KEMENTERIAN PERTANIAN MALAYSIA

UPGRADING OF IRRIGATION & DRAINAGE SCHEMES IN BALIK PULAU AND SEBERANG PERAI PULAU PINANG

FINAL REPORT

VOLUME V

ANNEXE F - ENGINEERING
ANNEXE G - ECONOMICS

1982

BINNIE DAN RAKAN (MALAYSIA)
KUALA LUMPUR
in association with
HUNTING TECHNICAL SERVICES LTD.
UNITED KINGDOM

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Contents of other volumes

'The irrigation schemes generally have adequate intake facilities . . . . .'

Sg. Burong Headworks

Sg. Kongsi Brushwood Weir

VOL. V

ANNEXE F

ENGINEERING

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Abbreviations used in this report

CHO	Constant head orifice
CSDS	Coconut Smallholders Development Scheme
DOA	Department of Agriculture (Jabatan Pertanian)
DID	Drainage & Irrigation Department (see JPT)
FAMA	Federal Agricultural Marketing Authority
FMP	Fourth Malaysia Plan
FSL	Full Supply Level
LADP	Integrated Agricultural Development Project
JKR	Jabatan Kerja Raya (Public Works Department)
JPBK	Jabatan Perancang Bandar & Kampong (State, Town & Country Planning Department)
JPT	Jabatan Parit dan Taliair (Drainage & Irrigation Department)
KGN	Koperasi Gabungan Negeri (Pulau Pinang)
LPN	Lembaga Padi Negara (National Padi Board)
LPP	Lembaga Pertubuhan Peladang (Farmers' Organisation Authority)
MADA	Muda Agricultural Development Authority (Kedah & Perlis)
MARDI	Malaysian Agricultural Research and Development Institute
MMS	Malaysian Meteorological Service
MOA	Ministry of Agriculture
MPPP	Majlis Perbandaran Pulau Pinang (Penang Island Municipal Council)
NEP	New Economic Policy
PBA	Pihak Berkuasa Air (Penang Water Authority)
RISDA	Rubber Industry Smallholders Development Authority
SPI	Seberang Padi Integrated Sdn Bhd
SEPU	State Economic Planning Unit
SERU	Socio-Economic Research Unit
TMP	Third Malaysia Plan
TOR	Terms of Reference
USDA	United States Department of Agriculture
JPN	Jabatanarah Permetaan Negara (Directorate of National Mapping).

Abbreviations used in this report

(continued)

Sg.	Sungai
Kg.	Kampong
ac	acres
ch	chains
ft	feet
gt	gantangs (1 gt = 5.6 lb of rice)
ha	hectares
in	inches
km	kilometres
kg	kilograms
L	Litres
lb	pounds
m	metres
mi	miles
m-m	man-month
s,sec	seconds
T	metric tonnes
CIF	Costs, Insurance and Freight
DBE	Dry Beans Equivalent
FFB	Fresh Fruit Bunches
FOB	Free on Board
IRR	Internal Rate of Return
NPV	Net Present Value
RSS	Ribbed Smoked Sheets

Metric Conversions

1 hectare (ha)	=	2.47 acres (ac)
1 T/ha	=	159 gt/ac
0.63 T/ha	=	100 gt/ac
1 m^3/day	=	220 gpd

F1 INTRODUCTION

F1.1 General

F1.1.1 This Annexe presents the results of the engineering studies carried out during the plan to upgrade the irrigation schemes of Pulau Pinang. It comprises six main components:

(a) Review of existing situation

(b) General proposals

(c) Criteria for upgrading irrigation facilities

(d) Sample areas

(e) Engineering materials and costs

(f) Operation and maintenance

The engineering studies on the drainage schemes are presented in Annexe J.

F1.2 Irrigation Schemes

F1.2.1 Seberang Perai

There are 15 irrigation schemes listed in the Terms of Reference in Seberang Perai. In addition 3 small areas south of Pinang Tunggal scheme are effectively separate schemes in their own right - Pokok Jeneris and two rainfed areas, Kampong Tasek and Kubang Menderong. Furthermore Tasek Junjong in the Southern District is in fact two separate schemes - Tasek Junjong and Kampong Kepala Gajah. The present and estimated future areas of each scheme are given in Table F1.1. The present total of irrigable land is about 13,820 ha (34,135 acres). Of this about 200 ha is cropped with vegetables but some 4,800 ha is presently uncultivated and effectively abandoned. The vegetable area is concentrated in the north east corner of the State in Pinang Tunggal and Kg. Tasek. The schemes are shown in Figure F1.1.

F1.2.2 On the listed schemes two are unlikely to remain under irrigation and are therefore not discussed in detail in this report. These are Mengkuang Mak Sulong and Cherok Tok Kun. There are some doubts as to the location of the former scheme, there being an area within the Kulim scheme referred to by this name. However, it has been taken to refer to an area on the Mengkuang river between Mengkuang Titi and Kg. Mengkuang. This scheme has been abandoned for several years and the headworks and canal system are in a poor state of maintenance. Much of the area is being converted to other crops - oil palm and rubber - and we understand that housing is to be built on part. There appears to be no desire by the local people for its rehabilitation for rice or other crops. Cherok Tok Kun suffers from the development pressures of the expanding town of Bukit Mertajam and much of the scheme area is scheduled for future urbanisation. It is a 'rainfed' area with severe water shortage problems partly as a result of the diversion of run-off from part of the catchment for urban water supply. It is now completely uncultivated, and it is unlikely to be economically or socially viable for upgrading and rehabilitation even if adequate groundwater supplies (the only realistic alternative water source) could be realised. In neither case therefore do we recommend any further investment on engineering infrastructure.

F1.2.3 The remaining schemes have been separated into five groupings for study. These groupings have been chosen both for the geographical location and inter-relation between the schemes, particularly with water control and management, and because of general similarities in the types of schemes and their problems. The groups are:

A - Sg. Muda scheme

B - The schemes in the north east of the State - Pinang Tunggal, Pokok Jeneris, Kampong Tasek and Kubang Menderong, Kuala Tasek, Jarak and Jarak Tengah.

C - Sg. Kulim scheme

D - The small schemes in the Central and Southern Districts - Alma, Machang Bubok, Renjau, Tasek Junjong, Kg. Kepala Gajah, Kuala Tasek and Sg. Duri

D - Juru scheme

Balik Pulau

F1.2.4 In addition two schemes in Balik Pulau are required to be studied. They are Sg. Burung (gross area 525 ha) and Sg. Pinang (601 ha). In both cases the area of land presently available for irrigated agriculture is less than these gazetted areas of padi. The difference in the areas is largely due to the conversion of some areas of coconut. For the formulation of engineering proposals and estimation of their costs we have assumed the rehabilitation of such areas to irrigated agriculture. These two schemes are taken together as Group F.

Designs

F1.2.5 Preliminary layouts have been prepared for all the schemes except Sg. Duri for which no suitable base map was available. For the four large schemes, Sg. Muda, Pinang Tunggal, Jarak and Sg. Kulim, these are at a scale of 1:12,672 (1 inch to 16 chains); for the remaining schemes they have been prepared at 1:6,336 (1 inch to 8 chains). In addition five areas have been subjected to detailed topographical survey and the systems have been designed in greater detail. These are discussed in Chapter F5. All these drawings are submitted in a separate volume (Annexe H). Except for the sample areas the layouts have been prepared in the absence of detailed topographic surveys for elevations. They must therefore be considered provisional, and changes must be expected at the detailed design stage. It was considered necessary however to prepare these layouts to illustrate and to cost adequately the proposals.

F1.2.6 A list of the drawings in Annexe H is given in Table F1.2.

Table F1.1 Scheme Areas

1. Sg. Muda

Existing gross area:- (incl. 75 ha outside main flood bund)	7,125 ha	
Area estimated lost to N/S expressway:	75 ha	
Area estimated lost to urban development:	100 ha	
Gross area assumed for project	6,950 ha	(17,165 ac)

2. Pinang Tunggal

Existing gross irrigated area under JPT control (incl. 160 ha outside main bund)	1,366 ha	
Area estimated lost to N/S expressway	16 ha	
	1,350 ha	
(includes approx. 135 ha presently planted with vegetables)		
Kg. Tasek gross area (includes approx. 65 ha presently planted with vegetables)	106 ha	
Pokok Jeneris gross area	90 ha	
Kubang Menderong	39 ha	
Gross area assumed for project (incl approx. 200 ha presently planted with vegetables)	1,585 ha	(3,915 ac)
In addition water required for MAARDI research station & Min of Agriculture station:	118 ha	

3. Jarak

Existing gross area, approx. (This includes part of area north of main canal and south of Tasek Gelugor town. This will be fed entirely from Ayer Melintas P.S in Tasek Gelugor scheme.)	790 ha	
Gross area assumed for project	778 ha	(1,900 ac)

4. Tasek Gelugor

Existing gross area approx. (See note for Jarak scheme)	250 ha	
Gross area assumed for project	262 ha	(647 ac)

n.b. Area supplied from Tok Bedu P.S: 70 ha
Area supplied from Ayer Melintas P.S: 192 ha

5. Sg. Kulim

Existing gross area	3,664 ha	
Areas estimated lost to expansion of Perai/ Bukit Mertajam urban area	175 ha	
Area lost to N/S expressway:	25 ha	
Area lost to E/W highway:	35 ha	
Areas lost to other minor urban encroachments:	60 ha	
Gross area assumed for project	3,369 ha	(8,320 ac)

6. Alma

Existing gross area	99 ha	
Area estimated lost to expansion of Bukit Mertajam urban area	17 ha	
Gross.area sssumed for project	82 ha	(203 ac)

There are no clear indications that there be changes to the areas of the remaining small schemes. Although minor changes to land use may occur, for this project the areas are assumed as presently measured:-

7.	Jarak Tengah	98 ha	(242 ac)
8.	Juru	244 ha	(603 ac)
9.	Machang Bubok	136 ha	(336 ac)
10.	Renjau	20 ha	(50 ac)
11.	Kuala Tasek	24 ha	(59 ac)
12.	Tasek Junjong	167 ha	(412 ac)
13.	Kg. Kepala Gajah	66 ha	(163 ac)
14.	Sg. Duri	20 ha	(50 ac)

Table F1. 2 - Annexe H Drawings

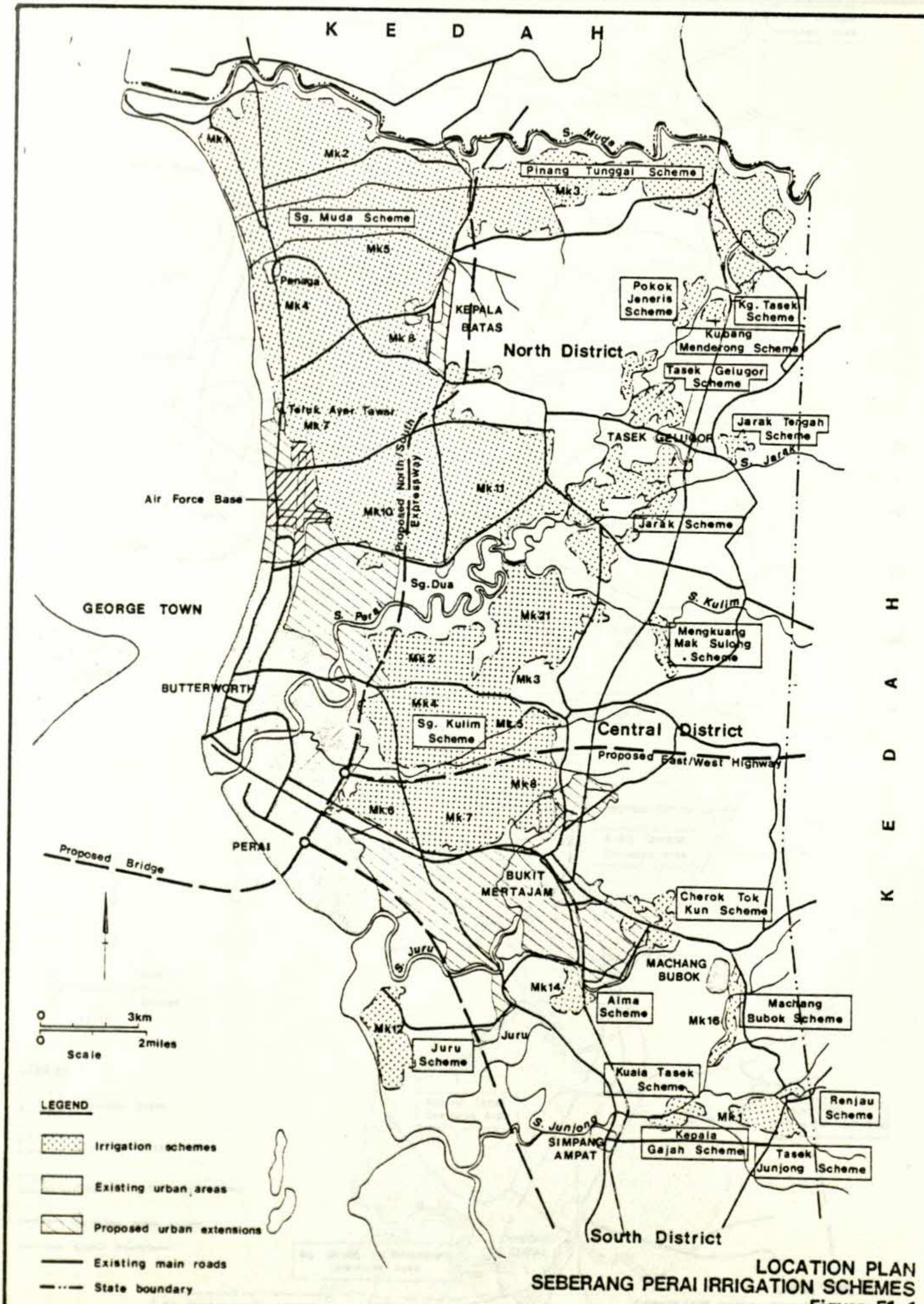
Drawing No.	Scale	Description
1	1 : 63,360	Seberang Perai Location Plan
2	1 : 6,336	Sungai Muda Scheme Sample Area (East) Survey
3	1 : 6,336	Sungai Muda Scheme Sample Area (West) Survey
4	1 : 6,336	Pinang Tunggal Scheme Sample Area Survey
5	1 : 6,336	Sungai Kulim Scheme Sample Area (West) Survey
6	1 : 6,336	Sungai Kulim Scheme Sample Area (East) Survey
7	1 : 6,336	Sungai Burong Sample Area Survey
8	1 : 6,336	Sungai Muda Scheme Sample Area (East)
9	1 : 6,336	Sungai Muda Scheme Sample Area (West)
10	1 : 12,672	Sungai Muda Scheme General Layout (North)
11	1 : 12,672	Sungai Muda Scheme General Layout (South)
12	1 : 6,336	Pinang Tunggal Scheme Sample Area
13	1 : 12,672	Pinang Tunggal Scheme General Layout
14	1 : 6,336	Pokok Jeneris, Kampong Tasek and Kubang Menderong Schemes General Layout
15	1 : 6,336	Tasek Gelugor Scheme General Layout
16	1 : 12,672	Jarak and Jarak Tengah Schemes General Layout
17	1 : 6,336	Sungai Kulim Scheme Sample Area (Alternative A)
18	1 : 12,672	Sungai Kulim Scheme General Layout
19	1 : 6,336	Machang Bubok and Alma Schemes General Layout
20	1 : 6,336	Tasek Junjong, Kepala Gajah, Renjau and Kuala Tasek Schemes General Layout
21	1 : 6,336	Juru Scheme General Layout

Drawing No.	Scale	Description
22	1 : 6,336	Sungai Burong Scheme Sample Area and General Layout
23	1 : 6,336	Sungai Pinang Scheme General Layout
24	1 : 12,672	Bukit Tengah Drainage Area General Layout
25	1 : 12,672	Bukit Minyak Drainage Area General Layout
26	1 : 12,672	Bukit Tambun Drainage Area General Layout
27	1 : 15,840	Nibong Tebal Drainage Area General Layout
28	1 : 12,672	Sungai Udang/Tanjung Berembang and Sungai Chenaham/Sungai Udang Kechil Drainage Schemes
29	1 : 6,336	Bukit Tambun Drainage Scheme Sample Area (No.1)
30	1 : 6,336	Nibong Tebal Drainage Scheme Sample Area (No.2)
31	1 : 50,000	Bukit Tengah, Bukit Minyak, Bukit Tambun, Nibong Tebal and Tanjong Berembang Drainage Areas - Soil Survey - Fresh Soil pH
32	1 : 50,000	Bukit Tengah, Bukit Minyak, Bukit Tambun, Nibong Tebal and Tanjong Berembang Drainage Areas - Soil Survey - Incubated Soil pH
33	a) 1 : 6,336 b) 1 : 500	Air Melintas Pumping Station Detail survey
34	1 : 50	Sungai Burong Irrigation Scheme - Survey of New Intake Site at Sungai Kongsi

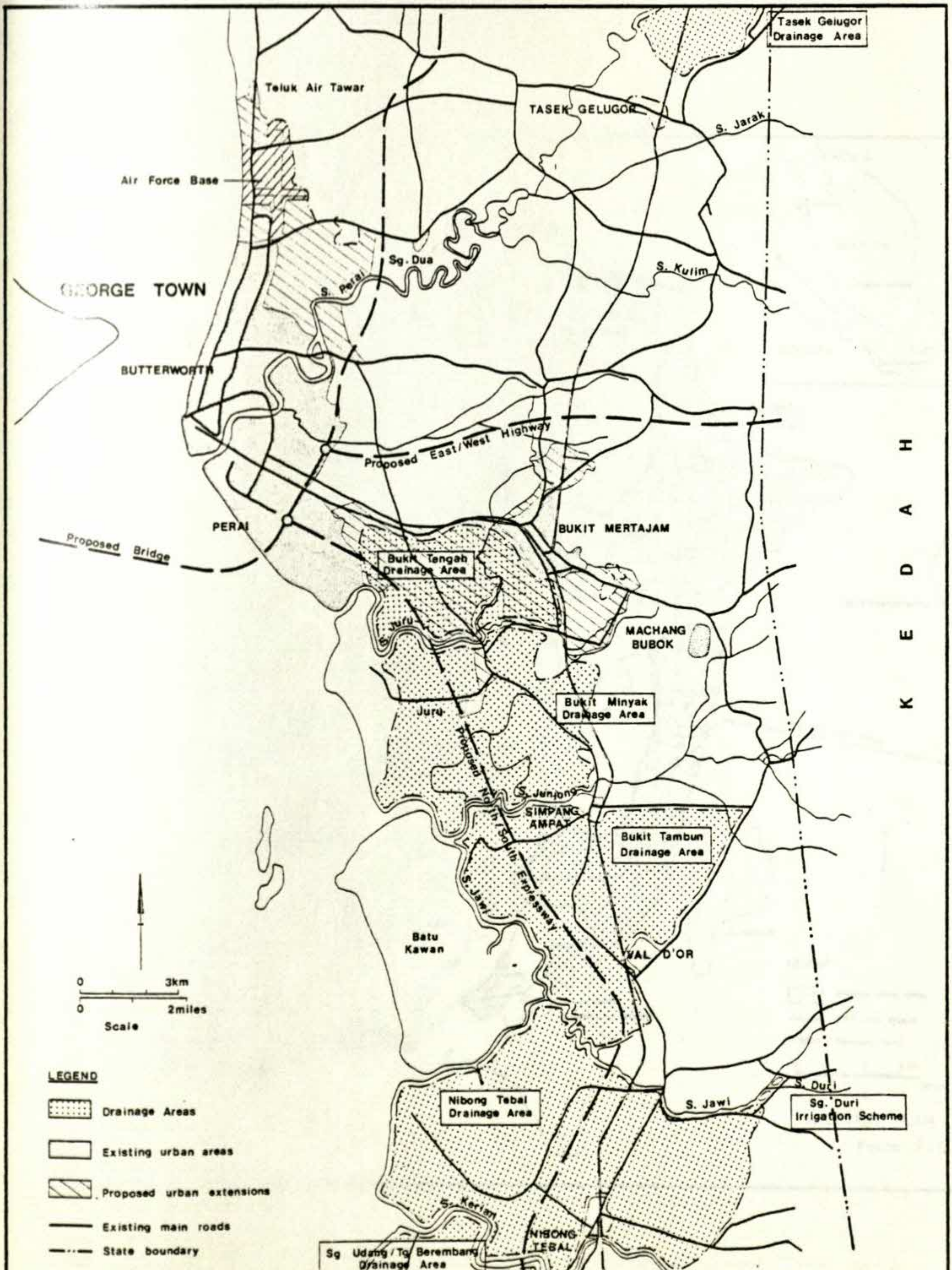
Note:

1. A scale of :-

1 : 792	=	1 in to 1 chain
1 : 6,336	=	1 in to 8 chains
1 : 12,672	=	1 in to 16 chains
1 : 15,840	=	1 in to 20 chains
1 : 63,360	=	1 in to 1 mile

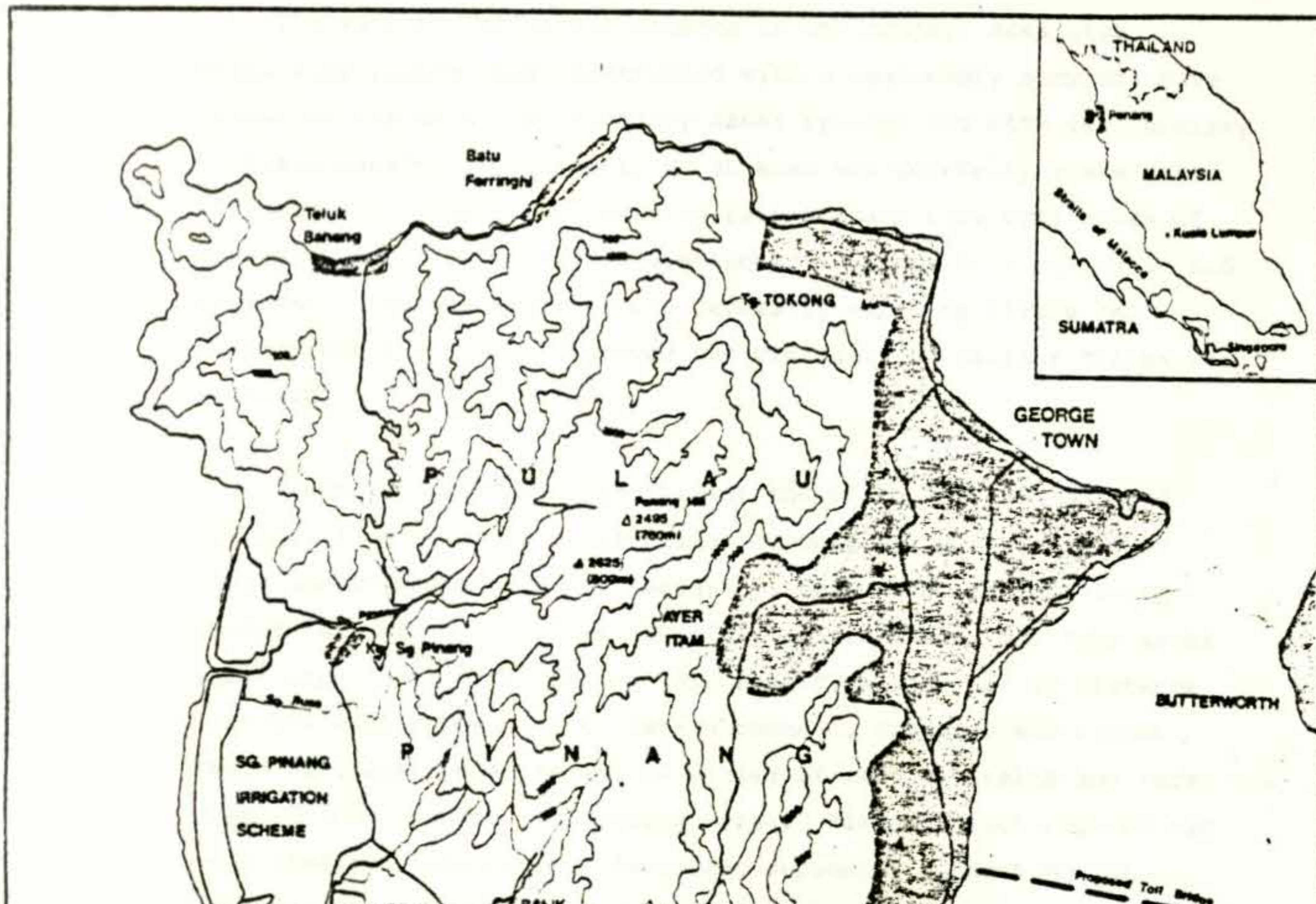


LOCATION PLAN
SEBERANG PERAI IRRIGATION SCHEMES
Figure F1.1



LOCATION PLAN
SEBERANG PERAI DRAINAGE AREAS

Figure F1. 2



LOCATION PLAN

Figure F1.3

F2 IRRIGATION SCHEMES : EXISTING SITUATION

F2.1 General

F2.1.1 The various irrigation schemes in the project area were originally planned and constructed with a reasonably comprehensive layout of the main and secondary canal systems but with few tertiary or field canals. Thus supply to an area was generally via a gated offtake on a secondary canal with farm-to-farm flow over areas of several hundred hectares and distances in excess of 1 km. Main and secondary drainage courses were generally existing rivers and streams and these were improved but virtually no smallar drains were provided.

F2.1.2 Since the original construction the State JPT has improved the situation with the construction of many new works. However these improvements have, of necessity, been directed to solving particular, severe problems and with limited funds, and many areas still experience difficulties with supply, either due to distance from the supply point or to lack of command, drainage and access. Table F2.1 lists the present densities of canals, drains and farm roads in each scheme in Seberang Perai. Although such figures can be misleading, the optimum densities depending so much on the particular location, layout and topography of a project, generally the present values are well below those considered desirable.

F2.1.3 The lack of sufficient tertiary and quaternary canals and drains prevents adequate control of water by individual farmers and there is little opportunity for farmers to improve their agricultural practices. They are reliant on upstream farmers for their water and must not interrupt the supply through their farms because of the needs of the downstream farmer. It is not feasible to control water depths to suit the stage of plant growth or for application of fertilisers. Frequently it is not possible to drain their fields prior to harvesting because other lower farmers may still require water to irrigate their fields or higher farmers may be draining off. Moreover because of the delays in receiving water and the unreliability of supply, it is difficult for farmers to keep to the optimum cropping schedules and the situation has now been reached in some areas where farmers are at all stages of the crop season thus creating further difficulties of control of supply and drainage. It is noticeable that in the areas at present most successfully farmed - i.e. the northern part of Sg. Muda scheme and Pinang Tunggal scheme - there is frequent use by the farmers of their own pumps, both for supply from a canal or drain, and for field-to-field supply in areas with command problems.

F2.1.4 Even in areas in which schedules are followed fairly closely by the farmers so that all are at a similar stage of cropping, a number of practical difficulties limit the potential yields. Among these problems are:

- The use of 'controlled drainage' irrigation in the lower areas. With water levels maintained high enough to suit the top farmers, the lower farmers may be submerged to a depth of 30 cm or more. Moreover with high drain water levels there is no possibility of any farmer being able to drain his fields or even have any control of water level.
- With field supply over long distances of flat, or even adverse gradients, water depths adjacent to the supply canal may need to be very deep to obtain command of farther areas.
- Similarly drainage of a field distant from a drain may require flooding of an intermediate low-lying field.
- Canals in some of the lower areas also act as drains. With supply levels kept high drainage is impossible.

Where tertiary/quaternary canals and drains are provided they are not always in the optimum location, with frequent cases of inadequate canal command and low lying areas undrained. Moreover these small unlined channels require frequent maintenance - local experience suggests that weed clearing should be carried out at least every two months. Rarely are there sufficient funds or personnel to enable this degree of input. Many of these small canals and drains do not have purchased reservations and disputes between farmers can result in a man deliberately destroying the canal over his land to interrupt supplies to his downstream neighbour. Also, particularly with the canals, they are often undersized and, having been constructed from the excavated material which has settled, have inadequate command and freeboard.

F2.1.5 In view of the many problems it is perhaps surprising that in the past production has been as high as it has. However, almost all of these problems are at the tertiary and quaternary level and the main systems are generally well maintained and operated, thus despite their deficiencies the existing systems are not the main cause of abandonment of rice growing in the State, although they are a contributing factor. Therefore improvements to the infrastructure are not in themselves likely to reverse the present trend of abandonment. The only significant benefits to be gained would be an increase in yields due to better control and use of water in those areas likely to remain rice-producing, and possibly a slowing down or even a halt in the rate of abandonment. The general proposals and criteria outlined in Chapter F4 for the upgrading and improvement of the infrastructure must therefore be considered in the overall context of the general recommendations of this report - i.e. increasing use of mechanisation to eliminate the shortage of labour, the development of group farms to improve profitability and enable the rehabilitation of the abandoned lands, and improved practices of husbandry and pest control to enable potential yields to be achieved.

Table F2.1 Summary of Existing Canal and Drain Densities

Scheme	Present Gross area (ha)	Canals Main (m/ha)	Canals Sec. (m/ha)	Canals Tertiary (m/ha)	Drains Main (m/ha)	Drains Sec. & Tert. (m/ha)
Sg. Muda	7,125	1.7	10	14	9	5
Pinang Tunggal (incl. Pokok Jeneris)	1,366	8	8	12	8	5
Tasek Gelugor	250	← 37 →		9	← 16 →	
Sg. Jarak	781	13	23	7	8	8
Jarak Tengah	98	← 25 →		14	← 18 →	
Sg. Kulim	3,369	2	5	16	← 13 →	
Machang Bubok	136	22	← 40 →		26	27
Renjau	20	← 41 →			← 100 →	
Kuala Tasek	24	← 41 →			35	13
Tasek Junjong	167	← 36 →			20	27
Kg. Kepala Gajah	66	← 55 →			20	37
Alma	99	← 22 →			6.5	4

F3 IRRIGATION SCHEMES : GENERAL PROPOSALS

F3.1 General

Common to virtually all the schemes is the lack of adequate tertiary and farm level facilities - supply canals, drains and access roads. A general discussion of these problems and proposals and criteria for improvement of the infrastructure is given in Chapter F4. Because of the universal nature of these needs they are not discussed in the following sections except to highlift particular problems. The recommendations of this chapter are thus primarily concerned with the headworks, the main and secondary distribution and drainage systems. The excellent state-wide road system provides, or will provide under approved JKR plans for the rural road programme, good primary access into all schemes. The lack of access is within the irrigation areas and this is discussed in the following chapter. Only the more important access requirements are discussed below.

F3.2 Sg. Muda Scheme (Group A)

F3.2.1 The Sg. Muda scheme lies in the north west quadrant of Seberang Perai. The present irrigable area is about 7,125 ha of which about 1,500 ha are abandoned (tanah rang with two years of non-cultivation) or have been left uncultivated long enough to require rehabilitation. Taking into account the future construction of the North/South Expressway through part of the scheme and minor encroachments of urbanisation, we estimate the gross area of the scheme will be reduced to about 6,950 ha (see Table F1.1). The alignment of this Expressway is presently being finalised, we understand. We have made no allowances in the proposals or the costs for the disruption caused by the road. Any such costs should be borne by the road project.

F3.2.2 Supply is entirely from the Sg. Muda via a single pumped intake at Bumbong Lima. River levels are controlled by a tidal barrage downstream near Kg. Rantau Panjang and two pumping stations with combined capacity of 14 m^3/s (500 cusecs - three No. 100 cusec and one No. 200 cusec electric pumps) raise the flow through a maximum total lift of 4.0 m into the main canal. The peak intake requirement for the scheme is estimated at 12.4 m^3/s so the existing pumping capacity is adequate. No major problem of siltation of either the inlet channel nor the canal systems are reported.

F3.2.3 The main canal runs due south from the intake for a distance of 12.3 km with secondary or branch canals A, B, C, D, E and F feeding areas to the west. At the southern end of the main canal further secondaries/branch canals supply the southern area. The canal passes under the three major drainage channels from the Pinang Tunggal scheme and Bertam and Malakoff estates - Sg. Tembus, Sg. Lahar Endin and Pt. Logan - which bear west or south-westward, by inverted syphon structures. Many areas are reported to have command difficulties and study of the available, fairly coarse-grid survey of the irrigation area suggests that the design water levels of the main canal should be at least 0.25 m higher over most of the canal to enable adequate command of all areas. (The canal has possibly been operated with higher water levels in the past by encroachment on the freeboard). Table F3.1 gives a comparison between the designed water levels at critical locations and the minimum we consider necessary to give adequate command. These latter values will need to be checked when the detailed surveys of all areas are available during the design stage but, since such a survey is likely to indicate isolated spots higher than picked up by the existing survey, we have allowed for the costs of raising of water level and canal banks over the whole length by 0.5 m. In any case we propose an access road along the entire length of the canal, which would itself necessitate a topping up of the bund.

F3.2.4 There are no escape weirs on the main canal, (or elsewhere) in this system). It is usually advisable to provide such safety features in each gated reach of a canal, however in view of the good operational record they would not appear necessary. However we would recommend a control structure at the end of the main canal with an escape weir for control of canal water levels and a turn-out gate for emergency or maintenance use.

F3.2.5 The problems of command may require raising of water levels in several of the secondary or branch canals. Except in the sample area where the detailed survey is available, final decisions must await the detailed surveys. However an allowance for possible earthworks associated with this is included in the estimate of scheme costs. A minor re-routing of part of secondary canal B, in the sample area and an increase in its capacity to supply the whole compartment, is proposed and this is discussed in more detail in Section F5.2. The one major improvement proposed for the system is the re-routing of the secondary canal C. The present alignment is through a low-lying area creating considerable difficulties with command of the areas either side. We propose the conversion of this canal to a drain and the construction of two new secondary canals parallel to but north and south of the present alignment.

F3.2.6 The other recurrent problem throughout the scheme is poor drainage. Paradoxically in some areas there are both command and drainage problems due to distance from supply points and drains and the flat gradients or slight undulations of the topography. Adding to the problem is the necessity in many areas for the use of 'controlled-drainage' irrigation because of the distance and difficulties of supply. We do not recommend the continuation of such practices and indeed only during the land preparation period do we accept any general need to control drainage water levels. (There are however a few areas, north of Penaga, where rice is being grown on particularly sandy soils and the control of drainage levels is necessary to sustain a water layer in the fields. Control should however be carried out at the tertiary level, not in the main drainage channels).

F3.2.7 The provision of tertiary and quaternary drains as discussed in Chapter F4 should eliminate many of the drainage difficulties. At the present time however most of the secondary canals also serve as drains in their lower reaches when drainage of excess water rather than irrigation is required. This does not allow the degree of control of water levels on-farm necessary for the increased mechanisation requirements and the irrigation supply and drainage system must be separated.

F3.2.8 Maintenance of the drainage system is a major task with weed growth occurring rapidly in the flat gradient, slow-moving flow, and considerable increase in the maintenance budget is necessary, as discussed in Chapter F7. The difficulties are highlighted by the secondary drains either side of the road between Kepala Batas and Kampong Bahru. These also act as the main drains for Kepala Batas and take the road run-off. As a result they are heavily silted and choked up with weeds, leaving the fields undrained and causing flooding when it rains. Between them they drain an area of about 1,200 ha. Both these channels need major improvement.

F3.2.9 Three main east/west drainage channels exit through tidal gates at the coast. These appear adequately sized but the State JPT have recurrent problems in clearing the outlet channels. In particular, the outlets from both Sg. Tembus and Sg. Abdul become blocked with the formation of bars. This appears to be a problem of littoral beach movement but traditional solutions, such as groins, are unlikely to be successful in the soft marine clays underlying the narrow beach of coarser deposits. This is a matter requiring further specialist study.

F3.2.10 The problem at Sg. Tembus may be alleviated somewhat by removing the need for backing up the flow in order to provide a pumped supply to the small area of Guar Tuan Syed. We consider this area can be supplied by gravity from the reconstructed secondary canal B as indicated in Figure F5.1 and Drawing 8 (Annexe H).

F3.2.11 The southern part of the scheme drains southwards into Sg. Perai. This was a tidal estuary but the main barrage has recently been completed and the river in this reach is now no longer subject to tidal intrusion. This will improve the drainage of the Sg. Muda scheme and the swamps along the river, some of which could be converted to rice production. However the large block east of Butterworth is planned for urban development and it is likely that similar pressures for urbanisation will exist around Sg. Dua. Moreover, we are proposing use of Sg. Perai water with a pumped intake supplying part of the Kulim scheme (see section F5.4). In view of the limitations of water supply we do not recommend the conversion of this swamp land to rice production particularly as the more important need is to upgrade the existing padi areas and to get abandoned land back into production.

F3.3 The North-Eastern Schemes (Group B)

F3.3.1 Not only because of their geographical location, these schemes have been grouped together mainly because their supply systems are interconnected as part of the Sg. Muda to Sg. Kulim transfer scheme. Figure F3.1 shows the principal features of this transfer system which allows flow to be drawn from Sg. Muda to supplement those in Sg. Jarak and Sg. Kulim. The main intake for this transfer system is at Pinang Tunggal on Sg. Muda, where the flow is pumped into a canal leading to Sg. Korok. This in turn leads into Sg. Kereh. The flow is abstracted from this river about 10 km downstream with a pumped intake at the Sg. Kereh headworks. A canal transfers the flow to Sg. Jarak, immediately upstream of the Jarak headworks, from where a second canal offtakes on the southern side of this river. This canal connects with Sg. Kulim via the Pdg. Chempedak booster pumping station in Kampong Jarak Atas. The flow is finally released into Sg. Kulim about 0.5 km upstream of the Kulim headworks enabling it to be abstracted for use in the Kulim scheme.

F3.3.2 With the exception of Jarak Tengah, for which abstraction is made from Sg. Jarak about 2 km upstream of the headworks, all the remaining group B schemes are supplied from this transfer system. The operation of these schemes, particularly with regard to water use and schedulling must therefore be integrated, together with that of Sg. Kulim scheme. In an average year the resources of Sg. Kulim, Sg. Kereh and Sg. Jarak are probably adequate for all the schemes except for Pinang Tunggal, and its three small associated schemes, Pokok Jeneris, Kg. Tasek and Kubang Menderong, which will be supplied directly from Sg. Muda. In the dry years however, there is considerable shortage and the transfer system is called into operation. The normal pumping requirements are thus low but the peak duties occurring for short periods once in 5 years are relatively high. The installed capacity at each of the pumping stations is adequate particularly with the additional capacity to supply Kulim from Sg. Perai as discussed in Section F5.4.

F3.3.3 The State JPT have formulated proposals for improving Sg. Kereh which forms a major part of the transfer system, with an increased section and provision of flood bunds. Presently the river is heavily overgrown. It was hoped to carry out full checks on the capacities and efficiencies of the transfer scheme but on both occasions when tests were planned torrential overnight rain ended the preceding dry spell. The consequent high river stages prevented accurate assessments of the transfer capabilities. However it appears that the present limitation of the system is probably Sg. Kereh in which 'bank-full' discharges of about 4.25 m^3/s (150 ft^3/s) were measured at Ayer Melintas Pumping Station. This is about the maximum requirement to be passed down the river but it would be dangerous to operate the system at such a river level, and the present capacity of the system is therefore judged to be about 75% of this - i.e. 3 m^3/s (110 ft^3/s). The proposed improvement scheme would have ample capacity for the peak irrigation requirements, but in the present situation with much of Sg. Kulim scheme abandoned there is unlikely to be a need to operate the transfer system. When the area is rehabilitated as part of the project, by the time there is a need for the extra flow, the proposed pumping station at Ptg. Pasir will provide part of the requirement thus reducing the peak transfer system demand to just over 3 m^3/s.

F3.3.4 In the past the Korok and Kereh rivers have acted as flood overflow channels for Sg. Muda. This function has been largely superseded by the construction of flood bunds along the southern bank of the Muda, however some flooding is still reported as occurring by over-topping of the bund in Kedah and also from back flow via a flood relief culvert through the bund. In both cases it is advisable to prevent such flows if practicable. However, any such works must be considered in the context of the whole river regime.

Pinang Tunggal Scheme

F3.3.5 The Pinang Tunggal scheme lies in the north east corner of the State along the southern bank of Sg. Muda. The total irrigated area is about 1,366 ha at present of which about 200 ha is cropped with vegetables - the actual area of vegetables varying from season to season. A small reduction to about 1,350 ha will be caused by the construction of the N/S expressway along the western edge of the scheme. These areas do not include Pokok Jeneris, Kampong Tasek or Kubang Menderong. In addition provision must be made for the system to supply an area of 85 ha currently being developed by MARDI at Bertam as a research station and an area of 33 ha presently used by MARDI at Bumbong Lima which we understand will revert to the Ministry of Agriculture as a rice multiplication station.

F3.3.6 The scheme is presently the most successful area farmed in Seberang Perai, with close to 100% double-cropping on the rice areas and with the farmers following fairly closely the optimum cropping schedules. This might suggest that the need for improvements in the infrastructure is less than elsewhere. However, far from being better than in other scheme the supply system at the tertiary level is possibly inferior and although there is a good main drain, Sg. Tembus, there are virtually no tertiary level drains. The success of the farming is thus largely due to the farmers themselves who in many cases have provided their own pumps to abstract from the canal system and even to pump from field to field to obtain command of higher areas, or to drain low-lying pockets without a gravity outlet. It is estimated that there are about 40 small pumps being privately operated within the scheme and improvements in the tertiary infrastructure should remove the need for these.

F3.3.7 Included in the total are three areas,which together cover about 160 ha, and lie between the main Sg. Muda flood bund and an older outer bund which is no longer maintained. These three pockets are well farmed but are subject to periodic flooding, reported as occurring annually. Since this outer bund already restricts the flood channel of the Sg. Muda until it is overtopped,some repairing and possible heightening should be carried out to reduce the incidence of flooding of the enclosed padi areas. Provided any such heightening does not raise the crest of the outer bund to the level of the main bund, floods of a level likely to endanger the latter will still overtop the outer bund and will not be restricted or raised any more than with the present situation. As noted in Section F3.3.4 however, the effect on flood levels in Sg. Muda would need to be studied in more detail before implementation - in particular any adverse effects on the flood protection works downstream and in Kedah. For costing however a bund level 0.6 m below the main bund crest is assumed.

F3.3.8 The scheme is divided into two parts by the north/south line of the railway. The intake is at Pinang Tunggal immediately east of the railway where a pumping station provides water both for this scheme and to the transfer system. The uprated station has three electrically powered pumps each with rated capacities of 3.8 m^3/s (135 cusecs) two with a total lift of 4.6 m (15' - 0") and the recently installed pump with a total lift of 4.9 m. The total capacity of the station is thus 11.4 m^3/s. The forebay of the station, between the river and the pump intakes, reportedly is subject to sand deposition and when the forebay is heavily silted material is also drawn through the pumps and deposited in the outlet bay. It appears that under normal operation the flow velocity in the downstream canals is too low to carry the material further and no serious problem of canal siltation has been reported. Consideration has been given to possible silt exclusion works at the inlet to the forebay. However any such works requiring construction in or adjacent to the river are extremely expensive especially with the need to allow abstraction at very low river levels. We consider therefore that the present mechanical clearing of material should continue. There are difficulties however in clearing the centre of the channel due to its width. A narrowing of the forebay could probably be accepted, with the construction of berms on one or both sides for dragline access. Alternatively a small raft-mounted suction dredger could be maintained in the forebay.

D3.3.9 The main distribution system divides immediately downstream of the pumping station, the area to west of the railway being supplied by gravity, the eastern area being presently supplied by a small booster pumping station. The distribution system in the large western block appears to work reasonably well and no major alterations are proposed. However in many places the banks of the main and secondary canals are too low to accommodate the full supply levels and, particularly in view of the command problems to many small areas around the edge of the irrigated area, a programme of

F3.3.20 The Ayer Melintas pumping station has 2 No. diesel pumps each of capacity 0.42 m^3/s (15 cusec) with a total lift of 3.0 m. The peak requirement is about 0.5 m^3/s so the existing installation is adequate. The pumping plant in both this station and that at Tok Bedu will be replaced by electrically-powered units when the pumping station is resited.

F3.3.21 The main problems in the Ayer Melintas area are command of a number of high areas and flooding from Sg. Kereh. The latter problem should be alleviated by the proposed improvements to the river. Most of the command difficulties will be reduced by general improvements to the canal system as discussed in Chapter F4, but isolated areas may require levelling. In addition there is inadequate drainage facilities in the Kg. Peng Batu area south of Tasek Gelugor town and a new secondary drain running southwards into Sg. Jarak is required.

F3.3.22 In the Tok Bedu area the most serious problem is flooding from Ladang Malakoff on the north and west sides. At present the only outlet for flooding outside the bund at Kg. Tok Bedor is via the main canal and frequently the main canal bund is breached by the local people to facilitate this. We propose a new drain through the irrigation area to discharge these flood waters and to serve the scheme.

Jarak Tengah

F3.3.23 Jarak Tengah is a scheme of about 100 ha on the right bank of Sg. Jarak about 20 km upstream of the main Jarak scheme headworks. A small pumping station with 1 No. 0.14 m^3/s (5 cusec) diesel pump with a total lift of 1.8 m abstracts from Sg. Jarak and supplies the western half of the scheme. It had been intended to install a second pumping station at the other eastern end of the scheme with similar capacity but this was never completed. The maximum calculated requirement for the whole scheme is 0.19 m^3/s so that if the entire area is to be irrigated then either the second station must be completed or the existing station uprated with provision of a second pump. We have allowed in the costings for the second station to be installed.

F3.3.24 The main problem is one of flooding and this has been one of the major causes of abandonment of fields so that less than 50% of the area is presently cropped in the higher fields near Kg. Besar. There are two reasons for the flooding. Firstly the flood bund along the river is apparently too low and is reportedly overtopped during high floods. (It is also reported by JPT, Kedah, that flooding occurs in the Otak Kerbau scheme in Kedah upstream of Jarak Tengah). The second cause of flooding is that part of the drainage from the Mayfield Estate to the north flows through the irrigation area and with the high river levels it cannot be discharged. We propose the construction of a large bunded channel through the scheme to isolate and discharge these cross-drainage flows, probably with associated collected drains along the northern edge of the scheme. Even with these works however, drainage problems are likely to remain because of the high river levels preventing discharge of excess water from the padi area. It may therefore be necessary to consider supplementary pumping of drainage flows from the Jarak Tengah area.

F3.3.25 In view of the drainage problems within the existing scheme, we cannot recommend the extension of the irrigation facilities into the low-lying areas along the river outside the flood bund and downstream between the Tasek Gelugor/Ara Kuda road and the railway line. These areas are unalienated State land but have in the past been farmed on a 'rainfed' basis. The area is designated as the site of the Tasek Kachang Puri Resettlement scheme, we understand.

Sg. Jarak

F3.3.26 The Sg. Jarak scheme lies in two main blocks either side of Sg. Jarak. The area on the right bank (411 ha) is fed from Sg. Kereh via the main transfer system canal. The left bank area (358 ha) is fed from Sg. Jarak via the Jarak/Kulim transfer canal; approximately half the area being supplied by gravity from the canal upstream of Padang Chempedak Booster P.S., and the other half from downstream of this pumping station. The latter can also be supplied, when adequate flow is available, from Sg. Kulim by reversing the flow in the last reach of the transfer canal, thus reducing the operation of the pumping station.

F3.4.2 The scheme actually comprises two old schemes - the original Sg. Kulim scheme, supplied from the present headworks on Sg. Kulim, and the smaller Kubang Semang scheme. This latter area, about 380 ha, was supplied from Sg. Kubang Semang by gravity but due to insufficient flows during the off-season and pollution of the supply by upstream factories this source was abandoned and the two schemes amalgamated with the Kubang Semang area being supplied by a booster pumping station (2 No. 0.35 m^3/s electric pumps with lift of 1.2 m). A second booster pumping station (capacity 0.42 m^3/s - 2 No. 0.21 m/s electric pumps with lift of 1.5 m) was later constructed at Permatang Rawa to extend irrigation to about 120 ha of highland in the south eastern corner of the scheme adjacent to Bukit Mertajam. A small area in the north at Permatang Pasir is also supplied from a booster pumping station.

F3.4.3 The main source of irrigation supply is Sg. Kulim with a gravity intake at a gated headworks across the river at Kg. Mengkuang Mak Sulong. As discussed in Chapter 5, Sg. Kulim does not have adequate resources for supply to the whole in a dry year. In the past, double-cropping of most of the area has been possible by the use of controlled drainage and the maximum use of rainfall - this was the first scheme in the country to practice double-cropping. However, increasing water supply abstractions and a number of very dry years in the last decade indicated the need for the transfer system (discussed in Section F3.3) to supplement the flows in Sg.Kulim from Sg. Muda. However, our studies suggest that significant use of this transfer system should only be required in years drier than average, and even this need should reduce with the provision of the proposed new intake pumping station to Ptg. Pasir discussed in detail in Section F5.4.

F3.4.4 The outstanding problem affecting this scheme is the vast abandonment of the padi fields, the extent of which has now reached about 90% of the total scheme area. The proximity of the scheme to the urban areas of Butterworth, Perai and Bukit Mertajam make it particularly susceptible to the pressures on labour and land. Although there are areas subject to problems of supply and drainage and flooding, in themselves they are not sufficient reason for this major decrease in farming activity. However if the scheme is to be re-established, the tertiary level infrastructure must be improved; at present the density of canals and drains is very low.

F3.4.5 The main distribution system is fairly good and though there are a number of minor improvements that should be made we are proposing no major changes to the system, other than the new Ptg. Pasir pumping station. This station will feed into the existing secondary canal and be able to supply the whole secondary block if required.

F3.4.6 The drainage system however has more problems and various improvements are necessary. In general there is a lack of drains, particularly at the tertiary level, and controlled drainage has been effected by control on secondary and primary drains. If the requisite control of water is to be achieved there must be free draining facilities and control of drain level, if practised at all, should be only during presaturation and at the tertiary level. Many of the primary and secondary drainage control structures should therefore not be used and preferably removed.

F3.4.7 The northern part of the scheme drains northwards into Sg. Perai and with the commissioning of the barrage and the provision of adequate tertiary drainage most of the drainage problems should be resolved. The central area of the scheme in Mukims 4 and 5 drains into Sg. Derhaka which in turn drains westwards into Sg. Perai, downstream of the barrage, via a tidal control gate. This river and those in the southern area are reportedly heavily silted, bringing material down from the steep hillsides to the east and depositing it in the flatter irrigation areas. There appears no way of reducing the need for maintenance of these rivers and it is important that they are kept clear. Tertiary drains are required in the areas both north and south of Sg. Derhaka. These would discharge into this main drain, running between the existing tertiary/branch canals. The southern area is drained by a number of channels which run southwards into Sg. Juru, upstream of the Juru 'dam' in the Bukit Minyak/Bukit Tengah drainage area. Operation of the outfall there is reported to be inadequate at times to discharge excess water satisfactorily. The problem is complicated by the proposed inclusion of much of this drainage area in the metropolitan expansion of Bukit Mertajam and Perai. The south-western corner of the scheme should drain out to Sg. Ganti and thence to the sea. However, the outlet control to Sg. Ganti is kept closed apparently to relieve downstream flooding. We have provisionally indicated that the drainage from part of this area could be diverted westwards and eventually back into Sg. Derhaka, but this will need to be considered further when the detailed surveys are available.

F3.4.8 The area between the northern edge of the scheme and Sg. Perai is presently swamp. With the completion of the barrage and the resulting improvements to the drainage it would be possible to convert this area into padi. However as discussed for Sg. Muda scheme (Section F3.2.11) the immediate objective of this project is to bring the main scheme back into full production and to ensure its future continuation. We do not therefore recommend at this stage any investment in extending the area of the scheme. Should the project be successful then this could be reviewed. The State JPT have prepared provisional plans for development of this area with a number of small schemes separately pumping from Sg. Perai. If the area is developed then we would recommend such systems. However the availability of water would be greatly affected by the proposed pumping station at Ptg. Pasir. We do not propose uprating the distribution system of Sg. Kulim to cater for a possible future expansion.

F3.5 Central and Southern District Schemes (Group D)

Machang Bubok

F3.5.1 This scheme is located south of Kg. Machang Bubok and consists of an area of 136 ha (335 acres) in a long narrow strip between Sg. Machang Bubok on the west and Sg. Bukit Teh on the south-east. The main supply is from Sg. Ayer Merah via a gravity intake at the gated headworks but subsidiary supplies for two small areas are taken from Sg. Machang Bubok in the north near the kampong and from Parit Balik Bukit which feeds a small area east of the Machang Bubok-Kampong Tasek road.

F3.5.2 The layout of the scheme with a long main canal supplying this narrow strip makes the standard concept of tertiary units impracticable, and we have retain the existing pattern of quaternary canals off-taking directly from the main canal. Each of these offtakes however should be provided with a 'tertiary' type offtake structure and a number of them can be operated in conjunction as a single 'tertiary unit'.

F3.5.3 With the high density of streams and rivers through the area drainage is good. River training works are required on Parit Balek Bumit which is steep and deeply incised and is causing significant bank erosion which is endangering some of the adjacent padi fields. Allowance has been made in the cost estimates for some bank stabilisation works.

F3.5.4 Access into the area is poor at present and vehicle access will be provided along the main canal.

Sg. Renjau

F3.5.5 The scheme is a small area of only about 20 ha (50 acres) fed by gravity from an intake with gated control structure across the Sg. Perangin. The scheme is divided, the area west of the road having no irrigation facilities and controlled drainage being practised. It is proposed to extend the existing canal system into this area. Drainage is good with Sg. Renjau in the north and Sg. Perangin along the southern side of the scheme.

Tasek Junjong

F3.5.6 We have considered the Tasek Junjong scheme as the eastern block of the two areas indicated in the Terms of Reference as making up the scheme - the other being Kg. Kepala Gajah. The scheme (167 ha - 412 acres) is fed by gravity from a headworks on Sg. Tasek Junjong.

F3.5.7 The distribution system has a fairly high density of canals and the shape and size of the holdings enables a high percentage to have direct access to a canal. No major works are required but minor improvements to the irrigation facilities will be made by extending canals to provide more direct supply to some of the fringe areas. The area is served by a reasonably efficient drainage system having direct access to Sg. Junjong and Sg. Tasek Junjong.

Kg. Kepala Gajah

F3.5.8 The area, 66 ha (163 acres), lies to the south of Sg. Junjong, either side of Sg. Chempedak from which it is supplied by gravity from a gated headworks. Both the canal and the drainage system layouts are reasonable and no major changes are proposed. There is no vehicle access into the area however and we propose two new roads, north and south of Sg. Chempedak, the former leading also to Kuala Tasek, as discussed below.

Kuala Tasek

F3.5.9 This scheme is located on the north bank of Sg. Junjong opposite Kepala Gajah. Supply is taken from the river by a small pumping station with a capacity of 0.085 m^3/s (3 cusecs). This compares with the calculated peak requirement of 0.06 m^3/s. The pumps will be replaced by electric units. A low concrete weir downstream of the intake controls river water levels. Only minor extensions of the canal system are required and drainage is good with the river fairly deeply incised. Vehicle access is poor however. At present a track leads into Kg. Kuala Tasek from the north but there is no vehicle access into the irrigation area. We propose a new bridge across Sg. Junjong connecting with the new access roads into Kg. Kepala Gajah.

Sg. Duri

F3.5.10 Sg. Duri is a small isolated scheme of about 20 ha in the Southern District. It consists of two separate areas supplied from separate headworks on Sg. Duri. However the lower area has apparently been abandoned for some years. The upper scheme is still being cultivated but probably only on a part time basis by families primarily involved in the surrounding rubber estates. The scheme is classed as rainfed and there are no reports of water shortages or requests to JPT for improvements. There appears little demand for it to be taken over by JPT, and in view of this and the management and operational difficulties posed by its isolation from the other schemes, we do not consider that any major capital investment can be warranted. We have allowed a sum in the cost estimates, however for minor improvements.

Alma

F3.5.11 Alma is a small non-gazetted area of about 100 ha, 3 to 4 km south of Bukit Mertajam. About 17 ha will be lost under the approved urban extensions of the Metropolitan Area. The scheme is likely to be almost surrounded by urban development if proposals for further extensions of the Metropolitan Area are implemented. The scheme presently suffers from water shortages and serious pollution of the river sources, Sg. Kelang Ubi and Sg. Kelang Kain, by upstream factories. As discussed in Annexe A the water shortage is likely to increase as the urban development extends into the catchment (approximately 50% of the catchment is scheduled to become urbanised).

F3.5.12 In view of these pressures on land and water there must be doubt as to whether the scheme will survive and in particular whether the area should be adopted and upgraded by JPT. Because of the problems of both water shortage and pollution we do not recommend any investment in the scheme unless significant quantities of groundwater are discovered. (We understand that trial boreholes may shortly be sunk by others and no decision on the scheme should be made until the results of those trials are evaluated).

F3.5.13 Despite this conclusion, the area was chosen as a sample area at an early stage in the study before the implications of the present situation were fully apparent. A detailed layout and cost estimate has therefore been prepared and is discussed in Section F5.5.

F3.6 Juru Scheme (Group E)

F3.6.1 Juru is known to suffer a major problem of water shortage and this is borne out by the analysis of available supplies in Annexe A, which indicates that the present source - Sg. Junjong Mati - is adequate to ensure supply to only about 40% of the scheme area in the off-season. The soils investigations have indicated that draining the area for other crops would result in an acid-sulphate condition. Therefore the area can only be considered for continuation of double-cropped padi or for conversion to oil palm. For the former an alternative or additional source of water must be developed. The only available source is Sg. Junjong which exits at the coast about 3 km south of Juru. As shown in Annexe A, there is adequate water available in the river to irrigate the whole scheme.

F3.6.2 The river is presently tidal up to about the railway bridge at Simpang Ampat, some 7 km inland (see Figure F3.2). Unless an offtake was provided upstream of this, with the resulting high costs of crossings of the railway and the trunk road, two main alternatives exist for the diversion of flows from Sg. Junjong. In both cases the existing intake on Sg. Junjong Mati would be retained:

A - A control gate across Sg. Junjong downstream of the exit of Sg. Junjong Mati enabling, with modifications to the existing Junjong Mati outlet gate, flows to be diverted back to the existing intake pumping station.

B - A new pumped intake abstracting higher up and transferring the flow to Sg. Junjong Mati via a canal/pipeline. A tidal gate would probably be required to prevent saline intrusion.

F3.6.3 Of the two systems the former has some advantages and would merit further detailed study; however a structure at this point would be a major undertaking with considerable difficulties of construction and dewatering. Furthermore it would be used to maintain a water level which might have a significant adverse effect on the drainage of the Bukit Tengah and Bukit Tambun areas. This could only be adequately checked with detailed survey information. In view of the uncertainties involved including possible effects on local tide levels, we have costed Alternative B in our proposals (Table F6.28).

F3.6.4 The intake in Alternative B has provisionally been sited downstream of the trunk road bridge where a control gate can be constructed across a relatively confined channel. The pumping station would be on the north bank, 2 to 3 m above the river level. A short length of pipeline would lead to a canal following the existing road and discharging into the east side of Sg. Junjong Mati. Provisional pumping details are listed in Table F6.8.

F3.6.5 One other possibility not shown on Figure F3.2 is to make use of the culvert/bridge that would be built over Sg. Junjong for the planned north/south expressway. This will pass over Sg. Junjong about midway between the two exits from Junjong Mati (see Figure F1.1) and the bridge/culvert structure could be combined with a gated control structure to divert flows along the east side of the expressway into Junjong Mati. In view of the uncertainties involved no further consideration has been given to this possibility at this stage and it has some of the drawbacks of Alternative A with regard to the effect on the drainage of surrounding areas. As with Alternative A, it would merit further consideration when more detailed knowledge of the road proposals are available.

F3.6.6 Within the irrigation area itself no major changes are proposed and the works involved would be the lining of tertiary canals and provision of quaternary infrastructure in line with the criteria discussed in Chapter F4.

F3.7 Group F - Balik Pulau

F3.7.1 The existing water sources are inadequate to provide a reasonable assurance of supply for even the main, wet season crop over the entire gazetted padi area. The situation is likely to become worse if proposals for urban development in the catchments, particularly that of Sg. Burung, are implemented. We propose therefore that new intakes are constructed on Sg. Kongsi and Sg. Rusa to make maximum use of all the available resources. Our earlier concept was to try and operate each source as an independent system to simplify the water management; however detailed consideration of the cropping patterns and available supplies indicated that a greater degree of flexibility in the distribution of water is required. Accordingly, we are proposing that the Sg. Pinang and Sg. Rusa systems be interconnected to form a main northern system and those from all the other stream intakes to form a main southern system. It would also be advantageous to interconnect these two main systems but the cost would be of the order of $400,000 for the works involved in a canal link, and this possibility has not been included in the total project costs. The operation of the project does not depend on such a link.

Sg. Pinang/Sg. Rusa

F3.7.2 The areas supplied from these sources will consist of the greater part of the existing 'Sg. Pinang Scheme', including those gazetted padi areas not presently available for rice irrigation, but excluding the two most southern blocks either side of Sg. Bagan Ayer Itam. The total area thus supplied is 494 ha.

F3.7.3 The existing gravity intake on Sg. Pinang will be retained with some minor modifications to the concrete weir and to the intake. The main distribution canal will follow the existing alignment south to Sg. Rusa, and thence to Kg. Melayu via the Pascot coconut estate. Consideration was given to re-routing this canal but the ground levels indicate the existing alignment should be retained. Considerable water losses are reported from the canal and in view also of its length and the difficulty of command we propose concrete lining throughout. Even with minimum longitudinal slope, however, command of the Kg. Melayu area is still a problem and it will be necessary to raise the canal levels over most of its length. There is adequate elevation at the exit from the intake culvert to provide this command.

F3.7.4 Sg. Rusa is not presently utilized and a new intake is proposed. This will be a small, low-lift pumping station with a capacity of about 90 L/s. A cost has been estimated assuming the provision of permanent facilities but consideration should be given at the design stage to the use of a trailer-mounted diesel pump. This station will have a relatively low use factor, being called upon only when gravity supplies from Sg. Pinang are inadequate, and a movable pump would have the advantage of use for other purposes such as drainage pumping or dewatering for maintenance activities. Only a simple shelter and platform would be required at Sg. Rusa. Water levels in Sg. Rusa to enable pumping would be controlled by the outfall tidal gates. The intake has been provisionally located adjacent to the crossing point of the main Sg. Pinang canal. The canal level should be sufficient to command all the up-slope areas and the pumped abstraction from Sg. Rusa will be discharged directly into this canal. This arrangement must be confirmed when the detailed survey is available.

F3.7.5 Drainage is poor through much of the area and particularly in the area north of Sg. Rusa flooding is report as a serious problem. A number of possible reasons may account for this and the topography of the area with low lying padi fields bounded on the seaward side by a slightly higher permatang (old beach deposits) creates a natural ponding effect. Cross-drainage flows, particularly the floods in Sg. Rusa itself, must be taken through the area and are presently discharged through a tidal control gate northwards into Sg. Pinang. Some of the smaller cross-drainage channels act also as field drains for the irrigation areas and, being interconnected with Sg. Rusa, any excess flows cause backing up and flooding. We propose to isolate cross-drainage flows from the irrigation areas by channelling them directly through, bunded on either side to prevent flooding. Drainage flows from the irrigation areas, needing to be discharged into these secondary channels, would be passed via flap gates to prevent back flow. Except during dry weather pumping from Sg. Rusa, water levels in the secondary drains would be kept as low as possible, subject only to the limitations of the tidal outfalls. Run-off from the hills to the east should be diverted south to Sg. Rusa, if possible, or north to the drain beside the road to Kg. Kuala Sg. Pinang via a cut-off drain east of the main road, and the two existing culverts under the road should be closed. Sg. Rusa itself presently is diverted abruptly northwards by the first reclamation bund, but release of flood flows could be improved by a re-alignment of the final section through the reclaimed Benteng Kg. Melayu area with a new gated tidal outfall. An existing old check structure in the river causing unnecessary constrictions should be demolished. Final designs must be dependent on the detailed survey but an estimate for these proposals is included in the total costs.

F3.7.6 The existing access into the area is poor. The provision of roads for combine harvesters will be expensive and we have limited this to a main east/west road continuing from Jalan Permatang Pasir into the Kampong Melayu area, with one short spur. 3 m farm roads will be provided along the canal distribution system as discussed in Chapter F4.

Sg. Kongsi/Sg. Ayer Puteh

F3.7.7 At present, the Sg. Kongsi is utilized only for the Pokok Kenanga area and for the block north of Kg. Jalan Baru; in the latter case via a bushwood diversion weir. Sg. Ayer Puteh is not utilized at all. Several options for the use of these two rivers are possible, the main alternative being:

- A new headworks and pumped intake on Sg. Kongsi at the existing Pokok Kenanga intake, supplying this small area and transferring the bulk of the flow direct into Sg. Burung upstream of its headworks; together with a separate pumped intake on Sg. Ayer Puteh supplying only the two blocks either side of Sg. Bagan Ayer Itam. In the latter case this might sensibly consist of diversion of Sg. Ayer Puteh to Sg. Bagan Ayer Itam with the intake adjacent to the two irrigation blocks being supplied.
- A single new pumped intake on Sg. Korok, into which both rivers presently flow, at Kg. Jalan Baru. Again part of the flow would be pumped into the Sg. Burung system upstream of the headworks, the remainder being transferred northwards to the two other blocks. A tidal gate would need to be constructed across Sg. Korok at this site to prevent saline intrusion, and control river levels.

Capital costs are less for the latter alternative, even including the tidal gate and although pumping costs are higher these will be somewhat offset by the reduced staff costs for a single pumping station. Moreover the second alternative provides greater flexibility in the use of the available supplies, particularly as at certain times it may be necessary to transfer all the available flows from both Sg. Kongsi and Sg. Ayer Puteh to Sg. Burung, which the first option does not permit. We therefore recommend the latter scheme.

F3.7.8 The pumping station has been sized for transference of all Sg. Kongsi/Sg. Ayer Puteh flows to Sg. Burung at the critical period during the dry year - i.e. 260 L/s (10 cusecs). The initial concept of a transfer canal has been discarded in the light of the topographical survey as it would require the water level at a height of about 2 m above ground level. An asbestos cement pumping main is therefore proposed, discharging immediately upstream of the Sg. Burung headworks. Under normal operation part of the flow will be transferred northwards and an open channel system, using the small existing aqueduct over Sg. Korok, can probably be utilized. (This will require confirmation by the detail survey particularly with regard to the command requirements of the northern block which will be supplied via an aqueduct or syphon across Sg. Bagan Ayer Itam). Because of the conflicting head requirements of the two systems, the transfer pipeline has been provisionally sized at 600 mm to minimise the friction head. Total head for the transfer pumping is thus about 5 m, and 3 pumps should provide adequate flexibility for both systems.

Sg. Burung

F3.7.9 The existing headworks and intakes on Sg. Burong will be retained. No major changes are proposed, however the design full supply level in the river is not adequate to provide command of the more distant areas of the scheme. Some freeboard exists to the gates and preliminary water level checks based on command levels through the sample area suggest it may not be necessary to raise the gate crests. This can only be confirmed when the detailed survey is available for the remainder of the commanded area.

F3.7.10 The main offtake is on the left bank feeding distribution canals leading south and westwards. The existing canals are somewhat oversized and we propose a smaller lined section with a raised full-supply water level over much of their length. The main and tertiary canal systems will generally follow the alignments of existing canals. The main exception to this is the supply to the most south western unit which in the past has relied on controlled-drainage irrigation. Our preliminary proposals envisaged feeding this block of land from the north western secondary canal (T.A. Sg. Burung) via a syphon under Sg. Nipah, but the lack of any gradient to the land west of the dividing road makes this impracticable, requiring a considerable elevation to the supply canal at its upstream end. We propose therefore to feed this area via the eastern secondary canal and a new supply canal running westwards under the road. The tertiary canal in this area will be constructed on the alignment of the existing drain and new drains constructed along the boundaries of the areas.

F3.7.11 The gazetted area of Kg. Enam along the coastal strip has no existing irrigation facilities and these will be extended from the neighbouring tertiary units. All canals will be sized for this area to revert to padi cultivation, with maize and vegetables in the off season.

F3.7.12 Drainage in the scheme is poor, particularly in the coastal half, and we propose a more rigorous separation of the internal and cross drainage flows as for the Sg. Pinang scheme. A number of new tertiary and quaternary drainage outlet gates discharging into the main drainage channels are proposed, with raised bunds to these channels where necessary. Siltation of the main outlet channels through the mangrove area is a problem, leading to blockage and malfunction of the main tidal gates. We propose that bunds be constructed beside the outlet channels through the swamps, in a similar manner to the flood bunds, providing access for tracked draglines to carry out maintenance.

F3.7.13 Main access is generally good and only limited lengths of 5.5 m wide roads are required. Tertiary access is however poor and 3 m roads are required along most canal routes.

<u>Sg. P. Betong</u>

F3.7.14 Flows from Sg. P. Betong are fed into the bottom end of the Sg. Burung system and we propose no change to this arrangement.

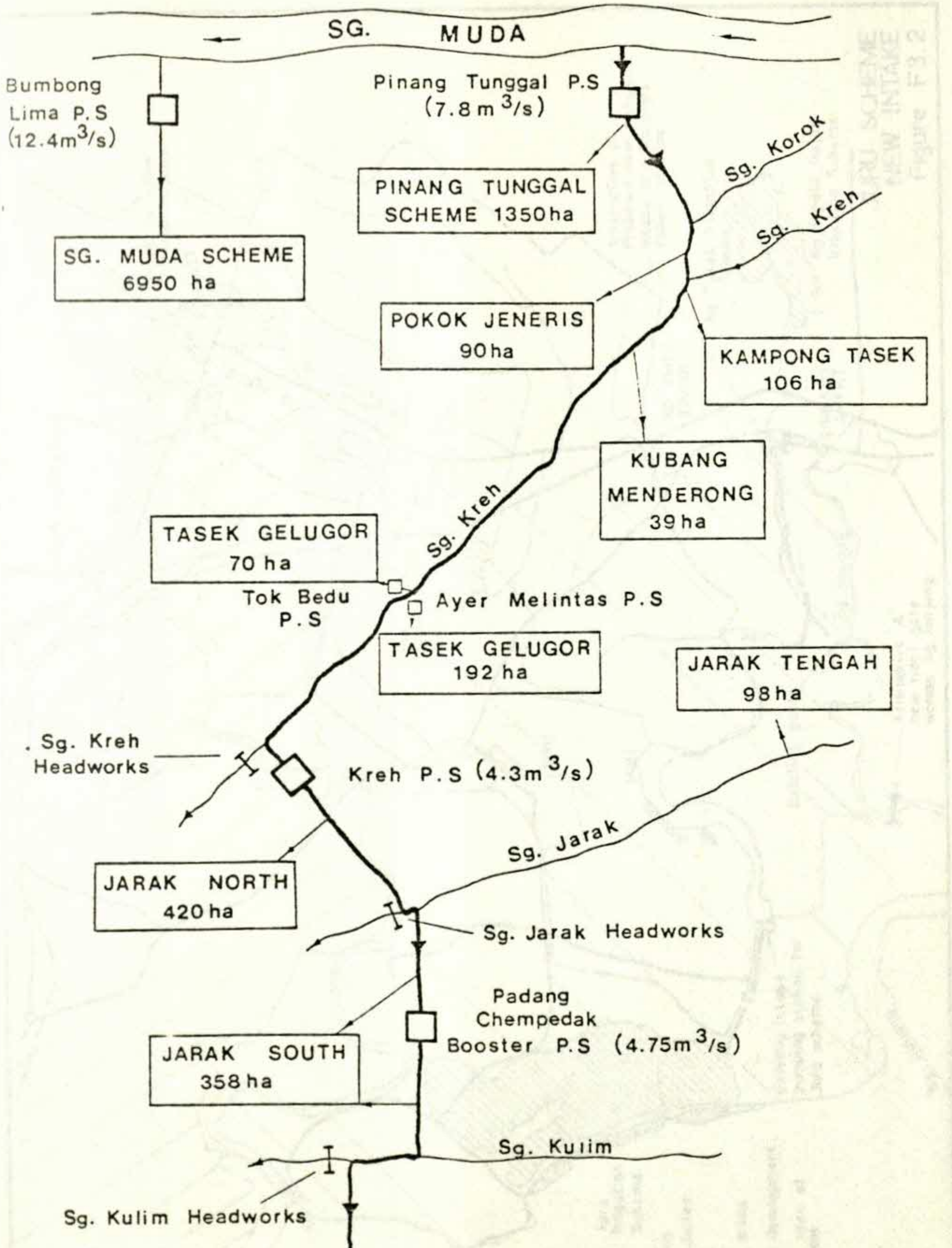
F3.7.15 The flows in this stream are reported to have been affected by the recent construction of a rural access road under the JKR programme. This must be remedied by construction of the necessary culverts as every water source is important to the project. We have included in our project cost estimates for the reconstruction of the small existing headworks which apparently causes some problems of flooding. Designs for this have been completed by the State JPT.

Pokok Kenanga

F3.7.16 The small block of Pokok Kenanga is upstream of the headworks on Sg. Burung and the proposed intake on Sg. Kongsi. It must be fed separately therefore. Doutbs must exist as to its long term viability in view of the pressure for urban development and therefore we do not propose any major capital works, such as the construction of a permanent river control structure on Sg. Kongsi. The existing intake arrangement will be retained with pumped abstraction into the supply canal. This runs through areas of sandy soils and water loss is reported as being heavy; the canal will therefore be lined. Vehicle access is difficult to provide for combine harvesters will be relatively very expensive. We have limited the project cost to a 3 m farm road running from the existing pumping station access track along the supply canal.

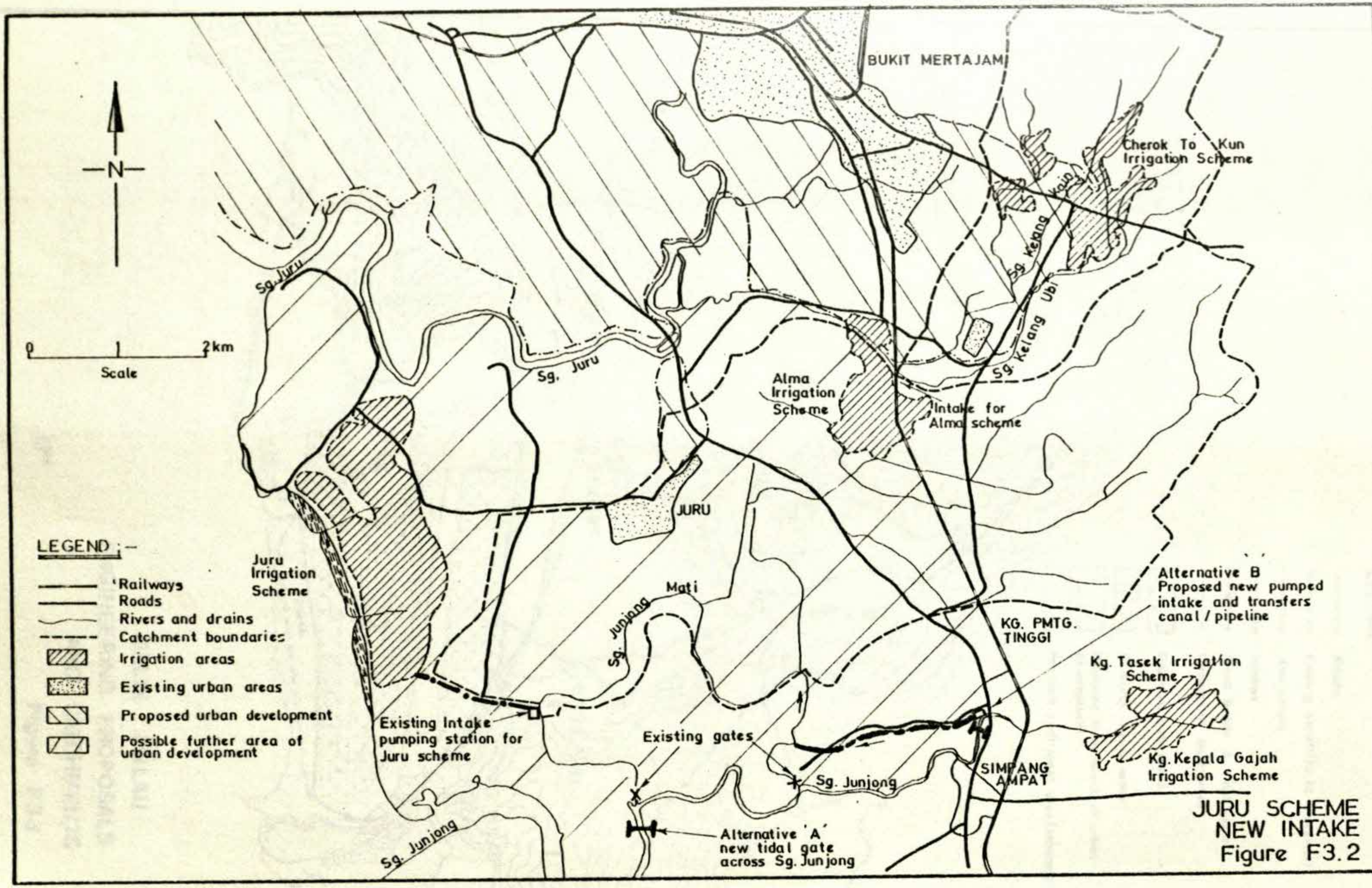
Table F3.1 Water Levels: Sg. Muda Main Canal

	Location	Designed full supply level (m)	Designed Freeboard (m)	Estimated Required spot FSL	Chainage (m)	Estimated Minimum Required canal FSL
1.	d/s of Pumphouse	3.96	1.0		0	4.06
2.	Secondary Canal A offtake	3.80	1.0	3.90	305	4.05
3.	Sg. Tembus syphon/ check structure	u/s- 3.80 d/s- 3.64	1.0 1.0		590	u/s - 4.05 d/s - 3.90
4.	Secondary Canal B offtake	3.61	1.0	3.48	1,970	3.86
5.	Sg. Lahar Endin Syphon/check	u/s- 3.59 d/s- 3.44	1.0 1.0		2,811	u/s - 3.84 d/s - 3.69
6.	Secondary Canal C offtake	3.41	1.0	3.66	4,006	3.66
7.	Kepala Batas: main road culvert/check	u/s- 3.39 d/s- 3.23	1.0 1.0		4,738	u/s - 3.64 d/s - 3.49
8.	Canal D offtake	3.22	1.0	3.41	5,418	3.47
9.	Canal E offtake	3.20	1.0	2.90	6,322	3.45
10.	Canal F offtake	3.18	1.0	3.41	6,950	3.43
11.	Pt. Logan syphon/ check structure	u/s- 3.17 d/s- 3.02	0.5 0.5		7,281	u/s - 3.42 d/s - 3.27
12.	Canal G offtake	3.00	0.5	2.87	7,363	3.26
13.	Canal H offtake	2.86	0.5	2.93	8,831	3.12
14.	Canal J offtake	2.71	0.5	2.93	10,351	2.96
	End	2.51	0.5		12,346	2.77

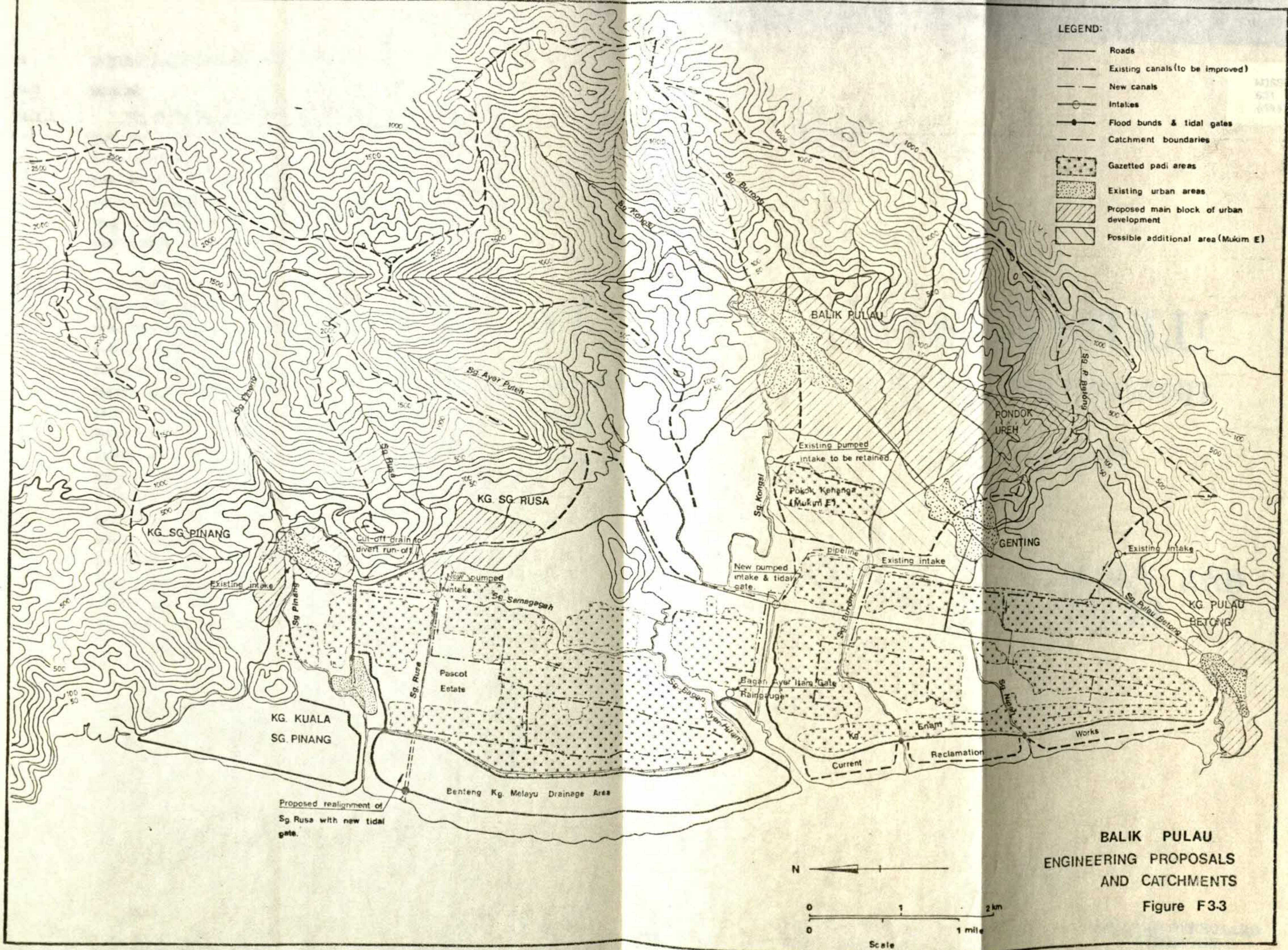


TRANSFER SYSTEM
AND SCHEMES ABSTRACTING FROM SUNGAI MUDA

Figure F3.1



JURU SCHEME
NEW INTAKE
Figure F3.2



BALIK PULAU
ENGINEERING PROPOSALS
AND CATCHMENTS
Figure F3-3

F4 CRITERIA FOR UPGRADING IRRIGATION FACILITIES

F4.1 General

F4.1.1 The criteria discussed in this chapter are mainly concerned with the infrastructure necessary for improving the farming of rice, which will be the main season crop over the entire project area and the off-season crop over more than 95%. There are some areas, particularly in Balik Pulau, which will have an off-season crop of vegetables and maize. The particular infrastructure requirements of these crops is discussed in Section F4.6.

F4.1.2 If there is to be a major future for rice production in the State of Penang then one of the necessary changes must be a reduction in the labour requirements from those of the traditional methods of cultivation. There are two main aspects to this. The first is the greater use of machinery for field preparation and harvesting and the second is the elimination of the labour intensive practice of transplanting, probably by one or more of the various methods of direct sowing. Both these practices require a greatly increased control of water use, particularly the latter which needs accurate control of water levels in the fields. To achieve such control a considerable increase in density of canals and drains is required, ideally providing supply and drainage to each individual field. Additionally improvements are necessary for vehicle access, particularly for the agricultural machinery, ideally to enable each farm to be reached without necessitating passage over adjacent farms. Thus the proposed improvements and additions to the infrastructure must be considered as a necessary part of the overall project implementation.

F4.1.3 The criteria laid out in the following sections, particularly those relating to size and layout of units, must be considered as guidelines only. There are considerable difficulties in standardising criteria for the development of infrastructure on an existing pattern of farm holdings such as exists in Penang. Some exception to those criteria must therefore be expected where their rigid application would result in an unreasonable solution. In addition, many of the criteria are based on the premises that a strict control of water and scheduling of farming activities can be eventually imposed. While the importance of this cannot be too highly stressed, particularly as occasional water shortages are likely, it is appreciated that there are considerable practical difficulties in achieving this. However, none of the proposed improvements place restrictions on the continuation of present practices during the period of implementation or during the gradual ensuing co-ordination of farming activities.

F4.1.4 The existing layouts of farm holdings within each scheme are generally very irregular with average farm sizes of less than 1 ha and a range of sizes from less than 0.2 ha to greater than 10 ha. Ideally not only every farm but every field should have access to a canal and drain if the desirable degree of water control is to be achieved. However with such an irregular pattern of small farms and even smaller fields it is clearly impracticable to achieve this with the JPT distribution and drainage systems. However, farmers should be encouraged to develop such systems. Considerable simplifications could be made to the system layouts if consolidation and redistribution of farm holdings were possible. The social and legal complications of such a procedure would be formidable however, and it has therefore been assumed that generally no re-arrangement of farm boundaries is feasible.

F4.1.5 The possibilities of organising group farms to manage larger units of land are discussed elsewhere in this report. Even within such a block it is unlikely that redistribution of land holdings, involving changes of ownership, would be feasible. Some economies in construction and management of water distribution might be achievable with the fields and the layout of irrigation and drainage systems redefined in a regular pattern without regard to the boundaries of individual holdings in such group farms. We are recommending that a large proportion of the total project is organized in such units, however for the purposes of this study and in assessing the costs of the proposed works we have designed the systems in all areas to suit as far as possible the existing layout of farms.

F4.1.6 Associated with any rationalisation of the field boundaries in the group farms would be possibility of increasing the size of the fields. However the use of large fields would involve considerable expense in land levelling if the degree of water level control required for direct seeding is to be achieved. In this respect the existing smaller fields have an advantage in that the tolerances on level are more easily achieved. The main advantage of larger fields is an increase in the efficiency of machinery use, particularly with the combine harvesters. However compared to the use of the combines in the existing small fields this increase in efficiency is not likely to have a significant effect on the farm or project economics. Moreover if a block of farmers are operating a group system with inputs and profits shared according to area of farm holding, there is no reason why the operation of combined need be restricted by field bunds. Rarely is there is a significant difference in level between adjacent fields and the damage to field bunds could be easily reparied. We consider therefore that generally there is little advantage in increasing field sizes, and the infrastructure improvements are proposed assuming no major changes to either farm or field boundaries. As far as reasonable, the distribution, drainage and access system will follow farm boundaries and will make use of existing facilities where these exist.

F4.1.7 Some land levelling however may be necessary to lower local high spots which would otherwise be out of command, or to fill isolated depressions with difficulties of drainage. As far as possible the systems will be designed to avoid such a necessity as we prefer not to disturb the existing field surface in areas which have been farmed for many years. Where land levelling is necessary the alternative being the costly raising of canal levels up through the system to the headworks, it will require the formulation of a careful specification of method, with the removal and replacing of top soil and the land planning carried out to close tolerances.

F4.2 System Concepts

Tertiary and Quaternary Units

F4.2.1 Because of the small size and haphazad arrangement of farms we have introduced, for the purposes of design and management, the concept of the 'quaternary unit' as the smallest discrete unit of the system. This is an area of generally between 5 and 10 ha, within which the farming activities should be closely co-ordinated whether as part of a larger group farm or as individual holdings. Within the quaternary unit supply and drainage may need to be from farm to farm and road access would be to the edge of the unit only. It is not feasible to provide vehicle access to every farm and machinery used for ploughing or harvesting must work systematically around the units from farm to farm as it would not be possible for a tractor or combine harvester to reach a distant isolated field across the intervening cultivation. With the larger combines presently being introduced into some areas, a quaternary unit could be harvested within 1 or 2 days. Thus it is desirable, if the combines are to be used efficiently, that cropping activities are closely co-ordinated throughout the unit - i.e. within 3 to 4 days, the time during which the crop is ready for harvest. Since on average only about 10 farmers are involved in a quaternary unit such co-ordination should be feasible, even where group farms are not established.

F4.2.2 Tertiary units - i.e. the area controlled by single irrigation offtake from a secondary or branch canal - will be made up of a number of quaternary units. For good management and efficient water use it is desirable that there is a degree of co-ordination between these quaternary units and that the whole tertiary unit follows the same general cropping schedule. We consider that units of about 50 ha are of the optimum size of water management but the restrictions of topography and the existing canal and drain layout mean that the actual size of tertiary units varies considerably. It has been found unavoidable to have occasional units of up to 100 ha and a minimum size of less than 40 ha. The average size is about 60 ha. Although on other schemes in Malaysia larger units are common, the small average size of farms on this project (less than 1 ha) suggests that the social/management problem of large units might be considerable; and indeed we understand that recently evolved criteria for a scheme presently being designed at Rompin and Endau on the east coast of Peninsular Malaysia are for a unit size of 50 ha. The reason for the adoption of the 50 ha unit on that scheme are however based on a situation that does not apply in Penang, and we do not consider that the application of similar criteria is applicable in this case.

F4.2.3 The Rompin and Endau scheme is a new development and as such, farm sizes and irrigation and drainage system layout can be optimised. We understand that the adopted farm size is 2.5 ha and the tertiary unit size is based on the concept that 20 farmers are about the maximum number that can reasonably be expected to work together as a group in the control and distribution of supplies within the tertiary unit. In Penang, as noted above, the average size of existing farm holdings is less than 1 ha, thus a tertiary unit of 20 farmers would be between 15 and 20 ha while a 50 ha unit might contain up to 70 farms. This smaller size of tertiary unit is impracticable while the uncontrolled distribution between 70 farmers we consider to be unacceptable and likely to lead to considerable inequalities in the distribution, with consequent social problems. Thus whereas in Rompin and Endau control by JPT can reasonably be limited to the tertiary offtake, in Penang, in areas where smallholder cultivation is likely to continue we consider it necessary for JPT to control to a lower level. The criteria for degree of control should be based on the number of farms rather than the area. Because of this we have adopted the concept of the quaternary unit as discussed above which will be supplied by a single quaternary canal, with the offtake from the tertiary controlled by JPT. The proposed sizes of quaternary units could perhaps be increased to encompass up to 20 farms, however practical considerations of farm layouts and the objective of supplying directly as many farms as possible generally indicates a smaller area should be supplied from a particular quaternary canal.

F4.2.4 In view of the need for JPT to control supplies within the tertiary unit, the size of the tertiary unit becomes of less relevance. Thus although we would prefer that all units were of equal size of about 50 ha, for ease of operation, we do not consider that the rigid application of such a criterion is necessary or practicable.

F4.2.5 The other aspect which is related to the size of the tertiary units is the operation of the combine harvesters. The large machines, presently being introduced into the northern areas of Penang from the Muda scheme in Kedah and most likely to become widely used, are capable of harvesting about 20 to 25 acres per day - i.e. about 65 ha each week. Thus the machines are most efficiently used with units of this size with no unnecessary travel back and forth between units or standing time awaiting the ripening of the next area. In practice however, with the variation of size of the tertiary units, the difficulty of maintaining a precisely organised programme, (even within a tertiary unit, let alone a large area) and the likelihood of different types and sizes of harvesters being employed, such an ideal programme is unrealistic. It must be expected that there will be some loss of efficiency through standing and travel time.

F4.2.6 Boundaries of tertiary units are largely determined by the topography and will generally coincide with physical features - i.e. secondary canals, tertiary and secondary drains. Ideally they would also coincide with social boundaries such as kampong holdings, however it would be almost impossible to reconcile the two criteria and moreover the haphazard arrangement of the farms and complications of absentee landlords make such an aim unrealistic.

System Operation

F4.2.7 Operation of the larger scheme (and the operation of all the schemes interconnected by the Sg. Muda to Sg. Kulim transfer system - i.e. schemes in Groups A, B and C) is proposed to be with 3 main cropping schedules, each staggered by 2 weeks. Crop water requirements have been assessed on this basis (Annexe A). Within the block following one schedule there will be a corresponding 2-week stagger so that the first farmers in that block are 2 weeks ahead of the programme of the last farmers. Thus throughout the whole scheme any activity will be spread over a period of 6 weeks. The smaller schemes however may have only 2 schedules (i.e. a 4-week total spread) and those less than the size of a tertiary unit are likely to have only a single schedule.

F4.2.8 As noted above the farmers within one tertiary unit must follow the same schedule. There are some advantages - minimisation of canal sizes and the movement of casual labour - in having the tertiary units of each block distributed throughout each scheme. However existing practices both in Penang State and elsewhere in Malaysia are for contiguous blocks, and with the increasing use of machinery and the proposed introduction of direct seeding techniques, labour movement is of less importance. Irrigation blocks therefore will be defined as discrete units, as far as possible coinciding with physical boundaries, such as areas supplied by secondary canals.

F4.2.9 Some improvements in matching irrigation requirements to supply may be possible with unequal sized irrigation blocks. However such improvements are relatively limited and moreover, with equal staggers between schedules, imply a non-uniform spread of farming activities. For both labour and machinery requirements this is undesirable and therefore irrigation blocks should be chosen to be as nearly equal in area as possible subject to the limitations of the physical boundaries. Equal blocks have the advantage that the schedules can be rotated year by year so that all farmers are equally treated over a period of years with regard to optimum climate conditions and possible water shortages. Again some theoretical improvements to matching supply and demand in dry years might be possible by varying the size of the irrigation blocks but this could cause considerable complications in management. We recommend that as far as possible the irrigation blocks, once defined, are not alterned. As indicated in Annexe A even in dry years when water shortages may occur (before the construction of any storage) and delays to the cropping programme may be necessary, this can probably be best achieved by delaying the entire irrigation blocks rather than providing the water available for only part of a block.

F4.2.10 Within one irrigation block either all the tertiary units can follow the same overall schedule or the block can be sub-divided with half the units one week in advance of the other half. If the latter then the stagger within each tertiary unit should be reduced to only 1 week. This latter option has several advantages:

- Because the main control on the farming programming is the initial delivery of water, a more uniform spread of activities can be enforced.
- As noted in Section F4.2.5 the average size of the tertiary units requires harvesting within 1 week for the most efficient use of the combine harvesters
- Not only are plant and labour requirements more evenly spread but also the total water requirements during the presaturation and field preparation period are smoothed out creating a more regular variation of demand through this critical period (see Chapter A6, Annexe A).

To minimise labour and plant movement, it would be preferable if, say alternate units within each main irrigation block were staggered by 1 week in this way. The main reservation to this is that if further increases the degree of water control and the social/management problems of persuading the farmers to follow a schedule, particularly when the adjacent unit may be receiving water a week earlier.

F4.2.11 Distribution should be controlled by means of gated control measurement structures at each secondary and tertiary offtake. In smallholder areas it will be necessary too to control the distribution from the tertiary canals within the tertiary units as discussed in Section F4.2.3. This will involve JPT in additional work over the present operation. Estimates and costs for the additional personnel required are given in Chapter F7. Quantitative control of flows is important not only at times of water shortage when equality of distribution is vital, but at all times in order to maintain high efficiency and reduce pumping costs. Normal operation, once all farmers are following the appropriate schedules, would require gates to be adjusted, on a regular, probably weekly, basis to flows corresponding to the calculated values for the average year. The gate operators/irrigation inspectors would make further adjustments to increase or decrease the supply as necessary in response to rainfall and observation of excess flows passing to the drains.

F4.2.12 Full rotation of supply (i.e. several days requirement supplied in a shorter period, with supply then being switched to other units on a rotational basis) is not recommended for immediate introduction, either at the tertiary level or within the tertiary units. As far as we know it is not employed to any significant extent elsewhere in Malaysia. Moreover there are considerable difficulties in designing a sensible system suitable for rotational operation on top of an existing complicated farm layout; either units must be equal or awkward programming of the supply period results.

F4.3 <u>Irrigation Distribution Systems</u>

F4.3.1 As discussed in Chapter F3 the existing main distribution systems (i.e. main, branch and secondary canals) are extensive and we propose no major alterations to the systems. (The only changes proposed are the re-routing of one or two secondary canals for reasons of command). However we recommend that all secondary and branch canal offtakes should have flow and measurement control. Similarly supply to a tertiary unit will be from a secondary or canal via a flow-control structure.

F4.3.2 Our initial proposal for irrigation control structures was for the Constant-Head Orifice (CHO) type of offtake. However the sample area surveys and discussions with JPT have indicated that a major design problem in the very flat areas which constitute most of the irrigation schemes, is the limitations of available head and command. Because of this head losses through structures must be minimised and under these conditions the CHO is likely to be drowned and influenced by changes not only in the upstream but also the downstream water level. It thus ceases to have adequate control of the flow. We therefore propose a simple, single-gated offtake with a triangular profile, 'Crump' measurement in the channel downstream, as shown in Figure F4.1. This is a relatively simple weir to construct and provide accurate flow measurement with the two advantages of an almost constant discharge coefficient and a modular flow with up to 75% tailwater submergence. Thus it can be designed for a low headloss yet to be unaffected by downstream water level variations. For example a typical tertiary offtake with flow of 150 L/s (5.3 cusecs) could be designed for a head of 0.2 m over a weir of width 0.85 m but the tailwater level could be as much as

0.15 m above the weir crest without affecting the discharge. Thus the minimum headloss could be as small as 0.05 m (2") over the weir and a total headloss of say 0.1 m (4") through the entire offtake.

F4.3.3 The other advantage of the proposed type of offtakes for all irrigation control structures is that the weir can be incorporated in the channel downstream of existing offtakes thus in many cases removing the need for demolition and reconstruction.

F4.3.4 Within the tertiary unit, as discussed in Section F4.2.3 we propose the use of quaternary canals to provide direct supply to the farms. Although many schemes in Malaysia, designed or upgraded in recent years have direct farm offtakes from the tertiary canal these are generally associated with farms of larger size, laid out in a more regular pattern. In this project we consider there is a need for quaternary canals and these have been introduced throughout except as discussed in Section F4.3.6 below.

F4.3.5 'Tertiary distribution boxes' are provided at each quaternary canal offtake (Figure F4.2). These will serve the dual purposes of providing control of the quaternary flow and of the tertiary canal water level at flows less than full supply. Because flow measurement to the quaternaries is desirable, we propose the use of a measurement device such as a Cipoletti weir, integrated with the offtake control gates.

F4.3.6 Despite the general need for supply to farm from quaternary only, the existing layout of farm holdings makes the rigid application of such a system difficult and results in frequent cases of two or three canals side by side. Although such systems are not uncommon elsewhere the relatively high costs of land acquisition here and the structures necessary for mechanised plant access make it difficult in some cases to justify only incremental improvements in water management and control. We propose therefore to adopt a compromise system in which supply will be from quaternary canals where reasonable, but farms abutting tertiary canals may be supplied directly from the tertiary. Relatively few of the farms are supplied directly however. At the design stage detailed consideration should be given to the relative costs of direct offtakes and quaternary canals in each case.

F4.3.7 Farm offtakes from tertiary canals will be piped through the bund and must have a control gate or valve to allow the offtake to be closed as required. We understand that development work is preceding at present on farm offtake design by MADA for the Muda scheme in Kedah and the details of the standard offtake should be decided only in the light of their recommendations. Offtake from quaternary canals will be simple pipes through the batas, without control gates.

F4.3.8 Ideally every farm should have direct access to a supply canal, particularly if the water control necessary for direct seeding is to be achieved. However, the small average size of holdings makes such an aim impracticable. We have therefore adopted the following objectives:

- Direct supply should be to as many as possible
- Where this is not practicable, farm-to-farm supply should be over distances not exceeding 300 m, and preferably through no more than 3 farms.

F4.3.9 We propose that tertiary canals are concrete-lined. Although the capital costs of construction are greater, there are significant saving in maintenance costs. This is becoming increasingly important with the rise in demand for labour throughout the State. Local experience indicates that with the flat gradients and low velocity flow in most of the irrigation systems, weed growth is prolific and clearing of unlined tertiary canals would be required at least every 2 months. Table F4.1 gives an economic comparison of the costs of lined and unlined sections for a typical flow and gradient. The net present costs are similar for the two cases if savings in land lost from production and its acquisition cost are included in the analysis. There are other, less easily quantifiable savings with the lined section:

- Lower structure transition costs
- Fewer men involved in maintenance and therefore less management cost
- Improvements in conveyance efficiencies,

in view of which we recommend the lining of tertiary canals throughout. Lining cannot however be justified on quaternary canals nor on main and secondary canals. In the latter case weed growth is not such a problem in the deeper water and there could be considerable costs involved with the re-shaping of the existing sections and the interruption of irrigation supplies during construction.

F4.3.10 Design flows for tertiary canals and offtakes were initially based on the requirement of presaturating the whole unit in 14 days in the 1-in-5 dry year. This however leads to uneconomically large canal sections. We propose therefore that tertiary canals be designed for a flow of 2.5 L/s/ha. This is adequate to presaturate the whole unit in 14 days for the main season crop in dry years and for the off-season crop in an average year in both Seberang Perai and Balik Pulau. The peak requirement for the off-season crop in dry years must be accommodated either by a reduction of freeboard for this short period or by extending the presaturation period in each unit to 21 days. (This can be achieved without affecting the overall programme). Similarly quaternary canals should be designed for 4.0 L/s/ha which enable main season presaturation of a quaternary block in 7 days or the supply of peak off-season presaturation requirements in 14 days. Offtakes, both tertiary and quaternary, should be designed to pass a flow 20% in excess of these values.

F4.3.11 For tertiary canals of small capacity (less than about 70 L/s - 2.5 cusecs - depending on the slope) standard precast-concrete 'block' section channels will be used. For larger canals the lining will consist of precast slab sections, as indicated in Figure 4.3, with side slopes 1 : 1 unless local soil conditions dictate. Table F4.2 gives details of the canal dimensions and capacities. For this study we have restricted the choice of sections to standard sections as used by JPT. However some savings of cost could be achieved with an additional section intermediate between the largest block section and the smallest trapezoidal section. This should be studied further at the design stage.

F4.3.12 Bund widths will be a minimum of 1.0 m on tertiary canals - wider on secondary and main canals depending on the capacity and height of water level above ground level. Increased bund widths may be required in accordance with the access criteria, Section F4.5.

F4.3.13 Quaternary canals are unlined and generally are found to be minimum size as indicated in Figure F4.3. Only for large quaternary units in flat areas may it be necessary to provide canals of greater size. Maximum length should be kept to about 500 m. Usually such canals are left to the farmers to construct and maintain. However this rarely proves fully satisfactory, and we recommend that the land is acquired and the canals constructed as part of the project costs. Bunds are taken as 0.3 m wide - equivalent to the field <u>batas</u>. They may be wider if foot or cycle access is required.

F4.4 <u>Drainage System</u>

F4.4.1 The drainage system serves two functions. Firstly it enables removal of excess rainfall from the fields and secondly it enables farmers to drain their fields when required, for instance for application of fertilisers or prior to harvesting. The first function determines the size of drains but the second function, particularly in a situation of increasing mechanisation and the possible introduction of direct seeding requiring accurate control of water levels, determines the density and layout of the channels.

F4.4.2 The need for individual control of water indicates that the drainage system should parallel the canal system with ideally, every farm having access to a drain. However with the existing farm layouts this is impracticable and therefore similar criteria as for the layout of canal systems are adopted. As with canals we would prefer farm discharge into a quaternary or field ditch but in some cases it is impracticable to provide quaternary drains and therefore direct discharge to tertiary drains is accepted.

F4.4.3 The design capacity of drains is based on the recommendations of JPT, Hydrological Procedure No. 18 (Ref. A13). Flooding in rice fields is permitted for a period of 3 days up to a depth of 0.3 m (12") provided this does not involve complete inundation of young seedlings. Design rainfalls are discussed in Annexe A. For drainage design in Seberang Perai a 3-day total rainfall of 220 mm (8.7") has been adopted representing a discharge of 8.5 L/s/ha (0.12 ft^3/s/ac). In Balik Pulau the design rainfall has been taken as 245 mm representing a discharge of 9.6 L/s/ha (0.13 ft^3/s/ac).

F4.4.4 The water level at the design drain discharge is taken as existing ground level (i.e. field level). Typical sections are indicated in Figure F4.3. Side slopes are taken as 1 : 1 in smaller channels and 1 : 1.5 in the larger tertiary drains. Gradients are generally flat and there is little possibility of velocities approaching permissible limits for the soils.

F4.4.5 Generally drainage water levels should be kept as low as possible to enable free draining of all areas. During presaturation however it is common practice to control the water levels in order to reduce infiltration. We have designed the systems with drainage control structures on tertiary (and occasionally on quaternary) drains. A typical design is shown in Figure F4.4. Main and secondary drains should not be controlled in this way as they must act to discharge storm run-off as quickly as possible.

F4.5. <u>Access Requirements</u>

F4.5.1 Vehicle and plant access requirements into the irrigation areas can be classed under two main categories:

- For agricultural machinery and for transport of fertilisers and produce.
- For maintenance and operation of the irrigation and drainage systems.

The farmer requires an access road of reasonable standard suitable for regular use, designed for the largest equipment and loads likely The O & M requirement is for lower standard tracks adequate for light vehicles and the occasional access of maintenance plant.

F4.5.2 As with the canal and drainage systems, ideally an access road should be provided to each farm; however with the existing farm layout this would not only be impracticable but also extremely expensive in capital cost and in loss of productive land. We propose therefore to provide vehicle access only to each quaternary unit. Such access will be 3 m - wide roads suitable for tractors and lorries. We do not consider that the additional cost of a road, suitable for the large combine harvesters, can be justified.

F4.5.3 Access for the combines must however be provided into the irrigation areas. As discussed in Section F4.2.5 the most efficient use of these machines is with continuous working around each tertiary unit; the scheduling of water and the programming of farming activities is based on this premise. We propose therefore to provide main access roads to each tertiary unit. Within the tertiary units combine harvesters must work from field to field, crossing over quaternary canals and drains only as necessary. Generally it will be possible to pass around these channels and avoid damage.

F4.5.4 Generally these main access roads will be provided along the main and secondary canal systems. In some cases it is more convenient alongside the major drainage channels, but the costs of bridging these drains to provide access to tertiary units on the far bank is much higher than the corresponding culvert crossings of the canals.

F4.5.5 Where full access is provided it should be designed for the large combine harvesters presently being introduced into the State. Although these machines are possibly larger than desirable it is unrealistic to assume that they can be prevented from being employed in view of the numbers presently operating in Kedah. The largest of these have track widths at about 3.5 m (11 ft 6 inches) and table widths about 4.5 m (14 ft 9 inches). Access roads must therefore be on bunds at least 5.5 m wide. Loaded with grain, these machines may weigh in excess of 6 tonnes. Bridges and culverts must be designed for this loading or for the heaviest lorries and trucks unless the entry of these can reasonably be restricted.

F4.5.6 In many cases the existing road network provides adequate access for the combines. Some existing tracks will need improving and upgrading. In a few cases new roads are being constructed by JKR as part of the on-going rural roads development programme. Generally roads to be provided for the irrigation project are not intended to be part of the State highway network, and frequently have been deliberately designed to prevent through traffic. However as well as providing benefits to the agriculture there is also a social benefit inherent in the provision of these roads. In many cases they parallel proposals for routes made by JKR and part of the cost of the project roads could be off-set as a social cost not directly connected with the viability of the project. In view of the difficulty of assessing any such cost off-setting, we have not attempted to do so; however we strongly recommend that close co-ordination is maintained with JKR and that any planning of access roads is not carried out in isolation. JKR standards on carriageway and reservation width for rural roads are considerably greater than those we propose. In some cases it may be advisable for the additional reservation width to be acquired to enable JKR to adopt and upgrade the road at a later date.

F4.5.7 Access roads within the tertiary unit may, as a general criterion, be either along the tertiary canals or along the tertiary drains. If alongside the canal then they would be at the bund level - i.e. 0.65 to 0.75 m above ground level - as shown in Figure F4.3. If alongside the drain then they could be lower but should be on a bund at least 0.45 m high to ensure that they would not be submerged during flooding. In the latter case a 1.5 m wide track would be provided along the canal bund for motorcycle access for operation and inspection. Thus the cost of a 3 m road along the canal represents only an additional 1.5 m width of bund. The cost of this (using Seberang Perai rates - Table F6.2) is about $18/m as compared to about $26/m for a road alongside the tertiary drain. Moreover access culverts across the relevant channel are more expensive over a drain (the average design discharge being more than 3 times greater) than a canal and the canal route more logically connects with the main access routes along the secondary canals (Section F4.5.4). Generally therefore we propose to provide a 3 m - wide access along each tertiary canal, although in a few instances it has been more suitable to provide the road along a drain.

F4.5.8 Road access is provided along one bank of the canals, and 'access culverts' are provided to enable tractor access into each quaternary unit across the canal. Typical details are shown in Figure F4.5.

F4.5.9 Maintenance access is required along each main, secondary and tertiary drain. Moreover a berm is required for spreading excavated material, both during initial construction and during subsequent maintenance. We propose providing a reservation 3.5 m wide along all these drains to enable access by tracked excavator.

F4.6 Criteria for Vegetable and Maize Areas

F4.6.1 Certain areas, particularly in Balik Pulau and in the north east corner of the State in Seberang Perai, will be growing crops other than rice. The infrastructure requirements for irrigating the proposed crops, vegetables and maize primarily, are different from those of flooded rice. However in Balik Pulau we are proposing alternating main and off-season crops of rice and vegetables/maize respectively, and in the relevant mainland areas it is preferable that the infrastructure provided allow farmers the choice of whether to grow rice or another crop. In both cases therefore the systems provided must be compatible with the requirements of irrigating either type of crop.

F4.6.2 Rice is irrigated under flooded conditions in flat bunded fields. Although maize can be irrigated by basin techniques it cannot stand continuous flooding. Vegetables cannot sensibly be grown in this way. We recommend therefore that both maize and vegetables be grown by furrow irrigation methods. In such a system water is fed into each furros from a canal along one end of the field. Ideally therefore the field should have a gentle slope to facilitate the flow of water down the furrows. However in this case the fields, levelled for rice cultivation, are essentially flat thus the hydraulic gradient of the furrow flow must be achieved within the depth of the furrow. In areas permanently under this form of irrigation, the furrows may be formed as small ditches, however in Balik Pulau where alternate crops are rice, the furrows must be formed by a ploughing technique, and because of the need to be levelled for the subsequent rice crop, cannot be substantial. There is a limit to the depth and hence to the length of any furrow. We have provisionally designed the systems such that the furrows do not exceed 150 m. With the heavy soils in the Balik Pulau area such lengths should be possible, however one of the objectives of the proposed pilot farm in that area must be to test the techniques and criteria for furrow irrigation under these conditions. It may be found necessary to increase the frequency of supply canals.

F4.6.3 With quaternary, or farm, canals at intervals not exceeding 150 m the density is greater than the minimum requirement for rice, for which we have proposed that the maximum distance of field supply should not exceed 300 m. (Moreover it should not be noted that the need to supply to each furrow precludes the use of direct farm offtakes from a tertiary canal, unless these feed into a farm canal). Thus there is a more demanding criterion in the areas with crops other than rice and, unless the cost of the additional infrastructure is to be borne through all areas that might be considered for non-rice crops it is necessary to define those areas, particularly in Balik Pulau, as it would not be possible to change the areas of double-rice cropping and of rice alternating with maize and vegetables each year. It should be noted however that the additional cost of the quaternary infrastructure necessary for furrow irrigation is of the order of \$300/ha (see Table F6.29 for example) which is less than 3% of the total project works. Moreover the layout of the quaternary infrastructure, consisting of unlined canals and small drains is not necessarily fixed for the life of the project. Changes to the systems can be made, particularly in the group farm areas, relatively simply and cheaply

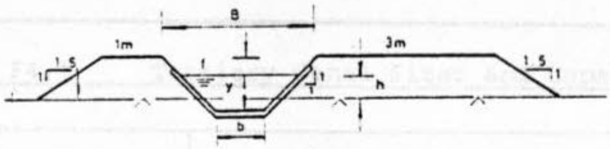
F4.6.4 Other techniques of irrigation are available for the vegetable and maize crops. Hand watering of small areas of vegetables is possible, and sprinkler irrigation with small pumps and moveable sets could be successful, particularly for the vegetables. Additional capital and running costs however are incurred. Even with low-head systems pumping pressures in excess of 20 m head are required. Trials to determine the most suitable equipment would need to be carried out, and this could be another objective of the pilot farm. However we have costed the project on the basis of furrow irrigation and we do not recommend the immediate introduction of sprinkler systems for widespread use. Elsewhere drip or 'trickle' irrigation systems have been successfully used for a wide variety of crops. Again however the capital cost is relatively high and probably could only be considered for a high value crop such as vegetables. However any consideration of the introduction of drip must be extremely cautious, as the type of equipment suitable for vegetable type crops requires very clean (i.e. sediment-free) water. We would not recommend its use with the present surface-water sources but might be successfully introduced if groundwater sources are developed.

F4.6.5 Corresponding to the increased density of canals, will be an increase in the density of quaternary drains. In areas that are cropped throughout the year with vegetables, the drains must remove the peak 1-in-5 year 24-hour rainfall. In Seberang Perai this is about 140 mm and corresponds to a drainage design criterion of 16 L/s/ha (0.22 ft^3/s/ac). In Balik Pulau however the 24-hour criterion only applies to the off-season crop i.e. during the months from February to August. During this period the 1-in-5 year 24-hour rainfall is about 122 mm and the design drainage capacity is 14 L/s/ha. Although in both cases this is a significant increase in the drainage requirement over that of the rice areas, the smaller areas served by each drain mean that the size of the quaternary drains is not increased. Thus the quaternary drains are costed as the standard size (Figure F4.3).

<u>Table F4.1 Comparison of Costs of Lined and Un-lined Tertiary Canal Section</u>

Consider typical tertiary canal serving unit of 60 ha i.e. $Q = 0.15\ m^3/s$ - with typical average gradient of 0.00015.

A. <u>Lined canal</u>



Standard section: TI, required:- y = 0.65, b = 0.30, h = 0.45
freeboard, f = 0.30 ∴ B = 2.10 m

Total capital cost = \$168/m (Table F6.3)

Maintenance cost of canal section only (other costs similar in both cases).

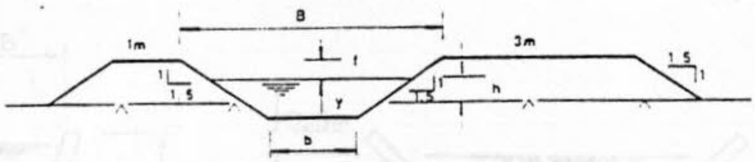
- grass cutting of unlined freeboard, 6 times per year at, say, $0.10/m^2$:- 0.42 x 0.10 x 6 = \$0.25/m
- materials and labour for repairs to lining at, say, 0.5% capital cost per year = 0.005 x 75 = \$0.38/m

Total = \$0.63/m

Net present cost of maintenance costs over 30 years at 10% p.a.
= 0.63 x 9.43 = \$5.94, say \$6

∴ Total present cost of lined section = \$174/m

B. <u>Unlined canal</u>



For minimum recommended ratio of b:y - i.e. b = 2y:-
y = 0.77, b = 1.54, h = 0.45, f = 0.45 m ∴ B = 5.2 m

Construction costs per metre:-

Fill	: $5.26\ m^3$ at \$16	=	\$84.2
Laterite road surfacing	: $0.77\ m^3$ at \$18	=	\$13.9
Trimming excavation	: $6\ m^2$ at \$1	=	\$ 6.0
Miscellaneous	: say		\$ 5.0
	Total cost	=	\$109.1/m

Maintenance cost of canal section:-

- weed clearing, 6 times per year at, say, $0.3/m^2$:- 6.0 x 0.3 x 6 = \$5.4/m/year

Additional loss of productive land = 5.2 - 2.1 = 3.1 m

Net revenue = \$2,400/ha/yr

∴ Net revenue loss = $\frac{3.1 \times 2,400}{10,000}$ = \$0.74/m/year

∴ Total annual costs = 5.4 + 0.74 = \$6.14/m

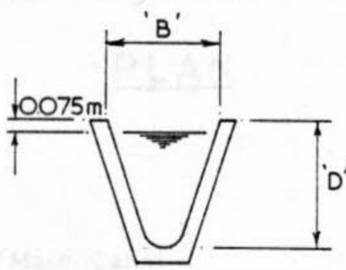
∴ Net present cost = 6.14 x 9.43 = \$57.9/m

∴ Total present cost of unlined section = <u>\$167/m</u> (excluding additional land acquisition)

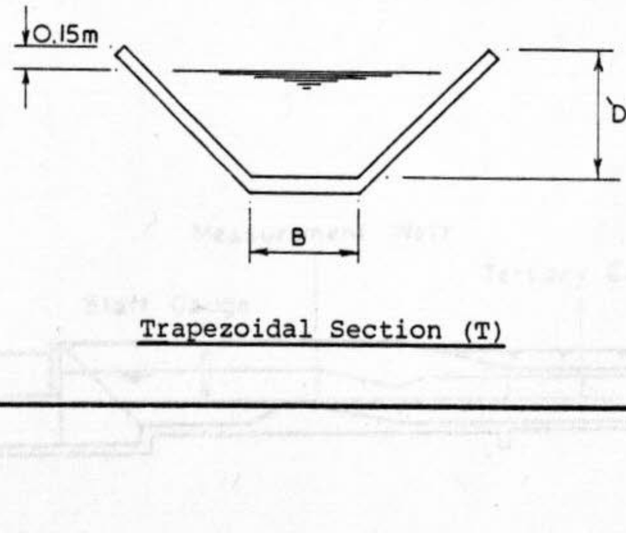
Additional land acquisition at average cost \$30,000/ha = 3.1 x 3 = <u>\$9.1/m</u>

Table F4.2 Tertiary Canal Sizes and Capacities

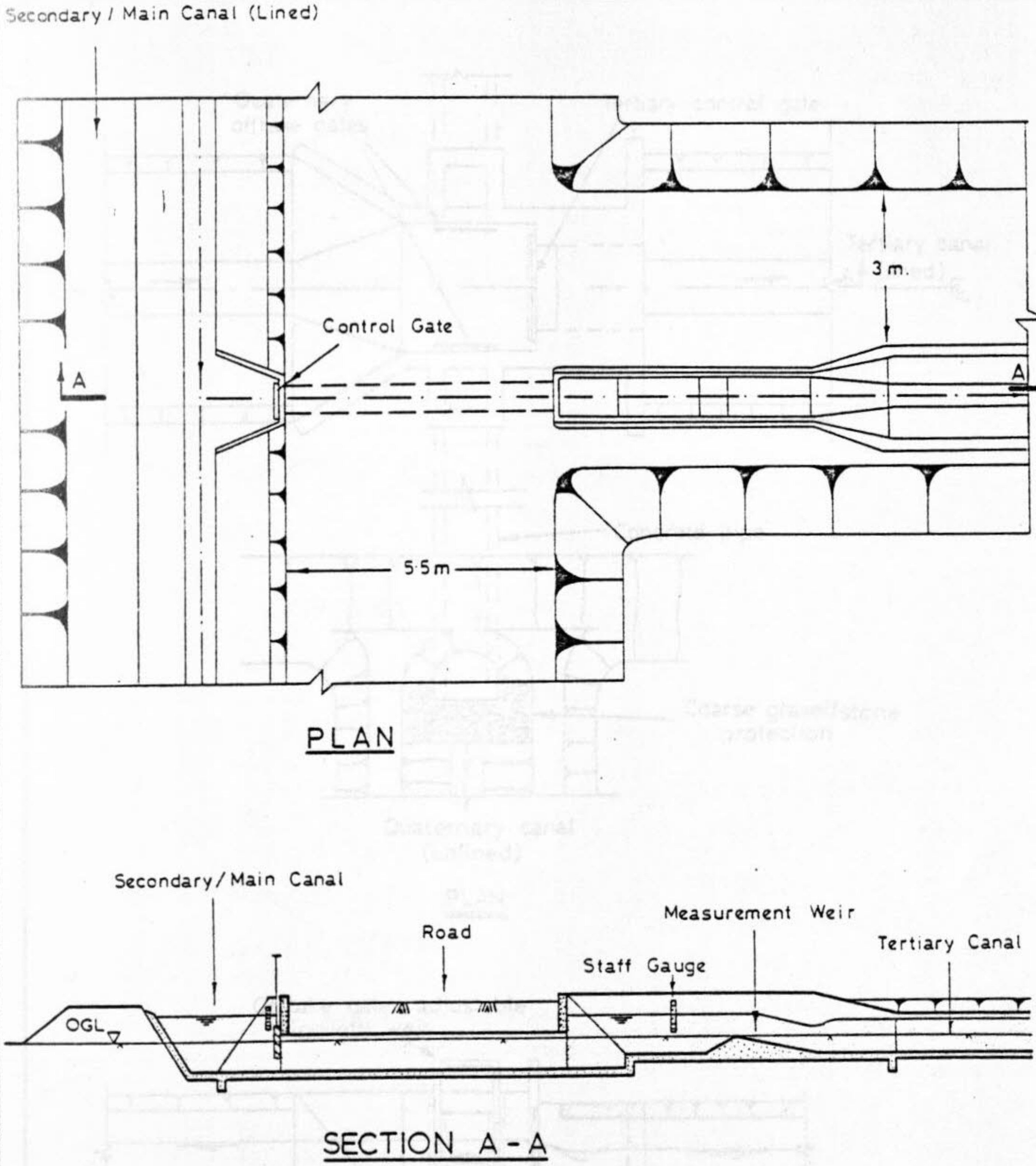
Section	'B' x 'D' (m)	Gradient .001	.0005	.0003	.0002	.0001
		Capacity (L/s)				
'18" block'	.46 x .46	65	45	35	30	20
'24" block'	.61 x .61	125	90	70	60	40
T I	.30 x .75	510	360	280	230	160
T II	.45 x .86	885	625	485	400	280
T III	.76 x1.19				1200	890
T IV	.76 x1.30				1490	1050



Block Section (B)

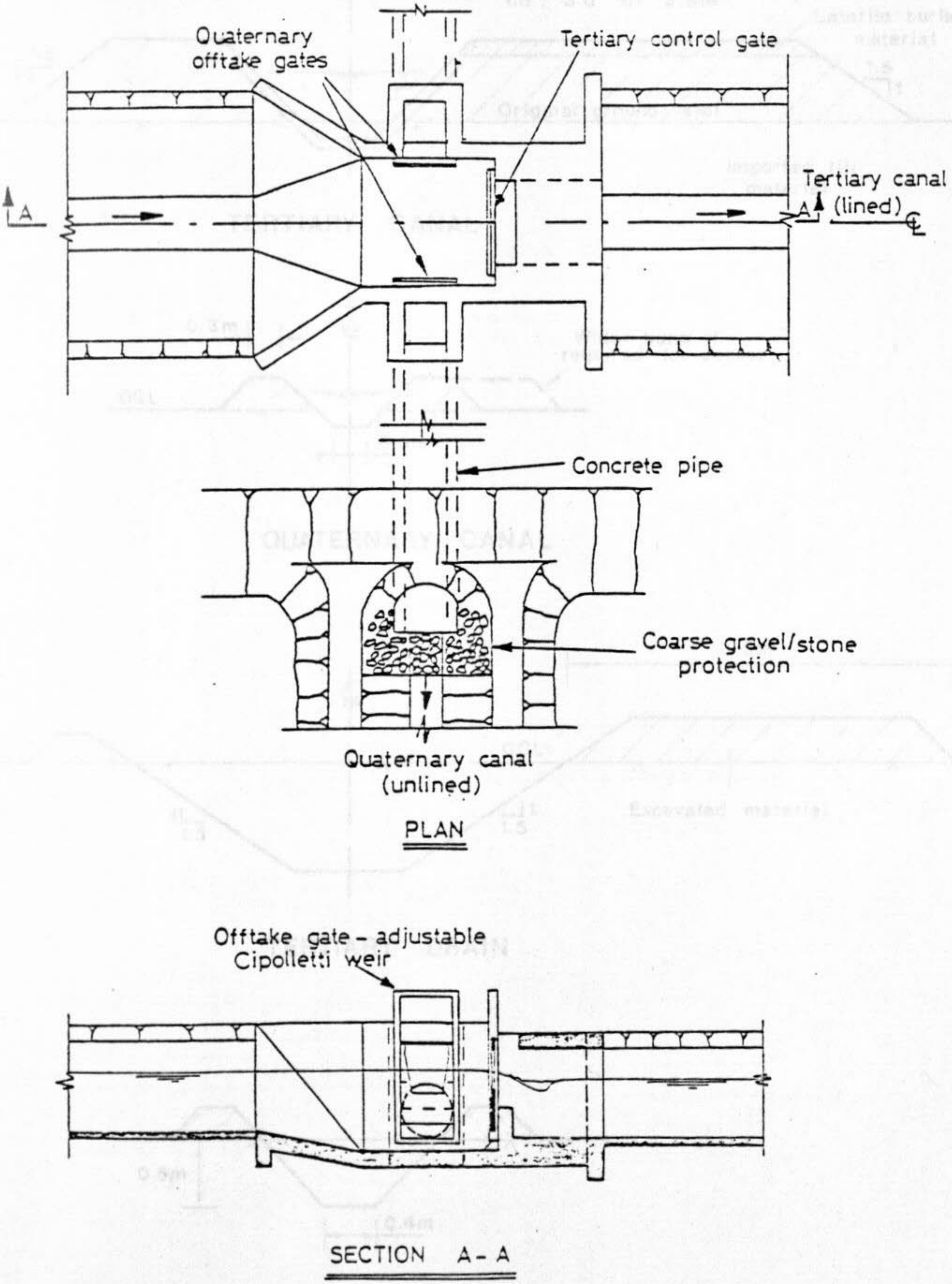


Trapezoidal Section (T)



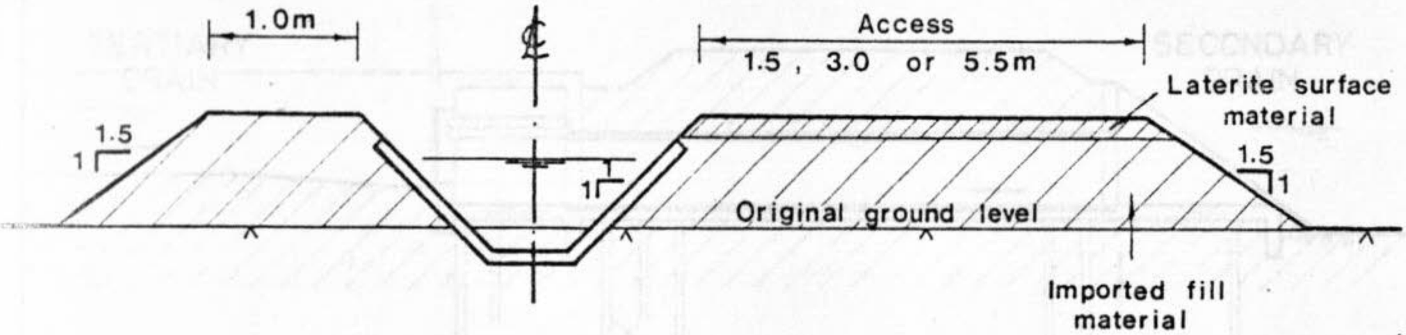
TERTIARY OFF-TAKE STRUCTURE

Figure F4.1

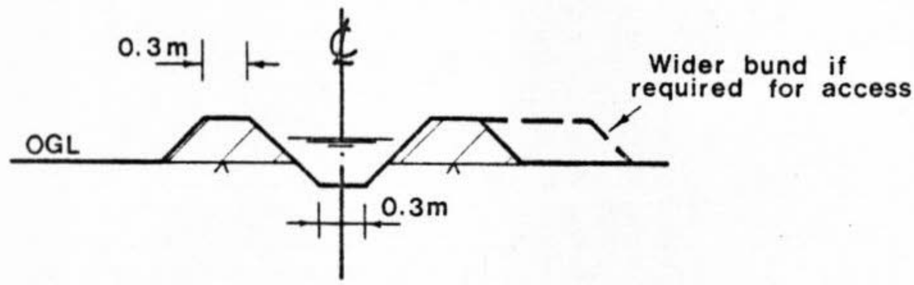


TERTIARY DISTRIBUTION BOX

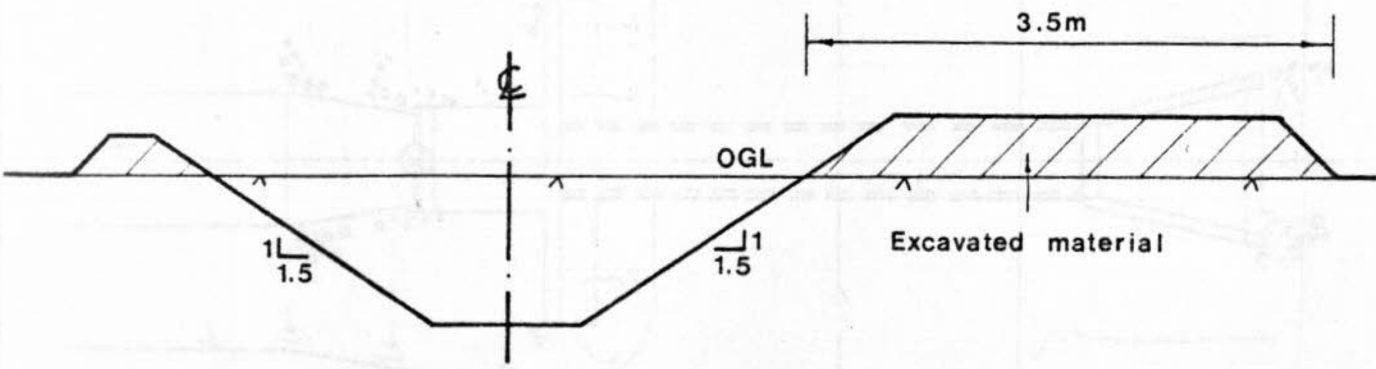
Figure F4.2



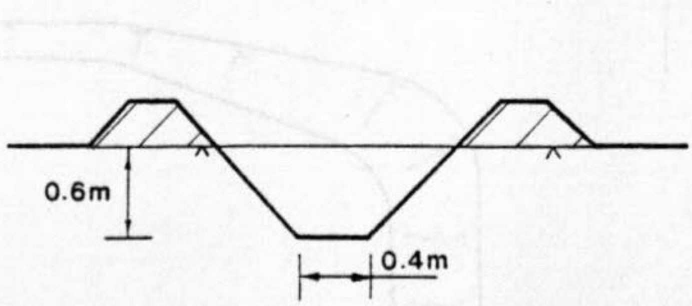
TERTIARY CANAL



QUATERNARY CANAL



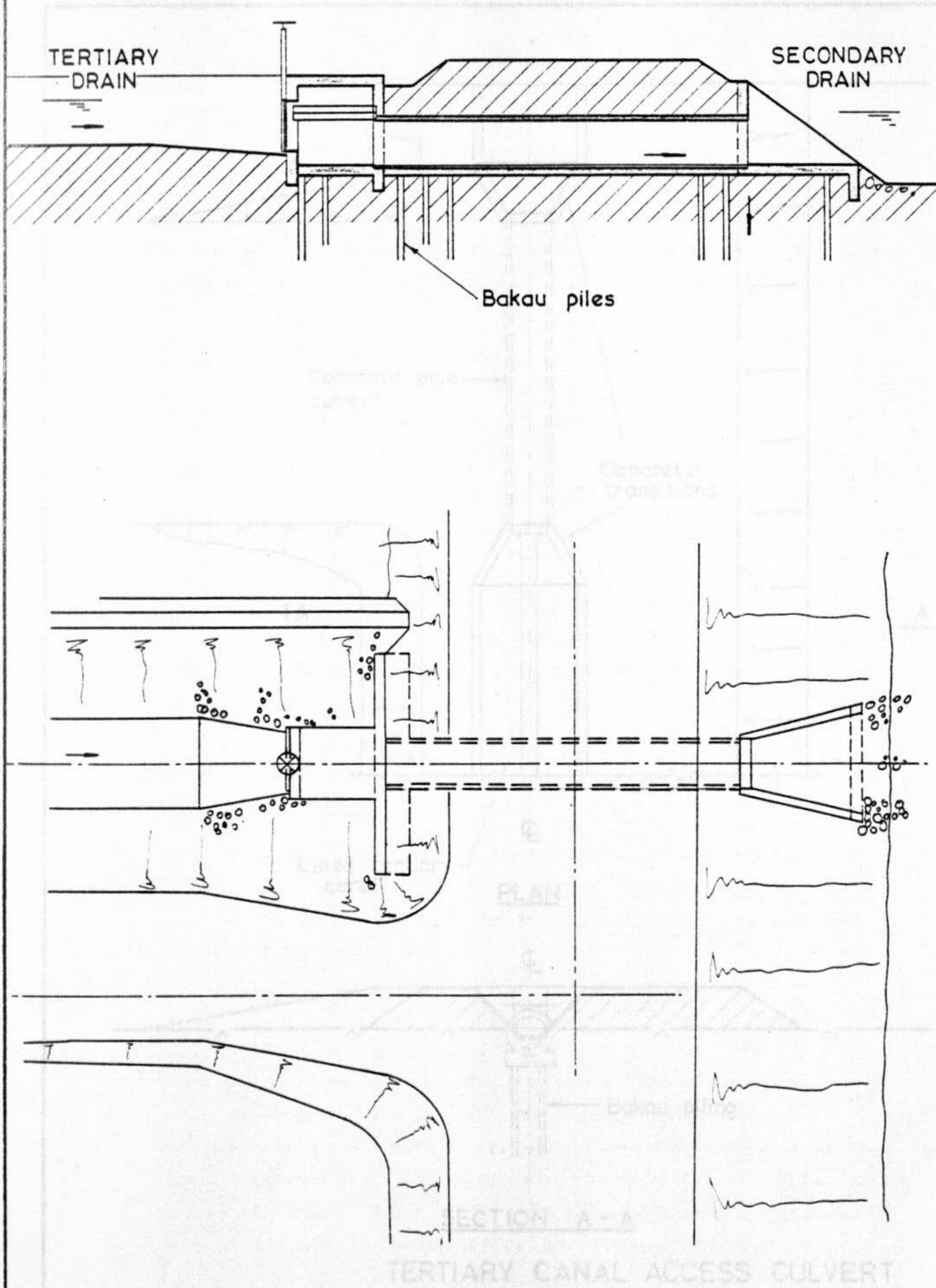
TERTIARY DRAIN



QUATERNARY DRAIN

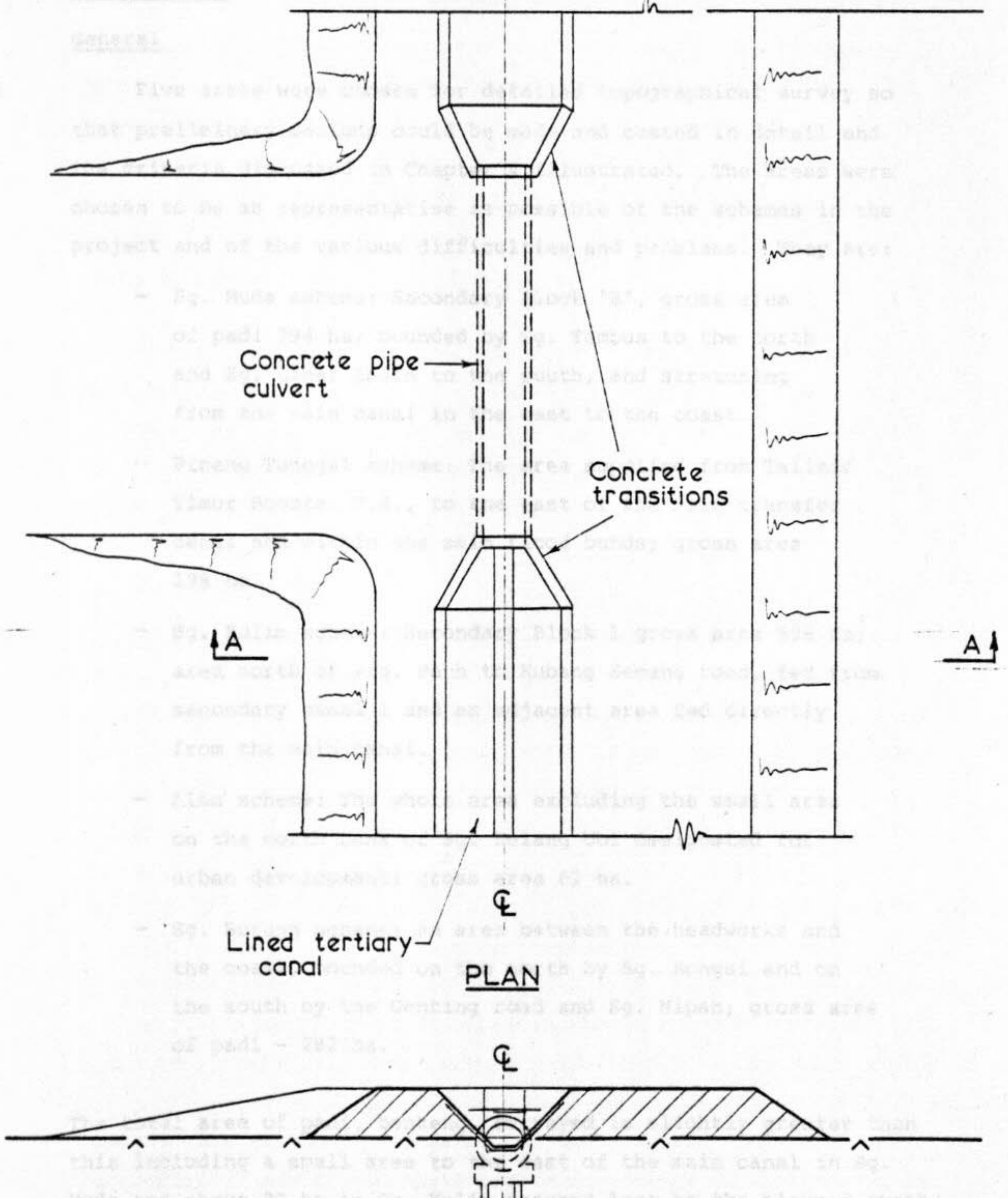
CANAL AND DRAIN DETAILS

Figure F4.3



DRAINAGE CONTROL STRUCTURE

Figure F4.4



TERTIARY CANAL ACCESS CULVERT

Figure F4.5

F5 SAMPLE AREAS

F5.1 General

F5.1.1 Five areas were chosen for detailed topographical survey so that preliminary designs could be made and costed in detail and the criteria discussed in Chapter 4 illustrated. The areas were chosen to be as representative as possible of the schemes in the project and of the various difficulties and problems. They are:

- Sg. Muda scheme: Secondary Block 'B', gross area of padi 794 ha; bounded by Sg. Tembus to the north and Sg. Lahar Endin to the south, and stretching from the main canal in the east to the coast.
- Pinang Tunggal scheme: The area supplied from Taliair Timur Booster P.S., to the east of the main transfer canal and within the main flood bunds; gross area 198 ha.
- Sg. Kulim scheme: Secondary Block 1 gross area 598 ha; area north of Ptg. Pauh to Kubang Semang road, fed from secondary canal 1 and an adjacent area fed directly from the main canal.
- Alma scheme: The whole area excluding the small area on the north bank of Sg. Kelang Ubi designated for urban development; gross area 82 ha.
- Sg. Burung scheme: An area between the headworks and the coast, bounded on the north by Sg. Kongsi and on the south by the Genting road and Sg. Nipah; gross area of padi - 282 ha.

The total area of padi, benteng, surveyed is slightly greater than this including a small area to the east of the main canal in Sg. Muda and about 20 ha in Sg. Kulim assumed lost to the planned north/south expressway. The area for which sample designs have been produced using the survey is 1954 ha representing about 14% of the total irrigated area, but in addition the remainder of the Sg. Burong scheme, excepting Pokok Kenanga has had preliminary designs carried out as discussed in Section F5.6 - an additional 211 ha.

F5.1.2 Detailed layouts for the sample areas have been prepared at a scale of 1 : 6,336 (8 chains to 1 inch). They are included in Annexe J. Being based on the topographic surveys it is not expected that significant changes will be required when the detailed designs are prepared. However part of the detailed design stage must be to check the alignments in the field and discuss the proposals with the local farmers. Some changes of detail at the quaternary level are thus probable.

F5.1.3 Hydraulic designs are indicated in Figures F5.1 to F5.7. Tertiary canals have been sized using the standard JPT sections. As discussed in F4.3.11 some savings may be possible with the use of at least one non-standard section and this should be considered further at the detailed design stage.

F5.2 <u>Sg. Muda Sample Area</u>

F5.2.1 The area consists of a long narrow block as described in Section F5.1.1, presently supplied in 3 ways. The upper part of the area is supplied from the main canal via secondary canal B. The lower part is supplied from secondary canal C to the south via a syphon back under Sg. Lahar Endin. The State JPT are presently carrying out works to interconnect these two canals and enable some supply to the lower area from canal B. In addition a small area, Kg. Guar Tok Syed, is supplied by a small pumping station abstracting from Sg. Tembus. We propose a rationalisation of the supply with an upgraded canal B supplying the whole area, removing the necessity for supply from C, and with adequate command to feed Guar Tok Syed by gravity. Canal B will follow its existing route initially but will be re-routed southwards over a length of about 1 km to rejoin the existing alignment alongside Sg. Lahar Endin. This southern edge is generally higher than the northern edge along Sg. Tembus and the secondary canal will parallel Sg. Lahar Endin thereafter.

F5.2.2 The upper part of the area generally slopes at about 1 : 2000 westward allowing reasonable slopes to the secondary and tertiary canals. The lower area nearer the coast however is much flatter and canal gradients as flat as 1 : 10,000 are required. In addition the <u>benteng</u> areas near the coast are broken up by <u>kampongs</u> and long tertiary canals are required. Command of these coastal areas dictates water levels and slopes in the secondary canal. Figure F5.1 gives canal sizes and full supply water levels throughout the secondary and tertiary system, and Figure F5.2 gives a longitudinal section down the secondary canal B. It appears that to get the required command levels within the block an increase in the full supply water level in the main canal is needed. This increase, however, is less than that required to obtain adequate command of other areas to the south as discussed in Section F3.2.3.

F5.2.3 Although the area slopes generally east to west, it is intersected by a number of depressions, probably old courses of Sg. Tembus or ever Sg. Muda, which break up the even surface. In some cases these have been excavated to form drainage channels. The main drainage is thus fairly good but tertiary drains are lacking and the irregular surface topography makes supply difficult and tertiary canals are relatively long and indirect. This is reflected in the high tertiary unit cost of $6,277/ha for the measured items (Table F6.9). Similarly tertiary unit boundaries are irregular (due in part to the very haphazard arrangement of farms) and sizes vary from about 46 ha to about 84 ha with an average of 61 ha.

F5.3 Pinang Tunggal Sample Area

F5.3.1 The area is presently one of mixed cropping with about half the area under rice and the other half cropped with vegetables throughout the year. Some interchange between the two crops does occur depending on the rains and availability of water. At present supply is pumped from the main Pinang Tunggal/Kereh transfer canal by the booster pumping station, Taliair Timur; however difficulties of command and inadequacies of supply (the station also supplies much of the area on the right bank of the main canal), have led many farmers to provide their own small pumps abstracting either from the canal or from Sg. Korok which runs through the centre of the area. This river is probably an old overflow channel from Sg. Muda and the topography, partly due to this channel cutting through, is very irregular.

F5.3.2 The existing canal divides into two with the northern canal feeding the lower, mainly rice, areas both inside and outside the main flood bund. The southern canal loops back crossing Sg. Korok twice via inverted syphons. The present alignments of both these canals appear generally reasonable. Thus the basic layout of the system will remain unaltered, however this dictates the number and size of the tertiary units which can only be two large units, although some small areas will be fed directly from the secondary canal downstream of the pumping station.

F5.3.3 Command of the south-eastern areas is difficult and the canal back as far as the pumping station needs to be raised considerably. This involves a significant additional cost of imported fill (Table F6.12) and the canal banks in one place are as much as 2 m above the surrounding ground level. Even so a small area on the east bank of Sg. Korok is still out of command and we have introduced a small booster pumping station to serve the area. Details are given in Table F6.8.

F5.3.4 The main booster pumping station, Taliair Timur, appears to be undersized. The existing capacity is only 0.56 m^3/s (20 ft^3/s) whereas the requirement for the sample area and area served outside the main bund is approximately 0.7 m^3/s. At present the station also serves part of the area on the west side of the transfer canal between it and the railway. The provision of a regulating structure in the transfer canal downstream of the pumping station may enable this area to be gravity fed; otherwise the pump replacement details listed in Table F6.7 will need amending.

F5.3.5 The layout of quaternary infrastructure has been made on the basis of the existing cropping i.e. areas presently cropped with vegetables have been designed in accordance with the criteria laid out in Section F4.6; the other areas have been designed for rice cropping. Some modifications to this may be indicated at the detailed design stage. However canals have been sized on the assumption that any area may be cropped with rice. The resulting cost of the quaternary infrastructure is relatively expensive at $1,423/ha (Table F6.12) but this has also been affected by the awkward topography.

F5.4 Sg. Kulim Sample Area

F5.4.1 The Sg. Kulim sample area is presently supplied from the main canal via secondary canal 1. The area is very flat and command of the more distant areas is difficult. The secondary canal has relatively recently been concrete lined to reduce friction losses without increasing the size and therefore the width of the canal. One small area, to the east of Ptg. Pasir road is supplied via a booster pumping station.

F5.4.2 We have prepared designs for two alternative layouts for the area.

- Alternative A maintains the existing supply system but with the secondary canal enlarged and the full supply level raised slightly. It appears to be possible to achieve this without a corresponding rise in the main canal operating levels but this will need a detailed check with particular attention to the losses through the existing syphons and culverts along this canal. With all the tertiaries lined and designed for very flat gradients it appears possible to provide adequate command of most areas. Some local levelling of high spots might be required but again a detailed check would be made before this were implemented. The area in Ptg. Pasir to which supplies are presently pumped would remain as a pumped area but the pumping station would be re-located to serve a larger area. This alternative has been detailed on the large scale plans submitted separately and is shown in Figure F5.4. Costs are given in Table F6.18.

- Alternative B allows similar gravity supply to most areas as in Alternative A but also enables supply to the whole secondary block from a new pumping station, Ptg. Pasir, abstracting from Sg. Perai. This layout is indicated in Figure F5.5 and costs are detailed in Table F6.19.

F5.4.3 Alternative B is about 50% more expensive than Alternative A - about \$1.7 x 10^6 in the cost of measured items. None-the-less we recommend this alternative as there are a number of advantages:

- It enables use to be made of the stored volume behind the new Perai barrage. As discussed in Appendix A this is a significant amount of water and its availability will reduce the risk of shortages.

- It enables greater flexibility in the operation of the Sg. Kulim scheme. Discussions with officers of the State JPT indicate that this is of considerable benefit.
- It enables reduction of the use of the transfer system and hence the cost of pumping - the estimated head required at Ptg. Pasir is estimated at 7 m compared to a total lift in excess of 11 m through the 3 pumping stations of the transfer system.
- By reducing the peak requirement from the transfer system, the capacity and number of pumps, that will need replacing at the end of their useful life, is reduced at each of the 3 transfer pumping stations. This saving is estimated at nearly $\$1.0 \times 10^6$ though its effect is delayed until some years after the construction of Ptg. Pasir.

F5.4.4 The new pumping station is sized to supply the whole of the secondary block (excluding the tertiary unit supplied direct from the main canal) at the peak rate of 2.5 L/s/ha. The total capacity of 1.3 m^3/s also corresponds to the use of the $3 \times 10^6 m^3$ storage in one month - the critical period over which shortages might occur. Details of the pumping plant are listed in Table F6.8. When there is adequate flow in Sg. Kulim, supply would be by gravity as at present with only the single tertiary unit in Ptg. Pasir receiving water pumped from Sg. Perai.

F5.4.5 The layout of farms in the Sg. Kulim scheme is more regular than in most other areas although by no means ideal. This is reflected in the lower density of tertiary canals and a corresponding lower unit cost of tertiary development - \$4,307/ha (measured items only) for Alternative B. On the other hand a higher density of quaternary canals is required and a higher cost of quaternary development - \$941/ha. The remainder of the Sg. Kulim scheme has similar farm layouts and it has therefore been considered reasonable to extrapolate this quaternary cost throughout. Tertiary costs in other areas have been assessed as discussed in Section F6.7.

F5.5 Alma Scheme

F5.5.1 Although doubts exist about the future of Alma because of the availability and quality of the water supply, it was chosen as a sample area at an early stage of the project, in order that survey might proceed, before the situation was fully appreciated. The future of the scheme is likely to depend on the finding and development of alternative groundwater sources, the exploratory drilling for which is beyond the scope of this report. If groundwater sources are developed then the distribution system will need to be modified to accommodate one or more borehole sources, not necessarily at the head of the present system. For this report we have designed and costed a system based on the existing intakes from Sg. Kelang Ubi as shown in Figure F5.6.

F5.5.2 The total area is only the size of one tertiary unit and the areas served by each canal are small thus block section canals can be used for the tertiaries throughout. The unit cost of the tertiary development is thus low - \$4,024 (see Table F6.22) even though three intakes are involved. It was originally intended to use this cost as the development cost in all the small schemes, however the preparation of detailed layouts for all these schemes enabled individual costs to be more accurately determined, and moreover showed Alma not to be particularly representative.

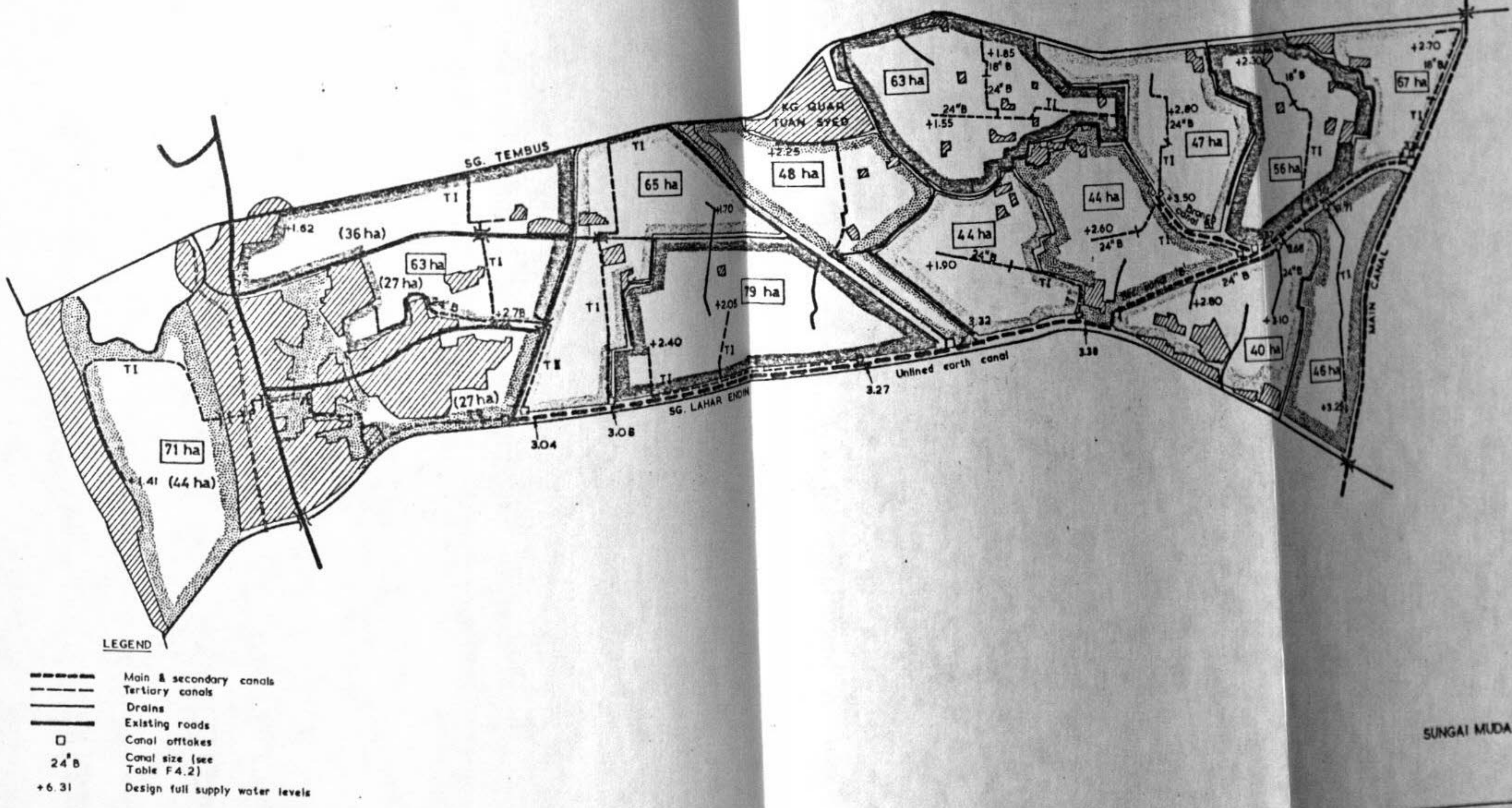
F5.6 Sg. Burung Scheme Sample Area

F5.6.1 As noted in Section F5.1.1 the survey covered an area of about 282 ha - i.e. about 60% of the scheme area (excluding Pokok Kenanga). However the results of the survey indicated such a regular topography that it was considered reasonable to extrapolate the contours through the remainder of the area and to design the entire system.

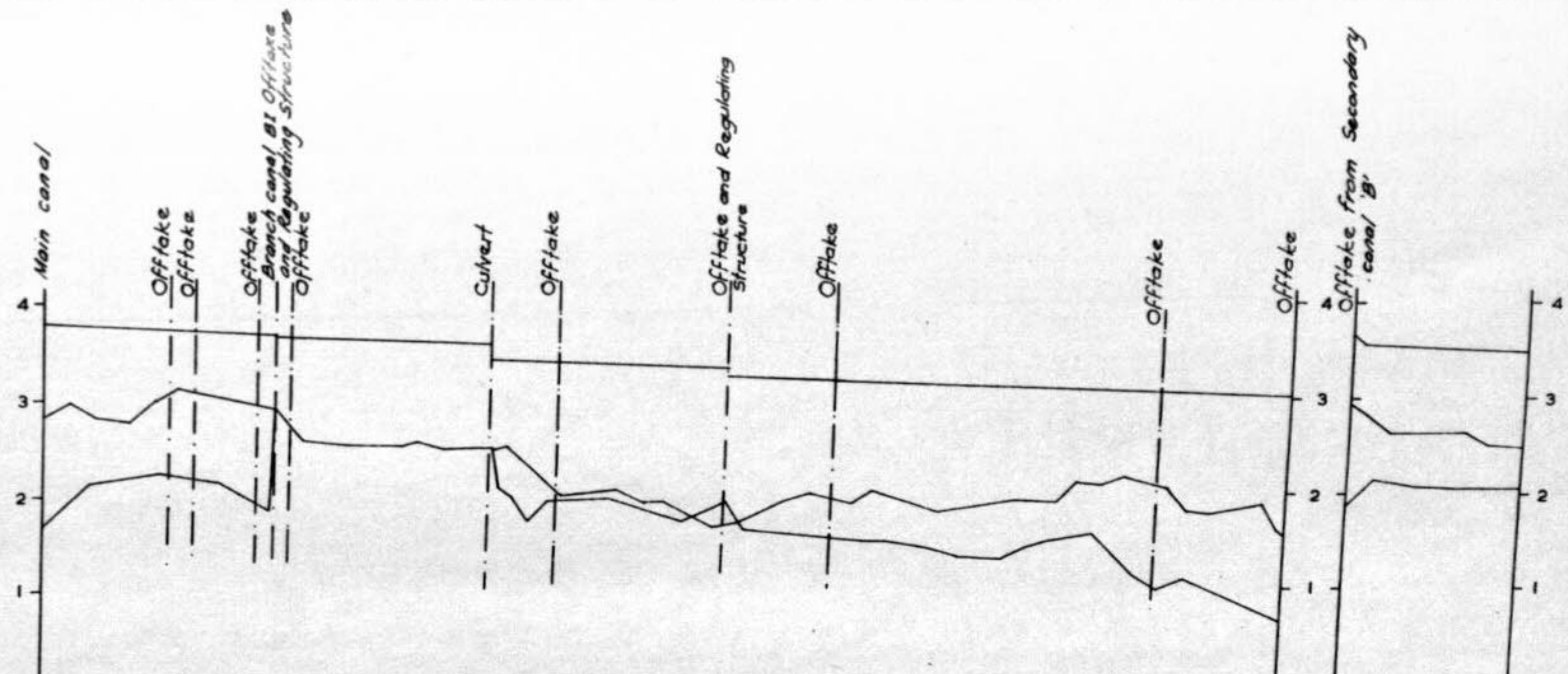
F5.6.2 The topography consists of a gentle east/west slope to the land east of the north/south road through the centre of the scheme, and a horizontal surface to the land west of this road - levels there being within ± 20 cm over distances in excess of 1 km. The main problem in the scheme is thus one of command of the most western areas. Canals have had to be designed for very flat gradients - 0.0002 to 0.0001 and are thus large with very slow flow velocities. Even with such flat slopes it appears that there could be insufficient elevation at the headworks. The most critical location is likely to prove the most south-eastern corner of the scheme and a final determination of the required river level upstream of the headworks will have to await the detailed survey of this area. It could necessitate modifications to the headworks' gates to increase this level, however the preliminary estimates are that this is not required and no allowance has been made in the costs.

F5.6.3 The scheme contains areas of both double-rice cropping and rice with vegetable/maize off-season. Thus quaternary infrastructure has been planned in accordance with criteria for both cropping patterns. For the double-rice' areas the quaternary infrastructure cost is estimated at \$814/ha and for the rice-vegetables/maize areas at \$1,168/ha. These are detailed in Table F6.29. Tertiary development costs (measured items only) are estimated at \$6,065 which is relatively high but is a consequence of the flat gradients and large canal sizes.

F5.6.4 Tertiary units are largely determined by the existing blocks of cultivation. This leads to large units - two of which are in excess of 100 ha with the inclusion of the coastal areas of Kg. Enam. It would be possible to break these large units up but at the expanse of considerable additional lengths of tertiary canals. In view of the present high estimates of development costs we do not consider this can be justified. Moreover these large units are proposed for operation as group farms where the unit size is of less importance than in smallholdings where farmers are each receiving a share of the flow.



SUNGAI MUDA SAMPLE AREA
CANAL DESIGN
Figure F5.1



DATUM O METRES

Secondary canal 'B'

CHAINAGE (METRES)	0	200	400	600	800	1000	1200	1400	1600	1800	2000	2200	2400
EXISTING GROUND LEVEL (m)	2.86	2.83	2.88	3.06	2.97	2.70	2.60	2.55	2.50	2.52	2.19	2.04	1.96
EXISTING INVERT LEVEL (m)	1.69	2.19	2.24	2.20	2.04	2.70	2.60	2.55	2.50	2.30	1.90	1.97	1.85
FULL SUPPLY WATER LEVEL (METRES)	3.76	3.74	3.72	3.70	3.68	3.64	3.62	3.60	3.58	3.41	3.39	3.37	3.35
NEW CANAL SLOPE	0.0001												

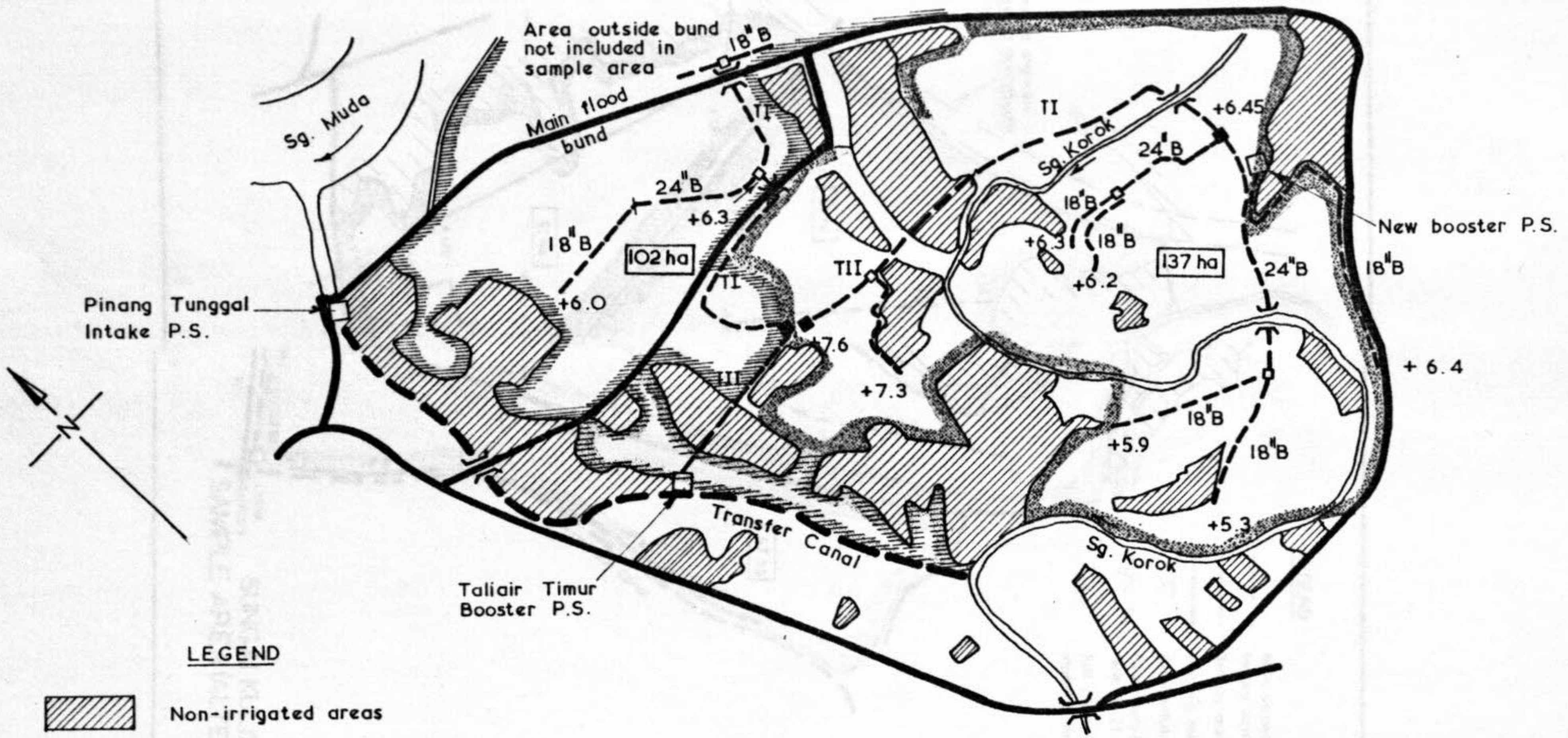
CHAINAGE (METRES)	2600	2800	3000	3200	3400	3600	3800	4000	4200	4400	4600	4800	4980
EXISTING GROUND LEVEL (m)	1.80	1.73	1.98	1.98	2.00	1.94	1.93	1.96	2.14	2.17	1.85	1.86	1.60
EXISTING INVERT LEVEL (m)	1.78	1.64	1.60	1.55	1.50	1.40	1.34	1.49	1.60	1.10	1.08	0.85	0.65
FULL SUPPLY WATER LEVEL (METRES)	3.33	3.26	3.24	3.22	3.20	3.18	3.16	3.14	3.12	3.10	3.08	3.06	3.04
NEW CANAL SLOPE	0.0001												

Branch canal 'B1'

CHAINAGE (METRES)	0	200	400	600	690
EXISTING GROUND LEVEL (m)	2.92	2.66	2.65	2.52	2.50
EXISTING INVERT LEVEL (m)	1.88	2.12	2.08	2.07	2.07
FULL SUPPLY WATER LEVEL (METRES)	3.67	3.55	3.53	3.51	3.50
NEW CANAL SLOPE	0.0001				

SUNGAI MUDA SAMPLE AREA
SECONDARY CANAL 'B'
LONGITUDINAL SECTION

Figure F5.2



LEGEND

Non-irrigated areas

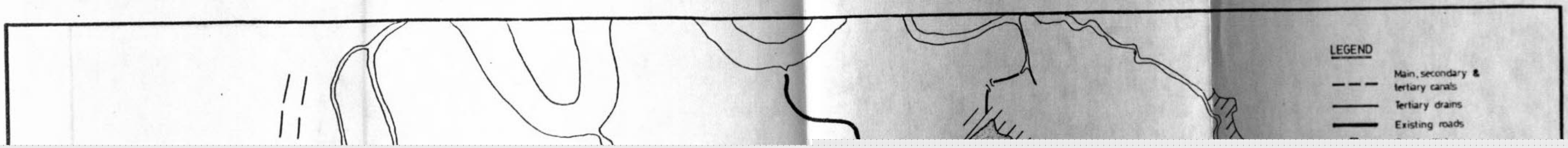
Roads

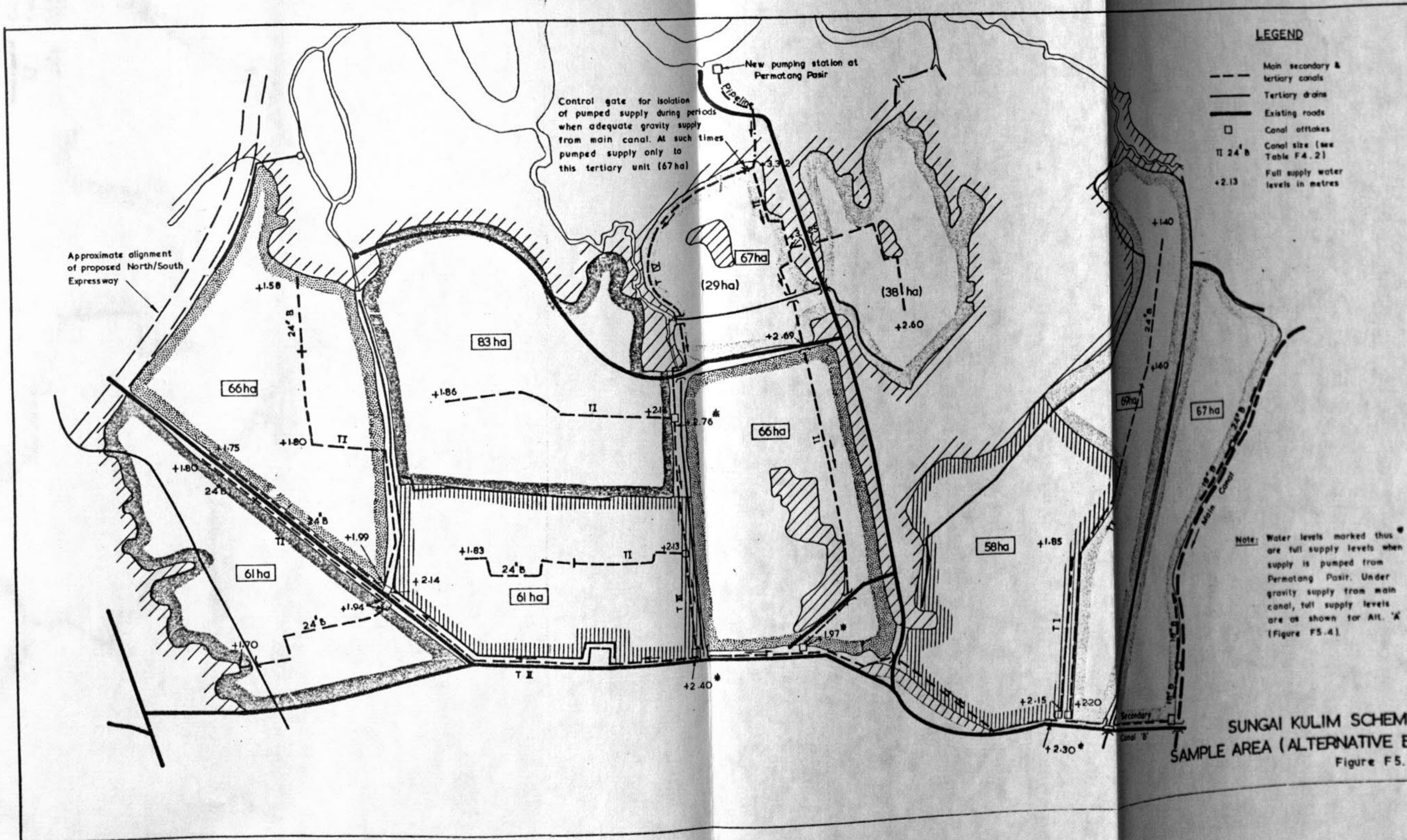
Canals

+6.31 Design full supply water levels

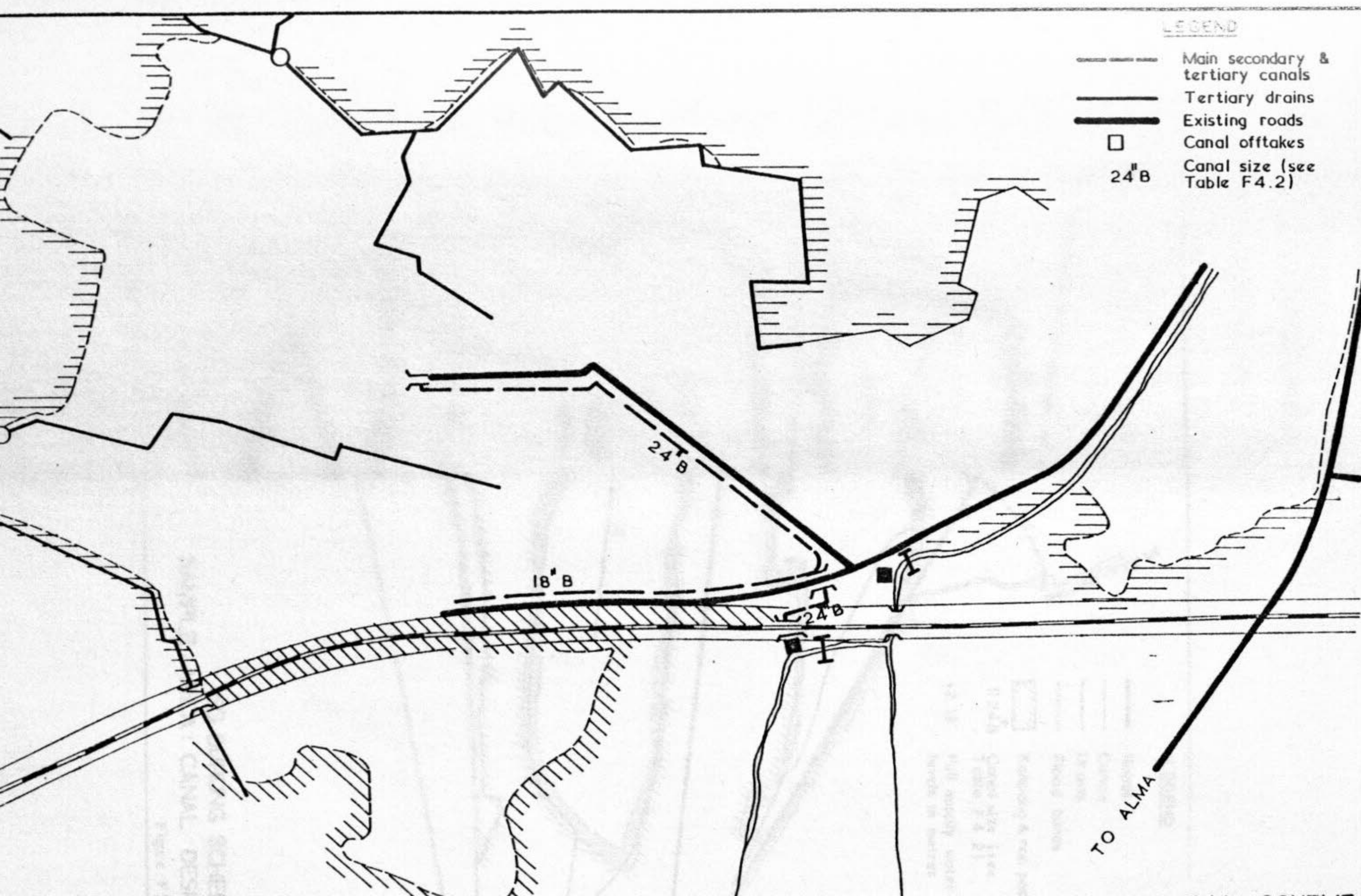
TI/18"B Canal sizes. See Table F 4.2

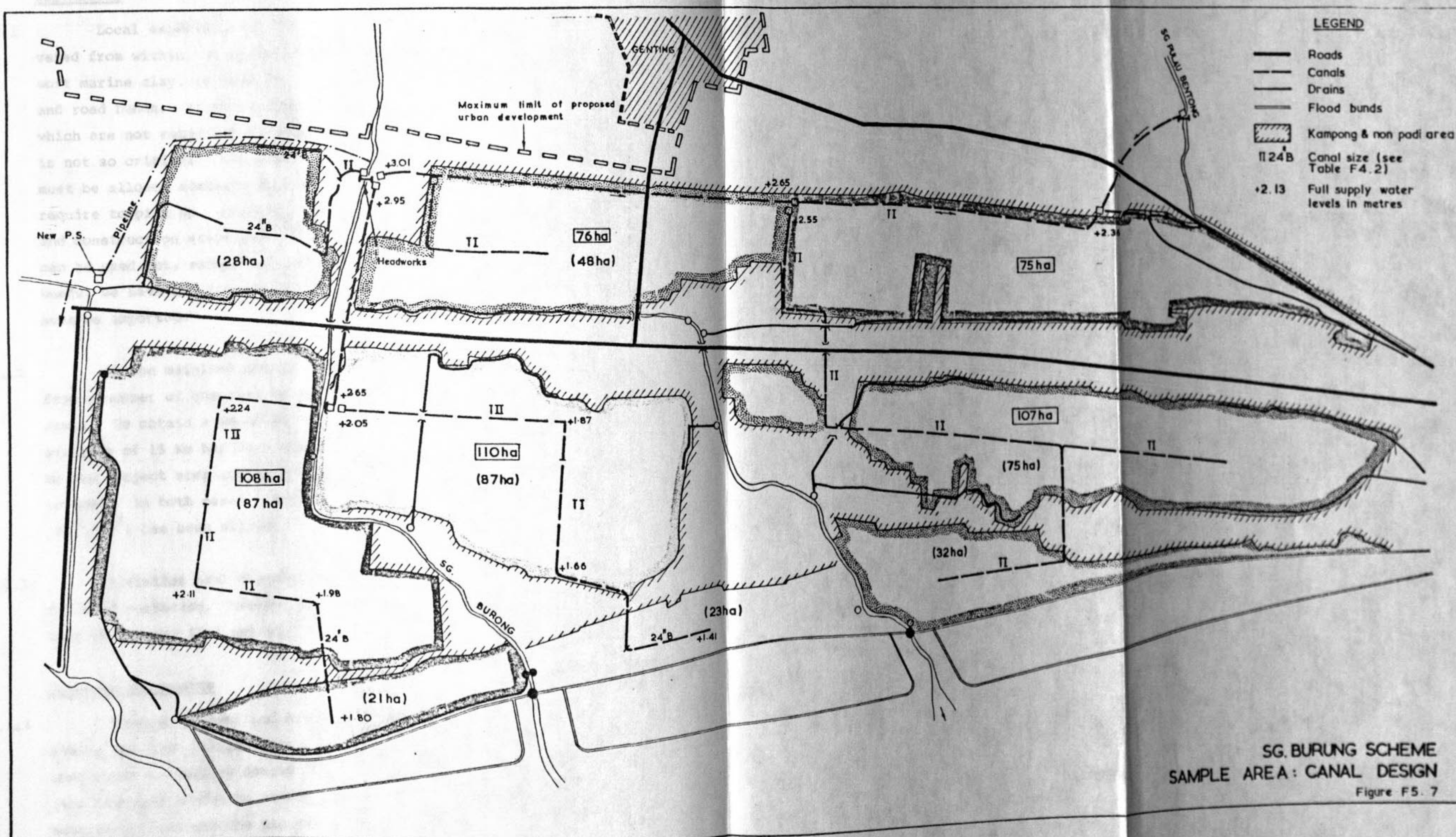
PINANG TUNGGAL SAMPLE AREA
CANAL DESIGN
Figure F5.3


LEGEND
Main, secondary & tertiary canals
Tertiary drains
Existing roads



SUNGAI KULIM SCHEME
SAMPLE AREA (ALTERNATIVE B)
Figure F5.5


LEGEND
Main secondary & tertiary canals
Tertiary drains
Existing roads
Canal offtakes
24"B
Canal size (see Table F4.2)
24"B
18"B
24"B
TO ALMA



SG. BURUNG SCHEME
SAMPLE AREA: CANAL DESIGN
Figure F5.7

F6 ENGINEERING MATERIALS AND COSTS

F6.1 Construction Materials

Earthworks

F6.1.1 Local experience of the JPT has indicated that material excavated from within the irrigation and drainage areas, being largely soft marine clay, is generally unsuitable for construction of canal and road bunds. It may however be used for flood bunds and the like, which are not subjected to heavy vehicle loads and where settlement is not so critical. Where used in this way the excavated material must be allowed adequate time for consolidation and is likely to require topping up. Detailed consideration and testing at the design and construction stage may indicate in some areas that local material can be used but, except for the construction of flood protection bunds, we have assumed for the costing of the works that fill material must be imported.

F6.1.2 On the mainland sources of suitable fill material are available from a number of quarries in the hills along the eastern side of the State. To obtain a generally applicable rate, an average haul distance of 15 km has been assumed. In Balik Pulau sources are close to the project area and an average haul distance of 10 km has been assumed. In both cases a source cost for the material of $\$2.0/m^3$ ($\$1.5/yd^3$) has been allowed.

F6.1.3 A similar haul distance has been assumed for laterite material for road surfacing. However an increase in the source cost, over that of general fill material, of $\$2.0/m^3$ ($\$1.5/yd^3$) is assumed.

Concrete Aggregates

F6.1.4 Sources of sand and coarse aggregates, in the form of crushed stone, are both available in the State. However both are likely to come under increasing demand for other major construction projects (the proposed bridge to Penang Island, the main North-South and East-West road links and the planned urban and industrial expansions including the Perai/Butterworth port facilities). Moreover there is a limit to the present practice of winning sand from the river beds; already some local effects on the river regimes are apparent. We have therefore been fairly conservative in our estimates of aggrega costs. On site costs of $33/m^3$ (\$25/yd^3) and \$45/m^3 (\$35/yd^3) have been taken for fine and coarse aggregates respectively on the mainland. In Balik Pulau a source of sand is available close to the project area and we have therefore adopted an on-site cost of \$30/m^3 (\$23/yd^3) for fine aggregate.

Cement

F6.1.5 Cement is manufactured in Malaysia and although occasional short-term shortages are reported, the indications are that production capacity will generally be sufficient to meet internal requirements for the foreseeable future. The price is controlled. An on-site cost, including transport of \$250/tonne has been adopted for Seberang Perai and an additional \$10 allowed for transport to Balik Pulau.

Timber

F6.1.6 Timber is available from local yards and sawmills. Costs depend on the size of material required. An average cost for sawn timber of the range of sizes needed for shuttering is about \$600/m^3. For the sizes required for structural purposes - i.e. footbridges etc. - the cost is about \$800/m^3.

Steelwork

F6.1.7 Mild steel reinforcement is manufactured in Malaysia. Ex-factory costs in March 1981 were quoted at about \$900/tonne for small diameters and \$830/tonne for larger diameters. High yield steel is only required in the form of mesh reinforcement for canal linings.

F6.1.8 The main requirement for fabricated steelwork on the project is for gates for canal and drainage control. The costs of these have been assessed individually depending on the size and type required.

Pipework

F6.1.9 Apart from short lengths of pressure pipes, for which costs have been assessed individually assuming the use of asbestos-cement pipes, the main requirement is for concrete culvert pipes.

the end of their useful life, having been installed for at least fifteen years. We have costed the replacement of these plants by electical-powered units during the construction period for each area served. The existing electrical pumping plants are generally well maintained and there is little evidence that major overhauls or replacements are required in the immediate future. For the purpose of costing however we have assumed that all such units, except for the recently installed third units at Pinang Tunggal, Kereh headworks and Padang Chempedak pumping stations, will be replaced at the end of the construction period in 1989/90/91. It is possible that a further complete replacement of the pumping plants will be necessary during the life of the project. However in view of the present standards of maintenance, we have not included for a second replacement which in any case would have a small present-value cost and a negligible effect on the project economics.

F6.1.14 Costs of pumping plant vary considerably depending not only on the power requirements but also on the type and arrangement of the pumps. Figure F6.1 indicates average costs of electric pumping plants based on actual costs of other pumping stations we have been involved with in Malaysia in recent years. Generally an additional 50% has been allowed for the electrical supply including transformers, switchgear and controls, although in some cases where the existing diesel stations or proposed new stations are distant from a power line, this percentage has been increased. Station pipework and fittings, and the building works have been assessed for each new installation. Details of the existing stations and the replacement requirements and costs are given in Table F6.7 and for new stations in Table F6.8.

F6.1.15 Costs of renewing existing pumping plants are only attributable to the project where the 'without project' situation would not require such replacement, i.e., in areas that are expected to be abandoned if the project were not carried out. The analyses are those proportions of the total costs considered attributable to the project.

F6.2 Transport Costs

F6.2.1 Most of the transport requirement is the movement of bulk loads such as fill materials and aggregates. It is assumed that these would be carried out by the contractor and a rate of \$0.4 per tonne per km of haulage distance has been calculated based on vehicle hire charges and estimated work loads.

F6.2.2 For the delivery of other materials and plant to site a rate of \$1.0 per tonne per km has been taken, to take into account the less compact loadings.

F6.3 Unit Rates

F6.3.1 Unit rates, to be used in the costing of the proposed works, are listed in Table F6.2 for the major items of construction. These rates have been assessed as representative of rates for similar types of work in north-west Malaysia as of mid-1981. They have been arrived at after discussions with JPT, both locally and centrally, and after comparison with rates in other reports, in recent contracts and those suggested in discussions with local contractors. In addition they have been checked against rates built up from basic costs - i.e. materials, transport, labour and plant with allowances included for the contractors' overheads and profits.

F6.3.2 In arriving at these units rates it has been assumed that all the works proposed would be carried out under fairly large contracts by national, Class A contractors - not on a piecemeal basis by small local firms.

F6.3.3 It is possible that some variation to the rates should be allowed from scheme to scheme, particularly with regard to imported fill with haulage being a major component of the cost. However it is not possible to identify with certainty the source of material a particular contractor might choose to use on a particular contract, and moreover it is not necessarily the case that haulage distance would be directly reflected in a tendered rate. We have therefore adopted an average set of rates which will be applied to the costing of all schemes.

F6.3.4 Where considered applicable allowance has been made for difficult site access and increased transport costs for imported fill - for example in construction of quaternary canals where access would have to be through the fields and possibly limited to periods between crops. Similarly, allowance is made in such cases for manual excavation and construction of bunds.

F6.4 <u>Canal and Drain Unit Costs</u>

F6.4.1 Generally works proposed on main and secondary canals are improvement works - widening where necessary, heightening of bunds, provision of access roads, etc. The extent and cost of such works depend on the size and present condition of the canal and they are assessed individually for each scheme.

F6.4.2 Tertiary canals will be concrete-lined. For costing the works, standard JPT sections are used though, as discussed in Section F4, some savings could possibly be made with an additional non-standard section. Based on the sample area designs, the most common section required is the smallest trapezoidal section (TI). In some units where head is very limited, larger sections at flat gradient are required. At the lower ends of tertiary canals it is frequently possible to reduce the section to the largest precast 'block-section' (24") and, in areas with adequate ground slope, it may be possible to use a greater percentage of 'block-sections' and with smaller section sizes. The breakdown of unit costs of new tertiary canals in Seberang Perai is given in Table F6.3 for various sections, with a standard 3 m wide access berm. Adopted unit costs for all sections and access widths in both Seberang Perai and Balik Pulau are given in Table F6.4 - the latter having been adjusted primarily for the difference in imported fill costs.

F6.4.3 Where tertiary canals are to be re-constructed on an existing alignment deductions of \$25/m for the larger, trapezoidal canals, \$15/m for the smaller block sections have been made to allow for the reduction of fill required due to the existing canal bunds.

F6.4.4 Where command considerations require canal heights above existing ground levels to be more than the minimum assumed in Tables F6.3 and F6.4, an allowance for additional fill requirements is made.

F6.4.5 Quaternary canals are unlined and for costing purposes, a standard size is assumed throughout, (Figure F4.3). The cost is estimated at \$5.2/m in Seberang Perai and \$4.8/m in Balik Pulau.

F6.4.6 Tertiary drains vary in section depending on the area served. However for preliminary design a number of standard sections have been costed. These are given in Table F6.5, and assume machine excavation. Quaternary drains, like the corresponding canals, have been costed for a standard section which would probably require manual excavation. Although of smaller section than the smallest tertiary drain, the increased excavation unit rate gives a similar unit cost for the quaternary drain. However we have adopted this calculated cost as the section is narrower, less land is lost from productive use, and the land acquisition cost is less.

F6.5 Structure Costs

F6.5.1 As with the main and secondary canals, costs of structures particular to a location or scheme will be assessed individually, however several types of structures are required for the proposed improvements to the infrastructure in all areas, namely:

- Tertiary offtakes
- Tertiary distribution boxes (quaternary offtakes)
- Access culverts
- Drainage control structures
- Direct tertiary/field offtakes
- Quaternary distribution boxes

F6.5.2 Average costs for typical sizes of each type of structure have been assessed on the basis of the designs indicated in Figures F4.1 and F4.5, and the unit rates in Table F6.2. These unit costs are given in Table F6.6. We understand that development work on direct offtakes is being carried out on other schemes in the country and the cost of \$500 is a nominal cost estimated in the absence of detailed proposals.

F6.7.2 Mainly because of differences in the tertiary canal costs due to the differing average unit sizes, and the layout and topography of the sample areas, the tertiary infrastructure costs show significant variations:

Sample Area	Infrastructure costs	
	Tertiary ($/ha)	Quaternary ($/ha)
Sg. Muda	6,277	855 (R)
Pinang Tunggal	7,791	1,423 (V)
Sg. Kulim (Alternative B)	4,776	941 (R)
Alma	4,024	-
Sg. Burung	6,065	814 (R) 1,168 (V)

(Note: 1. Costs are for measured items only.
2. R - Rice only area; V - Rice and vegetable/maize area)

The quaternary infrastructure costs are more consistent, though there is a notable increase in the costs for areas designed for vegetable or maize cropping. In view of the variations in the tertiary development costs it was not considered accurate enough to extrapolate the sample area unit costs over the whole project. Instead, therefore, only quaternary development costs have been applied in this way and tertiary canal and structure costs have been assessed for each scheme or secondary block individually.

F6.7.3 Based on the unit costs of Table F6.4 and typical canal sizes and access requirements as assessed for the sample areas, Figure F6.2 indicates the variation of average tertiary canal unit costs with tertiary unit size. Except for the sample areas and a few other small schemes where accurate sizing of tertiary canals can be made with the available information, tertiary canal costs have been estimated from this figure. Structures costs (offtakes and drainage control structures) increase more rapidly with increasing size and have been estimated from the average values for the relevant sample area in direct proportion to the average tertiary unit size.

F6.7.4 Tables F6.9 to F6.31 include detailed cost estimates for each scheme, and for the larger schemes, for each secondary block. Main and secondary canal and drainage works have been assessed for each area taking into account the size, present condition and, for structures, the numbers involved.

F6.7.5 Group total costs, including the additional percentages (F6.6.1) are given in Tables F6.11, F6.17, F6.21, F6.27, F6.28 and F6.31. These are summarised below:

Group	Total Cost ($\$ \times 10^6$)	Gross Area (ha)	Cost/ha ($/ha)
A (Sg. Muda)	76.6	6,950	11,000
B (N.E. schemes)	23.8	2,832	8,400
C (Sg. Kulim	30.8	3,369	9,200
D (Central & Southern schemes)	3.56	515	6,900
E (Juru)	3.49	244	14,300
F (Balik Pulau)	13.95	1,127	12,400

F6.8 <u>Land Acquisition</u>

F6.8.1 The total areas of land needing to be acquired for the proposed works are estimated for each group as:

A	366 ha	(5.3% of gross scheme area)
B	111 ha	(4.0%)
C	181	(5.4%)
D	19	(3.7%)
E	15	(6.1%)
F	48.7 ha	(4.3%)

This includes all works for main, secondary and tertiary distribution and drainage systems and for access roads (with due allowance for existing reservations). We do not consider it necessary for the Government to acquire quaternary canal and drainage reservations in the areas designated for group farms. These would be constructed initially as part of the main contract, but the responsibility for operation and maintenance would remain with the group farm management. In smallholder areas however we recommend the purchase of such reservations to avoid conflict between individual farmers and we have included for this quaternary infrastructure in the totals above.

F6.8.2 Assessments of land prices have been prepared for us by the Federal Valuation Office (Pejabat Penilaian & Perkhidmatan Harta). The estimates are on the basis of actual valuations made when land changed ownership; the principal influence on these prices is proximity to road. Thus padi land, bendang, fronting on a surfaced road is as high as $150,000 per acre (alongside the main roads on the southern edge of the Sg. Kulim scheme), while bendang lots four or more layers in from any road may be less than $5,000 per acre in Balik Pulau. As a general rule most of the works involved in the irrigation and drainage systems are away from the roads and only at occasional crossing points are frontage lots involved.

F6.8.3 The land valuations are on the basis of market value ignoring betterment, and assume the existence of Grade I titles. When these values vary widely, and exceed, as is the case, the agricultural floor price by factors of four or more we must assume that the market does not accept the permanence of current dividing lines between urban and agricultural use. Clearly the market may put a development value on land which takes little account of today's planning limits to metropolitan growth. Our agricultural economics studies have not used the land prices supplied by the Federal Valuation Office but assume the value of land is represented by its agricultural potential.

F6.8.4 Land values for acquisition purposes which are used in the main reports are as follows:

Scheme Group	Average land cost	Total land cost
A	$20,000/ha	$\$7.3 \times 10^6$
B	18,000/ha	2.0×10^6
C	35,000/ha	6.3×10^6
D	25,000/ha	0.5×10^6
E	30,000/ha	0.5×10^6
F	22,600/ha	1.1×10^6

Data supplied to us by the Federal Valuation Office is summarised or copied in Tables F6.33 to F6.36. It was emphasised to us that the values given are only estimates based on past changes of ownership, and cannot be regarded as "cost forecasts".

Table F6.1 Concrete Pipe Costs (Class X)

Dia. (mm)	Costs ($/m)				
	Ex-factory	Transport (1)	Handling, laying, jointing	Overheads & Profit	Total in place
150	18	1.0	1.5	6.5	27
300	28	1.9	3.0	12.1	45
450	50	3.2	5.4	21.4	80
600	70	5.2	7.4	27.4	110
750	95	7.4	10.3	37.3	150
900	130	10.0	13.7	46.3	200
1,050	160	12.8	17.0	55.2	245
1,200	205	16.0	21.8	72.2	315

Notes:

1. Transport from factory to site assumes 16 km average. (n.b. because of stacking problems reducing loads, transport costs taken as $2/T/km).

Table F6.2 Unit Rates

Item	Unit	Rate ($) Seb. Perai	Balik P.
Cement (on site)	tonne	250	260
Fine aggregate/sand (on site)	m^3	33	30
Coarse aggregate (on site)	m^3	45	45
Canal/drain bulk excavation (machine)	m^3	2	2
Canal/drain excavation (manual)	m^3	4	4
Trimming excavation	m^2	1.0	1.0
Excavation for structures (including trimming and backfill)	m^3	10	10
Imported fill	m^3	16	14
Additional cost on imported fill for poor access	m^3	1.5	1.5
Laterite surface for access roads	m^3	18	15.5
Mass concrete (including shuttering)	m^3	280	280
Structural concrete (including shuttering)	m^3	420	420
Structural concrete (including shuttering and reinforcement)	m^3	535	535
Concrete for canal linings (including shuttering)	m^3	400	400
M.S. reinforcement (fixed in place)	kg	1.75	1.75
Mesh reinforcement (fixed in place)	kg	2.00	2.00
Bakau piles	No.	9	9

Table F6.3 Breakdown of Tertiary Canal Unit Costs: Seberang Perai
(Costs per metre, for 3m wide road access)

Item	Unit	Rate ($)	18" block		24" block		TI		TII	
			Qty.	Cost	Qty.	Cost	Qty.	Cost	Qty.	Cost
Concrete	m^3	400	0.082	32.8	0.11	44.0	0.16	64.0	0.19	76.2
Mesh reinft.	kg	2.0	1.88	3.8	2.51	5.0	3.55	7.1	4.25	8.5
Transport and handling	lump sum		-	1.5	-	2.0	-	3.0	-	5.0
Fill	m^3	16	3.39	54.2	3.79	60.6	4.21	67.4	4.21	67.4
Trimming and blinding excav.	m^2	2.0	1.5	3.0	1.8	3.6	2.5	5.0	3.0	6.0
Laterite road surface	m^3	18	0.77	13.9	0.77	13.9	0.77	13.9	0.77	13.9
Miscellaneous(1)	lump sum		-	6.0	-	7.0	-	8.0	-	9.0
Total cost				115.2		136.1		168.4	-	186.0

Notes: 1.Includes for jointing precast units, grassing slopes etc.

Table F6.4 Unit Costs of Tertiary Canals

Canal Section	18" block	24" block	TI	TII
	(Cost in $/m)			
Seberang Perai (1)				
Minimum access track (1.5m bund)	105	125	155	170
Standard access road (3.0m bund)	120	140	175	190
Main access road (5.5m bund)	150	175	205	220
Balik Pulau				
Minimum access track	100	120	150	165
Standard access road	110	130	165	180
Main access road	140	160	195	210

Notes: 1. Values rounded up from those calculated in Table F6 .3

2. A deduction of $25/m made for re-construction of existing canal for trapezoidal lining; $15/m for block section

Table F6.5 Unit Costs of Tertiary and Quaternary Drains

Area Served (ha)	Dimensions B x D(m)	Quantity excav. (m^3)	Rate ($/$m^3$)	Cost ($/m)
Seberang Perai				
20	0.75 x 0.75	1.2	2.0	2.4
40	0.9 x 0.9	1.65	2.0	3.3
60	1.0 x 1.0	2.0	2.0	4.0
80	1.1 x 1.1	2.4	2.0	4.8
100	1.2 x 1.2	2.9	2.0	5.8
Balik Pulau				
20	0.75 x 0.75	1.2	2.0	2.4
40	0.9 x 0.9	1.65	2.0	3.3
60	1.2 x 1.0	2.2	2.0	4.4
80	1.2 x 1.2	2.9	2.0	5.8
100	1.5 X 1.2	3.2	2.0	6.4
Quaternary drains	0.4 x 0.6	0.6	4.0	2.4

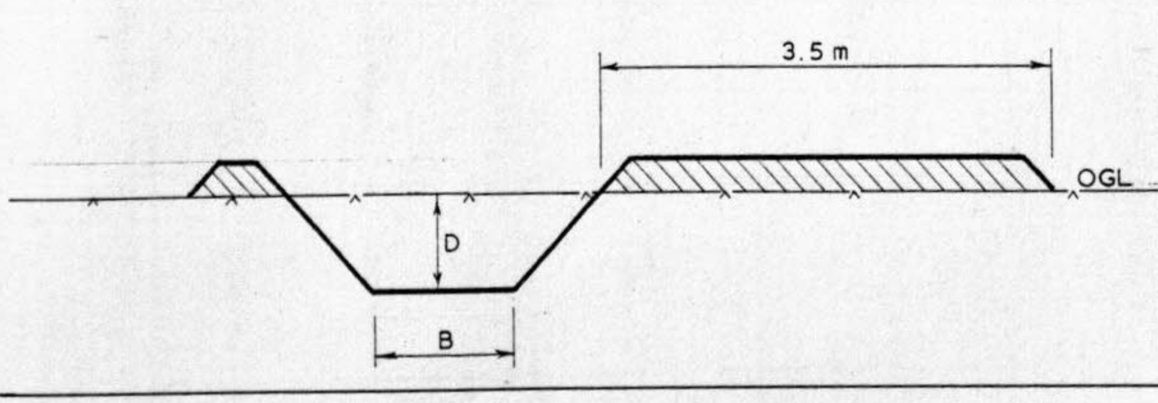


Table F6.6 Unit Costs of Structures

Note: Estimated costs taken as the same in both Seberang Perai and Balik Pulau

Tertiary offtakes:-	
For areas < 60 ha ; $Q < 0.18\ m^3/s$:- gate and pipe size 0.6m dia.	$ 8,500
For areas < 100 ha ; $Q < 0.30\ m^3/s$:- gate and pipe size 0.9m dia.	$ 11,500
Tertiary distribution boxes:-	$ 4,000
Access culverts (on tertiary canals):-	
0.6m dia.	$ 3,850
0.9m dia.	$ 5,500
Drainage control structures:-	
For areas < 30 ha ; gate and pipe size 0.6m dia.	$ 8,000
For areas < 70 ha ; gate and pipe size 0.9m dia.	$ 11,000
For areas < 120 ha ; gate and pipe size 1.2m dia.	$ 15,000
(n.b. Quoted areas are not applicable to maize/vegetable farms in Balik Pulau)	
Direct tertiary/field offtakes	$ 500
Quaternary distribution boxes	$ 500

Table F6.7 - **Existing Pumping Plants and Replacement Requirements**

Scheme	Station	Existing Installation: Diesel/ Electric	No of units	Rated Capacity (M^3/s/unit)	Total head (m)	Year Installed	Required Total Cap. (m^3/s)	Replacement Installation(1): No of units	Rated Capacity	Total head	Estimated total cost ($ x 10^3)	Notes
A. Sg. Muda	Bumbong Lima	E	3	2.83	4.0	1957	12.9	3	2.5	4.5	1,000	Replacement assumed 1990/91
		E	1	5.67	3.8	1967		1	5.5	4.5	450	
	Guar Tok Syed	D	1	0.11	2.4	1973	-	-			-	Area to be gravity supplied
	Pokok Sena	E	2	0.42	1.5	1967	0.63	2	0.35	1.5	52	Replacement 1990/91
B. Pinang Tunggal	Pinang Tunggal	E	2	3.82	4.6	1964	(7.8)	1	2.7	5.0	370	Maximum required of 7.8 m^3/s reduced to $6.5m^3/s$ by new Permatang Pasir P.S. Thus only 1 old pumpset need be replaced. Newly installed set adequate for Pinang Tunggal scheme thus all replacement cost attributable to Sg. Kulim scheme. Replacement 90/91
		E	1	3.82	4.9	1980	6.5					
	Taliair Timur Booster	D	2	0.28	3.0	1967	approx.0.7	2	0.35	3.5	125	Required capacity dependent on whether supply to area west of main canal can be gravity supplied. Replacement 84/85 - See note 2

(Table F6.7 - Contd.)

Table F6.7 - Existing Pumping Plants and Replacement Requirements

Scheme	Station	Existing Installation					Required Total Cap. (m^3/s)	Replacement Installation(1)				Notes
		Diesel/ Electric	No of units	Rated Capacity (M^3/s/unit)	Total head (m)	Year Installed		No of units	Rated Capacity	Total head	Estimated total cost ($\$ \times 10^3$)	
Tasek Gelugor	Kg. Tok Bedu	D	2	0.14	3.35	1970	0.25	2	0.14	3.5	50	Replacement 85/86
	Ayer Melintas	D	2	0.42	3.0	1969	0.50	2	0.30	3.0	90	Cost attributable to project as part of proposed P.S. relocation
Jarak	Kereh H/works Booster	E E	2 1	2.00 2.00	3.35 3.35	1966 1980	(4.5) 3.2	1	1.2	3.5	210	See note for Pinang Tunggal P.S. above
	Pdg. Chempedak Booster	E E	2 1	1.42 1.42	3.35 3.35	1967 1980	(4.1) 2.8	1	1.4	3.5	240	See note for Pinang Tunggal P.S. above
Jarak Tengah	Jarak Tengah	D	1	0.14	1.83	1970	0.13	1	0.14	2.0	15	Replacement 86/87
	Jarak Tengah (Barat)	Pumping plant not installed					0.13	1	0.14	2.0	15	Cost included as capital cost for scheme
C. Sg. Kulim	Kubang Semang	E	2	0.35	1.22	1963	0.88	2	0.45	1.5	70	Replacement 90/91
	Ptg. Rawa	D	2	0.21	1.52	1971	0.25	2	0.20	3.0	60	Replacement 85/86
D. Sg. Renjau	Sg. Renjau	D	1	0.14	1.83	1963	0.05	1	0.05	2.0	5	Replacement 85/86
Kuala Tasek	Kuala Tasek	D	1	0.14	1.83	1964	0.05	1	0.05	2.0	5	Replacement 85/86
E. Juru	Juru	D	2	0.42	2.74	1972	0.60	2	0.35	3.0	105	Replacement 89/90

Notes:

1. All replacement units costed as electric-powered.
2. Total costs are for pumping plant only and do not include switchgear, transformers etc. which are assessed at 50% of pump costs. Note also that in many cases plant replacement would be necessary without the projected. The project costs given in Table : F6.12 are those attributable to the project - not the total costs listed above.

Table F6.8 - New Pumping Stations

Scheme	Station	Required capacity (m^3/s)	No of units	Rated Capacity (m^3/s/unit)	Total head (m)	Estimated pumpsets ($ x 10^3)	Costs totals (1) ($ x 10^3)	Notes
B. Pinang Tunggal	Small booster station at East end of sample area	.03	1	0.03	1.0	4	14	
B. Pokok Jeneris, Kg. Tasek & Kubang Menderong	Intake Pumping station	.59	2	0.3	2.5	75	225	Head requirement only preliminary estimate.
C. Sg. Kilim	Permatang Pasir	1.3	3	0.5	5	300	850	Significant part of total design head of 7m is friction head. Individual pumps provisionally rated at $0.5m^3/s$ at 5m to give total capacity of $1.3m^3/s$ at 7m
E. Juru	Sg. Junjong	0.75	2	0.4	2	100	430	Cost excludes tidal gates on Sg. Junjong
F. Sg. Burong	Sg. Kongsi	0.26	3	0.12	3.5	60	330	Significant part of total design head of 5.0m is friction head. Individual pumps provisionally rated at $0.12m^3/s$ at 3.5m to give total capacity of $0.26 m^3/s$ at 5.0m.

Notes:

1. Total costs include for station pipework, electrical switchgears etc. and building and civil works associated directly with station. They do not include for river control structures or pipelines where these are required.

Table F6.9 - Sq. Muda Scheme: Sample Area Costs

Item	Unit	Rate ($)	Quantity	Cost ($ x 10^3)
Quaternary Development:-				
Quaternary canals	m	5.2	21,400	111.3
Tertiary division boxes	No.	4,000	56	224.0
Quaternary division boxes	No.	500	9	4.5
Direct offtakes	No.	500	94	47.0
Access culverts (0.6m)	No.	3,850	18	69.3
(0.9m)	No	5,500	20	110.0
Quaternary drains	m	2.4	22,800	54.7
Quaternary drain culverts	No.	1,000	58	58.0
Total cost of quaternary development (= $855/ha)				$ 678.9x10
New tertiary canals:-				
18" block section -				
no farm road	m	105	500	50.3
3m farm road	m	120	50	6.0
5.5 m farm road	m	150	350	52.5
24" block road -				
no farm road	m	125	1,500	187.5
3m farm road	m	140	1,350	189.0
5.5 m farm road	m	175	150	26.3
TI section -				
no farm road	m	155	4,750	736.3
3m farm road	m	175	5,300	927.5
5.5 farm road	m	205	800	164.0
TII section -				
no farm road	m	170	1,100	187.0
3m farm road	m	190	400	76.0
5.5 farm road	m	220	250	55.0
Total cost new tertiary canals (= $3,347/ha; av.cost = $161/m)			$ 16,500m	$2,657.4x

(Table F6.9 - Contd.)

Table F6.9 - Sq. Muda Scheme: Sample Area Costs

Item	Unit	Rate ($)	Quantity	Cost ($ x 10^3)
Reconstruction of existing canals:-				
24" block section:- no farm road	m	110	400	44.0
Tl section -				
no farm road	m	130	2,450	318.5
3m farm road	m	150	600	90.0
TII section				
no farm road	m	145	600	87.0
3m farm road	m	165	650	107.9
Total cost of reconstruction of tertiary canals: (=$804/ha, av.cost = $138/m)			(4,700m)	$647.4x1
Allowance for additional fill for tertiary canals:	m^3	16	4,200	67.2
Tertiary offtakes (0.6m)	No	8,500	7	59.5
(0.9m)	No	11,500	6	69.0
Tertiary drains				
New	m	5.0	5,500	27.5
Existing	m	3.0	2,300	6.9
Drainage control structures:-				
0.6m dia:-	No	8,000	9	72.0
1.9m dia:-	No	11,000	11	121.0
1.2m dia:-	No	15,000	3	45.0
existing:-	No	2,000	2	4.0
Farm roads (other than with tertiary canals)				
3m wide:	m	40	3,800	152.0
5.5m wide:	m	70	1,800	126.0
Miscellaneous other works	Sum	-	-	250.0
Total cost of tertiary development (=$6,277/ha)				$4,983.6x

(Table F6.9 - Contd.)

Table F6.9 - Sg. Muda Scheme: Sample Area Costs

Item	Unit	Rate ($)	Quantity	Cost ($ x 10^3)
Secondary canal works:-				
Imported fill	m^3	16	77,800	1,244.8
Imported laterite	m^3	18	3,300	59.4
Secondary drain works	m	5.0	23,700	118.5
Secondary canal and drain structures:-				
Main offtake	No	15,000	1	15.0
Branch canal offtake	No	15,000	1	15.0
Regulating structures	No	25,000	2	50.0
Culvert crossings of canal	No	20,000	2	40.0
Pipe crossings of drain	No	15,000	2	30,0
Bridge works:-				
Small	No	30,000	4	120.0
Large	No	175,000	4	700.0
Total cost of secondary works:-				$2,392.7xl
Total cost of all works in sample area (Sec. Block B) (=$9,290/ha)				$7,376.3xl

Table F6.10 - Sg. Muda Scheme: Secondary and Tertiary Costs

Item	Unit	Secondary block A (Area 1,533 ha; Av. tert. 73 ha)			Secondary block B(1) (Area 794 ha; Av. tert. 61 ha)			Secondary Block C (Area 1,368 ha; Av. tert. 46 ha)			Secondary Block D (Area 185 ha; Av. tert. 62 ha)			Secondary Block E (Area 228 ha; Av. tert. 46 ha)		
		Rate	Qty.	Cost ($ x 10^3)	Rate ($)	Qty.	Cost ($ x 10^3)	Rate ($)	Qty.	Cost ($ x 10^3)	Rate ($)	Qty.	Cost ($ x 10^3)	Rate ($)	Qty.	Cost ($ x 10^3)
Secondary canal earthwoks	m^3	17(4)	66,000	1,122	-	-	1,304	17(4)	115,000	1,955	17(4)	7,000	119	17(4)	14,000	238
Secondary drain earthworks	m^3	2	110,000	220	-	-	119	2	100,000	200	2	18,000	36	2	9,000	18
Secondary canal structures	Sum	-	-	430	-	-	120	-	-	655	-		135	-	-	60
Secondary drain strucrutes	Sum	-	-	800	-	-	850	-	-	975	-		30	-	-	50
Total				2,572			2,393			3,785			320			366
Tertiary canals(2)																
New	m	172	7,500	1,290	161	16,500	2,657	156	13,200	2,059	166	4,250	706	156	3,100	483
Existing	m	148	18,000	2,664	138	4,700	647	135	12,700	1,728	143	2,550	365	135	2,600	351
Additional fill	m^3	16	6,500	104	16	4,200	67	16	5,700	91	16	1,400	22	16	1,000	16
Tertiary offtakes(3)	No	12,000	21	252	9,900	13	129	7,500	30	225	10,000	3	30	7,500	5	38
Tertiary drains																
New	m	5	11,800	59	5	5,500	28	5	6,800	34	5	1,800	9	5	2,250	11
Existing	m	3	3,520	11	3	2,300	7	3	10,400	31	3	500	2	3	1,400	4
Drainage control structures(3)														-	-	-
New	No	12,500	13	163	10,350	23	238	7,850	5	39	10,400	2	21	-	-	-
Existing	No	2,400	-	-	2,000	2	4	1,500	3	5	-	-	-			
Other roads	m	50	6,700	335	49.6	5,600	278	50	4,200	210	50	5,600	280	50	500	25
Quaternary infrastructure	ha	855	1,533	1,311	855	794	679	855	1,368	1,170	855	185	158	855	228	195
Miscellaneous other works	Sum	-	-	600	-	-	250	-	-	560	-	-	200	-	-	165
Total				6,789			4,984			6,152			1,793			1,288
			($4,429/ha)			($6,277/ha)			($4,498/ha)							

Table F6.10 (Contd.) - Sq. Muda Scheme: Secondary and Tertiary Costs

Item	Unit	Secondary Block F (Area 1,454 ha; Av. tert. 66 ha)			Secondary Block G (Area 354 ha; Av. tert. 71 ha)			Secondary Block H (Area 233 ha; Av. tert. 78 ha)			Secondary Block J (Area 550 ha; Av. tert. 61 ha)			Pokok Sena (Area 251 ha; Av. tert. 84 ha)		
		Rate ($)	Qty.	Cost ($ x 10^3)	Rate ($)	Qty.	Cost ($ x 10^3)	Rate ($)	Qty.	Cost ($ x 10^3)	Rate ($)	Qty.	Cost ($ x 10^3)	Rate ($)	Qty.	Cost ($ x 10^3)
Secondary canal earthworks	m^3	17 (4)	85,000	1,445	17 (4)	36,000	612	17 (4)	9,500	162	17 (4)	19,000	323	-	-	-
Secondary drain earthworks	m^3	2	54,000	108	2	20,000	40	2	6,500	13	2	4,500	9	2	2,500	5
Secondary canal structures	Sum	-	-	1,590	-	-	200	-		100	-	-	110	-	-	-
Secondary drain structures	Sum	-	-	175	-	-	530	-		-	-	-	150	-	-	5
Total				3,318			1,382			275			592			10
Tertiary canals (2)																
New	m	168	10,500	1,764	171	5,300	906	174	3,000	522	166	6,550	1,087	-	-	-
Existing	m	146	15,500	2,263	147	2,400	353	150	2,200	330	143	5,100	729	152	5,200	790
Additional fill	m^3	16	6,500	104	16	1,500	24	16	1,100	18	16	2,150	34	-	-	-
Tertiary offtakes (3)	No	10,800	22	238	11,600	5	58	12,800	3	38	10,000	9	90	13,800	3	41
Tertiary drains																
New	m	5	9,600	48	5	1,750	9	5	2,450	12	5	8,500	43	5	2,800	14
Existing	m	3	3,600	11	3	2,400	7	3	2,050	4	3	-	-	3	1,200	4
Drainage control structures (3)																
New	No	11,300	10	113	12,100	2	24	13,300	-	-	10,400	2	21	-	-	-
Existing	No	2,150	4	9	2,300	2	5	2,550	1	3	2,000	1	2	-	-	-
Other roads	m	50	6,000	300	50	6,500	325	50	6,500	325	50	5,600	278	50	7,600	380
Quaternary infrastructure	ha	855	1,454	1,243	855	354	303	855	233	199	855	550	470	855	251	215
Miscellaneous other works	Sum	-	-	515	-	-	210	-	-	150	-	-	280	-	-	170
Total				6,608			2,224			1,601			3,034			1,614

Notes:
1. Sample area ; see Table F6.7 for detailed breakdown of costs.
2. Unit rates taken from Figure F6.2 for av. tertiary unit size, except in sample area.
3. Average structure costs calculated from values assessed for sample area in proportion to average tertiary unit size.
4. Rate includes for laterite topping and all associated works.

Table F6.11 Sg. Muda Scheme: Total Costs (Group A)

		M$ x 10^6
Main canal		3.93
Secondary canals and drains:		
Block A		2.58
Block B		2.39
Block C		3.79
Block D		0.32
Block E		0.37
Block F		3.32
Block G		1.38
Block H		0.28
Block J		0.59
Pokok Sena		0.01
Tertiary infrastructure		36.08
	Total measured items	\$55.04 x 10^6
Contractors' preliminary and general items		5.50
Physical contingencies		9.07
	Total construction cost	\$69.61 x 10^6
Engineering and survey		6.96
	Total Sg. Muda scheme:	\$76.57 x 10^6

Table F6.12 - Pinang Tunggal Sample Area Costs

Item	Unit	Rate ($)	Quantity	Cost ($ x 10^3)
Quaternary Development:-				
Quaternary canals:	m	5.2	13,450	64.7
Tertiary division boxes	No	4,000	29	116.0
Quaternary division boxes	No	500	12	6.0
Access culverts 0.6m dia.	No	3,850	10	38.5
0.9m dia.	No	5,500	2	11.0
Quaternary drains	m^3	2.4	9,700	23.3
Additional fill	m^3	16	1,400	22.4
		(Av. $1,423/ha)		281.5
New tertiary canals				
18" block section:-				
no farm road	m	105	1,640	172.2
24" block section:-				
no farm raod	m	125	480	60.0
Reconstruction of existing canals:-				
18" block section:-				
3m farm road	m	105	190	20.0
24" block section:-				
3m farm road	m	125	690	86.3
TI section:-				
no farm road	m	130	2,350	305.5
3m farm raod	m	150	150	22.5
TII section:-				
no farm road	m	145	950	137.8
Allowance for additional fill	m^3	16	12,300	196.8
Tertiary drains:	m	5	2,800	14.0
Tertiary offtakes	No	2	11,500	23.0
Drainage control structures				
0.6m dia.	No	6	8,000	48.0
0.9m dia.	No	3	11,000	33.0
Drain culverts	No	4	15,000	60.0
Bridge/culvert crossing	No	1	50,000	50.0

(Table F6.12 - Contd.)

Table F6.12 - Pinang Tunggal Sample Area Costs

Item	Unit	Rate ($)	Quantity	Cost ($ x 10^3)
Booster pumping station				
pumping plant	Sum	-	-	4.0
pipework	Sum			4.0
electrical equipment	Sum			4.0
building	Sum			2.0
	Total (excluding area outside main bund)			$ 1,524.6x10^3

Table F6.13 - Pinang Tunggal Scheme Costs				
Item	Unit	Rate ($)	Quantity	Cost ($ x 10^3)
Sample area total cost:	Sum	-	-	$1,525 x 10^3
Remaining area (1,152 ha)				
Main and secondary canal:-				
earthworks	m^3	16	64,000	1,024
structures:-				
offtakes	No	40,000	4	160
regulating structures	No	35,000	2	70
access budges/culverts	No	50,000	6	300
Secondary drains:-				
earthworks:-	m^3	2	26,000	52
structure:-				
control structures	No	15,000	6	90
bridges	No	100,000	2	200
Rehabilitation of existing structures	Sum	-	-	100
	Sub-total: main & secondary canal & drain works			$1,996x$10^3$
Tertiary canals:-				
New	m	155 (1)	14,800	2,294
Existing	m	137 (1)	7,340	1,005
Additional full	m^3	16	5,000	80
Tertiary offtakes	No	8,500 (2)	23	196
Tertiary drains: new	m	5	13,800	69
: existing	m	3	1,800	5
Drainage control structure	No	8,600 (2)	13	112
Quaternary infrustructure	ha	855 (3)	1,125	962
Miscellaneous other works	Sum	-	-	250
	Sub-total (Av. $4,317/ha)			$ 4,973x10^3
	Total measured items			$ 8,494x10^3

Notes:
1. Canal rates based on Figure F6.2 for average tertiary unit size of 50 ha.
2. Structure costs adjusted from average cost for Sg. Muda sample area in proportion to average tertiary unit size.
3. Taken as the same as for Sg. Muda sample area.

Table F6.14 - Pokok Jeneris, Kg. Tasek and Kubang Menderong Scheme Costs

Item	Unit	Rate ($)	Quantity	Cost ($ x 10^3)
Pumped Intake:-				
Rehabilitation of existing gated control structure	Sum	-	-	100
Civil works & building	Sum	-	-	80
Pumping plant	Sum	-	-	75
Electrical equipment	Sum	-	-	40
Station pipework etc.	Sum	-	-	30
New tertiary canals				
18" block : no read	m	105	880	89.3
: 5.5m road	m	150	500	52.5
24" block : no road	m	125	1,430	178.8
5.5m road	m	175	840	147.0
TI section: no road	m	155	680	105.4
Existing canals:				
24" block : 3m road	m	125	630	78.8
TI section: 3m road	m	150	930	139.5
Quaternary canals	m	5.2	7,100	36.9
Tertiary offtakes : 0.6m dia.	No	8,500	1	8.5
0.9m dia.	No	11,500	2	23.0
Tertiary division boxes	No	4,000	15	60.0
Access culverts : 0.6m dia.	No	3,850	5	19.3
0.9m dia.	No	5,500	3	16.5
Direct offtakes	No	500	17	8.5
Testiary drains	m	5	5,050	25.3
Quaternary drains	m	2.4	3,750	9.0
Drainage control structure:-				
0.6m dia	No	8,000	1	8.0
0.9m dia.	No	11,000	4	44.0
1.2m dia.	No	15,000	1	15.0
Miscellaneous works	Sum			75.0
		Total measured items		1,465.4

Table F6.15 Tasek Gelugor Scheme Costs

Item	Unit	Rate ($)	Quantity	Cost ($ x 10^3)
New headworks and pumping station at Ayer Melintas:-				
Sheet piling	sum	-	-	50.0
Concrete works	m^3	420	400	168.0
Excavation	m^3	2	1,200	2.4
Fill	m^3	16	200	3.2
Pumphous civil works (including foundations)	sum	-	-	100.0
Pumping plant (incl. elect. transformer & switchgear)	sum	-	-	150.0
Station & delivery pipework	sum	-	-	75.0
Miscellaneous works (scour gates etc.)				50.0
			Sub-total	598.6
			say	600.0
Main canal (provision of access road)	m	75	1,550	116.3
Lining of existing canals:-				
No road	m	117[1]	5,150	602.6
3m road	m	132[1]	1,100	145.2
New tertiary canals:-				
with 3m road	m	156[1]	970	151.3
Quaternary canals				
Existing:-	m	3.0	1,160	3.5
New:-	m	5.2	6,900	35.9
Tertiary offtakes: 0.6m dia.	No	8,500	4	34.0
0.9m dia.	No	11,500	1	11.5
Tertiary division boxes	No	4,000	14	56.0
Access culverts 0.6m dia.	No	3,850	1	3.9
0.9m dia.	No	5,500	1	5.5
Direct offtakes	No	500	15	7.5
Quaternary drains	m	2.4	10,250	24.6
Tertiary drains:	m	5.0	4,850	24.3
Drainage control structures				
0.6m dia.	No	8,000	2	16.0
0.9m dia.	No	11,000	2	22.0
1.2m dia.	No	15,000	1	15.0
Drainage culverts/ under existing roads and canals	No	15,000	9	135.0
			Total measured items	$2,020.1 x 10^3

Notes: 1. Canal rates based on Figure F6.2 for average tertiary unit size of 53 ha.

Table F6.16 Jarak and Jarak Tengah Scheme Costs

Item	Unit	Rate ($)	Quantity	Cost ($ x 10^3)
Main and secondary canal:-				
earthworks	m^3	16	65,000	1,040
structures	sum	-	-	100
Main and secondary drains and rivers	sum	-	-	100
Tertiary canals:-				
new	m	154 (1)	6,600	1,016
existing	m	136 (1)	9,940	1,352
additional fill	m^3	16	3,000	48
Tertiary offtakes	No	8,500 (2)	18	153
Tertiary drains: new	m	5	9,310	47
existing	m	3	2,600	8
Drainage control structures:-				
new	No	8,600 (2)	4	34
existing	No	2,000	15	30
Quaternary infrastructure	ha	941	876	824
Jarak Tengah (Barat) P.S.				
Pumping plant	sum	-	-	30
Switchgear etc.	sum	-	-	20
Allow for provision of electrical supply	sum	-	-	50
Station pipework	sum	-	-	20
Civil works and building	sum	-	-	50
Miscellaneous works	sum	-	-	200
	Total measured items			5,122

Notes: 1. Canal rates based on Figure F6.2 for average tertiary unit size of 50 ha.

2. Structure costs adjusted from average cost for Sg. Muda sample area in proportion to average tertiary unit size.

Table F6.17 Group B Schemes Total Costs

		M$ x 10^6
Pinang Tunggal:-		
Main and secondary canals		1.55
Secondary drains		0.44
Tertiary infrastructure		6.50
	Sub-total	$8.49 x 10^6
Pokok Jeneris, Kg. Tasek & Kubang Menderong:-		
Pumped intake : civil works		0.18
plant		0.14
Tertiary infrastructure		1.15
	Sub-total	$1.47 x 10^6
Tasek Gelugor		
Ayer Melintas headworks : civil works		0.32
plant		0.28
Main canal		0.12
Tertiary infrastructure		1.30
	Sub-total	$2.02 x 10^6
Jarak and Jarak Tengah:-		
Main and secondary canals		1.14
Main and secondary drains		0.10
Jarak Tengah (Barat) P.S. : civil works		0.05
plant		0.12
Tertiary infrastructure		3.71
	Sub-total	$5.12 x 10^6
	Total	$17.10 x 10^6
Contractors' preliminary and general items		1.71
Physical contingencies		2.82
	Total construction cost	$21.63 x 10^6
Engineering and survey		2.16
	Total Group B schemes	$23.79 x 10^6

Table F6.18 - Sg. Kulim Scheme: Sample Area Costs - Alternative A

Item	Unit	Rate ($)	Quantity	Cost ($ x 10^3)
Quaternary Development:-				
Quaternary canals	m	5.2	26,650	138.6
Tertiary division boxes	No	4,000	36	144.0
Quaternary division boxes	No	500	22	11.0
Direct offtakes	No	500	20	10.0
Access culverts (0.6m)	No	3,850	20	77.0
Access culverts (0.9m)	NO	5,500	17	93.5
Quaternary drains	m	2.4	20,100	48.3
Quaternary drain culverts	No	1,000	40	40.0
Total cost of quaternary development (= $941/ha)				$562.4x10^3$
New tertiary canals:-				
24" block section -				
no farm road	m	125	1,850	231.3
3m farm road	m	140	1,860	260.4
TI section -				
no farm road	m	155	1,640	254.2
3m farm road	m	175	1,430	250.3
5.5m farm road	m	205	350	71.8
TII section -				
no farm road	m	170	400	68.0
Total cost new tertiary canals (= $1,900/ha ; av.cost = $151/m)			(7,530m)	$1,136.0x10^3$

Table F6.18 - Sg. Kulim Scheme: Sample Area Costs - Alternative A

Item	Unit	Rate	Quantity	Cost ($ x 10^3)
Secondary canal works:-				
Improvements to existing canals:-				
TII section -	m	145	1,000	145.0
Increasing ht. of existing lined canals (including earthworks)	m	25	2,350	58.8
Secondary canal structures:-				
Offtake modifications	Sum	-	-	20.0
Bridge/culvert crossings	No	20,000	2	40.0
Secondary drainage works:-				
Improvements to existing drains	m	5	3,000	15.0
Secondary drain control structures : new	No	20,000	1	20.0
: existing	No	3,000	3	9.0
Bridge/culvert crossing	No	50,000	2	100.0
Allow for miscellaneous works:	Sum	-	-	50.0
Booster pumping station at Ptg. Pasir:-				
Pumping plant	Sum	-	-	17.0
Electrical equipment	Sum	-	-	8.5
Station pipework etc.	Sum	-	-	4.0
Building works	Sum	-	-	25.0
Total secondary works				$512.3x$10^3$
Total cost of sample area works - alternative A				$3,368.5x$10^3$

Table F6.19 - Sq. Kulim Scheme: Sample Area Costs - Alternative B

Item	Unit	Rate ($)	Quantity	Cost ($ x 10^3)
Note: Except costs as for Alternative A				
Quaternary development	ha	941	598	562.4
New tertiary canals:				
24" block section -				
no farm road	m	125	1,610	201.3
3m farm road	m	140	1,860	260.4
TI section				
no farm road	m	155	1,640	254.2
3m farm road	m	175	1,430	250.3
Reconstruction of existing canals:	m	138	4,250	587.4
Allowance for additional fill	m^3	16	1,300	21.0
Tertiary offtakes:- 0.6m	No	8,500	3	25.5
0.9m	No	11,500	7	80.5
Tertiary drains:	Sum	-	-	61.4
Drainage control structures	Sum	-	-	126.0
Roads other than with tertiary canals	Sum	-	-	20.0
Miscellaneous works	Sum	-	-	125.0
Total cost of tertiary development (= $4,307/ha)				$2,575.4x$10^3$

Table F6.19 - Sg. Kulim Scheme: Sample Area Costs - Alternative B

Item	Unit	Rate ($)	Quantity	Cost ($ x 10^3)
New secondary canals:-				
TIII section: no farm road	m	220	370	81.4
5.5m farm road	m	260	480	124.8
TIV section: no farm road	m	230	1,170	269.1
5.5m farm road	m	270	130	35.1
Allowance for additional fill	m^3	16	16,500	264.0
Improvements to existing canals	Sum	-	-	203.8
Secondary canal structures				
Modifications to offtake	Sum	-	-	20.0
Regulating/control structure	No	20,000	1	20.0
Bridge/culvert crossings	No	20,000	2	40.0
Syphon/crossings	No	35,000	3	105.0
Secondary drainage works:-				
earthworks	Sum	-	-	35.0
structures	Sum	-	-	124.0
New intake pumping station at Pg. Pasir:-				
pumping plant	Sum	-	-	300.0
electrical equipment	Sum	-	-	150.0
station pipework etc.	Sum	-	-	100.0
civil works (building, forebay etc.)	Sum	-	-	300.0
Pipeline to head of canal	m	715	450	322.0
Total cost of secondary works				$ 2,494.2x10^3
Total cost of sample area works - alternative B				$ 5,069.6x10^3

Table F6. 20 - Sg. Kulim Scheme: Secondary and Tertiary Costs

	Unit	Secondary block 1[1] (Area 598 ha; Av. tert. 66 ha)			Secondary block 1A (Area 552 ha; Av. tert. 69 ha)			Secondary block 2 (Area 902 ha; Av. tert. 60 ha)			Secondary block 3 (Area 967 ha; Av. tert. 54 ha)			Kubang Semang (Area 350 ha; Av. tert. 58 ha)		
		Rate ($)	Qty.	Cost ($ x 10^3)	Rate ($)	Qty.	Cost ($ x 10^3)	Rate ($)	Qty.	Cost ($ x 10^3)	Rate ($)	Qty.	Cost ($ x 10^3)	Rate ($)	Qty.	Cost ($ x 10^3)
Secondary canal earthworks	m^3	-	-	978	17	27,500	468	17	26,000	442	17	49,000	833	17	29,000	493
Secondary drain earthworks	m^3	2	17,500	35	2	16,000	32	2	46,500	93	2	48,000	96	2	18,000	36
Secondary canal structures	sum	-	-	1,352[2]	-	-	90	-	-	220	-	-	450	-	-	102
Secondary drain structures	sum	-	-	129	-	-	60	-	-	10	-	-	450	-	-	600
Sub-total				2,494			650			855			1,829			1,231
Tertiary canals:-[3]																
New	m	147	6,540	961	165	6,780	1,119	160	5,400	864	158	8,520	1,346	160	2,920	467
Existing	m	138	4,250	587	146	1,620	237	142	9,800	1,392	140	5,260	736	142	1,890	268
Additional fill	m^3	16	1,300	21	16	1,700	27	16	2,800	95	16	2,600	42	16	900	14
Tertiary offtakes:-[4]	No.	10,600	10	106	11,100	8	89	9,600	15	144	8,700	18	157	9,300	5	47
Tertiary drains:-																
New	m	5	7,650	38	5	4,050	20	5	13,570	68	5	9,960	50	5	5,300	27
Existing	m	3	7,700	23	3	3,280	10	3	3,250	10	3	4,850	15	3	250	1
Drainage control structures[4]																
New	No.	10,500	12	126	11,000	3	33	9,500	11	105	8,600	13	112	9,250	3	28
Existing	No.	3,000	4	12	3,000	3	9	2,000	6	12	2,500	4	10	2,000	1	2
Other roads	m	50	400	20	50	750	38	50	650	33	-	-	-	50	700	35
Quaternary infrastructure	ha.	940	598	562	940	552	519	940	902	848	940	967	909	940	350	329
Miscellaneous other works	sum	-	-	125	-	-	120	-	-	200	-	-	200	-	-	100
Sub-total				2,575			2,221			3,771			3,577			1,318
			($4,307/ha)			($4,024/ha)			($4,180/ha)			($3,699/ha)			($3,766/ha)	

Notes:
1. Sample area ; see Table F6. 18 for detailed breakdown of costs.
2. Includes Ptg. Pasir Pumping Station and associated works.
3. Except for sample area, rates for tertiary canals assessed from Figure F6.1
4. Average cost of structures assessed from sample area average cost, in proportion to average tertiary unit size.

Table F6.21 Sg. Kulim : Total Scheme Costs (Group C)

			($ x 10^6)
Main canal improvements:-			
Earthworks		1.02	
Structures		0.6	1.62
Secondary canal improvements			
Secondary block	1		2.50
(including new P.S. and associated works at \$1.17 x 10^6)			
Secondary block	1A		0.65
	2		0.85
	3		1.83
	Kubang Semang		1.23
Tertiary infrastructure (3369 ha at average \$3,995 /ha)			13.46
		Total measured items	\$22.14 x 10^6
Contractors' preliminary and general items			2.21
Physical contingencies			3.65
		Total construction cost	\$28.00 x 10^6
Engineering and survey			\$2.80 x 10^6
		Total Sg. Kulim Scheme:	\$30.80 x 10^6

Table F6.22 Alma Scheme Costs

Item	Unit	Rate ($)	Quantity	Cost ($ x 10^6)
New lined canals:-				
18" block with 3m road	m	120	480	57.6
24" block with 3m road	m	140	650	91
Quaternary canals	m	5.2	2,520	13.1
Offtakes : 0.6m dia.	No	8,500	3	25.5
Tertiary division boxes	No	4,000	3	12
Access culvert : 0.6m dia.	No	3,850	4	15.4
Direct offtakes	No	500	4	2
Drainage control structures: 0.6m dia.	No	8,000	2	16
Tertiary drains	m	5.0	2,100	10.5
Quaternary drains	m	2.4	1,450	3.5
Allow for improvement to existing drainage system	sum	-	-	15
Additional roadworks	m	50	350	17.5
Miscellaneous works	sum	-	-	75
		Total measured items		$354.1 x 10^6

Table F6.23 Machang Bubok Scheme Costs

Item	Unit	Rate ($)	Quantity	Cost ($ x 10^3)
Main canal works: (provision of access)	m	7.5	3,050	228.8
Quaternary canals: new	m	5.2	1,280	6.7
existing	m	3	5,405	16.2
Tertiary drains existing	m	2	2,000	4.0
Secondary/main drainage works	sum	-	-	100
Other roads	m	50	860	43
Canal culverts	No	15	3	45
Tertiary offtakes 400 mm	No	5,000	10	50
Miscellaneous works	sum	-	-	25
	Total measured items			$518.7 x 10^3

Table F6.24 Renjau Scheme Costs

Item	Unit	Rate ($)	Quantity	Cost ($ x 10^3)
Lining of existing canals				
18" block section: 3m road	m	105	320	33.6
24" block section: 3m road	m	125	425	53.1
Access culvert	No	3,850	1	3.9
Direct offtakes	No	500	7	3.5
Tertiary division box	No	4,000	1	4.0
Quaternary canal	m	5.2	240	1.2
Culvert under existing road	sum	-	-	15.0
Drainage works	sum	-	-	10.0
		Total measured items		$124.3 x 10^3

Table F6.25 Tasek Junjong Scheme Costs

Item	Unit	Rate ($)	Quantity	Cost ($ x 10^3)
Lining of existing canals				
No road	m	128 (1)	800	102.4
3m road	m	143 (1)	2,200	314.6
5.5m road	m	168 (1)	580	97.4
New tertiary canals:-				
3m road	m	161 (1)	180	29.0
Quaternary canals	m	5.2	3,520	18.3
Tertiary offtakes: 0.6m dia.	No	8,500	1	8.5
0.9m dia.	No	11,500	2	23.0
1.2m dia.	No	14,500	1	14.5
Tertiary division boxes	No	4,000	6	24.0
Access culverts 0.6m dia.	No	3,850	11	42.4
0.9m dia.	No	5,500	2	11.0
Direct offtakes	No	500	35	17.5
Quaternary drains: new	m	2.4	2,600	6.2
existing	m	2.0	1,400	2.8
Tertiary drains: existing	m	3	2,740	8.2
Drainage control structures				
new: 0.6m dia.	No	8,000	2	16.0
0.9m dia.	No	11,000	2	22.0
Miscellaneous works	sum			40.0
		Total measured items		$797.8 x 10^3

Notes: 1. Canal rates based on Figure F6.2 for average tertiary unit size of 61 ha.

Table F6.26 Kg. Kepala Gajah and Kuala Tasek Scheme Costs

Item	Unit	Rate (1) ($)	Quantity	Cost ($ x 10^3)
Lining of existing canals:-				
No road	m	120 (1)	240	28.8
3m road	m	135 (1)	850	114.8
5.5m road	m	165 (1)	500	82.5
Existing quaternary canals	m	3.0	2,680	8.0
New quaternary canals	m	5.2	900	4.7
Tertiary offtakes: 0.6m	No	8,500	1	8.5
0.9m	No	11,500	1	11.5
Tertiary division boxes	No	4,000	5	20.0
Access culverts: 0.6m	No	3,850	6	23.1
Direct offtakes:	No	500	9	4.5
Quaternary drains: new	m	2.4	2,100	5.0
existing	m	2.0	450	0.9
Tertiary drains : existing	m	3	2,600	7.8
Additional roadworks:	m	50	1,400	70
Bridge crossing of Sg. Junjong	sum	-	-	250
Miscellaneous works	sum	-	-	25
	Total measured items			$665.1 x 10^3

Notes: (1) Canal rates based on Figure F6.2 for average tertiary unit size of 45 ha.

Table F6.27 Group D Schemes Total Costs

	M$ x 10^6
Alma	
Tertiary infrastructure	0.35
Machang Bubok	
Main canal	0.23
Tertiary infrastructure	0.29
Sub-total	0.52
Renjau	
Tertiary infrastructure	0.12
Tasek Junjong	
Tertiary infrastructure	0.80
Kg. Kepala Gajah & Kuala Tasek	
Tertiary infrastructure	0.35
Additional access costs	0.32
Sub-total	0.67
Sg. Duri	
Tertiary infrastructure	0.10
Total measured items	\$2.56 x 10^6
Contractors' preliminary and general items	0.26
Physical contingencies	0.42
Total construction cost	\$3.24 x 10^6
Engineering and survey	0.32
Total Group D schemes	\$3.56 x 10^6

Table F6.28 - Juru Scheme Costs

Item	Unit	Rate	Quantity	Cost ($ x 10^3)
Quaternary Development:-				
Quaternary canals	m	5.2	11,250	58.5
Tertiary division boxes	No	4,000	27	108.0
Quaternary division boxes	No	500	15	7.5
Direct offtakes	No	500	25	12.5
Quaternary drains	m	2.4	7,300	17.5
Total cost of quaternary development (= $836/ha)				$ 204.0x10^3
New tertiary canals:-				
24" block section (no farm road)	m	125	2,900	362.5
Reconstruction of existing tertiary canals	m	110	2,800	302.5
Tertiary offtakes (0.6m)	No	8,500	7	59.5
Secondary offtake	No	20,000	1	20.0
Tertiary drains:-				
New m	m	5.0	1,700	8.5
Existing	m	3.0	8,700	26.1
Miscellaneous other works	Sum	-	-	120
Total cost of tertiary development (= $4,521/ha)				$ 1,103.1x10^3

Table F6.28 (Contd.) - Juru Scheme Costs

Item	Unit	Rate ($)	Quantity	Cost ($ x 10^3)
Main/Secondary works:-				
Canal Earthworks	m^3	17	17,500	298
Canal Structures	Sum	-	-	80
New Pumped Intake at Sungai Junjong:-				
Pumps	Sum	-	-	100
Civil Works (including pipeline)	Sum	-	-	330
Tidal Gates	Sum	-	-	600
Total cost of secondary development				$1,408x$10^3$
Total measured items				$2.51 x 10^6
Contractors' preliminary and general items				0.25
Physical contingencies				0.41
Total construction cost				$3.17 x 10^6
Engineering and survey				0.32
Total Juru scheme				$3.49 x 10^6

Table F6.29 - Sg. Burong Scheme Costs

Item	Unit	Rate ($)	Quantity	Cost ($ x 10^3)
Quaternary Development:-				
Rice only areas:-				
Quaternary canals	m	4.8	2,420	11.6
Tertiary division boxes	No	4,000	6	24.0
Quaternary division boxes	No	500	2	1.0
Direct offtakes	No	500	33	16.5
Access culverts : 0.6m	No	3,850	2	7.7
0.9m	No	5,500	3	16.5
Quaternary drains	m	2.4	3,000	7.2
Quaternary drainage control structure	No	8,000	5	40.0
Total cost of quaternary development in rice areas:- (= $814/ha)				$ $124.5x10^3$
Rice/vegetable & maize areas (excluding Kg. Enam area)				
Quaternary canals	m	4.8	13,200	63.4
Tertiary division boxes	No	4,000	16	64.0
Quaternary division boxes	No	500	13	6.5
Access culvert 0.6m	No	3,850	7	27.0
0.9m	No	5,500	12	66.0
Quaternary drains	m	2.4	7,520	18.0
Quaternary drainage control structures	No	8,000	4	32.0
Total cost of quaternary development in rice/vegetable & maize areas (= $1,168/ha)				$ 276.9x10
Quaternary infrastructure in Kg. Enam area:	Sum	-	-	88.8

(Table F6.29 - Contd.)

Table F6.29 - Sg. Burong Scheme Costs

Item	Unit	Rate ($)	Quantity	Cost ($ x 10^3)
Tertiary canals (assumed all totally rebuilt):-				
24" block section -				
with no farm road	m	120	400	48.0
with 3m farm road	m	130	500	65.0
TI section -				
with no farm road	m	150	2,185	327.8
with 3m farm road	m	165	7,470	1,232.5
with 5.5m farm road	m	195	390	76.1
TII section -				
with no farm road	m	165	300	49.5
with 3m farm road	m	180	1,000	180.0
Allow for additional fill	m^3	14	13,500	189.0
Total cost of tertiary canals (= $4,397/ha; av. cost = $177/m including added fill)			(12,245m)	$ 2,167.9x10^3
Tertiary offtakes 0.6m	No	8,500	3	25.5
0.9m	No	11,500	4	46.0
New culvert/syphon under raod	No	20,000	1	20.0
Modifications to existing structures	Sum	-	-	25.0
Tertiary drains new:-	m	5.0	11,490	57.5
existing	m	3.0	3,610	10.8
Drainage control structure:				
new	m	11,000	6	66.0
existing	Sum	-	-	20.0
Miscellaneous works				150.0
Total cost of tertiary development (including Kg. Enam area) (= $ 6,065/ha)				$ 2,990.1x10^3

(Table F6.29 - Contd.)

Table F6.29 - Sg. Burong Scheme Costs

Item	Unit	Rate	Quantity	COst ($ x 10^3)
Main/secondary canal works:-				
no farm road	m	165	510	84.2
3m farm road	m	180	910	163.8
5.5m farm road	m	210	830	174.3
Allow for additional fill	m^3	14	5,100	71.4
Main/secondary canal structures	Sum	-	-	45.0
Main/secondary drain works	Sum	-	-	100.0
Sg. Kongsi Intake & P.S:-				
Pumping plant	Sum	-	-	60.0
electrical equipment	Sum	-	-	30.0
station pipework	Sum	-	-	90.0
building and civil works	Sum	-	-	150.0
tidal gates	Sum	-	-	400.0
pipeline to Sg. Burong	m	400	1,200	480.0
Total cost of main & secondary works				$ 1,848.7x10^3
Pokok Kenanga area:-				
canal: 24" block with 3m road	m	130	1,000	130.0
access culverts	No	3,850	2	7.7
quaternary infrastructure	ha	1,168	32	37.4
tertiary drains	m	5	1,000	5.0
drainage control structure	No	8,000	1	8.0
modifications to intake: allow	Sum	-	-	15.0
Total cost of works in Pokok Kenanga				$ 203.1x10^3

Table F6.30 - Sg. Pinang Scheme Costs

Item	Unit	Rate ($)	Quantity	Cost ($ x 10^3)
Quatenary development:-				
Rice only areas:-				
Quartenary canals	m	4.8	6,580	31.4
Tertiary division boxes	No	4,000	12	48.0
Quaternary division boxes	No	500	1	0.5
Access culverts 0.6m	No	3,850	2	7.7
0.9m	No	5,500	4	22.0
Quaternary drains	m	2.4	3,000	7.2
Quaternary drainage control structures	No	8,000	1	8.0
Total cost of quaternary development in rice areas (= $849/ha)				$ 124.8x10^3
Rice/vegetable & maize areas				
Quaternary canals	m	4.8	29,000	139.2
Tertiary division boxes	No	4,000	32	128.0
Quaternary division boxes	No	500	11	5.5
Access culvert 0.6m	No	3,850	6	23.1
0.9m	No	5,500	24	132.0
Quaternary drains	m	2.4	15,100	36.2
Quaternary drainage control structures	No	8,000	8	64.0
Total cost of quaternary development in rice/vegetable & maize areas				$ 528.0x10^3

(Table F6.30 - Contd.)

Table F6.30 - Sg. Pinang Scheme Costs

Item	Unit	Rate ($)	Quantity	Cost ($ x 10^3)
Tertiary canals:-				
New	m	160 (1)	6,140	982.4
Existing	m	140 (1)	6,200	868.0
Allow for additional fill	m^3	14	5,200	72.8
Tertiary offtakes 0.6m	No	8,000	4	32.0
0.9m	No	11,500	4	46.0
Crossing Sg. Bagan Ayer Itam	Sum	-	-	40.0
Tertiary drains new	m	5.0	4,500	22.5
existing	m	3.5	4,550	15.9
Tertiary drainage control structures	No	11,000	7	77.0
Miscellaneous other works	Sum	-	-	200.0
Total cost of tertiary development (= $5,007/ha)				$3,009.4x$10^3$

(1) Canal rates based on Figure F6.2 for average tertiary unit size of 75 ha.

(Table F6.30 - Contd.)

Table F6. 30 - Sg. Pinang Scheme Costs

Item	Unit	Rate ($)	Quantity	Cost ($ x 10^3)
Main canal works:-				
3m road	m	180	2,900	522.0
5.5m road	m	210	1,100	231.0
Additional fill	m^3	14	23,000	322.0
Main canal structures	Sum	-	-	20.0
Main and secondary drainage works:-				
Extention to Sg. Rusa	m	35	750	26.3
Cut-off drain to east of mainroad	m	15	900	13.5
Improvements to existing drains	m	5	8,000	40.0
Other works	Sum	-	-	20.0
Drainage structures:-				
New tidal gate on Sg. Rusa	Sum	-	-	400.0
Other works	Sum	-	-	150.0
Sg. Pinang headworks modifications	Sum	-	-	50.0
Sg. Rusa intake and P.S.				
Pumping plant	Sum	-	-	30.0
Building and civil works	Sum	-	-	30.0
Other roadworks (not by a canal)				
Earthworks	m^3	15	5,200	78.0
Structures	Sum	-	-	45.0
Total cost main and secondary works				$ 1,977.8x10^3

Table F6.31 - Balik Pulau: Summary of Costs (Group F)

	($\$ \times 10^6$)
Sg. Burong Scheme:-	
Tertiary development - 493 ha at $6,065/ha:	2.99
Main and secondary works	1.85
Pokok Kenanga:	0.20
Total measured items	$ 5.04×10^6
Contractor's preliminary & general items	0.50
Physical contingencies	0.83
Total construction cost	$ 6.37×10^6
Engineering & Survey	0.64
Total cost	$ 7.01×10^6
Sg. Pinang Scheme:-	
Tertiary development - 601 ha at $5,007/ha:	3.01
Main and secondary works	1.98
Total measured items	$ 4.99×10^6
	0.50
Physical contingencies	0.82
Total construction cost	$ 6.31×10^6
Engineering and Survey	0.63
Total Cost	$ 6.94×10^6

Table F6. 32 - Breakdown of construction costs by type of input (percentage)

Item	Materials	Labour	Transport	Plant	Overhead/ Profit	Total
Imported fill	4.4	2.2	15.7	6.6	8.6	37.6
Concrete lining	4.0	1.3	0.8	0.4	1.9	8.4
Excavation	-	1.8	-	6.6	2.5	10.8
Struct: concrete	6.3	2.0	0.7	0.4	2.9	12.3
Material items	0.4	0.1	0.1	-	0.1	0.7
Labour items	0.1	2.0	0.2	0.2	0.8	3.4
	15.2	9.4	17.5	14.2	16.8	73.2

Contractors' preliminary and general items	7.3
Physical contingencies	12.1
Engineering and survey costs	7.4
	100.0

Table F6.33 Kulim Scheme Land Valuation

Area	Neasrest Road	Proximity to Road	Price (mean) M$ per acre
3	Jalan Permatang Pauh E side - Simpang Ampat	Frontage	87,000
		3rd layer in form road	30,000
		> 30 ch (600 m) from raod	18,000
		> 50 ch (1 km) from road	13,000
6/7	Permatang Pauh - Permatang Ara - Kubang Semang	Frontage	17,000
		10-ch-20 ch (200-400 m)	15,000
		30 ch (600 m) from raod	12,000
4	Bund-way from Kampong Permata to Kubang Semang	Frontage	16,000 - 21,000
8	Tanah Liat - Kubang Semang	10 ch-20 ch (200-400 m) from road	15,000 - 30,000
		> 20 ch (400 m) from road	14,000
5	Bukit Mertajam new road Jalan Muthupalaniapa	2nd layer from road	130,000 44,000

Table F6.34 Summmary of land values in Seberang Perai Utara

1) The following values refer to those areas near to principal roads between towns/villages north of Bagan Ajam and south of Kepala Batas.

Road frontage land

Kampong use	-	about 35,000 - 45,000 p. acre
Bendang use	-	about 15 - 25,000 p.acre (generally small plots)
Rubber & oil palm	-	about 25,000 p. acre if small plots (say up to 10 acres) about 10 - 15,000 if larger areas

2nd layer

Kampong use	-	about 25 - 35,000 p. acre
Bendang use	-	about 7 - 10,000 p. acre
Rubber & oil palm	-	about 7 - 10,000 p. acre

Interior

Kamoung use	-	about 15,000 p. acre
other uses	-	about 7,000 p. acre

2) Development Zone A, Teluk Ayer Tawar

These are generally lands ripe for housing development particularly those lying to the west of the main road,

Land with road frontage - about $7 psf (V.P. Value)
No road frontage but with access - about $6 - 6.50 psf (V.P)
Sea frontage with access - about $7 psf (V.P.)

3) Development Zone B, Kepala Batas

These lands are also ripe for housing and cottage industrial development.

Road frontage	-	about $2 - 3 psf
2nd layer	-	about $1 psf
Interior	-	about $25,000 p. acre

4) <u>Development Zone C, West of Sg. Dua</u>

Lands here are generally for light industries and some housing.

Lands zoned for light industry (with access) - $1.50 psf

Lands zoned for light industry (without access) - $1 psf

Interior lands with no access - about 15 - 20,000 p. acre

5) <u>Development Zone D, Penaga (In particular the land west of the main road)</u>

Frontage land (ripe for housing)	-	$1.50 - 1.75 psf
Frontage kampong land	-	$35 - 45,000 p. acre
Other use	-	$15 - 25,000 p. acre
2nd layer:		
Kampong land	-	about 30 - 35,000 p. acre
Others	-	about 10 - 15,000 p. acre
Interior		
Kampong land	-	20 - 25,000 p. acre
Others	-	about 10,000 p. acre

6) <u>The following values refer to all other areas</u>

Road frontage lots:		
Kampung use	-	about 30,000 p. acre
Bendang use	-	about 9,000 p. acre
Rubber/Oil Palm	-	about 10 - 12,000 p. acre
2nd layer		
Kampung	-	about $25,000 p. acre
Bendang	-	about $7,000 p. acre
Rubber/Oil Palm	-	about $9,000 p. acre
Interior		
Bendang/Rubber/Oil Palm	-	about 7,000 p. acre

Note: The above quoted values are only approximations and the values within the same locality can differ widely for various reasons, in particular the recommended land use by the State Authorities. Even for agricultural land the values will differ according to the type of crop grown. For example if a land has padi the value say is $7,000; if it is rubber it could be 7,500 (depending on age), if oil palm it would be about $ 8 - 9,000 and if fruit trees it will be about 12,000 p. acre, so it must be emphasised that the above figures only indicate the range.

Table F6.35 - Seberang Perai Selatan: Land Price Estimates

	Road Frontage	2nd layer	3rd/4th layer	Interior	Remarks
Bt. Minyak area					
N of Main road	\$4-\$6 WP				N E of main road all very expensive due to Bt. Mertajam expansion
S of Main road	2.50-3		12-18,000		
Road to Juru Town	1.30-1.50	38,000kg 23,000 R		7-8,000	
Road to Bt. Kechil	30,000		23,000 R	8,500 -10,000	
Permatang Tinggi	0.80-1.00				
Bukit Tambun					
Main road (Trunk road)	1.50-2 WP 30,000 -40,000 OP	15-25,000 R.OP 20,000		10-15,000 R.OP	
Main road Industrial Zone	40-50,000	28-40,000			
Roads to BT west of main road	1-2.20 m trunk 30-40,000 further from trunk rd.	20-30,000 Kg R, OP		8-10,000	
Roads East of Trunk road	30-45,000 Kg 26-32,000 R 20,000 OP(large)	25-30,000 Kg 20-25,000 R		8-12,500 R	
Nibong Tebal road to West	15-20,000 OP	12-15,000* R, OP		8-10,000	*Fronting laterite access road

Kg - Kampong land

WP - with potential for development

R - rubber land } including value of trees

OP - oil palm }

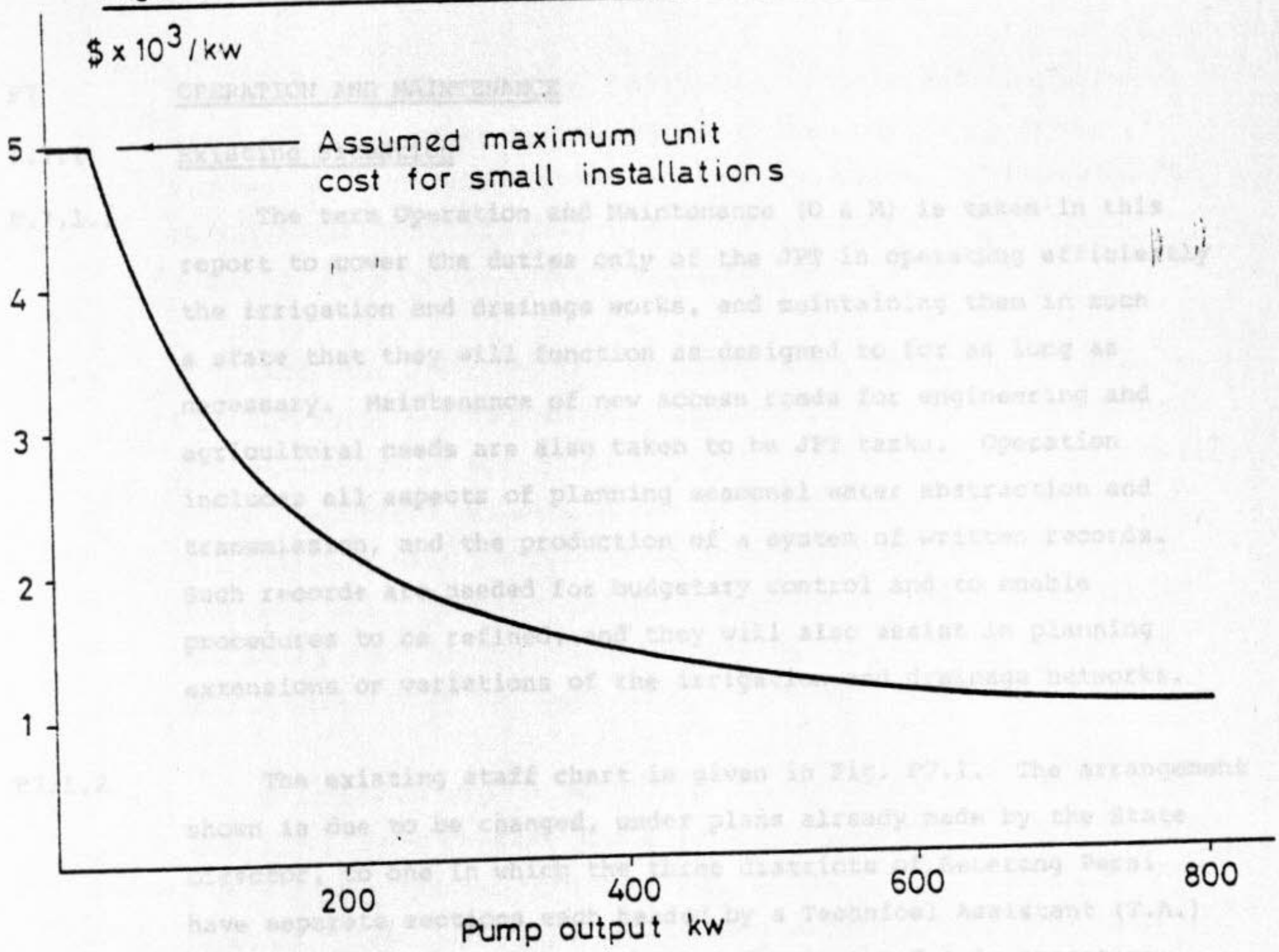
Table F6.36 - Land Values for Drainage Areas

All in M$ per acre

Area	Interior land	Approach strip perpendicular to road	
Bt. Minyak	10,000	25,000	(4 layers averaged)
Bt Tambun	9,000	20,000	"
Nibong Tebal	9,000	20,000	"
Tg. Berembang	10,000 (bendang)	14,000	
Tasek Glugor	7,000	20,000	

This is a simplified table prepared by Binnie dan Rakan from data in Table F6. 35

Figure F6.1 AVERAGE COSTS OF ELECTRIC PUMPING PLANTS



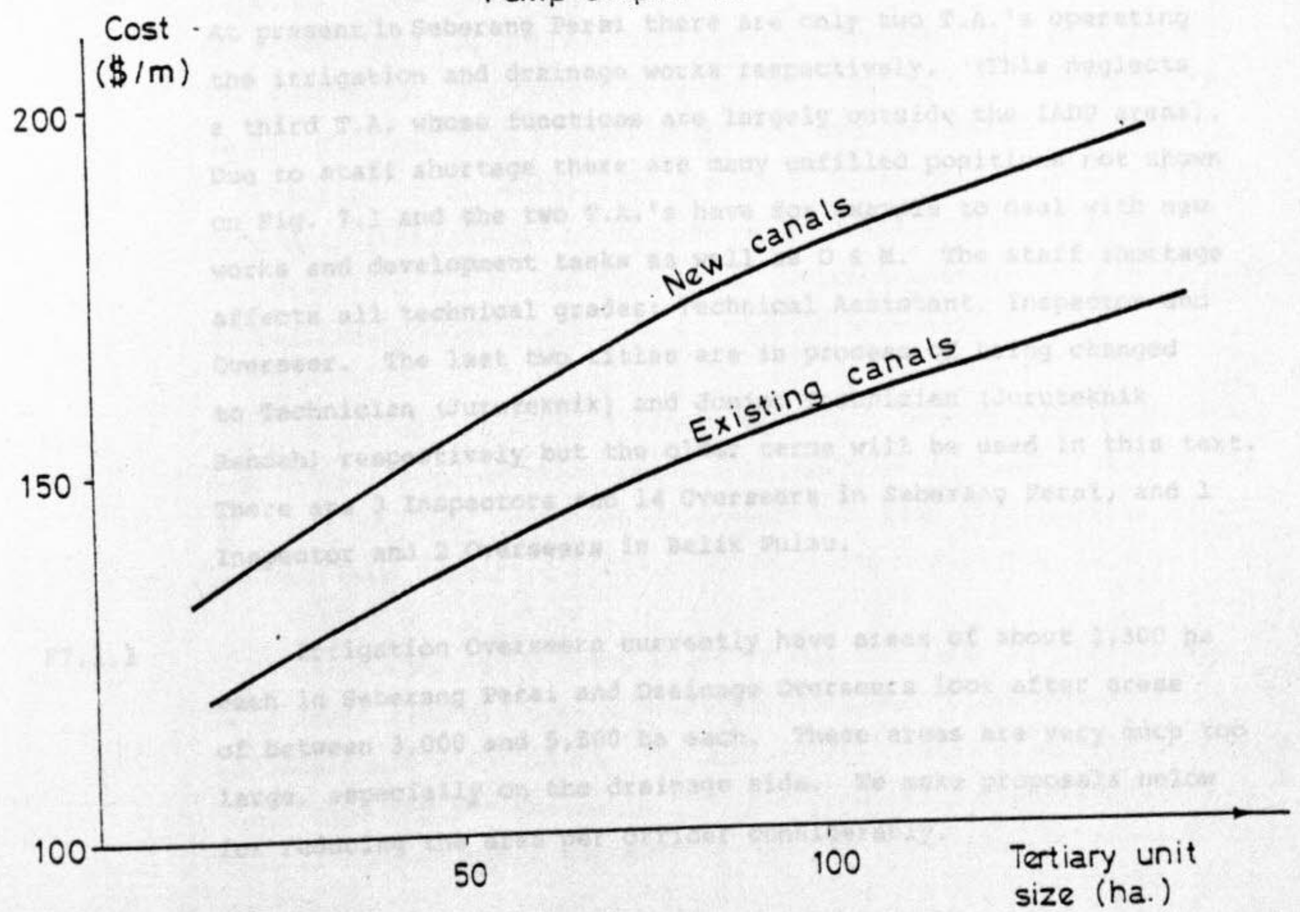


Figure F6.2 VARIATION OF AVERAGE TERTIARY CANAL UNIT COSTS WITH TERTIARY UNIT SIZE

F7 OPERATION AND MAINTENANCE

F.7.1 Existing Situation

F.7.1.1 The term Operation and Maintenance (O & M) is taken in this report to cover the duties only of the JPT in operating efficiently the irrigation and drainage works, and maintaining them in such a state that they will function as designed to for as long as necessary. Maintenance of new access roads for engineering and agricultural needs are also taken to be JPT tasks. Operation includes all aspects of planning seasonal water abstraction and transmission, and the production of a system of written records. Such records are needed for budgetary control and to enable procedures to be refined, and they will also assist in planning extensions or variations of the irrigation and drainage networks.

F7.1.2 The existing staff chart is given in Fig. F7.1. The arrangement shown is due to be changed, under plans already made by the State Director, to one in which the three districts of Seberang Perai have separate sections each headed by a Technical Assistant (T.A.) At present in Seberang Perai there are only two T.A.'s operating the irrigation and drainage works respectively. (This neglects a third T.A. whose functions are largely outside the IADP areas). Due to staff shortage there are many unfilled positions not shown on Fig. 7.1 and the two T.A.'s have for example to deal with new works and development tasks as well as O & M. The staff shortage affects all technical grades: Technical Assistant, Inspector and Overseer. The last two titles are in process of being changed to Technician (Juruteknik) and Junior Technician (Juruteknik Rendah) respectively but the older terms will be used in this text. There are 3 Inspectors and 14 Overseers in Seberang Perai, and 1 Inspector and 2 Overseers in Balik Pulau.

F7.1.3 Irrigation Overseers currently have areas of about 1,300 ha each in Seberang Perai and Drainage Overseers look after areas of between 3,000 and 5,500 ha each. These areas are very much too large, especially on the drainage side. We make proposals below for reducing the area per officer considerably.

F7.1.4 At Balik Pulau the staffing is more intensive on a per-hectare basis, but cannot be reduced. The isolation of Balik Pulau from both its controlling office (Georgetown) and the Seberang Perai staff mean that there must be enough officers there to cover sickness and emergency without outside assistance. Comments below on individual responsibilities and areas do not apply to Balik Pulau for this reason, unless specifically so qualified.

F7.1.5 Below the Overseers the operating staff comprises Gatekeepers, Pump Operators and Attendants. Gatekeepers on the Sg. Muda scheme have an average of nearly 400 ha each, (7 or 8 gates) and in addition there are keepers resident at the main tidal drainage gates. The major pumping stations operate 24 hours a day and each has 3 Pump Operators and 3 Attendants. Drainage water re-use stations and the supply stations for small schemes may only run for one or two shifts at any time and their staff is reduced in proportion.

F7.1.6 Maintenance work is controlled by the same staff structure as operation. Each Overseer has a labouring gang in his section, each with a <u>mandor</u> (ganger) and averaging 14 men. These numbers have recently proved insufficient for the necessary cutting and clearing of vegetation, and in 1981 this work has been let out to contract. The contractor is required to clear his section six times per year. We are informed this frequency is often not sufficient, and that supervision of the contractor's working on minor canals is difficult. This difficulty should be eliminated with the project proposal to concrete line all tertiary canals. Contract work could then be limited to main and branch canals, if it remains necessary at all.

F7.1.7 Within the irrigation canals desilting is very rarely necessary and there are no units of mechanical plant in regular or annual use for this purpose. Dragline excavators are used continuously on coastal bund repairs and desilting of large drains and rivers.

F7.1.8 Maintenance of pumping plant is done in Seberang Perai Utara by a small team of three tradesmen - chargeman electrician, fitter and assistant electrician. If repairs are needed which are beyond their capacity assistance is provided from the JPT workshop in Ipoh. This is no mechanical workshop for JPT in the State.

F7.1.9 Supporting services needed by and for the O & M staff can be listed as:

- training
- transport
- housing
- telecommunications
- welfare

F7.1.10 It appears that staff training at present is not adequate, and is limited to the possibility of attending a 2 or 4-week course at Kuala Lumpur for inspectors and overseers. A more extended training course is clearly necessary but would not be feasible within the limited scale of the Pulau Pinang JPT. However we should expect that suitable training could be available from MADA, and recommend that this is followed up. In view of the staff expansion in Pulau Pinang which will be needed with the Project we propose posts for Trainee Inspector (one) and Trainee Overseer (two) to be established. The trainees can understudy the regular staff and would be available to act in operational posts during staff absences. Trainees should be examined after one year and, if passed as satisfactory, appointed to regular posts when there are vacancies.

F7.1.11 Transport for staff of Overseer level and above is satisfactorily dealt with by the simple expedient of giving financial aid, if needed, for the purchase of a car or motorcycle and thereafter paying an adequate travelling and transport allowance. Official quarters for Inspectors, Overseers and Pump Operators are sufficient in Seberang Perai Utara though more houses are needed in the Central District.

F7.1.12 Telecommunications at present are poor, being limited to telephones in the JPT offices and senior staff housing. No inspectors or overseers have telephones or radio in their houses or at places of work. Provision of such links is essential to an effective O & M system, and the cheapest way in capital costs would be to connect all staff of overseers and above to the public telephone system. This may be open to abuse by excessive unofficial use of the telephone, but there should be administrative means of discouraging such abuse. The alternatives are a private JPT telephone network or radio. A private telephone network is probably the most reliable and effective, but its provision would depend on the degree of sophistication of the existing Jabatan Telekom system.

F7.1.13 Welfare has been included as an index word to draw attention to the need for a deliberate and sustained effort by those in authority, both in District administration and at JPT State headquarters, to encourage the efforts of the O & M staff and ensure that their contribution to the agricultural economy is appreciated. Specific welfare facilities like recreation halls and sports grounds may not be needed in the rather advanced society of Pulau Pinang, with its good transport provision, but the welfare of the O & M staff still requires to be actively considered, to ensure a high morale among them at all levels.

F7.2 Future Requirements

F7.2.1 In Figure F7.2 we show the proposed future O & M staff chart. This incorporates the principle of dividing the staff by Districts which has already been proposed by the State JPT. This principle of supervising areas, rather than drainage or irrigation works only, can be carried right down to Overseer level where appropriate, but normally the drainage and irrigation areas are well separated geographically. An exception is the Tasek Gelugor drainage area in the east of Seberang Perai Utara, which is surrounded by irrigation schemes.

F7.2.2 The new staff required in Seberang Perai and whom we have included in our incremental O & M costs, are:

1	Senior Engineer (half time)
1	Engineer
1	Technical Assistant
2	Inspectors (1 irrigation, 1 drainage)
3	Hydrological technicians
1	Chief Clerk
3	Clerks

plus Overseers and gatekeepers as in Tables F7.2 and F7.3.

In addition there are the three trainee posts mentioned in Section F7.1.10. No additional pumping station staff are necessary since some existing stations should be discontinued. In view of the reduction in maintenance load which will result from lining the minor canals and eliminating vegetation within them, and because we recommend that quaternary canals and drains are kept by the farmers, we do not recommend any increase in the general maintenance labour force for irrigation schemes.

F7.2.3 In the case of drainage areas there will be much additional work in maintaining water table control structures, new culverts and collector drains, and in providing a higher standard of bund maintenance, including lobster control. We estimate this requires a new gang to parallel the six Overseer posts; one gang of ten men is allocated to each Overseer and the average area of responsibility for one overseer will be about 2,000 ha. We recommend routine maintenance of the drain system to be as shown in Table F7.6.

F7.2.4 We also include a realistic-sized mechanical plant fleet for the drainage areas for drain, bund and road maintenance, with their operators. No such plant is in theory allocated now to drainage maintenance and therefore the "increment" in this case looks larger than it really is, because draglines and other excavators are in fairly regular use at present, though charged to other tasks. The following machines are proposed:

Table 7.1 Earthmoving and similar plant for Drainage area maintenance

	No. of units
Dragline excavators (22RB or similar)	7
Hydraulic back-hoe	4
Agric: tractor & trailer	2
Motor grader, 4 tons	1
Road roller, 5 tons	1

The only routine tasks which will continue to be let out to contract will be clearing of vegetation, etc: from main drains, and the supply only of laterite (red earth) for access road maintenance.

Table F7.2 Drainage area O & M requirements for Industrial and Manual Grades

Grade	Numbers of men		
	existing	proposed	increment
Gatekeeper	16	16	0
Plant operators			
large units	0	9	9
small units	0	9	9
Mandor/labourers (river clearing gangs excluded)	30	90	60
Total IMG	46	124	78

F7.2.5 In Tables F7.2 and F7.3 there are large increases in the numbers of Overseers and Gatekeepers, amounting to a doubling of the existing staff in both categories. An essential part of the upgrading operation is the development of closer links with the farmers and smallholders, and the operation and maintenance of a system of minor canals and drains, which, for the most part do not exist at present. The new establishment is shown in Table F7.3.

Table F7.3 Requirement for Overseer and Irrigation Area Gatekeepers

	Area per officer (ha)	No required	Existing Nos.	Incremental Nos.
Overseers				
Irrigation areas:				
Seberang Perai	800	19	11	8
Balik Pulau	-	3	2	1
Drainage areas	2000	9	3	6
Total		31	16	15
Gatekeepers				
Irrigation areas:				
Seberang Perai) group farms	300	23	42	42
) smallholders	120	61		
Balik Pulau	90	12	10	2
Total		96	52	44

F7.2.6 In the smallholder areas which will remain, (48% of Seberang Perai irrigation) the gatekeeper's task will be of crucial importance in ensuring the fair distribution of water within each tertiary unit. For this reason we have shown a much higher density in smallholder areas than group farm areas. In the latter the gatekeeper's responsibility would be limited to the works outside group farm boundaries. The appointment of gatekeepers within smallholder areas will require very careful selection in conjunction with the Penghulu and local civil administration. It may be that they should not be from the same kampong as the farmers of their area, as a certain "judicial distance" will need to be kept between them.

F7.3 Costs of Operation and Maintenance

F7.3.1 Incremental costs are given below:-

Table F7.4 - Operation and Maintenance Costs

	Item	Incremental annual costs (Mx 10^3$)	
		Irrigation	Drainage
1	Staff	445	429
2	Maintenance of		
	a) Quaternaries & tertiary drains	38	-
	b) Lined tertiaries	8	-
	c) Main & branch canals by contract	100	-
3	Red earth supply by contract	75	107*
4	Operation of new plant	71	366*
5	Clearing of drains	-	411*
6	Minor supplies and spares	50	
	Sub-total	787	1,313
7	Operation of pumping stations		117* (note 1)

* Items starred will be reduced pro rata to area if works in Bukit Tengah and Sg. Udang/Tg. Berembang are not proceeded with.

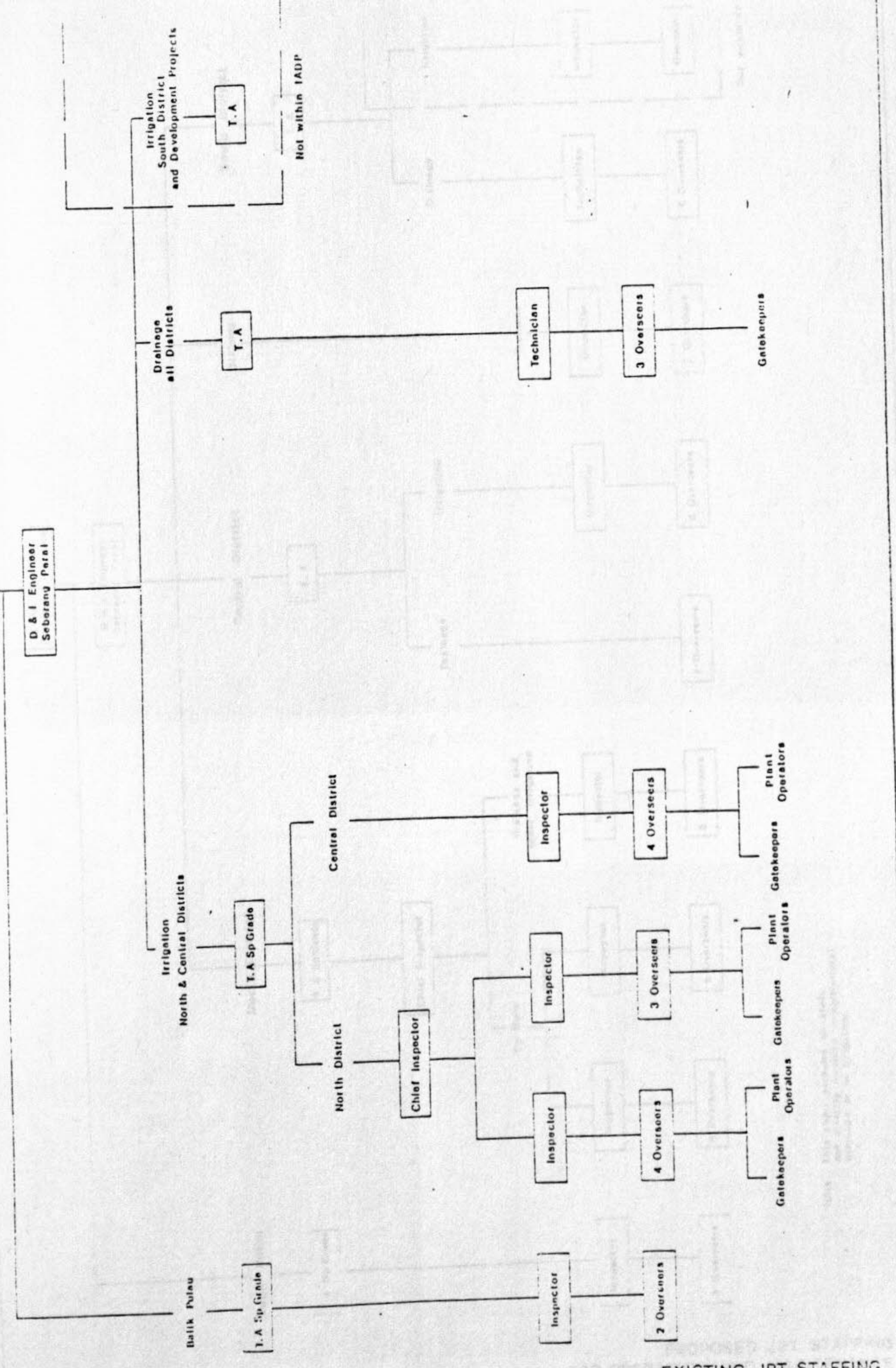
Note (1) - $105,000 of this figure applies to Bukit Tengah P.S. which is not recommended as a necessary improvement for agricultural reasons.

Table F7.5 - Incremental Operation and Maintenance Costs - Drainage areas

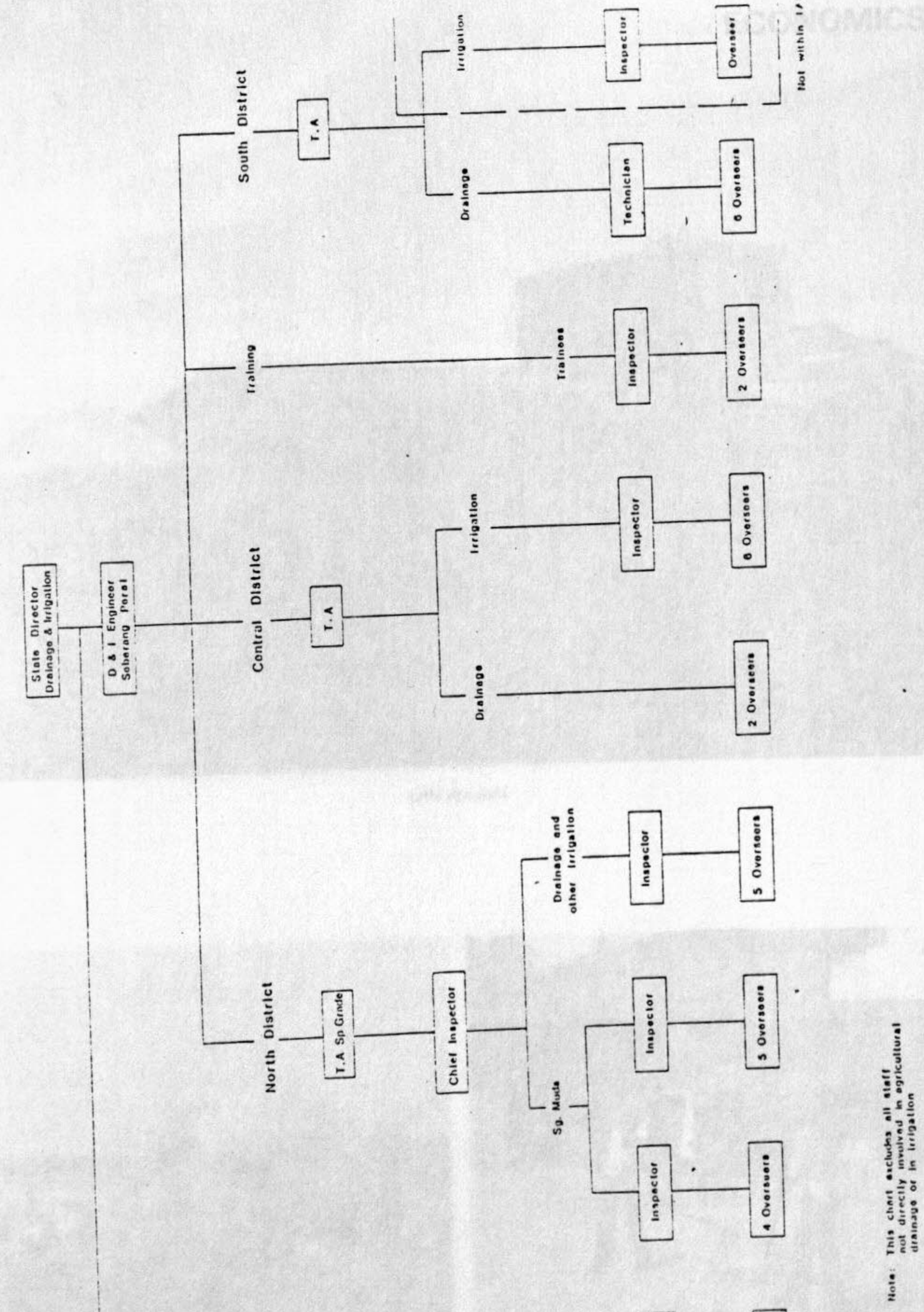
Item	Costs ($ x 1000)					
	Bkt. Tengah	Bkt. Minyak	Bkt. Tambun	Nibong Tebal	Sg. Udang	Total
1. Salaries (incremental - pro-rata)	27.34	94.12	121.15	164.72	21.67	429.00
2. Clearing of drains	55.65	66.07	114.26	145.27	3.00	411.25
3. Maintenance of roads (pro-rata)	6.72	23.11	29.74	40.44	6.50	106.51
4. O & M of plant and machinery (pro-rata)	23.00	80.00	100.00	145.00	18.00	366.00
5. Total O & M of provisional supplementary pump @ Juru Dam	105.00	-	-	-	-	105.00
6. Total O & M of emergency pumps	0.78	2.68	3.45	4.69	0.60	12.20
Total	218.49	265.98	368.60	500.12	76.77	1,429.96

Table F7.6 - Maintenance Schedule for drainage area

Item	Frequency: No of times per year
A. Clearing and slashing of Weeds	
1. Borrow pits	2
2. Main drains and rivers	4
3. Secondary drains	6
4. Feeder drains	to be carried out by smallholders as regularly as possible
B. Desilting	
1. Borrow pits, rivers main and secondary drains	once every two years
2. Outlets of tidal gates	1 - 2 times a year



EXISTING JPT STAFFING
FOR OPERATION AND MAINTENANCE
Figure F7.1



PROPOSED JPT STAFFING
FOR OPERATION AND MAINTENANCE
Figure F7.2

LPN rice mill

Transporting padi to mills

Drying padi in the open at rural rice mill

ANNEXE G

ECONOMICS

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TABLE

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for Malaysia and in general use by the EPU.

Economic Analyses

G1.1.5 Economic analyses are carried out at the group scheme level and at the aggregated project level. The latter include off-farm costs which cannot be attributed directly to the individual schemes. Sensitivity tests are carried out to indicate the stability of the project if costs were to rise and revenues to fall. Economic indicators, NPV's and IRR's, are calculated.

The Financial Analyses

G1.1.6 The financial analyses include the calculation of NPV's and IRR's at market prices, an estimate of financing requirements allowing for cost escalation and a comparison of present farm incomes with those anticipated after implementation of the project. Please note that all costs and potential benefits arising in the drainage areas are excluded from this Annexe.

G2 PRESENT AND FUTURE WITHOUT-PROJECT SITUATION

G2.1 Introduction

G2.1.1 In the economic analysis of Chapter G5, the mainland group of schemes (Seberang Perai) are distinguished from those on Penang Island (Balik Pulau).

G2.1.2 Traditionally the irrigation schemes of Seberang Perai have been almost entirely devoted to rice monoculture with two crops per year being grown throughout the majority of the area. A small area of diversified cropping, about 200 hectares of rice and vegetables, is practised in part of the Pinang Tunggal scheme, where topography and land levels have precluded double rice cropping. Double rice cropping has come under increasing pressure in recent years and padi land has been abandoned at an alarming rate. The reasons for abandoning land are well known and are generally listed as poor drainage, staggered planting, difficulty in controlling rodent pests, the small size of holdings, and high proportion of tenant farmers. Together they have resulted in low levels of income which have not been competitive with incomes offered in other rapidly expanding sectors in the urban-industrial areas.

G2.1.3 The Balik Pulau scheme comprising the two main irrigation areas of Sg. Pinang and Sg. Burung has traditionally been devoted to the cultivation of rice. Water availability however, has limited rice cultivation to a single main season crop in Sg. Pinang and restricted double rice cropping in Sg. Burung to a maximum area of about 200 ha. No other crops are grown on the padi land. Until the 1977/78 crop year (off-season 1977 main season 1977/78) both areas were fully cultivated in the main season whilst off-season cultivation (Sg. Burung) was well below the area potentially cultivable. From the 1978/79 crop year there has been continual decline in the main season areas cultivated. This decline has been particularly marked in Sg. Burung where by the 1980/81 main season only 15% of the cultivable area had been cropped. In the same season the area cropped in Sg. Pinang had fallen to just under half (48%) of the cultivable area. The socio-economic survey of Balik Pulau carried out by the Consultants indicated that the farmers themselves regarded pests as the most serious problem affecting rice cultivation.

G2.1.4 The current system of rice production is based on individually farmed smallholdings, the majority of which range in size between 0.2 ha and 2.5 ha with an average size of about 0.75 ha. The production system is labour intensive with land preparation, transplanting and harvesting mainly being carried out by hand methods.

G2.2 Areas

G2.2.1 As stated in the previous section a considerable area has been abandoned. Table G2.1 shows the estimated areas cultivated in the off and main seasons during the cropping year 1980/81.

Table G2.1 Present Cultivated Areas

Scheme	1980 - 81 Off Season	1980 - 81 Main Season
Group A		
Sungai Muda	6,707	5,540
Group B		
Pinang Tunggal	1,505	1,505
Jarak	360	340
Tasek Gelugor	168	240
Jarak Tengah	77	55
Group C		
Sungai Kulim	470	870
Group D		
Alma	95	95
Machang Bubok	58	115
Renjau	20	20
Kuala Tasek	20	20
Tasek Junjong	155	155
Sungai Duri	20	20
Group E		
Juru	58	115
Group F		
Pulau Pinang	0	275
Sungai Burong	110	75

G2.2.2 The rate of decline for different areas is not constant and in the 'future without' situation projections have been made for the separate schemes. Only Group D is expected to remain unchanged. Table G2.2 summarises the'future without' project areas for Groups A to F. 'Cropped area' refers to the total annual area cropped whilst the 'irrigable area' shown in brackets is the area of land upon which the crops are grown. Division of the former by the latter gives the cropping intensity.

Table G2.2 Cropped and Irrigable Areas, 'Without Project' (ha)

Group	Year 1981/82	1982/83	1983/84	1984/85	1985/86
A	9,485 (5,194)	8,697 (4,762)	7,907 (4,330)	7,119 (3,898)	6,223 (3,408)
B	3,710 (1,886)	3,550 (1,800)	3,340 (1,694)	3,200 (1,625)	3,200 (1,625)
C	800 (520)	540 (350)	540 (350)	540 (350)	540 (350)
D	793 (425)	793 (425)	793 (425)	793 (425)	793 (425)
E	150 (100)	113 (75)	75 (50)	75 (50)	75 (50)
F	375 (300)	325 250	275 (200)	275 (200)	275 (200)

Note: Bracketed Figures are Irrigated Areas

G2.3 Crop Yields

G2.3.1 As stated earlier most of the cultivated area normally grows rice with the exception of a net area of 180 hectares growing off-season vegetables in Pinang Tunggal. The present and future yield levels of rice are the major determinants of incremental benefits enjoyed as a result of rehabilitation.

G2.3.2 The yield data collected by the JPT for the main and off-season crops for the years 1976/77 to 1979/80 has been subjected to linear regression analysis to determine underlying trends (increasing or decreasing) and to predict a pre-project level of yields for 1980/81 and 1981/82, the years when rehabilitation of the schemes is expected to start. The analysis has been carried out at the individual scheme and aggregated scheme group level. The analysis for the aggregated schemes has been done both by weighting the average yields according to the scheme size and gross production and using a simple average of all scheme yields. The results of the analysis were as follows:-

(a) Sungai Muda: Main season yields are declining at around 4% per year whilst off-season yields are declining by about 8%. The yield data is for the entire scheme and it is not possible to differentiate between the northern/eastern part where double cropping is practised consistently throughout a large area and the southern part where there are large tracts of abandoned land. The southern part with its less reliable water supply and greater proportion of abandoned land (hence greater susceptibility to pests) will probably have significantly lower yields than the north and thus is likely to make the greatest contribution to the overall decline in yields.

(b) Pinang Tunggal: Main season yields have increased at about 2% per annum while off-season yields have declined at around 6%. Overall there is probably a slight declining trend in yields.

(c) Other Areas in Seberang Perai: There is little evidence of any increase in yield level over the last few years, and evidence to show that there is a significant decline in some sub-schemes.

(d) Balik Pulau:-

(i) Sungai Burung: Only main season data available. Data suggests increasing yields at around 4% per annum. Yields about average.

(ii) Sungai Pinang: Although the average yields for the four main seasons, 1976/77 to 1979/90, are slightly higher than Sungai Burong they are apparently declining at around 6% per annum.

G2.3.3 Taking the schemes in aggregate the data suggests a 3% per annum decline in main crops and a 4% per annum decline in off-season crops. Clearly it is unrealistic to expect linear relationships between yield and time to persist over medium to long periods and it can be expected that yield levels would probably level out by the stage where the abandonment of land is stabilized or stops. It is quite possible that the project area would eventually be left with a residual core of padi land consolidated near the major off-takes and distribution network. This area would be protected from rats and would not suffer from water shortage or drainage problems. This stage is rapidly being approached on all major schemes.

G2.3.4 Also the extension effort is intended to be intensified, the input subsidy is being continued and new varieties with higher yield potential are being released (e.g. MR1/MR7). Given these factors it is considered reasonable to assume that the declining yields from 1976/77 will soon at least be arrested and that an assumption of constant yields based on the 1980/81 levels (from the analysis) could be assumed for the 'without project' situation. The proposed yields for the 'without project' situation are given in Table G2.3. With the exception of Pinang Tunggal the yields are calculated as a weighted average. The annual average is derived as the mean of the off and main season yields.

G2.4 Crop Production Systems

G2.4.1 Smallholder rice production is based upon the simple husbandry techniques of traditional padi culture. In Balik Pulau smallholder production systems are of little interest since so much of the area has been abandoned. In Seberang Perai, however, some 6,000 hectares would be expected to remain under smallholder cultivation without the project.

G2.4.2 More than 50% of farm households in Seberang Perai are tenant cultivators. There are few fixed farm costs and an estimate of income for three representative farm sizes can be estimated from crop budgets. The budgets are presented below and anticipate that, even without rehabilitation, machinery will be substituted for labour in the production process. Mechanized land preparation, direct seeding and mechanized harvesting are likely to affect smallholder techniques both with and without rehabilitation. It is only, however, with rehabilitation of the irrigation and drainage system that rice cropping will become sufficientlyprofitable to encourage the widespread application of new technologies.

G2.4.3 Tables G2.4 and G2.5 summarises the without-project crop budgets in 1980 Ringgit for both financial and economic prices. Crop production costs have been adjusted downward from with-project crop costs to allow for the lower level of mechanization. Fertilizer is supplied free and use of it is not expected to be affected by profitability. These adjustments are:-

	% of 'Future With' Costs used in 'Future Without' Analysis
Fertilizer	0
Other Materials	80
Machinery	50
Labour	80
Other	50

Any further details of production costs can be found in Appendix GI . For scheme and project level financial analysis, both fertilizer and labour are costed at the market rate. For the purpose of assessing current farm incomes a variety of different assumptions are made about labour whilst fertilizer costs are not included.

G2.5 Farm Incomes

G2.5.1 Estimates of annual farm income, by scheme, are derived using these crop budgets and cropping intensities taken from Table G2.2. A tenant farmer and a landowner are considered, with three farm sizes of .60, .75, and .90 hectares. It is assumed that only rice is grown; vegetable production is only of significance in one small area in Pinang Tunggal covering some 180 hectares. Table G2.6 presents the results. Rent is estimated to be 1/3 of gross revenue for tenant farmers. It is assumed that the intensity on cultivated land has stabilized to its long term level; this corresponds to the last column of Table G2.2. These figures by themselves conceal widely different levels of crop intensity. In most of the areas of Seberang Perai a second crop is common whilst in Balik Pulau there is a marked off-season water shortage. The intensities can however be interpreted as to some degree reflecting the security of water supplies.

G2.5.2 These results show a maximum income for a landowning family on 0.60 hectares (1.5 acres) of M$1,935 per annum. This must be compared with a wage of around M$2,400/annum for unskilled industrial labour. The only crop providing a competitive return is vegetables. In the vegetable area of Pinang Tunggal the income for an owner cultivator producing rice, followed by vegetables, is M$6,419 for a .90 hectare plot. A sharecropper on 0.60 hectare receives only M$2,940 even when all labour is provided from the family.

Table G2.3 Without Project Yields by Scheme

Scheme	Main Season (1) (kgs/ha)	Off-Season (2) (kgs/ha)	Average Yield (kgs/ha)
Group A			
Sungai Muda	2,930	2,670	2,800
Group B			
Pinang Tunggal	3,750	2,880	3,300
Sungai Jarak	1,460	1,960	1,700
Tasek Glugor	1,820	2,170	2,000
Jarak Tengah	2,770	2,790	2,800
(Menkuang Mak Sulong) (3)	2,780	2,780	2,800
Pokok Jeneris	-	-	-
Kubang Menderong	-	-	-
		Group average	3,300
Group C			
Sungai Kulim		1,840	2,800
Group D			
Alma	2,350	2,350	2,350
Machang Bubok	1,470	1,510	1,500
Sungai Renjau	2,000	2,520	2,250
Kuala Tasek	1,600	2,250	1,900
(Cherok Tok Kun) (3)	-	-	-
Sungai Duri	2,820	2,820	2,800
Tasek Junjong	1,600	2,260	1,950
		Group average	2,240
Group E			
Juru area	1,600	1,600	1,600
Group F			
Balik Pulau	2,580	-	2,600

Notes:

(1) 1980/81 wet season
(2) 1980 dry season
(3) Unlikely to be retained

Table G2.4 Rice: Future Without-Project Crop Budgets
(1980 Constant M$/ha)

Group	FINANCIAL						ECONOMIC					
	A	B	C	D	E	F	A	B	C	D	E	F
Yield (T/ha)	2.8	3.3	2.8	2.2	1.6	2.6	2.8	3.3	2.8	2.2	1.6	2.6
Price (M$/T)	612	612	612	612	612	612	716	716	716	716	716	716
Gross Revenue	1,714	2,020	1,714	1,346	979	1,591	2,005	2,365	2,005	1,575	1,146	1,862
Production Costs	1,423	1,423	1,423	1,423	1,423	1,423	1,193	1,193	1,193	1,193	1,193	1,193
Net Revenue	291	599	291	(77)	(444)	168	812	1,172	812	382	(47)	669
Net Revenue (No Fertilizer Cost & only 50% of labour)	929	1,235	929	561	194	806	-	-	-	-	-	-
Net Revenue (No Fertilizer or labour costs)	1,331	1,637	1,331	963	596	1,208	-	-	-	-	-	-

Table G2.5 Vegetables' Future Without' Crop Budgets

(1980 M$/ha)

	Financial	Economic
Yield (T/ha)	13.3	13.3
Price (1)	496	422
Gross Revenue	6,596	5,612
Production Costs	3,340	2,871
Net Revenue	3,256	2,741
Net Revenue (No Fertilizer Costs and 50% of Labour)	4,723	-
Net Revenue (No Fertilizer or Labour Costs)	5,496	-

Table G2.6 Smallholder Farm Incomes Without Project

(1980 M$/Farm Household)

		Yield	Intensity	All Labour Services Provided by Family			50% of Labour Requirement Paid Wages		
				.60ha	.75ha	.90ha	.60ha	.75ha	.90ha
OWNER	A	2.8	1.83	1,461	1,827	2,192	1,020	1,275	1,530
	B	3.3	1.97	1,935	2,419	2,902	1,460	1,825	2,190
	C	2.8	1.54	1,230	1,537	1,845	858	1,073	1,288
	D	2.2	1.87	1,080	1,297	1,556	629	787	944
	E	1.6	1.50	536	671	805	175	218	262
	F	2.6	1.38	1,000	1,250	1,500	667	834	1,001
TENANT	A	2.8	1.83	834	1,042	1,250	393	491	589
	B	3.3	1.97	964	1,205	1,446	664	830	996
	C	2.8	1.54	702	878	1,054	330	413	496
	D	2.2	1.87	577	721	865	126	158	190
	E	1.6	1.50	243	304	365	(127)	(159)	(191)
	F	2.6	1.38	561	701	841	228	285	342

( ) - indicates negative values

G3 ENTERPRISE SELECTION AND FARM PLANNING

G3.1 Introduction

G3.1.1 The decline in rice production and cultivation in the State of Penang has been very marked in the last few years. The major (if indirect) contributor to this decline has been the intensive development of industry both on Penang Island and the mainland. This competes directly for land when urban expansion pushes the price of land beyond its value in agricultural use. Perhaps more important are the highly competitive employment opportunities which now exist and are likely to expand at a greater rate than the population.

G3.1.2 This expansion of alternative employment opportunities has not so much influenced the choice of crops but the systems under which they will have to be grown. Future development of irrigated agriculture will require not only that areas be reserved for agricultural use, but that farming becomes a profitable activity. Agronomic conditions, soil and marketing constraints have determined the choice of crops.

G3.1.3 There has been no deliberate attempt to create rural employment through the promotion of labour intensive production systems or techniques. Instead the primary aim has been to retain those areas presently being cultivated and to bring abandoned land back into cultivation. Thus, priority has been attached to identifying systems of cultivation which are practically feasible and which will provide those participating in them with incomes and working conditions that are competitive with those offered in other industries. This has meant that the introduction of more intensively mechanised operations has received considerable attention and that economic criteria such as returns to farmers' labour have assumed greater importance as compared with returns to land.

G3.2 Crop Selection

Land and Water

G3.2.1 The main factors influencing choice of suitable crops, and ultimately the cropping patterns proposed, are the quality of the soils and availability of irrigation water. The majority of soils throughout the Balik Pulau Area are deep, poorly drained heavy clays of marine origin (Kuala Kedah and Tebangau series). Whilst their fine texture and slow drainage characteristics are ideally suited to rice cultivation, they limit their suitability for the cultivation of other annual crops. Nevertheless, the soil studies have concluded that with improved drainage it would be possible to cultivate a range of other annuals and perennial fruit crops. These included maize, soya bean, fruit bearing vegetables, bananas and papaya. The latter were included with the condition that they would require more intensive (in-field) drainage. Groundnuts and a range of root vegetables were also considered but were eventually discarded as unsuitable because of difficulties in harvesting them on the clay soils.

G3.2.2 In Balik Pulau, the availability of water will be improved with the project, through the inclusion of additional sources Sg. Rusa, Sg. Ayer Puteh, and Sg. Kongsi in the system,but water availability in the off-season will continue to restrict the cropping pattern selected. There is no restriction however, in the main season, and if desirable, rice which has the highest water requirement of all the annual crops, could be cultivated throughout the entire area. In the off-season, the maximum rice area possible would be 415 ha but cultivation of rice to this extent would preclude the cultivation of any other annual crop on the remainder of the area. As a general rule, rice would have to be limited to about 300 ha, for the entire area to be cultivated with annual crops in the off-season. This would remain possible even during a 1-in-5-year drought. A 1-in-10-year drought however, would cause serious water shortages in the off-season. Off-season water supplies would not restrict the areas of perennial or semi-perennial crops which could be grown.

G3.2.3 In Seberang Perai, the majority of the soils of the area are deep, moderately developed, heavy clays of marine origin. Whilst their fine texture and slow drainage characteristics make them well suited to rice cultivation, they restrict their suitability for the cultivation of other annual crops. The irrigation water supplies in the average year are adequate for rice cultivation in the main and off-seasons, throughout all of the schemes apart from Juru. In one year in five water shortages may be experienced in the major schemes. These will occur at the beginning of the off-season and will delay about one-third of the crop. Potentially, one in ten year low flows could be much more serious, but existing plans for regulation of the major water sources in Kedah State should result in the impact of low flows in these years being negligible in the future. Overall the availability of water does not impose a serious constraint on the selection of crops.

Marketing

G3.2.4 The availability of markets for agricultural produce is not likely to restrict the type or quantities of crops grown. Penang State is a deficit rice producing area with the balance between production and consumption being made up by transfers from the neighbouring State of Kedah. Malaysia as a whole is a net importer of rice and the Government has a stated objective (Fourth Malaysia Plan: 1981 - 1985) of attaining self-sufficiency in rice production. In terms of Government policy, increasing rice production is clearly important. Of the other grains, maize is also important with almost 300,000 tonnes being imported in 1980. There should be little difficulty in marketing maize grain as the State has a well developed feed milling industry centred on Butterworth. Maize can also be marketed as fresh cobs, although the market for this commodity is probably limited.

The market potential for fruit and vegetables is good. The recently completed market studies for the Balik Pulau/Seberang Perai: Integrated Agricultural Development Project (MIDF Industrial Consultants Sdn. Bhd.: July 1980) indicated that to satisfy the market potential in 1985 the areas of vegetables and fruits could be increased by about 1,040 and 8,360 ha respectively. The potential for bananas was particularly important (2,550 ha). The increase in area of papaya required to meet future demands was estimated at about 150 ha, and since a major proportion of this is likely to be taken up in the non-irrigated areas in the next four years, the market potential for growing papaya is limited.

Selected Crops and Cropping Patterns

G3.2.5 Given that the land is ideally suited to rice cultivation and less well suited to the cultivation of other crops it is essential that rice should feature to the maximum extent possible within a cropping pattern that would aim at cultivating all available land in both seasons. Besides land suitability there are a number of other arguments to support a rice based cropping pattern:-

(a) the Government's agricultural services provided through the DOA and LPP are particularly geared towards promoting rice production.

(b) it is the Government's policy to encourage rice cultivation and to eventually achieve self-sufficiency.

(c) the farmers themselves are familiar with its husbandry and have indicated quite clearly in the socio-economic survey that they would prefer to continue cultivating rice than change to an alternative crop.

(d) given the present price structure, subsidies and potential yields, it is financially attractive giving high returns to both land and labour.

G3.2.6 In Balik Pulau rice cultivation throughout the wet season is possible and provided that the organizational structure evolves to provide the necessary incentives, it is proposed as the main crop. In the off-season, 300 hectares could be grown, the balance of the off-season area would be divided between maize (grain and cobs) at 590 ha and vegetables 150 ha.

G3.2.7 Whilst bananas and papaya have received very serious consideration, they were eventually not included in the cropping proposals. The main reasons for their exclusion were the more stringent requirements for drainage than the shallower rooted annuals, and the uncertainty over the time required to lower the water table sufficiently to allow their cultivation.

G3.2.8 In Seberang Perai double rice cropping is feasible and is the recommended cropping pattern throughout the area, with the exception of 180 hectares of vegetables in the Pinang Tunggal scheme.

G3.2.9 The large scale expansion of vegetable growing cannot be recommended, vegetable production by the existing growers will be continued with the project. Interviews with farmers indicated that with an improved irrigation reticulation and better command of the current vegetable areas, the farmers would continue to grow vegetables in the off-season. They would prefer however, to have a mixed system with a rice crop in the main season.

G3.2.10 In neither scheme is the introduction of perennial fruit such as bananas as an alternative to double rice cropping considered feasible. Crop budgets were prepared for bananas and papayas (Appendix GI). The expected returns from bananas (which represented the greatest market potential) and papayas are not markedly higher than double rice cropping and would be unlikely to justify additional drainage costs or the risks attached to their cultivation under less than ideal conditions. Although soya beans have not been included (mainly because of the lack of agronomic data available on their cultivation in this area) they could replace some maize in the cropping pattern for Balik Pulau. The returns from soya beans however are unlikely to differ significantly from the returns from a mixture of maize grain and fresh cobs, and thus the inclusion of soya beans would have little impact on farmers' incomes or on the project economics.

G3.3 <u>Crop Budgets</u>

G3.3.1 Crop Budgets were prepared to show the returns to different crops and are used in the economic and financial analysis of the Scheme Groups in the later chapters of this annexe. Detailed break downs of costs of production are contained in Appendix GI . In addition budgets were prepared for banana and papaya as an aid to crop selection. These are also reproduced in the summary table of budgets at financial or market prices (Table G3.2). A notable feature of the budgets is the substitution of mechanical services for labour. This is discussed in the next section and detailed derivations of costs for the various operations are contained in Appendix GI.

G3.3.2 Crop budgets have been prepared for the following crops:-

- smallholder rice
- mechanized rice production (group farms)
- mechanized maize grain production (group farms)
- fresh maize cob production
- mixed vegetables (okra, long bean, cucumber, brinjal and chilli)
  (separate vegetables budgets for Seberang Perai & Balik Pulau)
- bananas
- papayas

G3.3.3 The crop budgets (at project maturity) showing returns to land and labour at market prices are summarised in Table G3.2. Mixed vegetables (based on 65% okra, 10% long beans, 10% cucumbers, 10% brinjals and 5% chili) is the most attractive enterprise in terms of returns to land and also has a high return to labour. It is a technically demanding enterprise and has a high requirement for hand labour which will limit the overall extent to which it is grown. Fresh maize cob production also has a high revenue potential with high returns to both land and labour. Whilst the cultivation of fresh maize is much less demanding than vegetables, the extent to which it can be grown will almost certainly be limited by the volumes which can be marketed.

G3.3.4 The returns to land and labour are relatively high for both systems of rice production (smallholder and group farm) and when considered along with factors such as the particular suitability of the soils for rice cultivation and the farmers' preference for rice, maximising the area of rice grown is clearly justified. Whilst returns to labour from maize grain production are similar to smallholders rice, returns to land are very low. The maize production system proposed, however, is relatively simple and complementary to mechanized rice production. Given that it will be combined with the higher revenue-earning fresh maize cob production, its inclusion in cropping patterns can also be justified.

G3.3.5 Mechanized padi production on group farms has the hishest return to labour while its return to land is of a similar order to that for smallholder padi. Provided that the anticipated levels of yields are attained, the potential returns to labour from all of the enterprises should provide sifficient incentive for farmers to participates effectively in an irrigation and drainage rehabilitation programme.

G3.3.6 Although bananas and papayas are not included in the proposed cropping patterns for the irrigable areas, their crop budgets are summarized in Table G3.1. They represent possible additional revenue earning enterprises which farmers could attempt on an individual basis on small areas of non-irrigated land (such as house plots). Of the two, papayas is the most attractive with reasonably high returns to both land and labour. Returns from both however, would be of a similar order to those for double rice cropping.

G3.4 Crop Production Systems

G3.4.1 The current system of rice production is based on individually operated smallholdings ranging in size from less than 0.2 ha to over 2 ha with an average holding size of between 0.4 and 0.9 hectares. The production system is dependent upon a labour intensive technology with land preparation being the only operation completely mechanised. Mechanised harvesting employing contractors however has recently been introduced on a minority of farms in the Seberang Perai Area. This system has continued to operate successfully in the north-eastern part of the Sg. Muda scheme, Pinang Tunggal and some of the smaller schemes. In these areas a cropping intensity of 200% has largely been maintained. Being distant from the urban-industrial centres, they are less susceptible to the pressures created by alternative employment opportunities than areas to the south, and it is quite likely that a system of individual smallholder cultivation will persist.

G3.4.2 In the southern part of the Sg. Muda scheme and Seberang Perai Tengah (mainly the Kulim scheme) smallholder cultivation has not survived, and since an alternative production system has not evolved, large areas of land (about 4,800 hectares) have been left uncultivated. If this process is to be halted and abandoned land returned to cultivation, an alternative system of production which is less dependent upon hand labour and employs higher levels of technology will have to be introduced. A number of labour saving innovations have already been adopted in other rice growing areas of Malaysia. For instance, the use of combine harvesters is now widespread throughout the MADA scheme in Kedah, and direct sowing is being carried on successfully in parts of MADA and at Tanjung Karang in Selangor.

G3.4.3 Although these innovations are probably more easily introduced into larger scale units where irrigation can be more rigidly scheduled, they are clearly becoming important in smallholder rice production also. In view of this we do not believe that re-organisation of smallholders into larger units or groups is essential to the introduction and adoption of labour saving innovations, and therefore propose that smallholder production systems should continue in those areas where they are currently operating successfully and which are expected to remain in production were the project not to be implemented. Should the farmers voluntarily form larger groups or producer associations wiht a view to introducing larger scale mechanised operations they should be given every encouragement.

G3.4.4 As it is unlikely that smallholder cultivation can be easily reintroduced throughout those areas already abandoned, a larger scale mechanised system based on groups of farmers (owner-operators and tenants) is proposed. The experience in other schemes in Malaysia suggests that such a system would be technically possible and that it could lead to more rapid rehabilitation of abandoned land. The major problems with group farming however are expected to be organisational,and it is proposed that immediate priority should be given to establishing "pilot group farming areas" in order that suitable organisational forms can be tried and developed by the time engineering works are completed and full scale agricultural operations are about to commence. The two major farming systems proposed are described briefly in the following sections.

Smallholder Farming Systems

G3.4.5 The socio-economic survey results indicated that (at least in the short term) a proportion of the existing smallholders would wish to maintain their individual status and to continue farming as smallholders. Providing that these farmers represented a majority within their particular tertiary irrigation unit, there is no overriding reason why they should be persuaded to participate in any formal grouping or association. It is inevitable however, that they will have to accept a degree of co-operation if innovations such as mechanization of field operations are eventually to be introduced. If the advantages of formal grouping are clearly evident, it is quite likely that farmers would voluntarily decide to join in a formal group at a later stage. If this is the case it should be encouraged. In terms of area and numbers they represent a major part of the overall area and farm population. In Balik Pulau there will be an area of 140 ha cultivated by smallholders.

G3.4.6 With the introduction of mechanization to the surrounding areas it is unlikely that the smallholder farming systems will remain completely unchanged and there is no doubt that there will be a gradual uptake of innovations. Of the major rice innovations, mechanized land preparation, direct seeding and mechanized harvesting, it is most likely that adoption of mechanized land preparation (using power tillers) would be most rapid, and would probably be followed by mechanized harvesting in current use, it is recommended that "intermediate" alternatives such as self-propelled binders (cutting and binding) and stationary threshers are also considered. (See Annexe E, Chapter 5)

G3.4.7 It is impossible to predict the rate at which technical innovations such as these will be taken up. Overall they are not expected to have any significant impact on crop yields but will have a more direct influence on the pattern of labour usage. Since the rate of uptake of innovations is unpredictable and will in any case be unlikely to have a major impact on the economics of rice production, the following practices have been assumed in the preparation of crop budgets and farm models:-

(a) Land preparation will be completely mechanized with either power tiller or four-wheeled medium powered tractor.

(b) Rice will be hand transplanted.

(c) Weed control will be mainly through use of herbicides supplemented by hand weeding.

(d) The majority of the rice will be harvested by hand methods.

G3.4.8 Yield improvements will be largely attributable to availability of recommended seeds, fertilizers, herbicides and pesticides, improved control and availability of water, more timely planting of the rice crop and an intensified extension effort.

Group Farming

G3.4.9 Large scale group farming would apply to those areas uncultivated or abandoned at the time when the irrigation and drainage upgrading programme was implemented, and to those areas where existing farmers were determined to form groups and to adopt a large scale farming system. In Balik Pulau, the major part of Sg. Pinang and Sg. Burung is already uncultivated, large scale group farming will be the predominant system throughout Balik Pulau extending over at least 940 ha or 85% of the entire area. In Seberang Perai, 55% of the 12,400 hectares to be developed are expected to be farmed on a "group farm" basis.

G3.4.10 The group farm would comprise all of the holdings within a tertiary irrigation unit and thus would vary in size both in terms of number of members and overall area depending upon the size of the tertiary unit. The group farms would range between 50 and 80 ha comprising 60 to 120 land holdings. The members would include some landowners, owner-operators and the tenant farmers who had most recently been farming the area. The term "group farm" is used to describe any formal grouping of participants and may include any business form; company, partnership or co-operative. The important point is that group implies corporate action and responsibility rather than individual. The group would therefore have to have its own decision making committee or board and would have to decide on a procedure for electing them. Since the co-operative structure and procedures are already well understood, co-operatives probably represent the most suitable structure to adequately accommodate the large membership envisaged. The elected committee would be responsible for determining and implementing policies on behalf of its members and for hiring or appointing whatever managerial and supervisory staff considered necessary. As the businesses overall are not large and the farming systems proposed relatively simple, it is expected that a manager and two supervisors who would be responsible for organising and supervising field activities would be adequate for each group. (This arrangement has been the subject of discussion resulting in changed proposals after this Annexe was drafted).

G3.4.11 Should it prove impossible to interest groups of farmers in returning to cultivate abandoned land, the large scale system of cultivation proposed could equally well interest individual entrepreneurs or even small partnerships. These should not be discouraged since they will contribute to achieving the aim of returning abandoned land to cultivation. Also individual entrepreneurs can often bring a valuable innovative flair to production systems.

G3.4.12 The system is dependent upon landowners continuing to make their land available for cultivation by the group. Under the IADP it is proposed that a new Land Lease Section is established within the Land Office. This section would be responsible for payment of rents to the landlord and for recovery of rent from the farmer or groups of farmers. If this section is established it could well facilitate leasing arrangements between farmers and landlords. It is not, however, considered essential; for example, about 62% of all farmers successfully lease land from landowners in Balik Pulau.

G3.4.13 Two cropping systems, double rice cropping and main season rice followed by maize and vegetables are proposed for Balik Pulau. Seberang Perai group farms would be for double rice cropping only. Rice cultivation would have the following features:-

(a) Mechanised land preparation.

(b) Direct seeding.

(c) Use of herbicides supplemented by hand weeding for weed control.

(d) Mechanised harvesting (combine harvester).

G3.4.14 Two systems of direct seeding are possible; broadcasting of pre-germinated seeds into a wet seed bed, or drilling of dry seed into a dry seed bed using the technique and equipment developed at Tanjung Karang. It is likely that both would eventually be used with the choice between systems being determined mainly by weather and soil conditions from season to season. For budgeting purposes however, broadcasting of pre-germinated seed has been assumed.

G3.4.15 It is proposed that Machinery Service Centres are established in the project areas and that the majority of mechanised operations for land preparation and harvesting would be carried out by these centres. The possibility of some farms having their own tractor and cultivating equipment should not be ruled out,and this decision would be dependent upon the willingness and financial resources of the group members. We have assumed however, that the Centres would service the majority of farms on the grounds that the farm group members may not have the financial resources, and that maintenance, repairs and effective operation of machinery might be more easily arranged at service centres. Similarly, whilst one farm could not justify owning a combine harvester for its own crops, it could operate as a contractor to surrounding farms. Whilst it is recognized that this should be encouraged, it is unlikely that many farms would have the financial resources, and the majority of farms would be dependent on the service centre for harvesting their crops. Agricultural Services and Machinery Service Centres are discussed in section G3.6.

G3.4.16 Maize production in Balik Pulau would also be based on mechanised land preparation, planting and harvesting (grain only) by combine harvester, with weed control being maintained mainly by herbicides supplemented by hand methods as necessary. Maize grown for fresh cobs would be hand harvested.

G3.4.17 Vegetable production would be much more dependent upon hand labour and only land preparation would be mechanised. Since there is such a high dependence upon hand labour for vegetable production, it is proposed that this enterprise could be carried out by participants on an individual basis within an area designated for vegetable production during the off-season on each farm.

G3.5 Farm Models

G3.5.1 In addition to enterprise budgets and farm models for the cropping systems described earlier, potential livestock and poultry enterprises were considered. These are described in more detail in Appendix GVI. They were found to be high risk enterprises very sensitive to changes in feed and output prices.

Smallholder Farms

G3.5.2 A number of farm models have been prepared to indicate the potential levels of income available to participants in upgraded schemes. Smallholder farming is expected to be limited in extent to about 140 hectares in Balik Pulau but would cover nearly 5,200 of the 12,420 hectares (net irrigable area) to be rehabilitated in Seberang Perai. These smallholdings would be confined to a double rice cropping system with the exception of 180 hectares of vegetables in Group B. The model is shown in Table G3.3. Holding sizes of 0.60, 0.75 and 0.90 hectares are examined, as representing the range within which most farm sizes will lie.

G3.5.3 The farm sizes of 0.75 and 0.6 ha are the average farm size and most frequently occurring farm size group, 0.4 - 0.6 ha (1 - 1.5 ac) respectively in Balik Pulau, determined by an analysis of a sample of 271 farm sizes taken from the cadastral map of the area. Farm sizes in Seberang Perai Utara are sometimes larger therefore the 0.9 ha model was used. Annual rice yields are expected to build up over a three-year period from 6.7 tonnes per ha (both crops) to 8.6 tonnes per ha. The first year's yield has allowed for a limited amount of disruption following completion of the engineering construction works.

Smallholder Rice and Vegetables

G3.5.4 The rice and off-season mixed vegetable model is shown in Table G3.4; it only applies to the Pinang Tunggal area of Seberang Perai. Since such holdings tend to be smaller than double rice holdings due to the high demand for labour, a holding size of 0.5 hectares is used as a representative size. The yields are again expected to be built up over a three year period and allowance has been made for possible disruption to agricultural activities due to construction works in the first year. In this model incomes of owner-operators range between Ringgit 4,600 and 4,214 depending upon the extent to which hired labour is used to replace family labour. Direct subsidies would amount to around 10% of the total net revenue. Tenant farmers enjoy a very much lower income, as shown on the table.

Group Farms

Double Rice Cropping

G3.5.5 Double rice cultivation in group farms is the main cropping pattern used in agricultural planning. The expected level of income is indicated in Table G3.5. Farm sizes will depend upon the size of the tertiary irrigation unit and will vary between 50 and 80 hectares. The size chosen for the model is 60 ha, representing about 120 land holdings in Seberang Perai. The number of holdings may be less than 120 in some areas, and down to as few as 65 for average sizes of 0.75 ha. The number of holdings does not affect the budget for the group farm; only its total area affects the budget. Since a relatively new technology (direct sowing) is to be introduced, a four year period for yields to build up from 3.0 t/ha (475 gt/ac) to a maximum of 4.0 tonnes/hectare (636 gt/ac) from each of two crops a year is assumed. The economic performance of group farms is critically dependent upon the mode of paying rent and its amount. There are several alternatives but we cannot recommend that the status quo remains unaltered in cases where half of all crops is now handed over as rent. Either the fraction should be reduced to one third, or a ceiling should be fixed to the quantity of padi based on past yields. (Half of the crop at 425 gt/ac, 2.67 t/ha, per crop is the same as one third of the crop at 4.0 t/ha our assumed figure). If a half of future predicted yields were to be paid, then our farm budget shows no margin of profit for the workers.

G3.5.6 We propose the following method of rental payment and distribution of operating profit:

(i) Rent paid to landowners as one-third of the gross padi revenue, as paid at present in kind.

(ii) Non-working or absentee landowners receive no other share in profits.

(iii) Existing or recent holders of tenancies receive no share unless they are employed as full-time workers.

(iv) The whole profit is divided among the full-time workers, including owner-operators, and a small number of supervisors or others involved in the social or religious organisation at village level. We put this number at 20 shares - 15 workers and 5 others.

G3.5.7 The total labour requirement of 6,480 man-days is equivalent to about 15 full-time workers, with a balance provided by casual labour in peak activity periods. This might be constituted as follows:

15 permanent workers for 282 days a year	=	4,230
45 temporary workers for 50 days		2,250
		6,480

It is thought that this ratio, 15 workers from 65 to 120 families nominally interested in the 60 ha area, is a reasonable reflection of the present labour situation. It reflects the desire for a majority of adults to find employment off the farm.

G3.5.8 As shown in Table G3.5, the income for a permanent worker would consist of two parts: his wages at $7 per day and his share of the net revenues which, at project maturity, should amount to $2,448. With wages of $1,974 the annual income becomes $4,422. In addition, if the worker owned his original landholding he would receive a "landowners rental" of $816 (for 0.5 ha), making a total of $5,238 ($436 per month) after project maturity yields are reached.

Rice, Maize and Vegetable Farm (Balik Pulau)

G3.5.9 Group farming with rice in the main season and a mixture of vegetables and maize in the off-season would eventually occupy nearly three quarters of the Balik Pulau project area under our proposals. The cropping pattern proposed for this model is 100% rice in the main season followed by 75% maize (45 ha) and 25% vegetables (15 ha) in the off-season. The maize area would comprise 75% grown for grain and 25% for fresh cobs. Please see Table G3.6. The expected level of farm income is similar to that for double rice cropping though marginally lower. In Table G3.6, we show the figures based on paying the same rent to landowners as they would receive for a group farm operating on two padi crops. This will avoid any possible sense of injustice by landowners because some areas have been selected for double rice and others for rice, maize and vegetables. However we consider these rent payments are really too high bearing in mind that in the past, double cropping was the exception; in Balik Pulau Final Report a rather lower rent payment, based on a complex formula, is put forward.

G3.5.10 Using the rent assumption of rent being equal to 2/3 of the one padi crop, our working group farm members' income rises from $1,974 to $4,007 over four years for non-landowners, while owners of 0.75 ha would receive from $2,732 to $5,231 over the same period.

G3.6 Agricultural Services

G3.6.1 The Working Group on Farm production Services for Padi and Other Crops (July 1981 report) have made wide-ranging and comprehensive proposals to improve the existing agricultural services to farmers in the Balik Pulau/Seberang Perai areas as part of the Integrated Agricultural Development Project for that area. Those of particular importance to the irrigation farmers are:-

(a) The strengthening of the Extension Service by increasing the number of field workers, building two Regional Offices, introduction of the T & V system of extension and by making provision for Training.

(b) The establishment of a Crop Protection Unit within the DOA as a technical support service. It would be responsible for rat control campaigns.

(c) The Farmers' Organization Authority (LPP) would establish two Farm Mechanization Service Centres.

(d) Expansion of the number of Farmers' Development Centres by establishing five new Centres and four new Sub-Centres.

(e) The setting up of an Agricultural Produce Marketing Committee and establishment by FAMA of Marketing Centres in Balik Pulau and Seberang Perai.

(f) The establishment of a rice milling and drying complex by the LPN and general improvements for rice collection and marketing.

G3.6.2 We believe that the recommendations of the Working Group are appropriate and that when implemented they will provide a sound supporting infrastructure to farmers in the area. They adequately cover the requirement for marketing, input supply, crop protection and go some way towards strengthening of the extension services. Our proposals are complementary to those of the Working Group and are concerned mainly with detail such as increasing the numbers of extension workers and setting up Mechanization Service Centres.

Field Extension Workers

G3.6.3 We have estimated that one field extension worker would be required to provide an adequate service to farmers in Balik Pulau after rehabilitation and implementation of a mainly Group Farming System. In Seberang Perai the number is 12.

Machinery Service Centres

G3.6.4 Whilst two new Machinery Service Centres have been proposed by the Working Group for Seberang Perai, no provision has been made to set up a Centre in Balik Pulau. Implementation of the agricultural proposals will depend upon sufficient Centres being established to service both smallholders and Group Farms. The centres would comprise a small office, store for oil, grease, tools ar spare parts, a fuel tank, covered service area and hard-standing for tractors and machinery. Service facilities would include a compressor, welding equipment and range of basic tools for general maintenance and minor repairs. Overall they would comprise an area of approximately 5,000 sq. metres enclosed by a wire fence.

G3.6.5 Each centre would be staffed by a Manager, Field Supervisor, Wages and Fuel Clerk, Mechanic, Assistant Mechanic, drivers and their assistants (combine harvesters). A pick-up truck and motor cycle would be provided to facilitate transport of spare parts and supervision of drivers and machinery in the field. The capital cost of constructing a Centre is estimated at M$521,000, whilst the recurrent costs of management and supervision (Manager, Field Supervisor and clerical staff salaries, transport and general maintenance are estimated at M$37,900 per annum. Other operating costs such as mechanics' and drivers' salaries, spare parts, oils and fuels are included in the machinery operation and maintenance budgets. Table G3.7 summarizes the complement of machinery required.

G3.6.6 Four such centres will be required for Seberang Perai including the two already proposed, although these should be enlarged to our standard, and one centre is required for Balik Pulau.

G3.6.7 Locations of the centres should be based on nearest to the padi schemes served. Where convenient the existing Farmers' Organisation premises could be enlarged and combined with the machaninery service centre. This method appears possible for all the centres except D, Kulim South. The LPP centre at Cherok Tok Kun is separated from the southern Kulim padi arreas by at least 6 km of urban roads including Bukit Mertajam town centre, and it would therefore be unsuitable. We therefore suggest the following locations:-

	Machinery Centre	LPP Centre
A.	Sg. Muda North	Penaga
B.	Sg. Muda E Central	Pokok Sena
C.	Sg. Kulim North	Kg. Pelet
D.	Sg. Kulim South	(New site near Simpang Ampat - Bt. Tengah)
E.	Balik Pulau	Balik Pulau.

Table G3.1 Crop Budgets at Economic Prices (M$ per hectare)

Cropping System	Yield (tonnes) Year 1	2	3	4	Price (M$/tonne)	Gross Revenue (M$) Year 1	2	3	4	Direct Production Costs (M$/ha)	Net Revenue Year 1	2	3	4
Rice: Smallholder	3.35	4.0	4.3	4.3	716	2,399	2,864	3,079	3,079	1,193	1,206	1,671	1,886	1,886
Rice: Group farm	3.0	3.4	3.75	4.0	716	2,148	2,434	2,685	2,864	1,074	1,074	1,360	1,611	1,790
Vegetables (Pinang Tunggal) (1)	15.0	16.5	17.7	17.7	422	6,330	6,963	7,469	7,469	2,871	3,459	4,092	4,598	4,598
Vegetables (Balik Pulau) (2)	10.0	12.0	13.0	14.65	422	4,220	5,064	5,486	6,182	2,871	1,349	2,193	2,615	3,311
Maize (grain)	2.5	3.0	3.3	3.5	515	1,288	1,545	1,699	1,803	849	439	696	850	954
	('000 cobs)				('000 cobs)									
Maize (cobs)	22	25	28	30	68	1,496	1,700	1,904	2,040	858	638	842	1,046	1,182
Maize (75% grain 25% cobs)	-	-	-	-		1,340	1,584	1,750	1,862	851	489	1,095	899	1,011

Source: Consultants estimates detailed Appendix GI (Table GI.10)

Notes : (1) Smallholder vegetables
(2) Group farm vegetables

Table G3.2 Crop Budgets. Returns to Land and Labour at Financial Prices

Crop	Yield (1) (tonnes/ha)	Market Price (M$/tonne)	Gross Revenue (M$/ha)	Direct Production Costs (2) (M$/ha)	Net Revenue (3) (M$/ha)	Labour (man-days)	Cost (M$/ha)	Returns to Land (4) (M$/ha)	Returns to Labour (5) (M$/man-day)
Rice: Smallholder	4.3	612	2,632	411 (6)	2,221	115	805	1,416	19.3
Rice: Group farm	4.0	612	2,448	733 (6)	1,715	54	378	1,337	31.8
Maize (grain)	3.5	360	1,260	843	417	26	182	235	16.0
Maize (cobs)	30,000 (cobs)	8 ¢ per cob	2,400	698	1,702	45	315	1,387	37.8
Maize (grain 75%, cob 25%)			1,545	804	741	31	217	524	23.9
Vegetables (mixed)	14.65	494	7,236	1,800	5,436	220	1,540	3,896	24.7
Bananas (7) (year 3 onwards)	13.0	414	5,382	1,842	3,540	136	952	2,588	26.0
Papayas (7) (average annual over 3 year cycle)	21.4	330	7,062	3,230	3,832	135	945	2,887	28.4

Source: Consultants estimates detailed in Appendices

Notes :
(1) Yield at project maturity achieved after 3 years smallholder rice, 4 years for group farm rice, maize grain and cob and vegetables.

(2) Excluding labour: Mechanisation costs are included at contractors rates.

(3) Gross Revenue - direct production costs

(4) Net Revenue - labour costs.

(5) Net Revenue - number of mandays.

(6) Excluding fertiliser.

(7)

		Yield (tonne/ha)	Gross Revenue	Direct Production Costs	Net Revenue	Labour (man-days)	Labour Cost ($)	Returns to Land (M$/ha)	Returns to Labour (M$/man-day)
Bananas	Year 1	7.4	3,064	1,827	1,237	161	1,127	110	NA
	Year 2	15.4	6,375	1,545	4,830	132	959	3,872	36.5
Papayas	Year 1	5.3	1,749	2,965	(1,216)	172	1,204	NA	NA
	Year 2	33.0	10,890	3,388	7,502	117	819	6,683	64.1
	Year 3	26.0	8,580	3,338	5,242	117	819	4,423	44.8

Table G3.3 Farm Model: Smallholder Double Rice Cropping

Revenues & Gross Margins (per ha) per 2 crops	Year 1	Year 2	Year 3
Yield per year (tonnes) [1]	6.7	8.0	8.6
Farm gate price (M$/tonne)	612	612	612
Gross revenue (M$)	4,100	4,896	5,163
Production Costs (excluding labour and fertiliser)	822	822	822
Gross Margin per ha	3,278	4,074	4,441
Labour requirement (man-days)	230	230	230
Labour Cost	1,610	1,610	1,610
Direct Subsidies per ha [2]			
Price subsidy	1,108	1,323	1,422
Fertiliser subsidy	470	470	470
	1,578	1,793	1,892
Farm Incomes (M$/annum)			
Owner-operator			
0.90 ha farm	2,950	3,666	3,998
0.75 ha farm	2,458	3,055	3,331
0.60 ha farm	1,967	2,444	2,665
Tenant farmer [3]			
0.90 ha farm	1,722	2,198	2,420
0.75 ha farm	1,434	1,831	2,016
0.60 ha farm	1,148	1,465	1,613
Return to farm labour (M$/man-day)			
Owner	14.3	17.7	19.3
Tenant	8.3	10.6	11.7
Direct Subsidy per Farm			
0.90 ha farm	1,421	1,614	1,703
0.75 ha farm	1,183	1,345	1,419
0.60 ha farm	947	1,076	1,135

Notes for Table G3.3:

(1) Two crops

(2) Price subsidy $165 per tonne ($10 per picul)
Fertiliser $235 per ha

(3) Rent is based on 1/3 of the crop paid to the landlord.

Table G3.4 Farm Model: Smallholder Rice & Mixed Vegetables (Pinang Tunggal)

Revenues & Gross Margins (per ha)	Year 1	Year 2	Year 3
Rice: Main Season Crop			
Yield per season (tonnes)	3.35	4.0	4.3
Farm gate price (M$/tonne)	612	612	612
Gross Revenue per hectare	2,050	2,448	2,632
Production Costs (excl. labour & fertiliser)	411	411	411
Gross Margin per ha (M$)	1,639	2,037	2,221
Labour Requirement (man-days)	115	115	115
Direct subsidies per ha	789	896	946
Mixed Vegetables: Off-season Crop			
Yield (tonnes/ha)	15	16.5	17.7
Average price per tonne of mixed vegetables	496	496	496
Gross Revenues per ha	7,440	8,184	8,780
Direct Production Costs all family labour (1)	1,800	1,800	1,800
Direct Production Costs 50% family labour (2)	2,573	2,573	2,573
Gross Margin all family labour	5,640	6,384	6,980
Gross Margin 50% family labour	4,867	5,611	6,207
Farm Income 0.5 ha Farm (M$)			
A. Owner Operator			
all family labour for vegetables	3,639	4,210	4,600
50% hired labour for vegetables	3,252	3,824	4,214
B. Tenant Farmer			
all family labour for vegetables	2,057	2,438	2,698
50% family labour for vegetables	1,670	2,052	2,312
Subsidies per farm (M$)	394	448	473

Notes: (1) No hired labour

(2) 50% of labour requirement hired

(3) Tenant farmer is assumed to pay 1/3 of revenue for each crop.

Table G3.5 Group Farm Model: Double Rice Cropping

Revenues & Gross Margins (per ha, per year)	Year 1	2	3	4
Yield per year (tonnes) (1)	6.0	6.75	7.5	8.0
	M$	M$	M$	M$
Farm gate price (M$/tonne) (2)	612	612	612	612
Gross revenue	3,672	4,126	4,590	4,896
Production Costs (excluding fertiliser)	2,223	2,223	2,223	2,223
Gross Margin (excluding fertiliser)	1,449	1,903	2,367	2,673
Subsidies per ha				
Fertilisers (3)	450	450	450	450
Price subsidy	992	1,125	1,240	1,323
	1,442	1,575	1,690	1,773
Farm Income - 60 ha farm (120 members)				
Farm gross margin	86,940	114,180	142,020	160,380
Supervisory staff salaries	12,500	12,500	12,500	12,500
Incidental expenses	1,000	1,000	1,000	1,000
Rents (1/3 of gross revenue)	73,440	82,520	91,800	97,920
Margin available for distribution	nil	18,160	36,720	48,960
Distribution to 20 shareholders	nil	908	1,836	2,448
Total wage income included in production costs	45,360	45,360	45,360	45,360
Potential wage income for 15 permanent workers	1,974	1,974	1,974	1,974
Sum for distribution and wage income	1,974	2,882	3,810	4,422
Rent for 0.5 ha	612	688	765	816
Sum for owner/permanent worker	2,586	3,570	4,575	5,238

Notes: (1) The yield is the sum of two crops
(2) Includes subsidy M$165.4 per tonne ($10 per picul)
(3) Fertilisers are provided free

Table G3.6 Balik Pulau Group Farm Model: Rice, Maize & Vegetable Farm

	Year 1	Year 2	Year 3	Year 4
Revenues & Gross Margins (per ha)				
Yields: Rice (tonnes)	3.0	3.4	3.75	4.0
Maize Grain (tonnes)	2.7	3.0	3.3	3.5
Maize Cobs (1,000 cobs)	22,000	25,000	28,000	30,000
Vegetables (tonnes)	10.0	12.0	13.0	14.65
Gross Revenues (M$ per ha)				
Rice (M$612 per tonne) (1)	1,836	2,080	2,295	2,448
Maize: 0.75 ha grain; 0.25 ha cobs (maize grain M$360 per tonne; cobs 8 ¢ each)	1,169	1,310	1,451	1,545
Vegetables (M$494 per tonne) (2)	4,940	5,928	6,422	7,237
Production Costs (M$ per ha)				
Rice	1,111	1,111	1,111	1,111
Maize: 0.75 ha grain; 0.25 ha cobs	1,021	1,021	1,021	1,021
Vegetables	3,340	3,340	3,340	3,340
Gross Margins (M$ per ha)				
Rice	725	696	1,184	1,337
Maize (grain and cobs)	148	289	430	524
Vegetables	1,600	2,588	3,082	3,897
Farm Income - 60 ha farm (80 members) (60 ha rice; 45 ha maize; 15 ha vegetable)				
Gross Margin: Rice	43,500	58,140	71,040	80,220
Maize	6,660	13,005	19,350	23,580
Vegetables	24,000	38,820	46,230	58,455
Total Gross Margin	74,160	109,965	136,620	162,255
Supervisory staff salaries	12,500	12,500	12,500	12,500
Incidental expenses	1,000	1,000	1,000	1,000
Rents (2/3 of gross padi revenue:)	(4) 60,660	83,200	91,800	97,920
Margin available for distribution	nil	13,265	31,320	50,835
Distribution to 25 shareholders	nil	531	1,253	2,033
Total wage income included in production costs	55,545	55,545	55,545	55,545
Potential wage income for 20 permanent workers	1,974	1,974	1,974	1,974
Sum for distribution and wage income	1,974	2,505	3,227	4,007
Rent for 0.75 ha	758	1,040	1,148	1,224
Sum for owner/permanent worker	2,732	3,545	4,375	5,231

Notes:
(1) The yield is the sum of two crops
(2) Includes subsidy M$165.4 per tonne ($10 per picul)
(3) Fertilisers are provided free
(4) Rent in first year arbitrarily reduced to avoid loss

Table G3.7 Machinery Service Centres: Location and Machinery Complements

Centre	Tractors	Combine Harvesters (No)	Rotavators (No)	Disc-Harrows (No)	Trailers (No)
A. Sg. Muda North	25	10	20	5	5
B. Sg. Muda E. Central	25	10	20	5	5
C. Sg. Kulim North	20	6	16	4	4
D. Sg. Kulim South	20	6	16	4	4
E. Balik Pulau	12	4	9	3	3

G4 ECONOMIC PRICING ASSUMPTIONS

G4.1 Introduction

G4.1.1 The financial or "market" prices of inputs and outputs for agricultural activities are used in Chapter G3 of this Annexe and in Annexe F for engineering costs. In this chapter the methodology and underlying assumptions used to calculate economic prices for tradeable and non-tradeable goods and the primary factors of production are described. The values calculated will indicate the efficiency at economic prices and will be net of any price distortions resulting from taxes or subsidies, price fixing or artificially imposed market restrictions.

G4.1.2 The Little Mirrlees/Squire Van Der Tak methodology for economic cost benefit analysis is now widely accepted and used by project analysts in Malaysia. A set of national parameters for project appraisal, based on this methodology, was prepared by Veitch and Hamzah in 1979 and is approved by the Economic Planning Unit (EPU), Kuala Lumpur. The conversion factors derived for tradeable and non-tradeable goods and services (Veitch and Hamzah Vol. III, 1979) summarized in Appendix GII, Table GII.1 have therefore been used where appropriate in calculating economic prices from their market values. The economic prices of major inputs and outputs, however, have been calculated directly using border parity pricing principles.

G4.2 Tradeable Goods

G4.2.1 Economic prices for inputs or outputs of the project which are either imported into, or exported from Malaysia have been derived on the basis of border parity pricing and thus are determined by the projected f.o.b. or c.i.f. price adjusted for internal costs such as handling, storing, transport and processing incurred between the port of import or export and the farm gate. For major commodities such as rice, maize, oil palm products, copra and fertilizers, IBRD Commodity Price forecasts (November 1980) in 1980 constant values are used. EPU conversion factors have been used to derive the economic costs of internal distribution between f.o.b. and the farm gate from their costs at financial or market prices.

G4.2.2 EPU conversion factors are used to calculate the economic prices for fruit and vegetables, livestock products (meat and eggs), agricultural machinery and agro-chemicals.

Farm Outputs

G4.2.3 Rice:

Rice is the most important output of all the project schemes. The present consumption and production of rice in the State of Penang are estimated at approximately 110,000 tonnes and 45,000 tonnes respectively, the deficit being made up mainly by transfers from the neighbouring State of Kedah and small imports of high quality rice from Thailand. Although the localized deficit will almost certainly continue for the foreseeable future, the balance of production and consumption (and hence basis for price derivation) should be based on the wider regional perspective of Kedah-Perlis (Muda Plain) and the State of Penang, and on the country as a whole. Thus, whilst the Kedah-Perlis-Penang region is in surplus and is a principle source of rice for consumption centres such as Kuala Lumpur, the country is consistently a major importer of rice. The economic price therefore has been derived (Table G4.1) on the assumption that the country will remain a net importer and that increased production in the region will ultimately substitute for external imports to Kuala Lumpur.

G4.2.4 Maize:

Very little maize is currently grown in any of the irrigation schemes in the project area and even with the project it will remain a very minor crop. Malaysia is a major importer of maize and the basis for economic pricing (Table G4.2) has therefore been import parity.

G4.2.5 Oil Palm & Copra:

Oil palm products (oil and kernel) and copra are major export crops from Malaysia. The economic prices derived in Tables G4.3 and G4.4 have therefore been based on export parity.

G4.2.6 Fruit, Vegetables, Meat & Eggs:

The bulk of fruit and vegetables grown in the State are consumed locally. The agricultural proposals for the irrigation and drainage schemes allow for limited expansion of vegetable growing. The market for fruit and vegetables is expected to remain strong with significant shortfalls being predicted between future production and consumption (MOA Market Potential Study 1981). Despite short term cyclical movements between glut and deficit, the market for poultry meat and eggs is also expected to be good with deficits in production again being projected. The economic prices (Table G4.5) for all of these commodities have been calculated from their financial and "market" prices using Veitch and Hamzah conversion factors. The market prices have been obtained from the FAMA price data bank, augmented by information from farmers and wholesale markets.

G4.2.7 Fertilisers:

Although a certain amount of compounding of fertilisers is carried on in Malaysia the majority of basic fertilisers such as urea, sulphate of ammonia, phosphates and potash are imported. Economic prices for these based on import parity are estimated in Table G4.6. The price for compound fertilisers has been determined from the import price of basic nutrients with a margin added to cover local compounding costs.

G4.2.8 Agri-chemicals (Herbicides and Pesticides):

In terms of cost agri-chemicals are relatively minor inputs to the agricultural production systems proposed. Also the majority of the chemicals recommended for use are compounded in Malaysia. Economic prices (Tables G4.7) are therefore derived using the Veitch and Hamzah factor for agricultural inputs.

G4.2.9 Agricultural Machinery:

Machinery capital and operating costs have been broken down into their various components; c.i.f. costs, taxes, distribution dealers' margins, fuel, labour, insurance and contractors' margins, (Appendix GI) and a composite conversion factor for each operation calculated. The result of the analysis is summarised in Table G4.8.

G4.3 Non-Tradeable Items

G4.3.1 Non-tradeable items include the major engineering works concerned with irrigation and drainage, construction of roads and buildings and services such as transportation, handling and processing. They are made up of various combinations of tradeable goods, services and primary factors of production, and in addition are influenced by transfer payments such as taxes, duties or subsidies. Their financial cost does not therefore, reflect their true or "real" value to the national economy.

G4.3.2 The conversion factor for irrigation and drainage engineering costs has been derived by disaggregating the costs into their main components (materials, labour, transport, plant and contractors' overheads and profits) and applying the approprite Veitch and Hamzah conversion factor to each (Appendix GII Table GII.4). The factors used for all non-tradeables are summarized in Table G4.9.

G4.4 Primary Factors of Production

G4.4.1 The economic value of land, labour and capital has been assessed in terms of their opportunity cost i.e., the net value of production foregone by transferring these resources from their present use to alternative uses with the project. The cost of water per se, however, as opposed to the costs of providing or improving the distribution of water, is not treated as an economic cost. The estimates of water available for irrigation have made allowance for the demands of urban and industrial development and thus irrigation water can be regarded as having no competing alternative use, and if not used for irrigation would be ultimately discharged into the sea.

Land

G4.4.2 The opportunity cost of land is represented by the net value of production from that land without the project. Its opportunity cost in terms of what people would be willing to pay for it in other uses is much higher. It is however stated policy that the development areas be reserved for agriculture only. For economic analysis the net value is calculated using economic prices. The same cost is applied whether the land is to continue as padi land or whether it is required for construction of new canals, drains or access roads. The net value of production without the project is discussed more fully in Chapter G2.

Labour

G4.4.3 It is generally recognised that all categories of labour, skilled (managerial and professional personnel), semi-skilled (drivers, machine operators, clerks and foremen, etc.), unskilled casual labour and farm household labour are in relatively short supply. The anticipated growth in industrialization will mean that the current scarcity will prevail and almost certainly will be exacerbated. Given this, it can be reasonably assumed that market wage rates will reflect the opportunity cost of skilled, semi-skilled and farm household labour.

G4.4.4 Unskilled casual labour, however, should be considered within the context of a wider region, particularly as some of the labour employed (mainly in industry) has migrated into the area from states such as Kedah and Perlis where the current level of overt unemployment is expected to increase. In these circumstances the market wage may exceed the real opportunity cost of this labour in alternative employment in its area of origin. However, since unskilled casual labour will be employed mainly in construction, its opportunity cost will have been accounted for in the conversion factors used to obtain economic costs of construction works. The balance of unskilled casual labour not employed in construction activities will be relatively small and, since it need not necessarily originate from areas of open unemployment, it treated similarly to farm household labour.

G4.4.5 The economic prices for the various categories of labour are obtained by applying consumption conversion factors (Veitch and Hamzah 1979) to their estimated financial remuneration. The factors used are summarized in Table G4.10.

Capital

G4.4.6 The opportunity cost of capital is taken to be 10 per cent; this is the estimated level of the marginal product (at economic prices) of a unit of public investment. It is the discount rate the Economic Planning Unit (EPU) recommend for project appraisal of public sector projects in Malaysia.

Table G4.1 Derivation of Economic Price for Padi (Constant 1980 values)

	Factor (1)	1980	1981	1982	1983	1984	1985
F.o.b. price Bangkok (us$/tonne) (2)	1.00	440	493	526	538	550	561
Adjustment for poorer quality (3)		396	443	473	484	495	504
Freight and Insurance (4)	1.00	+30	+30	+30	+30	+30	+30
C.i.f. Malaysian Port (US$/tonne)		426	473	503	514	525	534
C.i.f. Malaysian Port (M$/tonne) (5)		937	1,041	1,107	1,131	1,155	1,175
Stevedoring and transport to KL (6)	0.67	+22	+22	+22	+22	+22	+22
Wholesale price at KL		959	1,063	1,129	1,153	1,177	1,197
Transport from Mill in Project Area to KL (7)	0.67	-22	-22	-22	-22	-22	-22
Price ex-mill in project area		937	1,041	1,107	1,131	1,155	1,175
Milling costs net of value of bran (8)	0.62	-39	-39	-39	-39	-39	-39
Price in mill		898	1,002	1,068	1,092	1,116	1,136
Equivalent padi price (9)		584	651	694	710	725	738
Transport & agents' margin mill to farm gate	0.67	-22	-22	-22	-22	-22	-22
Padi price (clean dry padi) at farm gate		562	629	674	688	703	716

Notes:

(1) Veitch and Hamzah: Economic Planning Unit (1979)
(2) IBRD Commodity Price Forecasts (Nov 1980) Thai 5% Broken f.o.b. Bangkok
(3) 10% discount on f.o.b. price
(4) Estimate 1980
(5) Exchange rate M$2.2 = US$1
(6) M$33 at financial rate
(7) M$32 at financial rate
(8) Milling costs inclusive of millers' margin. M$112 per tonne. By-product value M$49. ($112 - 49) x 0.62 = $39.
(9) 65% recovery of milled rice from padi assumed

Table G4.2 Maize: Derivation of the Economic Price at the Farm Gate[1] (1980 Constant Values)

	Conversion Factor	1980	1981	1982	1983	1984	1985
Price f.o.b. Gulf Port (US$ per tonne)[2]	1.00	130	150	186	191	196	201
C.i.f. costs US Gulf to Malaysian Port Butterworth (US$ per tonne)	1.00	+34	+34	+34	+34	+34	+34
C.i.f. price Butterworth (US$ per tonne)		164	184	220	225	230	235
C.i.f. price Butterworth (M$ per tonne)		361	404	484	495	506	517
Stevedoring at port, storage, handling and transport to feed mill (M$ per tonne)		+20	+20	+20	+20	+20	+20
Price in mill (M$ per tonne)[3]		381	424	504	515	526	537
Marketing and transport farm to mill[4]		-22	-22	-22	-22	-22	-22
Economic price at the farm gate		359	402	482	493	504	515

Notes:

(1) Malaysia is a net importer of maize (almost 400 tonnes in 1980). ∴ price is based on import parity.
(2) Imports are purchased from Thailand, Indonesia, Burma and USA. C.i.f. prices of USA grain however are lower than c.i.f. prices from other suppliers.
(3) Estimate.
(4) Assumed to be similar to rice.

Table G4.3 Oil Palm: (ffb) Economic Price at the Farm Gate (Constant 1980 Values)

	Conversion Factor	1980	1981	1982	Year 1983	1984	1985	1990
Palm Oil (US$/tonne)								
Palm Oil c.i.f. Europe (1)	1.00	580	594	602	617	632	647	625
Freight & insurance from Malaysian port (2)	1.00	-97	-97	-97	-97	-97	-97	-97
F.o.b. Malaysian port (Butterworth)		483	497	505	520	535	550	528
Palm Oil (M$/tonne)								
F.o.b. Butterworth		1,063	1,093	1,111	1,144	1,177	1,210	1,162
Transport oil from mill in project area to Butterworth (3)	0.67	-13	-13	-13	-13	-13	-13	-13
Price ex-mill in project area		1,050	1,080	1,098	1,131	1,164	1,197	1,149
Processing costs (4)	0.85	-84	-84	-84	-84	-84	-84	-84
Price in mill project area		976	996	1,014	1,047	1,080	1,113	1,065
Palm Kernals (US$/tonne)								
Palm Kernals c.i.f. UK	1.00	350	349	389	425	460	496	477
Freight & insurance Butterworth to UK (5)	1.00	-148	-148	-148	-148	-148	-148	-148
F.o.b. price Butterworth		202	201	241	277	312	348	329
Palm Kernals (M$/tonne)		444	442	530	609	686	766	724
Transport Butterworth to oil mill in project area (2)	0.67	-20	-20	-20	-20	-20	-20	-20
Ex-mill price in project area		424	422	510	589	666	746	704
Bagging (2)	0.67	-27	-27	-27	-27	-27	-27	-27
Price in mill		397	395	483	562	639	719	677
Fresh Fruit Bunches (ffb) (M$/tonne)								
Palm Oil price equivalent (6)		195	199	203	209	216	223	213
Palm Kernal price equivalent (7)		14	14	17	20	22	25	24
Value at mill in project area		209	213	220	229	238	248	237
Transport to Farm or Estate (2)	0.67	-13	-13	-13	-13	-13	-13	-13
Farm gate economic price		196	200	207	216	225	235	224

Notes:

(1) Malaysian 5% bulk. IBRD Commodity Price Projections (1980)
(2) $88.4 freight + $8.6 insurance & brokerage
(3) Estimate
(4) M$99 per tonne of oil produced
(5) $143 freight + $5 insurance & brokerage
(6) 20% extraction rate
(7) 3.5% extraction rate

Table G4.4 Copra: Economic Price at the Farm Gate(1) (Constant 1980 Values)

	Conversion Factor	1980	1981	1982	Year 1983	1984	1985	1990
US$ per tonne								
Projected price c.i.f. N.W. Europe	1.00	465	465	557	605	653	701	648
Freight, insurance, brokerage and commission(2)	1.00	-105	-105	-105	-105	-105	-105	-105
F.o.b. price Butterworth		360	360	452	500	548	596	543
M$ per tonne								
F.o.b. price Butterworth		792	792	994	1,100	1,206	1,311	1,195
Port handling and transport from project area(3)	0.67	-20	-20	-20	-20	-20	-20	-20
Price in project area		772	772	974	1,080	1,181	1,291	1,175
Processing (drying on farm)(4)	0.76	-19	-19	-19	-19	-19	-19	-19
Price of Copra at farm gate		753	753	955	1,061	1,162	1,272	1,156

Notes:

(1) Based on export parity
(2) Butterworth Shipping Co.
(3) Similar to palm kernals
(4) Estimate

Table G4.5 Economic Price for Fruit, Vegetables, Meat & Diary Products (Constant 1980 Values)

Commodity	Financial[1] Price (M$/tonne)	Conversion[2] Factor	Economic[3] Price (M$/tonne)
Fruit			
Bananas	414	0.85	352
Papayas	330	0.85	280
Mixed Vegetables[4]	496	0.85	422
Poultry: Meat (liveweight)	2,400	0.79	1,896
Eggs (per thousand)	180	0.87	157

Notes:

(1) Source: FAMA, farmers and wholesale markets.
(2) Veitch and Hamzah (1979).
(3) For 1980 and subsequent years i.e. will keep in line with general rates of inflation.
(4) Based on a mix of 5 vegetables: Okra 65%; long bean 10%; cucumber 10%; brinjal 10%; chillies 5%.

Table G4.6 Economic Price of Fertilizers at the Farm Gate[1] (Constant 1980 Values)

	Conversion Factor	1980	1981	1982	1983	1984	1985
US$ per tonne[2]							
F.o.b. Price Urea (Europe)	1.0	215	211	216	234	252	270
F.o.b. Price TSP (US Gulf)	1.0	175	188	180	196	212	228
F.o.b. Price Muriate of Potash (Vancouver)	1.0	115	110	105	106	107	108
F.o.b. Price Sulphate of Ammonia	1.0	IBRD	PROJECTION		NOT	AVAILABLE	
Freight and Insurance to Malaysia[3]	1.0	+115	+115	+115	+115	+115	+115
C.i.f. Prices Malaysia (M$ per tonne)							
Urea		726	717	728	768	807	847
TSP		638	667	649	585	620	656
Muriate of Potash		407	396	385	387	389	392
Sulphate of Ammonia		-	520	526	554	584	615
Handling, transport and marketing margins[4]	0.67	+40	+40	+40	+40	+40	+40
Price at Farm Gate							
Urea		766	757	768	808	847	887
TSP		678	707	689	625	660	696
Muriate of Potash		447	436	425	427	429	432
Sulphate of Ammonia		-	-	-	-	-	-
Compound (15:15:15)		728	728	728	764	802	842

Notes:
(1) All fertilizers are imported. ∴ prices are based on import parity
(2) IBRD Commodity Price Forecasts (November 1980)
(3) C.i.f. price Malaysia 1981 - similar trend to Urea assumed
(4) Estimate
(5) Estimated from import prices for basic nutrients + 20% for compounding

Table G4.7 Economic Prices for Agri-chemicals

Chemical	Unit	Market Price M$	Conversion Factor [1]	Economic Price M$
Pesticides:				
Gamma BHC	kg	1.41	0.86	1.21
Dieldrex	L	6.72	0.86	5.78
Azodrin	L	35.80	0.86	30.79
Agroide	kg	2.67	0.86	2.30
Malathion (80%)	L	11.8	0.86	10.15
Herbicides:				
Rumpotox (Butylester 24)	kg	8.36	0.86	7.19
24D Amine	L	10.00	0.86	8.60
Grammoxone (paraquat)	L	9.40	0.86	8.08
Fungicides:				
Dithane M45	kg	10.30	0.86	8.86
Benylate	kg	66.00	0.86	57.76

Note: (1) Veitch and Hamzah Group XVI Agricultural Inputs combined. (Appendix GII).

Table G4.8 Economic Costs for Mechanised Field Operation

	Conversion Factor	Economic Cost (M$/ha)	
		Service Centre	Contractor
power tiller cultivation	0.75	NA	148
rotavating (medium HP/tractor)	0.83	174	207
disc harrowing (medium HP/ tractor)	0.84	149	NA
combine harvesting	0.85	163	185

Note: Consultants' estimate (Appendix GI).

Table G4.9 Conversion Factors Used to Determine Economic Prices for Major Non-Tradeable Items

Item	Conversion Factor	Source Veitch and Hamzah
Irrigation & drainage works. (1)	0.79	Construction (XXIII)
Operation & maintenance	0.79	Construction (XXIII)
Building construction & maintenance	0.77	Construction (XXIII)
Engineering, design & supervision	0.72	Other Services (XXIX)
Transportation	0.66	Transport (XXV)
Handling & storage	0.66	Estimate

Note: (1) Appendix GII Table GII.1

Table G4.10 Economic Costs of Labour & Personnel

	Category (1)	Consumption Conversion Factor
I	Skilled Managerial Personnel	0.76
II	Semi-skilled	0.78
III	Unskilled casual & farm household labour	0.80

Notes: (1) Veitch and Hamzah (1979)
Category I "rich")
Category II "intermediate") Appendix GII Table GII.2
Category III "poor")

G5 ECONOMIC ANALYSES

G5.1 Introduction

G5.1.1 The purpose of the economic analyses is to determine the attractiveness of investment in upgrading the irrigation and drainage systems throughout Seberang Perai and Balik Pulau from the viewpoint of the national economy. The analyses are carried out at the grouped scheme and project levels and will, therefore, indicate the relative attractiveness of major schemes such as Sg. Muda, Sg. Kulim and Balik Pulau and the groups of minor schemes (Groups B, D and Juru). The methodology used is consistent with that recommended by the EPU, and thus investment in the project can be directly compared with similar investment opportunities in the agricultural sector.

G5.1.2 In this chapter the principal assumptions used concerning the "without and with-project situations" are described, and the results of the economic analyses are discussed in terms of the economic indicators, Present Value and Internal Rate of Return. A range of sensitivity tests has also been carried out to determine the "stability" of the project in response to increases in costs of engineering works or changes in gross revenues due to a delay in receipt of project benefits.

G5.2 The Without-Project Situation

G5.2.1 The without-project situation is an attempt to project, on the basis of present knowledge and trends, what is likely to happen to agricultural production in the project area if a decision not to proceed with implementation of the irrigation, drainage and agricultural proposals is taken. This has been described in Chapter G2.

G5.2.2 The areas producing in the without-project situation are, however, presented as a 'net loss' of crop area. By this it is meant that even with project implementation there will for some years, be significant areas that are being farmed and are giving returns at the 'Future Without' level of yields and production costs. If all the 'without-project' areas and margins are subtracted from those of the 'with-project' situation, the incremental benefits will be underestimated, because during the implementation period, there will still be a flow of production on unimproved land. Such areas are more logically subtracted from 'without' areas of unabandoned land than added to the "Future With' areas. Both they and 'Future-Without' areas are multiplied by the 'without project' crop margins.

G5.2.3 During the two year construction period preceding the completion of rehabilitation in each area, it has been estimated that production losses will be equivalent to 25% of the unimproved area's cropping. Once rehabilitation is complete the incremental benefits can be derived by subtracting the returns for 'future without' from the 'future with'. The calculation of 'future with' and 'net future without' areas are presented in Appendix G III.

Crop Production Costs

G5.2.4 Rice production costs do not vary greatly throughout the area since the major operations are fairly standard. Land preparation is mainly carried out by contractors using either power tillers or medium HP tractors, a standard package of fertilisers is provided free of charge: pesticides and herbicides are provided on credit and harvesting costs are determined by the unit of area rather than yield. The differences in yield therefore probably reflect infrastructural differences, seed used and the amount of labour which the farm households commit to operations such as weed control and irrigation. In economic prices the crop production costs for rice in the 'future without' situation are M$1,193/hectare whilst for vegetables the amount is M$2,871 (Tables G2.4 and G2.5).

Infrastructure

G5.2.5 It is assumed that without the project the existing physical infrastructure , access roads, irrigation system, drainage etc. would continue to be maintained at the present level. Thus repairs and replacement of structures and equipment would be carried out as necessary.

G5.3 The With-Project Situation

G5.3.1 A detailed account of the development programme is given in the main reports. The cropping season does not correspond to the calendar year and is taken to begin in March with the off-season and extended to the end of the main (wet) season the following January/February.

G5.3.2 Table G5.1 shows the completion times for areas in Seberang Perai. There will be four identifiable time stages: agricultural pilot, engineering sample, small holder and group farm areas. Development will initially concentrate on pilot group farms and then give priority to areas where design and survey are well advanced. Group farms will usually be developed on abandoned land and will come at the end of the programme. Thus unabandoned areas of smallholder production will be upgraded first. The total future net irrigable area in Seberang Perai is 12,421 ha (13,801 ha gross) of which 40% will be smallholder, 4% mixed and 56% will become group farming areas on what is currently '<u>tanah rang</u>' or abandoned land.

G5.3.3 For Balik Pulau the development will be as shown on Table G5.2.

<u>Cropping Patterns</u>

G5.3.4 The selection of crops and cropping systems for the Seberang Perai schemes and Balik Pulau is discussed in Chapter G3. The cropping systems proposed have been influenced by land capability, irrigation water availability, crop markets, relative profitability (financial prices) of crops, and by the experience and preferences of existing farmers. Rice double-cropping is proposed throughout all of the Seberang Perai schemes, apart from a small area (180 ha) of Pinang Tunggal where main season rice will be followed by a mixture of vegetables. Rice will be grown under two systems; a more labour-intensive system practised by smallholders and a mechanised system practised on larger scale group farms.

Because of limitations on the availability of irrigation water the cropping systems for Balik Pulau are more complex. Three systems are proposed:-

- Smallholders: rice double-cropping
- Group Farms : mechanised rice double-cropping
- Group Farms : main season rice and off-season maize and vegetables

Crop Budgets

G5.3.5 Crop budgets at economic prices (in constant 1980 M$) were summarised in Table G3.1. It is assumed that peak smallholder rice yields will be slightly higher than those for group farms and that they will be achieved a year earlier. Similarly smallholder vegetables yields in Pinang Tunggal are expected to be higher than group farm vegetable yields in Balik Pulau. The rice yield differences reflect the introduction of a new system of production while the higher smallholder vegetable yields in Pinang Tunggal reflect the existing skills and experience of the Pinang Tunggal vegetable growers. Crop direct production costs (detailed in Appendix GI) are assumed to remain constant irrespective of yields. The higher yields in the second, third and fourth years would have no more a marginal impact on labour requirements while the level of other inputs would remain the same. The costs included are materials, machinery, depreciation on hand tools and labour; transfer charges such as irrigation dues and quit rent have been excluded.

Other Farm Costs

G5.3.6 A number of other-on-farm costs, rehabilitation of abandoned land, rat control materials and management and clerical staff salaries for group farms, which can be directly attributed to the areas cultivated within each scheme, are also included in the cost stream. They are summarised in both economic and financial prices in Table G5.4 and discussed below:-

(a) Rehabilitation of abandoned land

These costs include the cost of applying herbicides (chemicals and application costs) to kill sedges, burning of sedges and a post-burning cultivation of the land. The latter would not replace normal land preparation, included in the crop budget. Rehabilitation costs are a once-only cost incurred on all group farm areas (apart from a small area of land in Balik Pulau where it is assumed that remaining smallholders would immediately adopt the group farming system).

(b) Rat control materials

The organisation of rat control campaigns would be the responsibility of the Crop Protection Services Unit of the Department of Agriculture, and provision for the staff required to provide effective services is included in the Balik Pulau - Seberang Perai IADP proposals (July 1981). Since provision has not been made specifically for rodenticides, these are included in the project costs.

(c) Group farm: staff salaries

These costs are based on an average requirement of one manager and one clerical officer per 150 ha block plus two field supervisors per 60 ha group farm. They can thus be reduced to a per hectare cost.

Agricultural Services

G5.3.7 The benefits from the project are expected to derive from the improvement of irrigation and drainage infrastructure and from improved agricultural services. The main components of the latter will be improved crop protection, an intensified extension effort and the establishment of a number of Machinery Services Centres. The principal cost of intensifying the extension effort will be the cost (wages, allowances and transport) of increasing the number of extension workers to meet the IADP target of one grass-root worker per 600 farm families. Altough two Machinery Service Centres are to be established under the IADP proposals, they are not adequate to carry out the rehabilitation programme on the scale envisaged in the upgrading of irrigation and drainage programme.

G5.3.8 The costs of providing the additional extension workers and the Machinery Services Centres have been included in the aggregated project level analysis. They have not been included in the group scheme analysis since they cannot be easily allocated to individual schemes or groups of schemes.

G5.3.9 The Machinery Service Centre costs comprise the incremental capital costs of the centres proposed (four in Seberang Perai and one in Balik Pulau), management and clerical staff salaries, and the building and site maintenance costs. The capital costs of machinery, and mechanic and drivers' salaries have already been accounted for in the hourly charges for mechanised field operations and therefore are not included.

Engineering Costs

G5.3.10 Table G5.5 summarizes engineering costs in 1980 economic prices for Groups A to E. The following factors should be borne in mind:

(a) Engineering costs were established in 1981 prices but have been deflated by 10% to express them in 1980 M$. This is the price base used for assessing agricultural benefits.

(b) To convert financial values to economic values conversion factors have been applied. These are .72 for engineering survey and design and .79 for all other costs. These have been drawn from the work of Veitch and Hamzah (See Appendix GII).

(c) Incremental O & M costs include some capital expenditure for pump replacement, as well as purchase of earth-moving plant.

G5.3.11 The capital cost of development at economic prices in undiscounted 1980 constant M$ are:-

	Amount in M$ million	M$ per net ha
Group A	54.51	8,715
B	16.95	6,915
C	21.91	7,226
D	2.53	5,473
E	2.48	11,286
F	10.04*	9,750*

* 1981 prices used for Balik Pulau.

G5.3.12 For the economic analyses it has been assumed that the irrigation and drainage systems will have an economic life of 40 years providing that full maintenance is carried out throughout this period. The incremental costs of operation and maintenance necessary to ensure this have been estimated and are included in the engineering costs. No salvage values are included for the capital works (canals, roads, drains and buildings) constructed under the project.

G5.4 Results

Methodology

G5.4.1 A range of economic indicators has been calculated:-

(1) Present Value of Benefits

(2) Present Value of Costs

(3) Net Present Value [(1) - (2)]

(4) Benefit Cost Ratio [(1) ÷ (2)]

(5) Internal Rate of Return (IRR)

Only (3) and (5) were calculated for Balik Pulau.

G5.4.2 The base year for discounting (year 0) is taken to be 1982/83 and present values are discounted at 10%, the rate recommended by the Economic Planning Unit (EPU).

Scheme Group Analyses

G5.4.3 Tables G5.6 to G5.11 give the major constituent items of the cost and benefit streams whilst Table G5.12 summarizes the results. The data used in the cash flows are shown in Appendix G V in both economic and financial terms.

G5.4.4 In Tables G5.6 to G5.11 the following should be noted: (these assumptions are needed to derive the incremental benefit stream from the areas in lines 1 - 3 and 7:)

- Group farms are developed on abandoned land.
- 'Abandoned Land' is developed after already cultivated land.

- Without-Project Area is shown as just the area that would be cultivated given no improvements. The net returns, however, are calculated with a net irrigable area that allows for production on land before it is rehabilitated. (Appendix GIII)

- The effort of construction on production in smallholder areas is equivalent to a 25% loss of Future-Without area over two years.

G5.4.5 Table G5.13 shows the farm revenues and costs with the project improvements. This table, in conjunction with Tables G5.6 - G5.11 is used to derive "with project" benefits. Supporting tables for area calculations, production and cost can be found in Appendix GIV.

Interpretation

G5.4.6 Measured at economic prices all the group schemes are economically viable. The internal rate of return is more than the test rate of 10%, the net present value is positive at the test rate and the Benefit-Cost Ratio is more than unity. Economic rates of returns are higher than financial ones since the price of the main output, rice, is subsidised. In addition, engineering costs are reduced by the application of the standard conversion factors which expresses domestic engineering costs in terms of their 'foreign exchange equivalent'. The major assumption of the analysis is that the opportunity cost of land in the without-project situation is reflected in its continued agricultural use rather than conversion for housing or industrial development. This will only be an appropriate assumption as long as non-economic considerations (land use and development regulations) govern. If land in the development areas must be used for agriculture and the government enforces this policy, it is appropriate to use the without-project agricultural returns as a measure of land value.

Sensitivity Analysis

G5.4.7 The cash flows were recalculated for two sensitivity assumptions reflecting a more pessimistic view of the future. These allow for a 20% increase in construction costs or a 2 year delay in achiveing benefits. Results with the basic case reproduced for comparison are in Table G5.14.

G5.4.8 The delay in benefits has a greater affect than the 20% increase in construction costs. In both cases, however, the grouped schemes treated as independednt projects are still economically viable.

G5.5 Project Level Analysis

G5.5.1 For both the Balik Pulau and Seberang Perai sets of schemes cash flows were calculated as an aggregation of the individual schemes. Table G5.15 shows the cash flows and includes additional costs for Machinery Service Centres and Extension Services, for Seberang Perai. Table G5.16 shows similar data for Balik Pulau.

G5.5.2 The results of the project analysis in economic prices are shown in Table G5.17.

G5.5.3 The overall investment plan generates sufficient agricultural benefits to establish economic viability.

Table G5.1 Development Stages and Farm Types - Seberang Perai (hectares net irrigable area)

1st Crop Season After Rehabilitation	Group A, Muda 1984/85	Group A, Muda 1986/87	Group A, Muda 1990/91	Group A, Muda Total	Group B, Pinang Tunggal 1984/85	Group B, Pinang Tunggal 1986/87	Group B, Pinang Tunggal 1987/88	Group B, Pinang Tunggal 1988/89	Group B, Pinang Tunggal Total	Group C, Kulim 1986/87	Group C, Kulim 1989/90	Group C, Kulim Total	Group D, C & S 1986/87	Group D, C & S 1989/90	Group D, C & S Total	Group E, Juru 1986/87	Group E, Juru Total	Total All Groups
Construction Phase	II	II	III		II	II	II	III		II	III		II	III		II		
1. Total Net Irrigable Area Improved	336	3,085	2,834	6,255	135	171	1,320	825	2,451	538	2,494	3,032	401	62	463	220	220	12,421
2. <u>Area Developed by Stage</u>																		
Pilot	336			336	135				135									471
Engineering Sample		715		715		171*			171	538		538	74		74			1,498
Other Smallholders		2,370		2,370			1,320**		1,320				327		327	220	220	4,237
Group Farm Areas			2,834	2,834				825	825		2,494	2,494		62	62			6,215
3. <u>Area Developed by Farm Types</u>																		
Smallholder		3,085		3,085		171	1,320		1,491				401		401	220	220	5,197
Mixed +										538		538						538
Group Farms	336		2,834	3,170	135			825	960		2,494	2,494		62	62			6,686

* Includes 74 hectares } rice and vegetables
** Includes 106 hectares } rice and vegetables

All other areas are double rice cropped

+ The Kulim sample area forms one rehabilitation unit, but comprises Group Farms and smallholders

Table G5.2 Development Stages and Farm Types Balik Pulau (net hectares)				
1st crop season after rehabilitation	1984/85	1988/89	1990/91	Total
Construction Phase	II	III	III	
1. Total Net Irrigable Area Improved	156	670	204	1,030
2. Area Developed by Stage				
Pilot	156			156
Engineering Sample	-			-
Other Smallholders		134		134
Group Farm Areas		536	204	740
3. Area Developed by Farm Types				
Smallholder double rice		134		134
Group Farms double rice	73	78		151
Group Farms rice, maize, vegetables	83	458	204	745

Table G5.3 Seberang Perai & Balik Pulau: Proposed Cropping Systems (Net cultivable hectares)				
	Smallholder		Group Farms	
Scheme	double rice	rice & vegetables	double rice	rice, maize & vegetables
	I	II	III	IV
Group A Sg. Muda	3,085	-	3,170	-
Group B Pinang Tunggal and N.E. area	1,311	180	960	-
Group C Sg. Kulim	538 (mixed)	-	2,494	-
Group D Schemes in South & Central Districts	401	-	62	-
Group E Juru	220	-	-	-
Group F Balik Pulau	134	-	151	745

Table G5.4 Other Farm Costs			
		Rate (1980 Constant M$)	
	Unit	Financial	Economic[4]
Rehabilitation	$/ha	240	200
Rat Control	$/ha	14.5	12.5
Management			
Central[1]	$/ha	98.3 (70)[2]	78 (54)[2]
Farm Level[3]	$/ha	208.4	165 (163)

Figures apply to Seberang Perai and Balik Pulau except as noted in note 2.

Notes:

(1)

	$	
Head Office	375,000	) spread over
7 branch officers @ $43,000	301,000	) 6,874 ha) of Seberang Perai

(2) Balik Pulau figures in brackets: based on $28 per ha for Head Office plus $42/ha for branch office (financial prices).

(3) $12,500 per 60 hectares equivalent to M$208/ha.

(4) Conversion Factor of 0.80, Veitch and Hamzah XXVIII.

Table G5.5 Engineering Costs in M$'000 at 1980 Prices (Economic)

		1982/83	1983/84	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90	1990/91	91+
Group A	Engineering Survey/Design	599	526	642	869	507	467	522	260	116	–
	Construction		4,611	9,882	10,292	2,305	5,358	10,198	6,198	1,142	–
	Incremental O & M			22	260	167	214	214	452	1,260*	531
	Total Annual Costs	599	5,137	10,546	11,421	2,979	6,039	10,934	6,910	2,518	531
Group B	Engineering Survey/Design	92	297	151	389	144	207	123	27	–	–
	Construction	–	931	1,617	4,680	2,641	2,774	2,614	262	–	–
	Incremental O & M	–	–	–	–	164	85	246	131	131	131
	Total Annual Costs	92	1,228	1,768	5,069	2,949	3,066	2,983	420 -	131	131
Group C	Engineering Survey/Design	83	66	152	507	207	366	334	84	–	–
	Construction	–	758	1,514	1,128	1,377	7,141	7,352	839	–	–
	Incremental O & M				85	40	40	40	383	1,143	184
	Total Annual	83	824	1,666	1,720	1,624	7,547	7,726	1,306	1,143	184
Group D	Engineering Survey/Design	61	16	41	56	14	8	7	2	1	–
	Construction	–	22	813	1,080	100	106	139	51	17	–
	Incremental O & M	–	–	–	22	20	20	20	24	24	24
	Total Annual	61	38	854	1,158	134	134	166	77	42	24
Group E	Engineering Survey/Design	74	18	60	45	12	–	–	–	–	–
	Construction	–	–	1,169	992	113	–	–	–	–	–
	Incremental O & M	–	–	–	–	–	29	148	29	29	29
		74	18	1,229	1,037	125	29	148	29	29	29

* Includes Pumping Plant Replacement

Economic Conversion Factors

Engineering Design/Survey = .72
Construction and O & M = .79

Inflation Factor = $\frac{1}{1.10}$

Table G5.6 Scheme Analysis Incremental Net Revenue, Project Costs and Net Cash Flows at Economic Prices (M$'000)

Group A: Sungai Muda

		Year											
		1982/83	1983/84	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90	1990/91	1991/92	1992/93	1993/94
(1)	With Project Net Value of Production												
	Development Programme												
	Smallholders (ha)					3,085	3,085	3,085	3,085	3,085	3,085	3,085	3,085
	Group Farms (ha)			336	336	336	336	336	336	3,170	3,170	3,170	3,170
	Total (Net Irrigable Area)			336	336	3,421	3,421	3,421	3,421	6,255	6,255	6,255	6,255
	Gross Revenue			1,443	1,636	16,607	19,596	20,922	20,922	33,097	34,718	36,141	37,155
	On Farm Production Costs			722	722	8,083	8,083	8,083	8,083	14,170	14,170	14,170	14,170
(2a)	Net Revenue (M$'000)			721	914	8,524	11,513	12,839	12,839	18,927	20,548	21,971	22,985
	Without Project Area (ha)	4,762	4,330	3,898	3,408	3,408	3,408	3,408	3,408	3,402	3,408	3,408	3,408
(2b)	Net Returns Without Project (1)	-	-	847	847	3,387	3,387	3,476	3,476	3,742	3,742	3,742	3,742
(3)	Incremental Benefits			(126)	67	5,137	8,126	9,363	9,363	15,185	16,806	18,229	19,243
(4)	Other Farm Costs												
	Rehabilitation of abandoned land ($200/ha)	-	-	67	-	-	-	-	-	70	-	-	-
	Rat Control ($12.5/crop/ha)			8	8	56	86	86	86	156	156	156	156
	Central Management ($79/ha)			27	27	25	25	25	25	250	250	250	250
	Farm Level Management ($167)			56	56	56	56	56	56	529	529	529	529
	Sub Total			158	91	137	167	167	167	1,005	935	935	935
(5)	Engineering Costs												
	Engineering Design/Survey	599	526	642	869	507	467	522	260	116	-	-	-
	Construction		4,611	9,882	10,292	2,305	5,358	10,198	6,198	1,142	-	-	-
	Incremental Operation and Maintenance			22	260	167	214	214	452	1,260	531	531	531
	Total Engineering Cost	599	5,137	10,546	11,421	2,979	6,039	10,934	6,910	2,518	531	531	531
	CASH FLOW (3)-(4)-(5)	(599)	(5,137)	(10,830)	(11,445)	2,021	1,920	(1,738)	2,286	11,662	15,340	16,763	17,777

Table G5.7 Scheme Analysis Incremental Net Revenue, Project Costs and Net Cash Flows at Economic Prices (M$000)

Group B : Pinang Tunggal

	Year									
	1982/83	1983/84	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90	1990/91	1991/92
(1) With Project Net Value of Production										
Development Programme										
Smallholders (ha)					171	1,491	1,491	1,491	1,491	1,491
Group Farms (ha)			135	135	135	135	960	960	960	960
Total			135	135	306	1,626	2,451	2,451	2,451	2,451
Gross Revenue			580	657	2,218	8,786	13,682	14,722	15,136	15,432
On Farm Production Costs			290	290	985	4,135	5,907	5,907	5,907	5,907
(2a) Net Revenue (M$000)			290	367	1,233	4,651	7,775	8,815	9,229	9,525
Without Project Area	1,800	1,694	1,625	1,625	1,625	1,625	1,625	1,625	1,625	1,625
(2b) Net Return Without Project			145	1,249	1,450	4,527	4,527	4,527	4,527	4,527
(3) Incremental Benefits			145	(882)	(217)	130	3,248	4,288	4,702	4,998
(4) Other Farm Costs										
Rehabilitation of abandoned land ($200/ha)			27	-	-	-	165	-	-	-
Rat Control ($12.5/crop rice)			3	3	8	41	61	61	61	61
Central Management			11	11	11	11	76	76	76	76
Farm Level Management			23	23	23	23	160	160	160	160
Sub Total			64	37	42	75	452	297	297	297
(5) Engineering Costs										
Engineering Design/Survey					144	207	123	27	-	-
Construction	92	297	151	389	2,641	2,774	2,614	262	-	-
Incremental Operation and Maintenance	-	931	1,617	4,680	164	85	246	131	131	131
Total Engineering Cost	92	1,228	1,768	5,068	2,949	3,066	2,983	420	131	131
CASH FLOW (3)-(4)-(5)	(92)	(1,228)	(1,687)	(5,987)	(3,200)	(3,011)	(187)	3,571	4,274	4,570

Table G5.8 Scheme Analysis Incremental Net Revenue, Project Costs & Net Cash Flows at Economic Prices (M$000)

Group C :Kulim

	Year 1982/83	1983/84	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90	1990/91	1991/92	1992/93
(1) With Project Net Value of Production											
Development Programme											
Smallholders (ha)					350	350	350	350	350	350	350
Group Farms (ha)					188	188	188	2,682*	2,682	2,682	2,682
Total					538	538	538	3,032	3,032	3,032	3,032
Gross Revenue					2,487	2,920	3,165	8,589	15,373	16,625	17,518
On Farm Production Costs					1,239	1,239	1,239	3,918	6,596	6,596	6,596
(2) Net Revenue (M$000)					1,248	1,681	1,926	4,671	8,777	10,029	10,922
Net Irrigable Area Without Project	350	350	350	350	350	350	350	350	350	350	350
Net Return Without Project			171	171	690	690	690	690	690	690	690
(3) Incremental Net Value of Production			(171)	(171)	558	991	1,236	3,981	8,087	9,339	10,232
(4) Other Farm Costs											
Rehabilitation of abandoned land					38	-	-	499	-	-	-
Rat Control					31	31	31	45	76	76	76
Central Management					15	15	15	113	212	212	212
Farm Level Management					31	31	31	240	448	448	448
Sub Total					115	77	77	897	736	736	736
(5) Engineering Costs											
Engineering Design/Survey	83	66	152	507	207	366	334	84			
Construction		758	1,514	1,128	1,377	7,141	7,352	839			
Incremental Operation and Maintenance				85	40	40	40	383	1,143	184	184
Total Engineering Cost	83	824	1,666	1,720	1,624	7,547	7,726	1,306	1,143	184	184
Net Cash Flow	(83)	(824)	(1,837)	(1,891)	(1,181)	(6,633)	(6,567)	1,778	6,208	8,419	9,312

Table G5.9 Scheme Analysis Incremental Net Revenue, Project Costs and Net Cash Flows at Economic Prices (M$000)

Group D : Central & Southern

	Year										
	1982/83	1983/84	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90	1990/91	1991/92	1992/93
(1) With Project Net Value of Production											
Development Programme											
Smallholders (ha)					401	401	401	401	401	401	401
Group Farms (ha)								62	62	62	62
Total					401	401	401	463	463	463	463
Gross Revenue					1,924	2,297	2,470	2,603	2,772	2,803	2,825
On Farm Production Costs					957	957	957	1,090	1,090	1,090	1,090
(2) Net Revenue (M$000)					967	1,340	1,513	1,513	1,682	1,713	1,735
Net Irrigable Area Without Project	425	425	425	425	425	425	425	425	425	425	425
Net Returns Without Project (M$000)			145	145	496	496	496	496	496	496	496
(3) Incremental Net Value of Production	-	-	(145)	(145)	471	844	1,017	1,017	1,186	1,217	1,239
(4) Other Farm Costs											
Rehabilitation of abandoned land						-	-	12	-	-	-
Rat Control					10	10	10	12	12	12	12
Central Management								5	5	5	5
Farm Level Management								10	10	10	10
Sub Total					10	10	10	39	27	27	27
(5) Engineering Costs											
Engineering Design/Survey	61	16	41	56	14	8	7	2	1	-	-
Construction		22	813	1,080	100	106	139	51	17	-	-
Incremental Operation and Maintenance				22	20	20	20	24	24	24	24
Total Engineering Cost	61	38	854	1,158	134	134	166	77	42	24	24
Net Cash Flow	(61)	(38)	(999)	1,303	327	700	841	901	1,117	1,166	1,188

Table G5.10 Scheme Analysis Incremental Net Revenue, Project Costs and Net Cash Flows at Economic Prices (M$000)

Group E : Juru

	Year									
	1982/83	1983/84	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90	1990/91	1991/92
(1) With Project Net Value of Production										
Development Programme										
Smallholders (ha)					220	220	220	220	220	220
Group Farms (ha)										
Total					220	220	220	220	220	220
Gross Revenue					945	1,071	1,181	1,260	1,260	1,260
On Farm Production Costs					473	473	473	473	473	473
(2) Net Revenue (M$000)					472	598	708	787	787	787
Future Without Areas	75	50	50	50	50	50	50	50	50	50
Net Returns Without Project	-	-	(1)	(1)	(4)	(4)	(4)	(4)	(4)	(4)
(3) Incremental Net Value of Production	-	-	1	1	472	598	708	787	787	787
(4) Other Farm Costs										
Rehabilitation of abandoned land					44	-	-	-	-	-
Rat Control					6	6	6	6	6	6
Central Management					17	17	17	17	17	17
Farm Level Management					37	.37	37	37	37	37
Sub Total					104	60	60	60	60	60
(5) Engineering Costs										
Engineering Design/Survey	74	18	60	45	12	-	-	-	-	-
Construction	-	-	1,169	992	113	-	-	-	-	-
Incremental Operation and Maintenance	-	-	-	-	-	29	148	29	29	29
Total Engineering Cost	74	18	1,229	1,037	125	29	148	29	29	29
Net Cash Flow	(74)	(18)	(1,128)	(1,036)	243	509	500	698	698	698

Table G5.11 Balik Pulau - Incremental Net Revenues, Project Costs and Net Cash Flows at Economic Prices (M$000)

	1982/83	1983/84	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90	1990/91	1991/92	1992/93	1993/94
Development Programme												
Small holders (ha)							134					
Group farms (2xrice)			73				151	151	151	151	151	151
Group farms (rice-maize)			83				541	541	745	745	745	745
Total area (ha)			156	156	156	156	826	826	1,030	1,030	1,030	1,030
Gross revenues			667.6	759.8	839.3	903.7	2,300.8	4,295.9	5,016.2	5,846.6	5,943.5	6,036.7
On farm food costs								1,939.1				
Net revenues			312.1	404.3	483.8	548.2	1,223.6	2,356.8	2,864.2	3,419.2	3,516.1	3,609.3
Without Project												
Net revenue			180.6	180.6	180.6	180.6	214.9	214.9	374.2	374.2	374.2	374.2
Incremental revenue			131.5	223.7	303.2	367.6	1,008.7	2,141.9	2,490.0	3,045.0	3,141.9	3,235.1
Other Farm Costs												
Rehabilitation $200/ha			31.2	-	-	-	134.0	-	40.8	-	-	-
Rat control			2.8	2.8	2.8	2.8	11.2	13.9	16.5	16.5	16.5	16.5
Group farm main: $216.65/ha			33.8	33.8	33.8	33.8	149.9	149.9	194.1	194.1	194.1	194.1
Total			67.8	36.6	36.6	36.6	295.1	163.8	251.4	210.6	210.6	210.6
Engineering Costs												
Design & Supervision	50.2	80.2	100.3	350.9	90.2	160.4	120.4	-	50.2	-	-	-
Construction	-	1,826.6	-	-	913.3	2,922.6	2,374.6	-	1,096.0	-	-	-
Operation & Maintenance	-	-	18.0	18.0	18.0	18.0	83.1	83.1	90.2	90.2	90.2	90.2
Total	50.2	1,906.8	118.3	368.9	1,021.5	3,101.0	2,578.1	83.1	1,236.4	90.2	90.2	90.2
Net Cash Flow	(50.2)	(1,906.8)	(54.6)	(181.8)	(754.9)	(2,770.0)	(1,864.5)	1,895.0	1,002.2	2,744.2	2,841.1	2,934.3

NPV: 8,714.6 IRR 20.5%

Table G5.14 Sensitivity Test of Group Schemes

Economic Prices (1980 M$ x 10^6)

Scheme	Basic Case					Costs Up					Benefit Delay				
	PV Benefits	PV Costs	NPV	B/C Ratio	IRR%	PV Benefits	PV Costs	NPV	B/C Ratio	IRR%	PV Benefits	PV Costs	NPV	B/C Ratio	IRR%
A	108.88	46.74	62.14	2.33	23.3	108.88	52.71	56.17	2.07	20.6	89.09	46.74	42.35	1.91	17.3
B	27.60	14.94	12.66	1.85	17.9	27.60	17.11	10.49	1.61	15.9	22.58	14.94	7.64	1.51	14.2
C	51.86	19.88	31.46	2.61	25.6	51.86	22.43	29.43	2.31	22.8	42.38	19.88	22.50	2.13	19.1
D	7.71	2.27	5.44	1.42	29.0	7.71	2.63	5.08	2.93	26.3	6.31	2.27	4.04	2.78	21.8
E	5.33	2.69	2.64	1.98	21.1	5.33	3.05	2.28	1.75	18.5	4.37	2.69	1.68	1.62	15.7
F	–	–	8.71	–	20.5	–	–	7.26	–	17.5	–	–	5.31*	–	16.5*

*Test results are for 10% reduction in gross revenues.

Table G5.15 Project Analysis (Economic Prices) 1980 Constant M$ x 10^3 - Seberang Perai

	1982/83	1983/84	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90	1990/91	1991/92	1992/93	1993/94
Incremental Benefits												
Scheme A	-	-	(126)	67	5,137	8,126	9,363	9,363	15,185	16,806	18,229	19,243
B	-	-	145	(882)	(217)	130	3,248	4,288	4,702	4,998	4,998	4,998
C	-	-	(171)	(171)	558	991	1,236	3,981	8,087	9,339	10,232	10,232
D	-	-	(145)	(145)	471	844	1,017	1,017	1,186	1,217	1,239	1,239
E	-	-	1	1	472	598	708	787	787	787	787	787
(1) Sub Total	-	-	(296)	(1,130)	6,421	10,689	15,572	19,436	29,947	33,147	35,485	36,499
Engineering Costs												
Scheme A	599	5,137	10,704	11,512	3,116	6,206	11,101	7,077	3,523	1,466	1,466	1,466
B	92	1,228	1,832	5,105	2,991	3,141	3,435	717	428	428	428	428
C	83	824	1,666	1,720	1,739	7,624	7,803	2,203	1,879	920	920	920
D	61	38	854	1,158	144	144	176	116	69	51	51	51
E	74	18	1,229	1,037	229	89	208	89	89	89	89	89
(2) Sub Total	909	7,245	16,285	20,532	8,219	17,204	22,723	10,202	5,988	2,954	2,954	2,954
Agricultural Services												
Machinery Centres			702	766	113	113	113	113	113	113	113	113
Extension		15	29	59	59	59	59	59	59	59	59	59
Sub Total		15	731	825	172	172	172	172	172	172	172	172
Cash Flow [(1)-(2)-(3)]	(909)	(7,260)	(17,312)	(22,487)	(1,970)	(6,687)	(7,323)	9,062	23,787	30,021	32,359	33,373

Table G5.16 Balik Pulau - Project Analysis at Economic Prices

Year	1982/83	1983/84	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90	1990/91	1991/92	1992/93	1993/94
Net cash flow (Scheme analysis)	(50.2)	(1,906.8)	(54.6)	(181.8)	(754.9)	(2,770.0)	(1,864.5)	1,895.0	1,002.0	2,744.2	2,841.1	2,934.3
Monitoring Service	-	-	1.9	1.9	1.9	1.9	10.0	10.0	12.5	12.5	12.5	12.5
Machinery Service Centre							401.2	35.1	35.1	35.1	35.1	35.1
Net Cash Flow (Project level)	(50.2)	(1,906.8)	(56.5)	(183.7)	(756.8)	(2,771.9)	(2,275.7)	1,849.9	954.4	2,696.6	2,793.5	2,886.7

NPV: 8,226 IRR 20%

Table G5.17 Project Level Analysis: Economic Indicators					
Scheme	1980 M$ x 10^6			Benefit Cost Ratio	IRR%
	Present Value of Benefits	Present Values of Costs	NPV		
Seberang Perai	201.36	88.94	112.42	2.26	22.3
Balik Pulau	-	-	8.23	-	20.0

G6 FINANCIAL ANALYSIS

G6.1 Introduction

G6.1.1 Financial Analysis refers to three distinct perspectives in implementation of the projects. These are:

(a) The effect on farm household incomes of rehabilitation of the irrigation schemes and the adoption of new cropping patterns and husbandry techniques.

(b) Recalculating the rates of return, for group and project level analyses, using financial instead of economic prices.

(c) Determining the budgetary implications in terms of financing requirements to pay for capital costs.

The first of these, (a) above, has been treated in Chapters G2 and G3.

G6.2 Calculation of Returns at Financial Prices

G6.2.1 The use of financial or market prices to appraise project viability corresponds to looking at the investment as if it were a large private sector project; all taxes have to be paid, whilst subsidies depress output prices below world levels. In particular fertilizer is charged at its market price rather than being free as it is with individual farmers. All labour is costed at the market wage rate and a subsidy is received on sales of rice.

G6.2.2 The basic assumptions concerning areas, cropping patterns and yield build-up are the same as those used in the economic analysis. The only difference is that market prices have been substituted for economic.

G6.2.3 Engineering costs are presented in Table G6.1 and are expressed in 1980 constant Ringgit. Current, 1981 values can be calculated from these by adding 10%. As with the economic costs the sum for incremental O & M includes pumpset replacement towards the end of the development period.

G6.2.4 Land acquisition costs have not been included in the analysis. The main reason for this is that land values are highly speculative and in general bear little relationship to the productivity of land in agricultural use. Also their inclusion would distort the analysis to the extent that direct comparison of the results with those of the economic analysis would be of little value. Since the net value of production without the project (at market prices) has been debited to the project, the opportunity cost of land has been taken into account. It is assumed that some high speculative prices are based upon the premise that land use regulations will either change or not be enforced.

G6.2.5 Table G6.2 shows the farm revenues and production costs for 1 hectare, on an annual basis.

G6.2.6 Tables G6.3 to G6.8 give the major constituent items of the cost and benefit stream in financial prices.

Results

G6.2.7 The results of the basic analysis along with those for the sensitivity tests are shown in Table G6.9.

G6.2.8 Although all of the schemes have acceptable NPV and IRR's they are markedly lower than the results of the economic analyses. The differences can be explained by:-

(a) The financial price used for padi was the current level which was assumed to remain constant in real terms throughout the life of the project. In contrast the economic price which was based on world markets (and not therefore affected by Government interference in the form of price fixing or subsidies) was projected as increasing in real terms in line with world market trends.

(b) The engineering costs at market values are over 20% higher than their real resources costs.

G6.2.9 The results, however, are not robust with respect to the sensitivity tests. 4 groups have IRR's below 10% on both of the sensitivity tests.

Project Analysis

G6.2.10 Table G6.10 shows the project cash flow for Seberang Perai in financial prices and Table G6.11 presents the result of the calculations. The returns are about half of those expressed in economic prices but are still acceptable. The project cash flow for Balik Pulau are given on Table G6.12.

G6.3 Project Financing Requirement

G6.3.1 The project capital costs have been expressed in constant terms for the purposes of the economic and financial analyses and do not therefore reflect price escalation and the actual amount of finance required during the implementation period. Although it is difficult to predict rates of price escalation the following rates have been applied (consultants' estimate) to give some indication of total capital financing requirements for engineering and building construction. Capital requirement at 1980 prices is taken as the sum of:

- the two lines "engineering survey/design" and "construction" for each group on Table G6.1.
- similar two lines for Balik Pulau on Table G6.8 reduced by the factor of 0.909.
- capital element only of Machinery Service Centres from Tables G6.10 and G6.12.

The resulting totals are scaled up by compounded escalation factors based on the following annual changes:

	1981/80	1982/81	1983/82	1984/83	1985/84	1986/85	1987/86
Percentage change year on year	10	10	8	8	8	8	8

G6.3.2 Using these assumptions the financing requirements are calculated for the years 1982/83 to 1990/91. These costs are by their nature very rough since the future rate of inflation can only be guessed at. The results are shown in Table G6.13. Note that drainage areas are excluded (see Annexe J).

Table G6.1 Engineering Costs M$'000 at 1980 Prices (Financial)

Group		1982/83	1983/84	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90	1990/91	1991+
Group A	Engineering Survey/Design	832	731	892	1,206	704	648	725	361	161	-
	Construction		5,836	12,509	13,027	2,918	6,782	12,909	7,845	1,445	-
	Incremental O & M			27	329	211	271	271	572	1,595*	672
	Total Annual Costs	832	6,567	13,428	14,562	3,833	7,701	13,905	8,778	3,201	672
Group B	Engineering Design/Survey	128	413	209	540	200	287	171	38	-	-
	Construction	-	1,178	2,046	5,925	3,344	3,511	3,309	332	-	-
	Incremental O & M	-	-	-	-	208	108	224	166	166	166
	Total Annual Costs	128	1,591	2,255	6,465	3,752	3,906	3,533	536	166	166
Group C	Engineering Design/Survey	115	92	211	704	287	508	465	117	-	-
	Construction	-	960	1,916	1,427	1,744	9,039	9,306	1,062	-	-
	Incremental O & M	-	-	-	707	50	50	50	485	1,446	233
	Annual Total	115	1,052	2,127	2,238	2,081	9,597	9,821	1,664	1,446	233
Group D	Engineering Design/Survey	85	23	57	77	19	11	10	3	2	-
	Construction	-	28	1,029	1,367	126	134	176	65	21	-
	Incremental O & M				27	26	26	26	30	30	30
	Annual Total	85	41	1,086	1,471	171	171	212	98	53	30
Group E	Engineering Design/Survey	103	25	84	63	16	-	-	-	-	-
	Construction	-	-	1,480	1,255	144	-	-	-	-	-
	Incremental O & M						37	187	37	37	37
	Annual Total	103	25	1,564	1,318	160	37	187	37	37	37

* Includes Pumping Plant Replacement

(Inflation Factor = $\frac{1}{1.10}$ from engineering costs)

Table G6.3 Scheme Analysis Incremental Net Revenue

Group A: Sungai Muda

	Year 1982/83	1983/84	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90	1990/91	1991/92	1992/93	1993/94+
(1) With Project Net Value of Production												
Development Programme												
Smallholders (ha)					3,085	3,085	3,085	3,085	3,085	3,085	3,085	3,085
Group Farms (ha)			336	336	336	336	336	336	3,170	3,170	3,170	3,170
Total			336	336	3,421	3,421	3,421	3,421	6,255	6,255	6,255	6,255
Gross Revenue			1,234	1,386	14,191	16,748	17,881	17,881	28,287	29,574	30,889	31,756
On Farm Production Costs			832	832	9,785	9,785	9,785	9,785	16,802	16,802	16,802	16,802
Net Revenue (M$000)			402	554	4,406	6,963	8,096	8,096	11,485	12,772	14,087	14,954
Without Project Area (ha)	4,762	4,330	3,898	3,408	3,408	3,408	3,408	3,408	3,408	3,408	3,408	3,408
(2) Net Returns Without Project	-	-	847	847	3,387	3,387	3,476	3,476	3,742	3,742	3,742	3,742
(3) Incremental Net Value of Production			(445)	(293)	1,019	3,576	4,620	4,620	7,743	9,030	10,345	11,212
(4) Other Farm Costs												
Rehabilitation of abandoned land			81	-	-	-	-	-	680	-	-	-
Rat Control			10	10	99	99	99	99	181	181	181	181
Central Management (98)			33	33	33	33	33	33	311	311	311	311
Farm Level Management (208)			70	70	70	70	70	70	659	659	659	659
Sub Total			194	113	202	202	202	202	1,831	1,151	1,151	1,151
(5) Engineering Costs												
Engineering Design/Survey	832	731	892	1,206	704	648	725	361	361			
Construction		5,836	12,509	13,027	2,918	6,782	12,909	7,845	1,445	-		
Incremental Operation and Maintenance			27	329	211	271	271	572	1,595	672	672	672
Total Engineering Cost	832	6,567	13,428	14,562	3,833	7,701	13,905	8,778	3,201	672	672	672
Cash Flow (3)-(4)-(5)	(832)	(6,567)	(14,067)	(14,968)	(3,016)	(4,327)	(9,487)	(4,360)	2,711	7,207	8,522	9,389

Table G6.4 Scheme Analysis Incremental Net Revenue, Project

Group B : Pinang Tunggal

	Year									
	1982/83	1983/84	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90	1990/91	1991/92
(1) With Project Net Value of Production										
Development Programme										
Smallholders (ha)					171	1,491	1,491	1,491	1,491	1,491
Group Farms (ha)			135	135	135	135	960	960	960	960
Total			135	135	306	1,626	2,451	2,451	2,451	2,451
Gross Revenue			496	557	2,243	7,891	12,105	12,963	13,346	13,598
On Farm Production Costs			334	334	1,154	4,985	7,028	7,028	7,028	7,028
(2) Net Revenue (M$000)			162	223	1,089	2,906	5,077	5,935	6,318	6,570
Future Without Area (ha)	1,800	1,694	1,625	1,625	1,625	1,625	1,625	1,625	1,625	1,625
Net Returns Without Project			121	864	989	2,900	2,900	2,900	2,900	2,900
(3) Incremental Net Value of Production			41	(641)	100	6	2,177	3,035	3,418	3,670
(4) Other Farm Costs										
Rehabilitation of abandoned land			32	-	-	-	198	-	-	-
Rat Control			4	4	9	47	71	71	71	71
Central Management			13	13	13	13	94	94	94	94
Farm Level Management			28	28	28	28	200	200	200	200
Sub Total			77	45	50	88	563	365	365	365
(5) Engineering Costs										
Engineering Design/Survey	128	413	209	540	200	287	171	38	-	-
Construction	-	1,178	2,046	5,925	3,344	3,511	3,309	332	-	-
Incremental Operation and Maintenance	-	-	-	-	208	108	224	166	166	166
Total Engineering Cost	128	1,591	2,255	6,465	3,752	3,906	3,533	536	166	166
Net Cash Flow	(128)	(1,591)	(2,291)	(7,151)	(3,702)	(3,988)	(1,919)	2,134	2,887	3,139

Group C : Kulim

	Year										
	1982/83	1983/84	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90	1990/91	1991/92	1992/93
(1) With Project Net Value of Production											
Development Programme											
Smallholders (ha)					350	350	350	350	350	350	350
Group Farms (ha)					188	188	188	2,682	2,682	2,682	2,682
Total					538	538	538	3,032	3,032	3,032	3,032
Gross Revenue					2,125	2,490	2,705	7,341	13,052	14,209	14,973
On Farm Production Costs					1,481	1,481	1,481	4,569	7,656	7,656	7,656
(2) Net Revenue (M$000)					644	1,009	1,224	2,772	5,396	6,553	7,317
Net Irrigable Area Without Project	350	350	350	350	350	350	350	350	350	350	350
Net Returns Without Project			98	98	393	393	393	393	393	393	393
(3) Incremental Net Value of Production			(98)	(98)	251	616	831	2,379	5,003	6,160	6,924
(4) Other Farm Costs											
Rehabilitation of abandoned land					45	-	-	599	-	-	-
Rat Control					16	16	16	54	88	88	88
Central Management					18	18	18	263	263	263	263
Farm Level Management					39	39	39	558	558	558	558
Sub Total					118	73	73	875	909	909	909
(5) Engineering Costs											
Engineering Design/Survey	115	92	211	704	287	508	465	117	-	-	-
Construction		960	1,916	1,427	1,744	9,039	9,366	1,062	-	-	-
Incremental Operation and Maintenance				707	50	50	50	485	1,446	233	233
Total Engineering Cost	115	1,052	2,127	2,238	2,081	9,597	9,821	1,664	1,446	233	233
Net Cash Flow	(115)	(1,052)	(2,225)	(2,336)	(1,948)	(9,054)	(9,063)	(160)	(2,648)	5,018	5,782

Table G6.6 Scheme Analysis Incremental Net Revenue, Proj

Group D : Southern

	Year										
	1982/83	1983/84	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90	1990/91	1991/92	1992/93
(1) With Project Net Value of Production											
Development Programme											
Smallholders (ha)					401	401	401	401	401	401	401
Group Farms (ha)								62	62	62	62
Total					401	401	401	463	463	463	463
Gross Revenue					1,644	1,963	2,110	2,338	2,366	2,395	2,414
On Farm Production Costs					1,164	1,164	1,164	1,318	1,318	1,318	1,318
(2) Net Revenue (M$000)					480	799	946	1,020	1,048	1,077	1,096
Future Without Project Area	425	425	425	425	425	425	425	425	425	425	425
Net Returns Without Project			54	54	184	184	184	184	184	184	184
(3) Incremental Net Value of Production			(54)	(54)	296	615	762	836	864	893	912
(4) Other Farm Costs											
Rehabilitation of abandoned land								15	-	-	-
Rat Control					12	12	12	13	13	13	13
Central Management								6	6	6	6
Farm Level Management								13	13	13	13
Sub Total					12	12	12	47	32	32	32
(5) Engineering Costs											
Engineering Design/Survey	85	23	57	77	19	11	10	3	2		
Construction	-	28	1,029	1,367	126	134	176	65	21		
Incremental Operation and Maintenance	-	-	-	27	26	26	26	30	30	30	30
Total Engineering Cost	85	41	1,086	1,471	171	171	212	98	53	30	30
Net Cash Flow	(85)	(41)	(1,140)	(1,417)	113	432	538	691	779	831	850

Table G6.7 Scheme Analysis Incremental Net Revenue, Project Costs and Net Cash Flows at Financial Prices (M$000)

Group E : Juru

	1982/83	1983/84	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90	1990/91	1991/92
	Year									
(1) With Project Net Value of Production										
Development Programme										
Smallholders (ha)										
Group Farms (ha)					220	220	220	220	220	220
Total					220	220	220	220	220	220
Gross Revenue					808	908	1,010	1,077	1,077	1,077
On Farm Production Costs					545	545	545	545	545	545
					263	363	465	532	532	532
(2) Net Revenue (M$000)										
Future Without Area	75	50	50	50	50	50	50	50	50	50
Net Returns Without Project	-	-	(8)	(8)	(33)	(33)	(33)	(33)	(33)	(33)
(3) Incremental Net Value of Production			8	8	263	363	465	532	532	532
(4) Other Farm Costs										
Rehabilitation of abandoned land					53	-	-	-	-	-
Rat Control					6	6	6	6	6	6
Central Management					22	22	22	22	22	22
Farm Level Management					46	46	46	46	46	46
Sub Total					127	74	74	74	74	74
(5) Engineering Costs										
Construction	103	25	84	63	16	-	-	-	-	-
Design and Supervision	-	-	1,480	1,255	144	-	-	-	-	-
Incremental Operation and Maintenance	-	-	-	-	-	37	187	37	37	37
Total Engineering Cost	103	25	1,564	1,318	160	37	187	37	37	37
Net Cash Flow	(103)	(25)	(1,556)	(1,310)	(24)	252	204	421	421	421

Table G6.8 Balik Pulau - Incremental Net Revenues, Project Costs and Net Cash Flows at Financial Prices (M$000)

Year	1982/83	1983/84	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90	1990/91	1991/92	1992/93	1993/94
							(1 crop)					
Development Programme												
Smallholders (2xrice)			-	-	-	-	134	134	134	134	134	134
Group farms (2xrice)			73	73	73	73	151	151	151	151	151	151
Group farms (rice-maize)			83	83	83	83	541	541	745	745	745	745
Total area (ha)			156	156	156	156	826	826	1,030	1,030	1,030	1,030
Gross revenues			595.8	678.4	749.2	806.9	2,065.7	3,866.4	4,529.6	5,301.7	5,392.3	5,479.4
On farm production costs			416.4	416.4	416.4	416.4	1,274.5	2,298.8	2,551.4	2,878.0	2,878.0	2,878.0
Net revenues			179.4	262.0	332.8	390.4	791.2	1,567.6	1,978.2	2,423.7	2,514.3	2,601.4
Without Project												
Net revenue			66.9	66.9	66.9	66.9	79.6	79.6	138.6	138.6	138.6	138.6
Incremental revenue			112.5		265.9	323.5	711.6	1,488.0	1,839.6	2,285.1	2,375.7	2,462.8
Other farm costs												
Rehabilitation ($240/ha)			37.4	-	-	-	160.8	-	49.0	-	-	-
Rat control			3.3	3.3	3.3	3.3	13.0	16.1	19.1	19.1	19.1	19.1
Farm management ($278.11/ha)			43.4	43.4	43.4	43.4	229.7	229.7	286.5	286.5	286.5	286.5
Total			84.1	46.7	46.7	46.7	403.5	245.8	354.6	305.6	305.6	305.6
Engineering Costs												
Design & Supervision	63.5	101.5	126.9	444.1	114.2	203.0	152.3	-	63.5	-	-	-
Construction	-	2,537.0	-	-	1,268.5	4,059.2	3,298.1	-	1,522.2	-	-	-
Operation & Maintenance	-	-	22.8	22.8	22.8	22.8	105.1	105.1	114.2	114.2	114.2	114.2
Total	63.5	2,638.5	149.7	466.9	1,405.5	4,285.0	3,555.5	105.1	1,699.9	114.2	114.2	114.2
Net Cast Flow	(63.5)	(2,638.5)	(121.3)	(318.5)	(1,186.3)	(4,008.2)	(3,247.4)	1,137.1	(214.9)	1,865.3	1,955.9	2,043.0

NPV: 1244 IRR 10.5%

Table G6.9 Group Scheme Analysis Basic Analysis and Sensitivity Tests

Financial Prices 1980 M$ x 10^6

	Basic Analysis					Costs Up (1)					Benefits Delayed (2)				
Group	PV Benefits	PV Costs	NPV	B/C Ratio	IRR%	PV Benefits	PV Costs	NPV	B/C Ratio	IRR%	PV Benefits	PV Costs	NPV	B/C Ratio	IRR%
A	58.94	59.68	(.72)	.99	9.9	58.96	68.41	(9.45)	.86	8.4	48.21	59.68	(11.51)	.81	8.0
B	20.14	18.83	1.31	1.07	10.8	20.14	21.58	(1.44)	.93	9.3	16.48	18.83	(2.35)	.88	8.8
C	34.55	25.03	9.52	1.38	14.4	34.55	28.26	6.29	1.22	12.6	28.23	25.03	3.21	1.13	11.3
D	5.76	2.88	2.88	2.00	19.8	5.76	2.32	2.44	1.74	17.3	4.76	2.88	1.88	1.65	15.3
E	3.54	3.42	.12	1.04	10.5	3.54	3.87	(.33)	.91	8.9	2.90	3.42	(.52)	(.85)	8.3
F	-	-	1.24	-	11.0	-	-	(.74)	-	8.8	-	-	(1.83)	-	7.5 (3)

(1) Construction up 20%

(2) Incremental Benefits Delayed 2 years

(3) Gross revenue down 10%

Table G6.10 Project Analysis (Financial Prices) - Seberang Perai

1980 Constant M$ x 10^3

	1982/83	1983/84	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90	1990/91	1991/92	1992/93	1993/94+
Incremental Benefits												
Scheme A	-	-	(445)	(293)	1,019	3,576	4,620	4,620	7,743	9,030	10,345	11,212
Scheme B	-	-	41	(641)	100	6	2,177	3,035	3,418	3,670	3,670	3,670
Scheme C	-	-	(98)	(98)	251	612	831	2,379	5,003	6,160	6,924	6,924
Scheme D	-	-	(54)	(54)	296	615	762	836	864	893	912	912
Scheme E	-	-	8	8	263	363	465	532	532	532	532	532
(1) Sub Total	-	-	(548)	(1,078)	1,929	5,172	8,855	11,402	17,560	20,285	22,383	23,250
Engineering Costs & Others												
Scheme A	832	6,567	13,622	14,675	4,035	7,903	14,107	8,980	5,032	1,823	1,823	1,823
Scheme B	128	1,591	2,332	6,510	3,802	3,994	4,096	901	531	531	531	531
Scheme C	115	1,052	2,127	2,238	2,199	9,670	9,894	2,539	2,355	1,142	1,142	1,142
Scheme D	85	41	1,086	1,471	183	183	224	145	85	62	62	62
Scheme E	103	25	1,564	1,318	287	111	261	111	111	111	111	111
(2) Sub Total	1,263	9,276	20,731	26,212	10,506	21,861	28,562	12,676	8,114	3,669	3,669	3,669
Agricultural Services												
Machinery Service Centres (incremental)			942	1,026	152	152	152	152	152	152	152	152
Extension Workers		20	40	80	80	80	80	80	80	80	80	80
(3) Sub Total		20	982	1,106	232	232	232	232	232	232	232	232
Cash Flow [(1)-(2)-(3)]	(1,263)	(9,296)	(22,261)	(28,396)	(8,809)	(16,921)	(19,939)	(1,506)	9,214	16,384	18,482	19,349

Table G6.11 Project Analysis - Summary Financial Prices

	1980 Constant M$ x 10^6				
	(1) Present* Value of Benefits	(2) Present* Value of Costs	(3) Net Present Value (1)÷(2)	Benefit Cost Ratio (1)÷(2)	IRR (%)
Seberang Perai	122.96	113.16	9.80	1.09	11.0
Balik Pulau	-	-	0.63	-	10.3

* Discounted at 10%

Table G6.13 Project Financing Requirements (M$ million) In Current M$

Year (Fiscal)	Requirement in 1980 M$ million	Factor	Sum in Current M$ million
1982/83 (1982)	1.321	1.210	1.598
1983/84 (1983)	11.674	1.307	15.258
1984/85 (1984)	21.590	1.411	30.463
1985/86 (1985)	27.037	1.524	41.204
1986/87 (1986)	10.759	1.646	17.709
1987/88 (1987)	24.794	1.778	44.084
1988/89 (1988)	30.053	1.920	57.702
1989/90 (1989)	9.823	2.073	20.363
1990/91	3.070	2.239	6.874
Total	140.121		235.255

APPENDIX GI

Crop Production Cost
and Revenue

Table GI.1

MACHINERY & MECHANIZATION COSTS

A. LAND PREPARATION

1.1 Power Tiller

(a)	Base Data Capital cost M$5,800 Life 5 years or 3,000 working hours (600 hours/year) Interest charges 10%	
		M$
(b)	Hourly Operating Costs:	
	- hourly capital charge (depreciation + interest)	2.55
	- fuel 3 L	1.35
	- repairs and maintenance	1.95
	- insurance	0.10
	Sub-total (rounded) $6.00 per hour	5.95
(c)	Cost of Cultivation per hectare	
	- 1st cultivation 14 hours per ha	84.00
	- 2nd cultivation 11 hours per ha	66.00
	Cost per hectare (rounded)	150.00
(d)	Current Contract Rates for two cultivations (per ha)	198.00
(e)	Margin for labour and contractors' profit (per ha)	48.00

Four Wheeled Tractor (60-70 HP) & Rotavator

(a)	Base Data: Tractor Capital cost M$48,420 Life 6 years or 6,000 hours (1,000 hours/year) Interest charges 10%	
(b)	Hourly Operating Costs:	
	- hourly capital charge (depreciation + interest)	11.10
	- fuel 10 L at M$0.45 per	4.50
	- repairs and maintenance	7.30
	- insurance	0.70
	- driver's wages per hour	2.00
		25.60
(c)	Base Data: Rotavator Capital cost M$9,360 Life 6 years or 4,800 hours (800 hours/year) Interest charges 10% Operating costs per hour	
	- hourly capital charge (interest + depreciation)	2.70
	- repairs and maintenance	1.80
	Hourly operating cost	4.50
(d)	Hourly Cost of Rotavating (b) + (c)	30.10

Table GI.2

WITH PROJECT: COSTS AT MARKET PRICES

Rice Production

A SMALLHOLDER

Direct Production Costs per hectare

			M$
(a)	Materials		
	Seeds 25 kgs per ha transplanted		15.00
	Plastic sheeting for nursery		2.50
	Wooden posts for fencing nursery		14.00
	Fertilizers 10 kgs Ammophos for nursery		10.20
	100 kgs Urea		75.00
	200 kgs of NPK compound		150.00
	Pesticides 23 kgs Gamma BHC		32.50
	2.5 L dieldrex		16.80
	Herbicides 4.5 kgs Rumpotox		38.00
	Miscellaneous		25.00
	Sub-total		379.00
(b)	Machinery Contractors[1]		224.00
(c)	Depreciation on tools and equipment		15.00
(d)	Labour inputs per hectare	Mandays	
	Land preparation nursery	5	35.00
	Bund maintenance and irrigation	20	140.00
	Transplanting and carrying	30	210.00
	Fertilizing	6	42.00
	Application of herbicides	6	42.00
	Application of pesticides	6	42.00
	Weeding	2	14.00
	Harvesting, threshing & cleaning	40	280.00
		115	805.00
(e)	Quit Rent and Irrigation		28.1

Summary:

Total direct costs	1,451.00
Direct costs excluding fertilizers	1,261.00
Direct costs excluding fertilizers and labour	411.00

Notes:

(1) Assumes 50% by two wheeled power tiller and 50% by four wheeled tractor.

Table GI.2 (Cont'd)

B. GROUP FARMING: With Mechanisation

<u>Direct Production Costs</u>

			M$
(a)	Materials		
	Seeds 100 kgs of seed per hectare		60.00
	Fertilizers 100 kgs urea		75.00
	200 kgs NPK		150.00
	Pesticides 23 kgs Gamma BHC		32.50
	2.5 L Dieldrex		16.80
	Herbicides 6.5 kgs Rumpotox		55.90
	Other inputs (sacking incidentals)		25.00
			415.20
(b)	Mechanisation		
	Land preparation (1)		210.00
	Harvesting		192.00
	Depreciation on hand tools and sprayers		15.00
(c)	Labour inputs per hectare	<u>Mandays</u>	
	Bund maintenance	5	35.00
	Preparation of pre-germinated seed	1	7.00
	Broadcasting seed	3	21.00
	Fertilizer application	6	42.00
	Irrigation	15	105.00
	Application of herbicides	9	63.00
	Application of pesticides	6	42.00
	Spot weeding	5	35.00
	Bagging and handling grain	4	28.00
		54	378.00
(d)	Quit Rent and Irrigation Charges		28.1

Summary:

Total direct costs	1,238.30
Direct costs excluding fertilizers	1,013.30
Direct costs excluding fertilizers and labour	635.30

Notes:

(1) Carried out by Group Farm equipment or Machinery service centre: Contractors rates of $250.00 per hectare for land preparation and harvesting are used in farm budgets.

Table GI.3

A. MAIZE PRODUCTION

Mechanized Maize Grain Production: Group Farms

			M$
(a)	Materials		
	Seed 25 kgs		17.50
	Fertilizers - rock phosphate	180 kgs	43.00
	- Muriate of potash	100 kgs	50.00
	- Urea	150 kgs	112.00
	Lime	750 kgs	45.00
	Herbicides Grammoxone	10 l.	94.00
	Pesticides Gamma BHC	1.25 gals	59.00
	Miscellaneous (sacking, etc)		20.00
			441.00
(b)	Mechanisation(1)		
	Land preparation: disc harrowing (4 hrs)		116.40
	Planting		28.00
	Fertilizer application		56.00
	Harvesting (combine) (1 ha per hour)		115.30
			315.70
	Mechanisation costs at contractors' rates		387.00
(c)	Depreciation on hand tools and sprayers		15.00
(d)	Labour	(mandays)	
	Bund maintenance and irrigation	8	56.00
	Pest control	4	28.00
	Weed control	6	42.00
	Seed and fertilizer handling	2	14.00
	Handling bagging grain at harvest	6	42.00
		26	182.00
(e)	Cost Summary		
	Total costs per hectare		954.00
	Costs excluding labour		772.00
(f)	Total costs assuming machinery contractors' rates		1,025.00
	Costs excluding labour assuming machinery contractors' rates		843.00

Note: (1) Machinery contractors' margin: $6 per hour for tractor use and $35 per hour for combine harvesting.

Table GI.3 (Cont'd)

B. Mechanized Maize Cobs Production : Group Farm

		M$
(a) Materials		
Seed 25 kgs		17.50
Fertilizers		205.50
Lime		45.00
Herbicides Grammoxone 10 L.		94.00
Pesticides Gamma BHC 1.25 gals		59.00
Miscellaneous		20.00
		441.00
(b) Mechanisation		
Land preparation: disc harrowing (4 hours)		116.40
Planting 1 hour per ha		28.00
Fertilizer spreading (2 hours)		56.00
		200.00
Mechanisation costs at contractors' rates (1)		242.00
(c) Depreciation on hand tools and sprayer		15.00
	(mandays)	
(d) Labour		
Bund maintenance and irrigation	8	56.00
Pest control	4	28.00
Weed control	6	42.00
Seed and fertilizer handling	2	14.00
Picking and carrying	25	175.00
	45	315.00
(e) Cost Summary		
Total costs		971.00
Costs excluding labour		656.00
(f) Total costs assuming machinery contractor		1,013.00
Costs excluding labour assuming machinery contractor		698.00

Note: (1) Contractors' margin $6 per tractor hour.

Table GI.5

Papayas: Production Costs

		Year 1	Year 2	Year 3
			(M$)	
(a)	**Material Inputs**			
	Planting material 2,075 seedlings	622		
	Fertilizer:			
	Year 1 450 kgs rock phosphate	108		
	180 kgs NPK compound	1,430		
	Year 2 & 3 2,700 kgs NPK compound		2,145	2,145
	900 kgs Superphosphate		752	752
	Lime: 25 tonnes in Year 1; 1 tonne from Year 2 onwards	150	60	60
	Mulching straw/grass	200		
	Herbicides:			
	Year 1 10 litres/ha	140		
	Year 2 4 litres		56	56
	Insecticides (malathion)	35	35	35
	Fungicide Dithane M45		35	35
	Packaging materials	50	250	200
		2,735	3,333	3,283
(b)	**Land Preparation**			
	Ploughing and disc harrowing (6 hours)	175	-	-
(c)	Depreciation on hand tools	30	30	30

	(d) Labour	Year 1 (mandays)	Year 2 (mandays)	Year 3 (mandays)	Year 1	Year 2	Year 3
	Digging holes and liming	65	5	5	455	35	35
	Carrying and planting	40	-	-	280	-	—
	Fertilizer application	12	15	15	84	105	105
	Pesticide application	14	14	14	98	98	98
	Mulching and shading	8	-	-	56	-	-
	Harvesting	10	60	60	70	420	420
	Irrigation and drainage	8	8	8	56	56	56
	Miscellaneous	15	15	15	105	105	105
		172	117	117	1,204	819	819

		Year 1	Year 2	Year 3
(e)	**Transfer Charges**			
	Quit rent	25	25	25
(f)	**Cost Summary**			
	Total Costs	4,169	4,207	4,157
	Costs excluding labour	2,965	3,388	3,338

Table GI.6

MIXED VEGETABLES : SMALL-HOLDERS
(65% okra; 10% long beans; 10% cucumbers; 5% chilli; 10% brinjal)

A. Okra

			Mandays	M$
(a) Materials				
Seeds	12 kgs per hectare			60.00
Fertilizers	NPK compound 500 kgs/ha			398.00
	Urea 200 kgs			150.00
Pesticides	Thiodan	110 litres		173.00
	Dieldrex	5.5 litres		37.00
	Azodrin	1.2 litres		43.00
	Thiram	1 kg		10.00
	Benlate	0.6 kg		37.00
Miscellaneous				150.00
				1,058.00
(b) Land Preparation (Contractor for 3 Cultivations)				336.00
				1,394.00
(c) Labour			210	1,470.00
Total costs per ha				2,864.00
Costs excluding labour (i.e. all family labour)				1,394.00
Costs assuming 50% family labour				2,129.00

Yield 20 tonnes: main crop 10 tonnes; 1st ratoon 6 tonnes; 2nd ratoon 4 tonnes.

B. Long Bean

			Mandays	M$
(a) Materials				
Seeds	10 kgs @ M$8.50			85.00
Fertilizers	NPK	500 kgs		398.00
	CCM	500 kgs		270.00
Pesticides				130.00
Herbicides				40.00
Staking materials				690.00
Miscellaneous				150.00
				1,763.00
(b) Land Preparation (3 Cultivations)				336.00
				2,099.00
(c) Labour			190	1,330.00
(d) Total costs per ha				3,429.00
Costs excluding labour				2,099.00
Costs including 50% labour				2,764.00

(e) Yield 12 tonnes per ha

Table GI.6 (Cont'd)

C. Cucumbers

			M$
(a)	Materials		
	Seeds 1.5 kgs		30.00
	Fertilizers Urea 125 kgs		94.00
	NPK compound 600 kgs		475.00
	Pesticides		180.00
	Staking materials		690.00
	Other miscellaneous inputs		150.00
			1,622.00
(b)	Land Preparation (3 Cultivations)		336.00
			1,958.00
(c)	Labour	Mandays	
		185	1,295.00
(d)	Total costs per ha		3,253.00
	Costs excluding labour		1,958.00
	Costs including 50% labour		2,605.00
(e)	Yield 20 tonnes per ha		

D. Chilli

(a)	Materials		
	Seeds 3 kgs		21.00
	Fertilizers - poultry dung		450.00
	- NPK compound 1,800 kgs		1,433.00
	Pesticides		880.00
	Miscellaneous inputs		300.00
			3,084.00
(b)	Land Preparation (3 Cultivations)		336.00
			3,420.00
(c)	Labour	Mandays	
		360	2,520.00
(d)	Cost Summary		
	Total costs		5,940.00
	Costs excluding labour		3,420.00
	Costs including 50% labour		4,680.00
(e)	Yield 13 tonnes per ha		

Table GI.6 (Cont'd)

E. **Brinjals**

			M$
(a)	Materials		
	Seeds 3 kgs		40.00
	Fertilizers - poultry dung		700.00
	- NPK compound 620 kgs		494.00
	Pesticides - Malathion 80% 25 L		295.00
	- Benylate 16 kgs		1,056.00
	Other miscellaneous inputs		250.00
			2,835.00
(b)	Land Preparation (3 Cultivations)		336.00
			3,171.00
(c)	Labour	Mandays	
		290	2,030.00
(d)	Cost Summary		
	Total costs		5,201.00
	Costs excluding labour		3,171.00
	Costs including 50% labour		4,186.00
(e)	Yield 24 tonnes per ha		

Table GI.7

Seberang Perai (Pinang Tunggal): Revenues and Gross Margins from Mixed Vegetables (M$ per hectare)

Crop	Yield[1] (tonne/ha)	Price (M$/tonne)	Revenue (M$/ha)	Direct Production Costs[1] (M$/ha)	Net Revenue (M$/ha)	Vegetable Mix					
						Proportion of mix (%)	Net Revenue (M$)	Labour (man-day)	Labour Cost (M$)	Return to Land[4] (M$)	Return to Labour[5] (M$)
Okra	18	500	9,000	1,394	7,606	65	4,945	136	952	3,993	36.4
Long bean	12	490	5,880	2,099	3,781	10	378	19	133	245	19.9
Cucumber	20	350	7,000	1,958	5,042	10	504	18	126	378	28.0
Brinjal	22	470	10,340	3,171	7,169	10	717	29	203	514	24.7
Chilli	13	930	12,090	3,420	8,670	5	434	18	126	308	24.1
						100	6,978	220	1,540	5,438	31.7

Notes:
(1) Consultants' estimate assuming improved water control and drainage.
(2) Source: FAMA records, farmer and wholesale market interviews. Price per tonne for mixed vegetables is M$496 per tonne of vegetables produced.
(3) Excluding labour: direct production costs per hectare for mixed vegetables is M$1,800 per ha.
(4) Net Revenue - labour costs.
(5) Net Revenue ÷ number of man-days.

Table GI.8

Balik Pulau: Revenues and Gross Margins from Mixed Vegetables (M$ per hectare)

Crop	Yield[1] (tonne/ha)	Price (M$/tonne)	Revenue (M$/ha)	Direct Production Costs[1] (M$/ha)	Net Revenue (M$/ha)	Vegetable Mix: Proportion of mix (%)	Net Revenue (M$)	Labour (man-day)	Labour Cost (M$)	Return to Land (4) (M$)	Return to Labour (5) (M$)
Okra	15	500	7,500	1,394	6,106	65	3,969	136	952	3,017	29.1
Long Bean	10	490	4,900	2,099	2,801	10	280	19	133	147	14.7
Cucumber	16	350	5,600	1,958	3,642	10	364	18	126	238	20.2
Brinjal	18	470	8,460	3,171	5,189	10	529	29	203	326	18.2
Chilli	10	930	9,300	3,420	5,880	5	294	18	126	168	16.3
						100	5,436	220	1,540	3,896	24.7

Notes:
(1) Consultants' estimate assuming improved drainage.
(2) Source: FAMA records, farmer interviews and wholesale market surveys. Price per tonne for vegetable mix is M$496 per tonne of vegetables produced.
(3) Excluding labour. Direct production costs for vegetable mix is $1,800 per ha.
(4) Net Revenue - labour costs.
(5) Net Revenue - number of man-days.

Table GI.9

Direct Production Costs per Hectare of Mixed Vegetables (M$/hectare)

Crop	Costs: 50% family labour	Costs: all family labour (1)	Proportion of crop mixture %	Contribution to Weighted Costs: 50% family labour	Contribution to Weighted Costs: all family labour
Okra	2,129	1,394	65	1,384	906
Long bean	2,764	2,099	10	276	210
Cucumber	2,605	1,958	10	260	196
Brinjal	4,186	3,171	10	419	317
Chilli	4,680	3,420	5	234	171
Weighted costs per ha of vegetable mixture				2,573	1,800

Note:

(1) Labour excluded from costs

Table GI.10

Crop Production Costs at Economic Prices (M$ per hectare)

Crop	Materials	Fertilizers	Mechanization	Depreciation on tools	Labour	Total
Rice: smallholder	87	271	178	13	644	1,193
Rice: group farm	163	258	338	13	302	1,074
Vegetables:						
okra	439	614	252	13	1,176	2,494
long bean	886	311	252	13	1,064	2,526
cucumber	890	656	252	13	1,036	2,847
brinjal	1,398	1,170	252	13	1,624	4,457
chilli	1,020	2,035	252	13	2,016	5,336
mixture						2,871
Maize (grain)	202	221	267	13	146	849
Maize (cobs)	202	221	170	13	252	858

APPENDIX GII

Economic Conversion Factors

Table GII.1 Veitch and Hamzah Conversion Factors

Sector No.	Composition of Sector	GCF Importable	GCF Exportable	GCF Combined
	TRADEABLES			
	(a) Consumer Goods			
I	Food (excluding rice)	.79	1.18	.91
II	Rice	.92	–	.92
III	Beverages & tobacco	.37	1.31	.43
IV	Clothing & footwear	.71	1.17	.84
V	Gross rent, fuel & power	.86	1.17	.97
VI	Furniture & household equipment	.69	1.39	.75
VII	Medical care & health expenses	.79	1.27	.81
VIII	Transport & communications	.63	1.16	.65
IX	Recreation, education & cultural services	.74	1.29	.79
X	Miscellaneous goods	.7	1.30	.73
	$\sum$ I-X Total: Consumer Tradeables	.74	1.20	.81
	(b) Other Goods			
XI	Rubber	.9	1.23	1.22
XII	Palm oil	–	1.43	1.43
XIII	Timber	.77	1.31	1.30
XIV	Tin	–	1.47	1.47
XV(a)	Petroleum - petrol	.47	1.13	.67
XV(b)	Petroleum - diesoline & oils	.84	1.13	.86
XVI	Agricultural inputs	.84	1.14	.86
XVII	Transport equipment & parts	.75	1.10	.76
XVIII	Construction materials	.82	1.12	.88
XIX	Investment goods	.82	1.25	.85
XX	Intermediate goods - consumer industries	.79	1.06	.84
XXI	Other intermediate goods & miscellaneous	.86	1.08	.90
	$\sum$ XI-XXI Non-consumer Goods Tradeables	.82	1.26	.99
	$\sum$ I-XXI Total: All Tradeables	.81	1.26	.97

Sector No.	Composition of Sector	GCF Importable	GCF Exportable	GCF Combined
	NON- TRADEABLES			
XXII	Electricity			.79
XXIII	Construction			.77
XXIV	Trade			.67
XXV	Transport			.66
XXVI	Public utilities			.89
XXVII	Banking financial & insurance			.69
XXVIII	Government & other social services			.80
XXIX	Other services ,			.72
XXX	Real estate			.76
	$\sum$ XXI-XXX Total: Non-Tradeables			.74
	$\sum$ I-XXX Total: All Goods & Services (Standard conversion factors)			.89

Source: Veitch and Hamzah (1979)

Table GII.2 Consumption Conversion Factors

	Poor	Intermediate	Rich
Rural households	.81	.79	.76
Urban households	.80	.78	.76
All households	.81	.79	.76

Source: Veitch and Hamzah (1979)

Table GII. 3 ECONOMIC PRICES FOR MECHANISED OPERATIONS

3.1 Machinery Capital Cost Elements

(a) Equipment not Attracting Import Duty (tractors and combine harvesters)

Cost Element	%	Conversion Factor	Weighted Conversion Factor
C.i.f. cost	66	1	.66
Taxes (surtax)	3	-	-
Distribution & handling to farm (1)	13	.74	.10
Dealers margin (2)	15	.70	.11
Factor applied			.87

Notes: (1) Veitch and Hamzah: Miscellaneous Services
(2) Estimate

(b) Equipment Attracting Import Duty (mainly cultivation equipment & power tillers)

Cost Element	%	Conversion Factor	Weighted Conversion Factor
C.i.f. cost	55	1	.55
Taxes and duty	13	-	-
Distribution	16	.74	.12
Dealers margin	15	.70	.11
Factor applied			.78

3.2 Capital & Operating Costs

(a) Power Tiller Cultivation

Cost Element	%	Conversion Factor	Weighted Conversion Factor
Capital costs (1)	43	.78	.34
Fuel (2)	35	.86	.30
Labour (includes contractors wages)	11	1.0	.11
Factor applied			.75

Notes: (1) 3.1 (b) above
(2) Veitch and Hamzah. Petroleum combined.

(b) Four Wheel Tractor & Rotavator[1]

Cost Element	%	Conversion Factor	Weighted Conversion Factor
Capital cost of tractor[1]	52	.87	0.45
Capital cost of implement[2]	13	.78	0.10
Fuel	12	.86	0.10
Labour	6	1.0	0.06
Contractors margin[3]	17	.70	.12
Factor applied			.83

Notes: (1) Source. Section 1.2 (d) above
(2) Hourly capital charge + repairs
(3) Estimate

(c) Four Wheel Tractor & Disc harrow[1]

Cost Element	%	Conversion Factor	Weighted Conversion Factor
Capital cost of tractor	53	0.87	0.46
Capital cost of implement	10	0.78	0.08
Fuel	13	0.86	0.11
Labour	6	1.0	0.06
Contractors margin	18	0.70	0.13
Factor applied			0.84

Notes: (1) Source: Section 1.3 above.

(d) Combine Harvesting[1]

Cost Element	%	Conversion Factor	Weighted Conversion Factor
Capital costs	60	0.87	0.52
Fuel	5	0.86	0.04
Insurance[2]	10	0.69	0.07
Operators + attendants	11	1.0	0.11
Contractors margin	15	0.70	0.11
Factor applied			.85

Notes: (1) Source 2 (b)
(2) Veitch and Hamzah: Banking Financial and Insurance

Table GII.4 Conversion Factor for Irrigation and Drainage Costs

Cost Component	Proportion of Total Cost (%)	Conversion Factor	
Materials	21	0.88	Veitch & Hamzah Construction Materials (XVIII) combined
Labour	13	1.0	
Transport	24	0.66	Veitch & Hamzah Transport (XXV)
Plant	19	0.82	Veitch & Hamzah Investment Goods (XIX) imported
Contractors' overheads(1) and profit	23	0.68	Consultants' estimates
		0.79	

Note: (1) 11.5% overhead and 11.5% profit.

APPENDIX GIII

Without Project - Areas Cultivated and Returns

Table G III.1 Without Project and Production on 'Future With' Areas Prior to Improvement

Group A : Sungai Muda

(explanatory notes are on pg. III - 5)

		hectares										
		82/83	83/84	84/85	85/86	86/87	87/88	88/89	89/90	90/91	91/92	92/93
(1) Future With Project												
Smallholders						3,085	3,085	3,085	3,085	3,085	3,085	3,085
Group Farms				336	336	336	336	336	336	3,170	3,170	3,170
Total				336	336	3,421	3,421	3,421	3,421	6,255	6,255	6,255
(2) Future Without Area (from Table G2.2)		4,762	4,330	3,898	3,408	3,408	3,408	3,408	3,408	3,408	3,408	3,408
(3) Future With Situation on Unimproved Areas		4,762	4,330	3,127	2,637	323	323	242	242	-	-	-
(4) Net Loss of Unimproved Area in Future With Situation		-	-	771	771	3,085	3,085	3,166	3,166	3,408	3,408	3,408
(5) Cropping Intensity on Unimproved Areas		-	-	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83
(6) Net Returns on Unimproved Areas Without Project (M$000)	Financial			847	847	3,387	3,387	3,476	3,476	3,742	3,742	3,742
	Economic			1,487	1,487	5,950	5,950	6,106	6,107	6,573	6,573	6,573

Table G III.2 Without Project and Production on 'Future With' Areas Prior to Improvement

Group B : Pinang Tunggal

		hectares								
		1982/83	1983/84	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90	1990/91+
(1) Future With Project										
Smallholders						171	1,491	1,491	1,491	1,491
Group Farms				135	135	135	135	960	960	960
Total		-	-	135	135	306	1,626	2,451	2,451	2,451
(2) Future Without Area		1,800	1,694	1,625	1,625	1,625	1,625	1,625	1,625	1,625
(3) Future With Situation on Unimproved Areas		1,800	1,694	1,582	1,252	1,124	-	-	-	-
(4) Net Loss of Unimproved Area in Future With Situation		-	-	43	416	501	1,625	1,625	1,625	1,625
(5) Cropping Intensity on Unimproved Area				1.98	1.97	1.97	1.97	1.97	1.97	1.97
(6) Net Returns on Unimproved Areas Without Project (M$000)	Financial			121	864	989	2,900	2,900	2,900	2,900
	Economic			145	1,241	1,450	4,527	4,527	4,527	4,527

Notes: * There are 180 hectares of vegetable cropped; 104 hectares are developed in these areas in 1986/87 and 104 hectares in 1987/88.

Table G III.3 Without Project and Production on 'Future With' Areas Prior to Improvement

Group C : Kulim

hectares

	1982/83	1983/84	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90	1990/91	1991/92	1992/93
(1) Future With Project											
Smallholders					350	350	350	350	350	350	350
Group Farms					188	188	188	2,682*	2,682	2,682	2,682
Total					538	538	538	3,032	3,032	3,032	3,032
(2) Future Without Area	350	350	350	350	350	350	350	350	350	350	350
(3) Future With Situation on Unimproved Area			263	263	-	-	-	-	-	-	-
(4) Net Loss of Unimproved Area in Future With Situation	-	-	87	87	350	350	350	350	350	350	350
(5) Cropping Intensity on Unimproved Area			1.87	1.87	1.87	1.87	1.87	1.87	1.87	1.87	1.87
(6) Net Returns on Unimproved Areas Without Project (M$000) Financial			98	98	98	98	98	98	98	98	98
Economic			171	171	690	690	690	690	690	690	690

Table G III.4 Without Project and Production on 'Future With' Areas Prior to Improvement
Group D, Group E : Southern, Juru

hectares

		84/85	85/86	86/87	87/88	88/90	89/90	90/91
Group D								
(1) Future Without Area		425	425	425	425	425	425	425
(2) Future With Situation on Unimproved Areas		301	301	-	-	-	-	-
(3) Net Loss of Unimproved Area in Future With Situation		124	124	425	425	425	425	425
(4) Cropping Intensity on Unimproved Area		1.87	1.87	1.87	1.87	1.87	1.87	1.87
(5) Net Returns on Unimproved Areas Without Project (M$000)	(Financial)	54	54	184	184	184	184	184
	(Economic)	145	145	496	496	496	496	496
Group E								
(1) Future Without Area		50	50	50	50	50	50	50
(2) Future With Situation on Unimproved Areas		37.5	37.5	-	-	-	-	-
(3) Net Loss of Unimproved Area in Future With Situation		12.5	12.5	50	50	50	50	50
(4) Cropping Intensity on Unimproved Area		1.5	1.5	1.5	1.5	1.5	1.5	1.5
(5) Net Returns on Unimproved Areas Without Project (M$000)	(Financial)	(16.7)	(16.7)	(33.3)	(33.3)	(33.3)	(33.3)	(33.3)
	(Economic)	(1)	(1)	(4)	(4)	(4)	(4)	(4)

General Notes on Tables G III.1 to G III.4

(1) Group Farms are on abandoned land.

(2) In the two years preceding construction and rehabilitation of an area there is a 25% reduction in returns over the Future Without Project Situation.

(3) All Group Farms are developed on abandoned areas. Thus there is no loss of production when compared to the Without Project Situation.

(4) Abandoned land is only rehabilitated after all smallholder areas have been improved, except pilot/sample areas which are undertaken first.

(5) The year headings are crop years starting with the off-season crop.

(6) Details of the status of the farm and the area calculations are contained in Tables G III.1 to G III.4. In addition, Tables G IV.I to G IV.5 give more detailed breakdown of future with project areas.

(7) Line (3), line (2) on G III.4, may be described alternatively as "Unimproved area which remains in production with the project".

APPENDIX GIV

With Project - Net Revenues at Financial and Economic Prices

Table G IV.1 With Project Net Revenue at Financial Price (M$000)

Group A : Sungai Muda

		1983/84	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90	1990/91	1991/92	1992/93	1993/94
Areas												
1. Muda Mk.7, Pilot	GF	-	336	336	336	336	336	336	336	336	336	336
2. Muda Mk.5,	SH				715	715	715	715	715	715	715	715
Engrg. Sample					2,370	2,370	2,370	2,370	2,370	2,370	2,370	2,370
3. Muda Nth Mk.1,2,5,8	SH								2,834	2,834	2,834	2,834
4. Sg. Muda	GF											
Total		-	336	336	3,421	3,421	3,421	3,421	6,255	6,255	6,255	6,255
Gross Revenues												
1. Muda Mk. 7, Pilot	GF		1,234	1,386	1,542	1,643	1,645	1,645	1,645	1,645	1,645	1,645
2. Muda Mk.5,	SH				2,932	3,501	3,763	3,763	3,763	3,763	3,763	3,763
Engrg. Sample					9,717	11,604	12,473	12,473	12,473	12,473	12,473	12,473
3. Muda Nth Mk.1,2,5,8	SH								10,406	11,693	13,008	13,875
4. Sg. Muda	GF											
Total			1,234	1,386	14,191	16,748	17,881	17,881	28,287	29,574	30,889	31,756
Production Costs												
1. Muda Mk. 7, Pilot	GF		832	832	832	832	832	832	832	832	832	832
2. Muda Mk.5,	SH				2,075	2,075	2,075	2,075	2,075	2,075	2,075	2,075
Engrg. Sample					6,878	6,878	6,878	6,878	6,878	6,878	6,878	6,878
3. Muda Nth Mk.1,2,5,8	SH								7,017	7,017	7,017	7,017
4. Sg. Muda	GF											
Total			832	832	9,785	9,785	9,785	9,785	16,802	16,802	16,802	16,802
Net Value of Production			402	554	4,406	6,963	8,096	8,096	11,485	12,772	14,087	14,954

Note: GF : Group Farm

SH : Smallholder

Table G IV.3 With Project Net Revenues at Financial Price (M$'000)

Group C : Kulim

		1983/84	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90	1990/91	1991/92	1992/93
Areas											
1. Engrg. Sample	GF				188	188	188	188	188	188	188
2. Engrg. Sample	SH				350	350	350	350	350	350	350
3. -								2,494	2,494	2,494	2,494
4. Kulim	GF										
Total					538	538	538	3,032	3,032	3,032	3,032
Gross Revenues											
1. Engrg. Sample	GF				690	776	863	920	920	920	920
2. Engrg. Sample	SH				1,435	1,714	1,842	1,842	1,842	1,842	1,842
3. -								9,158	10,290	11,447	12,211
4. Kulim	GF										
Total					2,125	2,490	2,705	11,920	13,052	14,209	14,973
Production Costs											
1. Engrg. Sample	GF				465	465	465	465	465	465	465
2. Engrg. Sample	SH				1,016	1,016	1,016	1,016	1,016	1,016	1,016
3. -								6,175	6,175	6,175	6,175
4. Kulim	GF										
Total					1,481	1,481	4,181	7,656	7,656	7,656	7,656
Net Value of Production					644	1,009	1,224	4,264	5,396	6,553	7,317

Note: GF : Group Farm
SH : Smallholder

Table G IV.4 With Project Net Revenues at Financial Price (M$'000)

Group D : Southern

		1983/84	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90	1990/91	1991/92	1992/93
Areas											
1. -		-	-	-	-	-	-	-	-	-	-
2. Alma	SH				74	74	74	74	74	74	74
3. South and Centre	SH				327	327	327	327	327	327	327
4. Miscellaneous	GF							62	62	62	62
Total					401	401	401	463	463	463	463
Gross Revenues											
1. -		-	-	-	-	-	-	-	-	-	-
2. Alma	SH				303	362	389	389	389	389	389
3. South and Centre	SH				1,341	1,601	1,721	1,721	1,721	1,721	1,721
4. Miscellaneous	GF							228	256	285	304
Total					1,644	1,963	2,110	2,338	2,366	2,395	2,414
Production Costs											
1. -		-	-	-	-	-	-	-	-	-	-
2. Alma	SH				215	215	215	215	215	215	215
3. South and Centre	SH				949	949	949	949	949	949	949
4. Miscellaneous	GF							154	154	154	154
Total					1,164	1,164	1,164	1,318	1,318	1,318	1,318
Net Value of Production					480	799	946	1,020	1,048	1,077	1,096

Note: GF : Group Farm
SH : Smallholder

Table G IV.5 With Project Net Revenues at Financial Price (M$'000)

Group E : Juru

		1983/84	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90	1990/91
Areas									
1. Juru	GF				220	220	220	220	220
	-								
Total					220	220	220	220	220
Gross Revenues									
1. Juru	GF				808	908	1,010	1,077	1,077
Total					808	908	1,010	1,077	1,077
Production Costs									
1. Juru	GF				545	545	545	545	545
Total					545	545	545	545	545
Net Value of Production					263	363	465	532	532

Note: GF : Group Farm

S H : Smallholder

Table G IV.6 With Project Net Revenues at Economic Prices (M$000)

Group A : Sungai Muda

		1983/84	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90	1990/91	1991/92	1992/93	1993/94
Areas												
1. Muda Mk.7, Pilot	GF	-	336	336	336	336	336	336	336	336	336	336
2. Muda Mk.5, Engrg. Sample	SH				715	715	715	715	715	715	715	715
3. Muda Nth Mk,1,2,5,8	SH				2,370	2,370	2,370	2,370	2,370	2,370	2,370	2,370
4. Sg. Muda	GF								2,834	2,834	2,834	2,834
Total		-	336	336	3,421	3,421	3,421	3,421	6,255	6,255	6,255	6,255
Gross Revenues												
1. Muda Mk.7, Pilot	GF		1,443	1,636	1,804	1,25	1,925	1,925	1,925	1,925	1,925	1,925
2. Muda Mk. 5, Engrg. Sample	SH				3,431	4,096	4,403	4,403	4,403	4,403	4,403	4,403
3. Muda Nth Mk, 1,2,5,8	SH				11,372	13,575	14,594	14,594	14,594	14,594	14,594	14,594
4. Sg. Muda	GF								12,175	13,796	15,219	16,233
Total			1,443	1,636	16,607	19,596	20,922	20,922	33,097	34,718	36,141	37,155
Production Costs												
1. Muda Mk. 7, Pilot	GF		722	722	722	722	722	722	722	722	722	722
2. Muda Mk.5, Engrg. Sample	SH				1,706	1,706	1,706	1,706	1,706	1,706	1,706	1,706
3. Muda Nth Mk.1,2,5,8	SH				5,655	5,655	5,655	5,655	5,655	5,655	5,655	5,655
4. Sg. Muda	GF								6,087	6,087	6,087	6,087
Total			722	722	8,083	8,083	8,083	8,083	14,170	14,170	14,170	14,170
Net Value of Production			721	914	8,524	11,513	12,839	12,839	18,927	20,548	21,971	22,985

Note: GF : Group Farm
SH : Smallholder

Table G IV.8 With/Without Project Net Revenues at Economic Prices (M$'000)

Group C : Kulim

		1983/84	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90	1990/91	1991/92	1992/93
Areas											
1. Engrg. Sample	GF				188	188	188	188	188	188	188
2. Engrg. Sample	SH				350	350	350	350	350	350	350
3. -		-	-	-	-	-	-	-	-	-	-
4. Kulim	GF							2,494	2,494	2,494	2,494
Total					538	538	538	3,032	3,032	3,032	3,032
Gross Revenues											
1. Engrg. Sample	GF				808	915	1,010	1,077	1,077	1,077	1,077
2. Engrg. Sample	SH				1,679	2,005	2,155	2,155	2,155	2,155	2,155
3. -		-	-	-	-	-	-	-	-	-	-
4. Kulim	GF							10,774	12,141	13,393	14,286
Total					2,487	2,920	3,165	14,006	15,373	16,625	17,518
Production Costs											
1. Engrg. Sample	GF				404	404	404	404	404	404	404
2. Engrg. Sample	SH				835	835	835	835	835	835	835
3. -		-	-	-	-	-	-	-	-	-	-
4. Kulim	GF							5,357	5,357	5,357	5,357
Total					1,239	1,239	1,239	6,596	6,596	6,596	6,596
Net Value of Production					1,248	1,681	1,926	7,410	8,777	10,029	10,922

Note : GF : Group Farm

SH : Smallholder

Table G IV.9 With/Without Project Net Revenues at Economic Prices (M$000)

Group D : (Southern)

		1983/84	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90	1990/91	1991/92	1992/93
Areas											
1. –		–	–	–	–	–	–	–	–	–	–
2. Alma	SH				74	74	74	74	74	74	74
3. South and Centre	SH				327	327	327	327	327	327	327
4. Miscellaneous	GF							62	62	62	62
Total					401	401	401	463	463	463	463
Gross Revenues											
1. –		–	–	–	–	–	–	–	–	–	–
2. Alma	SH				355	424	456	456	456	456	456
3. South and Centre	SH				1,569	1,873	2,014	2,014	2,014	2,014	2,014
4. Miscellaneous	GF							133	302	333	355
Total					1,924	2,297	2,470	2,603	2,772	2,803	2,825
Production Costs											
1. –		–	–	–	–	–	–	–	–	–	–
2. Alma	SH				177	177	177	177	177	177	177
3. South and Centre	SH				780	780	780	780	780	780	780
4. Miscellaneous	GF							133	133	133	133
Total					957	957	957	1,090	1,090	1,090	1,090
Net Value of Production					967	1,340	1,513	1,513	1,682	1,713	1,735

Note: GF : Group Farm

SH : Smallholder

Table G IV.10 With/Without Project Net Revenues at Economic Prices (M$000)

Group E : Juru

		1983/84	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90	1990/91
Areas									
1. Juru	GF				220	220	220	220	220
Total					220	220	220	220	220
Gross Revenues									
1. Juru	GF				945	1,071	1,181	1,260	1,260
Total					945	1,071	1,181	1,260	1,260
Production Costs									
1. Juru	GF				473	473	473	473	473
Total					473	473	473	473	473
Net Value of Production					472	598	708	787	787

Note: GF : Group Farm

APPENDIX GV

Group Scheme - Cash Flows in Economic and Financial Prices

Table G V.1 Economic & Financial Analysis

Group A : Sg. Muda

Year	Financial			Economic		
	Benefits	Costs	Net Cash Flow	Benefits	Costs	Net Cash Flow
1982/83	-	832	(832)	-	599	(599)
1983/84	-	6,567	(6,567)	-	5,137	(5,137)
1984/85	(445)	13,622	(14,067)	(126)	10,704	(10,830)
1985/86	(293)	14,675	(14,968)	67	11,512	(11,445)
1986/87	1,019	4,035	(3,016)	5,137	3,116	2,021
1987/88	3,576	7,903	(4,327)	8,126	6,206	1,920
1988/89	4,620	14,107	(9,487)	9,363	11,101	(1,738)
1989/90	4,620	8,980	(4,360)	9,363	7,077	2,286
1990/91	7,743	5,032	2,711	15,185	3,523	11,662
1991/92	9,030	1,823	7,207	16,806	1,466	15,340
1992/93	10,345	1,823	8,522	18,229	1,466	16,763
1993/94+	11,212	1,823	9,389	19,243	1,466	17,777
2023/24	11,212	1,823	9,389	19,243	1,466	17,777

Financial (M$mn)	Incremental Benefits	Costs	Net Present Value	Benefit Cost Ratio	IRR
(1) Basic Case	58.96	59.68	(.72)	.99	9.9
(2) Construction Costs Up 20%	58.96	68.46	(9.45)	.86	8.4
(3) Benefits Delayed by 2 Years	48.21	59.68	(11.51)	.81	8.0
Economical Prices (M$mn)					
(1) Basic Case	108.88	46.74	62.14	2.33	23.3
(2) Construction Costs Up 20%	108.88	52.71	56.17	2.07	20.6
(3) Benefits Delayed by 2 Years	89.09	46.74	42.35	1.91	17.3

10% discount rate is used to calculate the present value of cash flows

Table G V.2 Sensitivity Tests at Financial Prices

Group A: Sg. Muda

Year	Basic Benefits	Costs Up 20%	(1) Cash Flow	Delayed Benefits	Basic Costs	(2) Cash Flow
1982/83	-	832	(832)	-	832	(832)
1983/84	-	7,734	(7,734)	-	6,567	(6,567)
1984/85	(445)	16,124	(16,569)	-	13,662	(13,662)
1985/86	(293)	17,280	(17,573)	-	14,675	(14,675)
1986/87	1,019	4,618	(3,599)	(445)	4,035	(4,480)
1987/88	3,567	9,259	(5,692)	(293)	7,903	(8,196)
1988/89	4,620	16,688	(12,068)	1,019	14,107	(13,088)
1989/90	4,620	10,549	(5,929)	3,567	8,980	(5,413)
1990/91	7,743	5,321	2,413	4,620	5,032	(412)
1991/92	9,030	1,823	7,207	4,620	1,823	2,797
1992/93	10,345	1,823	8,522	7,743	1,823	5,920
1994/95+	11,212	1,823	9,389	9,030	1,823	7,207
				10,345	1,823	8,522
				11,212	1,823	9,389

Table G V.3 Sensitivity Tests at Economic Prices

Group A: Sg. Muda

Year	Basic Benefits	Construction + 20%	Net Cash Flow	Benefits Delayed	Basic Costs	Cash Flow
1982/83	-	599	(599)	-	599	(599)
1983/84	-	5,137	(5,137)	-	5,137	(5,137)
1984/85	(126)	12,680	(12,806)	-	10,704	(10,704)
1985/86	67	13,570	(13,503)	-	11,512	(11,512)
1986/87	5,137	3,577	1,560	(126)	3,116	(3,242)
1987/88	8,126	7,278	848	67	6,206	(6,139)
1988/89	9,363	13,141	(3,778)	5,137	11,101	(5,964)
1989/90	9,363	8,317	1,046	8,126	7,077	1,049
1990/91	15,185	3,751	11,434	9,363	3,523	5,840
1991/92	16,806	1,446	15,360	9,363	1,466	7,897
1993/94	18,229	1,446	16,783	15,185	1,466	13,719
1994/95	19,243	1,446	17,797	16,806	1,466	15,340
1995/96				18,229	1,466	16,763
				19,243	1,466	17,777

Table G V.4 Economic & Financial Analysis

Group B : Pinang Tunggal

Year	Financial			Economic		
	Benefits	Costs	Net Cash Flow	Benefits	Costs	Net Cash Flow
1982/83	-	128	(128)	-	92	(92)
1983/84	-	1,591	(1,591)	-	1,228	(1,228)
1984/85	41	2,332	(2,291)	145	1,832	(1,687)
1985/86	(641)	6,510	(7,151)	(882)	5,105	(5,987)
1986/87	100	3,802	(3,702)	(217)	2,991	(3,208)
1987/88	6	3,994	(3,988)	130	3,141	(3,011)
1988/89	2,177	4,096	(1,919)	3,248	3,435	(187)
1989/90	3,035	901	2,134	4,288	717	3,571
1990/91	3,418	531	2,887	4,702	428	4,274
1991/92	3,670	531	3,139	4,998	428	4,570
1992/93	3,670	531	3,139	4,998	428	4,570
1993/94	3,670	531	3,139	4,998	428	4,570

Financial	PV Benefits	PV Costs	NPV	Benefit Cost Ratio	IRR
(1) Basic Case	20.14	18.83	1.31	1.07	10.8
(2) Construction Up 20%	20.14	21.58	(1.44)	.93	9.3
(3) Delayed Benefits	16.48	18.83	(2.35)	.88	8.8
Economic					
(1) Basic Case	27.60	14.94	12.66	1.85	17.9
(2) Construction Up 20%	27.60	17.11	10.49	1.61	15.9
(3) Delayed Benefits	22.58	14.94	7.64	1.51	14.2

Table G V.5 Sensitivity Tests at Financial Prices

	Group B			Pinang Tunggal		
Year	Basic Benefits	Costs (Construction Up 20%)	Net Cash Flow	Delayed Benefits	Basic Costs	Net Cash Flow
1982/83	-	128	(128)	-	128	(128)
1983/84	-	1,826	(1,826)	-	1,591	(1,591)
1984/85	41	2,741	(2,700)	-	2,332	(2,332)
1985/86	(641)	7,965	(8,606)	-	6,510	(6,510)
1986/87	100	4,471	(4,371)	41	3,802	(3,761)
1987/88	6	4,696	(4,690)	(641)	3,994	(4,635)
1988/89	2,177	4,758	(2,581)	100	4,096	(3,996)
1989/90	3,035	602	2,433	6	901	(895)
1990/91	3,418	531	2,887	2,177	531	1,646
1991/92	3,670	531	3,139	3,035	531	2,504
1992/93	3,670	531	3,139	3,418	531	2,887
1993/94	3,670	531	3,139	3,670	531	3,139

Table G V.6 Sensitivity Tests at Economic Prices

Group B: Pinang Tunggal

Year	Basic Benefits	Costs (Construction Up 20%)	Net Cash Flow	Basic Benefits	Basic Costs	Net Cash Flow
1982/83	-	92	(92)	-	92	(92)
1983/84	-	1,414	(1,414)	-	1,228	(1,228)
1984/85	145	2,155	(2,010)	-	1,832	(1,832)
1985/86	(882)	6,041	(6,923)	-	5,105	(5,105)
1986/87	(217)	3,519	(3,736)	145	2,991	(2,846)
1987/88	130	3,695	(3,565)	(882)	3,141	(4,023)
1988/89	3,248	3,958	(710)	(217)	3,435	(3,652)
1989/90	4,288	769	3,519	130	717	(587)
1990/91	4,702	428	4,274	3,248	428	2,820
1991/92	4,998	428	4,570	4,288	428	3,860
1992/93	4,998	428	4,570	4,702	428	4,274
1993/94	4,998	428	4,570	4,998	428	4,570

Table G V.7 Economic & Financial Analysis

Group C : Kulim

Year	Financial Benefits	Financial Costs	Financial Net Cash Flow	Economic Benefits	Economic Costs	Economic Net Cash Flow
1982/83	-	115	(115)	-	83	(83)
1983/84	-	1,052	(1,052)	-	824	(824)
1984/85	(98)	2,127	(2,225)	(171)	1,666	(1,837)
1985/86	(98)	2,238	(2,336)	(171)	1,720	(1,891)
1986/87	251	2,199	(1,948)	558	1,739	(1,181)
1987/88	616	9,670	(9,054)	991	7,624	(6,633)
1988/89	831	9,894	(9,063)	1,236	7,803	(6,567)
1989/90	2,379	2,539	(160)	3,981	2,203	1,778
1991/92	5,003	2,355	2,648	8,087	1,879	6,208
1992/93+	6,160	1,142	5,018	9,339	920	8,419
1993/94	6,924	1,142	5,782	10,232	920	9,312

Results

Financial	PV Incremental Benefits	PV Costs	NPV	Benefit-Cost Ratio	IRR
Basic Case	34.55	25.03	9.52	1.38	14.4
Construction Costs Up 20%	34.55	28.26	6.29	1.22	12.6
Benefits Delayed 2 Years	28.23	25.03	3.21	1.13	11.3
Economic					
Basic Case	51.86	19.88	31.46	2.61	25.6
Construction Costs Up 20%	51.86	22.43	29.43	2.31	22.8
Benefits Delayed 2 Years	42.38	19.88	22.50	2.13	19.1

Table G V.9 Sensitivity Tests at Economic Prices

Group C : Kulim

Year	Basic Benefits	Costs (Construction Up 20%)	Net Cash Flow	Benefits Delayed 2 Years	Basic Costs	Net Cash Flow
1982/83	-	83	(83)	-	83	(83)
1983/84	-	976	(976)	-	824	(824)
1984/85	(171)	1,969	(2,140)	-	1,666	(1,666)
1985/86	(171)	1,946	(2,117)	-	1,720	(1,720)
1986/87	558	2,014	(1,456)	(171)	1,739	(1,910)
1987/88	991	9,052	(8,061)	(171)	7,624	(7,795)
1988/89	1,236	9,273	(8,037)	558	7,803	(7,245)
1989/90	3,981	2,371	1,610	991	2,203	(1,212)
1990/91	8,087	1,879	6,208	1,236	1,879	(643)
1991/92	9,339	920	8,419	3,981	920	3,061
1992/93	10,232	920	9,312	8,087	920	7,167
1993/94	10,232	920	9,312	9,339	920	8,417
				10,232	920	9,312
				10,232	920	9,312

Table G V.10 Economic and Financial Analysis

Group D: Southern Schemes

Year	Financial			Economic		
	Benefits	Costs	Net Cash Flow	Benefits	Costs	Net Cash Flow
1982/83	-	85	(85)	-	61	(61)
1983/84	-	41	(41)	-	38	(38)
1984/85	(54)	1,086	(1,140)	(145)	854	(999)
1985/86	(54)	1,471	(1,525)	(145)	1,158	(1,303)
1986/87	296	183	113	471	144	327
1987/88	615	183	432	844	144	700
1988/89	762	224	538	1,017	176	841
1989/90	836	145	691	1,017	116	901
1990/91	864	85	779	1,186	69	1,117
1991/92	893	62	831	1,217	51	1,166
1992/93+	912	62	850	1,239	51	1,188

	PV Benefits	PV Costs	M$mn NPV	Benefit-Cost Ratio	IRR
Financial					
(1) Basic Case	5.76	2.88	2.88	2.00	19.8
(2) Construction Up 20%	5.76	3.32	2.44	1.74	17.3
(3) Benefits Delayed 2 Years	4.76	2.88	1.88	1.65	15.3
Economic					
(1) Basic Case	7.71	2.27	5.44	1.42	29.0
(2) Construction Up 20%	7.71	2.63	5.08	2.93	26.3
(3) Benefits Delayed 2 Years	6.31	2.27	4.04	2.78	21.8

Table G V.11 Sensitivity Tests at Financial Prices

Group D: Southern Schemes

Year	Basic Benefits	Costs Construction + 20%	Net Cash Flow	Delayed Benefits	Basic Costs	Net Cash Flow
1982/83	-	85	(85)	-	85	(85)
1983/84	-	47	(47)	-	41	(41)
1984/85	(54)	1,292	(1,346)	-	1,086	(1,086)
1985/86	(54)	1,744	(1,798)	-	1,471	(1,471)
1986/87	296	208	88	(54)	183	(237)
1987/88	615	210	405	(54)	183	(237)
1988/89	762	259	503	296	224	72
1989/90	836	158	678	615	145	470
1990/91	864	89	775	762	85	677
1991/92	893	62	831	836	62	774
1992/93	912	62	850	864	62	802
1993/94				893	62	831
1994/95				912	62	850

Table G V.12 Sensitivity Tests at Economic Prices

Group D: Southern Schemes

Year	Basic Benefits	Costs Construction + 20%	Net Cash Flow	Benefits Delayed 2 yrs.	Basic Costs	Net Cash Flow
1982/83	-	61	(61)	-	61	(61)
1983/84	-	42	(42)	-	38	(38)
1984/85	(145)	1,017	(1,162)	-	854	(854)
1985/86	(145)	1,374	(1,519)	-	1,158	(1,158)
1986/87	471	164	307	(145)	144	(289)
1987/88	844	165	679	(145)	144	(289)
1988/89	1,017	204	813	471	176	295
1989/90	1,017	126	891	844	116	728
1990/91	1,186	72	1,114	1,017	69	948
1991/92	1,217	51	1,166	1,017	51	966
1992/93	1,239	51	1,188	1,186	51	1,135
1993/94				1,217	51	1,166
1994/95				1,239	51	1,188

Table G V.13 Economic & Financial Analysis

Group E: Juru

Year	Financial Benefits	Financial Costs	Financial Net Cash Flow	Economic Benefits	Economic Costs	Economic Net Cash Flow
1982/83	-	103	(103)	-	74	(74)
1983/84	-	25	(25)	-	18	(18)
1984/85	8	1,564	(1,556)	1	1,229	(1,228)
1985/86	8	1,318	(1,310)	1	1,037	(1,036)
1986/87	263	287	(24)	472	229	243
1987/88	363	111	252	598	89	509
1988/89	465	261	204	708	208	500
1989/90	532	111	421	787	89	698
1990/91	532	111	421	787	89	698
1991/92+	532	111	421	787	89	698

	PV Benefits	PV Costs	NPV	Benefit Cost Ratio	IRR
Financial					
(1) Basic Case	3.54	3.42	.12	1.04	10.5
(2) Costs (Construction + 20%)	3.54	3.87	(.33)	.91	8.9
(3) Benefits Delayed 2 Years	2.90	3.42	(.52)	.85	8.3
Economic					
(1) Basic Case	5.33	2.69	2.64	1.98	21.1
(2) Costs (Construction + 20%)	5.33	3.05	2.28	1.75	18.5
(3) Benefits Delayed 2 Years	4.37	2.69	1.68	1.62	15.7

Table G V.14 Sensitivity Tests at Financial Prices

Financial

Group E: Juru

Year	Benefits	Costs (Construction + 20%)	Net Cash Flow	Delayed Benefits	Costs	Net Cash Flow
1982/83	-	103	(103)	-	103	(103)
1983/84	-	25	(25)	-	25	(25)
1984/85	8	1,860	(1,852)	-	1,564	(1,564)
1985/86	8	1,569	(1,561)	-	1,318	(1,318)
1986/87	263	316	(53)	8	287	(279)
1987/88	363	111	252	8	111	(103)
1988/89	465	261	204	263	261	2
1989/90	532	111	421	363	111	252
1990/91	532	111	421	465	111	354
1991/92	532	111	421	532	111	421

Table G V.15 Sensitivity Tests at Economic Prices

Group E: Juru

Year	Basic Benefits	Costs (Construction + 20%)	Net Cash Flow	Benefits Delayed 2 Yrs.	Basic Costs	Net Cash Flow
1982/83	-	74	(74)	-	74	(74)
1983/84	-	18	(18)	-	18	(18)
1984/85	1	1,463	(1,462)	-	1,229	(1,229)
1985/86	1	1,235	(1,234)	-	1,037	(1,037)
1986/87	472	252	220	1	229	(228)
1987/88	598	89	509	1	89	(88)
1988/89	708	208	500	472	208	264
1989/90	787	89	698	598	89	509
1990/91	787	89	698	708	89	619
1991/92	787	89	698	787	89	698

APPENDIX GVI

Miscellaneous

Table G VI.1 Agricultural Services: Seberang Perai: Economic Prices

	1981/82	1982/83	1983/84	Year 1984/85	1985/86	1986/87	1987/88
1. MACHINERY SERVICE CENTRE							
Phasing				2	2		
Costs: Construction(1)				802.3	802.3		
Operation							
Salaries: Manager(2)					9.0	18.0	
Field Supervisors(2)					6.8	13.5	
Clerks(3)					9.4	18.8	
Transport(4)					7.9	15.8	
Maintenance of Centres(1)					16.0	32.0	
Miscellaneous(5)					14.4	14.4	
				802.3	865.8	112.5	
2. ADDITIONAL EXTENSION WORKERS							
Number			3	6	12	12	
Salaries and Allowances(2)			12.2	24.5	48.9	48.9	
Transport(4)			2.4	4.8	9.6	9.6	
			14.6	29.3	58.5	58.5	
3. TOTAL			14.6	831.6	924.3	171.0	

Notes: (1) Conversion Factor 0.77. Veitch and Hamzah Construction (XXIII).
(2) Consumption Conversion Factor 0.75. Veitch and Hamzah Skilled Managerial Personnel.
(3) Consumption Conversion Factor 0.78. Veitch and Hamzah Semi-skilled Managerial Personnel.
(4) Conversion Factor 0.66. Veitch and Hamzah Transport (XXV).
(5) Conversion Factor 0.72. Veitch and Hamzah Other Services (XXIX).

Table G VI.2 Agricultural Services: Seberang Perai: Financial Prices

	Year 1981/82	1982/83	1983/84	1984/85	1985/86	1986/87	1987/88	1988/89
1. MACHINERY SERVICE CENTRE								
Phasing					2	2		
Construction Costs (M$'000)				1,042	1,042	-		
Operation Costs								
(1) salaries:								
- Manager's ($6,000 per annum)					12.0	24.0	24.0	24.0
- Field Supervisors					9.0	18.0	18.0	18.0
- Clerks					12.0	24.0	24.0	24.0
(2) Transport					12.0	24.0	24.0	24.0
(3) Maintenance of Centres					20.8	41.6	41.6	41.6
(4) Miscellaneous					20.0	20.0	20.0	20.0
				1,042	1,127.8	151.6	151.6	151.6
2. ADDITIONAL EXTENSION WORKERS								
Number			3	6	12	12	12	12
Salaries and allowances ($5,440 per person)			16.3	32.6	65.3	65.3	65.3	65.3
Transport ($100 per worker per month)			3.6	7.2	14.4	14.4	14.4	14.4
			19.9	39.8	79.7	79.7	79.7	79.7
3. TOTAL COSTS			19.9	1,081.8	1,207.5	151.6	151.6	151.6

Table G VI.3 Balik Pulau: Agricultural Services Additional Costs at Economic Prices

	Year 1984/85	1985/86 onwards
MACHINERY SERVICE CENTRE COSTS (M$'000)		
Construction:	401.2	
Operation:		
(1) Salaries - Manager		4.5
Field Supervisor		6.8
Clerks		4.7
(2) Transport		3.9
(3) Maintenance of Centres		8.0
(4) Miscellaneous		7.2
	401.2	35.1

Table G VI.4 Balik Pulau: Agricultural Services Additional Costs at Financial Prices

	1984/85	Year 1985/86 onwards
MACHINERY SERVICE CENTRE COSTS (M$'000)		
Construction:	521.0	
Operation:		
(1) Salaries - Manager		6.0
Field Supervisor		4.5
Clerks		6.0
(2) Transport		6.0
(3) Maintenance of Centres		10.4
(4) Miscellaneous		10.0
	521.0	42.9

GVI.5 Memorandum on Livestock and Poultry

Alternate Enterprise

Livestock Enterprises

GVI.5.1 Poultry broiler and layer enterprises have been examined as potential sources of additional income to farmers in the Balik Pulau area. They are considered particularly relevant since they will not take up irrigable land and the market potential study (MIDF Industrial Consultants 1981) has projected shortfalls by 1985 of 2,800 tonnes of poultry meat and 92 million eggs in the Balik Pulau and Seberang Perai areas.

GVI.5.2 Livestock enterprises (cattle and buffalo) would be dependent upon irrigable land for the production of fodder and thus their inclusion would have to at the expense of irrigated cash crops. The returns from these enterprises are generally low and would not justify their inclusion in an irrigation scheme. Whilst this would also be true for imported exotic (or exotic cross) stock with higher production potential, exotic stock could not be recommended on the grounds of their high initial cost and their requirement for a very high level of husbandry and stockmanship if their production potential is to be realised.

Poultry: broiler enterprise

GVI.5.3 The economics of poultry meat production have been examined in terms of a 500 bird unit which is considered by producers to be the ideal number of birds for one poultry house. It is not however, regarded as a minimum economic size; poultry producers who have no other occupation normally consider 10 houses of 5,000 birds to be the minimum economic unit. Since broiler production is being considered here as supplementary activity to irrigated crop production, examination of a 500 birds is appropriate. Larger scale enterprises would comprise multiples of the 500 bird unit.

GVI.5.4 The "all in all out" system is proposed with four batches of birds produced per house per year. The cycle is thus 60 days occupation of the house by birds followed by 30 days for resting and cleaning the house. The house would comprise a concrete floor, RC walls and a corrugated aluminium roof. It would have electric lighting, self-feeding and an automatic water fountain, and depending upon the quality of materials used, would cost between M$1,000 and M$1,875 per house.

GVI.5.5 Table G12.1 presents the annual enterprise budget at 1980 market prices. Excluding labour the net revenue per year is $203 per annum or a return to labour of M$2.9 per man-day. If labour is charged at the going wage rate of M$7 per man-day the enterprise makes a loss of M$287 per annum. To produce a return to labour equivalent to rice cultivation (i.e. M$19.3 per man-day) the price of poultry meat would have to be raised by 33 cents a kg (20 cents per kati). The profitability of broiler production is highly cyclical and the situation modelled at 1980 prices may not be sustained. However, it is clearly a high risk enterprise, extremely sensitive to small price movements in poultry meat and feedstuff and cannot therefore, be recommended for widespread adoption by farmers in the project area.

Poultry: 500 bird layer enterprise

GVI.5.6 A 500 bird house is again considered as the ideal size of house but not necessarily the minimum economic size of poultry enterprise. The main features of the proposed system are:-

(a) Birds will remain in the same house from day old until completion of the laying period.

(b) The time from day old to point of lay is 140 days.

(c) The laying period would be 420 days after which all birds are sold.

(d) The production is expected to average 70% lay over the first 180 days of the laying period and 65% thereafter.

(e) Housing would comprise a concrete floor, RC walls and a corrugated aluminium roof aluminium roof. Water and electricity would be laid on. Houses would be provided with laying boxes.

GIV.5.7 Table G12.2 presents the enterprise budget over a 590 days period from day old to completion of the laying period and clearing out and resting of the house (30 days). The net revenue after charging for labour at $7 per man-day amounts to $650 per 500 batch of birds. Considering the high amounts of capital and risk involved this represents a low return. The return to labour is M$14.1 per man-day and is lower than any of the irrigated crop alternatives. Like broiler production it is highly sensitive to marginal changes in feed and output (egg) prices and cannot be recommended for widespread adoption by farmers.

Table GVI.6 500 Bird Broiler Enterprise Budget at Market Prices

	M$
Revenues	
1,938 birds(1) per year weighing 1.82 kg (3 kati) @ M$2.40 per kg ($1.45 per kati)	8,465.00
Production Costs	
Day old chicks @ 85¢ each	1,700.00
Feed: 4.6 kg per bird(2)	5,980.00
Water and electricity	70.00
Veterinary and medicines	300.00
Repairs and maintenance to housing(3)	50.00
Housing: depreciation and interest annual charge(4)	162.00
	8,262.00
Labour: 70 man-days per year for 4 batches	490.00
Net Revenue excluding labour	203.00
including labour	(287.00)

Source: Consultants estimates

Notes: (1) Assumes 2% additional birds supplied and 5% mortality.

(2) Starter mash $0.75 per kg and 0.7 kg per bird.
Grower mash $0.64 per kg and 1.6 kg per bird.
Finisher mash $0.66 per kg and 2.3 kg per bird.

(3) Assumes capital cost $1,000 per house. 5% of initial capital cost per annum.

(4) Assumes 10 year life and 10% interest.

Table GVI.7 Poultry: 500 Bird Layer Enterprise at 1980 Market Prices

	M$
Revenues	
180 days at 70% lay: 61,740 eggs @ 14.5 ¢	8,952.00
249 days at 65% lay: 73,320 eggs @14.5 ¢	10,631.00
Cull hens 470 (1.8 kg @ $1.5 per kg)[1]	1,269.00
	20,852.00
Production Costs	
Day old chicks (good laying breeds) @ $1.80 per chick	900.00
Feedstuff: day old - point of lay[2]	2,570.00
laying period[3]	14,350.00
Veterinary	100.00
Electricity and water	168.00
Repair and maintenance of houses and equipment[4]	405.00
Depreciation and interest on buildings and equipment	1,065.00
Sub-total	19,558.00
Labour: 92 man-days	644.00
Net Revenue excluding labour	1,294.00
including labour	650.00

Source: Consultants estimates

Notes:
(1) Mortality 6% from day old - point of lay) 2% additional
4% point of lay to cull) birds supplied
(2) 7.95 kgs per bird @ M$0.64 per kg (505 birds average)
(3) 45.3 kgs per bird @ M$0.66 per kg (480 birds average)
(4) Assumes a capital cost of M$5,000 and 5% of initialcapital costs per annum (590 day period)
(5) 15 year life of building and cages and 10% interest per annum (590 day period)