ANNEX-VI

ENVIRONMENT

ANNEX - VI

ENVIRONMENT

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VI. ENVIRONMENT

1. INTRODUCTION

1.1 General

Size of the Peninsular Malaysia is about 131,598 km^2 and is the southern most extension of mainland Asia. The peninsular has a central mountainous spine extending from north to south, and it mainly consists of raised marine sediments with granitic intrusions. The climate is equatorial with the range of average annual temperature of 28 to 32 °C. The highest rainfall on the peninsular exceeds 5,000 mm and the lowest is about 1,750 mm with the effects of south west (May - August) and north east (November - March) monsoons. Biological diversity of Peninsular Malaysia is rich with large Asian and small Australian components as shown in the following table. However, deforestation and land degradation have significantly affected wildlife populations, especially those occurring in lowlands of the peninsular. Some of the wildlife species of Malaysia are listed as critically endangered (10 species) and endangered (16 species) in the Red List of the International Union for Conservation of Nature and Natural Resources (IUCN), but there is no record of those species' distribution in the study sites (Table VI-1).

Summary of Wildlife Species in Malaysia

Group	Number of Sp.	Number of endemic Sp. (%)
Mammals	287	28(10)
Birds	501	9(2)
Reptiles	270	70(26)
Amphibians	158	57(36)
Higherplants	5,205	2,035(39)
Total	6,421	2,199(34)

Malaysia signed for Ramsar Convention in April, 1994. Tasek Bera in the State of Pahang is the only wetland listed under the convention at present time. One of the most significant ecosystems around the study sites is the mangrove forest, and major wetlands and mangrove forests around each project site are identified in this sudy as shown in Fig.VI-1. Perak State (including IADP Kerian/Sungai Manik and IADP Seberang Perak Schemes) holds nationally significant patches of mangrove, and Matang Forest Reserve has been proposed to be listed under the Convention.

Malaysian mangroves support rare wildlife species such as the hairy-nosed otter, proboscis monkey (Nasalis larvatus), crocodile (Crocodylus porosus), milky stork (Mycteria cinerea) and lesser adjutant (Leptoptilos javanicus) as well as other highly specialized animal species. Therefore, mangroves have significant conservation values. Main fauna and flora of those ecosystems are described in the main report. Recent status of fauna and flora can be an adequate indicator of a given ecosystem.

All study sites are located on the coastal line where mangroves often occur. Pesticides and fertilizers that are to be used in paddy fields are possibly drained through mangrove forests and cause detrimental impacts. Therefore, it is important to report present status of water quality. Much of the water quality data presented in this report were provided by the

Department of Environment (State Offices). Also, Environmental Quality Data 1992 - 1995 (Department of Environment 1996) was used to present changes in annual Water Quality Index (WQI) when adequate data were available.

1.2 Environmental Policy in Malaysia

Environmental Impact Assessment (EIA) in Malaysia has been developed to support environmental conservation planning in relation to new and/or the expansion of existing activities for development. The procedure and guidelines of EIA are national policies to minimize adverse effects o natural and social environments from any form of development. Therefore, the Federal Government of Malaysia cooperates closely with the State Governments to ensure all human activities are in an environmentally acceptable manner.

Environmental Quality (Amendment) Act 1985 was issued on 9 January 1986 with the amendment of the Environmental Quality Act 1974. A new section (i.e. 34A) was introduced in this amendment, which requests that any person intending to carry out a project for development submit a report on possible environmental impacts to the Director General of the Department of Environment (DOE) for approval.

The environmental policy in Malaysia was further refined, and the Environmental Quality (Prescribed Activities) (Environmental Impact Assessment) Order 1987 came into effect on 1 April 1988. At present time, an EIA assessing overall environmental impact from each activity for development is mandatory under this Order. The procedure of EIA has been described in "A handbook of Environmental Impact Assessment Guidelines," which was published by the DOE in 1995. More specific guidelines for a variety of activities including irrigation and drainage are also available.

According to the EIA guidelines in Malaysia, EIA procedure consists of two levels, which are (i) Preliminary Assessment and (ii) Detailed Assessment (Fig. VI-2). A preliminary assessment is mandatory for all projects that are likely to cause negative impact on natural and/or social environments. This assessment must be conducted in an early stage of the projects, and some form of public participation is required. However, a small amount of man-pour, budget, skills and equipment are needed. Objectives of this assessment are:

(1) To examine and select the best from the project options available.

(2) To identify and incorporate into the project plan appropriate abatement and mitigating measures

(3) To identify significant residual environmental impacts

On the other hand, a detailed assessment is to be carried out when residual environmental impacts have been predicted in a preliminary assessment. This assessment must be continued during project planning until it is finalized. Environmental data collection and public participation are required in this process. Objectives of this assessment are:

(1) To describe the significant residual environmental impacts predicted from the final plan

(2) To specify mitigation and abatement measures in the final project plan

(3) To identify the environmental costs and benefits of the project to the community

2. PRESENT CONDITON

2.1 Water Quality Index

A total of 119 major rivers in Malaysia were monitored under the Annual River Water Quality Monitoring Program. Water Quality Index (%) of Malaysia was used for the assessment of river water quality (Fig. VI-3). The formulae for the calculation of WQI are presented in the following table. Water quality data of each Scheme are presented in the subsequent sections of this Annex. However, sample sizes are rather small and data collection is not coherent so that the data cannot be compared directly. Therefore, more systematic data collection program needs to be established in the future.

Index	Calculation	Ranges
NH_3N (SIAN)	$= 100.5 - 105\ x$	for $x \leq 0.3$
	$= 94\ e^{0.573x} - 51\ x - 21$	for $0.3 < x < 4$
	$= 0$	for $x \geq 4$
BOD (SIBOD)	$= 100.4 - 4.23\ x$	for $x \leq 5$
	$= 108\ e^{0.053x} - 0.1\ x$	for $x > 5$
COD (SICOD)	$= -1.33\ x + 99.1$	for $x \leq 20$
	$= 103\ e^{0.0157x} - 0.04\ x$	for $x > 20$
DO* (SIDO)	$= 0$	for $x \leq 8$
	$= 100$	for $x \geq 92$
	$= -0.395 + 0.03\ x^2 - 0.0002\ x^3$	for $8 < x < 92$
SS (SISS)	$= 97.5\ e^{0.00676x} + 0.05\ x$	for $x \leq 100$
	$= 71\ e^{0.0016x} - 0.015\ x$	for $100 < x < 1000$
	$= 0$	for $x \geq 1000$
pH (SIPH)	$= 17.2 - 17.2\ x + 5.02\ x^2$	for $x < 5.5$
	$= -242 + 95.5\ x - 6.67\ x^2$	for $5.5 \leq x < 7$
	$= -181 + 82.4\ x - 6.05\ x^2$	for $7 \leq x < 8.75$
	$= 536 - 77\ x + 2.76\ x^2$	for $x \geq 8.75$
WQI	$= 0.15$ x SIAN + 0.19 x SIBOD + 0.16 x SICOD + 0.22 x SIDO + 0.16 x SISS + 0.12 x SIPH	

* = DO is in % saturation.
x = concentration in mg/l for all parameters except pH

2.2 IADP Pulau Pinang Scheme

(1) Fauna and Flora

No wildlife species that requires conservation plans has been reported within this scheme. There are two forest reserves, Pantai Aceh (100 ha) and Balik Pulau Forest Reserve (166 ha) on Pinang Island. Both of these reserves are located along the western coastline of the island and hold important habitats for migratory birds. However, not much information is available on those reserves.

(2) Water Quality

Sungai Muda sub-scheme is the largest irrigation area in this scheme, and its major source of water supply is Muda river. Most of the water used in this rice field is discharged into the sea through various waterways. Existing WQI data for Muda river from 1989 to 1995 are shown below. It is noted that the quality of water in this river has been gradually deteriorated, and the river is considered as slightly polluted in comparison with the general rating scale of the water quality index (Fig. VI-3).

Changes in Water Quality of Muda River from 1989 to 1995

	1989	1990	1991	1992	1993	1994	1995	Rate of change
WQI (%)	79	81	80	79	81	76	73	- 1.3

WQI = Average Water Quality Index (%): Very polluted (0 - 59); Slightly polluted (60 - 80); Clean > 80

Various parameters indicating water quality of a few rivers within this scheme are summerized in the following table. More detailed data are shown in Tables VI-2 to VI-6. However, data for DO were missing and that WQI values were unable to be calculated. There is not much difference in water quality of Jarak river between upstream and downstream. However, it is noted clearly that water quality of downstream in Kulim river is much more polluted than that of upstream. Agricultural activities may be contributing to this trend, but water quality is also affected seriously by industrial use and domestic use. Therefore, meticulous investigation is required to identify a main source of pollution and plan countermeasures. The data show that Muda river is relatively clean.

Water Quality Data of Jarak, Kulim and Muda Rivers in 1996

River*	n	BOD (mg/l)	COD (mg/l)	NH_3N (mg/l)	SS (mg/l)	DO (mg/l)	pH
1.Jarak(1)	10	3.0	16.2	2.3	61.0	-	6.9
2.Jarak(2)	11	3.2	14.5	2.1	76.0	-	6.9
3.Kulim(1)	11	1.0	8.3	0.7	75.9	-	7.0
4.Kulim(2)	10	7.3	34.5	2.8	125.6	-	7.0
5.Muda	10	1.2	9.8	0.6	82.4	-	7.4

BOD = Biochemical Oxygen Demand; COD = Chemical Oxygen Demand; NH_3N = Ammoniacal Nitrogen; SS = Suspended Solids; DO = Dissolved Oxygen

* Sampling points vary from upstream (1) to downstream (2).

2.3 IADP Kerian Scheme

(1) Fauna and Flora

Kerian area is so large in size and that is considered as a type of wetland. Kerian paddy field has been recognized as a major feeding ground for a large colony of black-crowned night-herons (Nycticorax nycticorax) at Kuala Kurau. This area is also known to be an important feeding ground for many bird species including lesser adjutants, herons, terns and kingfishers. In southern vicinity of this area, Matang Forest Reserve (40,711 ha), a large expanse of mangrove forest, is situated at the north of Kuala Gula extending to the south of Panchor. This forest reserve covers 51 km of the western coastline of the peninsula. Main vegetation includes Rhizohpra apiculata, R. mucronata, Bruguiera parviflora, B. gymnorrhiza, B. cylindrica, B. eriopetala, Avidennia sp., Sonneratia alba and Ceriops candolleana. Kuala Gula, northern part of the reserve, is currently proposed as a bird sanctuary, and possibly 43,000 to 85,000 migratory birds utilize this reserve during migration. Matang is also the last remaining area on Peninsular Malaysia, which is capable of supporting a viable breeding population of milky storks. The Malaysian population is critically endangered, having decreased to about 100 individuals.

Another ecosystem needs to be concerned for conservation is Kuala Kurau (250 ha). This area includes only 20 to 30 ha of mangroves (mainly Avicennia marina) at the estuary of Kurau river. However, its location is in the vicinity of the project site; furthermore, this small patch of mangrove forest supports one of the largest colonies (5,000 - 6,000 nests) of black-crowned night-herons in the world. Therefore, this area is considered as highly sensitive and holds a high conservation value.

(2) Water Quality

Overall water quality of Kurau river has been relatively consistent for the last seven years as shown below. Detailed water quality data were collected at the DOE, Perak State, with a sample size (n) of 4 for Kurau river, and data for Bukit Merah Reservoir with a sample size of 12 were gathered at GSL Water Sdn. Bhd (Table VI-7 to VI-10). The main water supply for Kerian Scheme is the Bukit Merah Reservoir and Bogak river. Most of the water discharged from this scheme is generally drained into the sea, but some of the water is driven into Kurau river. Bukit Merah Reservoir is located upstream of the irrigation system so that there is no impacts from the agricultural activity to its water. It is also noted that the water quality of Kurau river seems to be deteriorated toward downstream.

Changes in Water Quality of Kurau River from 1989 to 1995

	1989	1990	1991	1992	1993	1994	1995	Rate of change
WQI (%)	83	86	85	84	84	81	82	-0.2

WQI = Average Water Quality Index (%): Very polluted (0 - 59); Slightly polluted (60 - 80); Clean > 80

Water Quality Data of Kurau River and Bukit Merah Reservoir in 1996

River*	n	BOD (mg/l)	COD (mg/l)	NH_3N (mg/l)	SS (mg/l)	DO (mg/l)	pH	WQI (%)
1.Kurau(1)	4	1.6	27.5	0.3	8.5	6.3	6.5	84.4
2.Kurau(2)	4	1.5	21.9	0.2	26.8	2.9	5.7	72.0
3.Kurau(3)	4	1.4	28.1	0.3	21.0	2.5	5.9	72.1
4Bukit M. Res.	12	2.5	7.7	0.2	-	8.4	6.4	-

BOD = Biochemical Oxygen Demand; COD = Chemical Oxygen Demand; NH_3N = Ammoniacal Nitrogen; SS = Suspended Solids; DO = Dissolved Oxygen
WQI = Average Water Quality Index (%): Very polluted (0 - 59); Slightly polluted (60 - 80); Clean > 80
* Sampling points vary from upstream (1) to downstream (3) except the Reservoir.

2.4 IADP Sungai Manik Scheme

(1) Fauna and Flora

There are three major mangrove forests around Sungai Manik Scheme. Melintang Swamp Forest (45,000 ha) is located about 20 km south of this area. Rungkup Peninsula holds a 1,000 ha of mangrove forest between estuaries of Perak river and Bernam river. Telok Intan Swamp Forest (4,050 ha) is located at about 10 km north west of this scheme. Primary vegetation of Rungkup Peninsula are Sonneratia acida, Rhizophora spp. Bruguiera parviflora, B. cylindrica, Avicennia marina. This area, particularly at the north western corner of the peninsular known as Tanjung Beras, is important as a prawn nursery ground and wader habitat. Approximately 20 species of migratory birds have been recorded including rare species of the Asian dowitcher (Limnodromus semipalmatus) and eastern curlew (Numenius madangascariensis). It is also known to support a viable population of smooth otters (Lutrogale perspicillata). Telok Intan Swamp Forest is a remnant of former large expanse of peat swamp forest. Water regime flowing into this area is affected by the headworks in Batang Padang river within Sungai Manik sub-scheme. A variety of birds, mammals and other wildlife species have been identified in this area. A record of bird species includes the lesser adjutant, lesser tree duck (Dendrocygna javanica), white-browed crake (Porzana cinerea), Baillon's crake (P. pusilla), white-breasted waterhen (Amaurornis phoenicurus), seven species of Aredeidae and some species of kingfisher. Mammal species known in this area are otters, fruit bats, civets, Felis spp. and monkeys (Macaca spp.). Other wildlife species include monitors (Varanas salvator) water snakes and a variety of fishes.

(2) Water Quality

Most of the water for irrigation is taken from Batang Padang river in this area. Then, the water is drained into Perak river and partly through artificial outlet channels. Water quality of Perak river also affects this area and that is presented in the following section (IADP Seberang Perak Scheme). The size of Seberang Perak Scheme is larger than that of Sungai Manik Scheme, so it is likely that Seberang Perak Scheme causes more impacts to the water of Perak river. Existing water quality data of Batang Padang river with a sample size (n) of 3 are shown in the following table (also Tables VI-11 and VI-12). Water quality of this river does

not seem to vary significantly between upstream and downstream, and it is still in an acceptable quality.

Water Quality Data from Batang Padang River in 1996

River*	n	BOD (mg/l)	COD (mg/l)	NH_3N (mg/l)	SS (mg/l)	DO (mg/l)	pH	WQI (%)
1.B. Padang(1)	3	2.3	26.9	0.2	77.3	5.7	6.1	76.4
2.B. Padang(2)	3	1.7	26.9	0.2	97.7	6.9	6.5	74.7

BOD = Biochemical Oxygen Demand; COD = Chemical Oxygen Demand; NH_3N = Ammoniacal Nitrogen;
SS = Suspended Solids; DO = Dissolved Oxygen
WQI = Average Water Quality Index (%): Very polluted (0 - 59); Slightly polluted (60 - 80); Clean > 80
* Sampling points vary from upstream (1) to downstream (2)

2.5 IADP Seberang Perak Scheme

(1) Fauna and Flora

Seberang Perak Scheme is located near Sungai Manik area. Therefore, fauna and flora of important natural ecosystems around this scheme are likely to be consistent with the ones identified in the previous section.

(2) Water Quality

Large amount of water that is used in Sungai Manik Scheme and Seberang Perak Scheme is drained into Perak river. Also, Perak river is the main water source for Seberang Perak Scheme so that water quality of this river is likely to be affected seriously with agricultural practice. Existing water quality data were collected with a sample size (n) of 2 for upstream and 3 for the rest of the sampling points (Tables VI-13 to VI-15). Water quality tends to be deteriorated toward downstream in the river, but it is still relatively clean as shown below.

Water Quality Data from Perak River in 1996

River*	n	BOD (mg/l)	COD (mg/l)	NH_3N (mg/l)	SS (mg/l)	DO (mg/l)	pH	WQI (%)
1. Perak(1)	2	0.9	12.2	0.1	41.0	5.7	7.0	86.2
2. Perak(2)	3	1.6	12.4	0.1	38.0	4.7	6.6	85.0
3. Perak(3)	3	2.8	16.5	0.2	146.3	4.4	6.4	78.4

BOD = Biochemical Oxygen Demand; COD = Chemical Oxygen Demand; NH_3N = Ammoniacal Nitrogen;
SS = Suspended Solids; DO = Dissolved Oxygen
WQI = Average Water Quality Index (%): Very polluted (0 - 59); Slightly polluted (60 - 80); Clean > 80
* Sampling points vary from upstream (1) to downstream (3)

2.6 IADP Kemasin Semerak Scheme

(1) Fauna and Flora

Distribution of the mangrove is limited on the eastern side of the Peninsular Malaysia, and only a small patch of mangroves at the mouth of Semerak river has been known (Fig. VI-1). Plant species occurring in this area are mainly Avicennia intermdeia, Rhizophora apiculata, R. mucronata, and Sonneratia alba. Several bird species have been identified, and these include the white-throated kingfisher (Halcyon smyrnensis), barn owl (Tyto alba), black-naped oriole (Oriole chinensis), fly-eater (Gerygone sulphurea) and brahminy kite (Halisastur indus). Mammal species such as the plantain squirrel (Callossciurus notatus) and slender squirrel (Sundasciurus tenius) have been also reported in this area. "Sensitive ecosystems" around this project site would be Tumpat Lagoon (1,000 ha) and Sungai Golok Melaleuca Swamp (1,020 ha), but these areas are relatively far from Kemasin Semerak Scheme. Tumpat Lagoon is a large estuarine bay located at about 30 km north west of the scheme. A small population of the estuarine crocodile (Crocodylus porosus) may still exist in this area. Another "sensitive ecosystem," Sungai Golok Melaleuca Swamp, is situated at about 40 km north west of the project area. This area is dominated by Melaleuca cajeputi.

(2) Water Quality

Main sources of irrigation water for Kemasin Scheme are Kelantan river and Kemasin river, and most of the water used in paddy fields of this scheme is drained into Kemasin river. Water samples of Kemasin river were collected at rather upstream, and its water quality was considered to be clean as shown in the following table (also Tables VI-16 to VI-18). On the other hand, water quality of Semerak river tends to be deteriorated toward downstream.

Water Quality Data from Kemasin and Semarak Rivers in 1996

River*	n	BOD (mg/l)	COD (mg/l)	NH_3N (mg/l)	SS (mg/l)	DO (mg/l)	pH	WQI (%)
1.Kemasin	4	1.3	14.0	0.02	20.5	3.7	7.1	91.3
2.Semarak(1)	4	6.0	81.6	0.10	23.0	3.4	6.5	86.9
3.Semarak(2)	4	1.8	20.3	0.03	37.5	2.5	6.6	73.7

BOD = Biochemical Oxygen Demand; COD = Chemical Oxygen Demand; NH_3N = Ammoniacal Nitrogen; SS = Suspended Solids; DO = Dissolved Oxygen
WQI = Average Water Quality Index (%): Very polluted (0 - 59); Slightly polluted (60 - 80); Clean > 80
* Samples were collected from upstream (1) and from downstream (2)

2.7 IADP Ketara (Besut) Scheme

(1) Fauna and Flora

Primary vegetation around this scheme is Melaleuca cajeputi. Other plant species including Lagerstoemia speciosa, Thodomyrtus tomentosa and Licuala glabra occur in this area. Many species of birds can be observed in this area, which include the brahminy kite, white-

bellied sea-eagle (Haliaeetus leucogaster), heron and kingfisher. One group of dusky leaf-monkeys (Presbytis obscura) has also been reported in this area. Telong Melaleuca Swamp (10,000 ha) is located at around northern tip of the State of Terengganu. This is an extensive swamp dominated by Melaleuca cajeputi. Not much information is available for this area and large parts of the swamp have been alienated for agricultural use. There is a nesting ground of leatherback turtle (Dermochelys coriacea) in the south of this scheme. This species is listed as endangered in the Red List of IUCN; however, this area is about 100 km away and does not seem to be affected significantly with this proposed project.

(2) Water Quality

Overall water quality of Besut river has been slightly improving as shown below (also Tables VI-19 and VI-20). Detailed water quality data were collected at the DOE, Terengganu State, with a sample size (n) of 2 for each sampling point. Irrigation water for this scheme is taken mainly from Besut river and Angga river. The water used in the paddy fields in this area is discharged mainly into Besut river. Water quality of upstream and downstream in Besut river is regarded as clean.

Changes in Water Quality of Besut River from 1989 to 1995

	1989	1990	1991	1992	1993	1994	1995	Rate of change
WQI (%)	80	71	77	76	70	78	85	1.02

WQI = Average Water Quality Index (%): Very polluted (0 - 59); Slightly polluted (60 - 80); Clean > 80

Water Quality Data from Besut in 1996

River*	n	BOD (mg/l)	COD (mg/l)	NH_3N (mg/l)	SS (mg/l)	DO (mg/l)	pH	WQI (%)
1.Besut(1)	2	1.2	15.8	0.06	74	5.6	6.2	81.4
2.Besut(2)	2	0.6	10.6	0.1	18	4.5	6.0	87.6

BOD = Biochemical Oxygen Demand; COD = Chemical Oxygen Demand; NH_3N = Ammoniacal Nitrogen; SS = Suspended Solids; DO = Dissolved Oxygen
WQI = Average Water Quality Index (%): Very polluted (0 - 59); Slightly polluted (60 - 80); Clean > 80
* Sampling points vary from upstream (1) to downstream (2)

3. INITIAL ENVIRONMENTAL EXAMINATION (IEE)

3.1 Introduction

Environmental impact assessment is required as described in the guidelines issued by the DOE of Malaysia. Environmental impact assessment procedure in Malaysia is presented in Fig. VI-2. According to EIA Order 1987, environmental impact assessment is necessary when development is taken place after 1 April 1988. However, all of the irrigation schemes proposed in this project had started well before the EIA Order came in effect. Therefore, environmental

impact assessment in this study was conducted primarily according to JICA's environmental guidelines.

This environmental impact assessment is to meet JICA's requirements, which covers all the five granary areas of this study. In this initial stage of the study, an IEE is considered as a suitable form of environmental impact assessment. This assessment, therefore, mainly based on the background of the scheme, current condition of the study areas. However, possible adverse effects on environment are reported, and conservation plans are also discussed briefly. Objectives of this IEE are listed as follows:

(1) To describe detailed activities of the study,

(2) To survey present conditions of natural and social environments within and around the study areas,

(3) To predict, in a brief and relatively rough manner, potential impacts on natural and social environments within and around the study areas, and

(4) To recommend whether an EIA is further required or not, and to formulate its Terms of Reference (TOR) if required.

3.2 Methods

Initial Environmental Examination (IEE) is a quick form of environmental impact assessment and existing information and data are normally used for a judgement. For natural environment, most of the data used to judge a level of impact are presented in the section 2 of this Annex. Possible impacts on "sensitive ecosystems" (e.g. mangrove forests) due to deterioration of water quality in rivers are main concern of this study. Water quality data were collected primarily at the Department of Environment (headquarters and state offices). Furthermore, Departments of Wildlife Conservation, Forestry and Fisheries were visited to gather information on natural environment around the study sites.

For social environment, public participation was attained with questionnaire. It was conducted as part of farm survey in which 500 questionnaires were distributed to IADP Pulau Pinang (100), IADP Kerian/Sungai Manik (175), IADP Seberang Perak (100), IADP Kemasin/Semerak (65) and IADP Ketara (Besut) (60).
The environmental check-list of the International Commission on Irrigation and Drainage (ICID) is regarded as a suitable measurement on overall environmental impacts in Malaysia. This check-list covers both natural and social environments and was used for this IEE.

3.3 Results and Discussion

(1) Natural Environment

Construction of additional facilities and land clearing are not main portion of this study, and it is unlikely to cause significant impacts on physical environment (Table VI-21). Use of chemicals (e.g. fertilizer, herbicide and pesticide) is already a common agricultural practice, so that it is difficult to reduce the amount of chemicals being used at a significant scale. It is more realistic to assume that considerable amount of chemical compounds will continue to be used. Therefore, excessive use of agro-chemicals is the key factor to be considered as a main source of environmental impacts in this study. However, detrimental factors that require immediate attention have not been identified in this assessment.

Water Quality Index (%) shown in the section 2 of this report ranged from 72.1% (Sg. Kurau in Kerian Scheme) to 87.6% (Sg. Besut in Besut Scheme). This range is acceptable for wildlife including aquatic life, but the water with values less than 80% is considered as slightly polluted for general use. COD is one of the most important parameters to indicate a level of chemical substance in water. Sg. Kurau (21.9 to 28.1 mg/l) in Kerian Scheme and Sg. Batang Padang (26.9 mg/l) in Sungai Manik Scheme showed relatively high values of COD, which indicates that the water in those rivers contains a higher level of chemicals.

Mangrove forests, mudflats and peat swamp forests in the vicinity of the study sites are considered as sensitive ecosystems, and that these areas must be fully considered in terms of environmental conservation. These areas are used as resting, breeding and feeding sites by numerous species of wildlife, particularly by shore birds. When an excessive amount of chemical compounds is drained into rivers and ultimately to the sea, toxic substance can be absorbed by various wild animals and passed on to different trophic levels within an ecosystem. This process often strongly affect human health as well.

Extensive mangrove forests exist at downstream of both IADP Kerian/Sungai Manik and IADP Seberang Perak Schemes in Perak State, and water quality in some waterways in those schemes are relatively polluted. It does not seem that the level of pollution is serious at present time, but it is uncertain that the current water quality will be maintained. Additional chemical use that causes significant environmental impacts is possible, so it is imperative to establish a long-term environmental monitoring system.

(2) Social Environment

Public participation is important to understand the acceptability of development by the public, especially by local residents. Majority of the respondents (85%) answered that present irrigation facilities can be improved. As a result of the questionnaire, 63% of the respodents are aware of a minimum level of toxicity in terms of using chemicals for agriculture, and 76% of them are actually maintaining the minimum level. This result indicates that local farmers tend to minimize chemical use to avoid negative effects. Most of the respondents (81%) knew that owls can be used for controlling mice and rats, but only 38% of those people had practical knowlege about the technique. Only 26% of the respondents knew that a technique of using other biological agents such as ducks and fish to control pests (i.e. insects) is available.

Mangrove forests also hold considerable socio-economic importance supporting commercial fish and prawn fisheries, sustainable exploitation for timber, protecting the coastline from erosion and providing many different products to local communities in Malaysia. Matang Forest in Perak State can produce between 140 to 200 tons of timber per hectare by two commercial thinning with a 30-year rotation. Therefore, any damage to the mangroves potentially cause negative impacts to social environment as well.

3.4 Important Ecosystems

Wetlands often form particularly productive ecosystems, which provide many important benefits to a number of people. These benefits have a variety of functions such as providing natural resources, holding a rich biological diversity, barriers for natural disaster and cultural significance. In this study, the mangrove is identified as one of the most important constituents of the wetlands. Conservation of mangrove forests, ultimately significant wetlands is, therefore, critical for the success of this proposed project. Although these ecosystems are remained intact, they are fragile and susceptible to any changes in adjacent environment. It is, therefore, recognized that water quality of the surrounding waterways is particularly important, and a systematic program to monitor the water quality must be established.

3.5 Mitigation and Abatement Measures

Proposed project focuses on upgrading existing facilities for irrigation, so there is no activity, which needs to be redesigned immediately to avoid negative impacts on physical environment. However, it is likely that a considerable amount of agro-chemicals will continue to be used to reach the rice production that is aimed by NAP. Although serious detrimental effects associated with the use of agro-chemicals were not identified in this study, water quality data presented in this report do not seem to be sufficient enough to make a decisive judgment. Water samples must be collected at adequate locations throughout the year. There is no systematic water quality monitoring system to check particularly a level of agro-chemicals in the water used for irrigation. Therefore, it is imperative that a long-term environmental monitoring system be established to maintain adequate condition of natural environment.

Furthermore, monitoring changes in population trends of wildlife species and biological diversity within paddy fields and the surrounding areas may also be useful to detect any environmental impact. Wetlands including paddy fields are used by a number of wildlife species, and most of them are sensitive to changes in water quality, toxicity in aquatic food webs and disturbance of terrestrial habitats. Therefore, a change in status of wildlife living in and around wetlands can be an indicator of the degradation of an ecosystem. It is, therefore, worthwhile if an environmental monitoring system includes a systematic wildlife survey. For example, brief count of migratory birds can be useful.

One of the most practical and effective methods of reducing the use of chemicals on paddy fields is probably further development of Integrated Pest Management (IPM) of the Department of Agriculture. This is a unique and environmentally safe approach that is to use biological agents such as catfish and owls to control weeds and pests. The program is still in a

pilot study level and has not been fully implemented yet, and this is discussed further in the following section.

4. ENVIRONMENTAL MANAGEMENT PLAN (EMP)

4.1 Introduction

(1) General Background

Formulation of an Environmental Management Plan (EMP) is required for development projects in Malaysia. This is described in "Environmental Impact Assessment Guidelines for Drainage and/or Irrigation Projects" of the DOE. Initial Environmental Examination (IEE) for the project on modernization of water management system was completed in the first phase of this study in August, 1997. The IEE identified that the most significant potential environmental impact was to alter biological diversity by reducing river water quality. The National Agricultural Policy (NAP) of Malaysia is aiming to increase rice production; therefore, it is predicted that considerable amounts of agro-chemical will possibly be used. As a result, drainage water from granary areas may cause adverse effects on natural environment and ultimately on human health.

The main component of this proposed plan is to construct a water quality monitoring system, particularly to check drainage water around the paddy fields. In addition, a comprehensive feedback system is essential to maintain and to implement actual management actions. This section of this report proposes an environmental monitoring plan for IADP Pulau Pinang, IADP Kerian and IADP Ketara (Besut). This system is, however, applicable to other granary areas as well. This proposal mainly consists of:

(a) Establishment of a water quality sampling system (parameters, sampling locations, sampling cycles and a data management system)

(b) Establishment of a water quality management network (inter-departmental linkages/ communication with various departments and agencies)

(c) Staff training programs

(2) Environmental Policy

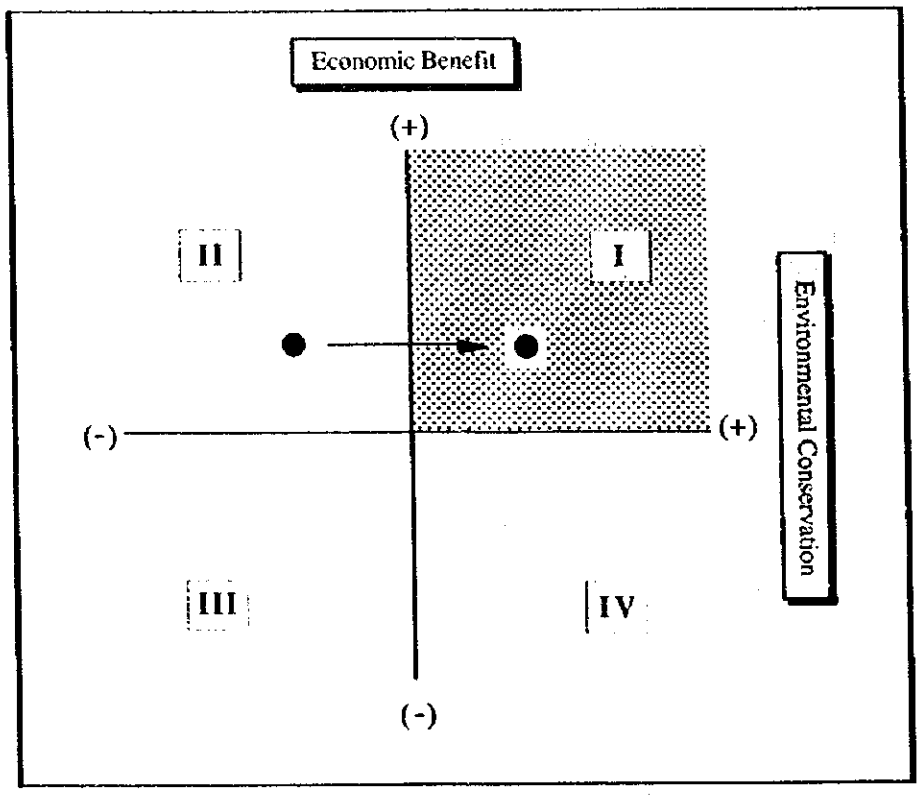
The basic environmental policy regarding the environmental management plan of the Semerak Rural Development Project (1997) was addressed as: recognizing that the land, water, air and biotic resources of Malaysia belong to both present and future generations, our commitment is to manage these in a sustainable manner by :

- identifying the most appropriate uses of the available resources consistent with traditional economic activities, technological development and best available cost-effective practices
- integrating environmental protection and improvements into the plans and operations
- meeting, or exceeding, state and federal environmental standards
- working together with farmers, other land users, community residents and state and federal agencies to identify and address environmental challenges

The goal of this policy is to maintain environmental condition and public health as well as commercial practices through the implementation of environmental monitoring, evaluation and feedback programs. The environmental management plan (EMP) presented in this report describes details of such programs, which contribute to achieving the goal of the environmental policy in relation to irrigation practices for paddy.

(3) Conceptual Model of Environmental Management Plan (EMP)

For the formulation of a project for development, economic benefit, as well as environmental profiles of the project, must be considered. Usually, these aspects are the two major parameters of the general propensity of a development project, and the relationships of the parameters can often be illustrated as the following diagram :



Relationships between Environmental Conservation and Economy in Development

This model is divided into four categories such as:

I : Increase economic benefit as well as quality of natural environment
II : Increase economic benefit but reduce quality of natural environment
III : Reduce economic benefit as well as quality of natural environment
IV : Reduce economic benefit but increase quality of natural environment

In general, irrigation projects fall into Category II due to improvement in agricultural practices with some environmental impacts (e.g. deterioration of water quality and land clearing). It is likely that the present IADP projects in Pulau Pinang, Kerian and Ketara (Besut) are also placed in Category II. The projects have raised paddy production, but the water quality around the paddy fields has assumed to be deteriorated due to the use of agro-chemicals without a monitoring system on drainage water.

Formulation of an EMP for the project on modernization of water management system is aiming to shift Category II to Category I. Parameters of environmental conservation associated with this development includes water quality, biological diversity and sustainable use of natural resources (e.g. fishery practice). However, the quality of drainage water from the paddy fields appears to be the most important and sensitive parameter to be monitored in the EMP.

Economic benefit can be assessed mainly by farmers' income in relation to changes in agricultural products. Economic benefit comes primarily from increase in rice production due to upgrading the current water management system. On the other hand, the EMP needs some initial input as well as management cost (e.g. equipment and remuneration for staff) for operating the water quality monitoring system. Furthermore, the EMP does not necessarily bring immediate economic benefit. The system, however, contributes on environmental conservation and also maintains some commercial benefit (i.e. downstream fishery practices) in a long-term basis by securing the water quality. When the water quality is deteriorated to some extent, immediate management actions such as changes in application of agro-chemicals will be necessary. If the cost of such an action exceeds; then, the project will be placed in Category IV of the diagram.

4.2 Staffing and Institutional Framework

For the smooth operation of the EMP, the development of an institutional framework, which enables the allocation of qualified staff to appropriate positions is inevitable. It is proposed that the following four positions be established in the DID to take certain responsibilities in the plan :

(1) Environmental Manager/Coordinator:
Headquarters of the DID (Planning and Evaluation Section)

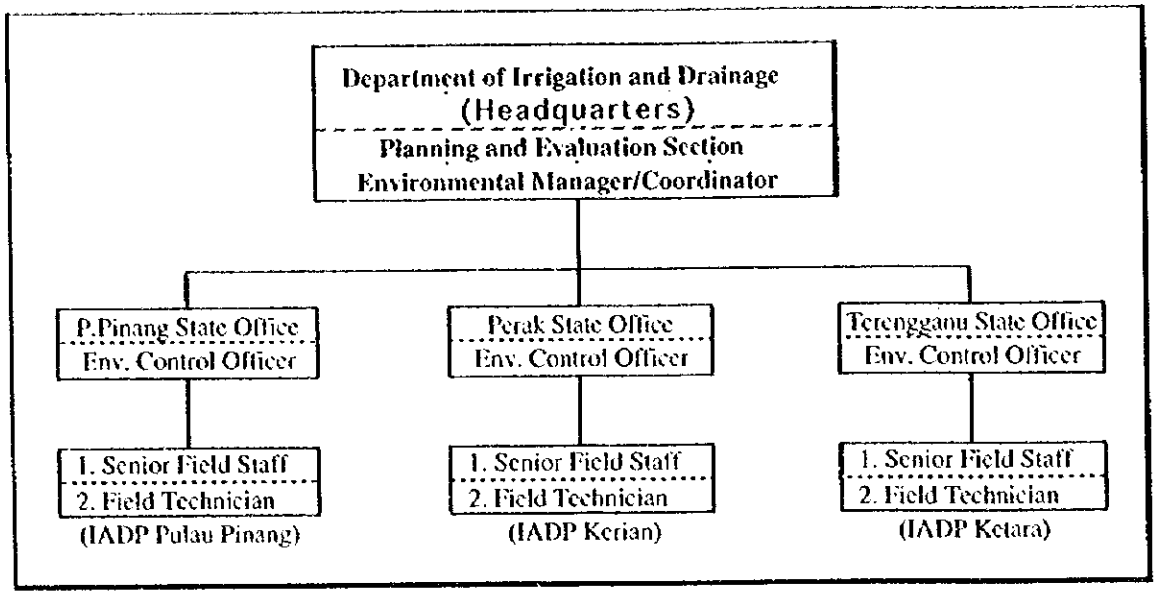
(2) Environmental Control Officer:
Each State Office of the DID

(3) Senior Field Staff:

Each field office (IADP Office/Granary Area)

(4) Field Technician:

Each field office (IADP Office/Granary Area)



Institutional Framework of the DID with the Environmental Management Plan (EMP)

These positions can be filled by new employees and/or concurrently held by present staff who are highly qualified to those positions. Qualifications and duties of each position are proposed as follows :

(a) Environmental Manager/Coordinator

(Qualifications and Experience)

•A University degree in natural sciences is required. At least five-year or more work experience in the field of environmental science (e.g. research and consulting) with the knowledge of Malaysia's environmental policy and legislation.

(Duties)

- Management and development of overall environmental monitoring and evaluation programs
- Internal and external communication/networking regarding environmental issues
- Implementing environmental management actions
- Maintenance of database
- Organizing staff training programs
- Supervising environmental control officers

(b) Environmental Control Officer

(Qualifications and Experience)

A diploma or certificate in agriculture, engineering or natural sciences from College or Institute with a few years of work experience in relation to environmental issues is required.

The advanced knowledge of computer is essential.

(Duties)

- Supervising field staff to conduct water sampling and analysis
- Data analysis and management
- Communication with headquarters (DID) regarding environmental data
- Evaluation of environmental impacts (i.e. water quality)
- Collating environmental data submitted by each local office
- Preparation of a half-yearly report to headquarters
- Organizing management actions with the DOA (i.e. changes in the use of agro-chemicals by farmers when required)

(c) Senior Field Staff

(Qualifications and Experience)

Minimum requirement of a high school diploma with some subjects in science and a few years of field experience is necessary. Automobile drivers license with a good record is essential. Field staff must have completed a proper training on water sampling and analysis, and the knowledge of basic computer use is required.

(Duties)

- Conducting/supervising all field sampling and data collection
- Maintenance of field equipment
- Communication with the environmental control officer
- Data entry and basic analysis (i.e. WQI calculation)
- Laboratory analysis (delivery of water samples to the laboratory)
- Preparation of a monthly environmental report (water quality report)
- Implementing management actions with the DOA (i.e. changes in the use of agro-chemicals by farmers)

(d) Field Technician

(Qualifications and Experience)

Minimum requirement of a high school diploma with some subjects in science. Automobile drivers license with a good record is essential. Technicians must complete a training program on water sampling and analysis.

(Duties)

- Conducting all the field sampling and data collection

- Maintenance of field equipment
- Laboratory analysis (delivery of water samples to the laboratory)
- Data entry and basic analysis

4.3 Inter-departmental Information Flow

Efficient transfer of information is the key factor of the effective EMP. Establishment of inter-departmental linkages between various departments and agencies (e.g. DID, DOE and DOA) is, therefore, crucial to implement the plan. A conceptual framework of the information network of the EMP is shown in Fig. VI-4. This is a cyclic system indicating a flow of necessary actions and information. All management decisions must be based on scientific data with a systematic monitoring system, and all management actions should be evaluated subsequently. There is no "dead end" within this work flow, and this information network should be active at any stage.

4.4 Staff Training (DID)

Staff training programs are an important part of the EMP. The training programs should be focused on data collection (water sampling/analysis), computer applications, data quality control/assurance and communication skills. It is important to design the training programs for particular purposes, and all instructors must be highly qualified. It is proposed to organize three levels of training, and the programs should be planed in cooperation with various departments. Particularly, the DOE currently offers some training programs in environmental management, so that the staff of the DID should be participating in the programs whenever possible. Regarding the training programs of the water quality sampling, National Hydraulic Research Institute (NAHRIM) can play the key roles in designing the programs. Furthermore, collaboration with Universities, research institutions and the Departments of Chemistry, Agriculture and Public Health is also encouraged.

The topics to be included in the training programs are proposed as follows:

Level	Approximate Qualifications	Topics
1.	Environmental Control Officer/ Other qualified staff	- Design and planning env. management programs - Data analysis (use of computer) - Environmental policy and related issues - Environmental impact evaluation and mitigation - Report writing and communication skills - Others
2.	Senior Field Staff/ Other qualified staff	- Principles of environmental management - Computer application (some analysis: WQI) - Environmental science (ecology and chemistry) (ecological sampling methods) - Report writing and communication skills - Others
3.	Field Technician/ Other qualified Staff	- Basic computer application - Basic environmental science (ecology and chemistry) - Ecology of fauna and flora (around paddy fields focusing on field identification) - Field sampling techniques - Basic laboratory analysis - Basic report writing and communication skills - Others

In addition to the staff training programs, it is important for the DID staff to attend occasional seminars and workshops when relevant programs are available. It is encouraged that the knowledge of environmental management and issues be kept updated whenever possible.

4.5 Water Quality Monitoring System

(1) Parameters

This is a permanent water quality monitoring system that is designed particularly to check the quality of drainage water from the paddy fields as well as to monitor effectiveness of management actions such as controlling the use of agro-chemicals by farmers. The following table indicates a list of parameters, which is a minimum requirement for the monitoring system. Other parameters can be included when it is necessary. The standard values of each parameter within water quality classes, which are defined by the DOE are also shown in the table, and water quality should be remained above Class III at all the time.

Parameters	Water Quality Classes					
	I	IIA	IIB	III	IV	V
Ammoniacal Nitrogen (Nh_3N) (mg/l)	0.1	0.3	0.3	0.9	2.7	2.7
BOD (mg/l)	1	3	3	6	12	12
COD (mg/l)	10	25	25	50	100	100
DO (mg/l)	7	5 - 7	5 - 7	3 - 5	3	1
SS (mg/l)	25	50	50	150	300	300
pH	6.5 - 8.5	6.5 - 9.0	6.5 - 9.0	5.0 - 9.0	5.0 - 9.0	—
Phosphorus (mg/l)	N.L.	< 0.2	< 0.2	< 0.1	—	0.1 <
Nitrate (mg/l)	—	—	—	—	—	—

N.L. = Natural levels

Class I : (Water Supply I) No treatment necessary, (Fishery I) Acceptable for very sensitive aquatic species

Class IIA : (Water Supply II) Conventional treatment required, (Fishery II)Acceptable for sensitive aquatic species

Class IIB : Acceptable for recreational use with body contact

Class III : (Water Supply III) Extensive treatment required, (Fishery III) Acceptable for common and tolerant species. Acceptable for livestock drinking

Class IV : Acceptable for irrigation

Class V : None of the above

Changes in general water quality can also be evaluated with the water quality index (WQI) being used by the DOE (Fig. VI-3). Using WQI values for the evaluation of drainage water allows comparison with other water quality data. Calculation of the WQI involves NH_3N, BOD, COD, DO, SS and pH, and its formulae are presented in the previous section (VI 2.1). It is recommended to have a guidance with the DOE for this analysis, and WQI values should be calculated in each month.

Present water quality of the study sites (IADP Pulau Pinang, IADP Kerian and IADP Ketara) was found to be only slightly polluted (WQI 70 - 80) in the first Phase of this study, so it is assumed that each parameter of the drainage water around the paddy fields is not polluted seriously (at least Class III) at the present time.

For irrigation purposes, other parameters are also suggested to be monitored. These parameters include: dissolved solids, specific conductance, sodium (Na), boron (B), calcium (Ca), chlorides (Cl), potassium (K) and trace metals.

(2) Sampling Locations

Establishment of fixed sampling stations in IADP Pulau Pinang, IADP Kerian and IADP Ketara (Besut) to monitor water quality is proposed. Proposed sampling locations are listed in the following table as well as shown in the maps (Fig. VI-5 to VI-8) :

Scheme	Plot No.	Name of River (Station)
IADP Pulau Pinang (Fig.VI-5 and VI-6)	P 1	Bumbong Lima Pump Station
	P 2	Pinang Tunggal Pump Station
	P 3	Kreh Pump Station
	P 4	Padang Cemedak Pump Station
	S 1	Sg. Kreh
	S 2	Sg. Tembus
	S 3	Sg. Abdul
	S 4	Sg. To Sani
	S 5	Sg. Jarak
	S 6	Sg. Jalutong
	S 7	
	S 8	Sg. Derhaka
	S 9	Sg. Kulim
IADP Kerian (Fig VI-7)	P 1	PT 30
	P 2	Sg. Bogak Pump Station
	S 1	Sg. Bakau
	S 2	Sg. Tg. Piandang
	S 3	Pt. Tokin
	S 4	Sg. Kurau
	S 5	Sg. Kurau
	S 6	TSN Besar
IADP Ketara (Besut) (Fig VI-8)	P 1	Sg. Kena Pump Station
	P 2	Alor Air Putih Pump Station
	P 3	Sg. Gerong Pump Station
	S 1	Sg. Kena
	S 2	Sg. Jertch
	S 3	Sg. Besut
	S 4	Sg. Angga
	S 5	Sg. Kerandang

Major drainage canals are selected for water sampling stations, which can check chemical residues efficiently. Pumping stations to recycle water for irrigation are important points to monitor water quality. These locations are shown as P in the maps. Major water intake points are also included in the monitoring system. Therefore, the system enables to check water quality for irrigation purposes, and also the results can be compared before and after the water being used for irrigation.

(3) Sampling Procedure

It is recommended that water sampling be carried out at least twice a month at each sampling station to obtain representative data for a month. However, the frequency of the sampling can be adjusted subsequently according to the propensity of the results. It is important to collect water samples when agro-chemicals are being applied. Fertilizers are normally used in a seeding period. On the other hand, insecticide and herbicide are applied on an irregular basis. Frequent sampling is recommended when a large amount of agro-chemicals is being used.

Sampling methods should be consistent with those of the DOE, and it is also recommended to have a guidance of the Department of Chemistry. All the necessary equipment for the sampling should be purchased and managed by the DID. Simple analysis can be carried out in the field; however, cooperation with institutions such as the Department of Chemistry and/or National Hydraulic Research Institute of Malaysia (NAHRIM) is required for more complicated laboratory analysis.

4.6 Cost Estimate for the Monitoring System

Summery of the cost estimate for the water monitoring program is presented in the main report. Breakdown (remuneration, equipment and analysis) of the estimate is shown in this section. Using automatic sensors is optional at this stage of the project, but a cost estimate for using such sensors is also presented in this section.

(1) Remuneration for the Proposed Positions

Provisional annual budget for remuneration of the necessary positions (section VI 4.2) at the DID are estimated for the initial five years in the following table.

(Unit: RM 1,000)

Position	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5
Environmental Manager	60	62	64	66	68
Environmental Control Officer	32	33	34	35	36
Senior Field Officer	22	22.8	23.6	24.4	25.2
Field Technician	14.5	15	15.5	16	16.5
Total	128.5	132.8	137.1	141.4	145.7

(Data Source) Department of Irrigation and Drainage, Planning and Evaluation Section

(2) Equipment and Analysis

Tentative costs for the equipment of water sampling and analysis are also estimated in the following table. This estimate, however, varies largely with a choice of equipment and the number of parameter. This estimate covers only basic parameters (NH_3H, BOD, COD, DO, SS, pH, P and N) for the first stage of the monitoring program, and more detailed budget planning will be necessary for an actual implementation of the program.

(Unit: RM)

Parameter	Equipment
pH	3,500
DO	4,800
BOD	1,400
COD	4,100
SS	9,000
NH_3H	450
P	100
N	150
Total	23,500

Cost of analysis (e.g. reagents) is also estimated in the following table. This budget planning is based on using spectrophotometers (Hach reagents). Each cost is a price of a single sampling/analysis. Total cost of sampling and analysis in each Scheme varies largely with a sampling frequency per month.

(Unit: RM)

Parameter	Cost of Analysis (Reagents) 1Sample/Each Station
pH	-
DO	6
BOD	277
COD	238
SS	-
NH_3H	12
P	18
N	26
Total	577

(3) Automatic Water Quality Sensor

For some of the parameters, automatic water quality sensors are available in recent years. The result of using such sensors seem to be reliable, and such a technique has been becoming popular. This sensor system can be used in this project, but it is important to establish an appropriate water quality monitoring system first.
Cost estimate of using an automatic sensor is shown below. DataSonde 4 (Hydrolab, U.S.A.) is used as an example of such a sensor in this estimate. This sensor can automatically store more than 120,000 measurements, and the longevity of the battery extends up to 120 days. Miscellaneous requirements in the table include batteries, cables and others. This estimate covers parameters such as DO, pH, SS and ammonia. Sensitive parameters such as BOD and COD need to be analyzed in a laboratory.

(Unit: RM)

Item	Price
Automatic Sensor	22,400
Optional Probes (DO, pH, SS, NH_3H)	23,800
Data Logger (display)	18,100
Miscellaneous	22,900
Total	87,200

4.7 Data Management

All the water quality data should be stored on computer files using locally available software packages (e.g. Lotus 1-2-3, dBase and Excel). Primary data collected at each IADP Office/Granary Area must be analyzed (e.g. WQI) and compiled into a monthly report. The monthly report must be forwarded to the State Office of the DID, and the senior field officer is responsible for this process.

Environmental control officer at each State Office collates all the data from local offices, and compiles a half-yearly report of the State. Then, the report should be transferred and properly stored at headquarters of the DID. It is recommended that the data be on a home page

of the DID so that any government agencies, interest groups and individuals can have access to the data. Particularly, the DID should have an active communication with various departments regarding water quality related environmental issues. These departments include:

- Department of Environment (overall environmental monitoring)
- Department of Agriculture (IPM and application of agro-chemicals)
- Department of Fishery (fish culture and fishery practices)
- Department of Forestry (mangrove conservation)
- Department of Wildlife and National Parks (bird species and other fauna and flora)
- Department of Health (public health)
- Department of Chemistry (analysis)

4.8 Other Indicators of Environmental Condition

The ecological status of fauna and flora around paddy fields can be sufficient indicators on environmental condition. Paddy fields are often used as feeding and resting grounds by many bird species. Herons and kingfishers are likely to be general indicators for environmental condition, because the distribution covers a wide range; furthermore, those species feed mainly on aquatic animals. Previous study (IEE in August 1997) identified that there is a large colony of the black-crowned night-heron in the vicinity of Kerian Scheme, and this population is recognized internationally for its size. Therefore, the ecological status of this species is particularly important as an environmental indicator for Kerian Scheme.

An annual bird count to estimate bird populations is relatively easy to be carried out. The DOA currently has a program on counting pest species as part of IPM (e.g. surveillance system), and many farmers and their children are involved in this program. Therefore, it is recommended that bird populations be estimated at least annually in cooperation with the DOA. Furthermore, working with NGOs and local interest groups is desirable. For the counting procedure, it is very important that the sampling technique be consistent (e.g. sampling season, use of binoculars and group size for survey) in every year. For the details of sampling methods of birds and/or any wildlife species, it is suggested to consult with the Department of Wildlife and National Parks, but the DID can take responsibility for organizing a survey around the paddy fields.

Analysis of tissue samples from representative specimens of bird and fish around the paddy fields can indicate the presence of pesticide residues. However, this analysis requires experts and suitable laboratory facilities. Therefore, this examination is recommended to be performed every three-year and/or when it is necessary. When several parameters of water quality indicate a possible accumulation of pesticide residues within an ecosystem, this analysis is a powerful tool to examine chemical contamination. It is suggested that this analysis be conducted in collaboration with Universities and/or research institutions when required.

The ecological status of downstream aquatic ecosystems must also be carefully monitored. Particularly, the ecological status of fish species and aquatic vegetation can indicate environmental condition. However, sampling techniques for those surveys involve some skills (i.e. species identification, catching and vegetation sampling) compared with the bird count. When any detrimental impacts on downstream aquatic animals are observed such as rapid reduction in some wildlife populations and/or fish stocks, careful investigations must be taken

place with the cooperation of various agencies. River maintenance flow as well as water quality should be checked for this type of situation.

4.9 Mitigation Measures

(1) Control of Chemical Application

The most beneficial output of the water monitoring system is to allow management of agro-chemicals with scientifically sound water quality data. When any excessive use of agro-chemicals is detected, it is important to search precisely for a possible cause. Then, appropriate management actions must be taken place immediately, and the DID and the DOA should play the key role in such a process. Therefore, there must be a smooth communication network between those departments.

In addition, the DOA is currently encouraging the farmers to follow established cropping schedules, so that fertilizers can be used more effectively. It has been suggested that long-lasting coated fertilizers (e.g. nitrogen) can be used to minimize adverse effects, but these are usually expensive. Details of the technical aspects of the fertilizer application in relation to cropping schedules are discussed in the agricultural section of this report.

Furthermore, the DOA recommends that only readily decomposable insecticides and herbicides be used. Although those chemicals normally contain toxic substances, it is inevitable to use them for some circumstances, so that they must be used very carefully. On the other hand, development of alternative methods to control pest populations is encouraged. Integrated Pest Management (IPM) of the DOA seems to be an appropriate approach to minimize adverse effects of using insecticides and herbicides.

(2) Integrated Pest Management (IPM)

Integrated Pest Management (IPM) of the DOA started mainly in the 1980s in Malaysia. Primary function of this program is to use biological agents to control pests and weeds in agricultural practices. It also includes a surveillance system and subsidy scheme encouraging appropriate use of pesticides. Effective use of pesticides with readily decomposable chemical substance is also an important part of the IPM. Therefore, this program can be a mitigation measure for reducing possible adverse effects of using insecticides, herbicides and other forms of agro-chemical in rice production.

It is reported that the IPM has been successful and an effective method to control pest populations in the rice farming practice. However, it seems that only limited data are currently available on its effectiveness. Before any management action is taken, important hypotheses must be tested statistically. This type of study must have treatment and control areas for a direct comparison. A research institution such as MARDI should be involved heavily in this type of project. It is also encouraged to collaborate with Universities, and graduate students in related fields (e.g. agriculture, zoology and ecology) can conduct research on various aspects of the IPM.

For example, releasing the barn owl (Tyto alba) with nest boxes around rice fields for controlling rat populations is one of the major practices of the IPM program. The main hypothesis with this program that must be tested is: the owls released in the field can actually control rat populations on the rice fields. The treatment site should be a rice field with a closed population of rats and owls, and the ecology of those animals should be studied to examine the hypothesis. Basic ecological aspects that must be analyzed in this experiment are listed as follows:

- Feeding behavior of the owls
- Population dynamics of the owls and rats
- Home range of the owls
- Utilization of the nest boxes by the owls

Furthermore, different biological agents (e.g. catfish and Muskovi ducks) to control a variety of pests have been considered and introduced into some rice fields. Having these animals as predators in the program, different pest species are expected to be reduced. However, crucial hypotheses must be tested with scientifically designed experiments before management actions are implemented. It is also very important to replicate the experiments, particularly when a management program plans to be carried out in a new area.

4.10 Other Environmental Issues

In the rice farming practice, considerable amounts of secondary product such as paddy straws, husks and rice bran are normally produced. The estimated weight of those products in Malaysia is shown in the following table. Most of these products, except rice bran, are not fully utilized at the present time. Most of the paddy straws are left in the paddy fields to be burned or plowed-in after the harvest. Much of the rice husks are also burned. It is said that this burning practice may cause some impacts on air quality. Although burning paddy straws makes ash, which can be nutrient for paddy in the following season, it has been suggested that the burning practice be reduced. Therefore, making compost with the secondary products has been suggested as an alternative usage of the products.

Items	Estimate (1,000 tons/year)
Paddy straw	1,629.7
Paddy husk	277.1
Rice bran	55.3
Total	1,962.1

(Hayakawa 1997: International Cooperation in Agriculture and Forestry. Vol.20, No.1•2)

Organic farming is considered as a safe and productive agricultural practice. There is a technique available to make compost with paddy straws, paddy husks, rice bran and chicken dung with the aid of effective microorganisms (EM). EM is a mixture of about 80 species of naturally occurring microorganisms, which can improve soil condition and plant growth. This is commercially available and currently being used at KADA. One cycle of making compost normally takes about 45 days. However, collecting rice straws in the field may present a

problem of labor input. Furthermore, it requires considerable space if this program is to be economically viable.

In addition, the secondary products can be used as a type of feed for livestock. However, cattle and sheep industries of Malaysia have not developed enough to make use of the secondary products. Self-sufficiency rate of beef is 22% as opposed to the chicken meat of 114% in Malaysia. Therefore, this consumption has a potential future use but cannot be an immediate option.

TABLES

Table VI-1 List of Malaysian wildlife species (mammals, birds and reptiles) classified as endangered species in the Red List of IUCN

\+ Critically endangered

Classification		Scientific Name	Common Name
Mammalia			
Insectivora			
(Soricidae)	+	*Chimarrogale hautu*	Malaysian water shrew
		Chimarrogale phaeura	Borneo water shrew
		Crocidura malayana	-
	+	*Suncus ater*	Black shrew
Chiroptera			
(Rhinolophidae)	+	*Hipposideros nequam*	-
(Vespertilionidae)		*Hesperoptenus doriae*	-
Carnivora			
(Felidae)		*Panthera tigris*	Tiger
(Viverridae)		*Cynogale benettii*	Otter-civet
Proboscidea			
(Elephantidae)		*Elephas maximus*	Asian elephant
Perissodactyla			
(Rhinocerotidae)	+	*Dicerorhinus sumatrensis*	Sumatran rhinoceros
	+	*Dicerorhinus s. harrissoni*	-
	+	*Dicerorhinus s. sumatrensis*	-
	+	*Rhinoceros s. sondaicus*	-
Artiodactyla			
(Bovidae)		*Bos javanicus*	Banteng
		Capricornis s. sumatraensis	Sumatran serow
Rodentia			
(Muridae)		*Maxomys alticola*	-
		Maxomys baeodon	-
		Rattus baluensis	-
Aves			
Psittaciformes			
(Psittacidae)		*Tanygnathus lucionensis*	Blue-naped parrot
Reptilia			
Crocodylia			
(Crocodylidae)	+	*Crocodylus siamensis*	Siamese crocodile
Testudines			
(Chelonidae)		*Chelonia mydas*	Green turtle
	+	*Eretmochelys imbricata*	Hawksbill turtle
		Lepidochelys olivacea	Olive ridley
(Dermochelyidae)		*Dermochelys coriacea*	Leatherback turtle
(Emydidae)		*Batagur baska*	River terrapin
	+	*Callagur borneoensis*	Painted terrapin

Table VI-2 Water Quality Data from Jarak River (upstream) of Pulau Pinang Scheme in 1996

Parameters/Months	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
BOD (mg/l)	4	5	5	2	2	2	4	*	< 2	< 0.5	3.6
COD (mg/l)	24	18	25	24	15	16	15	*	14	3	8
NH_3N (mg/l)	2.1	4.1	6.4	1.5	1.2	3.1	3.5	*	0.8	0.32	0.4
SS (mg/l)	27	7	1	167	77	45	66	*	61	143	11
DO (mg/l)	*	*	*	*	*	*	*	*	*	*	*
pH	7.1	7.2	7.6	6.9	7.3	7.3	6.8	*	6.9	5.7	6.1

Table VI-3 Water Quality Data from Jarak River (downstream) of Pulau Pinang Scheme in 1996

Parameters/Months	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
BOD (mg/l)	2	8	4	2	3	3	8	1	< 1	2.5	< 0.5
COD (mg/l)	16	19	25	26	12	18	12	17	3	11	< 1
NH_3N (mg/l)	2	3.2	0.5	6.1	1.7	3.9	1.9	1.5	1.1	0.39	0.4
SS (mg/l)	27	33	15	155	68	45	67	161	43	188	33
DO (mg/l)	*	*	*	*	*	*	*	*	*	*	*
pH	7	7.2	7.7	7.3	7.4	7.7	6.7	6.8	6.8	5.8	6

Table VI-4 Water Quality Data from Kulim River (upstream) of Pulau Pinang Scheme in 1996

Parameters/Months	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
BOD (mg/l)	1	1	1	1	1	1	1	1	< 2	< 0.5	< 0.5
COD (mg/l)	6	1	7	16	9	11	8	18	13	< 1	< 1
NH_3N (mg/l)	0.05	0.3	0.4	0.5	1.3	0.9	1.1	2.2	0.4	0.3	0.4
SS (mg/l)	24	60	25	111	61	90	88	149	104	100	23
DO (mg/l)	*	*	*	*	*	*	*	*	*	*	*
pH	7.2	7.3	7.6	7.6	7.3	7.8	6.7	6.6	6.5	5.9	6.2

Table VI-5 Water Quality Data from Kulim River (downstream) of Pulau Pinang Scheme in 1996

Parameters/Months	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
BOD (mg/l)	5	38	*	3	4	5	12	3	< 1	< 1	< 0.5
COD (mg/l)	19	196	*	18	25	17	46	11	11	< 1	< 1
NH_3N (mg/l)	4	7	*	6.8	2	1.5	2.9	2.4	2.1	1	1.03
SS (mg/l)	56	387	*	45	106	39	203	43	*	*	*
DO (mg/l)	*	*	*	*	*	*	*	*	*	*	*
pH	7	7.4	*	7.4	7.4	7.1	7.2	6.7	6.8	6.3	6.5

Table VI-6 Water Quality Data from Muda River of Pulau Pinang Scheme in1996

Parameters/Months	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
BOD (mg/l)	2	2	2	0	1	1	0	*	< 1	< 0.5	2
COD (mg/l)	11	12	4	15	6	8	7	*	14	3	4
NH_3N (mg/l)	0.1	0.4	0.3	0.2	0.9	1.4	1	*	0.9	0.1	0.2
SS (mg/l)	51	60	24	115	63	54	57	*	56	156	188
DO (mg/l)	*	*	*	*	*	*	*	*	*	*	*
pH	7.1	7.9	8.1	7.8	7.6	8.1	7.2	*	7.5	6.4	6.7

Table VI-7 Water Quality Data from Kerian River (upstream) of Kerian Scheme in 1996

Parameters/Months	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
BOD (mg/l)	*	1.3	*	*	1.1	*	*	2.3	*	1	*
COD (mg/l)	*	48.3	*	*	27.7	*	*	19.2	*	17	*
NH_3N (mg/l)	*	0.08	*	*	0.34	*	*	0.18	*	0.15	*
SS (mg/l)	*	5	*	*	30	*	*	17	*	30	*
DO (mg/l)	*	2	*	*	1	*	*	4	*	2.9	*
pH	*	6.4	*	*	5.5	*	*	6	*	5.73	*

Table VI-8 Water Quality Data from Kerian River (middle-stream) of Kerian Scheme in 1996

Parameters/Months	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
BOD (mg/l)	*	0.8	*	*	2.8	*	*	1.2	*	1	*
COD (mg/l)	*	22.3	*	*	31.1	*	*	23.1	*	11	*
NH_3N (mg/l)	*	0.13	*	*	0.32	*	*	0.34	*	0.2	*
SS (mg/l)	*	25	*	*	10	*	*	42	*	30	*
DO (mg/l)	*	3	*	*	2.3	*	*	3.7	*	2.6	*
pH	*	7.3	*	*	5.3	*	*	5.1	*	5.17	*

Table VI-9 Water Quality Data from Kerian River (downstream) of Kerian Scheme in 1996

Parameters/Months	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
BOD (mg/l)	2.5	*	*	2.2	*	*	*	0.5	*	1	*
COD (mg/l)	27.6	*	*	57.7	*	*	*	7.7	*	17	*
NH_3N (mg/l)	0.47	*	*	0.18	*	*	*	0.37	*	0.32	*
SS (mg/l)	5	*	*	5	*	*	*	7	*	17	*
DO (mg/l)	6.2	*	*	5.4	*	*	*	7.8	*	5.8	*
pH	5.6	*	*	6.4	*	*	*	7.2	*	6.7	*

Table VI-10 Water Quality Data from Bukit Merah Reservoir of Kerian Scheme in 1996

Parameters/Months	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
BOD (mg/l)	2	3	3	2	4	3	4	2	3	1	1	2
COD (mg/l)	4	11	16	6	11	10	10	5	7	4	4	4
NH_3N (mg/l)	0.17	0.14	0.16	0.23	0.24	0.16	0.18	0.16	0.18	0.18	0.15	0.15
SS (mg/l)	*	*	*	*	*	*	*	*	*	*	*	*
DO (mg/l)	8.67	9.5	8.72	9.66	8.78	8.48	7.69	6.07	8.78	*	*	7.38
pH	6.73	6.73	6.53	6.67	6.27	6.26	6.36	6.27	6.2	5.94	6.44	6.52

Table VI-11 Water Quality Data from Sg. Batang Padang (upstream) of Sungai Manik Scheme in 1996

Parameters/Months	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
BOD (mg/l)	*	*	*	2.8	*	*	*	*	0.8	*	3.2
COD (mg/l)	*	*	*	50	*	*	*	*	7.7	*	23
NH_3N (mg/l)	*	*	*	0.34	*	*	*	*	0.18	*	0.18
SS (mg/l)	*	*	*	105	*	*	*	*	66	*	61
DO (mg/l)	*	*	*	6	*	*	*	*	6.9	*	4.1
pH	*	*	*	5.5	*	*	*	*	7.4	*	5.4

Table VI-12 Water Quality Data from Sg. Batang Padang (downstream) of Sungai Manik Scheme in 1996

Parameters/Months	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
BOD (mg/l)	*	*	*	3.4	*	*	*	*	0.6	*	1
COD (mg/l)	*	*	*	75	*	*	*	*	3.8	*	2
NH_3N (mg/l)	*	*	*	0.37	*	*	*	*	0.13	*	0.13
SS (mg/l)	*	*	*	135	*	*	*	*	33	*	125
DO (mg/l)	*	*	*	6.2	*	*	*	*	8.5	*	6
pH	*	*	*	6.1	*	*	*	*	6.9	*	6.6

Table VI-13 Water Quality Data from Perak River (upstream) of Seberang Perak Scheme in 1996

Parameters/Months	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
BOD (mg/l)	*	*	0.8	*	*	*	*	*	*	*	1
COD (mg/l)	*	*	23.4	*	*	*	*	*	*	*	1
NH_3N (mg/l)	*	*	0.07	*	*	*	*	*	*	*	0.06
SS (mg/l)	*	*	60	*	*	*	*	*	*	*	22
DO (mg/l)	*	*	5.5	*	*	*	*	*	*	*	5.9
pH	*	*	7.3	*	*	*	*	*	*	*	6.7

Table VI-14 Water Quality Data from Perak River (middle-stream) of Seberang Perak Scheme in 1996

Parameters/Months	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
BOD (mg/l)	*	*	*	3.6	*	*	*	*	6	*	0.5
COD (mg/l)	*	*	*	28.6	*	*	*	*	7.7	*	1
NH_3N (mg/l)	*	*	*	0.07	*	*	*	*	0.07	*	0.28
SS (mg/l)	*	*	*	65	*	*	*	*	21	*	28
DO (mg/l)	*	*	*	3.6	*	*	*	*	5.9	*	4.7
pH	*	*	*	6	*	*	*	*	7.3	*	6.4

Table VI-15 Water Quality Data from Perak River (downstream) of Seberang Perak Scheme in 1996

Parameters/Months	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
BOD (mg/l)	*	*	*	4.6	*	*	*	*	2.7	*	1
COD (mg/l)	*	*	*	25	*	*	*	*	11.5	*	13
NH_3N (mg/l)	*	*	*	0.07	*	*	*	*	0.07	*	0.32
SS (mg/l)	*	*	*	90	*	*	*	*	167	*	182
DO (mg/l)	*	*	*	2.2	*	*	*	*	7	*	4
pH	*	*	*	6.2	*	*	*	*	7	*	6.1

Table VI-16 Water Quality Data from Semerak River (upstream) of Kemasin/Semerak Scheme in 1996

Parameters/Months	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
BOD (mg/l)	5.1	*	< 0.5	*	0.9	*	< 0.5	*	*	*	*
COD (mg/l)	11.3	*	17	*	32.2	*	20.8	*	*	*	*
NH_3N (mg/l)	0.03	*	0.02	*	0.06	*	< .02	*	*	*	*
SS (mg/l)	35	*	18	*	33	*	64	*	*	*	*
DO (mg/l)	2.2	*	34	*	1.7	*	2.7	*	*	*	*
pH	6.3	*	7.2	*	6.6	*	6.9	*	*	*	*

Table VI-17 Water Quality Data from Semerak River (Downstream) of Kemasin/Semerak Scheme in 1996

Parameters/Months	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
BOD (mg/l)	8.3	*	< 0.5	*	8.1	*	6.9	*	*	*	*
COD (mg/l)	11.5	*	72.9	*	226.5	*	15.5	*	*	*	*
NH_3N (mg/l)	< .02	*	< 0.02	*	0.09	*	0.2	*	*	*	*
SS (mg/l)	22	*	14	*	45	*	11	*	*	*	*
DO (mg/l)	2.1	*	6.2	*	2.7	*	2.7	*	*	*	*
pH	5.9	*	6.9	*	7	*	6.2	*	*	*	*

Table VI-18 Water Quality Data from Kemasin River of Kemasin/Semerak Scheme in 1996

Parameters/Months	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
BOD (mg/l)	2.4	*	0.8	*	1	*	0.9	*	*	*	*
COD (mg/l)	7.2	*	6.5	*	25	*	17.3	*	*	*	*
NH_3N (mg/l)	0.02	*	0.02	*	0.02	*	< 0.02	*	*	*	*
SS (mg/l)	12	*	24	*	26	*	20	*	*	*	*
DO (mg/l)	4.1	*	3.6	*	3	*	3.9	*	*	*	*
pH	6.5	*	8.1	*	6.7	*	7.1	*	*	*	*

Table VI-19 Water Quality Data from Besut River (upstream) of Ketara (Besut) Scheme in 1996

Parameters/Months	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
BOD (mg/l)	*	*	1.3	*	*	*	*	*	*	1	*
COD (mg/l)	*	*	10.7	*	*	*	*	*	*	20.9	*
NH_3N (mg/l)	*	*	0	*	*	*	*	*	*	0.07	*
SS (mg/l)	*	*	20	*	*	*	*	*	*	128	*
DO (mg/l)	*	*	4.5	*	*	*	*	*	*	5.7	*
pH	*	*	6.2	*	*	*	*	*	*	6.2	*

Table VI-20 Water Quality Data from Besut River (Downstream) of Ketara (Besut) Scheme in 1996

Parameters/Months	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
BOD (mg/l)	*	*	0.7	*	*	*	*	*	*	0.5	*
COD (mg/l)	*	*	10.9	*	*	*	*	*	*	10.2	*
NH_3N (mg/l)	*	*	< 0.02	*	*	*	*	*	*	0.16	*
SS (mg/l)	*	*	28	*	*	*	*	*	*	8	*
DO (mg/l)	*	*	4.9	*	*	*	*	*	*	4.5	*
pH	*	*	6.1	*	*	*	*	*	*	5.9	*

Table VI-21 Environmental check-list of the International Commission on Irrigation and Drainage (ICID)

Category	Check Items	Positive Impact very likely	Positive Impact possible	No Impact likely	Negative Impact possible	Negative Impact likely	No judgment possible at present	Comments
	Level of Impacts	A	B	C	D	E	F	
Hydrology	1-1 Low flow regime						X	
	1-2 Flood regime			X				
	1-3 Operation of dams			X				
	1-4 Fall of water table						X	
	1-5 Rise of water table			X				
Pollution	2-1 Solute dispersion			X				
	2-2 Toxic substances						X	
	2-3 Organic pollution			X				
	2-4 Anaerobic effects			X				
	2-5 Gas emissions			X				
Soils	3-1 Soil salinity			X				
	3-2 Soil properties			X				
	3-3 Saline groundwater			X				
	3-4 Saline drainage			X				
	3-5 Saline intrusion			X				
Sediments	4-1 Local erosion			X				
	4-2 Hinterland effect			X				
	4-3 River morphology			X				
	4-4 Channel regime			X				
	4-5 Sedimentation			X				
	4-6 Estuary erosion			X				
Ecology	5-1 Project lands			X				
	5-2 Water bodies						X	
	5-3 Surrounding areas						X	
	5-4 Valleys & shores			X				
	5-5 Wetlands & plains			X				
	5-6 Rare species			X				
	5-7 Animal migration			X				
	5-8 Natural industry			X				
Socio-economic	6-1 Population change			X				
	6-2 Income & amenity		X					
	6-3 Human migration						X	
	6-4 Resettlement			X				
	6-5 Women's role						X	
	6-6 Minority groups			X				
	6-7 Sites of value		X					
	6-8 Regional effects		X					
	6-9 User involvement		X					
	6-10 Recreation			X				
Health	7-1 Water & sanitation						X	
	7-2 Habitation			X				
	7-3 Health services			X				
	7-4 Nutrition			X				
	7-5 Relocation effect			X				
	7-6 Disease ecology			X				
	7-7 Disease hosts			X				
	7-8 Disease control			X				
	7-9 Other hazards			X				
Imbalance	8-1 Pests & weeds						X	
	8-2 Animal diseases			X				
	8-3 Aquatic weeds			X				
	8-4 Structural damage			X				
	8-5 Animal imbalances			X				
Total Number		0	4	40	0	0	9	

FIGURES

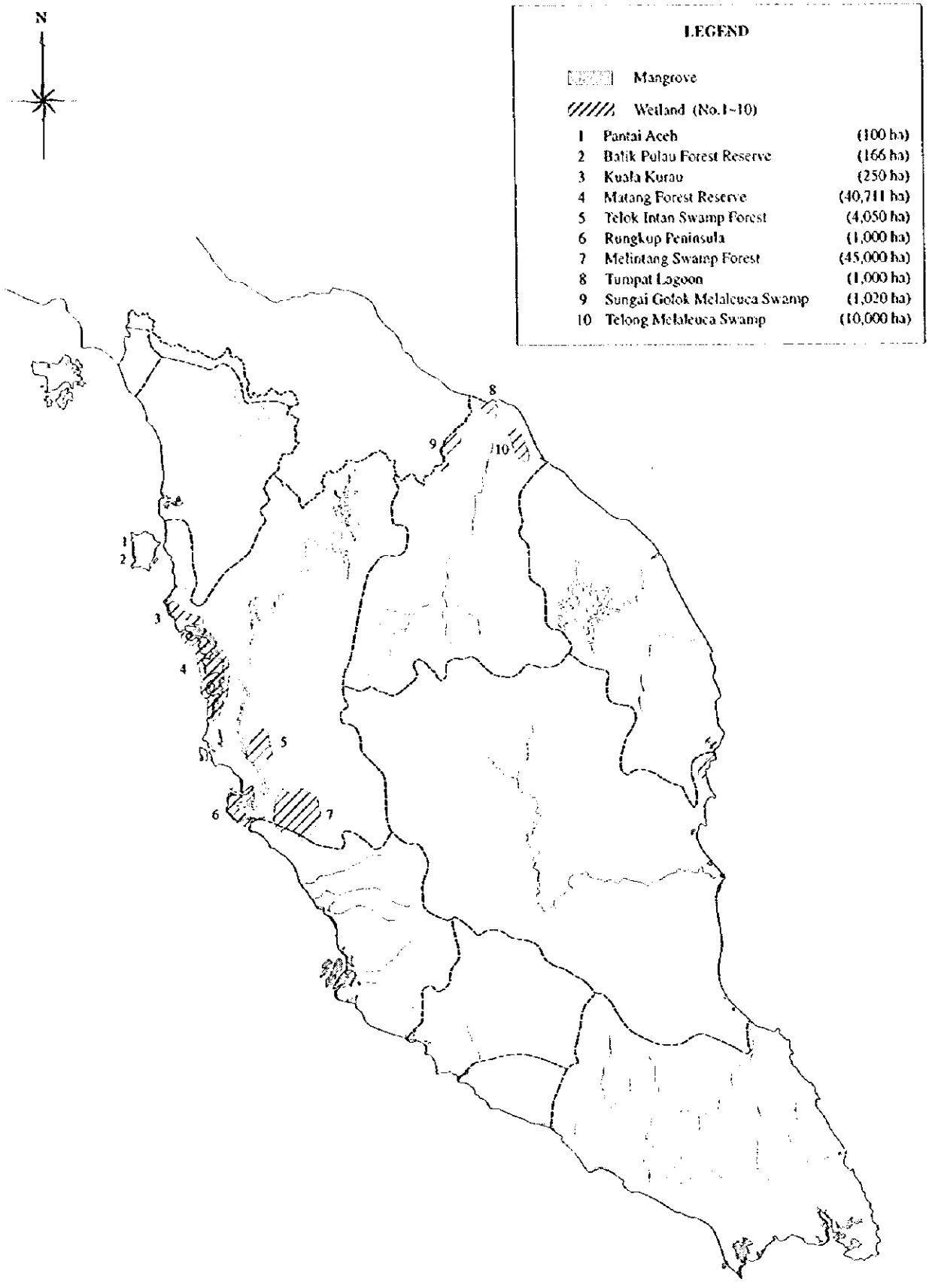
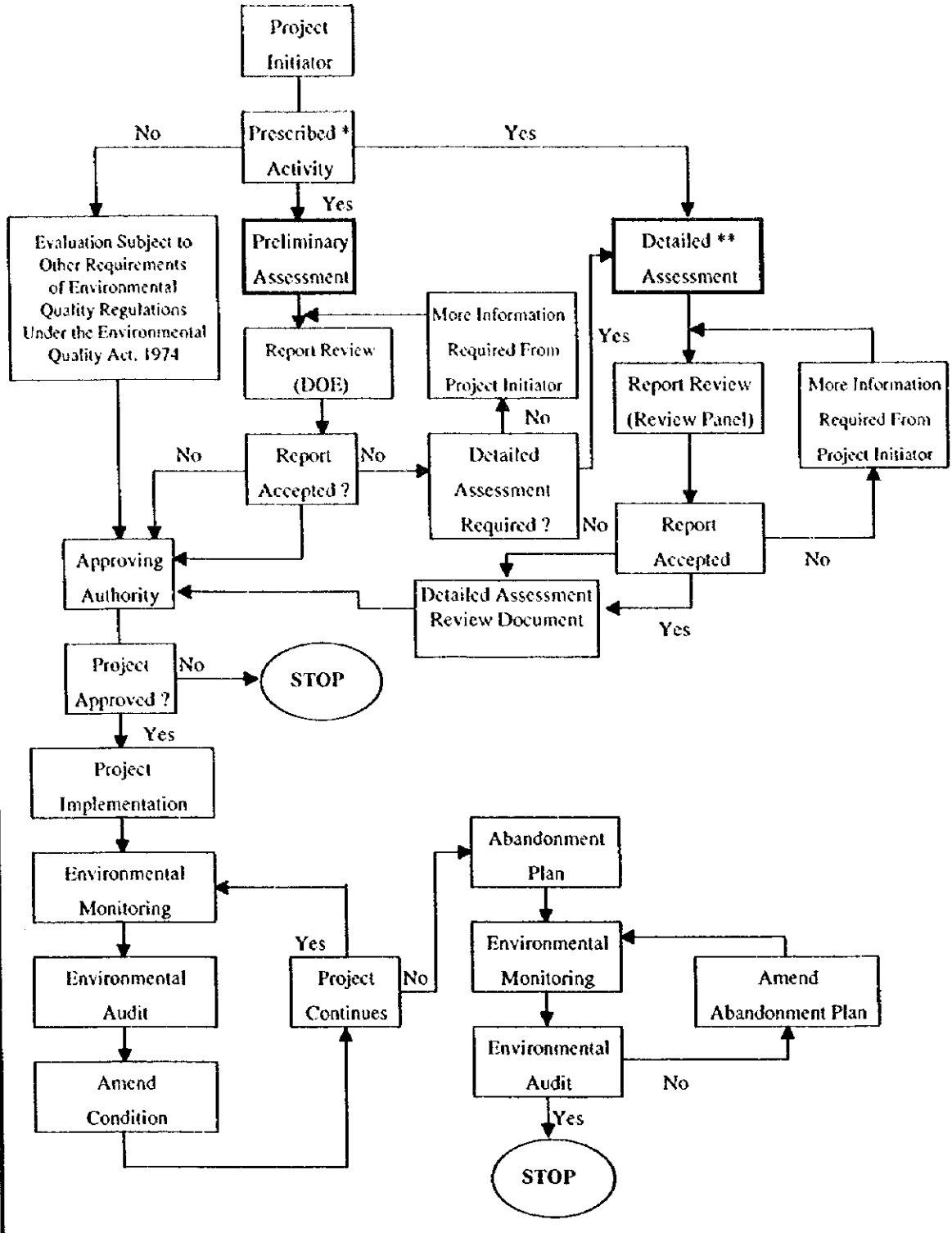


Fig. VI-1 Locations of Mangrove Forests and Major Wetlands around the Study Areas

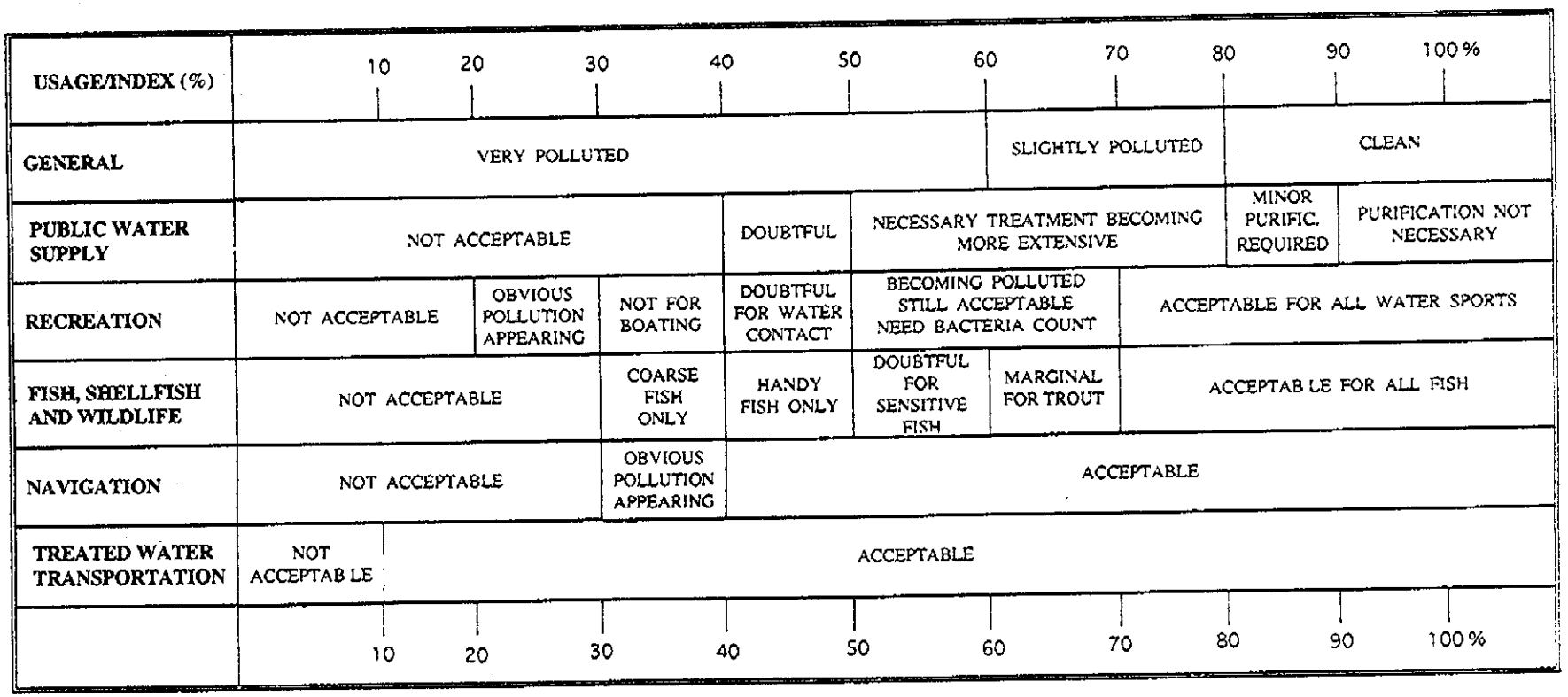


* Environmental Quality (Prescribed Activities) (Environmental Impact Assessment) Order 1987

** Consultation with Department of Environment on Terms of Reference

FIg. VI-2 Environmental Impact Assessment Procedure in Malaysia

Fig. VI-3 GENERAL RATING SCALE FOR THE WATER QUALITY INDEX (WQI) % IN MALAYSIA



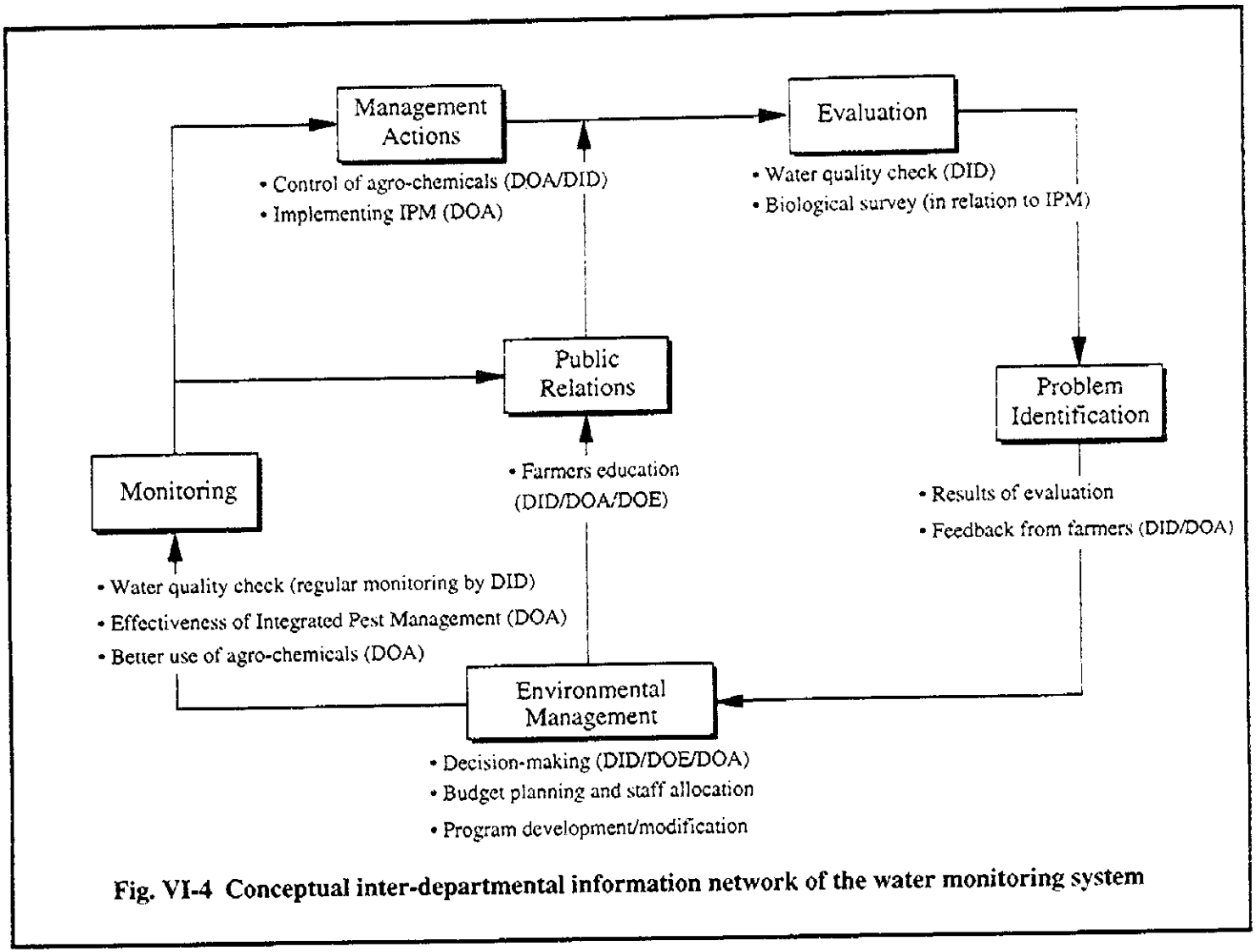


Fig. VI-4 Conceptual inter-departmental information network of the water monitoring system

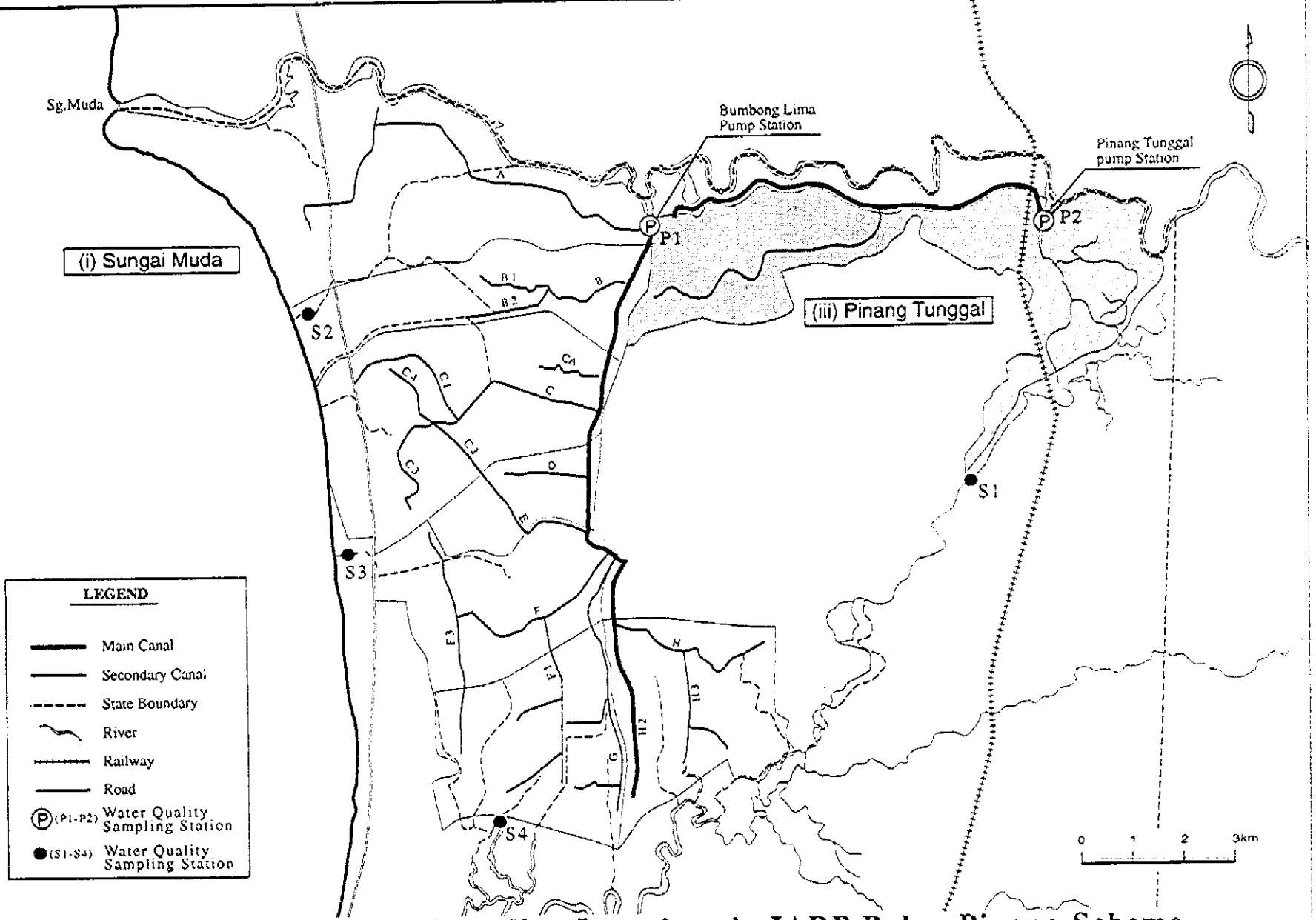


Fig. VI-5 Water Quality Sampling Locations in IADP Pulau Pinang Scheme (Sungai Muda & Pinang Tunggal Sub-Schemes)

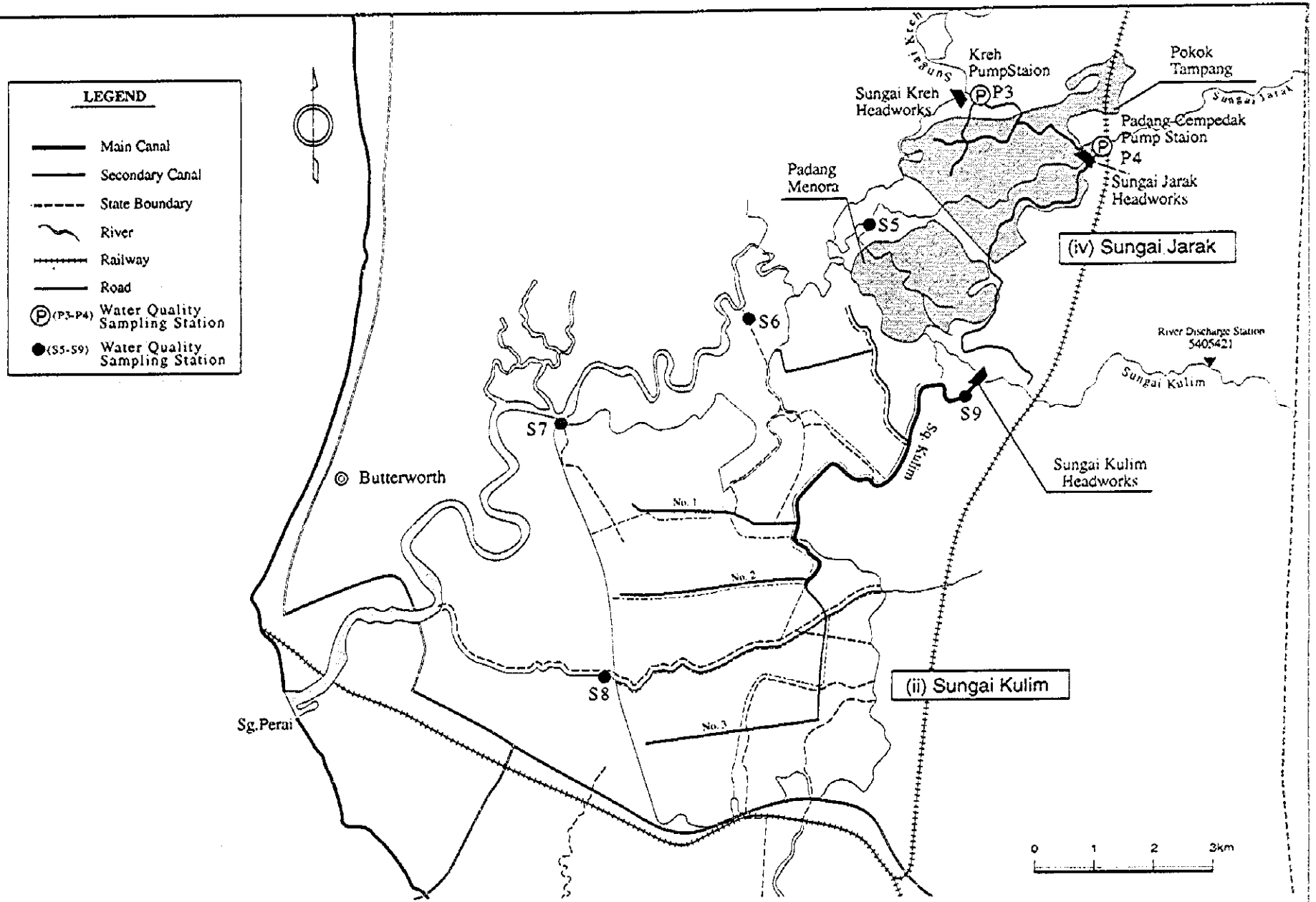


Fig. VI-6 Water Quality Sampling Locations in IADP Pulau Pinang Scheme (Sungai Kulim & Sungai Jarak Sub-Schemes)

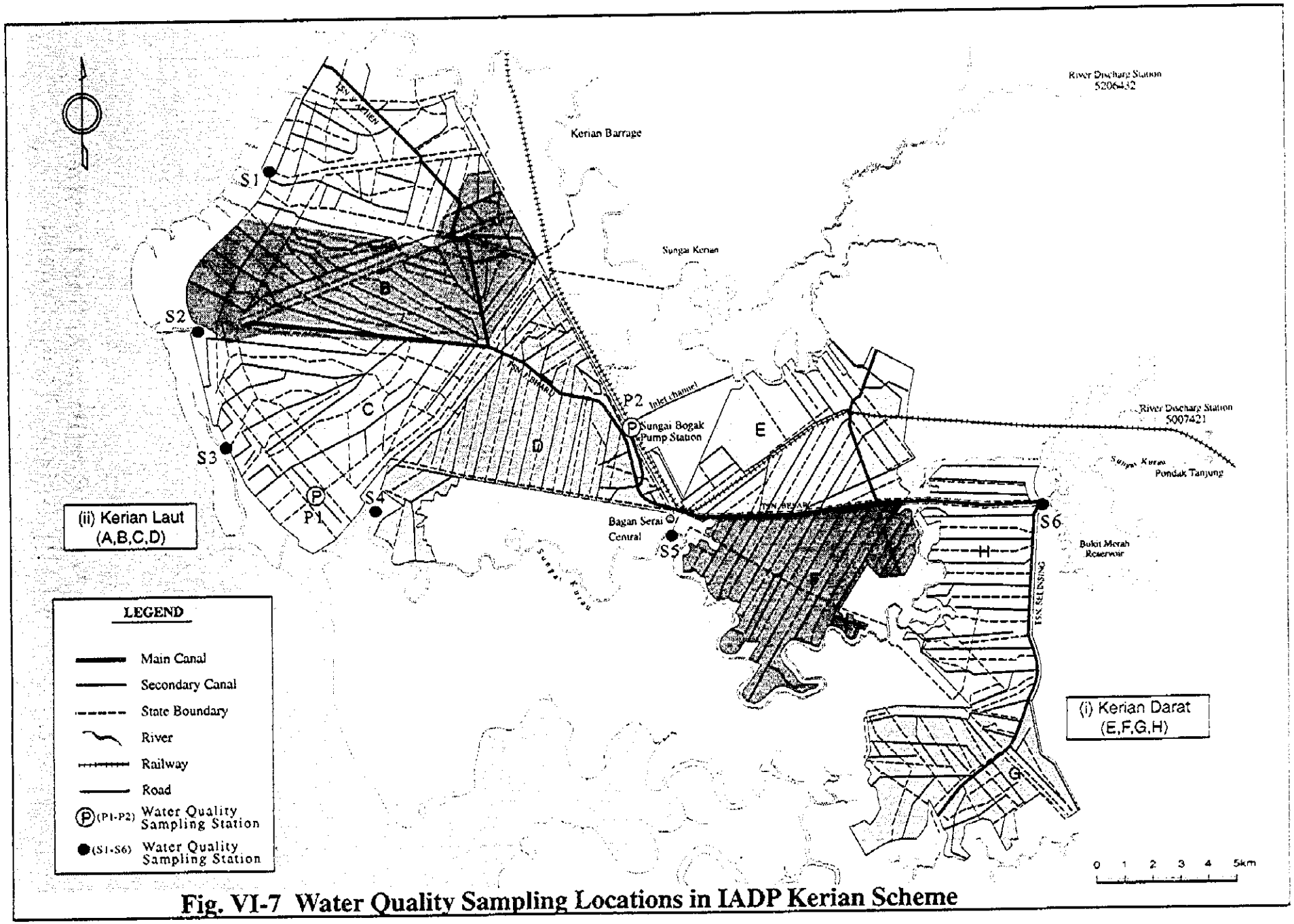


Fig. VI-7 Water Quality Sampling Locations in IADP Kerian Scheme

Fig. VI-7 Water Quality Sampling Locations in IADP Kerian Scheme

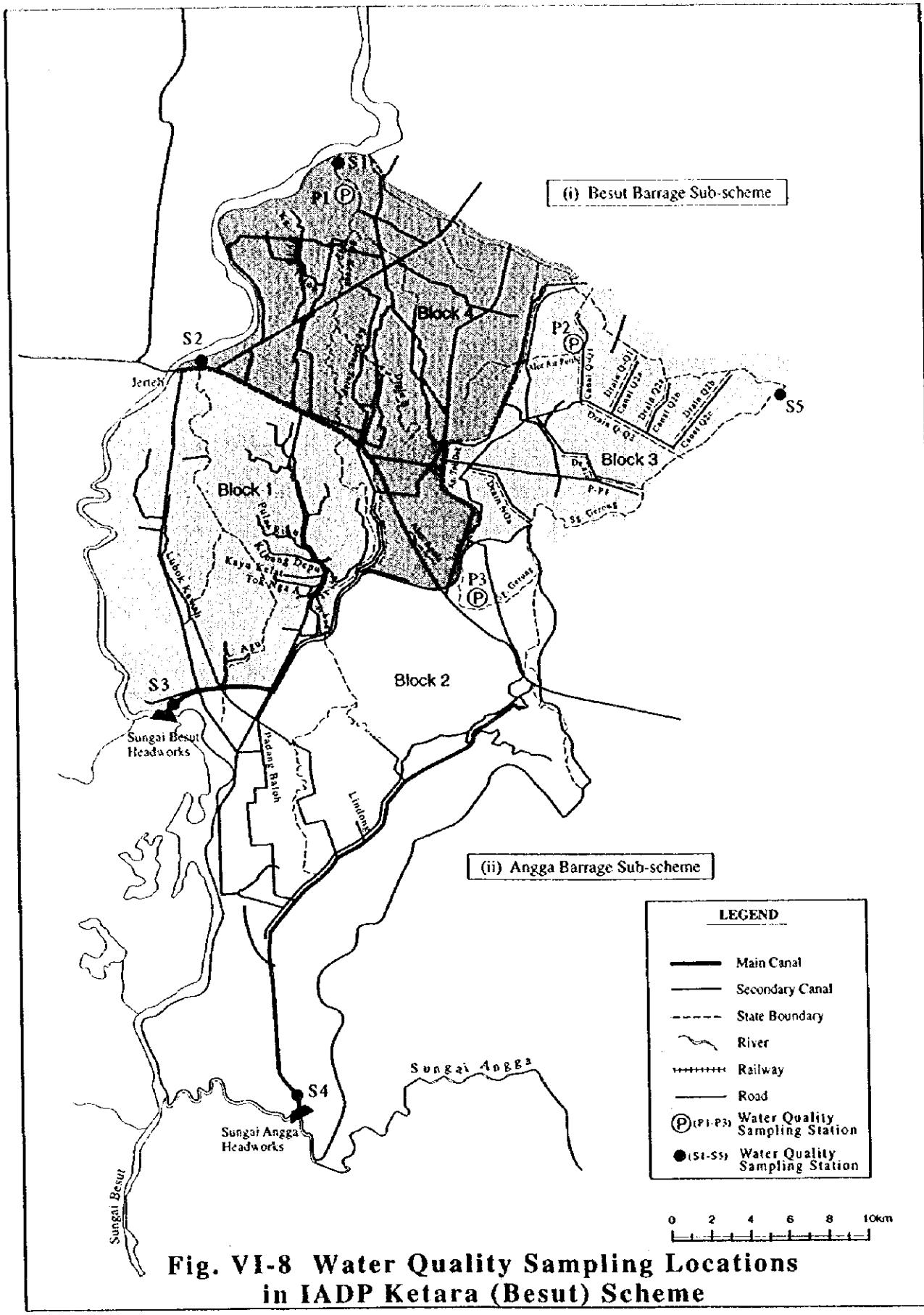


Fig. VI-8 Water Quality Sampling Locations in IADP Ketara (Besut) Scheme

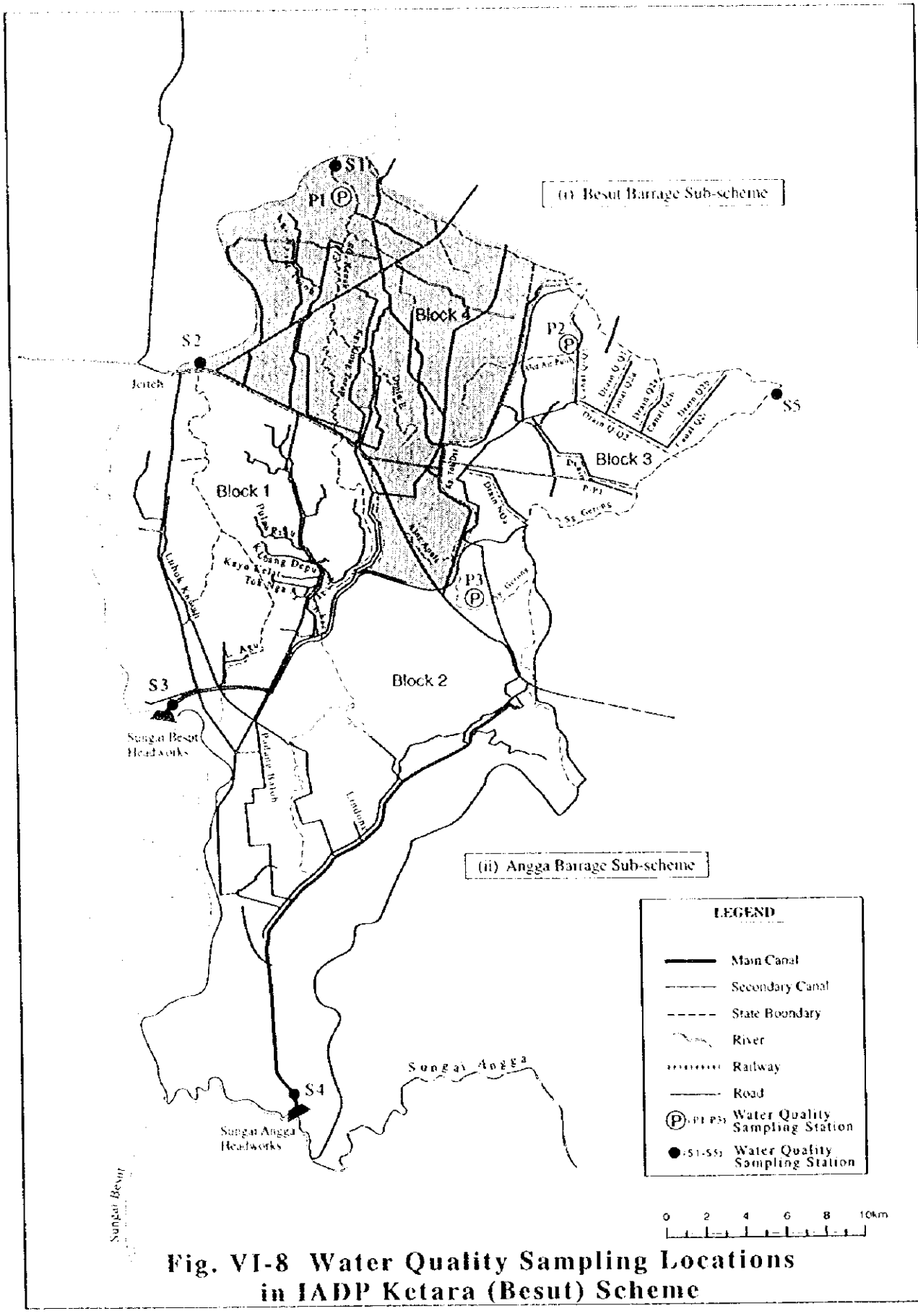


Fig. VI-8 Water Quality Sampling Locations in IADP Ketara (Besut) Scheme

ANNEX-VII

COST ESTIMATE

ANNEX - VII

COST ESTIMATE

Contents

List of Tables

VII. COST ESTIMATE

1. INTRODUCTION

This Annex explains the detail of project cost estimates in the master plan study for five granary scheme, namely IADP Pulau Pinang Scheme, IADP Kerian/Sungai Manik Scheme, IADP Seberang Perak Scheme, IADP Kemasin/Semerak Scheme and IADP Ketara (Besut) Scheme, and those in the feasibility study for the selected three schemes comprising of Kerian, Besut and Pulau Pinang Schemes. The project cost consists of the rehabilitation and improvement works for system infrastructures, those for in-field infrastructures, establishment of water management and monitoring facilities and training of water user's group.

2. BASIC CONDITIONS AND ASSUMPTIONS

For estimate of the Project Costs, it was assumed that domestic products and services in Malaysia would be used in accordance with the Malaysian governmental policy. Reference construction cost was obtained through unit cost analyses based on tender documents for similar construction projects in and around the Project areas as well as the Government Standard Price published by DID. Construction prices were updated up to Oct. 1997 level by multiplying Consumer Price Index published by Central Bank of Malaysia and Statistics Department.

Project cost is broadly divided into 1) initial investment cost, 2) replacement cost and 3) O&M cost. Initial investment cost is further divided into direct construction cost, physical contingency, engineering cost, administration and management cost and the cost for installation of electric devices such as computer hardware and software for modernization of water management system.

3. UNIT PRICE ANALYSIS

Unit cost of manpower and materials for the respective works of the projects are surveyed and estimated, as mentioned in the preceding paragraph, based on the contract prices of similar works taken from irrigation schemes such as Muda in IADP Pulau Pinang, Besut in Terrenganu as well as the Government Standard Price issued by DID in 1993. Consumer Price Index issued by the Central Bank of Malaysia and Statistics Department was used for updating prices up to Oct., 1997 level. The updated unit prices of manpower and the respective works are tabulated and shown as in Table VII-1 for the west coast schemes and in Table VII-2 for the east coast schemes.

4. PROJECT WORKS

Direct construction cost was estimated for the following work Items for the each granary scheme :

(1) Kerian Scheme

(a) System Infrastructure

- Concrete lining of canals: - main canal 62km, secondary 40km including desilting,
- Provision of check structures: -7nos. on main canal and 8 nos. on secondary canal
- Repair of damaged structures: - replacement of diversion gates, 16 nos., replacement of gate spindle, 2nos.
- Construction and repair of drainage control gates: - tidal gates, 2nos., control structures, 120 nos.,
- Desilting: - approximately 580km,
- Construction of bund: - approximately 153km,
- Construction of new drains: - approximately 17km,
- Installation of drainage pumps: - 10nos
- Asphalt pavement along main canals, approximately 40km,
- Widening, approximately 100km along tertiary canals

(b) In -field Infrastructures

- Land leveling
- Construction of In-field canal
- Provision of control boxes

(c) Water Management Facilities linked to Telemetry/Telecontrol System

- 5 key control points
- 3 second control points
- 7 key monitoring points
- 8 second monitoring points
- 13 third monitoring points

Installation of rain gauge
- Jalan Bharu, Alor Panchor, FCD Simpang Empat and Bukit Merah

(2) Besut Scheme

(a) System Infrastructure

- Replacement of Angga Barrage,
- Repair of gates for Besut Barrage,
- Concrete lining of canals: -main canal, 4.4km, secondary, 16.9km and 3km for tertiary canals,
- Raise of concrete lining: -8.8km along main canals and 2km for secondary canals,
- Provision of check structures: -5 nos. on main canal and one on secondary canal,
- Repair of damaged structures:- 74 nos..
- Construction of corneal structures, 15 nos.,
- Desilting:- approximately 16 km.
- Asphalt pavement along main canals, approximately 8 km,
- Widening and laterite pavement , 27km along tertiary canals.

(b) In -field Infrastructures

- Land leveling,
- Construction of In-field canal,
- Provision of control boxes ,

(c) Water Management Facilities linked to Telemetry/Telecontrol System

- 3 key control points,
- 2 second control points,
- 4 key monitoring points,
- 5 second monitoring points,
- 19 third monitoring points.

Installation of rain gauge
- Besut Barrage, Point O on Besut Main Canal, Point R on Angga Main Canal

(3) Pulau Pinang Scheme

(a) System Infrastructure

- Concrete lining of canals: - main canal, 35km, secondary, 79km including desilting,
- Provision of check structures: -6 nos. on main canal and 12 nos. on secondary canal,
- Repair of damaged structures: - replacement of two diversion gates,
- Desilting:- approximately 30 km for tertiary canal.
- Asphalt pavement along main canals, approximately 11 km,
- Widening, 100km along tertiary canals.

(b) In -field Infrastructures

- Land levelling,
- Construction of In-field canal,
- Provision of control boxes,

(c) Water Management Facilities linked to Telemetry/Telecontrol System

- 7 key control points,
- 4 second control points,
- 8 key monitoring points,
- 8 second monitoring points,
- 13 third monitoring points.

Installation of rain gauge
- R5503034, Pinang Tunggal Pump Station, Padang Cempedak Pump Station and diversion point of TA.2 of Sungai Kulim Sub-Scheme

(4) Sungai Manik Scheme

(a) System Infrastructure

- Construction of sand settling basin at intake,

- Concrete lining of canals(secondary and tertiary)
- Construction of check structures, road crossing, repair of damaged structures,
- Desilting of drainage canals, and
- Pavement and widening of farm roads.

(b) In -field Infrastructures

- Land levelling,
- Construction of In-field canal,
- Provision of control boxes,

(c) Water Management Facilities linked to Telemetry/Telecontrol System

- Installation of water level monitoring facility at downstream of intake, diversion work on left main canal and other primary points on main and secondary canals,
- Rainfall gauge at two representative points in the scheme area, and
- Installation of remote control system for primary gates.

(5) Seberang Perak Scheme

(a) System Infrastructure

- Desilting and reshaping of main canals and distributary canals,
- Concrete lining of canals (secondary and tertiary),
- Construction of check structures, spillway and repair of damaged structures,repair of damaged structures,
- Desilting of drainage canals, and
- Pavement and widening of farm roads.

(b) In -field Infrastructures

- Land levelling,
- Construction of In-field canal,
- Provision of control boxes,

(c) Water Management Facilities linked to Telemetry/Telecontrol System

- Installation of telecontrol system for primary gates including mortorization of intake gates, bifurcation gates,
- Installation of water level gauges at primary points in the scheme area, and
- Installation of rainfall stations at two representative points in the area.

(6) Kemasin/Semerak Scheme

(a) System Infrastructure

- Repair of damaged structures,
- Desilting of drainage canals, and
- Pavement and widening of farm roads(along tertiary canals)

(b) In -field Infrastructures

- Land levelling,
- Construction of In-field canal,
- Provision of control boxes,

(c) Water Management Facilities linked to Telemetry/Telecontrol System

- Installation of water level gauges at primary points in the scheme area, and
- Installation of rainfall stations at two representative points in the area.

5. COST ESTIMATE

5.1 Cost Estimate for Master Plan Study

5.1.1 Initial Investment Cost

As was stated in Section 2, initial investment cost comprises direct construction cost, physical contingency (15% of direct construction cost), engineering cost (10% of direct construction cost), administration and management cost (5% of direct construction cost). Direct construction cost mainly covers lining of selected canals, improvement of irrigation related structures, drainage facilities and farm roads, and establishment of water management/monitoring facilities. Engineering cost comprise remuneration for expatriate and local consultants/stuff and administration cost covers office running and maintenance cost including procurement of equipment required in the project office. Water management/monitoring facilities comprise hardware and software for telecontrol and telemetry systems.

Initial investment cost for five schemes is tabulated as follows and the details are shown in Table VII-3 to Table VII-7 :

unit : (1,000 RM)

	Initial investment cost			
scheme	System infra	In-field infra	Water management	Total
Pulau Pinang	32,060	4,316	10,307	46,683
Kerian	78,379	21,881	15,499	115,759
Sungai Manik	28,198	2,911	6,385	37,494
Seberang Perak	20,288	1,814	8,985	31,087
Kemasin/Semerak	1,700	861	1,651	4,212
Besut	26,796	2,435	4,447	33,678

Note : The above infrastructure cost in Kemasin/Semerak covers works only for Jelawat Rusa and Kemasin Hilir sub-scheme.

5.1.2 Replacement and O&M Cost

For successful achievement of modernization of water management system, it is inevitable to keep suitable condition of irrigation infrastructures. Therefore, taking into consideration of deterioration of irrigation structures due to passage of time, replacement cost, which covers 20% of initial construction cost, was assumed to be appropriated every 20 years. While, for replacement cost for water management / monitoring system, initial equipment cost is applied every 10 years. O&M costs which are expected to occur every year are estimated at RM 304 /ha/year for infrastructures and RM 250,000 /year for water management system. The result for each scheme is summarized as follows:

unit : (1,000 RM)

scheme	Replacement cost		O & M cost per year
	Infrastructures (every 20 years)	Water management (every 10 years)	
Pulau Pinang	7,275	7,928	3,169
Kerian	20,053	11,922	7,412
Sungai Manik	6,222	5,053	2,171
Seberang Perak	4,420	7,111	2,897
Kemasin/Semerak	512	1,270	750
Besut	5,846	3,421	1,820

Note : The above replacement and O&M costs for infrastructures in Kemasin/Semerak cover those only for Jelawat Rusa and Kemasin Hilir sub-scheme.

5.1.3 Training Cost for Water Users' Group

Training for Water users' groups, which are to be formatted in this works, will be planned at both off-site (National Water Management Training Center) and on-sites. The former is executed on 2 leaders from each group for three years and the latter is done on all members of groups for five years. The training cost is summarized below :

unit : (RM)

scheme	Number of group	Cost		
		Off-site	On-site	Total
Pulau Pinang	125	300,000	73,010	373,010
Kerian	84	201,600	134,850	336,450
Sungai Manik	36	86,400	40,300	126,700
Seberang Perak	20	48,000	23,330	71,330
Kemasin/Semerak	39	93,600	118,890	212,490
Besut	30	72,000	30,540	102,540

5.2 Cost Estimate for Feasibility Study in Selected Three Schemes

5.2.1 Kerian Scheme

(1) Data for Project Cost Estimate

Unit Prices of the respective works of Kerian Scheme are estimated based on the contract prices of similar works taken from Muda Irrigation Scheme in IADP Pulau Pinang which is adjacent to Kerian Scheme area and the Government Price Schedule issued in 1993. Consumer Price Index issued by the Central Bank of Malaysia and Statistics Department was used for updating prices to Oct., 1997 level.

(2) Initial Investment Cost

Initial investment costs for the scheme, which is divided into the works for system infrastructure, in-field infrastructure and water management / monitoring facilities, comprise direct construction cost, physical contingency (15% of direct construction cost), engineering cost (10% of direct construction cost), administration and management cost (5% of direct construction cost). Those are summarized below and the details are given in Table VII-8 to Table VII-11.

(Unit : RM)

Item	Direct cost	Contingency,engineering administration cost	Total
System infrastructure	64,422,000	19,326,600	83,748,600
In-field infrastructure	19,249,100	5,774,800	25,023,900
Water management	11,924,100	3,577,500	15,501,600
Total	95,595,200	28,678,900	124,274,100

(3) Replacement and O &M Cost

20% of initial construction cost every 20 years is adopted for replacement cost of infrastructures. For replacement cost for water management / monitoring system, initial equipment cost is applied every 10 years. O&M costs which are expected to occur every year are estimated at RM 325 /ha/year for infrastructures and RM 250,000 /year for water management system. The replacement and O & M costs for the scheme is summarized as follows:

(Unit : 1,000 RM)

Item	Cost
Replacement cost	
- Infrastructure (every 20 years)	21,754
- Water management/monitoring (every 10 years)	11,924
O & M cost (annual)	7,943

(4) Training Cost for Water Users' Group

Training for 84 water users' groups, which are to be formatted in this works, will be planned at both off-site (National Water Management Training Center) and on-sites. The former is executed for three years and 2 leaders from each group participate. The latter is done on all members of groups for five years. The costs are estimated at RM 336,450 consisting of RM 201,600 for off-site training and RM 134,850 for on-site training. The details are given in Table VII-12.

5.2.2 Besut Scheme

(1) Data for Project Cost Estimate

Unit Prices of the respective works of Besut Scheme are estimated based on the contract prices of similar works taken from Besut Irrigation Project in Terrenganu as well as the Government Price Schedule issued in 1993. Consumer Price Index issued by the Central Bank of Malaysia and Statistics Department was used for updating prices to Oct., 1997 level.

(2) Initial Investment Cost

Initial investment costs for the scheme, which is divided into the works for system infrastructure, in-field infrastructure and water management / monitoring facilities, comprise direct construction cost, physical contingency (15% of direct construction cost), engineering cost (10% of direct construction cost), administration and management cost (5% of direct construction cost). Those are summarized below and shown in Table VII-13 to Table VII-16.

(Unit : RM)

Item	Direct cost	Contingency,engineering administration cost	Total
System infrastructure	21,460,600	6,438,200	27,898,8000
In-field infrastructure	1,874,300	562,200	2,436,500
Water management	3,421,000	1,026,500	4,447,500
Total	26,755,900	8,026,900	34,782,800

(3) Replacement Cost and O & M Cost

Replacement cost of infrastructures is estimated at 20% of initial construction cost every 20 years. While, for replacement cost of water management / monitoring system, initial equipment cost is applied every 10 years. O&M costs which are expected to occur every year are estimated at RM 257 /ha/year for infrastructure and RM 250,000 /year for water management system. The replacement and O & M costs for the scheme is summarized as follows:

(Unit : 1,000 RM)

Item	Cost
Replacement cost	
- Infrastructure (every 20 years)	6,068
- Water management/monitoring (every 10 years)	3,421
O & M cost (annual)	1,577

(4) Training Cost for Water Users' Group

Training for 30 water users' groups, which have been formatted, will be planned at both off-site (National Water Management Training Center) and on-sites. The former is executed for three years and 2 leaders from each group participate. The latter is carried out on all members of groups for five years. The costs are estimated at RM 102,540 consisting of RM 72,000 for off-site training and RM 30,540 for on-site training. The details are shown in Table VII-18.

5.2.3 Pulau Pinang Scheme

(1) Data for Project Cost Estimate

Unit Prices of the respective works of Pulau Pinang Scheme are estimated based on the contract prices of similar works taken from Muda Irrigation Project in Pulau Pinang as well as the Government Price Schedule issued in 1993. Consumer Price Index issued by the Central Bank of Malaysia and Statistics Department was used for updating prices to Oct., 1997 level.

(2) Initial Investment Cost

Initial investment costs for the scheme, which is divided into the works for system infrastructure, in-field infrastructure and water management / monitoring facilities, comprise direct construction cost, physical contingency (15% of direct construction cost), engineering cost (10% of direct construction cost), administration and management cost (5% of direct construction cost). Those are summarized below and shown in Table VII-18 to Table VII-21.

(Unit : RM)

Item	Direct cost	Contingency,engineering administration cost	Total
System infrastructure	26,034,700	7,810,400	33,845,100
In-field infrastructure	3,320,800	996,200	4,317,000
Water management	7,929,900	2,379,300	10,309,200
Total	37,285,400	11,185,900	48,471,300

(3) Replacement Cost and O & M Cost

Replacement cost of infrastructures is estimated at 20% of initial construction cost every 20 years. While, for replacement cost of water management / monitoring system, initial equipment cost is applied every 10 years. O&M costs, which are expected to occur every year, are estimated at RM 299 /ha/year in Sungai Muda sub-scheme, RM 425 /ha/year in Pinang Tunggal sub-scheme, RM 380 /ha/year in Sungai Jarak sub-scheme and RM 525 /ha/year in Sungai Kulim sub-scheme. Moreover, RM 250,000 /year is applied to management cost for the water management system. The replacement and O & M costs for the scheme is summarized as follows:

(Unit : 1,000 RM

Item	Cost
Replacement cost	
- Infrastructure (every 20 years)	7,632
- Water management/monitoring (every 10 years)	7,930
O & M cost (annual)	3,584

(4) Training Cost for Water Users' Group

Training for 125 water users' groups, which are to be formatted in this works, will be planned at both off-site (National Water Management Training Center) and on-sites. The former is executed for three years with participation of 2 leaders from each group. The latter is carried out on all members of groups for five years. The costs are estimated at RM 373,010 consisting of RM 300,000 for off-site training and RM 73,010 for on-site training. The details are given in Table VII-22.

Breakdown of cost estimates in the respective work item are given in Table VII-23 to Table 28 for the system infrastructures, in Table VII-29 for the in-field infrastructures, in Table VII-30 to Table VII-42 for the water management system, in Table VII-43 to Table VII-44 for the irrigation monitoring and feedback system and in Table VII-45 to Table VII-47 for the training of water users' group.

TABLES

Table VII-1 Updated Unit Prices for West Coast Schemes

Description	Unit	Tender Price	Tender Year	Inflation Rate	Up-dated Price (Oct '97)	Adopted Price (RM)	Remarks Data sources
Canal and Drainage							
Irrigation Canal							
Earth Work							
Stripping 150 mm	m2	0.5	1993	1.137	0.57	**0.6**	Table of Average Standard Price as of 1992/1993 JPS
Excavation for canals	m3	3.6	1993	1.137	4.13	**4.1**	Table of Average Standard Price as of 1992/1993 JPS
Earthfill for canals	m3	8.3	1996	1.027	8.47	**8.5**	Muda Irrgation Scheme(BlockA1), JPS Pulau Pinnang
Turfing	m2	0.8	1996	1.027	0.82	**0.8**	Muda Irrgation Scheme(BlockA1), JPS Pulau Pinang
Concrete Lined Canal							
Trapezoidal Section Type 300/400/1:1	m	21.0	1996	1.027	21.57	**21.6**	Muda Irrgation Scheme(BlockA1), JPS Pulau Pinang
Trapezoidal Section Type 300/475/1:1	m	22.0	1996	1.027	22.59	**22.6**	Muda Irrgation Scheme(BlockA1), JPS Pulau Pinang
Trapezoidal Section Type 400/475/1:1	m	23.0	1996	1.027	23.62	**23.6**	Muda Irrgation Scheme(BlockA1), JPS Pulau Pinang
Trapezoidal Section Type 400/550/1:1	m	24.0	1996	1.027	24.65	**24.6**	Muda Irrgation Scheme(BlockA1), JPS Pulau Pinang
Trapezoidal Section Type 500/625/1:1	m	26.0	1996	1.027	26.70	**26.7**	Muda Irrgation Scheme(BlockA1), JPS Pulau Pinang
Trapezoidal Section Type 700/725/1:1	m	28.0	1996	1.027	28.76	**28.8**	Muda Irrgation Scheme(BlockA1), JPS Pulau Pinang
450mm Block section d=375mm	m	22.0	1996	1.027	22.59	**22.6**	Muda Irrgation Scheme(BlockA1), JPS Pulau Pinang
600mm Block section d=525mm	m	24.0	1996	1.027	24.65	**24.6**	Muda Irrgation Scheme(BlockA1), JPS Pulau Pinang
Related Structures							
Excavation for Structures	m3	4.5	1996	1.027	4.62	**4.6**	Muda Irrgation Scheme(BlockA1), JPS Pulau Pinang
50mm thick blinding layer G-10	m3	6.0	1996	1.027	6.16	**6.2**	Muda Irrgation Scheme(BlockA1), JPS Pulau Pinang
Grade 20 reinforced concrete	m3	169.0	1996	1.027	173.56	**173.6**	Muda Irrgation Scheme(BlockA1), JPS Pulau Pinang
Form work	m2	12.0	1996	1.027	12.32	**12.3**	Muda Irrgation Scheme(BlockA1), JPS Pulau Pinang
6mm dia M.S steel bars	kg	1.5	1996	1.027	1.54	**1.5**	Muda Irrgation Scheme(BlockA1), JPS Pulau Pinang
10mm dia M.S steel bars	kg	1.5	1996	1.027	1.54	**1.5**	Muda Irrgation Scheme(BlockA1), JPS Pulau Pinang
12mm dia M.S steel bars	kg	1.5	1996	1.027	1.54	**1.5**	Muda Irrgation Scheme(BlockA1), JPS Pulau Pinang
16-32mm dia M.S steel bars	kg	1.5	1996	1.027	1.54	**1.5**	Muda Irrgation Scheme(BlockA1), JPS Pulau Pinang
BMC DA6 mesh fabric reinforcement	m2	5.0	1996	1.027	5.14	**5.1**	Muda Irrgation Scheme(BlockA1), JPS Pulau Pinang
Precast Concrete Structures							
Road Culvert							
1200mmx900mmx6.0m	nos	12000.0	1993	1.137	13644.00	**13644.0**	Table of Average Standard Price as of 1992/1993 JPS
1200mmx1200mmx6.0m	nos	15000.0	1993	1.137	17055.00	**17055.0**	Table of Average Standard Price as of 1992/1993 JPS
1500mmx1500mmx22.53m	nos	22000.0	1993	1.137	25014.00	**25014.0**	Table of Average Standard Price as of 1992/1993 JPS
1500mmx1500mmx31.75m	nos	31000.0	1993	1.137	35247.00	**35247.0**	Table of Average Standard Price as of 1992/1993 JPS
1800mmx1800mmx10.225m	nos	14550.0	1993	1.137	16543.35	**16543.4**	Table of Average Standard Price as of 1992/1993 JPS
1800mmx1800mmx15.35m	nos	21825.0	1993	1.137	24815.03	**24815.0**	Table of Average Standard Price as of 1992/1993 JPS

Table VII-1 Updated Unit Prices for West Coast Schemes

Description	Unit	Tender Price	Tender Year	Inflation Rate	Up-dated Price (Oct '97)	Adopted Price (RM)	Remarks / Data sources
Concrete Pipe class S							
Concrete Pipe dia 300	m	82.5	1993	1.137	93.80	**93.8**	Table of Average Standard Price as of 1992/1993 JPS
Concrete Pipe dia 450	m	112.5	1993	1.137	127.91	**127.9**	Table of Average Standard Price as of 1992/1993 JPS
Concrete Pipe dia 600	m	190.0	1993	1.137	216.03	**216.0**	Table of Average Standard Price as of 1992/1993 JPS
Concrete Pipe dia 900	m	275.0	1993	1.137	312.68	**312.7**	Table of Average Standard Price as of 1992/1993 JPS
Concrete Pipe dia 1200	m	350.0	1993	1.137	397.95	**398.0**	Table of Average Standard Price as of 1992/1993 JPS
Concrete Pipe dia 1500	m	550.0	1993	1.137	625.35	**625.4**	Table of Average Standard Price as of 1992/1993 JPS
Gate							Table of Average Standard Price as of 1992/1993 JPS
345mmx350mm screw down gate	nos	440.0	1996	1.027	451.88	451.9	Muda Irrgation Scheme(BlockA1), JPS Pulau Pinang
		300.0	1993	1.137	341.10	341.1	Table of Average Standard Price as of 1992/1993 JPS
						451.9	
495mmx 500mm screw down gate	nos	550.0	1996	1.027	564.85	564.9	Muda Irrgation Scheme(BlockA1), JPS Pulau Pinang
		300.0	1993	1.137	341.10	341.1	Table of Average Standard Price as of 1992/1993 JPS
						564.9	
680mmx600mm orifice gate	nos	770.0	1996	1.027	790.79	**790.8**	Muda Irrgation Scheme(BlockA1), JPS Pulau Pinang
700mmx 700mm orifice gate	nos	770.0	1996	1.027	790.79	790.8	Muda Irrgation Scheme(BlockA1), JPS Pulau Pinang
		400.0	1993	1.137	454.80	454.8	Table of Average Standard Price as of 1992/1993 JPS
						790.8	
1000mmx1031mm screw down gate	nos	880.0	1996	1.027	903.76	903.8	Muda Irrgation Scheme(BlockA1), JPS Pulau Pinang
		600.0	1993	1.137	682.20	682.2	Table of Average Standard Price as of 1992/1993 JPS
						903.8	
1300mmx 1350mm screw down gate	nos	1320.0	1996	1.027	1355.64	**1355.6**	Muda Irrgation Scheme(BlockA1), JPS Pulau Pinang
1600mmx 1657mm screw down gate	nos	1980.0	1996	1.027	2033.46	**2033.5**	Muda Irrgation Scheme(BlockA1), JPS Pulau Pinang
Trash Screen							
815mm x 1900mm Trash Screen	nos	440.0	1996	1.027	451.88	**451.9**	Muda Irrgation Scheme(BlockA1), JPS Pulau Pinang
1100mmx 1200mm Trash Screen	nos	440.0	1996	1.027	451.88	**451.9**	Muda Irrgation Scheme(BlockA1), JPS Pulau Pinang
1400mmx 1600mm Trash Screen	nos	990.0	1996	1.027	1016.73	**1016.7**	Muda Irrgation Scheme(BlockA1), JPS Pulau Pinang
MS Grille							
294mmx800mm MS.Grill	nos	105.0	1996	1.027	107.84	**107.8**	Muda Irrgation Scheme(BlockA1), JPS Pulau Pinang
1041mmx 836mm MS.Grill	nos	370.0	1996	1.027	379.99	**380.0**	Muda Irrgation Scheme(BlockA1), JPS Pulau Pinang
990mmx1257mm MS Grill	nos	480.0	1996	1.027	492.96	**493.0**	Muda Irrgation Scheme(BlockA1), JPS Pulau Pinang
990mmx990mm MS Grill	nos	375.0	1996	1.027	385.13	**385.1**	Muda Irrgation Scheme(BlockA1), JPS Pulau Pinang
AC vent Pipe							
100mm dia A.C. vent Pipe	m	22.0	1996	1.027	22.59	**22.6**	Muda Irrgation Scheme(BlockA1), JPS Pulau Pinang
150mm dia A.C. vent Pipe	m	38.0	1996	1.027	39.03	**39.0**	Muda Irrgation Scheme(BlockA1), JPS Pulau Pinang
200mm dia A.C. vent Pipe	m	35.0	1996	1.027	35.95	**35.9**	Muda Irrgation Scheme(BlockA1), JPS Pulau Pinang

Table VII-1 Updated Unit Prices for West Coast Schemes

Description	Unit	Tender Price	Tender Year	Inflation Rate	Up-dated Price (Oct '97)	Adopted Price (RM)	Remarks / Data sources
Drainage Canal							
Excavation	m3	1.40	1996	1.027	1.44	**1.4**	Muda Irrgation Scheme(BlockA1), JPS Pulau Pinang
Embankment	m3	8.25	1996	1.027	8.47	**8.5**	Muda Irrgation Scheme(BlockA1), JPS Pulau Pinang
Related Structures							
Grade10 blindinglayer	m2	6.00	1996	1.027	6.16	**6.2**	Muda Irrgation Scheme(BlockA1), JPS Pulau Pinang
Grade20 reinforced concrete	m2	169.00	1996	1.027	173.56	**173.6**	Muda Irrgation Scheme(BlockA1), JPS Pulau Pinang
35mm thick grade A-HW dropboard	m2	65.00	1996	1.027	66.76	**66.8**	Muda Irrgation Scheme(BlockA1), JPS Pulau Pinang
40mm thick grade A-HW dropboard	m2	70.00	1996	1.027	71.89	**71.9**	Muda Irrgation Scheme(BlockA1), JPS Pulau Pinang
45mm thick grade A-HW dropboard	m2	75.00	1996	1.027	77.03	**77.0**	Muda Irrgation Scheme(BlockA1), JPS Pulau Pinang
Farm Road							
Earth Filling	m3	9.02	1993	1.137	10.26	**10.3**	Table of Average Standard Price as of 1992/1993 JPS
		8.25	1996	1.027	8.47		8.5 Muda Irrgation Scheme(BlockA1), JPS Pulau Pinang
						10.3	
Stripping	m2	0.3	1996	1.027	0.31	**0.3**	Muda Irrgation Scheme(BlockA1), JPS Pulau Pinang
150mm thick lateritic gravel surfacing (4m wide farmroad)	m2	1.7	1993	1.137	1.93		1.9 Table of Average Standard Price as of 1992/1993 JPS
		1.3	1996	1.027	1.34		1.3 Muda Irrgation Scheme(BlockA1), JPS Pulau Pinang
						1.9	
230mm thick lateritic gravel surfacing (5m wide farmroad)	m2	1.9	1993	1.137	2.16		2.2 Table of Average Standard Price as of 1992/1993 JPS
		2.0	1996	1.027	2.05		2.1 Muda Irrgation Scheme(BlockA1), JPS Pulau Pinang
						2.2	
Land levelling of Paddy Field							
Cost including depreciation, etc.	ha	147.54	1997	1.000	147.54		147.5 Tuan Samad S.P.U.1997
Cost including depreciation, etc.	ha	300.18	1997	1.000	300.18		300.2 Pengkalan Batu S.P.U 1997
Cost including depreciation, etc.	ha	231.53	1997	1.000	231.53		231.5 Ptg.Tok Jaya S.P.U 1997
Cost including depreciation, etc.	ha	198.30	1997	1.000	198.30		198.3 Ptg.Tok Bidan S.P.U 1997
	avg	219.39				**219.39**	

Table VII-2 Updated Unit Prices for East Coast Schemes

Description	Unit	Tender Price	Tender Year	Inflation Rate	Up-dated Price (Oct '97)	Adopted Price (RM)	Remarks / Data sources
Canal and Drainage							
Irrigation Canal							
Stripping 150 mm	m2	0.5	1993	1.137	0.57	**0.6**	Standard Price as of 1992/1993 JPS
Excavation for canals	m3	5.0	1996	1.027	5.14	**5.1**	Besut Irrigation Scheme compartment 1&2
Earthfill for canals	m3	10.0	1996	1.027	10.27	**10.3**	Besut Irrigation Scheme compartment 1&2
Turfing	m2	2.0	1996	1.027	2.05	**2.1**	Besut Irrigation Scheme compartment 1&2
Concrete Lined Canal							
Trapezoidal Type T1 b=400 d=400	m	50.0	1996	1.027	51.35	**51.4**	Besut Irrigation Scheme compartment 1&2
Trapezoidal Type T3 b=400 d=550	m	55.0	1996	1.027	56.49	**56.5**	Besut Irrigation Scheme compartment 1&2
Trapezoidal Type T7 b=500 d=700	m	75.0	1996	1.027	77.03	**77.0**	Besut Irrigation Scheme compartment 1&2
Trapezoidal Type T17 b=700 d=850	m	90.0	1996	1.027	92.43	**92.4**	Besut Irrigation Scheme compartment 1&2
Trapezoidal Type T29 b=900 d=1050	m	100.0	1996	1.027	102.70	**102.7**	Besut Irrigation Scheme compartment 1&2
(b:canal bed width, d:water depth)							
Block section BS525	m	38.3	1993	1.137	43.57	43.6	Standard Price as of 1992/1993 JPS
		70.0	1996	1.027	71.89	**71.9**	Besut Irrigation Scheme compartment 1&2
Block section BS375	m	33.4	1993	1.137	38.01	38.0	Standard Price as of 1992/1993 JPS
		50.0	1996	1.027	51.35	**51.4**	Besut Irrigation Scheme compartment 1&2
75mm thick G-20 concrete for canal	m2	35.0	1996	1.027	35.95	**35.9**	Besut Irrigation Scheme compartment 1&2
Related Structures							
Excavation for structures	m3	25.0	1996	1.027	25.68	**25.7**	Besut Irrigation Scheme compartment 1&2
Grade10 lean concrete	m3	180.0	1996	1.027	184.86	**184.9**	Besut Irrigation Scheme compartment 1&2
Grade 20 reinforced concrete	m3	350.0	1996	1.027	359.45	**359.5**	Besut Irrigation Scheme compartment 1&2
Form work	m2	35.0	1996	1.027	35.95	**35.9**	Besut Irrigation Scheme compartment 1&2
6mm dia M.S steel bars	kg	1.9	1993	1.027	1.93	1.9	Standard Price as of 1992/1993 JPS
10mm dia M.S steel bars	kg	3.0	1996	1.027	3.08	**3.1**	Besut Irrigation Scheme compartment 1&2
12mm dia M.S steel bars	kg	3.0	1996	1.027	3.08	**3.1**	Besut Irrigation Scheme compartment 1&2
25mm dia M.S steel bars	kg	3.0	1996	1.027	3.08	**3.1**	Besut Irrigation Scheme compartment 1&2
32mm dia M.S steel bars	kg	1.4	1993	1.137	1.61	1.6	Standard Price as of 1992/1993 JPS
BMC DA6 mesh fabric reinforcement	m2	11.8	1993	1.137	13.45	13.5	Standard Price as of 1992/1993 JPS

Table VII-2 Updated Unit Prices for East Coast Schemes

Description	Unit	Tender Price	Tender Year	Inflation Rate	Up-dated Price (Oct '97)	Adopted Price (RM)	Remarks
							Data sources
Precast Concrete Structures							
Road Culvert							
1200mmx900mmx6.0m	nos	12000.0	1993	1.137	13644.00	**13644.0**	Standard Price as of 1992/1993 JPS
1200mmx1200mmx6.0m	nos	15000.0	1993	1.137	17055.00	**17055.0**	Standard Price as of 1992/1993 JPS
1500mmx1500mmx22.53m	nos	22000.0	1993	1.137	25014.00	**25014.0**	Standard Price as of 1992/1993 JPS
1500mmx1500mmx31.75m	nos	31000.0	1993	1.137	35247.00	**35247.0**	Standard Price as of 1992/1993 JPS
1800mmx1800mmx10.225m	nos	14550.0	1993	1.137	16543.35	**16543.4**	Standard Price as of 1992/1993 JPS
1800mmx1800mmx15.35m	nos	21825.0	1993	1.137	24815.03	**24815.0**	Standard Price as of 1992/1993 JPS
Concrete Pipe class S							
Concrete Pipe dia 300	m	82.5	1993	1.137	93.80	**93.8**	Standard Price as of 1992/1993 JPS
Concrete Pipe dia 450	m	112.5	1993	1.137	127.91	**127.9**	Standard Price as of 1992/1993 JPS
Concrete Pipe dia 600	m	190.0	1993	1.137	216.03	**216.0**	Standard Price as of 1992/1993 JPS
Concrete Pipe dia 900	m	275.0	1993	1.137	312.68	**312.7**	Standard Price as of 1992/1993 JPS
Concrete Pipe dia 1200	m	350.0	1993	1.137	397.95	**398.0**	Standard Price as of 1992/1993 JPS
Concrete Pipe dia 1500	m	550.0	1993	1.137	625.35	**625.4**	Standard Price as of 1992/1993 JPS
Gate							Standard Price as of 1992/1993 JPS
345mmx350mm screw down gate	nos	300.0	1993	1.137	341.10	**341.1**	Standard Price as of 1992/1993 JPS
495mmx 500mm screw down gate	nos	300.0	1993	1.137	341.10	**341.1**	Standard Price as of 1992/1993 JPS
700mmx 700mm orifice gate	nos	400.0	1993	1.137	454.80	**454.8**	Standard Price as of 1992/1993 JPS
1000mmx1031mm screw down gate	nos	600.0	1993	1.137	682.20	**682.2**	Standard Price as of 1992/1993 JPS
Trash Screen							
815mm x 1900mm Trash Screen	nos	440.0	1996	1.027	451.88	**451.9**	Muda Irrigation Scheme(BlockA1), JPS Pulau Pinang
1100mmx 1200mm Trash Screen	nos	440.0	1996	1.027	451.88	**451.9**	Muda Irrigation Scheme(BlockA1), JPS Pulau Pinang
1400mmx 1600mm Trash Screen	nos	990.0	1996	1.027	1016.73	**1016.7**	Muda Irrigation Scheme(BlockA1), JPS Pulau Pinang
MS Grille							
294mmx800mm MS.Grill	nos	105.0	1996	1.027	107.84	**107.8**	Muda Irrigation Scheme(BlockA1), JPS Pulau Pinang
1041mmx 836mm MS.Grill	nos	370.0	1996	1.027	379.99	**380.0**	Muda Irrigation Scheme(BlockA1), JPS Pulau Pinang
990mmx1257mm MS Grill	nos	480.0	1996	1.027	492.96	**493.0**	Muda Irrigation Scheme(BlockA1), JPS Pulau Pinang
990mmx990mm MS Grill	nos	375.0	1996	1.027	385.13	**385.1**	Muda Irrigation Scheme(BlockA1), JPS Pulau Pinang
AC Vent Pipe							
100mm dia A.C. vent Pipe	m	45.0	1996	1.027	46.22	**46.2**	Besut Irrigation Scheme compartment 1&2
150mm dia A.C. vent Pipe	m	50.0	1996	1.027	51.35	**51.4**	Besut Irrigation Scheme compartment 1&2

Table VII-2 Updated Unit Prices for East Coast Schemes

Description	Unit	Tender Price	Tender Year	Inflation Rate	Up-dated Price (Oct '97)	Adopted Price (RM)	Remarks / Data sources
Drainage Canal							
Excavation	m3	5.00	1996	1.027	5.14	**5.1**	Besut Irrigation Scheme compartment 1&2
Earthfill	m3	10.00	1996	1.027	10.27	**10.3**	Besut Irrigation Scheme compartment 1&2
Related Structures							
Grade10 lean concrete	m3	180.0	1996	1.027	184.86	**184.9**	Besut Irrigation Scheme compartment 1&2
Grade 20 concrete	m3	350.0	1996	1.027	359.45	**359.5**	Besut Irrigation Scheme compartment 1&2
35mm thick grade A-HW dropboard	m2	65.00	1996	1.027	66.76	**66.8**	Muda Irrigation Scheme(BlockA1), JPS Pulau Pinang
40mm thick grade A-HW dropboard	m2	70.00	1996	1.027	71.89	**71.9**	Muda Irrigation Scheme(BlockA1), JPS Pulau Pinang
45mm thick grade A-HW dropboard	m2	75.00	1996	1.027	77.03	**77.0**	Muda Irrigation Scheme(BlockA1), JPS Pulau Pinang
Farm Road							
Embankment	m3	9.02	1993	1.137	10.26	**10.3**	Standard Price as of 1992/1993 JPS
Stripping 150mm	m2	0.3	1996	1.027	0.31	**0.3**	Besut Irrigation Scheme compartment 1&2
Compact Crusher Run 150mm thick	m2	6.5	1996	1.027	6.68	**6.7**	Besut Irrigation Scheme compartment 1&2
Compact Quarry Dust 50mm thick	m2	2.5	1996	1.027	2.57	**2.6**	Besut Irrigation Scheme compartment 1&2
Land levelling of Paddy Field							
Cost including depreciation, etc.	ha	147.54	1997	1.000	147.54	147.5	Tuan Samad S.P.U.1997
Cost including depreciation, etc.	ha	300.18	1997	1.000	300.18	300.2	Pengkalan Batu S.P.U 1997
Cost including depreciation, etc.	ha	231.53	1997	1.000	231.53	231.5	Ptg.Tok Jaya S.P.U 1997
Cost including depreciation, etc.	ha	198.30	1997	1.000	198.30	198.3	Ptg.Tok Bidan S.P.U 1997
	avg	219.39				**219.39**	
Piles							
Sheetpiles							
Larssen Type 2B L=12.00 m (Permanent Use)	m2		1997			**160.0**	Information from a Contractor
ditto for Temporary use	m2		1997			**96.0**	Information from a Contractor
Timber Piles							
5" x 5" x 16 ' long	nos	80.0	1993	1.137	90.96	**91.0**	Standard Price as of 1992/1993 JPS
6" x 6" x 16 ' long	nos	90.0	1993	1.137	102.33	**102.3**	Standard Price as of 1992/1993 JPS
Bakau Piles							
supply of dia 100mm, 4.6m long pile	nos.	25.0	1993	1.137	28.43	**28.4**	Standard Price as of 1992/1993 JPS
Handle, transport , pitch and drive	m	0.5	1993	1.137	0.57	**0.6**	Standard Price as of 1992/1993 JPS

Table VII-3 Initial Investment Cost (Master Plan)

Unit : RM

Scheme	Civil Works			Water Management / Monitoring System			Grand Total
	System Infrastructure	Infield Facilities	Total	Telemetry / Telecontrol System	Feedback System	Total	
Kerian	78,379,000	21,881,000	100,260,000	14,630,000	869,300	15,499,300	115,759,300
Besut	26,796,000	2,435,000	29,231,000	3,524,000	922,800	4,446,800	33,677,800
Pulau Pinang	32,060,000	4,316,000	36,376,000	9,387,000	920,000	10,307,000	46,683,000
Sungai Manik	28,198,000	2,911,000	31,109,000	5,775,000	609,700	6,384,700	37,493,700
Seberang Perak	20,288,000	1,814,000	22,102,000	8,121,000	863,700	8,984,700	31,086,700
Kemasin/Semerak	1,700,000	861,000	2,561,000	830,000	821,300	1,651,300	4,212,300

Table VII-4 Improvement Cost for System Infrastructure (1/2)
(Master Plan)

Kerian Scheme

Work Item	Construction Cost (RM)
1. Direct Cost	
Concrete Lining of Canals	42,972,000
Improvement of Drainage Facilities	13,089,000
Improvement of Farm Roads	3,759,000
Improvement of Related Structures	471,000
Total	60,291,000
2. Physical Contingency	9,044,000
3. Engineering Cost	6,029,000
4. Administration Cost	3,015,000
Grand Total	78,379,000

Besut Scheme

Work Item	Construction Cost (RM)
1. Direct Cost	
Replacement of Besut Barrage Gates	8,000,000
Construction of New Angga Barrage	1,800,000
Concrete Lining of Canals	7,659,000
Improvement of Drainage Facilities	534,000
Improvement of Farm Roads	1,440,000
Improvement of Related Structures	1,179,000
Total	20,612,000
2. Physical Contingency	3,092,000
3. Engineering Cost	2,061,000
4. Administration Cost	1,031,000
Grand Total	26,796,000

Pulau Pinang Scheme

Work Item	Construction Cost (RM)
1. Direct Cost	
Concrete Lining of Canals	22,473,000
Improvement of Drainage Facilities	99,000
Improvement of Farm Roads	1,860,000
Improvement of Related Structures	230,000
Total	24,662,000
2. Physical Contingency	3,699,000
3. Engineering Cost	2,466,000
4. Administration Cost	1,233,000
Grand Total	32,060,000

Table VII-4 Improvement Cost for System Infrastructure (2/2)
(Master Plan)

Sungai Manik Scheme

Work Item	Construction Cost (RM)
1. Direct Cost	
Construction of Settling Basin	113,000
Concrete Lining of Canals	18,600,000
Improvement of Drainage Facilities	74,000
Improvement of Farm Roads	2,095,000
Improvement of Related Structures	808,000
Total	21,690,000
2. Physical Contingency	3,254,000
3. Engineering Cost	2,169,000
4. Administration Cost	1,085,000
Grand Total	28,198,000

Seberang Perak Scheme

Work Item	Construction Cost (RM)
1. Direct Cost	
Concrete Lining of Canals	10,253,000
Desilting of Irrigation Canals	202,000
Improvement of Drainage Facilities	32,000
Improvement of Farm Roads	331,000
Replacement of Intake Gates	3,888,000
Improvement of Related Structures	900,000
Total	15,606,000
2. Physical Contingency	2,341,000
3. Engineering Cost	1,561,000
4. Administration Cost	780,000
Grand Total	20,288,000

Kemasin/Semerak Scheme

Work Item	Construction Cost (RM)
1. Direct Cost	
Concrete Lining of Canals	38,000
Improvement of Drainage Facilities	153,000
Improvement of Farm Roads	964,000
Improvement of Related Structures	153,000
Total	1,308,000
2. Physical Contingency	196,000
3. Engineering Cost	131,000
4. Administration Cost	65,000
Grand Total	1,700,000

Table VII-5 Improvement Cost for In-field Infrastructure (1/2)
(Master Plan)

Kerian Scheme

Work Item	Construction Cost (RM)
1. Direct Cost	
Land Leveling	5,700,000
Infield Channel	964,000
Control Box	508,000
Tramline	9,659,000
Total	16,831,000
2. Physical Contingency	2,525,000
3. Engineering Cost	1,683,000
4. Administration Cost	842,000
Grand Total	21,881,000

Besut Scheme

Work Item	Construction Cost (RM)
1. Direct Cost	
Land Leveling	1,443,000
Infield Channel	244,000
Control Box	186,000
Total	1,873,000
2. Physical Contingency	281,000
3. Engineering Cost	187,000
4. Administration Cost	94,000
Grand Total	2,435,000

Pulau Pinang Scheme

Work Item	Construction Cost (RM)
1. Direct Cost	
Land Leveling	2,665,000
Infield Channel	451,000
Control Box	204,000
Total	3,320,000
2. Physical Contingency	498,000
3. Engineering Cost	332,000
4. Administration Cost	166,000
Grand Total	4,316,000

Table VII-5 Improvement Cost for In-field Infrastructure (2/2)
(Master Plan)

Sungai Manik Scheme

Work Item	Construction Cost (RM)
1. Direct Cost	
Land Leveling	1,793,000
Infield Channel	307,000
Control Box	139,000
Total	2,239,000
2. Physical Contingency	336,000
3. Engineering Cost	224,000
4. Administration Cost	112,000
Grand Total	2,911,000

Seberang Perak Scheme

Work Item	Construction Cost (RM)
1. Direct Cost	
Land Leveling	1,118,000
Infield Channel	190,000
Control Box	87,000
Total	1,395,000
2. Physical Contingency	209,000
3. Engineering Cost	140,000
4. Administration Cost	70,000
Grand Total	1,814,000

Kemasin/Semerak Scheme

Work Item	Construction Cost (RM)
1. Direct Cost	
Land Leveling	510,000
Infield Channel	87,000
Control Box	66,000
Total	663,000
2. Physical Contingency	99,000
3. Engineering Cost	66,000
4. Administration Cost	33,000
Grand Total	861,000

Table VII-6 Cost for Establishment of Telemetry and Telecontrol System (Master Plan)

Name of Scheme	Central Station	Repeater Station	Water Level Gauge inc. RTU	Rainfall Gauge inc. RTU	Remote Gate/ Pump	Total Direct Cost	Physical Contingency	Engineering Cost	Administration Cost	Grand Total
Kerian	266,000	39,000	1,212,000	43,000	9,694,000	11,254,000	1,688,000	1,125,000	563,000	14,630,000
Besut			974,000	24,000	1,712,000	2,710,000	407,000	271,000	136,000	3,524,000
Pulau Pinang	266,000		1,344,000	29,000	5,582,000	7,221,000	1,083,000	722,000	361,000	9,387,000
Sg. Manik	266,000		532,000	49,000	3,596,000	4,443,000	666,000	444,000	222,000	5,775,000
Sb. Perak	266,000		1,150,000	5,000	4,826,000	6,247,000	937,000	625,000	312,000	8,121,000
Kemasin/Semerak	266,000		345,000	27,000		638,000	96,000	64,000	32,000	830,000

Table VII-7 Cost for Establishment of Monitoring Feedback System (Master Plan)

Name of Scheme	Direct Cost	Physical Contingency	Engineering Cost	Administration Cost	Total
Kerian	668,600	100,300	66,900	33,500	869,300
Besut	709,800	106,500	71,000	35,500	922,800
Pulau Pinang	707,600	106,200	70,800	35,400	920,000
Sg. Manik	468,900	70,400	46,900	23,500	609,700
Sb. Perak	664,200	99,700	66,500	33,300	863,700
Kemasin/Semerak	631,700	94,800	63,200	31,600	821,300

Table VII-8 Improvement Cost for System Infrastructure
(F/S for Kerian Scheme)

Work Item	Construction Cost (RM)
1. Direct Cost	
Concrete Lining of Canals	45,233,400
Improvement of Drainage Facilities	14,542,400
Improvement of Farm Roads	4,176,000
Improvement of Related Structures	470,200
Total	64,422,000
2. Physical Contingency	9,663,300
3. Engineering Cost	6,442,200
4. Administration Cost	3,221,100
Grand Total	83,748,600

Table VII-9 Improvement Cost for In-field Infrastructure
(F/S for Kerian Scheme)

Work Item	Construction Cost (RM)
1. Direct Cost	
Land Leveling	5,700,600
Infield Channel	965,000
Control Box	509,000
Tramline	12,074,500
Total	19,249,100
2. Physical Contingency	2,887,400
3. Engineering Cost	1,924,900
4. Administration Cost	962,500
Grand Total	25,023,900

Table VII-10 Cost for Establishment of TM/TC System
(F/S for Kerian Scheme)

Work Item	Construction Cost (RM)
1. Direct Cost	
Central Station	266,300
Repeater Station	38,700
Water Level Gauge inc. RTU	1,213,000
Rainfall Gauge inc. RTU	43,400
Remote Gate/ Pump	9,694,100
Total	11,255,500
2. Physical Contingency	1,688,400
3. Engineering Cost	1,125,600
4. Administration Cost	562,800
Grand Total	14,632,300

Table VII-11 Cost for Establishment of Monitoring Feedback System
(F/S for Kerian Scheme)

Work Item	Construction Cost (RM)
1. Direct Cost	
Master Station	227,000
Player & TV	355,000
Additional TV	6,000
Wiring	58,800
MOA, DID & DOA HQ	21,800
Total	668,600
2. Physical Contingency	100,300
3. Engineering Cost	66,900
4. Administration Cost	33,500
Grand Total	869,300

Table VII-12 Training Cost for Water Users' Group (Kerian Scheme)

Off-Site Training

Compartment	WUGs (Nos)	Total WUG Leaders	Training day per Leader	Unit RM/day/person	Total Cost (RM)
Compartment A&B	20	40	3	400	48,000
Compartment C	4	8	3	400	9,600
Compartment D	17	34	3	400	40,800
Compartment E&F	22	44	3	400	52,800
Compartment G&H	21	42	3	400	50,400
Total	84	168			201,600

On-Site Training

Compartment	Farmers (Nos)	WUGs (Nos)	Training day per farmer	Unit RM/day/person	Total Cost (RM)
Compartment A&B		20	2	5	
Compartment C		4	2	5	
Compartment D		17	2	5	
Compartment E&F		22	2	5	
Compartment G&H		21	2	5	
Total	13,485	84			134,850

Table VII-13 Improvement Cost for System Infrastructure
(F/S for Besut Scheme)

Work Item	Construction Cost (RM)
1. Direct Cost	
Replacement of Besut Barrage Gates	8,000,000
Construction of New Angga Barrage	1,800,000
Concrete Lining of Canals	8,509,200
Improvement of Drainage Facilities	533,300
Improvement of Farm Roads	1,439,500
Improvement of Related Structures	1,178,600
Total	21,460,600
2. Physical Contingency	3,219,100
3. Engineering Cost	2,146,100
4. Administration Cost	1,073,000
Grand Total	27,898,800

Table VII-14 Improvement Cost for In-field Infrastructure
(F/S for Besut Scheme)

Work Item	Construction Cost (RM)
1. Direct Cost	
Land Leveling	1,443,300
Infield Channel	244,700
Control Box	186,300
Total	1,874,300
2. Physical Contingency	281,100
3. Engineering Cost	187,400
4. Administration Cost	93,700
Grand Total	2,436,500

Table VII-15 Cost for Establishment of TM/TC System
(F/S for Besut Scheme)

Work Item	Construction Cost (RM)
1. Direct Cost	
Central Station	Installed in Pilot Project
Repeater Station	0
Water Level Gauge inc. RTU	974,900
Rainfall Gauge inc. RTU	24,200
Remote Gate/ Pump	1,712,100
Total	2,711,200
2. Physical Contingency	406,700
3. Engineering Cost	271,200
4. Administration Cost	135,600
Grand Total	3,524,700

Table VII-16 Cost for Establishment of Monitoring Feedback System
(F/S for Besut Scheme)

Work Item	Construction Cost (RM)
1. Direct Cost	
Master Station	227,000
Player & TV	390,500
Additional TV	8,000
Wiring	62,500
MOA, DID & DOA HQ	21,800
Total	709,800
2. Physical Contingency	106,500
3. Engineering Cost	71,000
4. Administration Cost	35,500
Grand Total	922,800

Table VII-17 Training Cost for Water Users' Group (Besut Scheme)

Off-Site Training

Compartment	WUGs (Nos)	Total WUG Leaders	Training day per Leader	Unit RM/day/person	Total Cost (RM)
Compartment 1	8	16	3	400	19,200
Compartment 2	5	10	3	400	12,000
Compartment 3	8	16	3	400	19,200
Compartment 4	9	18	3	400	21,600
Total	30	60			72,000

On-Site Training

Compartment	Farmers (Nos)	WUGs (Nos)	Training day per farmer	Unit RM/day/person	Total Cost (RM)
Compartment 1	659	8	2	5	6,590
Compartment 2	509	5	2	5	5,090
Compartment 3	858	8	2	5	8,580
Compartment 4	1,028	9	2	5	10,280
Total	3,054	30			30,540

Table VII-18 Improvement Cost for System Infrastructure
(F/S for Pulau Pinang Scheme)

Work Item	Construction Cost (RM)
1. Direct Cost	
Concrete Lining of Canals	23,640,100
Improvement of Drainage Facilities	98,400
Improvement of Farm Roads	2,066,500
Improvement of Related Structures	229,700
Total	26,034,700
2. Physical Contingency	3,905,200
3. Engineering Cost	2,603,500
4. Administration Cost	1,301,700
Grand Total	33,845,100

Table VII-19 Improvement Cost for In-field Infrastructure
(F/S for Pulau Pinang Scheme)

Work Item	Construction Cost (RM)
1. Direct Cost	
Land Leveling	2,665,100
Infield Channel	451,500
Control Box	204,200
Total	3,320,800
2. Physical Contingency	498,100
3. Engineering Cost	332,100
4. Administration Cost	166,000
Grand Total	4,317,000

Table VII-20 Cost for Establishment of TM/TC System
(F/S for Pulau Pinang Scheme)

Work Item	Construction Cost (RM)
1. Direct Cost	
Central Station	266,300
Repeater Station	0
Water Level Gauge inc. RTU	1,344,600
Rainfall Gauge inc. RTU	29,200
Remote Gate/ Pump	5,582,200
Total	7,222,300
2. Physical Contingency	1,083,400
3. Engineering Cost	722,300
4. Administration Cost	361,200
Grand Total	9,389,200

Table VII-21 Cost for Establishment of Monitoring Feedback System
(F/S for Pulau Pinang Scheme)

Work Item	Construction Cost (RM)
1. Direct Cost	
Master Station	227,000
Player & TV	390,500
Additional TV	6,000
Wiring	62,300
MOA, DID & DOA HQ	21,800
Total	707,600
2. Physical Contingency	106,200
3. Engineering Cost	70,800
4. Administration Cost	35,400
Grand Total	920,000

Table VII-22 Training Cost for Water Users' Group (Pulau Pinang Scheme)

Off-Site Training

Blocks	WUGs (Nos)	Total WUG Leaders	Training day per Leader	Unit RM/day/person	Total Cost (RM)
Sungai Muda	105	210	3	400	252,000
Sungai Kulim	10	20	3	400	24,000
Pinang Tunggal	7	14	3	400	16,800
Padang Menora & Pokok Tampang	3	6	3	400	7,200
Total	125	250			300,000

On-Site Training

Blocks	Farmers (Nos)	WUGs (Nos)	Training day per farmer	Unit RM/day/person	Total Cost (RM)
Sungai Muda		105	2	5	
Sungai Kulim		10	2	5	
Pinang Tunggal		7	2	5	
Padang Menora & Pokok Tampang		3	2	5	
Total	7,301	125			73,010