN DRY SEASON
SETTLEMENT
RIVER
RESIDENCY
UNDER BRUSH
NOTE: ALL ELEVATION WE HAVE BROUGHT FROM BM NO.1 AT MARINGGAI AS IF +10.00 METERS.
PT. KERTAHAYU
PROVENCE : LAMPUNG
DIVISION : LAMPUNG TENGAH
DISTRICT : LABUAN MARINGGAI
AGRICULTURAL DEPARTMENT
FISHERY DIRECTORAT PROJECT
SURVEY BY: SOEHARIYONO
DRAUGHTSMAN: SURYONO
SCALE 1:10 000
DATE ON AUG 11, 70
SHEET NO. 1/4.
INFORMATION: LARGEST FROM TOPOGRAFIE MAP WITH SCALE 1:50 000

FIGURE 9

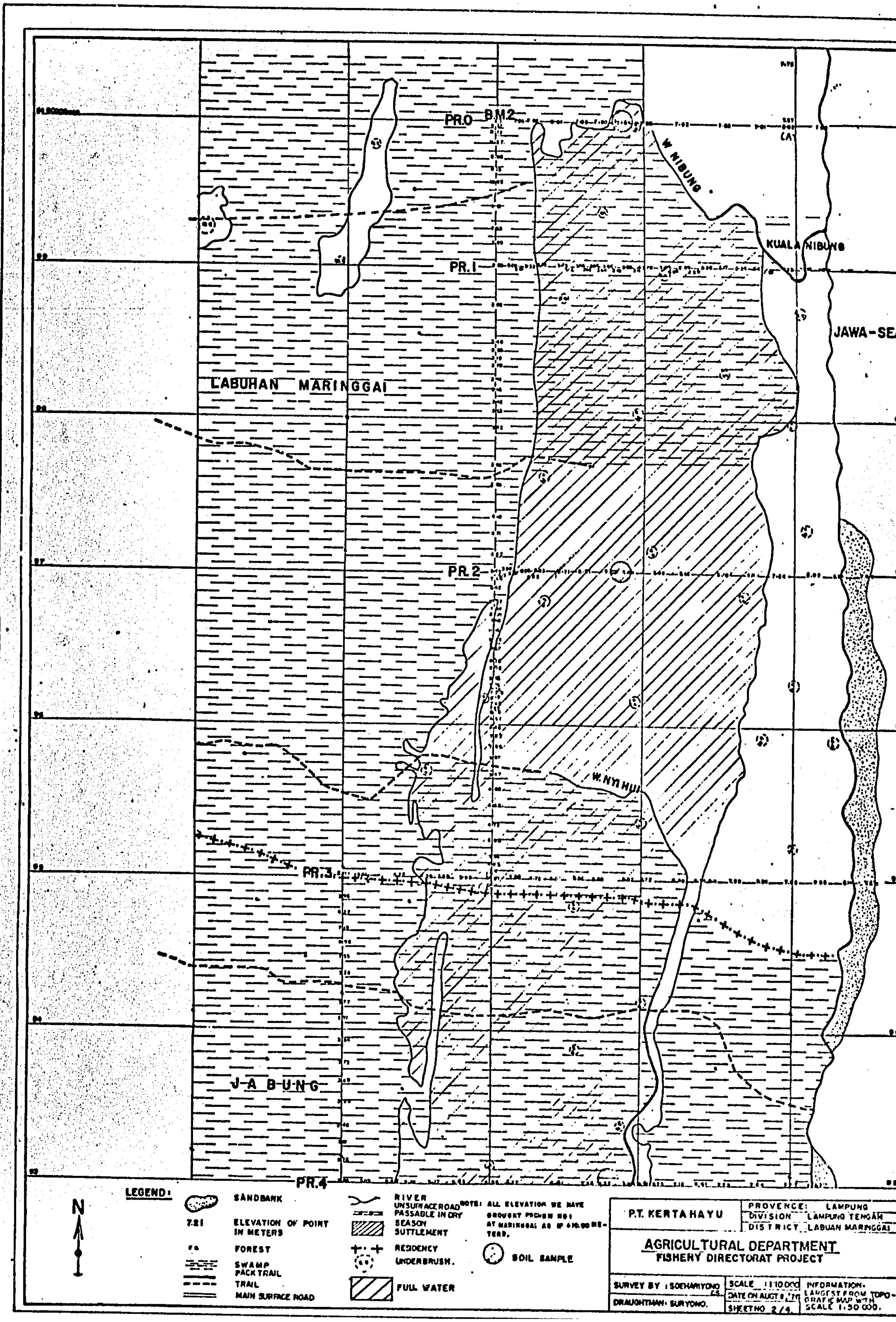
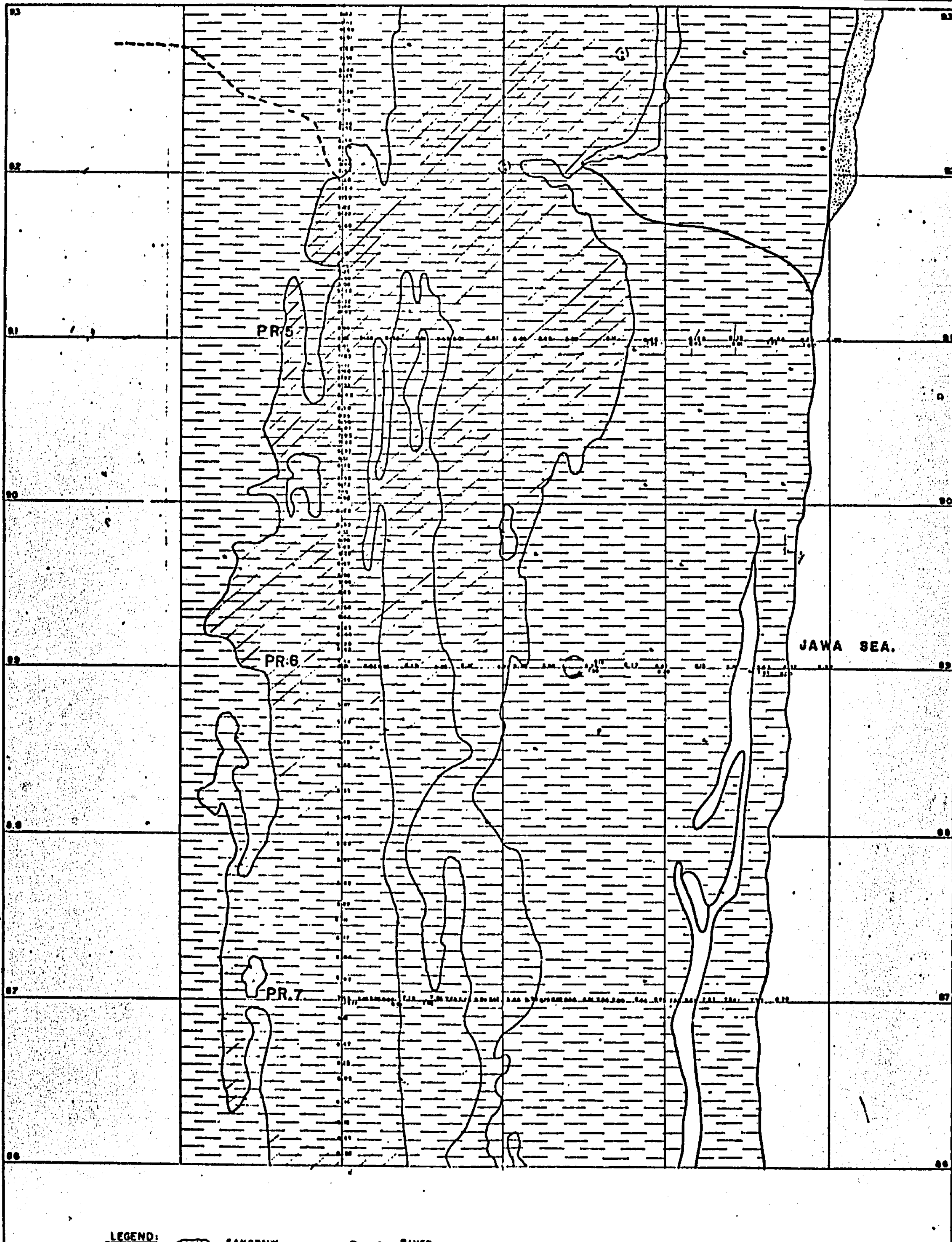

PR.0
BM2
W. NIBUNG
KUALA NIBUNG
PR.1
JAWA-SEA
LABUHAN MARINGGAI
PR.2
W. NYIHUI
PR.3
J A B U N G
PR.4
N
LEGEND:
SANDBANK
7.21 ELEVATION OF POINT IN METERS
FOREST
SWAMP
PACK TRAIL
TRAIL
MAIN SURFACE ROAD
RIVER
UNSURFACE ROAD PASSABLE IN DRY SEASON
SUTTLEMENT
RESIDENCY
UNDERBRUSH.
FULL WATER
SOIL SAMPLE
P.T. KERTA HAYU
PROVENCE: LAMPUNG
DIVISION LAMPUNG TENGAH
DISTRICT LABUAN MARINGGAI
AGRICULTURAL DEPARTMENT
FISHERY DIRECTORAT PROJECT
SURVEY BY : SOEHARIYONO
DRAUGHTMAN: SURYONO.
SCALE 1:10.000
SHEET NO 2/4.
INFORMATION: LARGEST FROM TOPOGRAFIC MAP WITH SCALE 1:50.000.

FIGURE 10



N

LEGEND:

- SANDBANK.
- 7.21. ELEVATION OF POINT. IN METERS.
- FOREST.
- SWAMP.
- PACK TRAIL.
- TRAIL.
- MAIN SURFACE ROAD
- RIVER.
- UNSURFACEROAD PASSABLE IN DRY.
- SEASON SUTTLEMENT.
- RESIDENCY.
- UNLERBRUSH.
- FULL WATER.
- SOIL SAMPLE

NOTE: ALL ELEVATION WE HAVE. BROUGHT FROMBM NO 1. AT MARINGGAI AS IF 110.00 METERS.

P.T. KERTA HAYU	PROVENCE: LAMPUNG. DIVISION : LAMPUNG TENGAH. DISTRICT : LABUHAN MARINGGAI

AGRICUL TURAL DEPARTMENT.
FISHERY DIRECTORAT PROJECT

SURVEY BY: SOEHARIYONO C.S DRAUGHTMAN: SURYONO	SCALE : 1:10.000. DATEON AUG. '70 SHEETNO 3/4.	INFORMATION LANGEST FROM TOPOGRAFIE MAP WITH. SCALE 1 50 000

FIGURE II

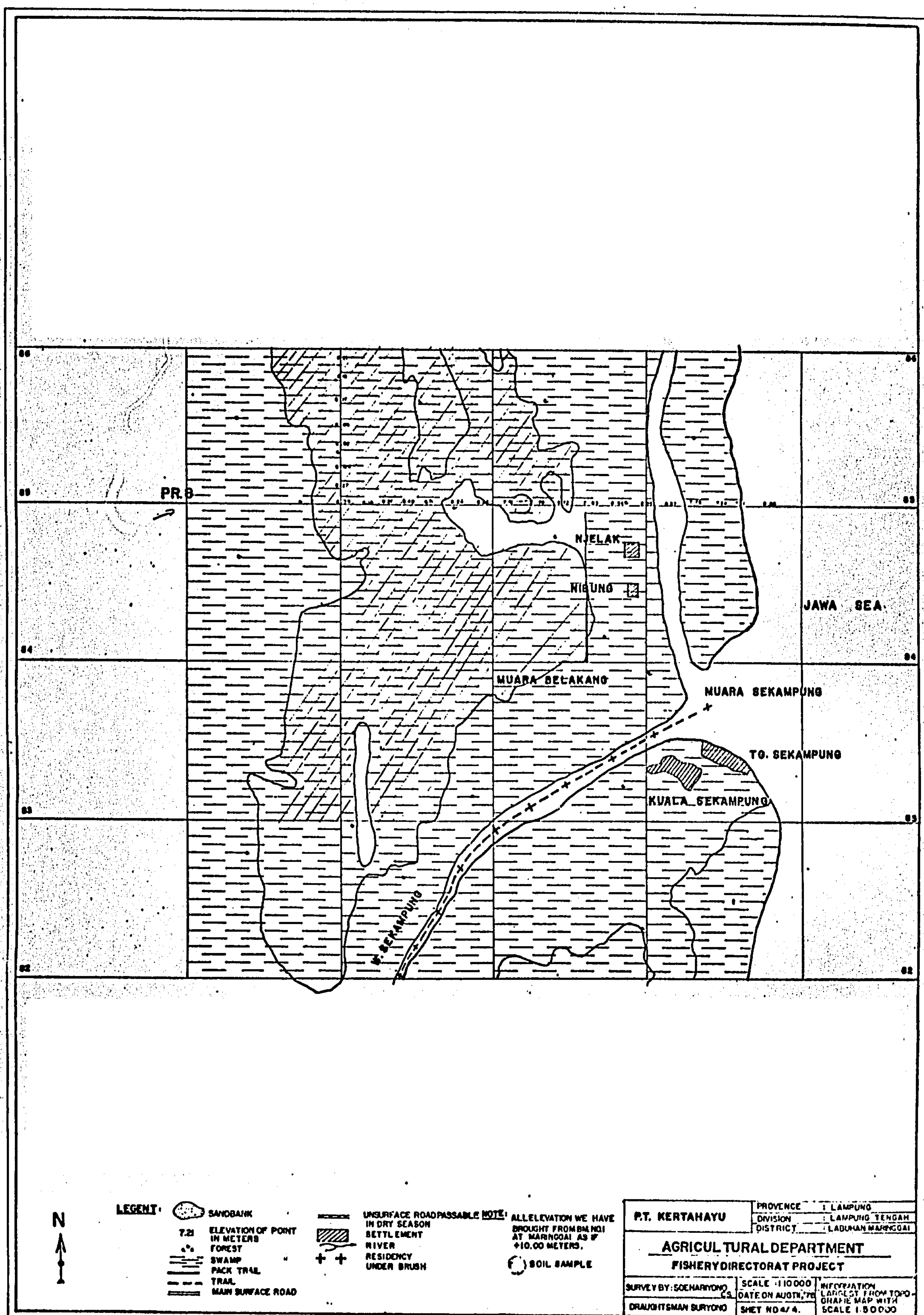

PR.8
NJELAK
NIBUNG
JAWA SEA.
MUARA BELAKANG
MUARA SEKAMPUNG
TG. SEKAMPUNG
KUALA SEKAMPUNG
S. SEKAMPUNG
N
LEGENT:
SANDBANK
7.21 ELEVATION OF POINT IN METERS
FOREST
SWAMP
PACK TRAIL
TRAIL
MAIN SURFACE ROAD
UNSURFACE ROAD PASSABLE IN DRY SEASON
SETTLEMENT
RIVER
RESIDENCY
UNDER BRUSH
NOTE: ALL ELEVATION WE HAVE BROUGHT FROM BM NO I AT MARINGOAI AS IF +10.00 METERS.
SOIL SAMPLE
P.T. KERTAHAYU
PROVENCE : LAMPUNG
DIVISION : LAMPUNG TENGAH
DISTRICT : LABUHAN MARINGGAI
AGRICULTURAL DEPARTMENT
FISHERY DIRECTORAT PROJECT
SURVEY BY: SOEHARIYONO CS.
DRAUGHTSMAN SURYONO
SCALE 1:10 000
DATE ON AUGTH, '70
SHET NO 4/4.
INFORMATION LARGEST FROM TOPOGRAFIE MAP WITH SCALE 1:50000

FIGURE 12

APPENDIX C

SOCIAL SOUNDNESS ANALYSIS

LAMPUNG BRACKISH WATER FISHERIES PROJECT

SOCIAL SOUNDNESS ANALYSIS

David Nasatir, Ph.D.

JAKARTA, July 1976

CHECCHI AND CO. — WASHINGTON, D.C.

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   b. organization in the project
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D. Changes in Power and Participation

FOOTNOTES

REFERENCES

APPENDICES

A. Work Programs to Counterparts

B. "Socio Cultural Feasibility" by S.V. Bersamin

RECOMMENDATIONS

1. A phased approach to project development should be adopted that establishes target dates for the functioning of social services as well as for the construction of physical facilities.

2. Present residents of the project area should be involved in project planning as well as project participants.

3. Labor force for project construction should be recruited on the site as well as from project participants.

4. Spontaneous migrants - present and future - should be incorporated in plans for recruitment, local social facilities (including government), and support.

5. Recruitment of participants should be done in a manner that will insure a complete range of occupational and social roles for the new villages.

6. Representatives of the project participant community should visit the site and confer with resident community leaders prior to actual transmigration.

7. Food for the total number of actual transmigrants - not just five per family - should be guaranteed project participants for a period sufficient for ponds to reach targeted levels of production; approximately three years.

8. No families should be moved until adequate food and housing exists on the site.

9. Project participants should be guaranteed an adequate supply of fry, fertilizer and seeds for the first three years.

10. Participating families should be provided with work animals and agricultural implements required to perform the tasks programmed as well as conduct supplemental agricultural activities.

11. An intensive campaign should be mounted in the target area to achieve the supression of Malaria.

12. A demonstrable commitment to the practice of family planning should be a prerequisite for participation in the project.

13. A continuing program for public health and for family planning education should be incorporated in the project.

14. A provision should be made for the construction and staffing of a secondary or vocational school in the project region.

15. Project Management (water, harvesting schedules, etc.) and community government structures should be integrated.

SUMMARY

Substantial development in the cash economy of Lampung province will not occur just because transmigrants from Java are given access to fishponds, fry, fertilizer, credit and training in the new technology of tambak operations. Major changes in the social structure will be required involving the systems of land tenure, marketing and local self government. The totality of changes required in these systems is neither clearly identifiable nor readily achievable, but there is reason to believe that the necessary preliminary steps are within the realm of possibility. With these accomplished, the likelihood of a successful outcome will be substantially increased.

The promise of government assistance for a family move to Lampung is appealing to many landless farm families in Central Java and previous transmigration efforts have involved giving land to such people. However, there is no precedent for moving fishermen who may also operate tambaks. The pressure to obtain land is not so intense for those who gain their living from the sea, and the rationale behind the appeal to become full-time operators of high production tambaks is blunted by the absence of any model for this kind of behavior, the absence of a clearly defined market for the product, and ambiguities regarding the precise nature of land tenure that will exist.

In order for potential transmigrants to adapt to the practices and procedures required to make the new tambaks operate as planned, an extensive training program will be required. Subsistance will have to be provided project participants until the project is operating as planned and the training and supervision required to bring production up to planned levels may have to extend over several years. Without a sustained training effort, even with additional economic supports, project participants will be forced to engage in subsistance agriculture - for which they will be totally unequipped. Such a turn of events would be highly detrimental to the planned development of the project.

Project participants will be willing to incur debt for activities perceived to benefit them if there is a reasonable assurance that the costs will not be too high. It is unlikely that any investment of resources will be made if there is no clear chance of benefitting directly from the investment. Land tenure arrangements currently under consideration that do not vest the farmers with title to the land and its improvements will inhibit investment for such purpose.

Operation and management of the project water system requires close supervision and collaboration by project participants. Spontaneous organization by the settlers to accomplish this task

will not occur, yet participant involvement in government and management is essential to the success of the endeavor. Consequently, plans for project management and community government must be developed in combination. Technical assistance in this area must be provided until project production goals have been reached and sustained for a period of time.

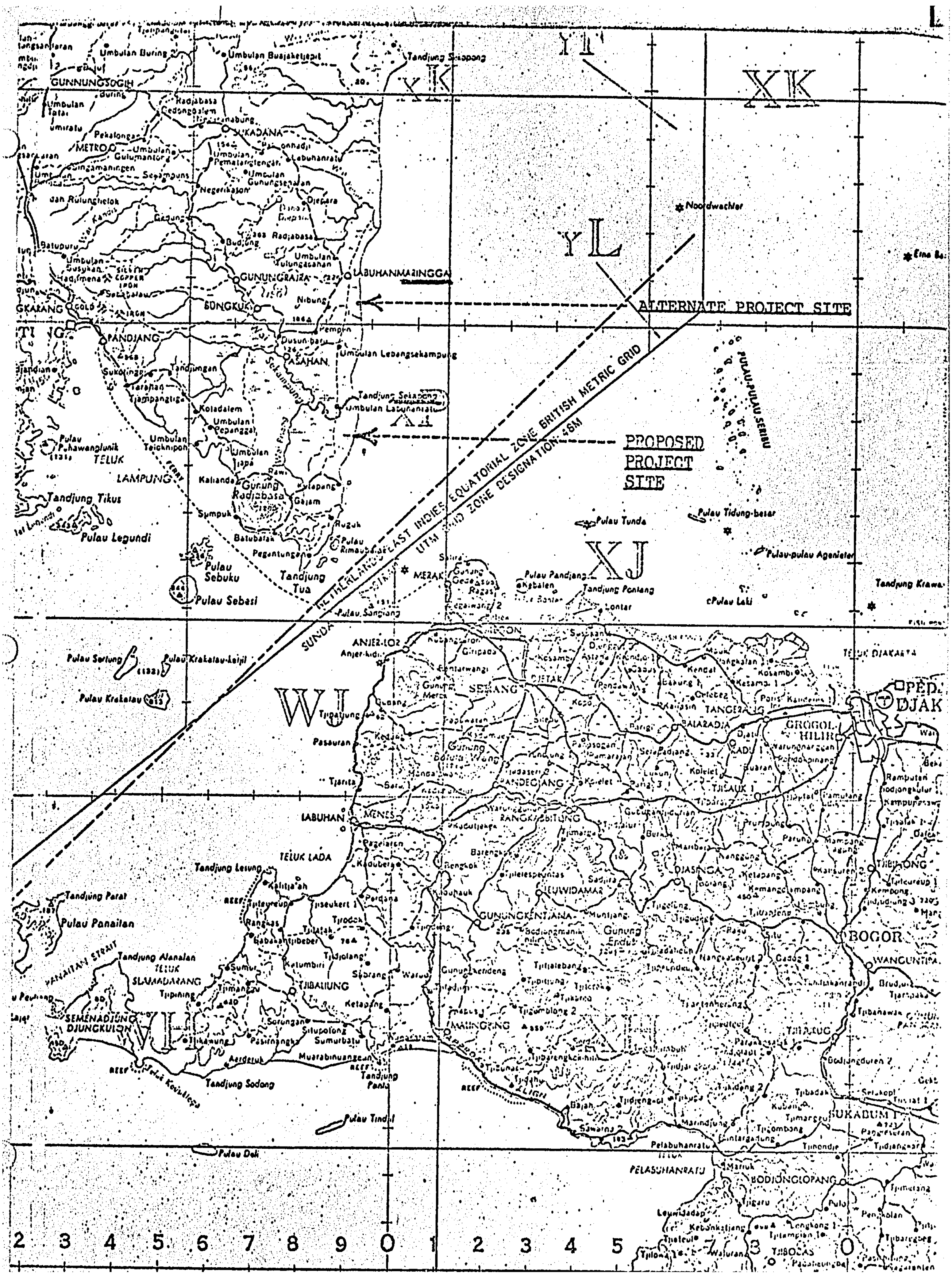
There is at least one important environmental difference between Central Java, (where participants would be recruited) and the project site in Lampung: Malaria is endemic in Lampung. Estimates of the death rate among transmigrants due to this disease run as high as fifteen percent. Permanent dehabilitation among the survivors is common.

To the extent that no effort has yet been made to involve potential participants in project planning, an excellent opportunity exists to enhance the degree and nature of the participation by transmigrant women. Participation in project development must not be limited to the project population: involvement of those already on the site is also required.

Present plans for the transmigration of tambak farmers into the project area are not sufficiently advanced to permit an accurate assessment of their adequacy. Among the possibilities discussed is amplification of the criteria for selection to assure a distribution of occupational skills within the villages to be formed. Consideration is also given to the recruitment and training of farm families rather than those with a fishing background.

Although land allocation is discussed no recommendations are made concerning the particular method to be adopted. Proposals for individual ownership and control, in this case, conflict with plans to avoid subdivision or agglomeration of landholdings. No clear solution to this dilemma is presented in the proposal. The consequences of the policy alternatives are discussed and further work on this problem is recommended.

The government of Indonesia has developed explicit criteria for the initial outfitting of farms. Only if these are augmented to include the special needs of tambak operators, and only if stringent provisions are made to guarantee the fulfillment of these criteria, will successful resettlement be facilitated.



YL
XK
ALTERNATE PROJECT SITE
PROPOSED PROJECT SITE
SUNDA NETHERLANDS EAST INDIES EQUATORIAL ZONE BRITISH METRIC GRID
UTM GRID ZONE DESIGNATION 48M
XJ
WJ
PULAU-PULAU SERIBU
LABUHANMARINGGA
METRO
SUKADANA
GUNUNGSUGIH
PANDJANG
TELUK LAMPUNG
Tandjung Tikus
Pulau Legundi
Pulau Sebuku
Pulau Sebesi
Tandjung Tua
Gunung Radjabasa
Kalianda
Pulau Sangiang
Pulau Sertung
Pulau Krakatau
Pulau Tunda
Pulau Tidung-besar
Noordwachter
MERAK
ANJER-LOR
SERANG
TANGERANG
BALARADJA
GROGOL HILIR
PANDEGLANG
RANGKASBITUNG
LABUHAN
MENES
TELUK LADA
Tandjung Lesung
Tandjung Parat
Pulau Panaitan
PANAITAN STRAIT
Tandjung Alanalan
SEMENADJUNG DJUNGKULON
TELUK SLAMADARANG
TJIBALIUNG
MALINGPING
LEUWIDAMAR
DJASINGA
GUNUNGKENTJANA
BOGOR
WANGUNTIPA
SUKABUMI
Tandjung Sodong
Pulau Tindil
Pulau Deli
PELABUHANRATU
BODJONGLOPANG
Pulau Tundjung
Pulau Laki
Pulau Panaitan
2 3 4 5 6 7 8 9 0 1 2 3 4 5 7 8 0

NARRATIVE

The materials in this section were derived from a review of the documents cited in the attached list of references, interviews with officials of USAID, relevant agencies of the Government of Indonesia at the national and local levels, interviews with tambak operators, fishermen, farmers, and community leaders in Central Java and in Sumatra, at the site of the proposed project.

A. SOCIOCULTURAL FEASIBILITY

1. Project Location:

The area provide for the project is located in Lampung Province of Sumatra. According to an estimate made in 1973, the population density of the province was about 87 people per square kilometer and 80% of the population live by subsistance farming in rural areas. These factors make the local sale of project-grown fish rather difficult, due to the general lack of money and the absence of large concentrations to facilitate marketing and distribution of a perishable project. The bulk of the Gross Regional Product for Lampung Province derives from agriculture but fishing is viewed as an important source of income yet to be developed. Only 25,000 tons of seafood was produced in all of Lampung in 1973[1]. The province has been a primary object of government efforts to encourage relocation of the Indonesia population from densely populated areas of Java to Sumatra and the outer islands ever since 1905. A net migration of approximately 600,000 was reported for the 1961 - 1971 decade.[2]

The Site originally proposed is located immediately to the south of the Sekumpung River. It is a swampy area with some low ridges of drier ground, and extends for approximately eight kilometers along the coast of the Java Sea and about one kilometer inland from the coast. The coastal strip is covered with mangrove trees, used by current residents for fire wood. Depending upon final determination of the suitability of the site for the creation of brackish water fish ponds, the area included may extend up to four kilometers further inland along its entire length. A similar area, north of the river, is under consideration as an alternative site should be original selection prove unfeasible.

Estimates of the population currently living in this area vary. Observations made in an excursion up the Sekumpung River, short walks along the river banks and interviews with community leaders and local residents suggest at least 5000 residents are currently settled in the village of Way Sekumpung, Blukang, Umbulan Labuhan Ratu, and along the banks of the river for a distance of seven kilometers from the river's mouth. Examination of aerial photographs and observations made during a low altitude reconnaissance flight indicates additional settlement patterns exist throughout the proposed project area. Agricultural activities of several kinds can be observed in the area in addition to fishing, and preliminary attempts at tambak culture are being conducted in Way Sekampung, Blukang, and Maringgai.

Agricultural activities include forestry, coconut palm, sugar, cassava, and rice culture. Some small livestock was also observed although crocodiles tend to reduce this kind of activity in the less densly populated areas. Subsistence farming and barter constitute the major forms of local economic activity but there is enough evidence of manufactured goods, such as boat motors, fishing net floats, sawmill lumber, and portable radios, to suggest there is also a fair commerce with outside areas.

The provincial Department of Fisheries is constructing a demonstration tambak at Way Sekampung. Some of the village residents, including the village leader, have undertaken to profit from this example and have begun construction of their own ponds next to their residences. None of these efforts is functioning, however, and at least one potential pond is being converted to coconut culture. Land preparation is difficult work and is taking a long time. It appears that some difficulty is being encountered in filling the existing ponds with salt water. No tambak culture was observed to be producing milkfish in the project area although fishing by various methods, including gill nettings, trapping, and ocean techniques, is weidely practiced. The only functioning tambak actually observed had been stocked by tidal inflow and a sample drawn from the pond contained no milkfish.

2. Project Population

Most of the people observed along the river banks live in villages of 30 to 150 families. They have small gardens by their homes although they may live a short walk or boat ride from their coconut plantations of forestry activities. Those villages at the river mouth are populated almost exclusively by fisherfolk, and more than a dozen fishing boats were in evidence during a visit to the site.

The residents questioned indicated that the population in the immediate project areas was made up almost entirely of "spontaneous", (unassisted) migrants from Java and Kalimantan. Lampungese were not in evidence in this frontier area, and the settlers encountered communicated easily in Bahasa Indonesian. The predominant religion of the area is Moslem.

No one encountered held formal title to the land he occupied, yet the residents were obviously working extremely hard to clear property, erect structures, cultivate crops and improve fishing catches.

More precise information about the characteristics of the population currently dwelling in the area proposed for this project was solicited from the Director General of Fisheries (see Appendix A). The request was later modified to include data from the North side of the river as well. These data had not yet been made available at the time of writing this report.

Casual conversations with native Lampungese residing in the capital city of Tanjungkarang revealed some latent hostility toward the steady stream of migrants from other parts of the archipelago. Further inquiries with the author of a study of transmigration project on the Abung River in Sumatra suggested the possibility of conflict emerging in the future as the effect of the migrant population becomes clearer in the competition for available resources.[3] A village leader in Way Sekampung viewed the project with favor if it meant possible participation of present residents in the anticipated benefits, but expressed some reservations about the likelihood of full incorporation of present residents in the planned development. No formal planning for such involvement has been articulated in the project proposal in its present form.

Interviews with officials of the Transmigration agency located in that area of Central Java mentioned as a potential source for recruiting transmigrant families revealed no prior experience in recruitment or transfer of fishermen or tambak farmers. It was stated however, that the agency felt no difficulty would be encountered in locating 1,000 - 2,000 families that would be interested in resettlement.

These same officials stressed the importance, (if such a project is undertaken) of involving the recruited families in some of the planning process - at least at the level of sending community leaders to the site for an on-the-spot inspection prior to the move. Reliance solely on the reports by Transmigration personnel on the living conditions to be expected for the new settlers has been found to be slightly misleading on past occasions. This has lead to a rate of voluntary return migration exceeding fifty percent on some projects.

The problem of overcrowding is recognized by residents of existing tambak areas. Since local custom requires division of an estate among all the children in the family, tambak holdings in areas where expansion is not possible quickly become too small to be viable.

Some children are then forced off the land (pond) although they are not necessarily forced to leave the village. These family members may augment the family income by ocean fishing, by working as laborers, or engaging in cottage industries.

The family is the fundamental unit of social organization in Central Java and claims the primary loyalties of most individuals. Families may be quite extensive and include a fair percentage of a village. Marked disparities in life styles within a village are difficult to sustain in such circumstances and changes that tend to produce disparities are viewed with less favor than those that improve the general conditions for all family members.

There are three groups to be considered when assessing the benefits that are likely to accrue from this project. Those who move to the frontier area, those already settled there, and those left behind in the move. It is not clear that the removal of 1,200 families from crowded areas in Central Java will have much impact at all on those left behind. The arrival of 1,200 families in Sumatra, however, will have a profound effect on the current settlers in that area.

Assuming that any settlers currently occupying land that will be used by the project will be few in number and satisfactorily compensated for their displacement, at least two kinds of impacts on the remaining settlers can be identified. First, it is very likely that the opportunity for employment as laborers in the project construction will augment local incomes and, in general, the local economy should benefit from the rapid growth in population. Unless some effort is made to include the local residents in the development in some planned way, however, there is a strong likelihood of creating some rather marked inequities. If the income from fish farming is substantially higher than that obtained prior to migration, it will probably exceed that of the "spontaneous" migrants by a significant amount. This would have the consequence of placing those families who had migrated using their own resources at a disadvantage compared with those who relied on government assistance. An effort to obtain information regarding the plans of the Transmigration authority regarding this problem has not produced any documentation as of this writing.

The University of Indonesia is currently involved in a project in cooperation with the local government of Kabupaten Tangerang (a fish pond area near Jakarta) to promote local development. Overcrowding is seen as a major problem there, but outmigration is not seen as a desirable solution to any large degree. No recommendation from this project are available as yet, but they should prove to be of some utility as the existing rate of population increase in

Lampung Province suggests that the population in the project area will be at least twice as large as current plans allow for within a very short time. It will double by natural increase alone in less than thirty years.

Plans to deal with the emergent problem of overcrowding are not yet well specified for this project. At the very least, however, it is thought to expand the tambak activity all along those areas of the Sumatra coast suitable for this type of activity. No reliable estimate of the extent of such areas is currently available, although it may not be as extensive as originally thought.

The Director General of Fisheries stressed the importance of taking steps to avoid recreating the situation (of many small pond holdings) the project is being undertaken to relieve. As an important step in this direction, he has suggested that the Government of Indonesia retain partial or full title to the land.[4] This device would prevent undesired subdivisions or accumulations.

It should be noted that the adoption of this suggestion would successfully limit the number of people entitled to operate a fishpond, and keep the size of the fishponds constant. This limitation would, presumably, provide some incentive for further expansion into nearby undeveloped areas. It is not clear, however, how this pattern of land tenure would affect those offspring unwilling (or unable) to carry on the development of new lands; it seems likely that they would be forced into the labor market. Since only about 36 percent of the available manpower in Lampung in 1973 was reported as "employed", the efect of making further additions to the labor force should be carefully considered.[5] Being forced from the land is likely to increase migration to urban areas.

3. Project Organization

No specific mechanism for involvement of the target population in the processes of problem identification and solution has been proposed for this project, but the administrative structure suggested for managing the technical aspects of tambak operation might be expected to do so. It should be noted, however, that this is a technical-administrative organization and not a representational one.

In the past, an "informal" leadership pattern has emerged among resettled populations and this has articulated with a more "formal" system dependent from the central government. It is reasonable to expect a similar system will emerge here, but no provision has been made for articulation of the leadership structure with the managerial structure. Failure to do so may lead to some conflict at later stages when managerial and social priorities are not in accord.

Some mechanism is required for the rational resolution of such conflicts. This kind of problem is indicative of the novel organizational difficulties associated with this project; many of the contemplated activities are without precedent within the Directorate General of Fisheries.

a. Organization of the Project

Either the Directorate General of Fisheries, or the Directorate General of Transmigration, both of which are headquartered in Jakarta, will be responsible for the development of the proposed program. The final choice for project responsibility has yet to be made. The provincial branch of the chosen Directorate General would be given instruction from Jakarta regarding what was to be done, in what location and when it was to be done. The Provincial office then would have the responsibility of designing and implementing the necessary arrangements to accomplish these goals.

This project requires close collaboration with several other agencies, including Rural Development, Forestry, Education, Health, and Public Works. Collaboration is required not only for its initialization, but for continued operation as well. While a general agency exists for facilitating such coordination (BAPPEDA), preliminary indicators suggest they are not yet involved in this project to the degree necessary for its success. The level of involvement of collaborating departments, such as Transmigration, Public Works, Health, Education and Forestry also appeared to be too slight, at this stage, to auger well for success.[6]

The current state of project planning shows careful attention to the construction of the project but lacks an adequate treatment of the problems associated with project operation, population growth and social change. There is no provision for natural growth within the project, although the entire project is seen as replicable.

The rudimentary settlement plan calls for the creation of ten villages of 120 families each. This is to be done sequentially as the physical facilities (such as housing and water supply) are completed. Planning for these villages should take into account that the actual number of individuals likely to be involved in any move sponsored by the transmigration authority will exceed the number of individuals being directly supported by the agency. There may be as many as double the sponsored number and village planning should take this into account to avoid creating undesirable living conditions at the very start of the program. This planning should include the provision of all tools and implements necessary for tambak developments, household construction and small scale agricultural activities.

Enough food should be provided to support the actual number of people living on the site until the fishponds are producing at their targeted level to avoid the need for settlers to devote their time to subsistence farming instead of tambak operation.

At least four villages of 120 families would have to be constructed to provide the minimum unit considered to be a village from the perspective of Transmigration. Thus it is important to plan to construct the primary school, clinic, warehouse, village meeting place, religious structure, marketplace, administrative service center and roads for the first 120 families to be settled and locate later village sites accordingly. The market areas will require planning and, initially, some subsidy, due to lack of cash in the local economy, and the low opportunity for entrepreneurial activity among project participants.

In considering the layout and design of individual housing units, at least ¼ hectare homelots should be provided, according to the statements of Transmigration officials in Jakarta and Semarang. Some additional land should be provided for agricultural development as well as work animals, hand tools and seed. Part of this additional land might be used for support of the work animals, of cows and other domestic livestock.

A schedule should be developed to assure that the rate of transmigration does not exceed the absoring capacity of the infrastructure. This schedule should include objectively verifiable indicators of adequate functioning of social organizations as well as physical facilities. Thus migration should not begin until public health facilities are constructed and the staff on site, for example. Succeeding units of migration should not be undertaken until neighborhood associations, and mutual assistance associations have been formed.

The entire sequence of social development should be as closely programed and monitored as the physical development program. This development program should include formal incorporation of present residents - as well as potential transmigrants - in the project planning process. This involvement should extend upward through informal local community leaders as well as downward from the provincial government.

b. Organization in the Project

Although potential transmigrants are likely to be highly familiar with a system of production tied to a cash economy, they will be unfamiliar with the high degree of coordination required for the operation of the project as planned. They will bring only a rudimentary form of social organization with them and will have to rely on the emergence of an autochtonous one after arrival. The provincial government structure will extend downward to the village level and it is often (though not always) the case that community leadership and government authority are vested in the same individuals.

The conventional structure of government is to be supplemented in this project by a "Community Management Organization", (CMO), responsible for coordinating all activities required for the successful operation of the fish farming industry. No precedent for such an organization has been observed locally. There is a well developed tradition of demonstration stations, intensification agents and voluntary associations of farmers (i.e. the local government) but existing cooperatives of fisherman and fish farmers are not viewed as providing a promising model for local governments.[7] The manner of gaining voluntary compliance with the unusual and unfamiliar technical demands of the large-scale fish farming activity as promulgated by the CMO is not clear and no mechanism is envisioned for resolving any conflicts that might emerge between social and economic priorities.

The above situation might be alleviated by making the technical experts of the CMO municipal employees with training, certification and a base salary provided by the Department of Fisheries and incentives provided by local productivity. A new model for mobility would thus be created whereby local technical experts become employed at the local level. By subordinating the CMO to the village government structure the fundamental problem of community participation in planning for change may also be addressed; in particular the problems of subdivision and land tenure, inheritance patterns and aggregation of land holdings.

Although uncommon in Central Java and Lampung, land holdings in North Sumatra are by certificate and (at least in Aceh), where community land holdings (adat) are the rule, land use is by letter of use. Such letters are reported as being acceptable to banks for collateral purposes, and by the land users as well.[8] Tambak operators in this system are subject to expropriation of their ponds but compensated for surface improvements. A similar system might be considered for the Way Sekampung Project.

In any event, some disruption of present patterns of social organization is seen as a consequence of the project both for existing settlers and potential transmigrants.

4. Allocation of Time

Participants in this project are seen as being entirely in the cash economy with a primary responsibility to their fishponds. With the exception of home gardens, they will not be in the subsistence agriculture society, although all the surrounding countryside is. Full time devoted to fish farming is seen as sufficient to produce an income for the pond operators greater than could be obtained by other locally available means.

The plan to employ the transmigrant settlers in the early phases of development (including the clearing and preparation of land and building of canals, dikes, roads and houses) would involve quite a different allocation of time and the phasing of this activity must be given careful attention. If an initial module of one hundred hectares is considered, for example, only 40 men would be potentially available for all construction tasks if the entire labor force were to be drawn from the transmigrants themselves. It is unlikely, even with an augmented labor force, that full production from the fishponds could be expected before a period of from 3-5 years had elapsed after the start of construction. Some provision for "temporary" housing and feeding of families during the development period is required and the budgeted allotment of $800 does not appear to be adequate for the task.

Once the project has reached a stable state of operation, the forty families within each 100-hectare section can be expected to help one another in activities such as harvesting of fish, an activity that might take place approximately every four or five days throughout the year if the most sophisticated management is employed and two crops are harvested. If high levels of planned coordination are not reached it is likely that most harvesting will be done within two seasons of about one month each.

If the dikes and gates are well constructed initially, and care is taken in the preparation and stocking of the fishponds, relatively little time will need to be spent on pond maintenance and sorting of undesirable fish. However, a great deal of time will be required in getting the fish to any large market, such as the provincial capital of Tanjungkarang or to Jakarta.

If the farmers are required to sell locally to middlemen who bring in supplies and take out fish, a great deal of "leisure" time will be available for other activities including both subsistance and cash crop farming, ocean fishing, participation in community government, construction of buildings and boats, clearing and developing new lands or preserving fish for market.

Although land tenure and some other aspects of social life in Western Sumatra are organized in a matrilineal fashion, and women there do play an important part in the wholesale marketing system, this pattern is not readily visible in Lampung. Casual observation of settlers in the target area suggests the general shortage of labor provides an opportunity for women to expand their traditional economic participation into areas outside the traditional ones of household, maintenance of fish nets, household gardening, agricultural labor and catching fish fry. Should a fish processing activity be established, additional opportunities for wage labor might be presented.

Most village government and social life takes place in public meeting areas such as the mosque, local store or coffee shop. Since the religious infrastructure - which tends to exclude women from participation - may be slow to develop in a new settlement, the opportunities for women to participate in local decision making may be enhanced. At least one woman in the general area of the project is reported to be functioning as an informal village leader.[5)]

5. <u>Motivation</u>

Systematic information regarding the motives of potential transmigrants is not available. Resettlement of families from the more densly populated areas of Java to the outer islands is clearly stated as an element of national policy that merits a Directorate General devoted exclusively to this task. Interviews with the Director of the Transmigration office in Semarang (presumably the target area for recruitment of potential transmigrants) revealed no precedent for the relocation of fishermen or tambak farmers. Since the project assumes potential settlers will already have some familiarity with tambak operations, it is assumed that recruits will come from the landless, those with tambak holdings too small to support their families, (see Section VI, part H of Appendix B for the suggestions of S.V. Bersamin on this matter), and those unsuccessful or generally frustrated with their surroundings. It is hoped the project would attract the most dynamic, entrepenurial and innovative sectors of this population, the "pull" to Lampung should be strongest for the most innovative, and with the most to gain, the "push" to leave existing areas will be felt most strongly by those least successful there.

It is not obvious that moving from areas with a well developed infrastructure to one lacking the most rudimentary services will appeal to all sectors of the community. The project must provide the opportunity for obtaining title to lands, the chance to obtain lands for children, access to ocean fishing activities for surplus labor, availability of foodstuffs for purchase and, in general, a promise of a better life within a forseeable time period. Total reliance on the project activities, as proposed, will not accomplish that end. At first, it would appear, only those at the very bottom of the social structure in the target recruiting areas are likely to see the move as a chance for betterment. It is unlikely, however, that this sector of the population will be suited for the technical demands of the project's operation without intensive training and extensive technical assistance.

6. Minimum Participator Profiles

The project design calls for a series of ten transmigrations. It anticipates that the new technology and attendant coordination of activities will be quickly adopted in order that the full productive potential of the project might be realized. In order to facilitate this adoption, it has been assumed that some familiarity with tambak practice will constitute a precondition for recruitment of potential transmigrants. However Transmigration officials in Semarang claim no experience to date in recruiting fishermen or fishfarmers. Transmigration in Jakarta would like to recruit from this general area but report the people there are not eager to leave since "they feel they have enough with open sea fishing".[10)] Getting experienced tambak farmers may thus prove difficult. Provision for intensive training in the new technology - including its organizational as well as manual aspects - must therefore be provided at the earliest possible moment.

As an alternative, recruitment of farmers quite removed from the fishing and tambak tradition might be considered. Cooperative instituitions seem to be well developed among local farmers making the problems associated with land tenure and water management somewhat more tractable. By recruiting those unfamiliar with the old tambak technology, the new technology can be tought in its entirity, without conflict.

The construction and development phases of the project, as currently envisioned, do not provide for much training. If it is provided during construction, construction time will be slowed and demonstration ponds will be missing. If it is provided after construction, at least five months is required for a full cycle of demonstration; thus farmer adoption at the techniques advocated can be expected to take somewhat longer (perhaps two or three cycles) before permitting the benefits of the new technology to be clearly demonstrated.[11)] Full production potential would not be possible until a year or two, at the minimum, after the completion and initialization of pond operations. A somewhat longer period is more likely.

7. Matching Participators and the Project

At the present, Transmigration selects candidates from a pool of eligble families without regard to the composition of the resulting new communities. Mr. Margono (Chief of Transmigration in Semarang) stated in an interview that necessary skills must be formed on the site, probably within a few years, since Transmigration does not select on this basis.[12] At the very least an inventory of skills and occupation present among candidates, such as teachers, religious leaders, barbers, carpenters, entertainers, midwives, health practitioners, storekeepers, coffeeshop proprietors, etc., should be undertaken and an effort made to select from eligibles in a way that fills community needs as well as the needs generated solely by consideration of tambak activities.

The eligibility criteria employed by Transmigration emphasises the selection of younger (20-40 years) heads of household, without infants (less than one year) or aged (over 60).

Support is provided to move only five family members, suggesting a greater tendency to pick younger families without many dependents or richer families that can afford to support the move of additional dependents themselves. In either case, there is a higher potential for rapid population growth on the new site than present plans take into account.

No provision has been made for a family planning adjunct to this project and without it, and a definite population policy, the project is likely to be required to support many more individuals - even at the start - than has been planned for.

The population of the project area will certainly be at least double the planned size within 10 years of initial settlement, if not immediately! Given the risks of frontier life and the need for an extended family to provide vital services - including old age security - the pressures for procreation will be even larger than in the original setting, where most of the families were left behind.

The minimum requirements for the project as planned constitute a family unit - not an individual - capable of learning about and adopting to an entirely new style of fish farming. These families must be capable of constructing a new social infrastructure as they develop their homesteads. They must be healthy, innovative and adoptive with a willingness to be "unconventional". They are likely to be those ready to move to urban areas anyway, but the appeal of a rural life style must outweight the call of the city for them. Those well integrated "at home" will be discouraged by the remoteness and isolation of the project. Special care must be taken in recruiting to clarify the rigors of the task and obtain committed, enthusiastic, qualified participants.

Although not presently contemplated, training might just as well take place prior to migration - successful mastery of the new skills becoming a prerequisite for the transfer. Evidence of a serious commitment to family planning might also be considered as a criterion of selection at this stage as well as mastery of appropriate public health techniques.

It is important to note that, contrary to earlier reports, the proposed project area is not entirely without inhabitants. In fact, several thousand people currently in the southern area would be directly affected by the project although not included in it. The number of inhabitants in the proposed alternative site had not been determined as of this writing. In some ways present inhabitants may benefit by an increased local market for their products, for example, and access to the improved transportation infrastructure this project will bring with it. Increased legitimacy for local requests for government assistance in areas such as health and education will also result from an argumented population. Many of the current residents are fisherfolk who would benefit from any improvements in marketing. Those who engage in tambak fishery might also profit from a local source of fingerlings.

It is clear that the project will make a large impact of the availability of fish fry in the area. This impact is likely to be negative from the point of view of the existing fisherfolk since they tend to use what they catch themselves.

Certainly the local protein supply will be improved and rice and coconut farmers in the area should find a new local market for any surplus of these products they might have.

8. <u>Obstacles</u>

No evidence was obtained of any hostility toward the project from government sources. Although there was a definite lack of awareness, involvement and planning, all agencies contracted agreed in principle that the project was a desirable one. Local residents, when asked, did not seem opposed to the idea and, indeed, sought ways to benefit from it.

A major reservation was expressed by the sponsoring agency, however, if a mechanism could not be devised that would prevent a duplication of the original condition of the migrants - i.e. no improvement - after a generation or so.[13)] The mechanism suggested revolved about state ownership of the fish ponds; this would appear to be antithetical to the project purpose.

There is some reason to believe that the risk of malaria is considerably higher in the proposed project area than in the target areas for recruitment of project participants. One motive for return migration in previous efforts to bring settlers to Sumatra has been the illness contracted by settlers in the new areas. No malaria suppression campaign or public health campaign is now planned for the project.

When a malaria suppression campaign is launched, it should include present residents of the area as well as the population transmigrated expressly for this project. Funds for such a campaign have yet to be identified.

In addition to malaria suppression and public health training in sanitary waste disposal and the maintenance of adequate drinking water supplies, the project requires a family planning program in order to avoid too rapid a growth in its population. Given the importance of children within the local culture, some obstacles might be encountered in this area.

The market for the milkfish to be produced appears problematic at the time of this writing. The local population is rural and difficult to reach from the project site. The Jakarta market is some distance away and might require icing the fish, but "generally, the people regard iced fish as something that is not fresh and whose good eating qualities have been altered... In fact, iced fish is not salable in certain regions of the country."14)

9. Communication Strategies

The organizational technology of tambak culture upon which this project is based has no precedent in Indonesia. The research and demonstration facilities maintained by the Department of Fisheries in Jepara are sixty percent the size of the smallest module contemplated for construction. The proposed project, in its entirety, is fifty times the size of the Jepara facility. The managerial complexities associated with an activity of this size are considerable and it is not clear they can be dealt with, de novo, without prior planning and instruction.

Identification, recruitment and training of the managerial cadre should be undertaken sufficiently in advance of project completion to permit their availability prior to the first efforts at fish cultivation. A structure, such as a farmer training program, "model" fish farms and farmers, and an information feedback device must be created. Some thought should be given to providing a channel for social mobility by training farmers to become "experts". Early participants could gain status and recognition by providing information to later migrants and, eventually, to other tambak operators, should the project be replicated. An effort should be made to begin this activity at the project participant recruitment stage. This would require close collaboration between fisheries, Transmigration and the officials of the Agricultural Extension and Training Agency.

It might also be an opportune moment to involve the University of Indonesia Institute of Community Development in an effort to create a long term socially responsive feedback mechanism for the identification of emergent problems. This community planning, as an adjunct to rural development, would be of general benefit as well as providing the potential for instruction, as needed, to deal with the problems of the new life style imagined by this project. Instruction in public health as well as fertilizing, in family planning as well as marketing, in community organization as well as water management.

B. SPREAD EFFECTS: THE DIFFUSION OF INNOVATION

The lands to the north of the Sekampung River are similar to the proposed site and, as the proposed site may not actually be feasible, are being considered as an alternative. The project envisions a series of replications extending northward and this is the most explicit process of diffusion that is planned, yet it is likely that there will be diffusion of project innovations in other ways as well.

There are two kinds of innovation incorporated in this project: technical and organizational. Project participants must employ a collection of techniques that are highly developed in Taiwan and the Philippines in order to arrive at targeted levels of milkfish production. Although each of these techniques is known in Indonesia and, indeed, the entire complex is employed in some government demonstration ponds, their practice is not widespread.[16] This project will provide by far the largest and most advanced effort to incorporate state-of-the-art technology in Indonesian tambak activities. Crucial to its success will be establishment of stable sources of supply for milkfish fry and a guaranteed availability of fertilizer for aquacultural use. These two effects alone would have a profound impact on increasing the production of milkfish throughout Indonesia, but the entire effort will serve as a model for other tambak operators to emulate.

The proposed project is of such magnitude that the very coordination of its activities requires the development of innovative organizational forms. Once developed and in practice, they can be reproduced to serve the coordinative and managerial needs of many activities in addition to those associated with tambak culture. At this stage, however, the detailed design of the requisite organizations has yet to be developed.[17)]

An important step toward successful realization of this project will require concerted efforts in the areas of fish pond management, marketing, public health, education, and family planning. In order to reduce the risk project participants will incur by moving into a region known to harbor malaria, a general campaign for control of the disease vector in the project area should be undertaken. Since there are already several thousand residents of this region, they should also benefit directly from such a campaign, if it is not confined merely to the distribution of medicine to project participants. In a similar fashion, any efforts directed at health education and family planning will, almost certainly, spread to nearby residents.

Some form of population control is essential if the project participants are to avoid recreation of the overcrowded conditions of Central Java within a generation. To the extent a successful program is developed, it could certainly serve as a model for other areas. It should be recalled, however, that there are strong forces working against any such program undertaken in a rural Muslim area, such as the project site. Institution of a commitment to family planning as a condition of participation, if enacted, would provide an important precedent for other transmigration projects.

While aspects of the innovations represented in this project might be taken over piecemeal in other areas of Indonesian life, it will be difficult to achieve the targeted levels of fish production elesewhere without replicating the project in its entirety; and there are limits to the amount of land currently suitable for such an activity.

1. <u>Leadership and Authority</u>

Since specific areas for diffusion have not been targeted, no effort has been made to identify the opinion leaders through which diffusion might take place. It is intended that project participants will be trained in the new technology by experts from the Department of Fisheries. It is certainly plausible, however, that successive cadres from Fisheries might also be trained on the project. The opportunity to participate in large scale, intensive, highly rationalized activities of the type envisioned might prove useful to community change agents from a variety of fields.

Despite the plans for exposing project participants to the technology of fish farming, formidable problems remain associated with its adoption. The community of settlers will be a new community. Its informal leaders will not emerge immediately and no mechanism exists to identify potential leaders and assure their articulation with the technical aspects of the project.

If it is decided to involve the University of Indonesia's Community Development Program in the project, the opportunities for an integrated, multisector impact would be enchanced.[18)]

Once again, it is worth considering the idea of recruiting farm families totally unfamiliar with the technique and lifestyle of tambak operators. This would profoundly alter the structure of interdependency whereby fishermen are in debt to boat owners (who market the catch) who are, in turn, in debt to money lenders. While this system provides security to the fisherman during periods where the catch is poor it inhibits vertical mobility.

An integrated program of preparation and training prior to the move to Lampung would also allow identification of emergent informal leaders - as well as spread of the tambak technology to non-participants at the training site. Those who remained behind would still benefit from the training program in tambak operation and in other areas as well. If public health, community, organization, and family planning activities are part of the pre-migration program, mounted on a fairly large scale and employed as part of the participant selection program, the benefits will be spread even further. This would also provide opportunities to reinforce modernizing tendencies within the established leadership structure remaining behind.

Once on the site, caution must be exercised to assure that those identified as opinion leaders in the technical areas of project operation are given the support necessary for them to perform their functions. In particular, their fry and fertilizer supplies must be guaranteed.[19)] Since the aquaculture practices of the project participants are likely to be very different from those of the fisherfolk currently occupying the general area, it is important that the project participants be reassured of the wisdom of the risk they are taking. They must have demonstrably higher yields from the start.

Devices to reduce the potential for hostility toward the project deriving from the exclusion of present residents of the project area should be sought by cooptation of the resident elite. This might be done by taking steps to include them in project planning, participant recruitment, and training activities. The spread of public health and local government innovations would also be enhanced by this procedure.

Finally, involvement of provincial government leaders should be encouraged from the earliest stages. As stated earlier, there is not much evidence, as of this writing, that such involvement has taken place.

2. Patterns of Mobility

Tambak cultivation has a seasonal quality. Fry are available, ponds are stocked, and fish are harvested twice a year, at most; slack periods are usually occupied by ocean fishing activities. The products are usually marketed to wholesalers who come to the fishing village. Travel outside, at least for subsistance farmers and fisherfolk of the Way Sekampung region, is rather limited, and tends to be along the river itself. Outside vendors sell their wares from boats that ply the river. Health facilities and educational resources (as well as fresh drinking water) must be obtained several kilometers up river from the proposed settlement area, or inland from Marenggai.

There are demonstration fish ponds under construction at Way Sekampung and at Marenggai. Fishery experts will, presumably, be resident at or near the site. The provincial office is several arduous hours away by car, however, and no telephone communication exists at the moment. Visits to the site by regional officials can be expected to be infrequent. Once initial training activities have been completed, there is no easy way to keep continuous monitoring of the application of the new technology of fishfarming without a resident staff - or a steady commute from provincial headquarters.

As noted earlier, if care is taken in design of the technical-managerial organization required for the every day operation of the fishponds, new avenues of vertical mobility can be created for project participants. They can, themselves, become extension agents or model fishfarmers. Since there is, as yet, no tambak activity in Indonesia approaching the levels of production anticipated for this project, successful participants in this program may well come into demand as "people's consultants".

3. Previous Project Design and Execution

The Department of Fisheries of Indonesia maintains a large (35 hectares) research facility at Jepara , developed with the aid of the UNDP, and demonstration ponds throughout Indonesia. As of this writing, none of these is currently producing at a level exceeding one half the level of production forecast for this project. No evidence was readily available regarding the degree to which the techniques illustrated by these facilities are being taken over by local tambak operators. It should be noted, also, that the Jepara facility is currently installing a 53-horsepower diesel engine to power a pump required to fill and drain its ponds, and it is unlikely that many local operators could copy this kind of innovation. The highest production in Indonesia is to be found in Aceh, Sumatra, and parts of Sulawesi where yields begin to approximate targeted figures. It should be noted that these are also areas with tidal fluctuations two to three times as large as those found in the project area.

4. Maximum Information and Resource Distances

The primary product to spread from this project is knowledge about methods of intensive aquaculture. It is likely to spread via the Department of Fisheries' own program of demonstration ponds and extension agents. Perhaps most important will be legitimation of fertilizer use by fishfarmers, and a consequent freeing up of this vital ingredient for their use. The demand for fry will, presumably, intensify efforts to locate and transport this crucial input in a manner more efficient and reliable than currently practiced. The interaction of fry suppliers and project participants should facilitate the flow outward of project technology.

To the extent a successful managerial structure can be articulated with that of community government, a new type of social arrangement will have been created. This synthesis could provide a basis for modernizing many aspects of agricultural production in Indonesia.

Even if ten percent of the target population adopts all elements of the new technology in the first two years, and fifty percent adopts them within four years, fish production for the project would not begin to approach targeted levels until well past the time that the population that is supposed to be supported by the project will have far exceeded the targeted level.[20] Nevertheless, it can be expected that specific innovations will also be adopted by those few spontaneous migrants already practicing tambak culture in the area and at least some of the innovations are likely to be carried along with any of the transmigrants withdrawing from the project. Of course most, if not all, of the project innovations will be carried away by the offspring of transmigrants reared on the project site but forced to move away due to the proposed indivisibility of pond holdings. Should they become fisherfolk, as many of their neighbors now are, they may well introduce some of the organizational forms developed by the project into the maritime culture where, as of now, they appear to be absent.

C. SOCIAL CONSEQUENCES AND BENEFIT INCIDENCE

1. Access to Resources and Opportunities

The project is intended to help landless Javanese. It will provide an opportunity to move to an undeveloped area on Sumatra and to operate a fish farming enterprise that will provide a family income far in excess of what they now realize. Younger, smaller families are more likely to be chosen to participate. The number of families to be involved (1,200) is not large enough to have any deleterious effects on the economy of Central Java caused by their removal. Their arrival in the project area, however, will add substantially to the local population.

2. Employment

Even before the project families move to the Way Sekampung area, a noticable impact from the project will be detectable. The labor force required for project construction will number several thousand, at the least, and will live in the area for a minimum of two years prior to full scale tambak operations. If this force is recruited locally, it will provide a sharp increase in local income for the duration of the project construction phase. It is not clear just what would happen to this cash flow upon completion of the project, but it is likely to cease. If the construction force is recruited from elsewhere, they will provide a new market for local products and, presumably, will raise the prices for all goods in the project area. Whether this new market will be large enough to stimulate increased trade with areas outside the project, however, is certainly open to question. It is likely that at least some of the construction force, or its supply system, will also remain in the area after the project's completion.

Although the exact site of the project had not been determined at the time of this writing two areas were being seriously considered. Should the original area south of the Sekampung River be chosen, it would certainly limit the possibilities of agricultural expansion for any of the settlers currently in the area, but it would also open up road access to this population which is now quite isolated.

Once operational, the project will provide employment for tambak operators, fry catchers, fish transporters, and associated marketing personnel. Schools, clinics, roads, and other elements of the project infrastructure could serve the larger population of the area as well if plans to do so were incorporated in the project design phase.

D. CHANGES IN POWER AND PARTICIPATION

Project demands for fertilizer should benefit other fish farmers in their quest for this relatively scarce input that is primarily reserved for rice farmers. It will, however, compete with local rice farmers for the fertilizer that is available.

The product itself will probably raise the level of protein in the diets of the tambak operators and, if these were previously farmers, the increase may be very substantial. Milkfish is, perhaps, the most expensive fish marketed locally. Unless there is an unanticipated break in the price structure, or a profound change in the market, the project is most likely to serve the nutritional needs of the less poor sectors of the urban population of Jakarta.

In any event, as currently envisioned, the project bypasses the conventional structure for venture capital and, as such, is likely to be viewed with indifference (at best) by those excluded from profiting from the new development. To the extent these sectors are intimately connected to the marketing mechanism, as suggested by Emmerson, some difficulty may be encountered in marketing the final product.[21]

FOOTNOTES

1. Lampung in Brief by the Regional Planning Department, Provincial Government of Lampung, 1974, p.6.

2. Op.cit. p.1

3. N.D. Abdul Hameed, FAO Rural Development Economist, in private conversation.

4. Meeting at Directorate General of Fisheries, Monday, 28 June 1976.

5. Lampung in Brief op.cit. p.15

6. No indications of the project appear in any of the proposed budgets for the next two years; provincial officials had no copies of the proposal - although they had received them; the principal Provincial official responsible for legitimizing inter-departmental collaboration and authorizing expenditures was unavailable to the feasibility team; initial understandings regarding the degree of participation of agencies outside of fisheries appeared to be in error.

7. E.G. Walters, in private conversation.

8. Feasibility study for Aceh Project, p.39.

9. E.G. Walters, in private conversation.

10. Interview with Mr. Margono, Transmigrasi, Semarang 25 June.

11. See: Tomoo Hattori, "Agriculture of Six Villages in Central Thailand and Central Java" in Southeast Asian Studies. Vol. XII, No.3, November 1974.

12. Semarang, 25 June.

13. Interview with Admiral Surdjono, Director General of Fisheries, 28 June.

14. Bersamin, Report by the Agriculture Specialist to the Appraisal Mission and Fisheries Project Supervision Mission in Indonesia (September, 1975) p.I-18

15. Bersamin, op.cit. p.I-12

16. Some idea of the difficulty to be anticipated in achieving project production goals of 2,000 kg per hectare per year may be gained from the "Report by the Aquaculture Specialist to the Appraisal Mission and Fisheries Project Supervision Mission to Indonesia" (September, 1975) where Dr. S.V. Bersamin notes, "The target for the fisheries fishpond sub-project is to at least double the annual production to about 700 to 800 kg per hectare during the first few years. This is a realistic goal considering the many problems which have yet to be surmounted." (emphasis added). Section I, p.14.

17. "Experience in other countries indicates that a favorable prognosis can be projected for the fish farmers of Indonesia if everyone in the organization works for a common goal - the good of the whole organization." S.V. Bersamin, ibid p.16.

"Managing a large area via a cooperative is a new thing in Indonesia - but desirable." Slamet Prayitno, 22 June.

"If the success of the project is inextricably tied to the coop idea, it won't work" E.G. Walters, 22 June.

18. Dr. Does Sampoerno, probable director of the Institute, has expressed interest in such an involvement.

19. The availability of fry and fertilizer for agriculture is still questionable at the time of writing this report cf. Bersamin, op.cit. p.I-20.

20. This would conform to the rate of adoption of a single innovation as reported by Tomoo Hattori, op.cit.

21. "Biting the Helping Hand: Modernization and Violence in an Indonesian Fishing Village" by Donald K. Emmerson in, Land Tenure Center Newsletter Number 51, January-March 1976 pp-1-15.

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APPENDIX D

MARKETING AND ECONOMIC ANALYSIS

LAMPUNG BRACKISH WATER POND PROJECT

MARKETING and ECONOMIC ANALYSIS

Robert Manly

October 1976

CHECCHI and COMPANY
Washington, D.C.

APPENDIX D

LAMPUNG BRACKISH WATER POND PROJECT
MARKETING AND ECONOMIC ANALYSIS

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APPENDIX D

LAMPUNG BRACKISH WATER POND PROJECT MARKETING AND ECONOMIC ANALYSIS

This appendix provides an analysis of the economic feasibility of the Lampung brackish water pond project. A basic assumption of the analysis is that a site can be found which is suitable for water management by pumps. Other assumptions regarding the level of technology employed, design criteria, and project organization are based on recommendations of specialists on the study team, which included an aquaculturalist, a sociologist, a water resources engineer, and an expert in the field of tidal hydraulics. The findings and recommendations of these specialists are reported in detail in separate appendices to this report.

The first section (Section A) of the analysis examines the existing fish marketing process and price structure. Section B presents the supply (production) and demand (market) assumptions used to calculate revenue flows for the project under consideration, and discusses alternative strategies for achieving the market targets. Section C is a summary of project investment costs under varying assumptions of pond size and construction methods. The expected operating performance of the project at full production is described in Section D.

In Section E, the internal rate of return on investment (IRR) criterion is used to evaluate anticipated project benefits from the point of view of project participants, and from point of view of society as a whole. Section F introduces a methodology for measuring external benefits through the sector approach. This methodology is then used to calculate a "sector benefit rate of return" for the Lampung project.

A. The Marketing System

1. System Characteristics

The fish marketing system in Indonesia is characterized by the large number of fish varieties sold in the markets, the numerous and widely scattered fishing harbors and landing places, and the multiplicity of small fisherman units and retail outlets. The collection and distribution networks that have been developed to service this system are equally complex and differentiated. An overall fishery production of 1.4 million tons annually is handled by some 1.2 million fishermen (calculated on a full-time basis), and about twice this number of persons are engaged in collecting, financing and distributing fishery products to final consumers. The division of function and labor involved in this complex network network system may be outlined as follows:

Producers
- Marine fishermen
- Inland fishermen
- Culture pond fishermen

Agents
- Collection traders buying at their own risk
- Collection traders acting as consignment agents

Sellers at auction
- Fishermen
- Collection traders
- Wholesalers

Auctioneers
- Fishermen cooperatives
- Local administrations

Buyers at auction
- Wholesalers
- Processors

Buyers at wholesale
- Other wholesalers
- Retailers
- Processors

Buyers at retail

Transportation linkages are involved at almost every step in the system. Modes of transport include short and long distance trucking, railroads, motorized cycles, bicycles and people on foot.

Within this chain of marketing relationships and functions a most interesting and essential system of credit and management has evolved. The dispersion of fish landing places throughout Indonesia has kept the system from becoming monolithic in structure. Rather, it has grown up on the basis of personal relationships, in which each element in the chain may extend credit for the product or services rendered to the next in line. For example, a fisherman may consign his fish to his collection trader and transporter, who pass this credit on to the wholesaler, who in turn gives credit to the retailer, who may extend it to his customers. Payment, of course, is then made in the reverse order. Such a system depends on trust earned over time by not defaulting on obligations incurred.

In order to initiate or keep such a chain of credit or any part of it functioning, its participants must have either sufficient financial resources of their own, or access to the services of a moneylender(s). In the above example, the initial credit may have been extended by the boat owner or by a person willing to finance both the fisherman and the purchase of his boat and gear. In return, the lender would expect to designate the wholesaler to receive the landed fish. Wholesalers may adopt a similar managerial role by extending credit to retailers, or their wholesale operations may be financed by other money lenders. Boat owners, wholesalers and money lenders tend to act as managers for those parts of the production and marketing system to which they extend credit. In this capacity, they provide the element of system control that works to balance supply and demand.

The scale of these management operations is small. The volume of turnover among coastal urban wholesalers ranges from eighty to one thousand kilograms of fish per day. Inland urban wholesalers handle even smaller amounts, an average of about seventy kilograms per day. The working capital and/or loans involved are estimated to range from US$250 to US$4,000.

2. The Significance of the Fish Wastage Factor in the Marketing System

The market price of fish incorporates the incremental costs and profit margins of each step in the marketing system. An allowance for wastage must also be included in the market price. In its simplest form, this allowance is based on the assumption that a certain number of spoiled fish are discarded in the markets, although according to the findings of this study only a very small number of fish are wasted in this manner. More typical in Indonesia is the deterioration in quality and price of fresh fish, particularly when insufficient ice and/or refrigeration are used.

Two examples can be provided to illustrate this point. When baskets averaging about fifty kilograms of fish each are opened on the Jakarta auction floor between 2 and 5 o'clock in the morning, they are surrounded by wholesalers who hand select those fish they wish to buy at that day's auction price. The remaining fish are pushed into a pile and sold at a lower price, sometimes a third less, to a different group of wholesalers with a different clientele, or to processors who will salt the fish for sale to still another segment of the final market.

In the retail-end of the trade, there is a morning market where fresh fish from which the ice used in transport has been removed are sold at high prices. Fish that are not sold are offered at substantially lower prices in the afternoon, and at still lower prices to processors at the end of the day. In some cases, fish not sold at the end of the day are iced and held overnight in the expectation that they can be sold at higher morning prices the next day. The practice of overnight icing and then removing the ice before putting these fish on the retail display tables has given iced-fish a bad reputation among consumers. This tends to discourage distributors from supporting improvements in the 'cold-chain', which would redound to the benefit of everyone.

One way of calculating the wastage factor is illustrated below. Prices and percentages applied are derived from surveys conducted in the Jakarta market. The prices are converted from Rupiahs at the rate of 414.5 to one US Dollar.

Jakarta auction					
Selected fish sale	80% of 50 kg	=	40 kg (see retail below)		
Processor sale	20% of 50 kg	=	10 kg @ 61¢	=	$ 6.10
Jakarta retail					
Morning sale	70% of 40 kg	=	28 kg @ 157¢	=	43.96
Afternoon sale	20% of 40 kg	=	8 kg @ 126¢	=	10.08
Processor sale	10% of 40 kg	=	4 kg @ 61¢	=	2.44
					$62.58

Average price 50 kg @ $62.58= 125¢

Wastage factor calculation (1 - 125/157)100 = 20%

More extensive study of the wastage factor is needed. Particular emphasis should be placed on identifying and classifying specific causes of wastage and their relative importance, as well as on the relative costs of improvements in procedures and equipment to reduce its negative impact on prices received by fishermen.

In any marketing system, an allowance for wastage must be included in the price paid by the consumer. When wastage factors are high, prices rise accordingly, and the consumer responds by buying less fish. The result is that fishermen's incomes in the aggregate decline due to this constraint on the volume they are able to sell. As sales decline, the elements in the marketing chain work to keep down the prices paid to suppliers at each step in the process. As the initial supplier, the fisherman is most subject to this accumulative pressure and receives a proportionately lower price for his fish.

3. Price Structures

Prices are established at each node in the marketing network. Only two of these prices, however, are available for information and statistical purposes on a regular basis. These are (1) auction prices and (2) retail prices. Prices paid to agents, wholesalers, transporters and other middlemen are generally not provided to the public. They are difficult and costly to obtain, even with established sampling techniques, because of the time element involved and the many price changes that result from daily and seasonal fluctuations in supply and demand. In spite of these obstacles, intermediate prices have been calculated on the basis of data developed and related proportionately to the auction and retail prices prevailing in Lampung and Jakarta in mid-1976.

a. Lampung Price Structure

As milkfish are not marketed in Lampung Province, the estimates which follow are based on Spanish mackerel prices, which were found to be competitive with prices for milkfish in other market areas during the survey period.

The net price to the fisherman is the auction price less the cost of his boat and gear, which in the case of participants in the Lampung project would be substituted by per capita operating costs. The price to the wholesaler at the landing place is the auction price plus the cooperative or administrative fee.

	US cents/kg
Auction price	60
Less: boat and gear cost	14
Net to fishermen	46
Auction price	60
Plus: auction fee, 5%	3
Price to wholesalers	63

Between the price to the wholesaler and the retail price there are many distribution costs, including ice, transport and storage as well as labor, rent, interest and profit for both wholesaler and retailer. Finally, an estimate of the wastage factor must be included.

	US cents/kg
Price to wholesaler	63
Ice, transport and storage	6
Labor, rent, interest and profit	28
Wastage factor	11
Retail price	108

Note that the wastage factor in this case is only 10 percent of the retail price. In the example cited earlier the factor was 20 percent because of the intermediate loss when the fish were shipped from other landing places to the Jakarta auction place packed in baskets with chunks instead of flake ice. The chunks had crushed many of the fish during the transportation and the ice had melted before arrival, resulting in additional and unnecessary wastage.

b. Jakarta Price Structure

The price structure in Jakarta is examined because Jakarta is expected to be a significant market for Lampung project fish. Its large size, high retail prices, and location less than 150 kilometers by boat from Maringgai provide a highly attractive opportunity for marketing milkfish of a standardized size, in large daily volume. High volume is an important factor because it allows the fish to be packed to arrive in the best condition at low unit costs and a minimum risk of wastage. Together these advantages should offset the cost of interisland transportation and so generate for the project returns approximately equal to those realized from sales to the Lampung market.

The Jakarta price structure is more complex than that for Lampung Province because of inter-auction transactions. These transactions include purchasing, packing and transporting fish from their landing place auctions to Jakarta, where they are sorted to meet the many variations in retail tastes and demand.

The calculations of the price structure begin with the readily available auction and retail prices for milkfish in the Jakarta supply base and market during mid-1976. These prices are next used to establish gross margins for fishermen, inter-auction trade, and the Jakarta wholesale/retail margin. The margins are then broken-down according to principal functions including calculated wastage factors.

	US cents/kg
Publicly obtained prices	
Landing place auctions price	60
Jakarta auction price	87
Jakarta morning retail price	157
Functional price margins	
Fishermen price margin	60
Inter-auction margin (87¢ - 60¢)	27
Jakarta margin (157¢ - 87¢)	70
	157
Break-down of price margins	
Fishermen price margin	
Landing place auction price	60
Less: boat and gear cost	14
Net to fishermen	46

Inter-auction margin	
Landing cooperative fee	3
Packing, ice, transport, etc.	17
Wastage factor	7
Inter-auction margin	27
Jakarta margin	
Jakarta cooperative fee	4
Packing, ice, transport, etc.	8
Labor, rent, interest, profit o wholesalers and retailers	45
Wastage factor	13
Jakarta margin	70

B. Project Demand and Supply Assumptions

1. Market Targets

Milkfish (Chanos chanos) is neither marketed nor produced in Lampung Province at the present time. During the three-year period 1968-1970, however, some thirty-three metric tons of milkfish were reported to have been harvested near the project site three kilometers north of Maringgai, from thirty-five hectares of brackish water ponds developed by Dr. Abisar. Unfortunately, wave action so damaged the pond dikes, which were built too near to the sea, that the ponds had to be abandoned. 1/

The above experience is an insufficient base on which to project potential demand for milkfish in the Lampung market area. Rather, demand must be inferred from data for other areas in Indonesia where milkfish are regularly supplied and consumed. These data are shown in Exhibit D-1 below:

1/ It should be noted that the present project design includes a 'green belt' about one-half a kilometer wide between the ponds and the sea which will preserve the wet-land ecology and protect the ponds from storm and wave damage as well.

EXHIBIT D-1

MILKFISH DEMAND BY SELECTED PROVINCE [a]

Province	Population Distribution (percent)	Demand Per Capita (kgs/year)	Comment
Central Java	20.5	.28	High interisland market potential
West Java	21.5	.42	
East Java	21.9	.54	
Lampung	2.3	nil	Limited potential
Aceh	1.7	3.62	Low interisland market potential
South Sulawesi	4.4	2.70	
Other Provinces	27.7	.03	
Total	100.0	.45	

a/ Supporting population and milkfish production data are provided in Exhibit D-2 on the following page.

Lampung Province is made up of three kapubatens or districts. The population of the northern kapubaten is small, widely dispersed and too distant from the project site to constitute a good market for fresh fish from Maringgai. The southern kapubaten has a substantial population concentration in the Tanjungkarang-Telukbetung area that is served by its own large fishing harbor, with which fish being transported from 150 kilometers away are at a competitive disadvantage. The rest of the southern area has limited market potential for reasons similar to those which apply to the northern district. However, the central kabupaten is a natural market area for fresh fish from the project location.[1]

1/ The most concentrated marketing area for milkfish in Lampung Province is illustrated in Exhibit D-3. This area is served by a 138-kilometer all-weather road running from Tanjungkarang on Lampung Bay through the city of Metro and on to the large village of Maringgai on the east coast of the province. About 580,000 people live close to this route. Eight small village fish markets were visited on the road, and the information obtained has been taken into account in the preparation of this marketing report.

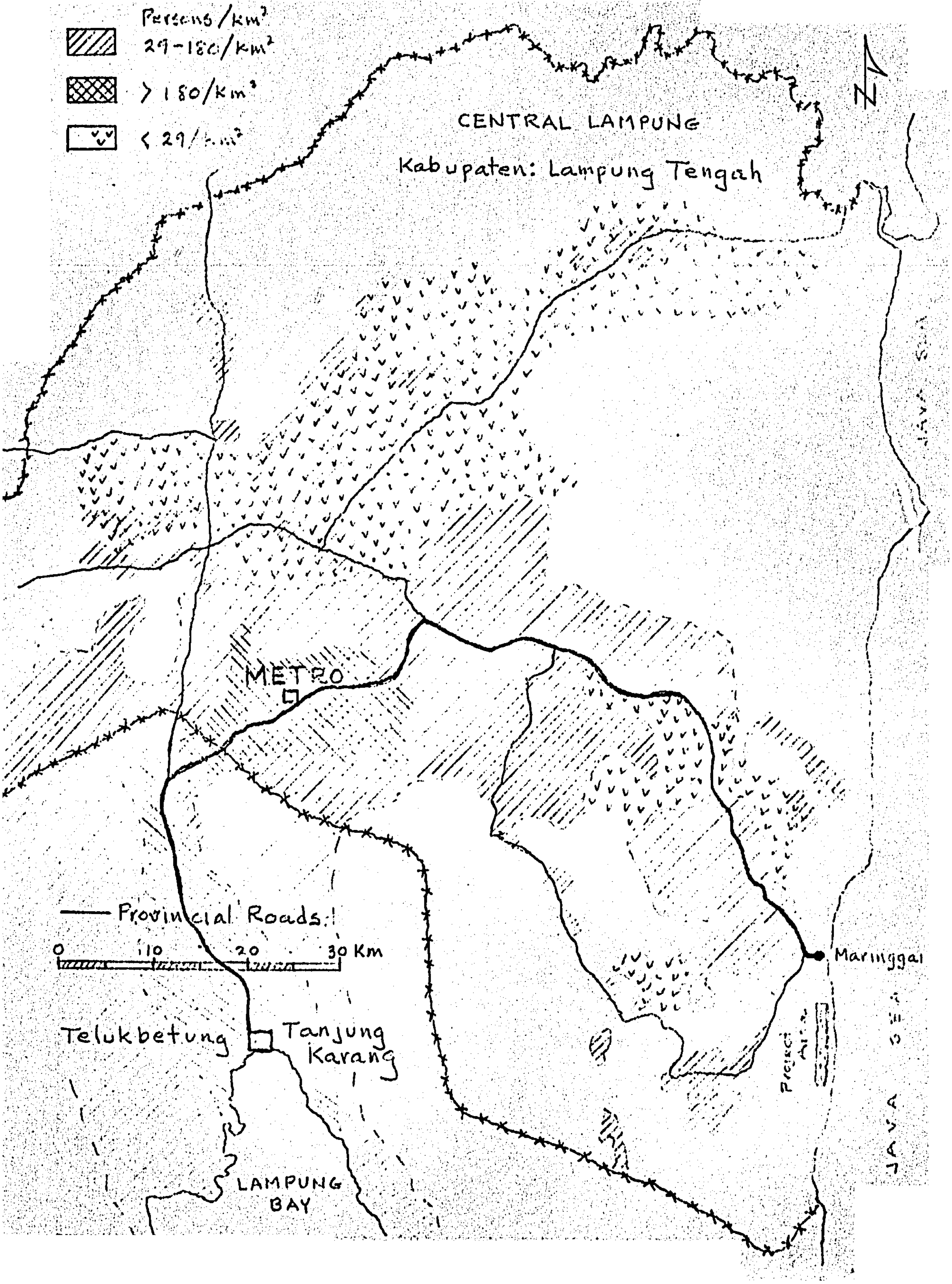
EXHIBIT D-2

BRACKISH WATER POND PRODUCTION PER CAPITA BY PROVINCE, 1968-1972

Year	South Sulawesi	East Java	Central Java	West Java	Sumatra Lampung	Sumatra Aceh	Other Provinces	All of Indonesia
				Population in Thousands				
1968	4,992	24,440	23,269	24546	2,455	1,903	31,171	112,776
1969	5,061	24815	23,646	25,121	2,568	1,942	31,878	115,031
1970	5,136	23,646	24,061	25,732	2,682	1,983	32,628	117,447
1971	5,224	25,696	24,529	26,405	2,805	2,030	33,459	120,148
1972	5,369	26,214	25,023	27,118	2,889	2,090	34,412	123,115
1973	5,515	26,726	25,512	27,839	2,974	2,151	35,371	126,088
1974	5,663	27,234	25,997	28,570	3,060	2,214	36,345	129,083
Projection								
1975	5,813	27,742	26,582	29,310	3,149	2,278	37,236	132,110
1976	5,966	28,254	26,970	30,066	3,240	2,344	38,350	135,190
1977	6,122	28,771	27,464	30,840	3,334	2,412	39,399	138,342
1978	6,283	29,300	27,968	31,635	3,432	2,483	40,478	141,579
				Milkfish Production in Metric Tons				
1968	12,252	12,367	5,448	9,375	13	5,499	974	45,928
1969	12,061	12,790	10,382	10,181	10	5,431	1,021	51,876
1970	14,348	12,636	8,858	11,752	10	7,123	1,181	55,908
1971	15,752	16,193	5,321	11,933	-	7,968	1,289	58,456
1972	15,118	13,339	3,311	10,374	-	8,018	973	51,203
Projection								
1973	15,828	13,363	4 592	11 414	-	8,217	1,061	54,475
1974	16,593	13,617	5,050	11,999	-	8,457	1,130	56,846
1975	17,390	13,940	5,150	12,600	-	8,700	1,220	59,000
1976	18,136	14,405	5,394	12,928	-	9,048	1,252	61,163
1977	18,860	14,610	5,770	13,350	-	9,410	1,270	63,270
1978	19,640	15,043	5,923	13,703	-	9,784	1,325	64,948
				Milkfish Production Per Capita in Kilograms				
1968	2.45	.51	.23	.38	n	2.89	.03	.41
1969	2.38	.52	.44	.41	n	2.80	.03	.45
1970	2.79	.53	.37	.46	n	3.59	.04	.48
1971	3.02	.63	.22	.45	-	3.93	.04	.49
1972	2.82	.51	.13	.38	-	3.84	.03	.42
Projection								
1973	2.87	.50	.18	.41	-	3.82	.03	.43
1974	2.93	.50	.19	.42	-	3.82	.03	.44
1975	2.99	.50	.19	.43	-	3.86	.03	.45
1976	3.04	.51	.20	.43	-	3.86	.03	.45
1977	3.08	.51	.21	.43	-	3.90	.03	.46
1978	3.11	.51	.21	.43	-	3.94	.03	.46

EXHIBIT D-3

CENTRAL LAMPUNG MARKETING AREA



Provided there is an adequate supply, future milkfish demand in Lampung Province may be calculated initially at 780 tons per year. This figure assumes an annual per capita demand of 0.42 kgs., the same as for West Java, and a population of 1,860,000 which includes all residents of the central kapubaten, and 50 percent of those who live in the south. Thereafter, demand is expected to increase in proportion to population growth at a rate of three percent per year, based on Central Statistical Office estimates.

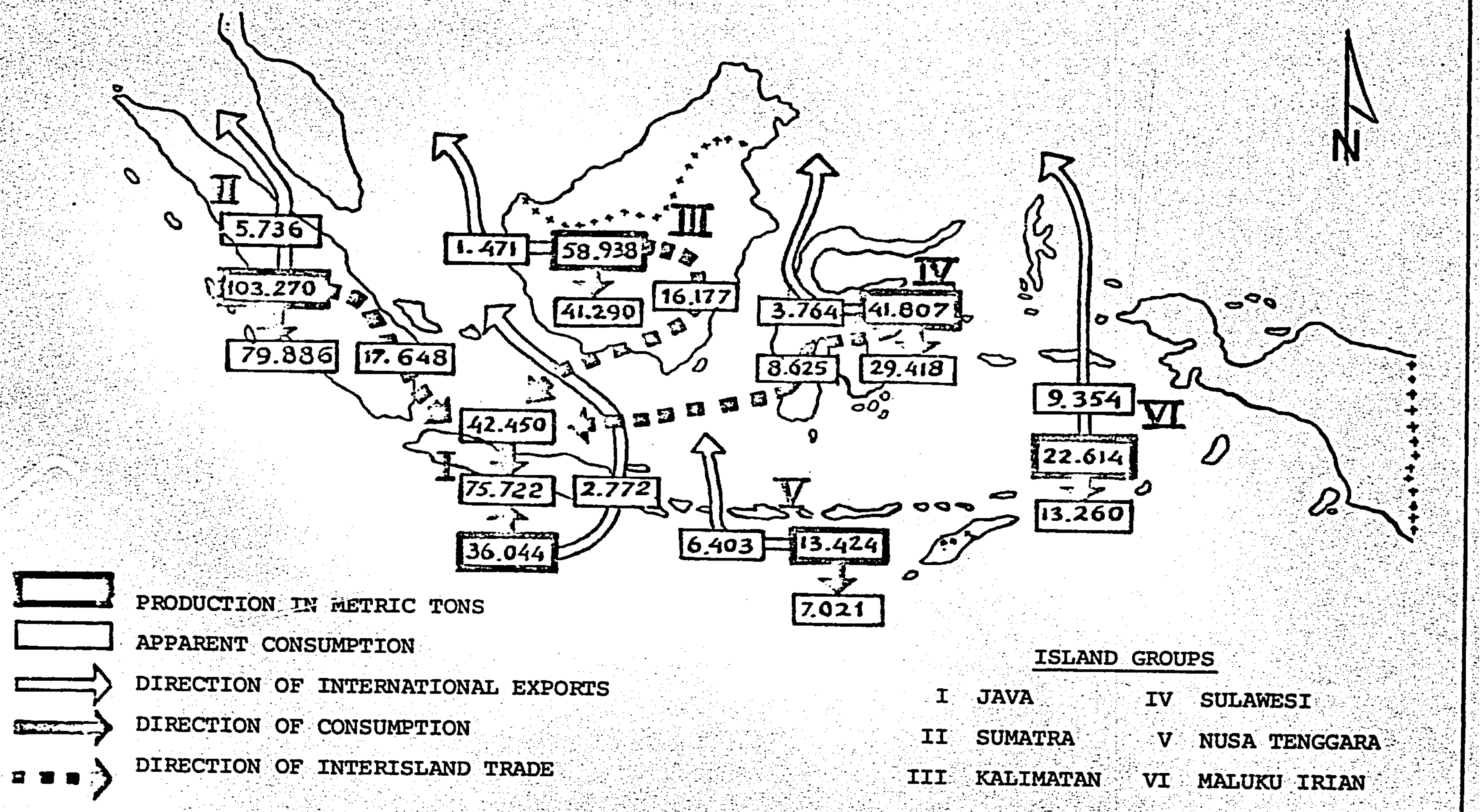
Two additional factors were taken into account in developing this projection. The first relates to the relatively low per capita demand, which derives from the fact that many current residents of Lampung Province have moved there since the 1930's from Central Java, where the propensity to consume fish has traditionally been only around two kilograms per year for all fishery products. The second is the relatively low demand elasticity for fish, which means that demand estimates must be conservative if high enough prices are to be maintained, and if the project is to receive a fair return on the fish sold in the Lampung market territory.

In view of the limited size of the local market, interisland markets will have to be developed to absorb a large part of the project's output, which is expected to reach 2,610 tons per year at full production. Central Java and West Java are the most promising target areas. East Java is not considered a potential market because it already produces a surplus and ships milkfish to Jakarta in West Java.

Studies and projects conducted by the Directorate of Fisheries support this conclusion. Exhibit D-4 shows the projected increases in fishery production and the expected distribution flow during the years of the Second Five Year Plan. On the basis of this general flow pattern, the government has constructed eight coastal fishing harbors around the Java Sea as shown in Exhibit D-5. Fish will be collected at these points and transported to the

EXHIBIT D-4

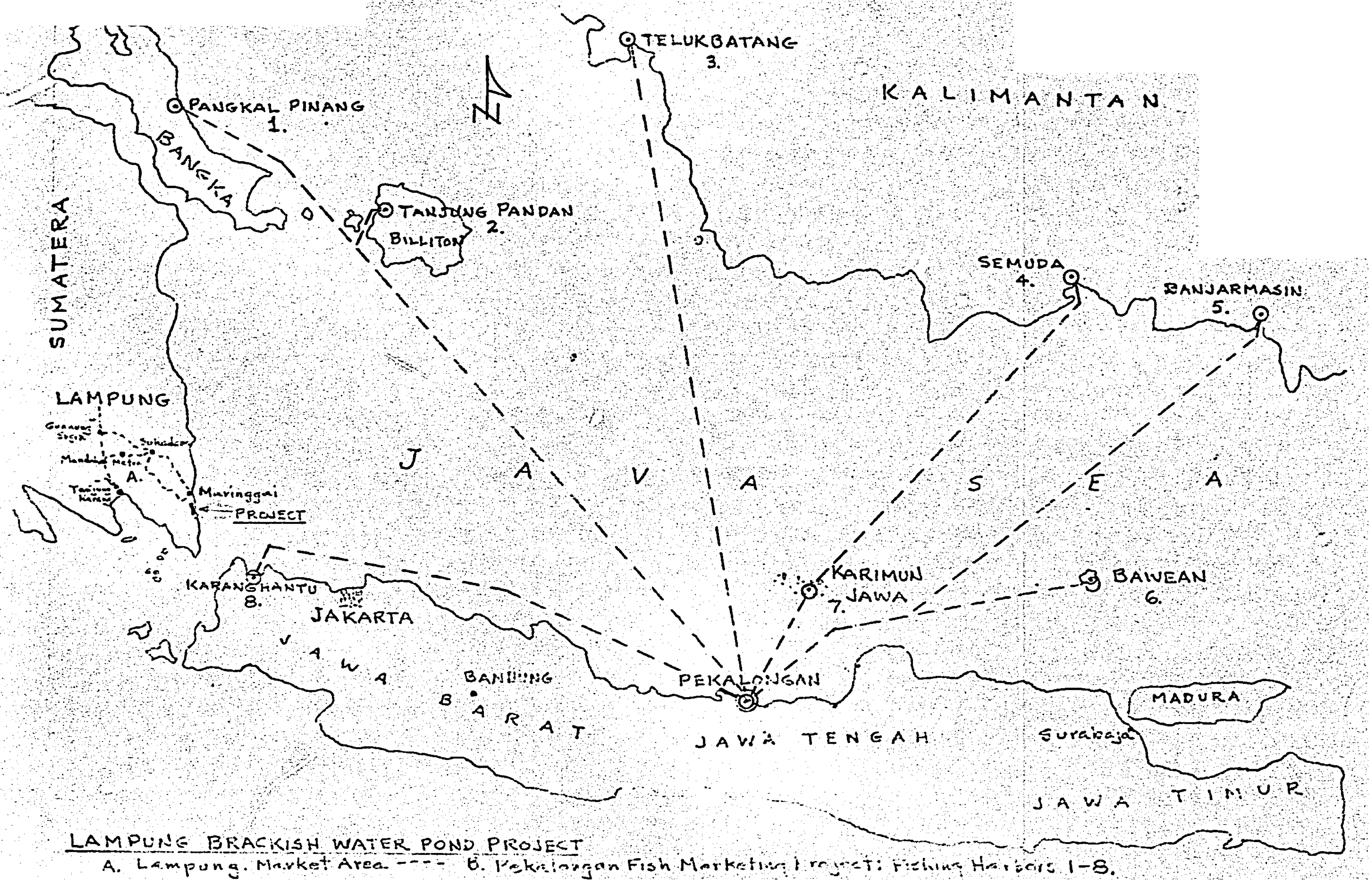
PROJECTED INCREASES IN FISHERY PRODUCTION AND DISTRIBUTION DURING SECOND FIVE-YEAR PLAN



Source: Directorate Generale of Fisheries, Jakarta.

EXHIBIT D-5

PEKALONGAN FISH COLLECTION SATELLITE PROJECT



Pekalongan harbor facilities, from where they will be distributed to target market areas in Central and West Java. Refrigerated cold storage, transport, ice plants and chill rooms are included in the plan, and will form a so-called 'cold-chain' throughout the system. The present lack of such a cold chain in the marketing of fresh fish is reported to be a major reason for the 15-20 percent wastage factor between the time the fish is caught and the time it reaches the retail outlet.

As can be seen in Exhibit D-5, the Lampung brackish water pond project is well located to serve as a ninth collection point in the Pekalongan satellite system. Its inclusion in the system could eliminate the need to develop independent marketing arrangements in Java in order to sell project production in excess of local demand.

2. Production Targets

The project will consist of 2,900 hectares of pond surface, ten percent of which will be used for nursery pond operations. Project construction is estimated to extend over a period of 60 months, with the first four 50-hectare modules ready for stocking at the end of the twentieth project month. Every two months thereafter, three additional pond modules totalling 150 hectares are expected to be added, until all 2,900 hectares of rearing and nursery ponds have been completed and stocked.

Harvesting of the first four modules is scheduled to start in the twenty-fourth month. Fish yields per hectare of ponds are expected to be low during the first year, but to increase over six seasons to an average annual yield of 900 kilos per hectare. These targets are conservative, and no trouble should be expected in meeting them as planned.

A detailed production schedule for the first six years of the project is provided in Exhibit D-6. Production targets by period, year, and day are shown in the right hand column. At full production, the ponds are scheduled

EXHIBIT D-6

SCHEDULED MILKFISH PRODUCTION

by 150-hectare increments and 4 month periods,
at full production of 900 kilos per hectare

Increments	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	Total Production		
Hectares	200	350	500	650	800	950	1100	1250	1400	1550	1700	1850	2000	2150	2300	2450	2600	2750	2900	By	By	By
2.5 ha. Ponds	80	140	200	260	320	380	440	500	560	620	680	740	800	860	920	980	1040	1100	1160	Period	Year	Day
Project Month	(Production in Metric Tons)																					
24	15																			15		
26		15																		15		
28	20		15																	35		
30		20		15																35		
32	25		20		15															60		
34		25		20		15														60		
36	30		25		20		15													90	310	1.0
38		30		25		20		15												90		
40	35		30		25		20		15											125		
42		35		30		25		20		15										125		
44	40		35		30		25		20		15									165		
46		40		35		30		25		20		15								165		
48	45		40		35		30		25		20		15							210	880	2.9
50		45		40		35		30		25		20		15						210		
52	50		45		40		35		30		25		20		15					260		
54		45		45		40		35		30		25		20		15				255		
56	55		45		45		40		35		30		25		20		15			310		
58		45		45		45		40		35		30		25		20		15		300		
60	60		45		45		45		40		35		30		25		20		15	360	1695	5.6
62		45		45		45		45		40		35		30		25		20		330		
64	60		45		45		45		45		40		35		30		25		20	390		
66		45		45		45		45		45		40		35		30		25		355		
68	60		45		45		45		45		45		40		35		30		25	415		
70		45		45		45		45		45		45		40		35		30		375		
72	60		45		45		45		45		45		45		40		35		30	435	2300	7.7
74		45		45		45		45		45		45		45		40		35		390		
76	60		45		45		45		45		45		45		45		40		35	450		
78		45		45		45		45		45		45		45		45		40		400		
80	60		45		45		45		45		45		45		45		45		40	460		
82		45		45		45		45		45		45		45		45		45		405		
84	60		45		45		45		45		45		45		45		45		45	465	2570	8.6
86		45		45		45		45		45		45		45		45		45		405		
88	60		45		45		45		45		45		45		45		45		45	465		
90		45		45		45		45		45		45		45		45		45		405		
92	60		45		45		45		45		45		45		45		45		45	465		
94		45		45		45		45		45		45		45		45		45		405		
96	60		45		45		45		45		45		45		45		45		45	465	2610	8.7

to yield 465 metric tons every four months, or 2,610 metric tons per year. Estimated daily production of marketable fish is 8.7 metric tons.

3. Marketing Strategy

As the project will need to market portions of its production in both Lampung Province and Java, its marketing strategy must deal effectively with the system outlined in Section A.

The Maringgai fish auction provides a natural and well located outlet for supplying the local market. These local sales create no planning problems because there are already wholesalers in Lampung who can become directly involved. In the case of interisland trade, however, it is important to establish at what point sales to Java should commence. A workable target date is considered to be one year after the first pond starts harvesting fish and production has reached about one ton per day (basis: 300 working days per year). A year later, output is expected to total about three tons per day and should continue to increase thereafter until the project achieves full production of about eight and one-half tons per day, 70 percent (six tons) of which will be marketed in Java.

The above target date is suggested because effective marketing in Java will depend on creating suitable arrangements with both wholesalers and transporters. Transporters will need to move a minimum of one ton per day if unit cost rates are not to exceed what the project can afford to pay without incurring serious losses in the beginning stages of market expansion.

In marketing milkfish in Java, project management can make one of several alternative arrangements. The simplest arrangement would be to join the Pekalongan fisheries project as a ninth satellite As such the Lampung project would receive regular payments for the fish shipped at prices free alongside (FAS) the Pekalongan refrigerated boats at Maringgai.

Alternatively, the Lampung project management could develop independent working relationships with Java wholesalers capable of handling the excess volume of milkfish. In this case, either the wholesalers (or their agents) would buy milkfish directly at the project site and provide for their own interisland transportation, or the project management would arrange for transportation and delivery of the fish to the wholesalers at designated harbors or landing places in Java.1/

Both methods require that the fish be iced if they are to reach Java markets in a condition fresh enough to obtain a fair price. Refrigerated boats suitable for transportating the fish are not presently available and careful attention must be paid to providing for this important link in the marketing cold-chain. In addition, a cold storage plant will have to be built at Maringgai for receiving and icing milkfish from the ponds, and equipment for loading them onto boats for shipment to Java will have to be purchased. Improvements to the Maringgai harbor will also be required. For purposes of this study, it is assumed that all necessary storage and transport facilities will be developed independently of the Lampung project.

The Lampung project is designed to utilize economies of scale in market penetration, in conjunction with the cold-chain marketing concept. The proposed system will reduce wastage loss and thus increase incomes to the project farmers, who can expect to sell a greater volume at better prices than they could otherwise achieve.

1/ It may also be possible to ship the fish by air as is now being done in the Philippines, for example. One advantage of air shipments is the fact that the domestic airport in Jakarta is well located for city-wide distribution. An additional advantage is the reduction in fish wastage, which would compensate for the higher costs. At present, however, governmental restrictions on both air movements and on fish entering the Jakarta market, place the feasibility of this alternative to sea transportation in doubt.

C. Project Investment Costs

Investment costs for the Lampung project range from a low of Rp. 3,072,748 to a high of Rp. 3,877,666, depending on whether the 2,900 hectares of pond surface area 1/ are divided into 2.5 hectare or 5.0 hectare ponds, and on whether hand labor or machine methods predominate in the construction of the dikes and canals. Exhibit D-7 shows design quantities, unit prices, and total project investment costs for alternative pond sizes and construction methods. Case A and Case B assume that 1,160 pond farms of 2.5 hectares each will be built, utilizing hand labor and machinery respectively. Cases C and D use the same cost assumptions regarding construction methods for 580 five-hectare farms. In all four alternatives, human settlement costs are calculated on the basis of one family per pond.2/

Costs are arranged under three major headings: (1) pond facilities; (2) human settlement; and (3) technical assistance, relocation and participation. Engineering and contingency fees are listed separately at the bottom of the exhibit, followed by a summary statement of foreign exchange costs. All costs were developed by the team engineer, and are broken down in detail in Appendix B to this report.

As the totals indicate, doubling the size of each pond from 2.5 to 5.0 hectares reduces pond construction costs by about 14 percent, and housing costs by nearly 50 percent. Whereas Cases A and C maximize the use of common labor, Cases B and D utilize machinery to complement the labor force in a cost-effective manner and so reduce total costs by an average of 7 percent. The least-cost alternative is that which provides for the construction of five-hectare ponds with machine methods.

1/ In addition to the 2,900 hectares of pond surface area, 350 hectares will be necessary for dikes, roads, and village areas. With the inclusion of the 950-hectare green belt between the ponds and the Java Sea, project land requirements total 4,200 hectares.

2/ In Cases C and D, it is assumed that the 2.5 hectare nursery ponds will be operated at a rate of two ponds per family.

EXHIBIT D-7

LAMPUNG BRACKISH WATER POND PROJECT

DESIGN QUANTITIES, UNIT PRICES, AND TOTAL INVESTMENT COSTS FOR ALTERNATE POND SIZES AND CONSTRUCTION METHODS

Cost Elements	Design Quantities 2.5 Ha. Ponds	Design Quantities 5.0 Ha. Ponds	Unit Prices (000 Rp) Labor Method	Unit Prices (000 Rp) Machine Method	2.5 Ha. Ponds A. Labor Methods	2.5 Ha. Ponds B. Machine Methods	5.0 Ha. Ponds C. Labor Methods	5.0 Ha. Ponds D. Machine Methods
Pond Facilities								
Heavy Clearing	1267 ha.	1267	239.6		303,573	303,573	303,573	303,573
Timber Sales	1267 ha.	1267	98.1		(124,200)	(124,200)	(124,200)	(124,200)
Light Clearing	1933 ha.	1933	41.4		80,026	80,026	80,026	80,026
Net Cost	3200 ha.	3200			259,399	259,399	259,399	259,399
Dikes & Canals, M^3								
Road dike	47083	47083	.82	.60	38,608	28,250	38,608	28,250
Seaside dike	66852	66852	.82	.60	54,819	40,111	54,819	40,111
Division dike	107879	107879	.82	.60	88,461	64,727	88,461	64,727
Pump canals	345216	345216	.82	.60	283,077	207,130	283,077	207,130
Interior dikes	603288	335160	.82	.82	494,695	494,695	274,831	274,831
Sea channels	250200	250200	.60	.60	150,120	150,120	150,120	150,120
Cross drains	57600	57600	.80	.60	46,080	34,560	46,080	34,560
Underwater exc.	9600	9600	1.20	1.20	11,520	11,520	11,520	11,520
Totals					1,167,380	1,031,113	947,516	811,249
Structures, M^3 and ea.								
Excavations	17258	11924	1.20		20,709	20,709	14,309	14,309
Reinforced concrete	1879	1478	80.00		150,320	150,320	118,218	118,218
Stone masonry	3596	3254	26.00		93,495	93,495	84,603	84,603
Brick masonry	4640	4124	22.00		102,080	102,080	90,738	90,738
Rip nap.	883	883	4.14		3,656	3,656	3,656	3,656
Pump house gates	58 ea.	58 ea.	20.00		1,160	1,160	1,160	1,160
Pond screens	1140 ea.	638 ea.	8.28		9,439	9,439	5,283	5,283
Pond gates	1140 ea.	638 ea.	4.14		4,720	4,720	2,597	2,597
Totals					385,579	385,579	320,564	320,564
Equipment Installed								
Pumps and engines: FX	-	58 ea.	3730		216,340	216,340	216,340	216,340
Installation	-	58 ea.	1659		96,222	96,222	96,222	96,222
Totals		58 ea.	5389		312,562	312,562	312,562	312,562
Sub-Total: Pond Costs (1)					2,124,920	1,988,653	1,840,041	1,703,774
Human Settlement								
Houses (2)	1200	600	331.2		397,440	397,440	198,720	198,720
Wells (2)	48	28	45.0		2,160	2,160	1,260	1,260
Land certificates	1200	600	10.4	20.8	12,480	12,480	12,480	12,480
Access road (1)	4.5 km	4.5 km	8320		10,359	10,359	10,359	10,359
Project road (1)	17.0 km	17.0 km	2320		39,134	39,134	39,134	39,134
Schools, clinics, offices (2)	1	2/3	44712		44,712	44,712	29,808	29,808
Totals					506,285	506,285	291,761	291,761
Technical Assistance, Relocation, Participation								
AID - FX equivalent	-	-	-		105,697	105,697	105,697	105,697
Trust fund	-	-	-		57,201	57,201	57,201	57,201
GOI	-	-	-		342,377	342,377	342,377	342,377
Totals					505,275	505,275	505,275	505,275
Engineering 10% on items (1)	-	-	-		217,441	203,815	188,953	175,327
Contingency 20% on items (1), (2)	-	-	-		523,745	496,492	423,864	396,611
Total Project Cost, 000 Rp.					Rp 3,877,666	3,700,520	3,249,894	3,072,748
Total Project Cost $, 000 (US$1 = 414.5 Rp)					US$ 9,356	8,928	7,841	7,413
Foreign Exchange Cost $, 000					US$ 777	777	777	777

Exhibits D-8 through D-11 present investment costs for each alternative case. Expenditures are phased over a five-year period based on recommendations of the team engineer. The number of construction personnel engaged, common labor income, and foreign exchange components are shown by year in each exhibit. Case A is the most labor-intensive of the alternatives; Case D (5.0 hectare ponds, machine methods) the least. In all cases, foreign exchange costs are identical.

D. Operating Assumptions

1. Revenue Flows

The Lampung and Jakarta price structures derived in Subsection A 3 above indicate that, in both markets, the landing place auction price received by the fisherman is US$0.60 per kilogram. The project revenue flows, estimated on the basis of the scheduled milkfish production (Exhibit D-6) and a price per kilo of US$0.60, are as follows:

Project Year	Production Metric Tons	Revenue Flow ,000 US Dollars
1	-	-
2	-	-
3	310	186
4	880	528
5	1695	1017
6	2300	1380
7	2570	1542
8-50	2610	1566

Thus, at full production of 2,610 tons, project revenues may be estimated in current prices at US$1,566,000 annually. The proportion of this revenue derived from the Lampung market is US$468,000 based on the estimated 780-ton market potential. It should be emphasized that in order to achieve these revenue levels, project management will need to develop relationships

EXHIBIT D-8

ALTERNATIVE CASE A

LAMPUNG BRACKISH WATER POND PROJECT

PROJECT INVESTMENT COSTS
(Hand Methods for Main Dikes and Canals)
2.5 Hectare Ponds/US Pumps

Cost Elements	Unit	Project Costs	First Year	Second Year	Third Year	Fourth Year	Fifth Year
				(One US$ = 414.5 Rp.)			
Production Facilities							
Clearing & grubbing (net)	Rp	259,399	39,740	46,320	96,339	77,000	-
Dikes & Canals	Rp	1,167,380	140,086	280,171	280,171	280,171	186,781
Structures	Rp	385,579	19,279	77,116	115,674	96,395	77,115
Equipment installed	Rp	312,562	15,628	62,514	78,140	78,140	78,140
Sub-Total	Rp	2,124,920	214,733	466,121	570,324	531,706	342,036
Engineering 10%	Rp	212,492	21,473	46,612	57,032	53,171	34,207
Contingency 20%	Rp	424,984	42,947	93,224	114,065	106,341	68,407
Total, 000 Rp.	Rp	2,762,396	279,153	605,957	741,421	691,218	442,307
Total $, 000	$	6,665	673	1,462	1,789	1,668	1,073
Human Settlement							
Houses + 20%	Rp	476,928	92,603	92,603	106,514	92,604	92,604
Wells + 20%	Rp	2,592	519	519	518	518	518
Land certificates	Rp	12,480	-	3,120	3,120	3,120	3,120
Roads + 30%	Rp	64,341	45,967	18,374	-	-	-
Schools, etc. + 20%	Rp	53,655	10,730	10,730	10,735	10,730	10,730
Total, 000 Rp	Rp	609,996	149,819	125,346	120,882	106,972	106,972
Total $, 000	$	1,472	362	302	292	258	258
Technical Assistance, Relocation, Participation							
AID - T/A	Rp	105,697	25,000	50,000	30,697	-	-
GOI & TF	Rp	399,578	79,578	80,000	80,000	80,000	80,000
Total, 000 Rp	Rp	505,275	104,578	130,000	110,697	80,000	80,000
Total $, 000	$	1,219	252	314	267	193	193
Total Project Cost $, 000	$	9,356	1,287	2,078	2,348	2,119	1,524
Persons Employed	No.		705	1,187	1,375	1,294	893
Common Labor Income $, 000	$		324	545	631	594	410
Foreign Exchange $, 000	$		88	225	204	130	130

FINANCIAL ESTIMATING: The above cost estimates are based on constant prices, whereas financial costs must take into account a projected factor for inflation, which is estimated in Indonesia to be averaging some fifteen percent annually. The appropriate factors for application to project costs, revenues and expenses are as follows:

	Year	1st yr.	2nd yr.	3rd yr.	4th yr.	5th yr.
Start of project	1977	1.15	1.32	1.52	1.75	2.01
" "	1978	1.32	1.52	1.75	2.01	2.31
" "	1979	1.52	1.75	2.01	2.31	2.66

EXHIBIT D-9

ALTERNATIVE CASE B

LAMPUNG BRACKISH WATER POND PROJECT

PROJECT INVESTMENT COSTS
(Machine Methods for Main Dikes and Canals)
2.5 Hectare Ponds/US Pumps

Cost Elements	Unit	Project Costs	First Year	Second Year	Third Year	Fourth Year	Fifth Year
				(One US$ = 414.5 Rp.)			
Production Facilities							
Clearing & grubbing (net)	Rp	259,399	39,740	46,320	96,339	77,000	-
Dikes & Canals .85	Rp	1,031,113	123,734	247 467	247,467	247,467	164,978
Structures	Rp	385,579	19,279	77,116	115,674	96,395	77,115
Equipment installed	Rp	312,562	15,628	62,514	78,140	78,140	78,140
Sub-Total	Rp	1,988,653	198,381	433,417	537,620	499,002	320,233
Engineering 10%	Rp	198,865	19,838	43,342	53,762	49,900	32,023
Contingency 20%	Rp	397,731	39,676	86,683	107,524	99,801	64,047
Total, 000 Rp	Rp	2,585,249	257,895	563,442	698,906	648,703	416,303
Total $, 000	$	6,237	622	1,359	1,686	1,565	1,005
Human Settlement							
Houses + 20%	Rp	476,928	92,603	92,603	106,514	92,603	92,604
Wells + 20%	Rp	2,592	519	519	518	518	518
Land certificates	Rp	12,480	-	3,120	3,120	3,120	3,120
Roads + 30%	Rp	64,341	45,967	18,374	-	-	-
Schools, etc. + 20%	Rp	53,655	10,730	10,730	10,735	10,730	10,730
Total, 000 Rp	Rp	609,996	149,819	125,346	120,887	106,972	106,972
Total $, 000	$	1 472	362	302	292	258	258
Technical Assistance, Relocation, Participation							
AID - T/A	Rp	105,697	25,000	50,000	30,697	-	-
GOI $ TF	Rp	399,578	79,578	80,000	80,000	80,000	80,000
Total, 000 Rp	Rp	505,275	104,578	130,000	110,697	80,000	80,000
Total $, 000	$	1,219	252	314	267	193	193
Total Project Cost $, 000	$	8,928	1,236	1,975	2,245	2,016	1,456
Persons Employed	No.	-	632	1,042	1,229	1,148	800
Common Labor Income $, 000	$	-	290	478	564	527	367
Foreign Exchange Cost $, 000	$	-	88	225	204	130	130

FINANCIAL ESTIMATING: The above cost estimates are based on constant prices, whereas financial costs must take into account a projected factor for inflation, which is estimated in Indonesia to be averaging some fifteen percent annually. The appropriate factors for application to project costs, revenues and expenses are as follows:

	Year	1st yr.	2nd yr.	3rd yr.	4th yr.	5th yr.
Start of project	1977	1.15	1.32	1.52	1.75	2.01
" "	1978	1.32	1.52	1.75	2.01	2.31
" "	1979	1.52	1.75	2.01	2.31	2.66

EXHIBIT D-10

ALTERNATIVE CASE C

LAMPUNG BRACKISH WATER POND PROJECT

PROJECT INVESTMENT COSTS
(Hand Methods for Main Dikes and Canals)
5.0 Hectare Ponds/US Pumps

Cost Elements	Unit	Project Costs	First Year	Second Year	Third Year	Fourth Year	Fifth Year
				(One US$ = 414.5 Rp.)			
Production Facilities							
Clearing & grubbing (net)	Rp	259,399	39,740	46,320	96,339	77,000	-
Dikes & canals	Rp	947,516	113,702	227,404	227,404	227,404	151,602
Structures	Rp	320,564	16,059	64,236	95,739	80,295	64,235
Equipment installed	Rp	312,562	15,628	62,514	78,140	78,140	78,140
Sub-Total	Rp	1,840,041	185,129	400,474	497,622	462,839	293,977
Engineering 10%	Rp	184,004	18,513	40,047	49,762	46,284	29,398
Contingency 20%	Rp	368,008	37,026	80,095	99,524	92,568	58,795
Total, 000 Rp	Rp	2,392,053	240,668	520,616	646,908	601,691	382,170
Total $, 000	$	5,771	580	1,256	1,561	1,452	922
Human Settlement							
Houses + 20%	Rp	238,464	47,295	47,295	49,282	47,296	47,296
Wells + 20%	Rp	1,512	302	303	303	302	302
Land certificates	Rp	12,480	-	3,120	3,120	3,120	3,120
Roads + 30%	Rp	64,341	45,967	18,374	-	-	-
Schools, etc. + 20%	Rp	35,770	7,154	7,154	7,154	7,154	7,154
Total, 000 Rp	Rp	352,567	100,718	76,246	59,859	57,872	57,872
Total $, 000	$	851	243	185	145	139	139
Technical Assistance, Relocation, Participation							
AID - T/A	Rp	105,697	25,000	50,000	30,697	-	-
GOI & TF	Rp	399,578	79,578	80,000	80,000	80,000	80,000
Total, 000 Rp	Rp	505,275	104,578	130,000	110,697	80,000	80,000
Total $, 000	$	1,219	252	314	267	193	193
Total Project Cost $, 000	$	7,841	1,075	1,755	1,973	1,784	1,254
Persons Employed	No.	-	558	965	1,139	1,065	712
Common Labor Income $,000	$	-	256	443	523	489	327
Foreign Exchange Cost $, 000	$	-	88	225	204	130	130

FINANCIAL ESTIMATING: The above cost estimates are based on constant prices, whereas financial costs must take into account a projected factor for inflation, which is estimated in Indonesia to be averaging some fifteen percent annually. The appropriate factors for application to project costs, revenues and expenses are as follows:

	Year	1st yr.	2nd yr.	3rd yr.	4th yr.	5th yr.
Start of project	1977	1.15	1.32	1.52	1.75	2.01
" "	1978	1.32	1.52	1.75	2.01	2.31
" "	1979	1.52	1.75	2.01	2.31	2.66

ALTERNATIVE CASE D

EXHIBIT D-11

LAMPUNG BRACKISH WATER POND PROJECT

PROJECT INVESTMENT COSTS
(Machine Methods for Main Dikes and Canals)
5.0 Hectare Ponds/US Pumps

Cost Elements	Unit	Project Costs	First Year	Second Year	Third Year	Fourth Year	Fifth Year
				(One US$ = 414.5 Rp.)			
Production Facilities							
Clearing & grubbing (net)	Rp	259,399	39,740	46,320	96,339	77,000	-
Dikes & canals .85	Rp	811,249	97,350	194,700	194,700	194,700	129,799
Structures	Rp	320,564	16,059	64,236	95,739	80,295	64,235
Equipment installed	Rp	312,562	15,628	62,514	78,140	78,140	78,140
Sub-Total	Rp	1,703,774	168,777	367,770	464,918	430,135	272,174
Engineering 10%	Rp	170,377	16,878	36,777	46,492	43,013	27,217
Contingency 20%	Rp	340,755	33,755	73,554	92,984	86,027	54,435
Total, 000 Rp	Rp	2,214,906	219,410	478,101	604,394	559,175	353,826
Total $, 000	$	5,343	529	1,153	1,458	1,349	854
Human Settlement							
Houses + 20%	Rp	238,464	47,295	47,295	49,282	47,296	47,296
Wells + 20%	Rp	1,512	302	303	303	302	302
Land certificates	Rp	12,480	-	3,120	3,120	3,120	3,120
Roads + 30%	Rp	64,341	45,967	18,374	-	-	-
Schools, etc. + 20%	Rp	35,770	7,154	7,154	7,154	7,154	7,154
Total, 000 Rp	Rp	352,567	100,718	76,246	59,859	57,872	57,872
Total $, 000	$	851	243	185	145	139	139
Technical Assistance, Relocation, Participation							
AID - T/A	Rp	105,697	25,000	50,000	30,697	-	-
GOI & TF	Rp	399,578	79,578	80,000	80,000	80,000	80,000
Total, 000 Rp	Rp	505,275	104,578	130,000	110,697	80,000	80,000
Total $, 000	$	1,219	252	314	267	193	193
Total Project Cost $, 000	$	7,413	1,024	1,652	1,870	1,681	1,186
Persons Employed	No.	-	493	835	1,010	935	625
Common Labor Income $, 000	$	-	226	383	463	429	288
Foreign Exchange Cost $, 000	$	-	88	225	204	130	130

FINANCIAL ESTIMATING: The above cost estimates are based on constant prices, whereas financial costs must take into account a projected factor for inflation, which is estimated in Indonesia to be averaging some fifteen percent annually. The appropriate factors for application to project costs, revenues and expenses are as follows:

	Year	1st yr.	2nd yr.	3rd yr.	4th yr.	5th yr.
Start of project	1977	1.15	1.32	1.52	1.75	2.01
" "	1978	1.32	1.52	1.75	2.01	2.31
" "	1979	1.52	1.75	2.01	2.31	2.66

with wholesalers and transporters capable of achieving smooth and effective daily distribution arrangements designed to keep wastage factors to a minimum.

2. Operating Expenses

The quantities and prices of fish fry and materials utilized in pond operations are summarized in Exhibit D-12. Assumptions regarding quantities required are based on recommendation of the team aquaculturist (Appendix A). Current unit prices were obtained during a survey of local fish markets, and subsequently verified by personnel at the Directorate of Fisheries. Totals shown are on an annual basis, at full production.

3. Operating Funds Flow

Revenue flows enter the system when milkfish are sold at auction. A four-percent auction fee, plus the costs of operating supplies and materials, are deducted from gross receipts. The balance is available for (1) distribution to project fishermen, and (2) management and amortization costs.

Exhibit D-13 below summarizes the projected annual operating performance of the Lampung project at full production. The statement shows an operating income of $771,000, or 49 percent of sales.

EXHIBIT D-12

LAMPUNG BRACKISH WATER POND PROJECT

ANNUAL COSTS OF OPERATING SUPPLIES AND MATERIALS

Expense Items	Units	Quantity	Unit Prices Rp.	Project Expenses (,000 Rp.)
Project Area				
Green-belt between ponds and Java Sea	ha.	950		
Roads and village areas	ha.	200		
Dike and canal surface area	ha.	150		
Pond water area:				
Fingerling nurseries	ha.	290		
Milkfish rearing ponds	ha.	2,610		
Total	ha.	4,200		
Milkfish Production				
Milkfish reared to 250 grams each	no./ha.	1,333		
Fish rearing seasons	no./ha.	3		
Harvestable fish per year per ha.	No./ha	4,000		
Total harvestable fish per year	,000	10,440		
Production of milk fish per year	m.t.	2,610		
Fry Requirements				
Fry to fingerling to fish mortality	%	30		
Fry per season per ha. of rearing ponds	no.	1,900		
Fry at start of season/ha. of nursery	no.	17,200		
Total fry required per year	,000	14,900	7.5	111,750
Total fry expense				111,750
Fertilizer and Pesticides Requirements				
Rice bran, 1976, per ha./season	kg.	520	20	
Total annual quantity, 2,900 ha.	m.t.	4,524		90,460
TSP per hectare per season	kg.	33	120	
Total annual quantity, 2,900 ha.	kg.	287		34,440
Pesticide, Brestan 60 per ha./year	kg.	1	10,000	
Total annual quantity, 2,900 ha.	kg.	2,900		29,000
Total fertilizer and pesticide				153,900
Water Pumping Requirements				
Fuel to run 58 pumps, 880 hrs. per year	liters/yr.	153,120	50	7,656
Oil changes per 50 hours running time	liters/yr.	5,107	150	766
Annual repairs of pumps 10% of cost	no.	58	414,500	24,041
Total pumping expense				32,463
Fishermen Materials Required				
Seine nets: 50 m., 10 ha./net, 3 yr. life, 2,610 ha.	no./yr.	87	30,000	2,610
Dip nets: 4 per 10 ha., 2 yr. life, 2,900 ha.	no./yr.	580	1,500	870
Dug-out-boats: 1 per 5 ha., 10 yr. life, 2,900 ha.	no./yr.	58	10,000	580
Plastic pails: 11 per 10 ha., 3 yr. life, 2,900 ha.	no./yr.	1,060	750	795
Plastic bags: 3 per 5 ha., 1 yr. life, 2,610 ha.	No./yr.	1,566	75	117
Oxygen: 1 m^3 per 5 ha., 1 yr. life, 290 ha.	m^3/yr.	58	3,000	174
Small baskets: 2 per 5 ha., 3 yr. life, 2,610 ha.	no./yr.	348	300	104
Total fishermen materials expense				5,250
Annual Fry and Materials Expenses at Full Operation) ,000 Rp.				Rp 303,363
) US$,000				US$ 732
Technical Payroll Required	persons	25	633,600	Rp 15,900

EXHIBIT D-13

LAMPUNG BRACKISH WATER POND PROJECT

PROFORMA OPERATING STATEMENT

Revenue at full production		$1,566	100%
Less auction fees 4%		63	4%
Net revenue		$1,503	96%
Less operating supplies and materials			
Fry expense	$270		17%
Fertilizer, etc.	371		24%
Water pumping	78		5%
Fishermen materials	13		1%
Total supplies and materials		732	47%
Operating income		$ 771	49%

E. Internal Rate of Return Analysis

1. Project Surplus Flows and Economic Rates of Return by Alternate Construction Designs

Exhibit D-14 shows the derivation of surplus flows and project economic rates of return (PERR) for each of the alternative construction cases described in Section C.

The domestic and foreign exchange components of investment costs are taken from Exhibits D-8 through D-11. No shadow prices were applied to foreign exchange costs, as it was found realistic rates were established on the money markets with the help of the national bank.

EXHIBIT D-14

SUMMATION OF PROJECT RATES OF RETURN BY ALTERNATE CONSTRUCTION DESIGNS

Alternate Designs	Year	Domestic Costs	Labor Wage Adjustment	Foreign Exchange Costs	Pond Operations Expense	Pond Operations Revenue	Adjusted Surplus Flow
		(In Thousands of US Dollars)					
Case A	1	- 1199	324	- 88			- 963
	2	- 1853	545	- 225			- 1533
	3	- 2144	631	- 204	- 88 - 1	186	- 1618
	4	- 1989	594	- 130	- 250 - 3	528	- 1244
	5	- 1394	410	- 130	- 482 - 7	1017	- 572
	6				- 654 - 9	1380	735
	7				- 730 - 9	1542	821
	8-50				742 - 10	1566	834
					Alternative Case A PERR		10.9%
Case B	1	- 1148	290	- 88			- 946
	2	- 1750	478	- 225			- 1497
	3	- 2041	564	- 204	- 87	186	- 1582
	4	- 1886	527	- 130	- 247	528	- 1208
	5	- 1326	367	- 130	- 475	1017	- 544
	6				- 645	1380	735
	7				- 721	1542	821
	8-50				- 732	1566	834
					Alternative Case B PERR		11.1%
Case C	1	- 987	256	- 88			- 819
	2	- 1530	443	- 225			- 1312
	3	- 1769	523	- 204	- 87	186	- 1351
	4	- 1654	489	- 130	- 247	528	- 1014
	5	- 1124	327	- 130	- 475	1017	- 385
	6				- 645	1380	735
	7				- 721	1542	821
	8-50				- 732	1566	834
					Alternative Case C PERR		12.7%
Case D	1	- 936	226	- 88			- 798
	2	- 1427	383	- 225			- 1269
	3	- 1666	463	- 204	- 87	186	- 1308
	4	- 1551	429	- 130	- 247	528	- 971
	5	- 1056	288	- 130	- 475	1017	- 356
	6				- 645	1380	735
	7				721	1542	821
	8-50				732	1566	834
					Alternative Case D PERR		13.0%

PERR (Project Economic Rate of Return) Sensitivity

A 10% change in total project investment costs will change the PERRs by 10.7%, ceteris paribus.
A 10% change in total pond expense will change the PERRs by 9.0%, ceteris paribus.
A 10% change in total pond revenue will change the PERRs by 17.6%, ceteris paribus.

In lieu of developing shadow prices for construction labor, which are difficult to quantify, [1/] a wage adjustment is provided for. This has the effect of treating unskilled labor as a benefit which contributes to consumption and income in the project area.

The life of the project is assumed to be 50 years. Some Indonesian fishponds are still in operation after as many as two hundred years. Moreover, land turned into ponds appreciates in value. Inquiries into pond prices revealed that they were about double those of nearby improved agricultural land.

Pond operating expense and revenue flows are based on data in Exhibits D-12 and D-13, pro-rated by year according to the fish production schedule. Pond operating expenses exclude the cost of family labor, which is treated as a surplus flow or benefit. They also do not take into account the fact that chemical fertilizers for fishpond-use are subsidized by the government, which would benefit the farmer in excess of the rates of return shown.

The economic rates of return for each of the cases under consideration are shown below:

Alternate design	Size of farm	Construction method	Project economic rate of return (%)
Case A	2.5	labor	10.9
Case B	2.5	machine	11.1
Case C	5.0	labor	12.7
Case D	5.0	machine	13.0

1/ In earlier studies of this project, construction labor was shadow priced at thirty-three percent of market wages.

The sensitivity of these rates of return to changes in investment and operating costs and project revenues was tested for the following assumptions:

- <u>Investment costs:</u> a ten percent change in total project investment cost will alter the rate of return by 10.7 percent;
- <u>Operating costs:</u> a ten percent variation in pond expenses will change the rate by 9.7 percent;
- <u>Revenues:</u> a ten percent increase or decrease in project revenues will result in a 17.6 percent change in the rate.

The overall impact of such changes can be illustrated for Case D, where if total costs were ten percent lower, and revenues ten percent higher, the rate of return would rise from 13 percent to 17.8 percent.

2. Farmer Income Benefits

The potential of the Lampung project for generating adequate incomes for the families operating the ponds depends to a major extent on the number and size of ponds that are established, and to a lesser extent on the types of construction methods used. If the government's objective is to maximize individual farmer income levels, then the costs of construction, the number of ponds, and consequently the number of families participating in the project, will have to be reduced. If, on the other hand, the priority is to resettle as many families as possible, then the ponds should be smaller in size and more numerous, and family incomes held relatively low.

Exhibits D-15 and D-16 illustrate the sensitivity of internal rates of return to capital invested in the project to variations in pond size, construction methods, and family income levels. The assumptions used to calculate these rates are provided in Exhibit D-15.

EXHIBIT D-15

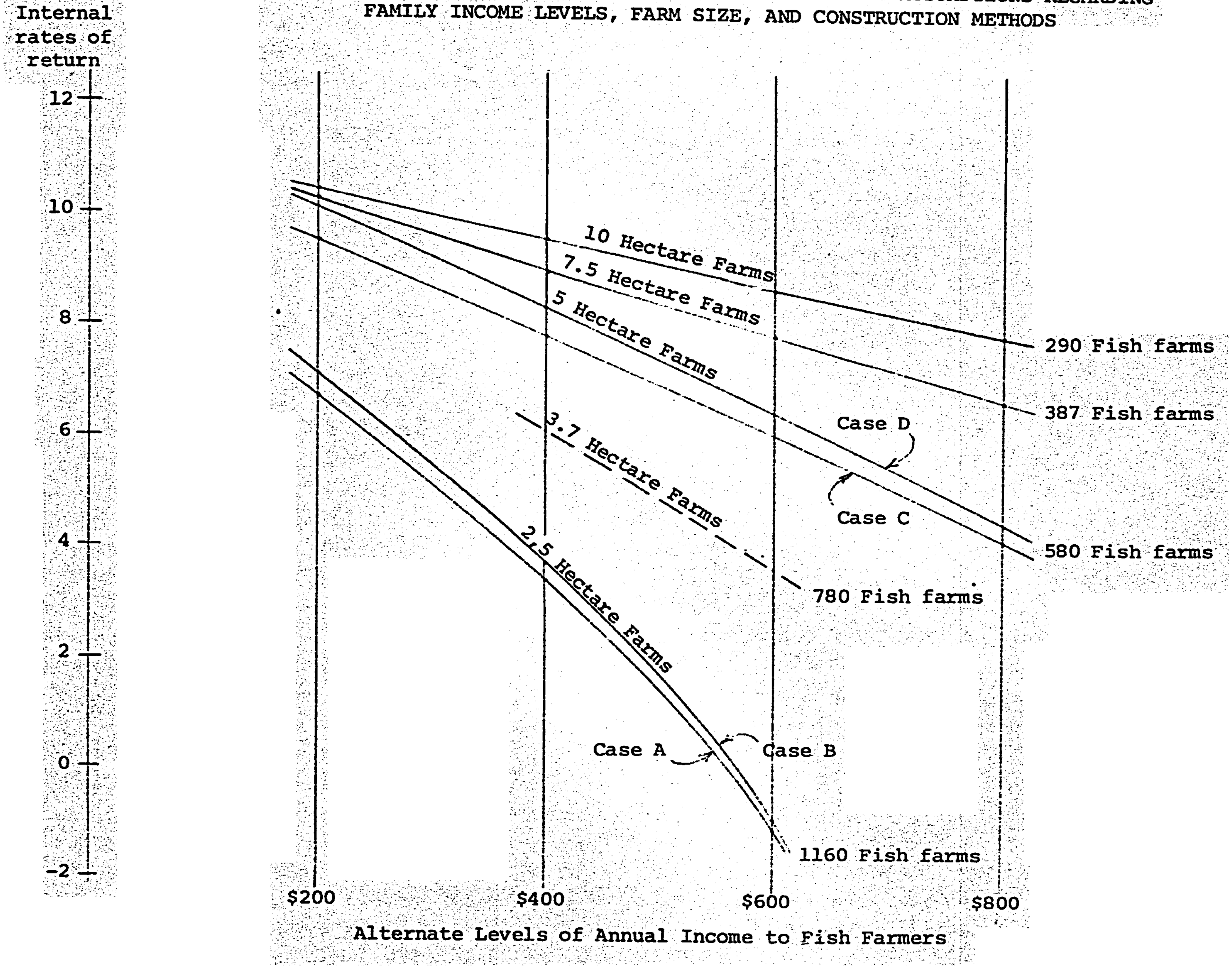
INCOME-EXPENSE FLOWS BY SIZE OF INDIVIDUAL FARMS

Size of Fish-Farm	2.5 hectares		5.0 hectares		7.5 ha.	10.0 ha.
Construction Method	Labor	Machine	Labor	Machine	Avg.	Avg.
Label	A	B	C	D	-	-
Total project cost of fish-farm *	$ 7,266	$ 6,897	$ 12,719	$ 11,980	$ 18,925	$ 25,500
Annual fish-farm revenue at full production	1,350	1,350	2,700	2,700	4,050	5,400
Operating expense ex. family labor	630	630	1,260	1,260	1,890	2,520
Operating income	$ 720	$ 720	$ 1,440	$ 1,440	$ 2,160	$ 2,880
Operating income adjusted to start-up schedule						
Year 1	$ 240	$ 240	$ 480	$ 480	$ 720	$ 960
Year 2	480	480	960	960	1,440	1,920
Year 3 and after	720	720	1,440	1,440	2,160	2,880
Alternate levels of fish-farm family incomes						
a. Level	$ 200	$ 200	$ 200	$ 200	$ 200	$ 200
b. Level	400	400	400	400	400	400
c. Level	600	600	600	600	600	600
d Level	800	800	800	800	800	800
Net surplus flows - cost of fish-farm family incomes						
a. Level - $200						
Year 1	$-7,226	$-6,857	$-12,439	$-11,700	$-18,405	$-24,740
Year 2	280	280	760	760	1,240	1,720
Year 3 and after	520	520	1,240	1,240	1,960	2,680
b. Level - $400						
Year 1	$-7,426	$-7,057	$-12,639	$-11,900	$-18,605	$-24,940
Year 2	80	80	560	560	1,040	1,520
Year 3 and after	320	320	1,040	1,040	1,760	2,480
c. Level - $600						
Year 1	$-7,626	$-7,257	$-12,839	$-12,100	$-18,805	$-25,140
Year 2	- 120	- 120	360	360	840	1,320
Year 3 and after	120	120	840	840	1,560	2,280
d. Level - $800						
Year 1	$-7,826	$-7,457	$-13,039	$-12,300	$-19,005	$-25,340
Year 2	- 320	- 320	160	160	640	1,120
Year 3 and after	- 80	- 80	640	640	1,360	2,080
Internal rates of return to public capital invested at:						
a. Level family income - $200	6.7	7.1	9.5	10.1	10.2	10.4
b. Level family income - $400	3.4	3.7	7.8	8.3	8.9	9.5
c. Level family income - $600	-1.1	-0.9	6.0	6.4	7.8	8.6
d. Level family income - $800	n.a.	n.a.	4.1	4.4	6.6	7.8

* Less cost of housing payable from family income. Housing payments over 15 years at 10% interest equal $8.60 per month or $103.00 per year.

EXHIBIT D-16

ACHIEVABLE INTERNAL RATES OF RETURN UNDER ALTERNATE ASSUMPTIONS REGARDING FAMILY INCOME LEVELS, FARM SIZE, AND CONSTRUCTION METHODS



The most noticeable feature among the relationships shown on the exhibits is that internal rate of return values decrease with increases in farm-family incomes. This is not surprising in view of the fact that both are competing for a greater share of the limited operating income pie. Equally apparent is the rise in internal rates of return as farm sizes increase, and the number of fish farms and families who must earn a living from them decline.

The lowest curve in Exhibit D-16 is for 2.5 hectare farms. This indicates that, while small farms can accommodate more families, they are unable to provide reasonable levels of family income and internal rates of return. The average per capita income in Indonesia is estimated to range between $80 and $120 per year, or $400 to $600 for a family of five. Analysis of statistical reports of the Directorate General of Fisheries indicates that fish farmer incomes lie near the bottom of this range. The internal rate of return to a project yielding $400 to families operating 2.5 hectare ponds would average 3.5 percent. With a $600 family income, the return would be minus 1 percent, indicating that project participants would require a permanent subsidy if their standards of living were to be maintained at this level.

While five-hectare farms with $600 income levels return 6.2 percent, they provide for only half as many people. Nevertheless, in view of the opportunity cost of capital in Indonesia, which, allowing for inflation, varies from five to nine percent, [1/] the ponds would have to be at least five hectares in size to provide the farmers with a family income of $400 to $600 and project sponsors with an adequate return on their investment.

1/ Current savings interest rates in Indonesia are between 20 and 24 percent. The rate of inflation is in the 15 percent per year range.

F. External Project Benefits

This section illustrates how a sector benefit measurement (SBM) approach may be used to evaluate the social, or indirect, benefits of a development project. It will be seen that, when these external benefits are taken into account, rates of return are more favorable than when the analysis is limited to surplus flows emanating only from the project.

1. Methodology

The SBM approach is a vertical treatment of the steps involved in delivering a product to the marketplace. One way to visualize this approach is to consider the sector of the economy to which the product belongs as a column extending upward from the basic raw material to a final output sold to consumers. The column is divided into blocks by horizontal lines to indicate individual steps in the production and marketing process. A given project may fall within any one of these blocks. The SBM benefits attributable to such a project depend upon its position in the column. If it is at or near the bottom, it accumulates benefits from each block above it in the form of employment and wages resulting from the spontaneous development and/or expansion of facilities and services needed to move the product to market.

The unit of measurement in this approach is the price charged at each step in the process, which may be quantified for any project. The final price is usually posted or listed at the point of final sale. While intermediate prices are more difficult to establish, their determination is usually not beyond the resources available to those who conduct feasibility studies.

Each step in the production and marketing process is examined for its contribution to employment and wages. The resulting benefits can be expressed as a percentage of the value added to the product step by step. Such information is generally available from industry input-output studies that have been conducted in most if not all developing countries. Wage and value added ratios are known from such studies to be quite stable and are most useful references for checking study results.

This vertical approach to benefit measurement is in contrast to present methods of estimating direct project benefits and then attempting to augment them by quantifying the indirect or social benefits associated with a project. Social benefits measurement lacks precision, as it is not possible to place firm values on such indirect project impacts.

2. Sector Benefit Rates of Return

The Lampung project falls within the Indonesian fisheries sector. Defined in this manner the project includes benefits accruing to fish farmer families as well as to those persons and their families who become directly involved in reselling the fish produced by these fishermen. 1/ The SBM approach provides a precise method of measuring these benefits that are external to the project's net surplus flow. This precision is possible because price serves as a positive limiting factor. In the case of a fishpond or marine fisheries project, this factor is the difference between the final retail price and the price received by a pond farmer or fisherman, that is, the unit value-added per kilo of fish sold.

In view of the interest in measuring project benefits to the poor majority, unit value-added may be reduced to a more sensitive net benefit indicator by extrapolating that portion represented by wages and converting it into a wages to unit value added (SBM) ratio. In the case of fish sold at

---

1/ The market survey identified a number of fish resellers and calculated their present incomes. On the average these incomes were found to be about two-thirds of the mean national income per family of five persons, indicating that any improvement in their standard of living resulting from development of the Lampung project would be a significant external benefit.

Lampung and Jakarta markets, the SBM ratio or benefit indicator accruing to the project was found to average 0.371, or 37.1 percent. The prices to which this ratio applies, and the resulting benefits expressed in US cents per kilogram of fish, are as follows:

Lampung Province	:	.371 (108¢ - 60¢) = 17.8¢ per kilo
Jakarta Market	:	.371 (157¢ - 60¢) = 36.0¢ per kilo

The volume of fish expected to be sold in the markets each year, multiplied by the factors shown above, give the external sector benefits which can be added to those benefits previously identified as net surplus flows. External benefits are computed as follows.

	Lampung Province			Jakarta Market			
Years	,000 kgs	(f)	Amount	,000 kgs	(f)	Amount	Total
1	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-
3	310	17.8¢	$ 55,180	-	-	-	$ 55,180
4	404	17.8¢	71,912	476	36.0¢	$ 171,360	243,272
5	498	17.8¢	88,644	1167	36.0¢	420,120	508,764
6	592	17.8¢	105,376	1663	36.0¢	598,680	704,056
7	760	17.8¢	135,280	1765	36.0¢	635,400	770,680
8-50	780	17.8¢	138,840	1785	36.0¢	642,600	781,440

The sector benefit rate of return (SBRR) is calculated after first adding net surplus flows from the project construction and operating phases to the external sector benefit flows shown above. In the case of the Lampung project, sector benefit rates (SBRR) compare with national economic rates of return (NERR) as follows:

Case	PERR	SBRR
A	10.7	19.5
B	10.9	20.0
C	12.4	22.3
D	12.8	22.9

APPENDIX E

TIDAL HYDRAULICS

FINAL REPORT

LAMPUNG BRACKISH WATER FISHERIES PROJECT

BARD GLENNE, Ph.D., P.Eng.

TIDAL HYDRAULICS

JAKARTA, JULY 13, 1976

CHECCHI AND CO.
WASHINGTON, D.C.

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    Investigation Programs

        "Meteorologica Data Requirements", 22 June 1976
        "Tidal Data Requirements", 22 June 1976
        "Tidal Data", 2 July 1976

PREFACE

This report is concerned with the climatic, hydrologic, tidal, and environmental data base necessary to complete the technical feasibility study of the Lampung Pilot Brackish Water Pond Development as outlined in Contract No. AID/afr-C-1141 between USAID and Chedchi and Co., Washington D.C. A Summary and Recommendation section is offered in regard to interpretation of the data and information.

After a preliminary examination of available maps, reports and articles an Investigation Program detailing the meterological and tidal data requirements was delivered to counterpart on 22 June 1976 (see Appendix). From 28 June to 2 July, 1976 a visit was paid to Lampung and the project site, during which tidal and salinity measurements were made. Following these observations, on 2 July 1976, a second Investigation Program requesting tidal information was delivered to counterpart (see Appendix).

So far, no reply or data in response to the Investigation Programs has been received from counterpart. Nor have any special reports or data regarding the project or project site been prepared by counterpart. A dearth of information, especially concerning tidal and topographic conditions, has forced a reliance in this report on generally available maps and reports as well as on the few on-site measurements made.

The conclusions and recommendations offered herein are the soundest that may be made under the circumstances. Further effort expended will probably not improve on the data base unless a new data collection program can be instigated and performed.

SUMMARY AND RECOMMENDATIONS

From the available literature (see References) and observations the following general conclusions may be drawn regarding the climatologic, hydrologic, tidal and environmental conditions of the project area:

* The average air temperature is $26.9^{\circ}C$. Seasonal fluctuations in air temperature are small with a standard deviation of average monthly temperatures of $0.7C^{\circ}$.
* Relative humidity is fairly constant with an average value of about 62%.
* The 16-year precipitation record at Maringgai shows an average annual precipitation of 1830 mm with about 50% of it ~~occurring~~ occurring during December through March.
* A 24-hour rainfall of 168 mm has an average return period of 10 years.
* The average daily pan evaporation is 4.2 mm. Precipitation exceeds evaporation during nine months.
* The average wind velocity is 6.5 kph. During January-April the winds are north and north-westerly while June-October sees mainly south and south-easterly winds.
* The drainage area of the Sekampung River is about 4750 km^2. The river which is about 75-100 meter wide and 6-10 meters deep carries an average advective discharge of about 140 m^3/s.
* The tidal prism in the Sekampung River extends to well above the project area. Surface water salinities in the Sekampung River adjacent to the project area run from 4 ppt upstream to about 9 ppt at Sekampung on an ebbing tide.

* Groundwater levels in the project area seem to be from 0 to 1 m below ground level. The groundwater in shallow wells in the project area is slightly saline.
* The tide in the project area is mainly diurnal with an average tidal amplitude of 60 ± 5 cm. Coastal tidal currents are northward during the ebbing period of the Sekampung River.
* A suspended sediment zone exists along the coast. Fine sediment (organic mud) deposits are found at the month of the Sekampung River and on several reaches of the coast.
* Domestic water supply is either from shallow (1-2 meters) wells where the groundwater is not too saline or transported from inland.
* The environmental impact will to a large extent depend on how the land clearing operation is performed. Considerable wildlife as well as native vegetation now exist in the project area.

Based on this study and impressions gained while reading the literature and conferring with officials and local personnel the following recommendations are made:

1. Tidal amplitudes in the project area are too small to allow efficient filling and draining of a large number of fishponds by gravity. Pumping of water is necessary if more than 1-5 ha of fishponds are to be filled and drained per canal. Pumping of water   alleviate the usual stringent requirement for the ground elevation to be slightly above   the lowest tide

and 0.5 meters below the highest tide. Since clearing costs of mangrove on low land are considerable the installation of pumps open up the possibility of avoiding the mangrove coastal zone for actual fishpond developments.

2. Surface water salinities in the Sekampung River are too low to use the water for filling of fishponds. Tapping the saline tidal wedge in the River for the same purpose is too complicated to be practical.

3. Fishponds should be filled through canals connected to the saline coastal water. Care must be taken when constructing and operating such canals to avoid mud deposits in the canal inlets.

4. To improve sanitary conditions the regional government should drill and case deep wells (6-10 meters) for domestic water supply in new villages.

5. The regional requirement of a 400-500 meter wide greenbelt along the coast should be followed. The greenbelt should also be extended to include the banks of the Sekampung River. Throughout the project area trees should be left wherever possible to act as windbreaks and shade for humans and fish.

HYDROLOGY OF PROJECT AREA

In order to cope with storm runoff, overland flow, seepage, floods, fishpond inflow and outflow, and environmental problems it is necessary to have a firm knowledge of the hydrology of the project area. Very little hydrologic information exists for the project area, however, since climatic conditions do not vary drastically throughout this section of Lampung data have been collected for the closest reporting stations.

A. Climatology:

Most of the applicable meteorological data come from a report authored by H. Humphrey's & Sons of London in 1975 (Ref. 5). The particular gaging station of value is Sribawono which is located about 25 km NNW of the mouth of the Sekampung River. Climatological data for Sribawono are shown in Table 1.

Long term estimates of annual rainfall over the project area indicate a value of about 1900 mm/year (Ref. 5).

Table 1. Climatological Data for Sribawono, 1971-74 *

(Lat. 05°20'S, Long. 105°45'E)

Month	Air Temp. °C	Rel. Hum. %	Sun-shine hr/d	Eva-poration mm/d	Rain-fall mm/month	Wind Run km/d	Wind Direc-tion
Jan.	25.8	63	3.2	3.7	391	161	NE-NW
Feb.	26.1	65	3.7	3.4	351	154	NW
Mar.	26.3	64	3.6	3.7	339	147	NE-NW
Apr.	27.5	61	4.7	4.4	143	144	NE
May	27.0	64	2.9	3.7	161	120	SE-SW
June	26.7	65	2.9	3.7	225	138	SE-SW
July	27.5	62	3.6	3.4	67	175	SE
Aug.	27.1	63	3.7	4.4	148	164	E-S
Sep.	27.4	59	4.4	4.9	174	198	E-SE
Oct.	28.2	56	4.7	5.4	89	179	E-SE
Nov.	27.0	58	3.5	5.1	127	148	SE-SW
Dec.	26.3	63	2.8	4.1	349	142	-
Tot.			1330	1520	2565		
Avg.	26.9	62	3.7	4.2	214	156	

* source: Hydrological Network Lampung Province, H. Humphreys & Sons, London, 1975. Part 2, Volume 2.

Long term estimates of annual open water evaporation over the project area indicate a value of about 1600 mm/year (Ref. 5). The 1971-74 reporting period at Sribawono may therefore be assumed to be somewhat (35%) wetter than the average year during the last fifty years.

Rainfall data for Meringgai (1830 mm/year) and for Palas (1810 mm/year) listed in Reference 13 tend to support this last conclusion.

Rainfall intensity - duration analysis for the precipitation station of Sukadana (22 km north-west of Jepara) indicates that a 24 hour rainfall of 168 mm has an average return period of 10 years (Ref. 5).

B. Runoff:

The Sekampung River has a drainage area of approximately 4750 km^2 at its mouth. The streamgaging station with the largest drainage area is located at Purorahayu and has a drainage area of 1743 km^2 or 37% of the total drainage area. The station at Pujorahayu has been used since 1968, however the record for 1968-70 is suspect (Ref. 5 & 6).

The long-term monthly and annual streamflows have been calculated for Pujorahayu in Reference 5. A logarithmic approach to variation in the streamflows of the Sekampung drainage area leads to the result that streamflow at the mouth of the Sekampung River is approximately 200% of that at Pujorahayu. This gives an average annual advective flow at the mouth of about 140 m^3/S with a low monthly flow of about 70 m^3/S in September and a high monthly flow of about 220 m^3/S in February and March.

At Pujorahayu the difference in flood stage and drought stage is about 2.5 meters. Near the mouth of the Sekampung River this difference is considerably less, mainly due to the presence of the ocean.

During times of flood the Sekampung River overflows its banks and inundates considerable areas. Part of the project area near the River is undoubtedly inundated during February - March. However the higher terrain which may be as high as 2 meters above sea level does not become inundated. Most of the residences on both sides of the River are located on this high ground.

C. Groundwater:

Very little data exist regarding soils and groundwater conditions in the project area.

Inspections on the project site have revealed that the groundwater table is essentially at ground level or slightly below the ground. Most of the villages, which are located on the highest terrain, have dug wells and the water level in these wells was usually about 1 meter below the ground level when viewed in June/July 1976.

When viewed from the air the project area (especially on the south side of the River) appeared to have standing water over it from the coast to a distance of about 1.5 km inland. Most of this water is saline as is the water in many of the dug wells.

A deep percolation loss of 1 mm per day has been assumed in Reference 14 for clayey soils. This is considerably less than the evaporation rate of 3-4 mm per day which exists for standing water in the area.

D. Water Quality:

Reference 5 contains information on the water quality of surface water and groundwater in Lampung. Unfortunately none of the sampling stations is located near the project area.

On 1 July 1976 salinity and temperature measurements were made in the lower reach of the Sekampung River. At the time of the measurements the tide was ebbing (Low Tide at approximately 1400 hours at Sekampung). Table 2 gives the measurement results.

Table 2. Salinity of Sekampung River, 1 July 1976

Distance from Sekampung	Time of Sampling	Salinity	Temperature
6 km	0930	4 ppt	85° F
5 km	1011	8 ppt	86° F
4 km	1043	4 ppt	86° F
2.5 km	1100	5 ppt	-
1 km	1110	7 ppt	85° F
at Sekampung	1154	9 ppt	-

Table 2 shows the surface waters of the lower reach of the Sekampung River to be relatively fresh during the ebbing tide. Higher salinities may be found near the end of the flooding tide and in the saline bottom wedge of the River.

The surface waters of the Sekampung River are not saline enough to be used for filling fishponds with shrimp and/or milkfish cultures. To tap the saline tidal wedge for the same purpose is impractical, especially during times of high streamflow.

TIDAL HYDRAULICS

When examining the tidal phenomenon as it affects the project site, located near the mouth of the Sekampung River on the northwest side of the Strait of Sunda, it is important that several effects be considered. Although these effects are usually treated individually for analysis purposes it should be kept in mind that in nature two or more of the effects are usually superimposed on each other to produce a complex coastal current and tidal amplitude pattern. The integrated pattern is commonly denoted as the tidal phenomenon although several of the effects (i.e. wind, geostrophic, streamflow, barometric pressure) may be independent of the tidal mechanism.

A. <u>Currents</u>:

The prevailing ocean current in the Sunda Strait is about 0.6 knots in a northeasterly direction (approximately 34°) during the rainy season (Oct. - Mar.) and about 0.7 knots in a southwesterly direction (approximately 214°) during the dry season (Apr. - Sept.) (Ref. 3).

The tidal currents in the Strait of Sunda are 1-2.3 knots in the southwesterly direction and 0.6-1.8 knots in the northeasterly direction with the higher currents occurring during the lunar cycle when the tidal amplitudes reach a maximum. A maximum southwesterly current of about 3 knots may thus be found during the dry season and a maximum northeasterly current of about 2.4 knots during the rainy season. Winds may assert an additional surface current component.

The tidal currents in Sunda Strait are by and large diurnal in nature with a small semi-diurnal component. The current periodicity is approximately 24.8 hours with High Slack Water occurring 3-5 hours prior to High Tide. Low Slack Water coincides approximately with Low Tide.

On the coast, in the Sekampung River area, these coastal currents are attenuated due to the widening of the Sunda Strait and the friction of the coastal shelf. Near the mouth of the Sekampung River the ocean currents are affected by the river mouth (estuary) hydrography as well as the advective flow of the River.

During ebbing of the estuary the coastal current is northward which places the relatively fresh river water to the north of the river mouth. Differences in densities force the relatively fresh river water to spill out as a surface layer over the more saline ocean water.

The fine clayey sediments contained in the river water are deposited immediately seaward of the estuary to form the estuary bar or are carried northward by the ocean current. Prevailing winds and waves from the northeast may upset this pattern.

The streamflow in the Sekampung River produces a maximum advective freshwater current of 0.5-3 knots across the estuary bar depending on season. In addition the tidal prism interchange causes a reciprocating tidal current. in the River.

B. Amplitudes

Simply speaking a tide may be viewed as a long ocean wave formed by attraction to the moon and the sun. Temporal variations in tidal amplitudes are due to changes in the lunar cycle as well as the ordinary diurnal and semidiurnal changes. Spatial variations in tidal amplitudes are due to the earth's orientation and the hydrography of landmasses and coastal bays and headlands. Narrow inlets or constricted entrances to bays or estuaries usually cause significant spatial variations in tidal amplitudes. The same is found in bays where near resonance conditions may be created by the tidal phenomenon.

The tidal amplitude is of vital importance when filling and draining fishponds by gravity. Jamandre Jr. and Rabanal (Ref. 11) state in their UNDP report that 100 cm is the minimum tidal amplitude necessary for efficient gravity operation of fishponds. Bersamin (Ref. 12) reiterates this conclusion in his World Bank report.

To determine the available tidal amplitude in the project area data were taken from the Tide Tables (Ref. 4) and observations of tidal amplitude were made on the outside and inside of the Sekampung estuary. Three tidal stations, Tanjung Priok in Jakarta on Jawa, Teluk Betung near Tanjungkarang in Lampung, and Tanjung Pandan on Belitung, are located fairly close to the project area and have tidal records tabulated in the Tide Tables (Ref. 4). In addition Mr. Rachmat of the Biro Oseanografi, Navy Department of Hydrography, Jakarta furnished the author with amplitude records from Merak on Jawa which is located directly across the Sunda Strait from the project area.

One station, Teluk Betung, exhibits a semi-diurnal tide while the other two show a mainly diurnal tide with a dominant period of 24.8 hours. The Teluk Betung tidal station is located at the head end of a 40 km long bay (Teluk Lampung) and the tidal record is most likely influenced by the bay geometry and hydrography (Ref. 10). The 24-hour tidal observation carried out on June 30/July 1 at the project site showed a diurnal tide characteristic.

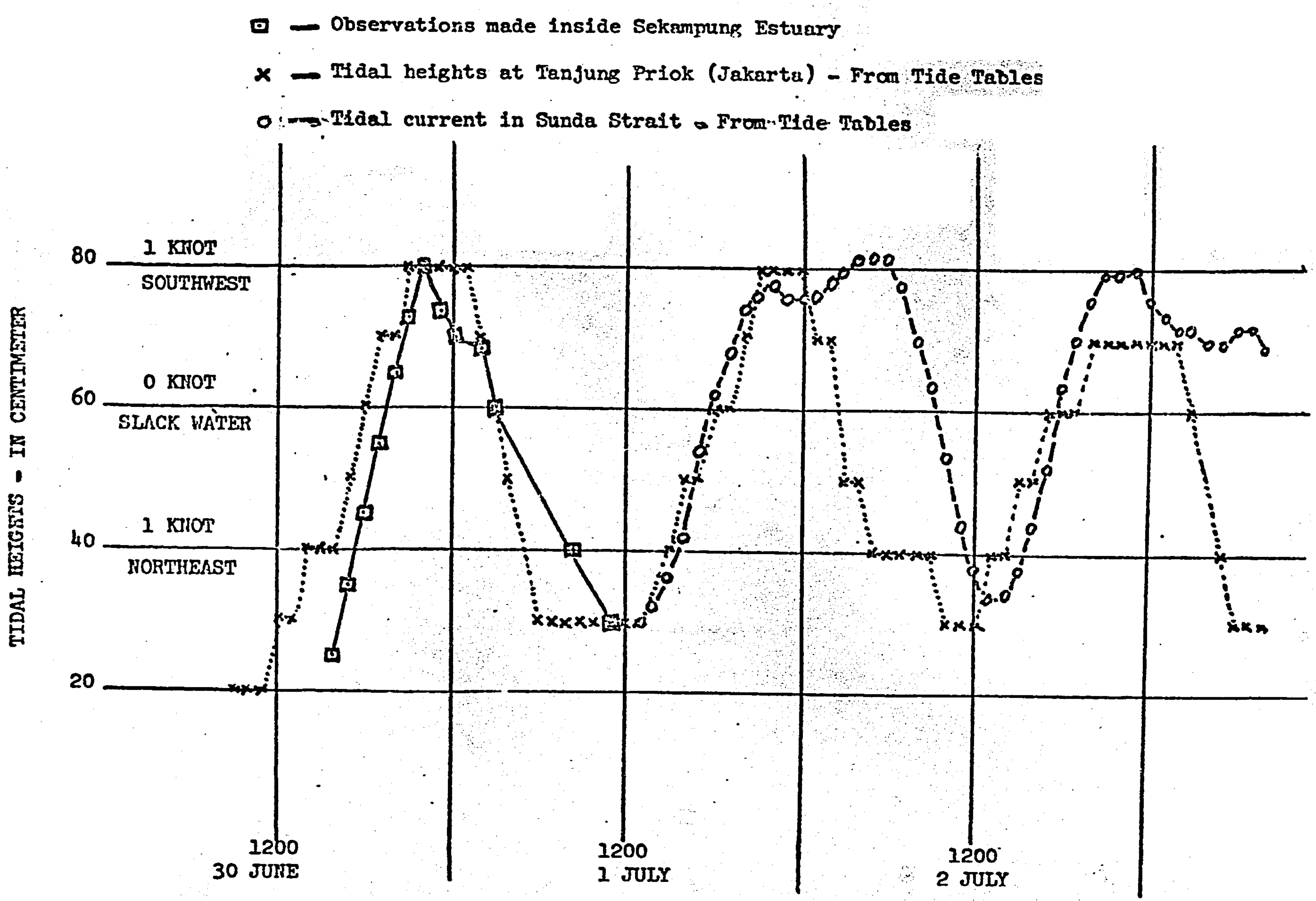
Table 3 gives a summary of tidal characteristics at four locations as well as at the project site. The data at Sekampung are based on a 24-hour observation period.

Table 3. Summary of Tidal Characteristics

Station	Province	Distance	Tide Type	Avg. Amplitude
Tanjung Pandan	Belitung	345 km	Diurnal	169 cm
Teluk Betung	Lampung	110 km	Semi-diurnal	74 cm
Tanjung Priok	Jakarta	135 km	Diurnal	59 cm
Merak	West Java	44 km	-	45 cm
Sekampung	Lampung	-	Diurnal	60 cm ± 5 cm

Two of the tidal stations in Table 3, Tanjung Pandan and Teluk Betung, are of little value when trying to estimate the tidal characteristics at or near Sekampung. Tanjung Pandan is located too far away from Sekampung (345 km) and Teluk Betung is located at the head of a considerable bay.

FIGURE 1. TIDAL HEIGHTS AND CURRENTS



During June 30/July 1 when the tide was observed inside and outside the Sekampung estuary the tidal heights in the estuary were found to follow closely those predicted for Tanjung Priok in the Tide Tables (Ref. 4). When correlating the thirteen observations of tidal heights at Sekampung with the corresponding thirteen predicted tidal heights at Tanjung Priok a linear correlation coefficient (r value) of 0.91 was obtained. It therefore seems reasonable to assume that the tidal heights at Sekampung do not diverge significantly from those predicted for Tanjung Priok in the Tide Tables (Ref. 4).

An average tidal amplitude of about 60 cm may therefore be assumed for Sekampung with a maximum amplitude of about 100 cm and a minimum amplitude of about 30 cm. This conclusion is also supported by observations of beach faces in the area. A longer period of observation of tidal heights at Sekampung would be necessary in order to further refine this conclusion.

An investigation of possible tidal choking across the bar at the mouth of the Sekampung estuary gives an approximate friction coefficient of about 0.3 and negligible choking of the tidal amplitude across the bar (Ref. 9). The observations taken outside the Sekampung estuary of tidal amplitude were masked by wave action and an accurate comparison of inside and outside amplitudes could not be made.

C. Structures:

To admit saline water to the fishponds and to drain superfluous water from the project area canals must be dug through the green-belt of vegetation lining the coast and connected to the sea. In practice it is difficult to make the connection maintenance free because of the constant erosion and sedimentation process taking place on a coast. Reference 15 contains design information on the various structures (groins, jetties, etc.) used for stabilization purposes.

The onshore-offshore transport of sand is usually seasonal and wave size dependent. Small waves normally transport sand onto the beach face while bigger waves tend to erode the beach face. Longshore transport of sediments is caused by the oblique impact of waves on the beach. Again a seasonal variation is often found.

The prevailing wind directions on the coast are from the N-NW during Jan.-April and from S-SE during June-October. This should mean a southward transport of sediments during Jan.-April and a northward transport during June-Oct.

The project-area coast has a relatively small tidal amplitudes and a gentle wave climate. However the fineness of the sediments found in the area means a constant sediment suspension along the coast. The littoral zone is therefore relatively wide and active along the project area and canal openings may silt up. To prevent this canals should occasionally be flushed and dredged when necessary.

The small tidal amplitudes mean that pumping facilities would be necessary to convey sufficient quantities of saline water (about 120 m^3/day/ha.) through the canals to the fishponds.

ENVIRONMENTAL IMPACTS

Prior to 1973 no fishponds existed in Lampung. At the present time, fishponds are under construction in Maringgai and Sekampung. Part of the reason for this late development has been the environment; namely lack of tidal amplitude for filling and draining of the fishponds by gravity.

Usually fishponds have been built one by one, and their environmental impacts have been slow and gradual. In the case of Sekampung the proposal is to develop 3000 ha over a relatively short time span and the environmental impact will be sudden and considerable. Basically the impact will be on humans, land, water resources, wildlife, fish, and flora and fauna.

A coastal belt $\frac{1}{2}$-1 km wide is now covered with mangrove. Inland of this strip forested areas (api-api, pidada, baicau) and grasslands exist. The natural environment will change from jungle, grassland and beach to one of cleared land, subdivision and organized fish cultivation. The impact of this change depends to a large extent on exactly how the land clearing is carried out. To minimize the impact a green-belt should be left standing along the coast and between fishpond sections. A source of firewood should be made available to keep trees in the green-belt from being cut for firewood. The green-belts will act as windbreaks and provide shade to humans, fish and animals.

The presence of a large water surface as well as less greenery will affect the nicro-climate of the area. Wind and humidity will increase slightly as will the ground temperature. Drainage of surrounding swampland may be necessary to control mosquito breeding.

Roads and villages will be located on relatively high ground and easily identified. Care must be taken to prevent them from becoming eyesores.

Birdlife is presently plentiful in the area. Egret, hawk, and cicarawa can be easily seen and heard. With the removal of trees the birds will lose their nesting sites and may choose to emigrate. If not, they will probably be hunted to extinction in the area. Tigers have also been reported and crocodiles exist in the Sekampung River. Monkeys now live in the wooded areas.

The Sekampung River will become an important artery with increased boat trafficz to Palas and Sekampung. Undoubtedly this will have an impact on the river banks as settlements grow up along the river.

A considerable increase will also be seen in the boat traffic into and out from Sekampung. This will have the effect of making a trading center out of Sekampung which is not an ideal townsite because of its lack of potable water and high saline groundwater condition.

Along the coast, canal inlets will be constructed and seawater withdrawn. This will have an effect on the longshore sediment transport with erosion and deposition patterns forming.

Draingage of fishponds and land will add nutrient-rich water to the coastal water. This should enhance coastal fishing. Reports from East Java (Ref. 8) indicate that the use of insecticides (thiodan) in ricefields has affected fishpond cultivation. Since the use of herbicides and pesticides in fishpond cultivation must be applied in a manner not to decrease the fishpond production it is probable that fishpond drainage can safely be discharged to the coastal environment.

Reference 8 outlines the concern existing regarding Indonesia's coastal environment. Sediments, insecticides and oil are listed as the worst pollutants. Mud deposits in the coastal zone is a problem in the project area. Careful soil management procedures need be established to avoid washing soils from denuded areas into the Sea of Java.

DOMESTIC WATER SUPPLY

Contaminated water is the principal agent in transmission of typhoid, cholera and dysentery (shigellosis). Although difficult to quantify, the benefits from a potable water supply and an effective method of excreta disposal are thought to outweight the costs of providing such systems (Ref.1).

At present some villages on the East Lampung coast must import its domestic water due to salt penetration of groundwater aquifers. Others obtain their water from hand-dug wells, about 1-1.5 meters deep. Water consumption varies from about 20 lcd to about 50 lcd (Ref.2). Excreta disposal is usually into a nearby canal or stream.

To remedy this situation, 6-10 meter deep wells should be driven and cased. The top should be fitted with a hand pump and sealed. Such a hydrant can usually yield about 5-8000 lpd and supply 100-200 persons. Water treatment is rarely necessary. Cost of such a well and hand pump is usually about 30,000 Rupiah or about 300 Rupiah per capita.

Excreta disposal should be by pit latrines. Pit latrines are usually dug by hand at a cost of about 2000 Rupiah and should be sealed with earth when nearly full.

One of the aims of the proposed project is to improve upon the living conditions of the transmigrants. The sanitary system outlined above constitutes a minimum requirement necessary to achieve acceptable public health standards. Since each village is not capable of drilling and casing its wells the sanitary system, and probably the major share of its cost, must be the responsibility of the regional government.

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A P P E N D I X

I N V E S T I G A T I O N   P R O G R A M S

LAMPUNG BRACKISH WATER FISHERIES PROJECT

Meteorological Data Requirements:

22 June, 1976

1. Evaporation record

    * average monthly pan evaporation in South Sumatra

2. Precipitation record

    * average monthly precipitation near project site

3. Solar Radiation record

    * average monthly solar radiation in South Sumatra

4. Wind Velocity and Direction record

    * average monthly wind per day and dominant direction near project site

LAMPUNG BRACKISH WATER FISHERIES PROJECT

Tidal Data Requirements:

22 June, 1976

1. Tidal record from Mareingai

   * data for one lunar cycle (elevation vs. time)

2. Estuary salinities in the Sekampung River

   * salinities of bottom and surface waters in the river, starting at the mouth and proceeding upstream at 500-meter intervals

3. Suspended sediment concentrations in the Sekampung River

   * suspended ~~sediment conc~~ sediment concentrations of surface and bottom waters in the river, approximately four km upstream from mouth

4. River stages and flows in the Sekampung River

   * highand low river levels at a point approximately four km upstream from mouth (fluctuations in river stage with season)

   * approximate flows and velocities in the Sekampung River (flood season, dry season), near its mouth

INVESTIGATION PROGRAM

2 July 1976

TIDAL DATA

To be measured during 5-10th of July 1976.

Tidal heights to be measured every hour on the staff gage established in front of the Department of Fishery station in Airud, Way Sekampung.

Measurements should be to the nearest 5 centimeter and should last for three days (72 hours).

An example of a data sheet is shown below:

Date	Hour	Tidal height
5-7-76	0100	-
"	0200	-
"	0300	-
"	00400	-