BAY OF BENGAL PROGRAMME

DEVELOPMENT OF SMALL-SCALE FISHERIES

EXPLORATION OF THE POSSIBILITIES
OF COASTAL AQUACULTURE
DEVELOPMENT IN ANDHRA PRADESH

BOBP/WP/17

TECHNICAL COOPERATION (TCDC)
AMONG DEVELOPING COUNTRIES

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Development of Small-Scale Fisheries GCP/RAS/040/SWE

EXPLORATION OF THE POSSIBILITIES OF COASTAL AQUACULTURE DEVELOPMENT IN ANDHRA PRADESH

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TECHNICAL COOPERATION AMONG DEVELOPING COUNTRIES (TCDC)

Cooperating Agency:

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This working paper is the report of a three-member mission from the Directorate General of Fisheries, Indonesia, which visited Andhra Pradesh for six weeks early in 1981 at the request of the Government. The FAO/SIDA Bay of Bengal Programme (BOBP) acted as supporting agency for the mission in accordance with the Buenos Aires Action Plan of the United Nations to foster Technical Cooperation among Developing Countries (TCDC).

Several people in the state assisted the mission during the study. Mr. S. Banerjee, Director of Fisheries, and other fishery officers in Hyderabad and at district levels in Krishna, West Godavari, East Godavari, Srikakulam and Nellore provided information and made necessary arrangements for field visits and interviews; logistic support from district collectors and sub-collectors greatly facilitated the work of the mission.

Dr. M. Karim of the BOBP assisted the mission during the study and the report preparation. The costs of travel and of servicing the mission were met by BOBP, also the costs of publication of the report.

The Bay of Bengal Programme for the Development of Small-Scale Fisheries, GCP/RAS/040/SWE, referred to in brief as the Bay of Bengal Programme (BOBP), is funded by the Swedish International Development Authority (SIDA) and executed by the Food and Agriculture Organisation of the United Nations. Five countries — Bangladesh, India, Malaysia, Sri Lanka and Thailand — are members of the Programme. Its main aims are to develop and demonstrate technologies and methodologies to improve the conditions of small-scale fisherfolk and the supply of fish from the small-scale sector in the Bay of Bengal region.

The views and recommendations presented in this paper are those of the mission members and not necessarily those of the Directorate-General of Fisheries, Indonesia or the FAO.

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1. THE MISSION

1.1 Background

1.1.1 Between 1972 and 1979, fish production in Andhra Pradesh fluctuated between 178,600 tonnes and 258,600 tonnes; the best year was 1974. Of this 159,000 tonnes came from the sea and the rest from inland waters. The traditional fisheries produce over 90 per cent of the total.

1.1.2 The policy of the Government is to accelerate fish production from all available sources, to increase export earnings from fish, and to improve the socio-economic status of fishermen.

1.1.3 The brackishwater resources of Andhra Pradesh include estuaries, creeks, canals, tidal flats and salt marshes which together cover an estimated area of 0.2 million hectares. There is an abundance of naturally-occurring juveniles of commercially-valuable species such as shrimp *(Penaeus indicus, P. monodon),* milkfish *(Chanos chanos)* and mullets *(Mugil spp)* that could be captured for stocking fish farms, and the climate and other environmental factors are in general favourable for culture of such species. However, the rise and fall of the tides on the coast of Andhra Pradesh is small, and the elevation of the land above the sea, particularly in the south of the state, is such that opportunities for pond culture with natural refreshment and replenishment of the pond water are limited. For these reasons, coastal aquaculture is for the most part still at the experimental stage in Andhra Pradesh, cultivation of fish is as yet on a very small-scale, and with few exceptions employs traditional, extensive methods.

1.1.4 The policy of the Government is to develop those areas of derelict land on the coastline that are most suitable for aquaculture, so as to produce both shrimp and fish. This will be done as far as possible through cooperatives of people from the weaker sections, fishermen in particular. Other areas of public lands on the coastline, where fish farming should be possible. may be allotted to private entrepreneurs, small and big.

1.1.5 In pursuit of these aims, the Government of Andhra Pradesh requested technical assistance in exploring the possibilities of developing coastal aquaculture, and the Directorate-General of Fisheries of Indonesia kindly agreed to fiet'd a mission to provide the requested assistance. The FAO/SIDA Bay of Bengal Programme undertook to act as supporting agency under the concept of Technical Cooperation among Developing Countries (TCDC), fostered by the United Nations under the Buenos Aires Action Plan.

1.2 Terms of reference, composition and activities

1.2.1 The terms of reference of the mission are reproduced in Appendix 1. Briefly, the mission was to review the present activities in coastal aquaculture in the state; to identify potential sites for shrimp culture by small-scale fish farmers; and outline the requirements for establishment and operation of a pilot project. In assessing the potential for development and further expansion of coastal aquaculture, the mission took into account the following factors:

- The present level of technology employed by fish farmers.
- The availability of undeveloped lands within a favourable range of ground elevation and tidal amplitude.
- The manpower situation in the weaker sectors, particularly among the fishermen.
- The quality, quantity and effectiveness of government services provided to the aquaculture industry.
- The availability of credit for small-scale fisheries activities.
- The local, national and export marketing situations.
- Related infrastructure such as roads and availability of ice and other facilities.

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- The possibility of utilizing pumps to fill ponds in elevated areas.
- The probable impact of aquaculture development on employment, income, nutrition and other socio-economic aspects of the low-income population.

1.2.2 The members of the mission were:

Soleh Samsi, Fisheries Biologist
Sihar Siregar, Fishery Specialist
Martono, Aquaculture Engineer

all three of whom were members of the staff of the Directorate-General of Fisheries, **Indonesia.**

1.2.3 The mission began work in the field on 27 January 1981 ana continued until 6 March 1981. A detailed itinerary is attached (Appendix 2). Of the nine administrative districts on the coast of Andhra Pradesh, five were visited.

1.2.4 Appendix 3 lists the principal documents consulted by the mission. Additional new information on hydrology and soil types was provided by the Department of Fisheries of Andhra Pradesh, which mounted a three-day survey in the field during September 1980 in order to obtain it.

2. CURRENT SITUATION

2.1 Geography

2.1.1 The state of Andhra Pradesh lies between latitudes 13o **40' and 19°N and longitudes 80°E and 85°E. It is** bounded by the Bay of Bengal in the east, the state of Tamil Nadu in the south, Karnataka in the west and south-west, Maharashtra in the north-west and Orissa and Madhya Pradesh in the north. The state has 23 revenue districts, of which nine are coastal (Appendix 4).

The total area is 277,000 km^2 or 8.4% of the Union. The coastline is 942 km long and the continental shelf (up to 200 m depth) has an area of more than 31,000 km^2.

2.1.2 The climate is tropical and characterised by two monsoons: the north-east monsoon (October/December) and the south-west monsoon (June/September). Cyclonic weather is common during October and November. The calmest period is from January to April. The temperature varies between 15°C and 44°C. The main rivers are the Godavari and Krishna. Valuable natural resources and products include iron, edible oils and oil cakes, tobacco, jute, sugar, rice, cotton, onion, coconut, chillies and mangoes.

2.2 Fisheries development

2.2.1 The Government of Andhra Pradesh is responsible for the development of fisheries within the state although the Central Government issues guidelines for overall planning and also finances some development schemes. Present policies regarding fisheries development, including brackishwater aquaculture, have been outlined above (Section 1.1).

2.2.2 The government operates schemes for giving financial grants to aid fisheries development. Several development agencies and financial institutions also play important roles in implementing fisheries activities; they include the Agricultural Refinancing Development Corporation (ARDC), the National Cooperative Development Corporation (NCDC), the Integrated Rural Development Programme (IRDP), the Drought Prone Area Programme (DPAP), the Small Farmers Development Agency (SFDA) and the Scheduled Castes and Backward Classes Committee (SC & BC) as well as commercial banks. All of these provide assistance to fishermen in the form of credit.

2.3 Present state of brackishwater aquaculture

Three government institutions deal with the subject.

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2.3.1 The Central Institute of Fisheries Education (CIFE) operates a farm on a 7.5 ha site, with 2.6 ha of water surface, for field experiments and demonstrations. The Institute offers training in management of shrimp hatcheries, management of fish and shrimp farms, culture of food organisms, etc. The productivity (from small ponds) is said to be between 1,200 kg/ha and 2,000 kg/ha of fish and shrimp.

2.3.2 A brackishwater experimental fish farm of 0.75 ha was established by the Indian Council of Agricultural Research (ICAR) as one of their All India Coordinated Research Projects. The project was subsequently transferred to the Andhra Pradesh Agricultural University. Mono-culture of *Penaeus monodon* has produced 430 kg/ha in two crops per year. A 10-month long polyculture experiment with mullet, milkfish and shrimp yielded 1063 kg/ha of fish and shrimp.

2.3.3 The Andhra Pradesh Fisheries Corporation (APFC) is operating a shrimp culture project on a 76 ha site. The ultimate area of water surface in the ponds is planned to be 45 ha; 23 ponds, each 1 to 1.25 ha, have been completed. The systematic stocking of the ponds with fish and shrimp seeds commenced in September, 1980.

The Corporation has plans for constructing large-scale brackishwater farms in different districts; they will lease the ponds to fish farmers, particularly fishermen cooperatives, on a long-term basis. The Corporation will provide technical guidance and supervision for culture operations, buy the entire production from the farmers and recover from the farmers the costs of construction in easy instalments.

2.3.4 Some individuals in Srikakulam district have for long been practising brackishwater culture in backwaters in a traditional way, by trapping and holding. Various improvements in the methods of culture have been implemented by some fish farmers in Kakinada.

2.4 Potential for brackishwater aquaculture

2.4.1 The Department of Fisheries carried out a survey of a preliminary nature (with relatively few individual observations) during 24—26 September 1980 simultaneously in the nine coastal districts. The area covered was 64,000 ha. The proportions owned by various proprietors are given in Appendix 5.

From these comparatively few and short-term observations, the Department of Fisheries made a tentative estimate that about 17,000 ha in all might be suitable for coastal aquaculture.

3. OBSERVATIONS

After the field visits, discussions with people concerned and study of available reports and other material, the mission was able to make the following observations:

3.1 Climate

3.1.1 In general, the climatic conditions of the coastal districts are favourable for brackishwater aquaculture of the kind practised in the region.

3.1.2 The year can be divided into four seasons, namely: south-west monsoon (June—September), north-east monsoon (October—December), winter (January—February) and summer (March—May). The minimum air temperatures which occur in the month of January are 18—20°C. Maximum temperatures (36—40°C) occur in May. Appendix 6 gives details for the five coastal districts.

The average rainfall is in the order of 1000 mm per year, the lowest being recorded from Prakasam district and the highest from East Godavari. The monsoons account for more than 90% of the rainfall (Appendices 7 a and b).

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3.2 Vegetation

3.2.1 The density of vegetation at the different sites examined varied a great deal, but was generally low. There is no vegetation at some of the sites visited e.g. Calingapatnam and Takalli in Srikakulam district; Pedamynavarilanka and Mutyapalli in West Godavari district; Pedapatnam, Interu, Palakaiatippa and Sorlagandi in Krishna district and Tadakothikuppam and Ramapuram in Nellore district. The sites visited in East Godavari district have vegetation cover to the extent of 10 to 75 per cent.

3.2.2 The predominant species in the vegetation are *Avicennia* with a very few *Rhizopora* in the form of shrubs less than 1 m high. The clearing of such vegetation would not be a great problem on any of the sites except at Pora and Polekurru in East Godavari district and at Gilakaladindi in Krishna district. Additional financial provision would be required whenever mangrove clearing is necessary.

3.3 Land elevation and tidal amplitude

3.3.1 The economics of brackishwater farming in ponds is affected by the height of the site above the sea and by the tidal range i.e. the total rise and fall. The ground elevation most to be preferred is one which approximates the mean sea level (MSL) or the mean between mean high tide (MHT) and mean low tide (MLT). In such a case, and if there issufficient rise and fall of tide, refreshment, emptying and replenishment of pond water can be effected without the use of pumps. Where the ground is high above the water, pond construction is more expensive because more excavation has to be undertaken, or else resort has to be had to pumping water. Pumping may in any case be necessary in situations where the tidal range is smaller than the required depth of water in the ponds. This is the case in the south of Andhra Pradesh.

3.3.2 Unfortunately there was no data on the topography and the ground elevation of the sites visited. According to the quick, rough survey of September 1980 and the mission's own observations, it would seem that the proposed sites in Krishna, West Godavari, East Godavari and Srikakulam districts have in general somewhat high elevations. The rise of tide recorded during the 3-day survey conducted by the Department was only in the range of 0.07—0.44 m in Krishna district, 0.08—0.80 m in West Godavari district and 0.02—0.90 m in East Godavari district, whereas for the type of fish farming contemplated, pond depths must be up to 1 metre. Pumping is therefore unavoidable at some stage of the fish farming cycle if conventional techniques of cultivation, requiring emptying, refilling and replenishment of the ponds, are used. Based on the data available on tidal amplitudes the coast can be divided into three areas:

- Medium tidal areas with 1.20—1.60 m as in West Godavari, East Godavari and Srikakulam districts.
- Low tidal areas with tidal fluctuation 0.80—0.90 m as for example in Krishna district.
- Very low tidal areas where the tidal fluctuation does not exceed 0.8 m as for example in Nellore district.

3.4 Soil

3.4.1 Sandy soil is not recommended for brackishwater pond construction because it is unsuitable for construction of stable dykes and allows seepage of water. Acid sulphate soil, with low pH, should also be avoided.

3.4.2 The data from the September survey and field observations revealed that the soils generally are sandy barns and clayey loams in Srikakutam, sandy clays and silty clays in East Godavari, sandy clays and clayey barns in West Godavari and Krishna districts and sandy or sandy barns in Nellore district. The soil pH is in the range 7.5 to 8.5 in the five districts.

3.4.3 The soil quality in all the districts, except Nellore, seems favourable for brackishwater farming.

3.4.4 The mission made no observations on the availability of fertilizer.

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3.5 Water quality

In brackishwater fish farming, the quality of the water in respect of salinity, temperature, turbidity, pH, dissolved oxygen and CO_2, and absence of detrimental chemicals such as ammonia and agricultural pesticides, is important.

3.5.1 Milkfish *(Chanos chanos)* and shrimp *(Penaeus monodon)* haveawide range of tolerance to salinity (0—40 ppt) but a concentration of 10—25 ppt is most favourable for theirsurvival and growth.

The brackishwater species of interest are also eurythermal but if the temperature approaches or exceeds 40°C mass mortalities of farmed stock must be expected. This is why the design of shallow fish ponds in the tropics should provide for a deep ditch or peripheral canal in which the fish can take shelter from the heated surface water.

The turbidity of water will influence the depth to which sunlight can penetrate and stimulate the growth of natural food in the pond.

As regards acidity, a pH of between 6.5 and 8.5 is considered fair to good for pond productivity.

3.5.2 Water quality at the sites visited appears to be good to satisfactory. Salinities in the range 5—38 ppt were recorded in the districts from Krishna to Srikakulam. The salinity in Pulicat lake (Nellore district) reportedly rises to 80 ppt at times. Records show that pH and temperature remain most of the time within tolerable limits.

3.6 Seed supply

3.6.1 Timely and adequate supply of seed of the desired species is a prerequisite for successful farming. In many instances, fish farmers rely on natural seed supply, especially in brackishwater culture. The availability of adequate natural seed supply in the vicinity of such fish farms must therefore be carefully checked. In the longer term, it might be wise to consider the establishment of hatcheries for both shrimp and fish.

3.6.2 Published data and observations in the field suggest that the natural seed supply of commercial species of fish *(Chanos chanos* and *mugil spp)* and shrimp *(P. monodon* and *P. indicus)* is plentiful in the vicinity of most of the potential sites. Although the seeds are available throughout the year, the availability of shrimp seed peaks in June—August and October—December. For milkfish the peak periods of abundance are April—July and November—December while for mullets the peak is during October—February.

3.7 Observations on particular sites

3.7.1 *Kakarapali, Srikakulam district*

The mission visited a brackishwater site in Kakarapali, Tekali taluk. It covers 1236 ha and is owned by the East Coast Chemical Ltd., a state corporation. It is located 10 km inland and is only slightly influenced by the tide; rise and fall is 0.3—0.35 m.

The saltwater creek which cuts across the land harbours the seed of milkfish and mullet from May to September. Some fishermen practise traditional fish culture in saltwater reservoirs which they fill by pumping water from the nearby creek. The shrimp and fish seeds get into the reservoirs along with the incoming water and grow there for 4—6 months after which the crop is harvested. The farmers find this culture practice quite profitable because of the low costs. In view of the very low tidal amplitude and sandy nature of the soil, the site cannot be recommended for brackish-water fish ponds. Some areas on the site which, according to the available data, remain permanently submerged (1 to 2 m of water) appear to be suitable for pen culture.

3.7.2 *Ca/ingapatnam (Vomerava/li)*

A brackishwater shrimp and fish culture complex covering 36 ha is being constructed under the direct control of the District Fisheries Cooperative Corporation (DFCC) of which the District Collector is the chairman and the Assistant Director of Fisheries is the secretary. About 60 ha of additional area suitable for aquaculture is available in the neighbourhood. The environmental

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factors at the sites appear to be favourabTe. The feeder canal coming from the Vamsadhara river estuary is, however, too narrow to supply adequate water to the whole area. Moreover, the nearby salt industry competes with the fish project for water.

The DFCC plans to obtain additional water directly from the sea by using the drainage canal of the project as a supply canal during high tides. Such an arrangement works at best temporarily because the ponds will be prone to silting. Although dredging once or twice a year might solve this problem, it would be expensive and a permanent liability. It would be better to widen the existing narrow feeder canal to two or three times its present width in order to provide adequate water to the farm, or alternatively to excavate a new feeder canal at a point of the site close to the river.

Three one-hectare ponds were under construction at the time of the mission's visit. The mission suggests that one set of five ponds should be compTeted in the first instance and trial culture operations conducted before constructing more ponds. A suitable design of pond for this site would be the one recommended below which is designated Type-B.

3.7.3 *Pulicat lake*

The mission visited three sites on Pulicat lake, namely: Thadakotha (75 ha), Ramapuram (200 ha) and Vatambedu Kuppam (30 ha). The salinity at these sites is very high, 40—60 ppt, and the tidal fluctuation low, 1—31 cm. For these reasons none of these sites can be recommended for brackish-water culture.

Pen culture trials with mullet or shrimp in the lake itself in water depths of 1 to 2 m might be worthwhile. Some of the salt pans in this area could be utilized for shrimp culture during the rainy season.

3.8 Manpower

3.8.1 In Krishna, West Godavari, East Godavari and Srikakulam districts the total number of fishermen is around 270,000 of whom only 54,000 or one-fifth of the total number are really active fishermen while the rest usually work as labourers in the fish industries. The income of a fisherman is said to be Rs. 200/month.

3.8.2 Technical support, training and extension are discussed in Chapter 4.

4. OUTLINE OF PROPOSED PROJECT

4.1 Strategy

4.1.1 The mission is of the opinion that the Government plan for large-scale brackishwater aquaculture activities should be preceded by pilot schemes on sites typical of various distinct ecological areas, particularly in respect of land elevation and tidal amplitude. The sites for such pilot schemes should be selected in areas where adequate space is available for further expansion of fish or shrimp farming activities centering around the pilot scheme.

4.1 .2 The system of aquaculture envisaged is culture in certain types of pond as recommended below.

Each pilot scheme could consist of five to ten ponds, the practicable minimum being five. Each pond, 1—1.5 ha, would be owned by a family of fish farmers/fishermen. Thus, there would be five to ten families in each pilot scheme. These families would be grouped together to form fish farmer associations.

4.2 Design of ponds

4.2.1 Taking into account the ground elevation and the tidal fluctuation, the mission recommends one or other of two types of modules for the pilot schemes. Both types of pond will have a peripheral canal and central platform in order to reduce costs of construction.

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4.2.2 *Pond type-A*

The arrangement and principal features of a Type-A pond complex are shown in Appendix 8. Each pond unit would be square, with a peripheral canal 6.0 m wide and 90—100 cm deep; over the platform (center portion) the depth of water would be 40—50 cm. Appendix 9 shows the stages of digging.

The shape of Type-A ponds is square in order to minimize costs of construction. The one hectare unit will consist of a nursery pond of 200 m^2, a catching pond of 300 m^2 and a rearing pond of 9500 m^2. The depth of water is the least in the nursery pond and the greatest in the catching pond as indicated in Appendix 8. The recommended culture system for this type of pond is polyculture of milkfish and prawn, with two culture periods per year. Pre-stocking pond preparation should include ploughing of the pond bottom, pest eradication, fertilization, etc., in order to increase the productivity of the pond.

4.2.3 Type-A ponds are recommended for low tidal areas (tidal fluctuation 0.8 to 0.9 m), such as Kanuru, Pedapatnam and Gilakaladindi in Krishna district. The total available area considered suitable for brackishwater fish ponds at those three sites is about 300 ha which could accommodate up to 300 units of one-hectare family-size fish ponds.

During the survey of September 1980 the ground bevel was submerged at high tide to a depth of 22—27 cm. The tidal range near the sites was 80—90 cm. These findings suggest that the canal will have to be excavated to a depth of at least 70 cm. The ground in way of the platform would then have to be excavated to a depth of 20 cm. Watering and dewatering of the ponds may be possible by gravity during June—November when the biggest rise and fall of tide is experienced. During the remaining six months of the year, i.e. from December—May, resort must be had to pumping in order to fill the pond and replenish pond water from time to time. Permanent provision of a pump is suggested in order that the farmers can meet any urgent requirement of water exchange or replenishment at any time of the year.

4.2.4 Type-A is also recommended for Pora, Pandi and Pallam in East Godavari district. Although the district, in general, is classified as a medium-tidal area where the tidal fluctuation is 1.20—1.60 m, these 3 sites are situated as much as 17 km inland and the rise and fall of tide is only 0.80—0.90 m.

4.2.5 *Pond type-B*

This design is recommended for sites of medium tidal fluctuation (1.2—1.6 m).

The Type-B pond, although of the same area as Type-A, differs in shape and depth of excavation. It is rectangular (50 m x 200 m) because experience suggests that shrimp grow better in long narrow ponds. The depth of excavation should be 100 cm for the peripheral canal and 70 cm over the platform. Although, therefore, the earthworks required are greater than for Type-A, and hence initial capital investment is heavier, management i.e. watering and dewatering of the pond could be done entirely by using the tide and gravity. This would obviate the need for a pump and the concomitant capital and recurring costs for pumping and maintenance. The reason for deeper excavation, despite wider tidal fluctuations in the areas under consideration, is that the land elevation is relatively high at these sites.

Monoculture of high-priced shrimp is recommended for this type of pond.

The general layout of a Type-B pond complex and detailed design of an individual pond have been depicted in Appendix 10.

4.2.6 The sites suitable for Type-B ponds include Pedamynavarilanka in West Godavari (280 ha); Polekurru in East Godavari (800 ha); and Calingapatnam (Vomeravalli) in Srikakulam (36 ha).

4.2.7 Basic designs for various water control gates to be used in both Type-A and Type-B ponds are furnished in Appendix 11.

4.3 Organization and management

4.3.1 Depending on the policy of the Government regarding the allocation and use of public

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land, the pilot schemes might be administered either under a Pilot Scheme Management Unit (PMU) or an Industrial Organization (Nucleus Industry).

4.3.2 The purpose of the PMU pilot schemes would be to develop appropriate culture techniques suitable for small-scale operators belonging to the weaker section, who will initially need government support and assistance. An ample allotment of land in the vicinity would have to be provided to each family for housing and for necessary subsidiary activities.

4.3.3 The pilot schemes to be undertaken by the industrial sector (Nucleus Industry) would aim at developing culture techniques suited to, or requiring, entrepreneurial or large-scale operations. The latter type of scheme would also provide employment to some of those members of the weaker sections who have not become owners of family-size ponds allotted to small-scale fish farmers or fishermen.

4.3.4 Broad schematic representations of the organization and administration of a PMU and a Nucleus Industry are provided in Appendices 12 and 13 respectively.

4.4 Manpower and training

4.4.1 At present the brackishwater section of the Directorate of Fisheries does not possess sufficient manpower, knowledge or experience to undertake useful production-oriented experimental work in coastal aquaculture on a sufficient scale to support even the pilot schemes. The section would have to be strengthened by recruitment of people of various appropriate disciplines who are thoroughly familiar with the relevant aspects of fish biology, shrimp biology, economics and engineering as applied to brackishwater aquaculture. Recruitment would be followed by both short-and long-term training in Southeast Asian countries, e.g. Taiwan, the Philippines and Indonesia. This training might be carried out as part of the technical assistance provided under a suitably designed project. See 4.5 below.

4.4.2 The mission also sees a need to strengthen the extension organization in those districts (East Godavari, West Godavari and Srikakulam) where there are good opportunities for establishing coastal aquaculture. The extension workers could in due course receive appropriate training at CIFE or other suitable institutions at Kakinada.

4.5 Technical Assistance

4.5.1 Technical assistance will be required by the Government if it is to undertake the proposed pilot schemes. This would take the form of provision of the various international experts under the auspices of a suitably-designed project.

4.5.2 A pond engineer would be needed in the first year who would be responsible for all work related to pond construction. In the second year, the services of one expert in brackishwater fish culture and one in socio-economics would be needed. These two experts would be responsible for specifying the culture techniques and formulating the training and extension programme. In addition, there would have to be a Project Adviser to coordinate the various activities of the other experts.

The proposed duration of appointment of the international experts is:

Adviser	..	3 years from the inception of the project.
Pond engineer	..	1 year from the inception of the project or until works are complete.
Brackishwater fish culturist	..	2 years from the inception of the project.
Socio-economist	..	1 year at a time to be decided by the Project Adviser.

4.5.3 Training of national counterparts is discussed in 4.4 above.

4.6 Physical facilities

Each of the sites covered by the project would have to be equipped with facilities such as a classroom/dormitory, practical laboratory and workshop, fresh water supply, staff housing and transport facilities. Technical and administrative staff as well as extension workers would have

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to be provided with accommodation as close to the project as possible. The detailed specifications and quantities would be determined by the Project Adviser.

4.7 Production

For purposes of estimating earnings, it has been assumed that production will be as follows:

4.7.1 Type-A unit of five hectares:

Year I	: fish – 1750 kg;	shrimp – 250 kg
Year II	: fish – 3000 kg;	shrimp – 375 kg
Year III	: fish —4375kg;	shrimp – 625kg
Year IV	: fish – 5000 kg;	shrimp – 750 kg
Year V	: fish – 6000 kg;	shrimp – 1250 kg.

4.7.2 Type-B unit of five hectares:

Year =500 kg; Year 11=825 kg; Year 111=1000 kg; Year IV=2000 kg; Year V—XII=2500 kg.

4.8 Costs and earnings

4.8.1 The cost of establishing a Type-A complex of five 1 ha ponds is estimated at Rs. 90,250 of which Rs. 75,000 will be investment cost and the rest initial operating costs. A Type-B complex of five 1 ha ponds is estimated to cost Rs. 131,500 of which Rs. 115,000 would be capital works and equipment. The estimated costs for the two types of pilot schemes are furnished in Appendices 14 and 15.

No infrastucture costs are included. It is assumed that no hired labour will be required, and that suitable provision has been made for ensuring adequate income to the fish farming families during the start-up period. The costs of extension, training and international technical assistance are also excluded. The capacity for capital investment of the weaker section is very limited and therefore it has been assumed that:

—the beneficiaries/weaker sections receive 95% of the total required credit with the balance of 5% as their share of contributed capital;

—that there is an initial grace period of two years for repayment of credit;

– the land will be provided by the Government free of cost.

The cash flows have been worked out in Appendices 16 and 17.

On this basis, the internal rate of return of a five hectare Type A unit (polyculture of shrimp and fish) and of a five hectare Type B unit (monoculture of shrimp) have been estimated for a project life of 12 years at 40% and 37% respectively.

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5. SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

1. On the basis of data on the tidal fluctuation over three days in September 1980, the mission classified the sites visited into three categories:

Areas of medium tidal fluctuation (1.2—1.6 m)	..	Srikakulam, W. Godavari and E. Godavari districts.
Areas of low tidal fluctuation (0.8—0.9 m)	..	Krishna district
Areas of very low tidal fluctuation	..	Pulicat lake (Nellore district).

2. Provided that earth excavation is undertaken to varying extents, the medium and low tidal sites could be utilized for brackishwater pond culture. The Pulicat Lake in which there are small tidal fluctuations might be suitable for aquaculture in pens, but pond culture in this general area would not be feasible.

3. Any Government plan for large-scale commercial brackishwater farming should be preceded by pilot schemes at suitable sites typical of the various areas as classified in (1) above. A pilot scheme should comprise one or two five-hectare units, each unit consisting of five one-hectare ponds.

4. For pilot schemes, the mission recommends two types of pond modules, each of 1 ha:

(i) The A-type pond: shallow, square, partially pump-fed and partially tide-fed ponds in areas of low tidal fluctuation; for poly-culture of fish and shrimp.

(ii) The B-type pond: deeper, rectangular and completely tide-fed ponds needing more excavation, in areas of medium tidal fluctuation and high land elevation; for mono-culture of shrimp.

In order to economise on construction costs it is recommended that both Type-A and Type-B ponds should be constructed with central platforms and peripheral canals.

5. To ensure that the pilot schemes are properly established and operated effectively and efficiently, the coastal aquaculture section in the Directorate of Fisheries should be strengthened by recruitment of additional biologists, economists and engineers. These together with existing staff should receive training in pond engineering, fish and shrimp culture and the socio-economic aspects of brackishwater aquaculture, in appropriate overseas countries. The extension staff should subsequently be trained at CIFE or other suitable institutions at Kakinada in various practical aspects of aquaculture.

In addition, international technical assistance should be sought in the supervision of the pilot schemes.

6. The Government should give consideration to acquiring the necessary international technical assistance in training its own staff and in supervision of the pilot schemes through a formal project financed by international or bilateral assistance and on the lines of the outline given in Chapter 4 above.

<<

Appendix 1

Andhra Pradesh (India) – Coastal Aquaculture Mission

TERMS OF REFERENCE

The mission will explore the possibilities of coastal aquaculture development in Andhra Pradesh as to suitable locations, species, seed supply and culture techniques, with special reference to shrimp culture, and will in particular:

(i) review the activities in shrimp/fish culture by the state of Andhra Pradesh, make recommendations for improvements/further development of ongoing activities and provide technical advice as required, with particular reference to engineering aspects in regard to the activities currently being proposed for implementation;

(ii) identify a compact geographical area with good potential for coastal aquaculture development and within such area a suitable location for establishing a pilot project for experiment! demonstration of shrimp culture, possibly in combination with finfish in coastal brackish-water ponds, for the benefit of small-scale fish farmers. It is envisaged that planning for the extensive development small-scale pond farming in the identified area will also be undertaken in due course through the pilot project;

(iii) outline the requirements for establishment and operation of the pilot project with specification of

- physical facilities
- technical assistance
- personnel and organisational set-up
- training
- capital and operating costs.

In assessing the requirements, the mission will particularly keep in view the land policies of the government vis-a-vis aquaculture development and the need to develop and demonstrate technology appropriate to the small-scale sector with optimum utilisation of locally available resources and skills.

<<

Appendix 2

ITINERARY

27th January 1981	Departed Jakarta.
28th	Arrived at Madras and held discussions with Mr. V. L. C. Pietersz, Development Adviser, and Dr. M. Karim, Fisheries Adviser of the BOBP.
29th	Mission joined by Dr. Karim and travelled to Hyderabad.
30—31st	Halt at Hyderabad. Discussions with the Secretary, Forests and Fisheries and Rural Development and officials of the Directorate of Fisheries.
1st February	Mission joined by Mr. M. N. Rao and Mr. D. V. Reddy. Travelled to Machilipatnam (Krishna district).
2—7th	Halt at Machitipatnam. Visited 8 brackishwater sites.
8th	Travelled Machilipatnam — Narsapur (West Godavari district).
9th	Visited five brackishwater sites.
9th	Travelled from Narsapur to Kakinada (East Godavari district).
10–19th	Halt at Kakinada. Visited CIFE, Andhra Pradesh Agriculture University fish farm, brackishwater fish farm of the Andhra Pradesh Fisheries Corporation, CIFRI, private fish farms, brackishwater sites at Corangi, Byravapalem, Amalapuram, etc.
20th	Travelled to Srikakulam.
20—21st February	Halt at Srikakulam. Visit to brackishwater project sites at Calingapatnam (Vomeravalli) and Tekalli.
22—23rd	Travelled to Visakhapatnam and proceeded to Sulurpet.
24th	Tour in Pulicat lake area.
25th	Travelled to Tirupathi and Hyderabad.
26—27th	Halt at Hyderabad. Discussion with officials.
28th	Travelled to Madras.
1—5 March	Halt at Madras. Report writing. Discussions with FAO officials and fisheries officials, submission of a summary report.
6th	Mission returned to Jakarta.

<<

Appendix 3

LIST OF PRINCIPAL DOCUMENTS CONSULTED

1. Project for the Development of Small-Scale Fisheries in the Bay of Bengal — Preparatory Phase. FAO: IOFC/DEV/78/44.2.
2. Project Report: Development of Brackishwater Fisheries, Directorate of Fisheries, Andhra Pradesh, Hyderabad.
3. District Statistics of Andhra Pradesh, Bureau of Economic and Fisheries, Andhra Pradesh, India.
4. "A Review of Brackishwater Shrimp Farming in Tamil Nadu and Andhra Pradesh, India." FAO/UNDP. Small - Scale Fisheries Promotion in South Asia, RAS/77/044, Working Paper 33, Madras, 1980.
5. Brackishwater Prawn & Fish Culture Project at Calingapatnam, Srikakulam District, Andhra Pradesh, India.
6. "Status of Coastal Aquaculture in India" by M.J. George, Central Marine Fisheries Research Institute, Cochin 682 018.
7. Note on Brackishwater Fish Farming in West Godavari District.
8. "Brackishwater Fish and Prawn Culture" by S. M. Dwivedi and D. V. Reddy. Central Institute of Fisheries Education, Bombay.
9. Brackishwater Fish Farm of Andhra Pradesh, Fisheries Corporation Limited, Kakinada, India by D. V. Reddy.

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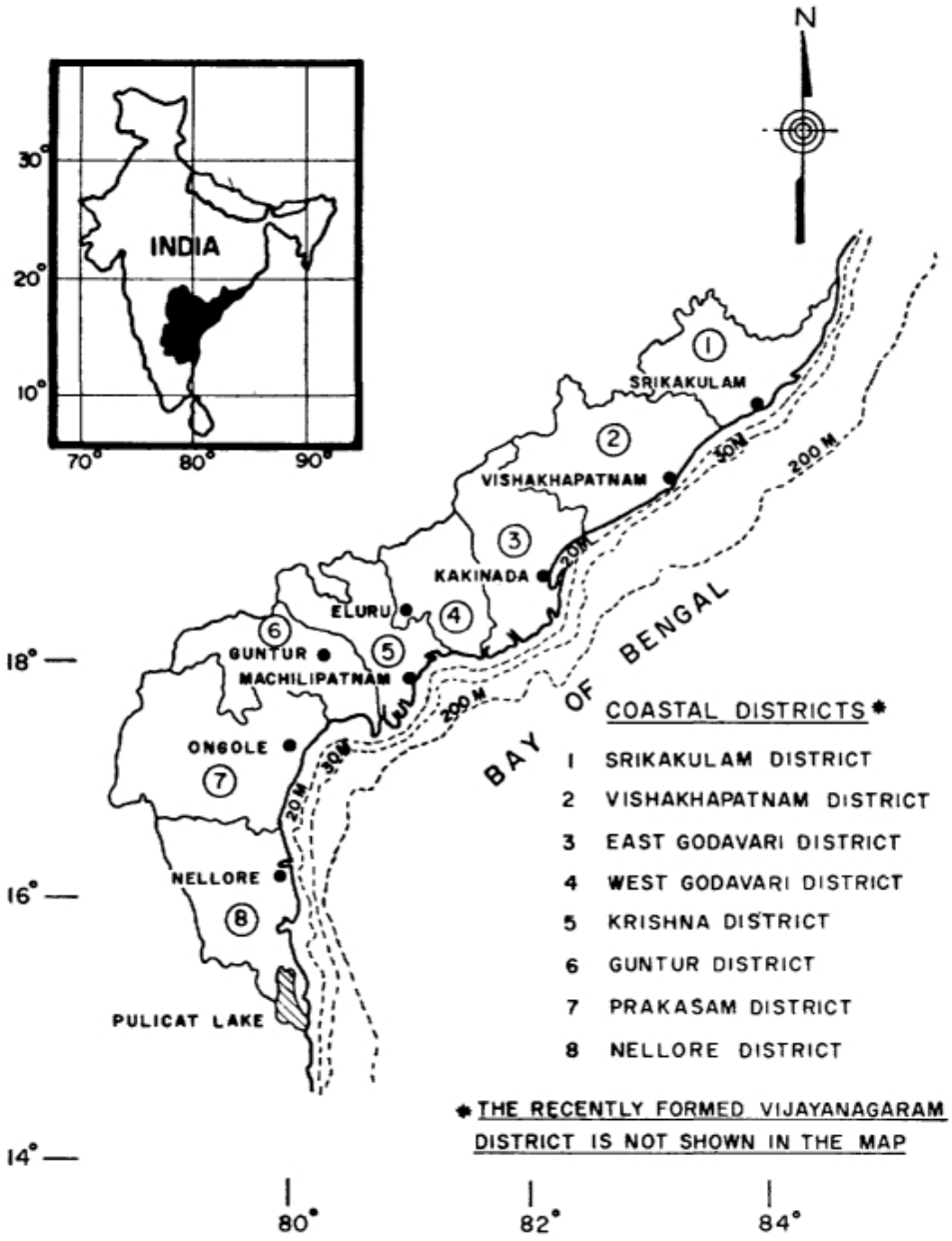
APPENDIX-4

COASTAL MAP OF ANDHRA PRADESH



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Appendix 5

AREA AND OWNERSHIP OF BRACKISHWATER RESOURCES IN ANDHRA PRADESH*

District	Area by ownership (Ha)						
	Fisheries Dept.	Revenue Dept.	Forest Dept.	Salt Dept.	Port Dept.	Private	Total
1. Srikakulam	346	854	—	1029	200	1503	3932
2. Vizianagaram	—	34	—	—	—	9	12
3. Visakhapatnam	—	714	—	87	—	490	1291
4. East Godavari	—	4274	19533	—	96	935	24838
5. West Godavari	—	1583	—	—	—	1884	3467
6. Krishna	—	16419	8000	—	—	243	24662
7. Guntur	—	254	1310	—	—	31	1595
8. Prakasam	—	1059	—	242	—	111	1412
9. Nellore	—	2690	—	26	—	37	2753
Total	346	27850	28813	1381	296	5243	63962

* Includes land submerged by the highest high tide, but excludes the Pulicat lake.

<<

Appendix 6

TEMPERATURE RANGES BY MONTHS AND STATIONS

(In O°Centigrade)

Sl. No.	Station	Maximum Minimum	January	February	March	April	May	June	July	August	Septem-ber	October	Novem-ber	Decem-ber
1.	Calingapatnam	Maximum	27.6	29.9	32.0	34.1	36.2	33.9	31.2	30.9	32.5	31.3	30.6	27.1
		Minimum	17.9	20.4	23.1	25.5	27.9	27.0	25.4	25.4	25.6	24.5	21.9	19.1
2.	Kakinada	Maximum	29.0	30.4	33.1	36.6	40.2	36.1	32.1	30.7	32.9	33.0	31.1	28.9
		Minimum	20.0	21.4	23.3	25.6	28.8	26.8	25.5	24.9	25.6	25.0	23.4	20.7
3.	**Machilipatnam**	Maximum	28.3	29.3	31.0	34.1	38.5	35.8	32.7	30.8	34.5	32.4	30.6	28.4
		Minimum	29.5	21.9	23.6	26.0	29.0	27.3	25.6	25.0	26.0	25.2	23.6	21.2
4.	Nelbore	Maximum	30.3	31.5	33.9	37.8	40.1	36.9	35.2	35.2	34.5	33.6	30.4	28.5
		Minimum	20.4	22.5	23.5	26.0	28.9	27.5	26.2	26.2	26.0	25.8	23.5	22.0
5.	Visakhapatnam	Maximum	28.4	29.9	32.9	34.9	37.8	35.5	32.2	31.3	32.9	32.9	31.1	28.8
		Minimum	19.0	20.7	23.4	26.2	28.8	27.9	26.1	25.8	26.1	26.1	22.7	20.4

<<

Appendix 7a

AVERAGE ANNUAL RAINFALL

(in Millimetres)

Sl.No.	District	1974–75	1975–76	1976–77	1977–78	1978–79
1.	Srikakulam	986	1,215	1,121	1,062	1,070
2.	Visakhapatnam	936	1,390	1,195	1,157	1,018
3.	East Godavari	1,085	1,360	1,426	1,158	1,116
4.	West Godavari	938	1,176	1,339	985	1,177
5.	Krishna	832	1,145	1,137	892	1,415
6.	Guntur	756	917	1,050	941	1,215
7.	Prakasam	755	816	870	713	1,193
8.	Nelbore	804	1,152	1,584	986	1,259
	Coastal Andhra	887	1,146	1,215	987	1,182

Source: Bureau of Economics and Statistics, Andhra Pradesh.

Appendix 7b

RAINFALL BY SEASON

(in Miilmetres)

Year	South-West Monsoon (June to September)	North-East Monsoon (October to December)	Winter period (January and February)	Hot weather period (March to May)	Total
1974–75 ..	**522**	**265**	**15**	**46**	**848**
1975–76 ..	944	319	1	40	1,304
1976–77 ..	673	251	Nil	100	1,024
1977–78 ..	502	382	30	53	967
1978—79 ..	830	171	36	113	1,150

Source: Bureau of Economics and Statistics, Andhra Pradesh.

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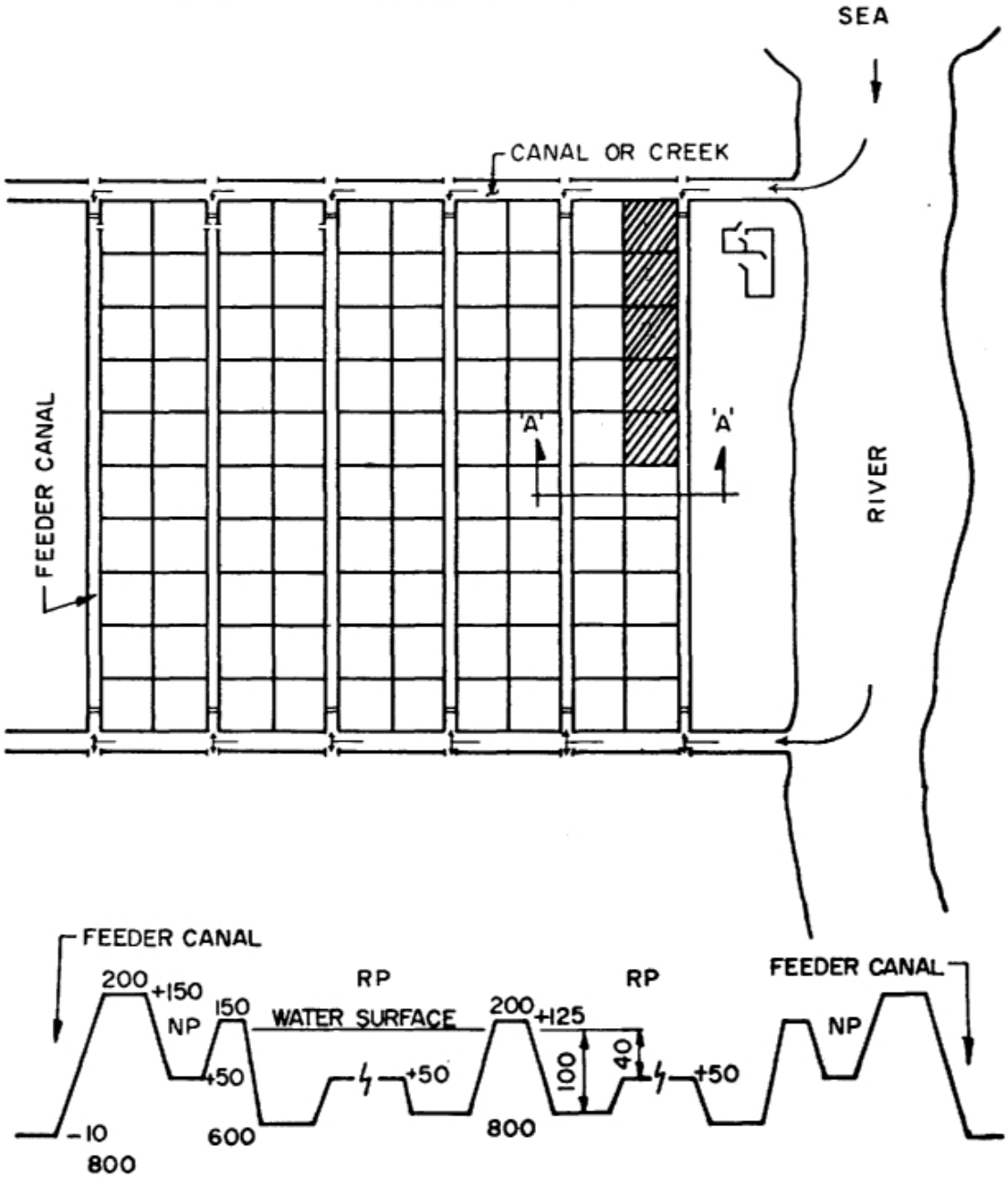
APPENDIX —8 (8A,8B,BC)

CULTURE POND (TYPE—A

All figures ore in cm unless otherwise stated

APPENDIX— 8A

GENERAL LAYOUT OF PONDS COMPLEX



CROSS SECTION – A A

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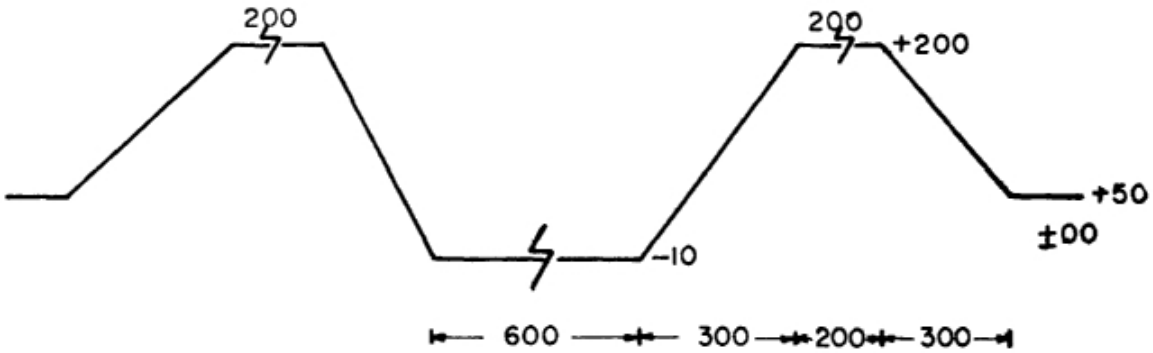
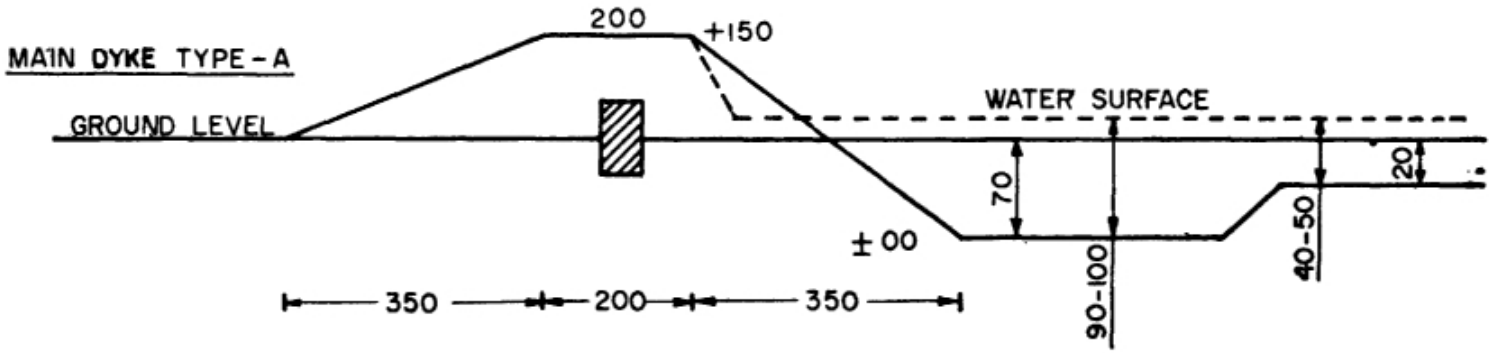
APPENDIX-BA (CONTINUED)

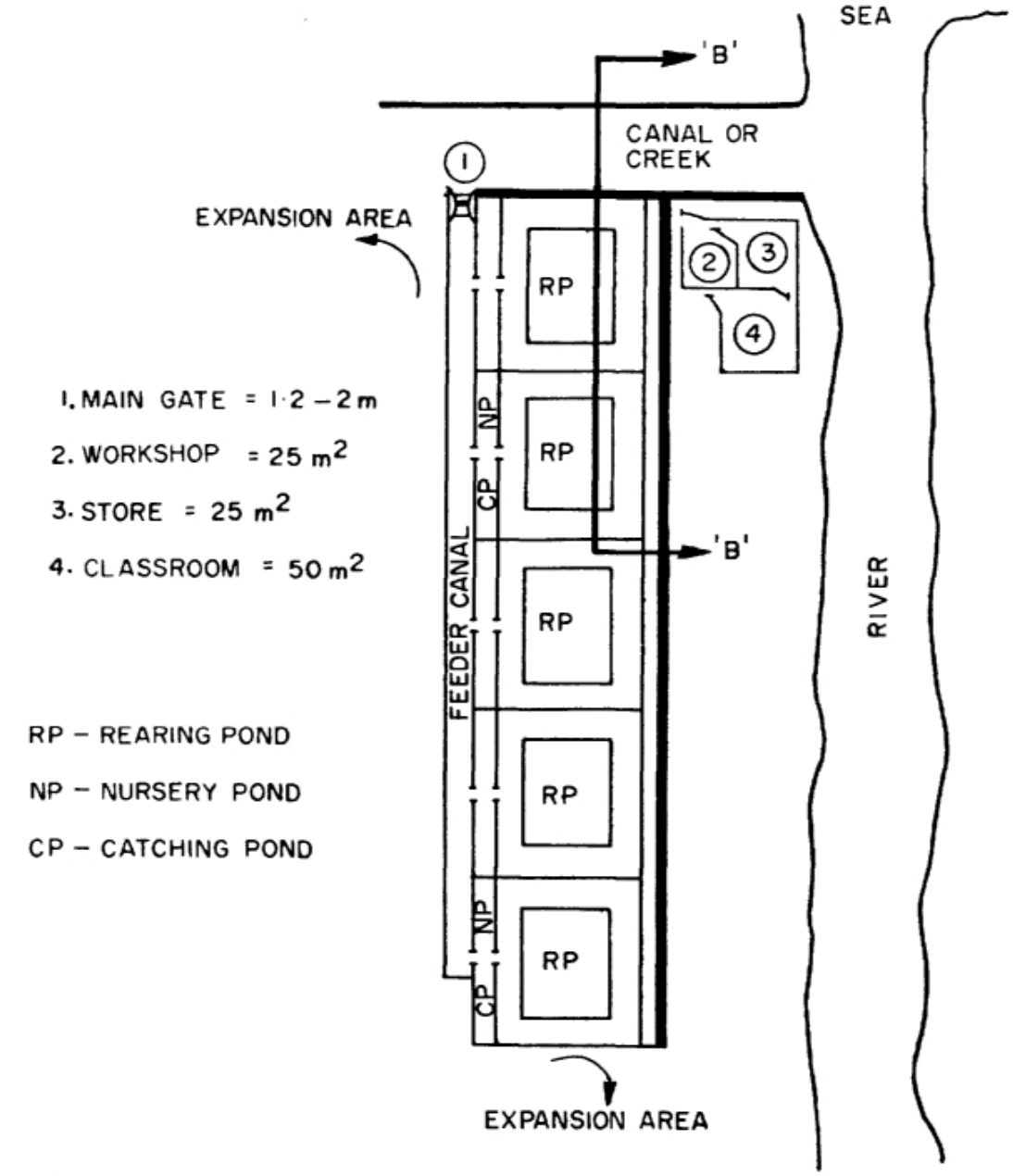
CROSS SECTIONS OF_FEEDING CANAL AND MAIN DYKE OF TYPE A MODULE

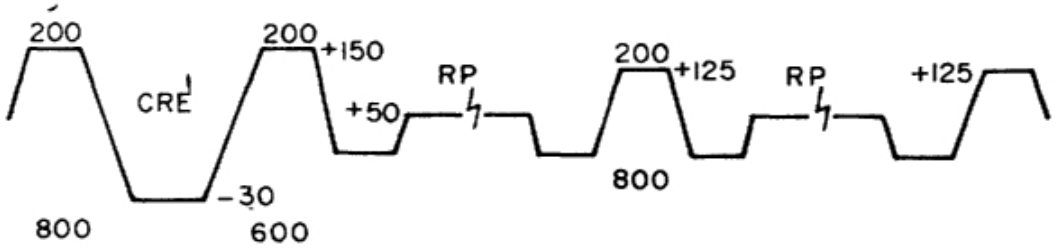




APPENDIX – 8 8

ENLARGED PLAN OF FIVE-POND PILOT PROJECT



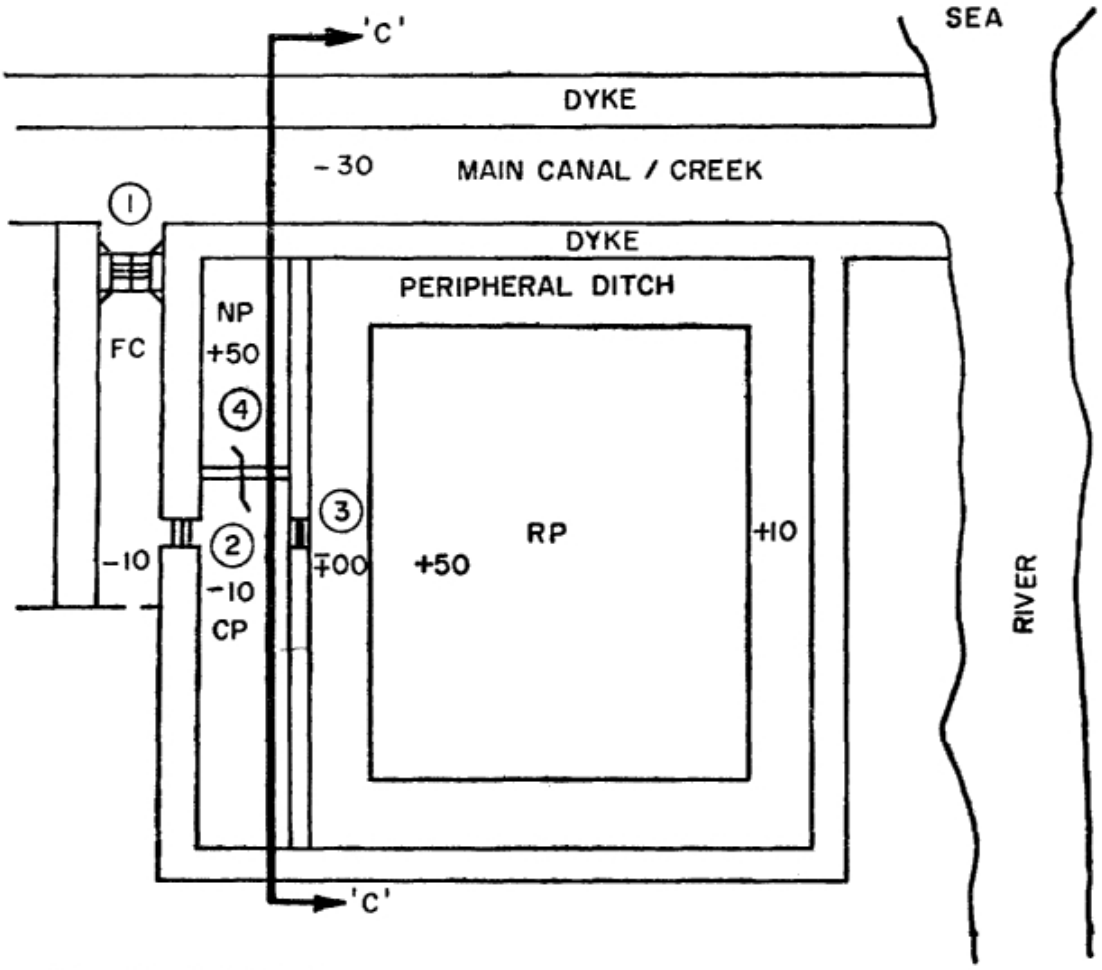


CROSS SECTION – BB

<<

APPENDIX —8C

DETAILED VIEW OF SINGLE POND UNIT

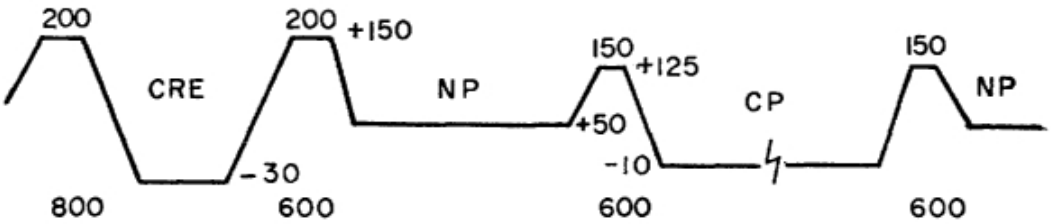


FC – FEEDER CANAL
NP – NURSERY POND – 200 m^2
CP – CATCHING POND – 300 m^2
RP – REARING POND – 9500 m^2

1. MAIN GATE – 2 m – WIDE
2. CATCHING POND GATE – 1m – WIDE
3. REARING POND GATE – 1m – WIDE
4. NURSERY POND GATE / PIPE

REQUIRED WATER DEPTH IN :–

REARING POND = 40 cm
NURSERY POND = 30 - 40 cm
CANAL = 120 cm



CROSS SECTION – CC

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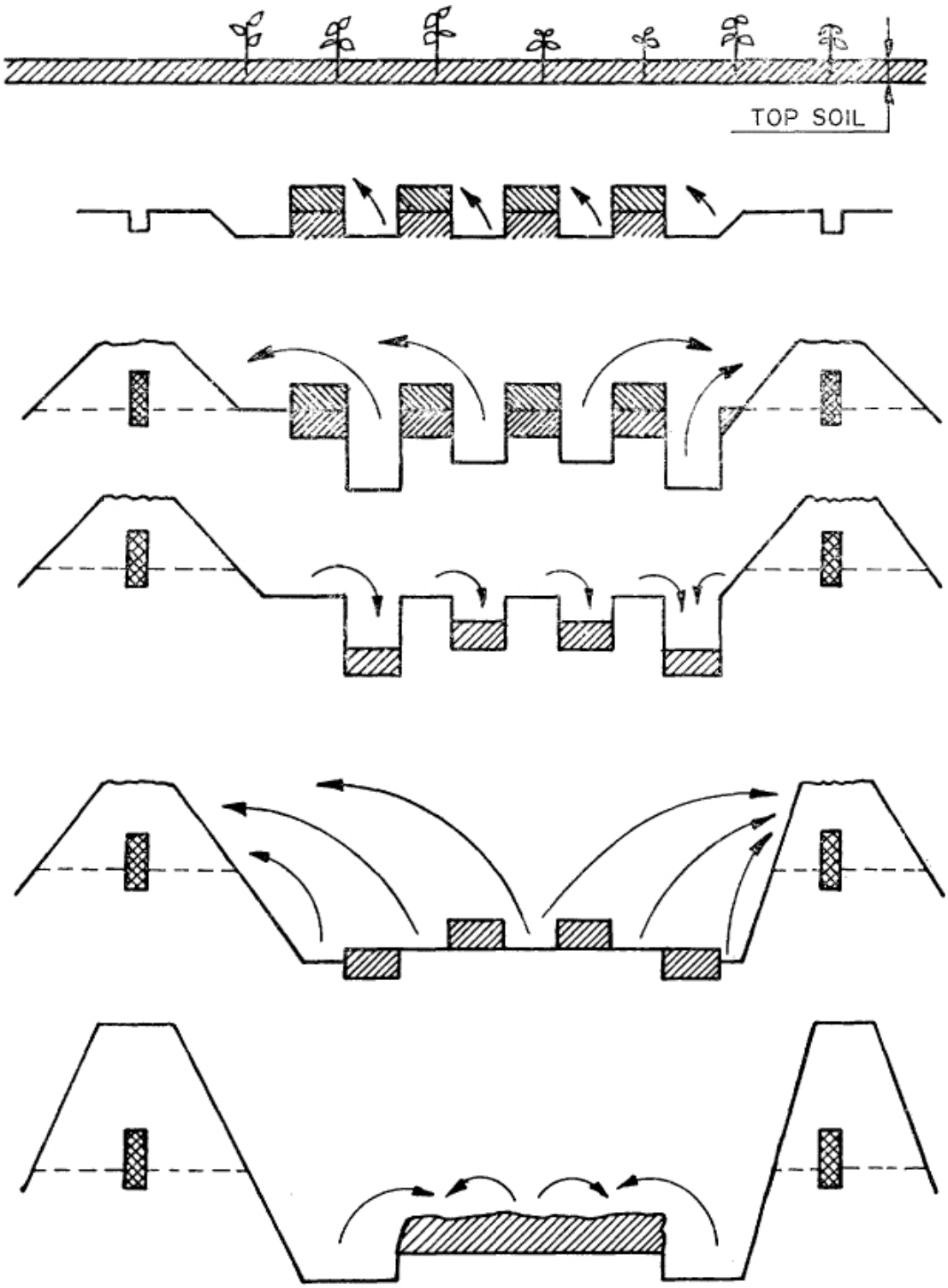
APPENDIX - 9

METHOD OF EXCAVATION TO CONSERVE TOP SOIL



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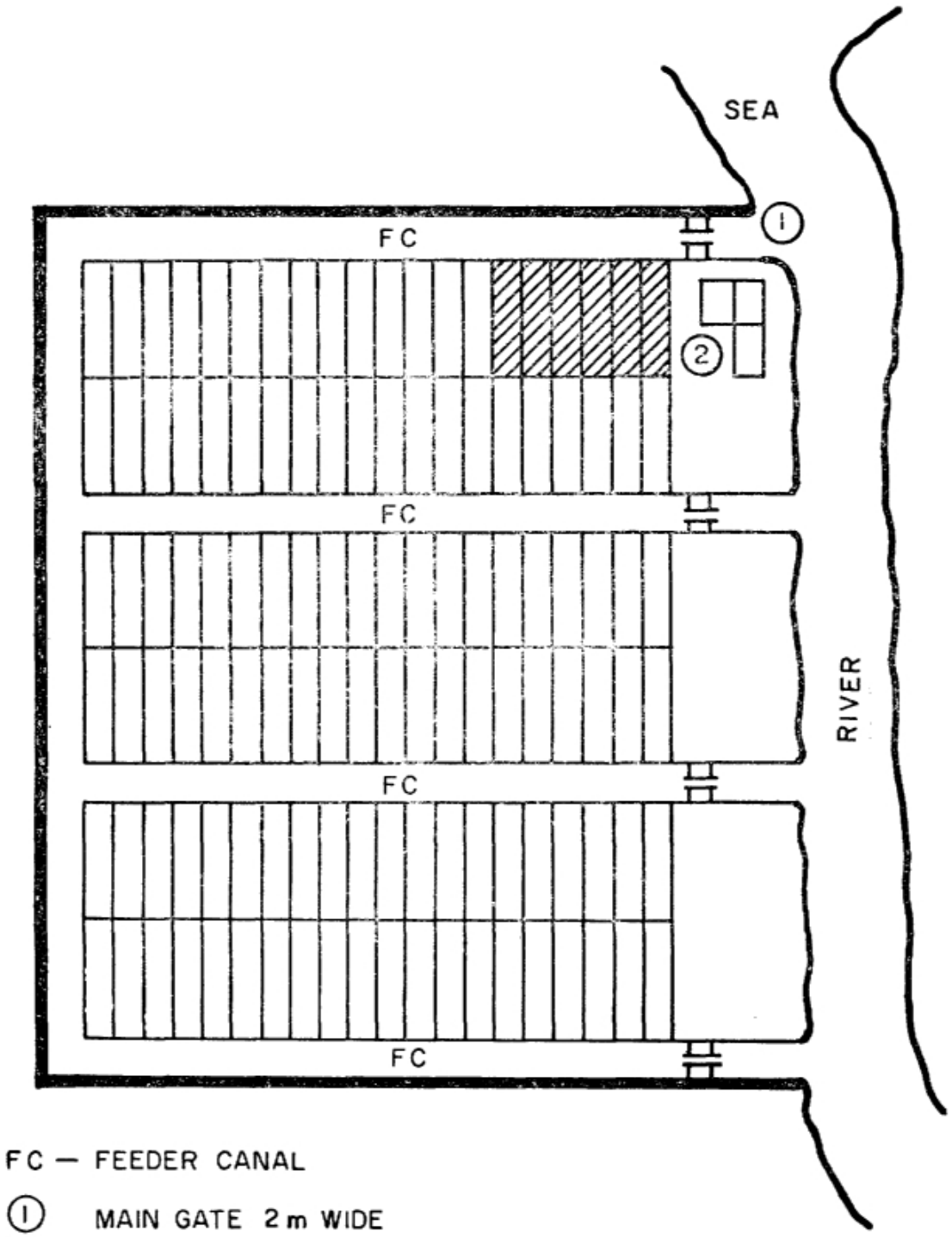
APPENDIX-IO (IOA ,IOB ,IO C)

CULTURE POND (TYPE—B

All figures are in cm unless otherwise stated

APPENDIX . IOA

GENERAL LAYOUT OF PONDS COMPLEX



FC — FEEDER CANAL

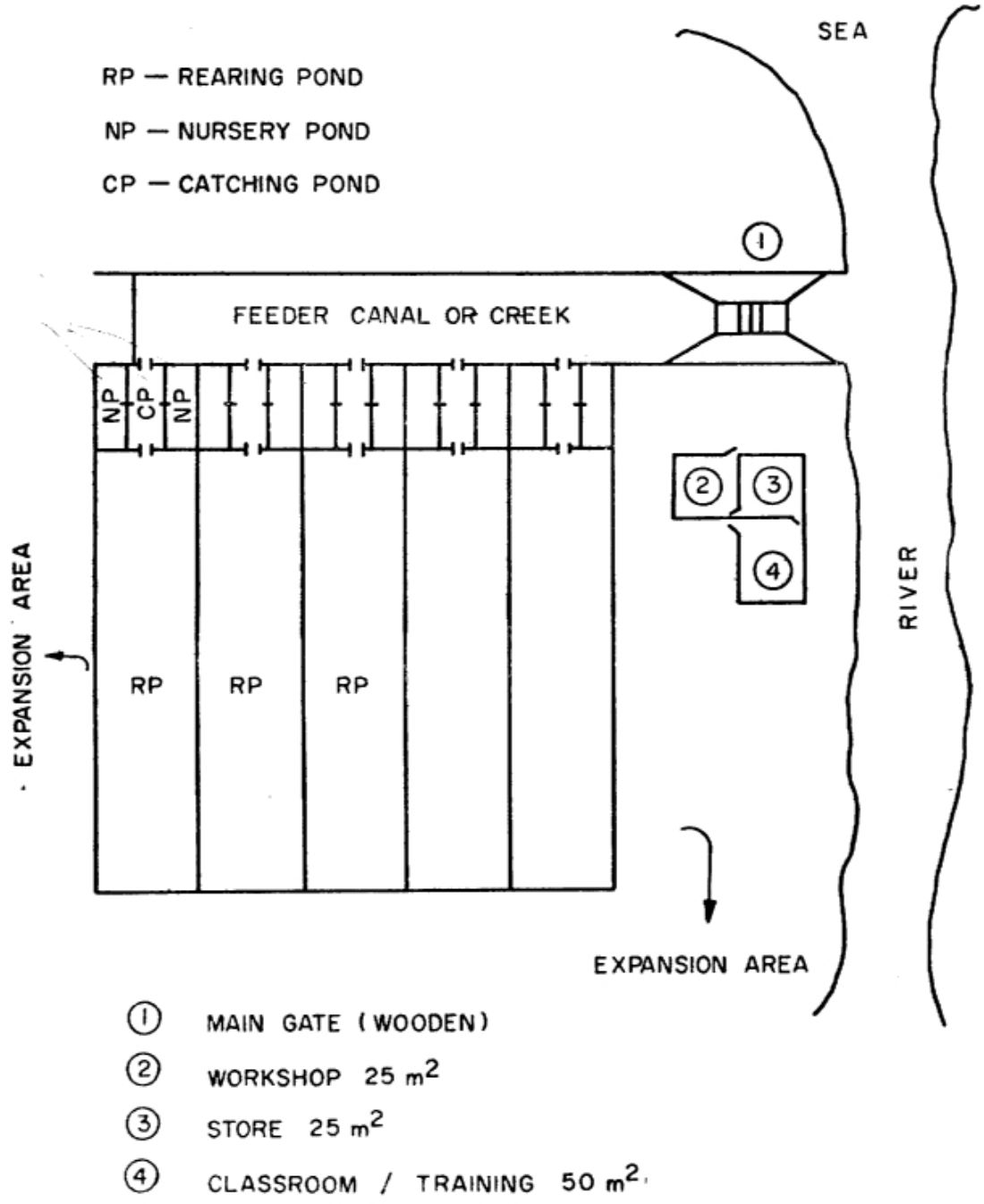
① MAIN GATE 2 m WIDE

② UNIT DEMONSTRATION POND WITH 100 m^2 HOUSING FACILITIES

<<

APPENDIX- 10 B

ENLARGED PLAN OF FIVE-POND PILOT PROJECT



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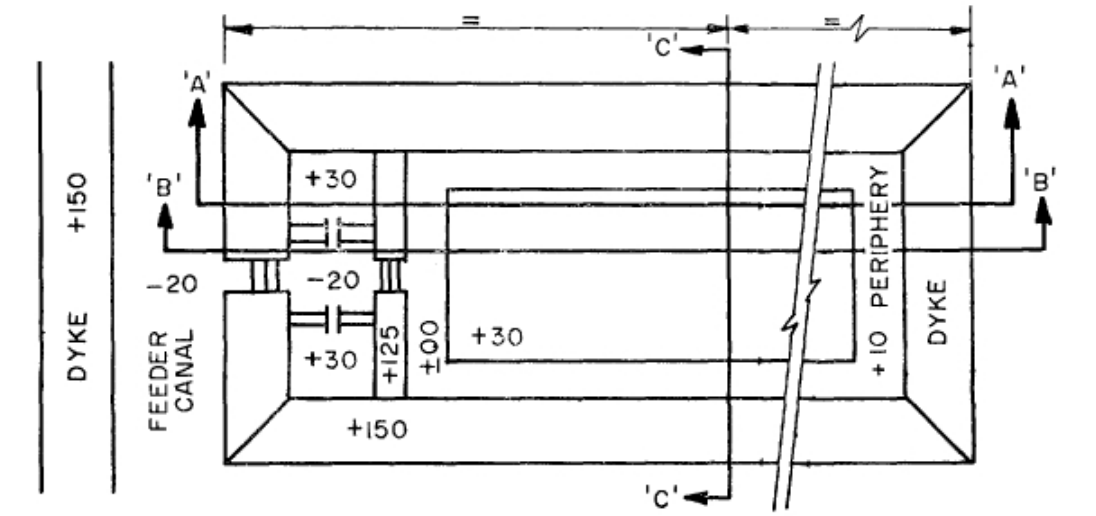
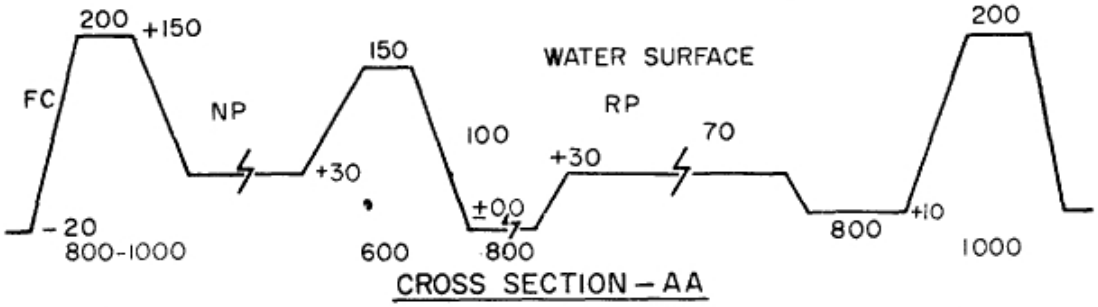
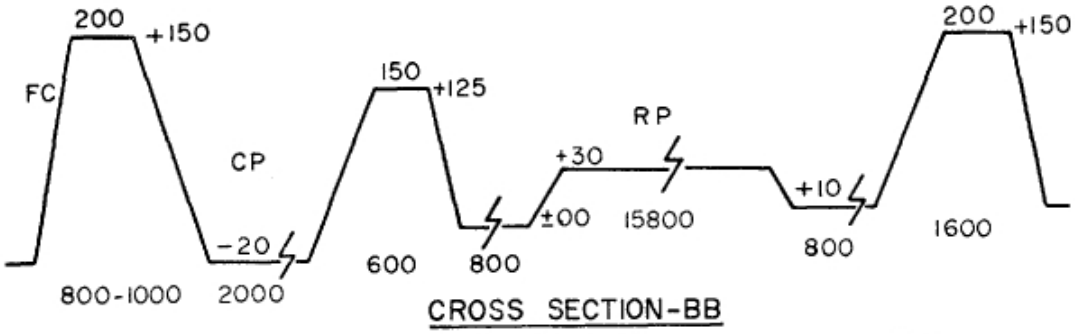
DETAILED VEW OF SINGLE POND UNIT

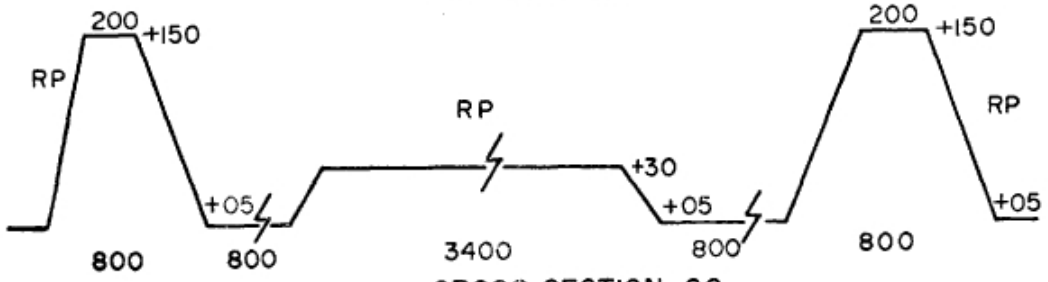




CROSS SECTION – AA



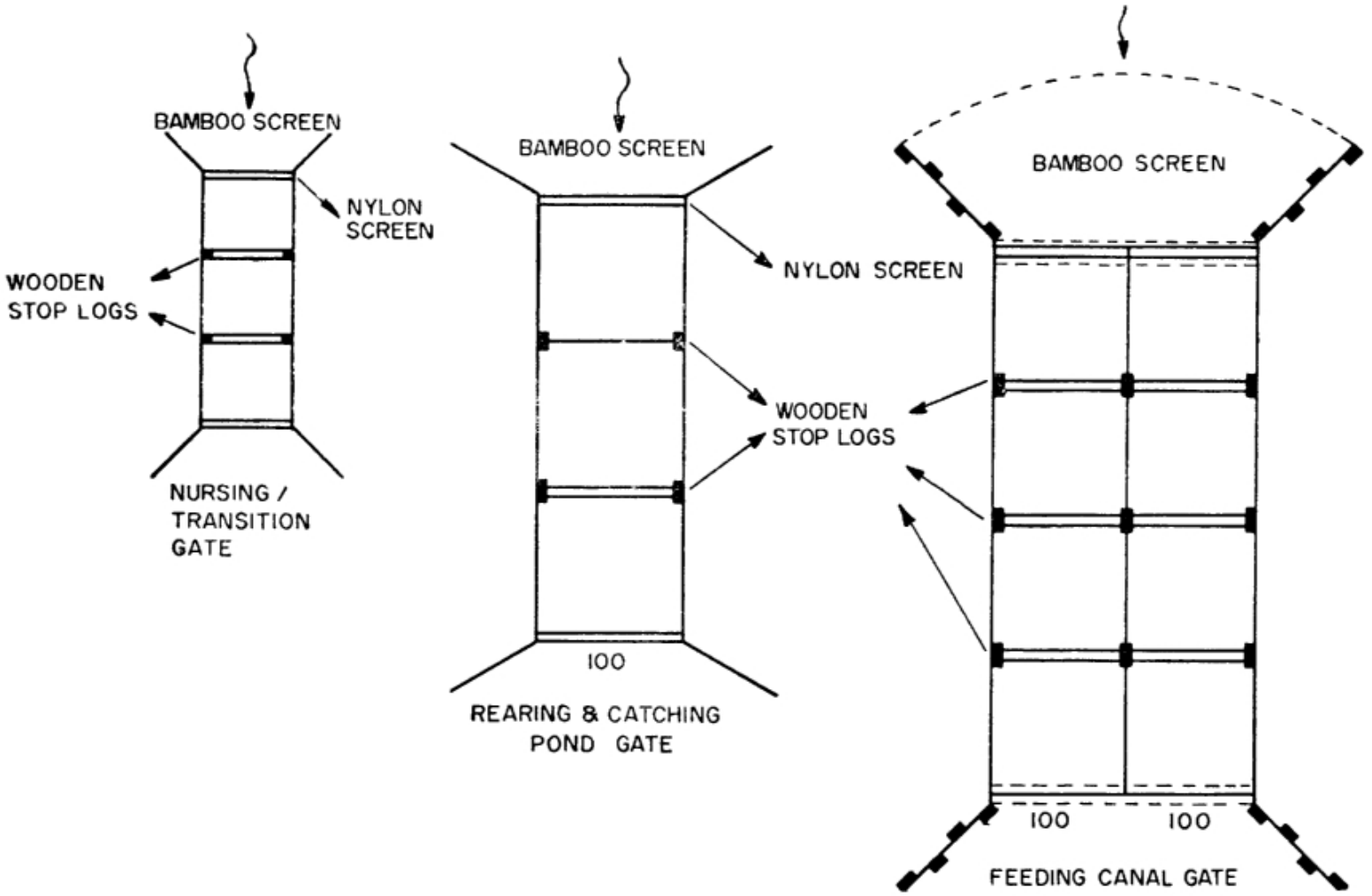
CROSS SECTION-BB



CROSS SECTION-CC

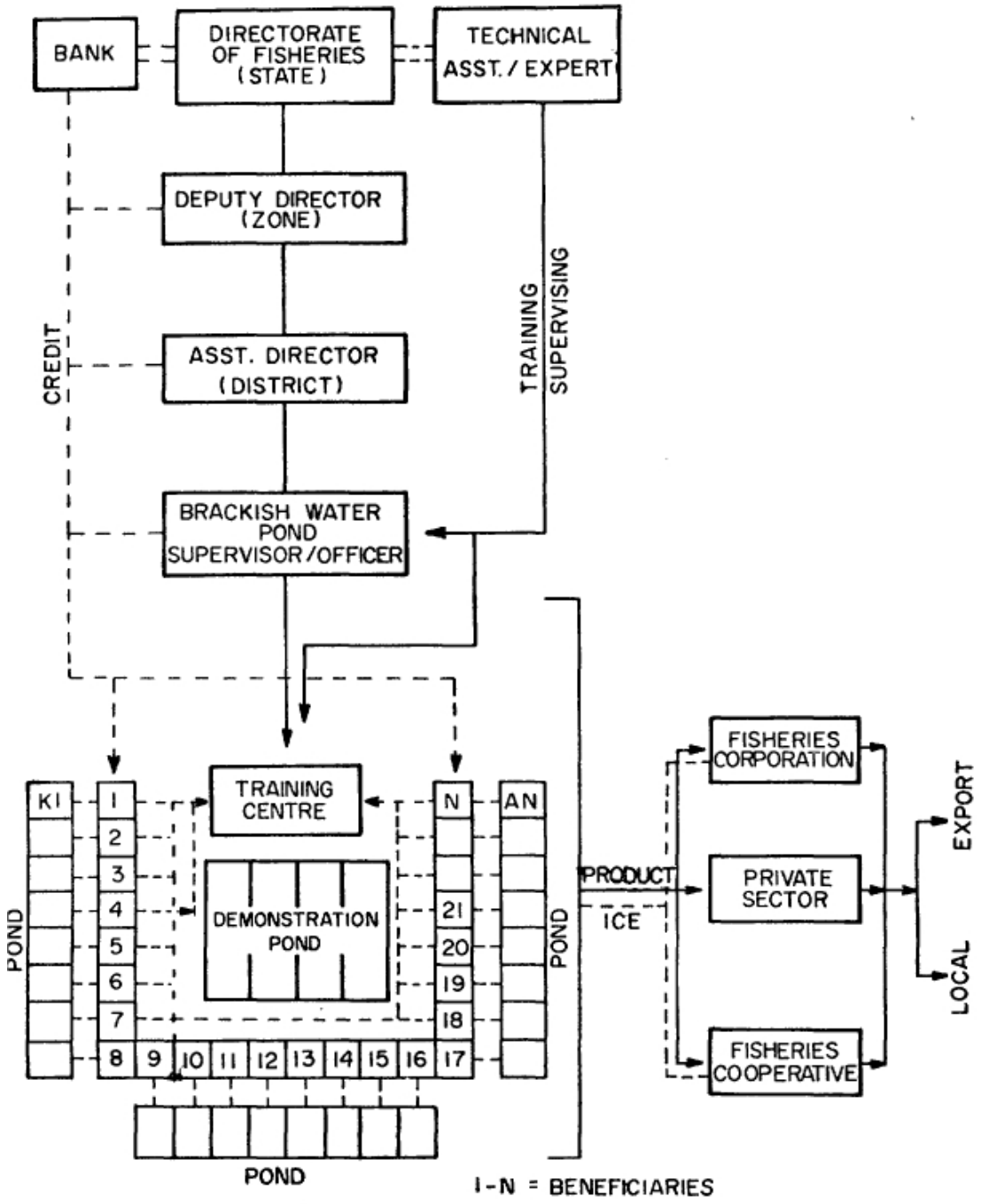
APPENDIX —II

DESIGNS OF WATER CONTROL STRUCTURES FOR TYPE A & B PONDS



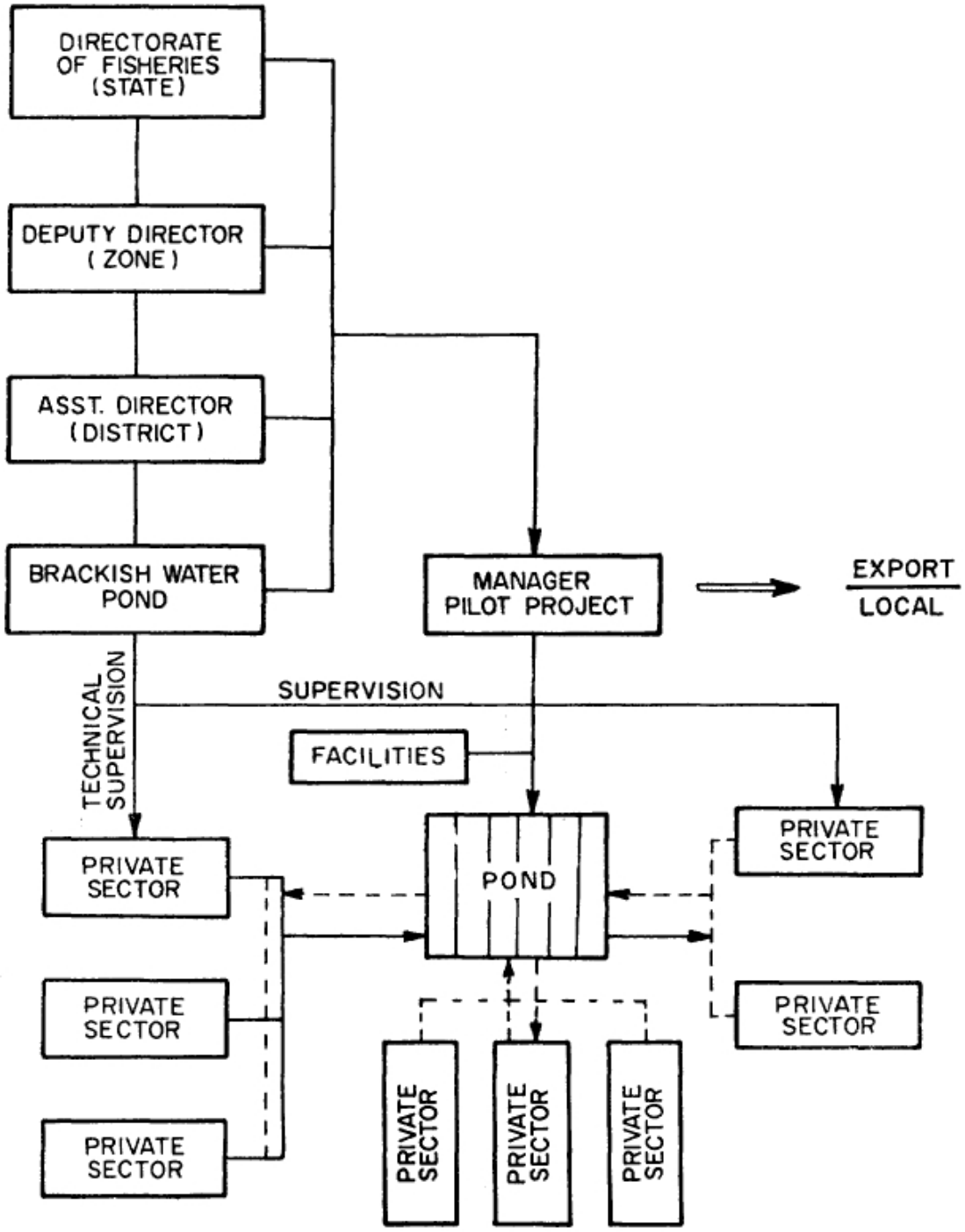
APPENDIX- 12

ORGANIZATION OF PROJECT MANAGEMENT UNIT



APPENDIX-I3

ORGANISATION OF NUCLEUS INDUSTRY



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Appendix 14

COST ESTIMATES FOR *TYPE A* PILOT PROJECT (5x1 ha ponds)

1. Investment cost:

— Excavation: 15,000 m3 soil at Rs. 2.50/m3		Rs.	37,500
— Main gate (1) secondary gates (10), gate/pipes (5)		**Rs.**	**8,000**
— Mangrove clearing		Rs.	7,000
— Equipment, nets, carpentry tools, limnological kits etc.		Rs.	2,500
— Pump*		Rs.	10,000
— Miscellaneous		Rs.	10,000
		Rs.	75,000

2. Annual operating cost:

— Seed :- Shrimp:	50,000 x 2 crops x Rs. 0.05	Rs.	5,000
Milkfish:	25,000 x 2 crops x Rs. 0.015	Rs.	750
— Fertilizer:			
Urea	500 kg x 2 crops x 2 Rs./kg	Rs.	2,000
TSP	250 kg x 2 crops x 2 Rs./kg	Rs.	1,000
Cowdung	5 tonne x 2 crops x 50 Rs./tonne	Rs.	500
— Pesticide	5 kg x 2 crops x 50 Rs./kg	Rs.	500
— Harvesting	2 crops x Rs. 750	Rs.	1,500
— Levelling	2 crops x Rs. 600	Rs.	1,200
— Fuel & Oil		Rs.	1,800
— Maintenance cost of pumping		Rs.	1,000
		Rs.	15,250

* The pump will be replaced after ten years.

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Appendix 15

COST ESTIMATES OF *TYPE B* PILOT PROJECT (5 ponds x 1 ha)

1. Investment:

— Excavation ±37,000 m3 soil	x 2.5 Rs./m3	Rs.	92,500
— Main gate (1) secondary gates (10) sluices (10)		Rs.	7,500
— Mangrove clearing		Rs.	5,000
— Equipment (nets etc.)		Rs.	2,500
— Miscellaneous		Rs.	7,500
		Rs.	1,15,000

2. Annual operating cost:

— Seed (shrimp) :	100,000 x Rs. 0.05 x 2 crops	Rs.	10,000
— Fertilizer:			
Urea	500 kg x 2 Rs./kg x 2 crops	Rs.	2,000
TSP	250 kg x 2 Rs./kg x 2 crops	Rs.	1,000
Cowdung	5 tonne x 50 Rs./tonne x 2 crops	Rs.	500
— Pesticide	5 kg x 50 Rs./kg x 2 crops	Rs.	500
— Harvesting	Rs. 600 x 2 crops	Rs.	1,200
— Levelling	Rs.650x2 crops	Rs.	1,300
		Rs.	16,500

<<

Appendix 16

CASH FLOW FOR ONE UNIT CONSISTING OF FIVE ONE-HECTARE BRACKISHWATER PONDS OF TYPE A USED FOR POLYCULTURE OF SHRIMP AND FINFISH

No.	Item	Year	1	2	3	4	5	6	7	8	9	10	11	12
	Cash inflow:													
	1. Sales of fish (4 Rs./kg)		7000	12000	15000	20000	25000	25000	25000	25000	25000	25000	25000	25000
	2. Sales of shrimp (35 Rs./kg)		8750	13125	21875	26250	43750	43750	43750	43750	43750	43750	43750	43750
			15750	25125	36875	46250	68750	68750	68750	68750	68750	68750	68750	68750
	3. Credit (investment cost plus working capital)		86500	—	—		—	—		—	—	—	—	—
	Total cash inflow (1 +2+3)		102250	25125	36875	46250	68750	68750	68750	68750	68750	68750	68750	68750
	Cash outflow:													
	1. Investment		75000	—	—	—	—	—	—	—	—	—	10000	—
	Operating Cost													
	—Seed		5750	5750	5750	5750	5750	5750	5750	5750	5750	5750	5750	5750
	— Fertilizer		3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500
	— Pesticide		500	500	500	500	500	500	500	500	500	500	500	500
	—Harvesting		1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500
	—Levelling		1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200
	—Fuel/oil		1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
	—Maintenance		1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
	2. Total operating cost		15250	15250	15250	15250	15250	15250	15250	15250	15250	15250	15250	15250
	3. Interest (12%)		10380	10380	10380	9340	8300	7270	6230	5190	4150	3110	2080	1040
	4. Principal repayment		—	—	8650	8650	8650	8650	8650	8650	8650	8650	8650	8650
II.	Total cash outflow (1+2+3+4)		100630	25630	34280	33240	32200	31170	30130	29090	28050	27010	35980	24940
Ill.	Net cash flow (I–lI)		1620	(505)	2595	13010	36550	37580	38620	39660	40700	41740	32770	43810

<<

Appendix 17

CASH FLOW FOR ONE UNIT CONSISTING OF FIVE ONE-HECTARE PONDS OF TYPE B USED FOR MONOCULTURE OF PRAWN/SHRIMP

No.	Item	Yearl	2	3	4	5	6	7	8	9	10	11	12
	Cash inflow:												
	1. Sales of shrimp (35 Rs./kg)	17500	28875	43750	70000	87500	87500	87500	87500	87500	87500	87500	87500
	2. Credit (investment cost, working capital)	125750	—	—	—	—	—	—	—	—			
I	Total cash inflow (1+2)	143250	28875	43750	70000	87500	87500	87500	87500	87500	87500	87500	87500
	Cash outflow:												
	1. Investment cost	115000	—	—	—	—	—	—	—	—	—	—	—
	Operating Cost:												
	—Seed	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
	— Fertilizer	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500
	— Pesticide	500	500	500	500	500	500	500	500	500	500	500	600
	–Harvesting	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200
	— Levelling	1300	1300	1300	1300	1300	1300	1300	1300	1300	1300	1300	1300
2.	Total operating cost	16500	16500	16500	16500	16500	16500	16500	16500	16500	16500	16500	16500
	3. Interest (12%)	15090	15090	15090	13580	12070	10565	9055	7545	6035	4525	3020	1510
	4. Principal repayment	—	—	12575	12575	12575	12575	12575	12575	12575	12575	12575	12575
II	Total cash outflow (1+2+3+4)	146590	31590	44165	42655	41145	39640	38130	36620	35110	33600	32075	30585
Ill.	Net cash flow (I–Il)	(3340)	(2715)	(415)	27345	46355	47860	49370	50880	52390	53900	55405	56915

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