Table 7.1-2 TYPICAL CROSS SECTION OF JETTY AND COST COMPARISON

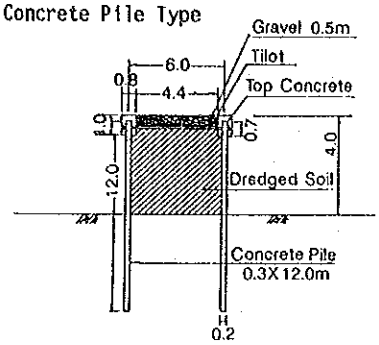
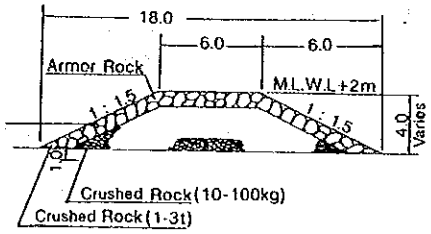
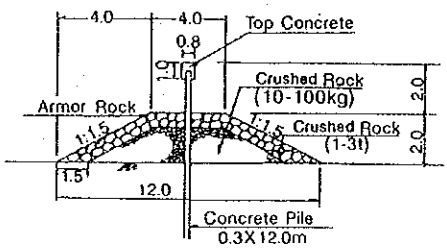
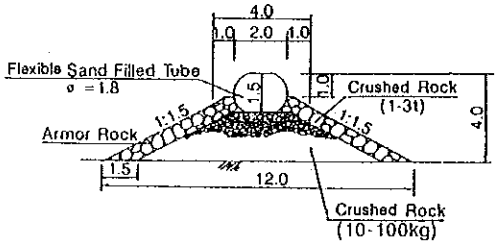
Structural Type / Structure Figure	Item	Q'ty	Volume	Unit Price (RM)	Cost (RM)
(1) Concrete Pile Type 	Gravel	1	2.2 m3	60	132
	Concrete	2	1.32 m3	400	528
	Concrete Pile	2	2 pier	2,900	5,800
	Dredged Soil	1	20.7 m3	5	104
	Total Cost				6,564
(2) Rubble Mound Type 	Crushed Rock (1-3t)	1	23.63 m3	95	2,245
	Crushed Rock (10-100kg)	1	24.38 m3	60	1,463
	Total Cost				3,708
(3) Rubble Mound with Concrete Pile 	Concrete Pile	1	1 pier	2,900	2,900
	Concrete	1	0.65 m3	400	260
	Crushed Rock (1-3t)	1	6.25 m3	95	594
	Crushed Rock (1-100kg)	1	9.75 m3	60	585
	Total Cost				4,339
(4) Rubble Mound with Sand Filled Tube 	Flexible Sand Filled Tube	1	1 m	2,200	2,200
	Crushed Rock (1-3t)	1	8 m3	95	760
	Crushed Rock (1-100kg)	1	15 m3	60	900
	Total Cost				3,860

Table 7.1-3 TYPICAL CROSS SECTION OF SUBMERGED JETTY AND COST COMPARISON

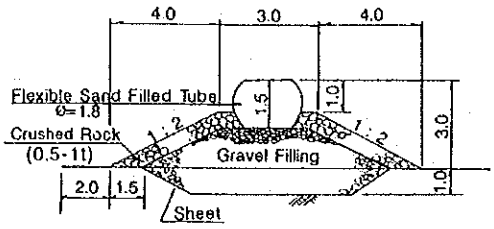
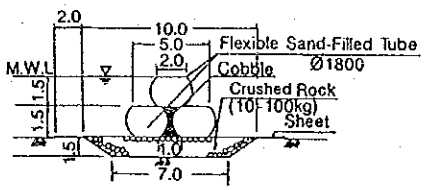
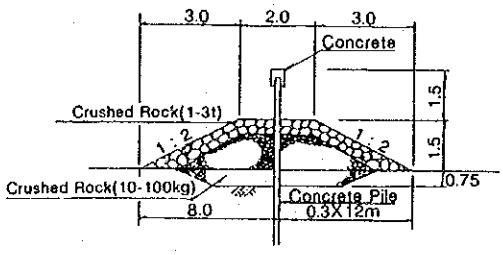
Structural Type / Structure Figure	Item	Q'ty	Volume	Unit Price (RM)	Cost (RM)
(1) Submerged Rubble Mound with Concrete Pile	Sheet	1	21 m2	35	735
	Crushed Rock (60-300kg)	1	5 m3	95	475
	Cobblestone Filling	1	29.25 m3	60	1,755
	Flexible Sand-Filled Tube	1	1 m	2,200	2,200
	Total Cost				5,165
(2) Submerged Sand Filled Tube	Sheet	1	17 m2	35	595
	Crushed Rock (60-300kg)	1	12.75 m3	60	765
	Cobblestone Filling	1	0.75 m3	60	45
	Flexible Sand-Filled Tube	3	3 m	2,200	6,600
	Total Cost				8,005
(3) Submerged Rubble Mound Concrete Pile	Sheet	1	21 m2	35	735
	Concrete Pile	1	1 pier	2,900	2,900
	Concrete	1	0.65 m3	400	260
	Crushed Rock (1-3t)	1	3 m3	95	285
	Crushed Rock (10-100kg)	1	20.5 m3	60	1,230
	Total Cost				5,410

Table 7.1-4 TYPICAL CROSS SECTION OF TRAINING WALL AND GROIN

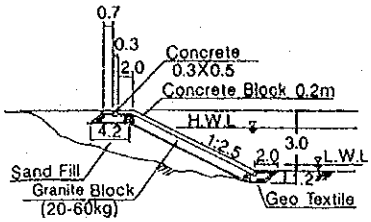
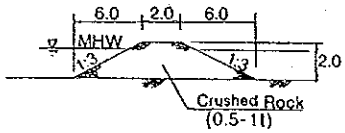
Structural Type / Structure Figure	Item	Q'ty	Volume	Unit Price (RM)	Cost (RM)
Training Wall	Concrete	1	0.15 m3	250	38
	Concrete Block	1	2.1 m3	150	315
	Geotextile	1	13.6 m	35	476
	Granite Block	1	11.2 m3	60	672
	Total Cost				1,501
Groin	Crushed Rock (0.5-1.0t)	1	16 m3	95	1,520
					
	Total Cost				1,520

Table 7.1-5 UNIT CONSTRUCTION COST

Item	Description	Unit	Rate (RM)
1	Excavation for reservoir at river mouth	m3	5.0
2	Excavation for structure	m3	6.5
3	Earthfilling with local spoil materials including compaction	m3	7.0
4	Supply and transport sandy material to site at sea.	m3	30.0
5	Gravel filling	m3	60.0
6	Supply,delivery and placing rock		
	gradation 2.0-5.0 t	m3	95.0
	--ditto- 1.0-3.0 t	m3	95.0
	--ditto- 200-500 kg	m3	60.0
	--ditto- 100-300 kg	m3	60.0
	--ditto- 10 -100 kg	m3	60.0
7	Supply,delivery place concrete block with cement mortar	m2	150.0
8	Concrete works (with re-bar)	m3	400.0
9	Concrete works (without re-bar)	m3	250.0
10	Form works	m2	25.0
11	Supply,delivery and driving concrete piles (l=12.0 m,b=1.0 m)	m	2,900.0
12	Supply,delivery and driving steel sheet pile(type-III,L=12.0 m)	m	3,800.0
13	Supply,delivery and placing geotextile sheet	m2	30.0
14	Supply,delivery and placing flexible sand-filled tubes(dia.1800 mm)	m	2,200.0
15	Supply,delivery and placing dia.300 rubble stone for slope protection(t600)	m2	80.0

Note:
1. Unit costs include all mobilization, site preparation, together with all material supply,labour,construction, equipment,profit and overhed.
2. Assumed that rock materials are locally available.
3. Item 14 (material and installation method) is to be imported.

Table 7.1-6 BREAKDOWN OF ESTIMATED DREDGING UNIT COST

Case	Work Item	Unit Cost (RM)	Percent (%)
Inner Channel	1. Pump Dredging Operation	3.00	49.8
(L < 1,500 m)	2. Anchoring Boat Operation	0.31	5.1
	3. Transportation Pipe	0.15	2.5
	4. Floater	0.55	9.1
* Muddy Soil *	5. Rubber Joint	0.22	3.6
	6. Installation & Withdrawal (Floater)	0.15	2.5
	7. Anchoring Facility	0.48	8.0
	8. Installation & Withdrawal (Trans. Pipe)	0.32	5.3
	9. Disposal of Dredged Material	0.85	14.1
		6.03	100.0
		(6.0)	
	1. Pump Dredging Operation	3.67	72.4
	2. Anchoring Boat Operation	0.38	7.5
	3. Transportation Pipe	0.09	1.8
* Sandy Soil *	4. Floater	0.33	6.5
	5. Rubber Joint	0.13	2.6
	6. Installation & Withdrawal (Floater)	0.07	1.4
	7. Anchoring Facility	0.24	4.7
	8. Installation & Withdrawal (Trans. Pipe)	0.16	3.2
		5.07	100.00
		(5.0)	
Offshore Channel			
(1,500 m < L &	1. Pump Dredging Operation	3.44	50.0
L < 3,000 m)	2. Anchoring Boat Operation	0.35	5.1
	3. Transportation Pipe	0.22	3.2
	4. Floater	0.83	12.1
* Muddy Soil *	5. Rubber Joint	0.33	4.8
	6. Installation & Withdrawal (Floater)	0.20	2.9
	7. Anchoring Facility	0.24	3.5
	8. Installation & Withdrawal (Trans. Pipe)	0.42	6.1
	9. Disposal of Dredged Material	0.85	12.4
		6.88	100.0
		(7.0)	
	1. Pump Dredging Operation	4.13	69.6
	2. Anchoring Boat Operation	0.42	7.1
	3. Transportation Pipe	0.13	2.2
* Sandy Soil *	4. Floater	0.50	8.4
	5. Rubber Joint	0.20	3.4
	6. Installation & Withdrawal (Floater)	0.10	1.7
	7. Anchoring Facility	0.24	4.0
	8. Installation & Withdrawal (Trans. Pipe)	0.21	3.5
	9. Disposal of Dredged Material	5.93	100.00
		(6.0)	

L : Length of sand transportation pipeline.

Table 7.1-7 COST COMPARISON IN NPV OF ALTERNATIVE CASES AT PERLIS RIVER MOUTH

Perlis River Case-1 Cap.+Main. Dredging
Case-2 Cap.+Main. Dredging +Sub. Jetty

		Volume (m3)	Unit Cost (RM)	Cost (RM)
Capital Dredging				
	Outer	: 1,289,700	7.0	9,027,900
	Inner	: 184,400	6.0	1,106,400
Maintenance Dredging (without Sub. Jetty)		: 360,900	7.0	2,526,300
Maintenance Dredging (with Sub. Jetty)		: 162,400	6.0	974,400
Submerged Jetty		: 103,000	190.0	19,570,000
Interest		8%		

** Net Present Value of Construction Cost **

Unit : '000 RM

Year	Case-1 Capital Dredging	Case-1 Maintenance Dredging	Case-1 Total	Case-2 Capital Dredging	Case-2 Maintenance Dredging	Case-2 Submerged Jetty*1	Case-2 Total
1	10,134		10,134	10,134		9,785	19,919
2		2,526	2,526		1,750	9,785	11,535
3		2,526	2,526		974	117	1,092
4		2,526	2,526		974	117	1,092
5		2,526	2,526		974	117	1,092
6		2,526	2,526		974	117	1,092
7		2,526	2,526		974	117	1,092
8		2,526	2,526		974	117	1,092
9		2,526	2,526		974	117	1,092
10		2,526	2,526		974	117	1,092
11		2,526	2,526		974	117	1,092
12		2,526	2,526		974	117	1,092
13		2,526	2,526		974	117	1,092
14		2,526	2,526		974	117	1,092
15		2,526	2,526		974	117	1,092
16		2,526	2,526		974	5,871	6,845
17		2,526	2,526		974	5,871	6,845
18		2,526	2,526		974	117	1,092
19		2,526	2,526		974	117	1,092
20		2,526	2,526		974	117	1,092
21		2,526	2,526		974	117	1,092
22		2,526	2,526		974	117	1,092
23		2,526	2,526		974	117	1,092
24		2,526	2,526		974	117	1,092
25		2,526	2,526		974	117	1,092
26		2,526	2,526		974	117	1,092
27		2,526	2,526		974	117	1,092
28		2,526	2,526		974	117	1,092
29		2,526	2,526		974	117	1,092
30		2,526	2,526		974	117	1,092
NPV of Direct Cost			35,485				41,912
NPV of Project Cost *2			49,395				58,342

*1 Construction Period for Submerged Jetty is 2 Years.
*2 (NPV of Direct Cost)x1.392, including other indirect cost.

Table 7.1-8 COST COMPARISON IN NPV OF ALTERNATIVE CASES AT KEDAH RIVER MOUTH

Kedah River Case-1 Cap.+Main. Dredging
Case-2 Cap.+Main. Dredging+Sub. Jetty

		Volume (m3)	Unit Cost (RM)	Cost (RM)
Capital Dredging				
	Outer	: 1,004,400	7.0	7,030,800
	Inner	: 219,400	6.0	1,316,400
Maintenance Dredging (without Sub. Jetty)		: 332,400	7.0	2,326,800
Maintenance Dredging (with Sub. Jetty)		: 149,600	6.0	897,600
Submerged Jetty		: 104,420	190.0	19,839,800
Interest		8%		

** Net Present Value of Construction Cost **

Unit : '000 RM

Year	Case-1 Capital Dredging	Case-1 Maintenance Dredging	Case-1 Total	Case-2 Capital Dredging	Case-2 Maintenance Dredging	Case-2 Submerged Jetty*1	Case-2 Total
1	8,347		8,347	8,347		9,920	18,267
2		2,327	2,327		1,612	9,920	11,532
3		2,327	2,327		898	119	1,017
4		2,327	2,327		898	119	1,017
5		2,327	2,327		898	119	1,017
6		2,327	2,327		898	119	1,017
7		2,327	2,327		898	119	1,017
8		2,327	2,327		898	119	1,017
9		2,327	2,327		898	119	1,017
10		2,327	2,327		898	119	1,017
11		2,327	2,327		898	119	1,017
12		2,327	2,327		898	119	1,017
13		2,327	2,327		898	119	1,017
14		2,327	2,327		898	119	1,017
15		2,327	2,327		898	119	1,017
16		2,327	2,327		898	5,952	6,850
17		2,327	2,327		898	5,952	6,850
18		2,327	2,327		898	119	1,017
19		2,327	2,327		898	119	1,017
20		2,327	2,327		898	119	1,017
21		2,327	2,327		898	119	1,017
22		2,327	2,327		898	119	1,017
23		2,327	2,327		898	119	1,017
24		2,327	2,327		898	119	1,017
25		2,327	2,327		898	119	1,017
26		2,327	2,327		898	119	1,017
27		2,327	2,327		898	119	1,017
28		2,327	2,327		898	119	1,017
29		2,327	2,327		898	119	1,017
30		2,327	2,327		898	119	1,017
NPV of Direct Cost			31,769				39,712
NPV of Project Cost *2			44,223				55,279

*1 Construction Period for Submerged Jetty is 2 Years.
*2 (NPV of Direct Cost)x1.392, including other indirect cost.

Table 7.1-9 COST COMPARISON IN NPV OF ALTERNATIVE CASES AT TG.PIANDANG RIVER MOUTH

Tg.Piandang River
Case-1 Cap.+Main. Dredging
Case-2 Cap.+Main. Dredging + Sub. Jetty

		Volume (m3)	Unit Cost (RM)
Capital Dredging			
Outer	:	188,600	7.0
Inner	:	224,700	6.0
Maintenance Dredging(without Sub. Jetty)	:	72,500	7.0
Maintenance Dredging(with Sub. Jetty)	:	32,600	6.0
Maintenance Dredging (with Sub. Jetty and Reservoir)	:	11,410	6.0
Submerged Jetty	:	44,730	190.0
Reservoir	:	4,500	60.0
Interest	8%		

** Net Present Value of Construction Cost **

Unit : '000 RM

	Case-1			Case-2			
Year	Capital Dredging	Maintenance Dredging	Total	Capital Dredging	Maintenance Dredging	Submerged Jetty	Total
1	2,668		2,668	2,668		8,499	11,167
2		508	508		196	51	247
3		508	508		196	51	247
4		508	508		196	51	247
5		508	508		196	51	247
6		508	508		196	51	247
7		508	508		196	51	247
8		508	508		196	51	247
9		508	508		196	51	247
10		508	508		196	51	247
11		508	508		196	51	247
12		508	508		196	51	247
13		508	508		196	51	247
14		508	508		196	51	247
15		508	508		196	51	247
16		508	508		196	5,099	5,295
17		508	508		196	51	247
18		508	508		196	51	247
19		508	508		196	51	247
20		508	508		196	51	247
21		508	508		196	51	247
22		508	508		196	51	247
23		508	508		196	51	247
24		508	508		196	51	247
25		508	508		196	51	247
26		508	508		196	51	247
27		508	508		196	51	247
28		508	508		196	51	247
29		508	508		196	51	247
30		508	508		196	51	247
NPV of Direct Cost		7,714					14,361
NPV of Project Cost *1		10,738					19,991

*1 (NPV of Direct Cost)x1.392, including other indirect cost.

Table 7.1-10 COST COMPARISON IN NPV OF ALTERNATIVE CASES AT BERUAS RIVER MOUTH

Beruas River Case-1 Cap.+Main. Dredging
Case-2 Cap.+Main. Dredging + Sub. Jetty

		Volume (m3)	Unit Cost (RM)	Cost (1000RM)
Capital Dredging				
Outer	:	359,800	7.0	2,518,600
Inner	:	324,300	6.0	1,945,800
Maintenance Dredging (without Sub. Jetty)	:	128,200	7.0	897,400
Maintenance Dredging (with Sub. Jetty)	:	57,700	6.0	346,200
Submerged Jetty	:	37,340	190.0	7,094,600
Interest		8%		

** Net Present Value of Construction Cost **

Unit : '000 RM

Year	Case-1 Capital Dredging	Case-1 Maintenance Dredging	Case-1 Total	Case-2 Capital Dredging	Case-2 Maintenance Dredging	Case-2 Submerged Jetty	Case-2 Total
1	4,464		4,464	4,464		7,095	11,559
2		897	897		346	43	389
3		897	897		346	43	389
4		897	897		346	43	389
5		897	897		346	43	389
6		897	897		346	43	389
7		897	897		346	43	389
8		897	897		346	43	389
9		897	897		346	43	389
10		897	897		346	43	389
11		897	897		346	43	389
12		897	897		346	43	389
13		897	897		346	43	389
14		897	897		346	43	389
15		897	897		346	43	389
16		897	897		346	4,257	4,603
17		897	897		346	43	389
18		897	897		346	43	389
19		897	897		346	43	389
20		897	897		346	43	389
21		897	897		346	43	389
22		897	897		346	43	389
23		897	897		346	43	389
24		897	897		346	43	389
25		897	897		346	43	389
26		897	897		346	43	389
27		897	897		346	43	389
28		897	897		346	43	389
29		897	897		346	43	389
30		897	897		346	43	389
NPV of Direct Cost			13,406				15,950
NPV of Project Cost *1			18,660				22,202

Note *1 (NPV of Direct Cost)x1.392, including others indirect cost.

Table 7.1-11 COST COMPARISON IN NPV OF ALTERNATIVE CASES AT KUANTAN RIVER MOUTH

Kuantan River Case-1 Cap.+Main. Dredging
Case-2 Cap. Dredging + Jetty

		Volume (m3)	Unit Cost (RM)	Cost (1000RM)
Capital Dredging				
Outer	:	617,700	6.0	3,706
Inner	:	0	5.0	0
Maintenance Dredging (without Sub. Jetty)	:	217,000	6.0	1,302
Jetty	:	161,490	78.0	12,596
Groin	:	1,650	1,500.0	2,475
Interest	:	8%		

Net Present Value of Construction Cost

Unit : '000 Ringgit

Year	Case-1 Capital Dredging	Case-1 Maintenance Dredging	Case-1 Total	Case-2 Capital Dredging	Case-2 Jetty*1	Case-2 Total
1	3,706		3,706	3,706	7,536	11,242
2		1,302	1,302	651	7,536	8,187
3		1,302	1,302		90	90
4		1,302	1,302		90	90
5		1,302	1,302		90	90
6		1,302	1,302		90	90
7		1,302	1,302		90	90
8		1,302	1,302		90	90
9		1,302	1,302		90	90
10		1,302	1,302		90	90
11		1,302	1,302		90	90
12		1,302	1,302		90	90
13		1,302	1,302		90	90
14		1,302	1,302		90	90
15		1,302	1,302		90	90
16		1,302	1,302		90	90
17		1,302	1,302		90	90
18		1,302	1,302		90	90
19		1,302	1,302		90	90
20		1,302	1,302		90	90
21		1,302	1,302		90	90
22		1,302	1,302		90	90
23		1,302	1,302		90	90
24		1,302	1,302		90	90
25		1,302	1,302		90	90
26		1,302	1,302		90	90
27		1,302	1,302		90	90
28		1,302	1,302		90	90
29		1,302	1,302		90	90
30		1,302	1,302		90	90
NPV of Direct Cost			16,884			18,285
NPV of Project Cost *2			23,502			25,452

*1 : Construction Period for Jetty will be 2 Years.
*2 : (NPV of Direct Cost)x1.392, including others cost (see sub-section 6.8.2).

Table 7.1-12 COST COMPARISON IN NPV OF ALTERNATIVE CASES AT KERTEH RIVER MOUTH

Kerteh River Case-1 Cap.+Main. Dredging + Training Wall
Case-2 Cap. Dredging + Jetty + Groin + Reservoir

		Volume (m3)	Unit Cost (RM)	Cost (RM)
Capital Dredging				
Outer	:	120,200	5.0	601,000
Inner	:	158,700	5.0	793,500
Maintenance Dredging (without Jetty)	:	120,200	5.0	601,000
Jetty	:	60,500	78.0	4,719,000
Reservoir	:	5,000	10.0	50,000
Training Wall	:	850	1,500.0	1,275,000
Groin	:	300	1,500.0	450,000
Interest	:	8%		

** Net Present Value of Construction Cost **
Unit : '000 RM

Year	Case-1 Capital Dredging	Case-1 Training Wall	Case-1 Total	Case-2 Capital Dredging	Case-2 Structure Cost	Case-2 Total
1	1,395	1,275	2,670	1,395	5,219	6,614
2	601	8	609		31	31
3	601	8	609		31	31
4	601	8	609		31	31
5	601	8	609		31	31
6	601	8	609		31	31
7	601	8	609		31	31
8	601	8	609		31	31
9	601	8	609		31	31
10	601	8	609		31	31
11	601	8	609		31	31
12	601	8	609		31	31
13	601	8	609		31	31
14	601	8	609		31	31
15	601	8	609		31	31
16	601	8	609		31	31
17	601	8	609		31	31
18	601	8	609		31	31
19	601	8	609		31	31
20	601	8	609		31	31
21	601	8	609		31	31
22	601	8	609		31	31
23	601	8	609		31	31
24	601	8	609		31	31
25	601	8	609		31	31
26	601	8	609		31	31
27	601	8	609		31	31
28	601	8	609		31	31
29	601	8	609		31	31
30	601	8	609		31	31
NPV of Direct Cost			8,760			6,447
NPV of Project Cost *1			12,194			8,974

Note *1 (NPV of Direct Cost)x1.392, including other indirect cost.

Table 7.1-13 COST COMPARISON IN NPV OF ALTERNATIVE CASES AT MARANG RIVER MOUTH

Marang River
Case-1 Cap. + Main Dredging + Breakwater + Training Wall + Groin
Case-2 Cap. Dredging + Breakwater + Jetty + Groin + Reservoir

		Volume (m3)	Unit Cost (RM)	Cost (1000RM)
Capital Dredging				
Outer	:	39,600	5.0	198
Inner	:	67,100	5.0	336
Maintenance Dredging	:	39,600	5.0	198
Breakwater	:	128,970	78.0	10,060
Jetty (with Breakwater)	:	147,753	78.0	11,525
Training Wall	:	650	1,500.0	975
Groin	:	360	1,500.0	540
Reservoir	:	4100	10.0	41
Interest	:	8%		

Net Present Value of Construction Cost

Unit : '000 Ringgit

Year	Case-1 Capital Dredging	Case-1 Structure Cost	Case-1 Total	Case-2 Capital Dredging	Case-2 Structure Cost	Case-2 Total
1	534	11,275	11,808	534	12,106	12,639
2	198	68	266		73	73
3	198	68	266		73	73
4	198	68	266		73	73
5	198	68	266		73	73
6	198	68	266		73	73
7	198	68	266		73	73
8	198	68	266		73	73
9	198	68	266		73	73
10	198	68	266		73	73
11	198	68	266		73	73
12	198	68	266		73	73
13	198	68	266		73	73
14	198	68	266		73	73
15	198	68	266		73	73
16	198	68	266		73	73
17	198	68	266		73	73
18	198	68	266		73	73
19	198	68	266		73	73
20	198	68	266		73	73
21	198	68	266		73	73
22	198	68	266		73	73
23	198	68	266		73	73
24	198	68	266		73	73
25	198	68	266		73	73
26	198	68	266		73	73
27	198	68	266		73	73
28	198	68	266		73	73
29	198	68	266		73	73
30	198	68	266		73	73
NPV of Direct Cost			13,678			12,453
NPV of Project Cost *1			19,040			17,335

*1 : (NPV of Direct Cost)x1.392, including others cost (see sub-section 6.8.2).

Table 7.1-14 COST COMPARISON IN NPV OF ALTERNATIVE CASES AT TERENGGANU RIVER MOUTH

Terengganu River
Case-1 Cap.+ Main. Dredging + Breakwater + Groin (1)
Case-2 Cap. Dredging + Breakwater + Jetty + Groin (2)

		Volume (m3)	Unit Cost (RM)	Cost (RM)
Capital Dredging				
Outer	:	167,100	5.0	836
River Mouth	:	760,000	5.0	3,800
Inner	:	813,200	5.0	4,066
Maintenance Dredging	:	167,100	5.0	836
Breakwater	:	213,725	78.0	16,671
*Breakwater (Part)	:	68,713	78.0	5,360
Jetty	:	307,430	78.0	23,980
Groin (1)	:	720	1,500.0	1,080
Groin (2)	:	1,170	1,500.0	1,755
Interest		8%		

** Net Present Value of Construction Cost **

Unit : '000 RM

Year	Case-1 Capital Dredging	Case-1 Structure*1 Cost	Case-1 Total	Case-2 Capital Dredging	Case-2 Structure*2 Cost	Case-2 Total
1	8,702	8,875	17,577	8,702	10,365	19,066
2	836	8,875	9,711	557	10,365	10,922
3	836	107	942	279	10,365	10,643
4	836	107	942		187	187
5	836	107	942		187	187
6	836	107	942		187	187
7	836	107	942		187	187
8	836	107	942		187	187
9	836	107	942		187	187
10	836	107	942		187	187
11	836	107	942		187	187
12	836	107	942		187	187
13	836	107	942		187	187
14	836	107	942		187	187
15	836	107	942		187	187
16	836	107	942		187	187
17	836	107	942		187	187
18	836	107	942		187	187
19	836	107	942		187	187
20	836	107	942		187	187
21	836	107	942		187	187
22	836	107	942		187	187
23	836	107	942		187	187
24	836	107	942		187	187
25	836	107	942		187	187
26	836	107	942		187	187
27	836	107	942		187	187
28	836	107	942		187	187
29	836	107	942		187	187
30	836	107	942		187	187
NPV of Direct Cost			33,525			37,086
NPV of Project Cost *3			46,667			51,624

Note *1 Construction Period for Breakwater is 2 Years.
*2 Construction Period for Breakwater and Jetty is 3 Years.
*3 (NPV of Direct Cost)x1.392, including other indirect cost.

Table 7.1-15 COST COMPARISON IN NPV OF ALTERNATIVE CASES AT OYA RIVER MOUTH

Oya River Case-1 Cap. + Main. Dredging + Training Wall
Case-2 Cap. Dredging + Jetty

		Volume (m3)	Unit Cost (RM)	Cost (1000RM)
Capital Dredging				
Outer	:	31,300	5.0	157
Inner	:	0	5.0	0
Maintenance Dredging (without Sub. Jetty)	:	31,300	5.0	157
Jetty	:	79,020	78.0	6,164
Training Wall	:	1,300	1,500.0	1,950
Groin	:	3,850	78.0	300
Interest	:	8%		

Net Present Value of Construction Cost

Unit : '000 Ringgit

Year	Case-1 Dredging Cost	Case-1 Structure Cost	Case-1 Total	Case-2 Dredging Cost	Case-2 Structure Cost	Case-2 Total
1	157	1,950	2,107	157	6,464	6,620
2	157	12	168		39	39
3	157	12	168		39	39
4	157	12	168		39	39
5	157	12	168		39	39
6	157	12	168		39	39
7	157	12	168		39	39
8	157	12	168		39	39
9	157	12	168		39	39
10	157	12	168		39	39
11	157	12	168		39	39
12	157	12	168		39	39
13	157	12	168		39	39
14	157	12	168		39	39
15	157	12	168		39	39
16	157	12	168		39	39
17	157	12	168		39	39
18	157	12	168		39	39
19	157	12	168		39	39
20	157	12	168		39	39
21	157	12	168		39	39
22	157	12	168		39	39
23	157	12	168		39	39
24	157	12	168		39	39
25	157	12	168		39	39
26	157	12	168		39	39
27	157	12	168		39	39
28	157	12	168		39	39
29	157	12	168		39	39
30	157	12	168		39	39
NPV of Direct Cost			3,688			6,530
NPV of Project Cost*1			5,134			9,090

*1 : (NPV of Direct Cost)x1.392, including others cost (see sub-section 6.8.2).

Table 7.1-16 COST COMPARISON IN NPV OF ALTERNATIVE CASES AT PAPAR RIVER MOUTH

Papar River Case-1 Cap.+Main. Dredging + Training Wall + Groin
Case-2 Cap.Dredging + Jetty + Groin + Reservoir

		Volume (m3)	Unit Cost (RM)	Cost (1000RM)
Capital Dredging				
Outer	:	46,000	5.0	230
Inner	:	173,900	5.0	870
Maintenance Dredging (without Sub. Jetty)	:	46,000	5.0	230
Jetty	:	13,880	78.0	1,083
Groin	:	400	1,500.0	600
Training Wall	:	400	1,500.0	600
Reservoir	:	800	10.0	8
Interest	:	8%		

Net Present Value of Construction Cost

Unit : '000 Ringgit

Year	Case-1 Dredging Cost	Case-1 Structure Cost	Case-1 Total	Case-2 Dredging Cost	Case-2 Structure Cost	Case-2 Total
1	1,100	750	1,850	1,100	1,691	2,790
2	230	5	235		10	10
3	230	5	235		10	10
4	230	5	235		10	10
5	230	5	235		10	10
6	230	5	235		10	10
7	230	5	235		10	10
8	230	5	235		10	10
9	230	5	235		10	10
10	230	5	235		10	10
11	230	5	235		10	10
12	230	5	235		10	10
13	230	5	235		10	10
14	230	5	235		10	10
15	230	5	235		10	10
16	230	5	235		10	10
17	230	5	235		10	10
18	230	5	235		10	10
19	230	5	235		10	10
20	230	5	235		10	10
21	230	5	235		10	10
22	230	5	235		10	10
23	230	5	235		10	10
24	230	5	235		10	10
25	230	5	235		10	10
26	230	5	235		10	10
27	230	5	235		10	10
28	230	5	235		10	10
29	230	5	235		10	10
30	230	5	235		10	10
NPV of Direct Cost			4,135			2,688
NPV of Project Cost *1			5,756			3,742

*1 : (NPV of Direct Cost)x1.392, including others cost (see sub-section 6.8.2).

Table 7.1-17(1/4) PRIORITIZATION (Case 1-1 & 1-3)

(Total costs in 5 years are equalized.) (Unit: '000 RM)

Priority	Serial	Name	State	Initial Cost	O&M Cost (Per Year)
	1	Perlis	Perlis	10,134	2,526
	5	Kedah	Kedah	8,437	2,327
	14	Tg. Piandang	Perak	2,668	508
	19	Beruas	Perak	4,465	897
	46	Endau	Johor	1,726	785
First	51	Pahang	Pahang	10,024	59
	61	Marang	Terengganu	12,639	73
	67	Kelantan	Kelantan	4,810	28
	81	Mukah	Sarawak	35,080	204
				89,983	7,407
	2	Baru	Perlis	1,396	613
	8	Cenang	Kedah	2,092	850
	9	Muda	P.Pinang	1,044	641
	12	Pinang	P.Pinang	1,817	738
	15	Gula	Perak	3,241	1,696
	23	Selangor	Selangor	920	519
Second	32	Melaka	Melaka	118	58
	43	Pontian Kecil	Johor	795	393
	44	Sedili Besar	Johor	841	525
	53	Kuantan	Pahang	3,706	1,302
	62	Terengganu	Terengganu	26,452	943
	59	Dungun	Terengganu	534	343
				42,956	8,621
	3	Sanglang	Kedah	382	189
	6	Yan	Kedah	2,086	880
Third	30	Linggi	Melaka	345	140
	45	Mersing	Johor	42,322	241
	55	Kemaman	Terengganu	94	85
				45,229	1,535
	4	Jerlun	Kedah	286	141
	11	Kerian	P.Pinang	397	224
	48	Rompin	Pahang	16,614	98
Forth	50	Nenasi	Pahang	474	428
	58	Paka	Terengganu	122	122
	78	Sadong	Sarawak	1,008	568
	80	Oya	Sarawak	2,107	168
	89	Padas	Sabah	226	127
	98	Tawau	Sabah	560	228
				21,794	2,104

Table 7.1-17(2/4) PRIORITIZATION (Case 1-2)

(Total costs in 5 years are equalized.) (Unit: '000 RM)

Priority	Serial	Name	State	Initial Cost	O&M Cost (Per Year)
	1	Perlis	Perlis	10,134	2,526
	2	Baru	Perlis	1,396	613
	5	Kedah	Kedah	8,437	2,327
	9	Muda	P.Pinang	1,044	641
	12	Pinang	P.Pinang	1,817	738
	14	Tg. Piandang	Perak	2,668	508
First	15	Gula	Perak	3,241	1,696
	19	Beruas	Perak	4,465	897
	23	Selangor	Selangor	920	519
	46	Endau	Johor	1,726	785
	51	Pahang	Pahang	10,024	59
	61	Marang	Terengganu	12,639	73
	67	Kelantan	Kelantan	4,810	28
	81	Mukah	Sarawak	35,080	204
				98,401	11,614
	3	Sanglang	Kedah	382	189
	30	Linggi	Melaka	345	140
	32	Melaka	Melaka	118	58
	43	Pontian Kecil	Johor	795	393
Second	44	Sedili Besar	Johor	841	525
	45	Mersing	Johor	42,322	241
	48	Rompin	Pahang	16,614	98
	55	Kemaman	Terengganu	94	85
	59	Dungun	Terengganu	534	343
	78	Sadong	Sarawak	1,008	568
				63,053	2,640
	4	Jerlun	Kedah	286	141
	6	Yan	Kedah	2,086	880
	8	Cenang	Kedah	2,092	850
	11	Kerian	P.Pinang	397	224
	50	Nenasi	Pahang	474	428
Third	53	Kuantan	Pahang	3,706	1,302
	58	Paka	Terengganu	122	122
	62	Terengganu	Terengganu	26,452	943
	80	Oya	Sarawak	2,107	168
	89	Padas	Sabah	226	127
	98	Tawau	Sabah	560	228
				38,508	5,413

Table 7.1-17(3/4) PRIORITIZATION (Case 2-1 & 2-3)

(Initial costs are equalized.) (Unit: '000 RM)

Priority	Serial	Name	State	Initial Cost	O&M Cost (Per Year)
	1	Perlis	Perlis	10,134	2,526
	5	Kedah	Kedah	8,437	2,327
	14	Tg. Piandang	Perak	2,668	508
	19	Beruas	Perak	4,465	897
	30	Linggi	Melaka	345	140
First	46	Endau	Johor	1,726	785
	53	Kuantan	Pahang	3,706	1,302
	59	Dungun	Terengganu	534	343
	61	Marang	Terengganu	12,639	73
	67	Kelantan	Kelantan	4,810	28
				49,464	8,929
	9	Muda	P.Pinang	1,044	641
	23	Selangor	Selangor	920	519
	32	Melaka	Melaka	118	58
	43	Pontian Kecil	Johor	795	393
Second	44	Sedili Besar	Johor	841	525
	51	Pahang	Pahang	10,024	59
	55	Kemaman	Terengganu	94	85
	81	Mukah	Sarawak	35,080	204
	98	Tawau	Sabah	560	228
				49,476	2,712
	2	Baru	Perlis	1,396	613
	3	Sanglang	Kedah	382	189
	8	Cenang	Kedah	2,092	850
	12	Pinang	P.Pinang	1,817	738
Third	45	Mersing	Johor	42,322	241
	50	Nenasi	Pahang	474	428
	80	Oya	Sarawak	2,107	168
	89	Padas	Sabah	226	127
				50,816	3,354
	4	Jerlun	Kedah	286	141
	6	Yan	Kedah	2,086	880
	11	Kerian	P.Pinang	397	224
	15	Gula	Perak	3,241	1,696
Forth	48	Rompin	Pahang	16,614	98
	58	Paka	Terengganu	122	122
	62	Terengganu	Terengganu	26,452	943
	78	Sadong	Sarawak	1,008	568
				50,206	4,672

Table 7.1-17(4/4) PRIORITIZATION (Case 2-2)

(Initial costs are equalized.) (Unit: '000 RM)

Priority	Serial	Name	State	Initial Cost	O&M Cost (Per Year)
	1	Perlis	Perlis	10,134	2,526
	2	Baru	Perlis	1,396	613
	5	Kedah	Kedah	8,437	2,327
	9	Muda	P.Pinang	1,044	641
	12	Pinang	P.Pinang	1,817	738
First	14	Tg. Piandang	Perak	2,668	508
	15	Gula	Perak	3,241	1,696
	19	Beruas	Perak	4,465	897
	23	Selangor	Selangor	920	519
	46	Endau	Johor	1,726	785
	51	Pahang	Pahang	10,024	59
	53	Kuantan	Pahang	3,706	1,302
	61	Marang	Terengganu	12,639	73
	67	Kelantan	Kelantan	4,810	28
				67,027	12,712
	3	Sanglang	Kedah	382	189
	8	Cenang	Kedah	2,092	850
	30	Linggi	Melaka	345	140
	32	Melaka	Melaka	118	58
	43	Pontian Kecil	Johor	795	393
Second	44	Sedili Besar	Johor	841	525
	45	Mersing	Johor	42,322	241
	48	Rompin	Pahang	16,614	98
	50	Nenasi	Pahang	474	428
	55	Kemaman	Terengganu	94	85
	59	Dungun	Terengganu	534	343
	78	Sadong	Sarawak	1,008	568
	98	Tawau	Sabah	560	228
				66,179	4,146
	4	Jerlun	Kedah	286	141
	6	Yan	Kedah	2,086	880
	11	Kerian	P.Pinang	397	224
Third	58	Paka	Terengganu	122	122
	62	Terengganu	Terengganu	26,452	943
	80	Oya	Sarawak	2,107	168
	81	Mukah	Sarawak	35,080	204
	89	Padas	Sabah	226	127
				66,756	2,809

Table 7.1-18 COST DISBURSEMENT SCHEDULE OF FIRST PHASE PROJECT

(Unit : '000 RM)

Case	Item	Malaysia Plan 7th	8th	9th	10th
(Total costs are equalized.)					
	No. of River Mouths	21	35	35	35
Case 1-1	Initial Cost	132,939	67,023		
	Maintenance Cost	40,070	89,238	98,335	98,335
	Total Cost	173,009	156,261	98,335	98,335
	No. of River Mouths	14	24	35	35
Case 1-2	Initial Cost	98,401	63,053	38,508	
	Maintenance Cost	29,035	64,670	84,803	98,335
	Total Cost	127,436	127,723	123,311	98,335
	No. of River Mouths	9	21	26	35
Case 1-3	Initial Cost	89,983	42,956	45,229	21,794
	Maintenance Cost	18,518	58,588	83,978	93,075
	Total Cost	108,501	101,544	129,207	114,869
(Initial costs are equalized.)					
	No. of River Mouths	19	35	35	35
Case 2-1	Initial Cost	98,940	101,022		
	Maintenance Cost	29,103	78,270	98,335	98,335
	Total Cost	128,043	179,292	98,335	98,335
	No. of River Mouths	14	27	35	35
Case 2-2	Initial Cost	67,027	66,179	66,756	
	Maintenance Cost	31,780	73,925	91,313	98,335
	Total Cost	98,807	140,104	158,069	98,335
	No. of River Mouths	10	19	27	35
Case 2-3	Initial Cost	49,464	49,476	50,816	50,206
	Maintenance Cost	22,323	51,425	66,590	86,655
	Total Cost	71,787	100,901	117,406	136,861

Note : No. of fishermen : 22,105
Maintenance cost per capita : RM98,335 / 22,105 / 5years = RM 890/person
Average product per capita : RM 22,155
Burden for maintenance : 890 / 22,155 = 4%
Per kilogram of product : RM 2.1/kg x 4% = RM 0.084/kg

Table 7.2-1 WORK ITEMS AND QUANTITIES OF TG. PIANDANG RIVER MOUTH IMPROVEMENT PROJECT

Item	Unit	Quantity	Remarks
1. Dredging Works			
1) Captial Dredging			
Outer	cu.m.	56,500	L=1900 m
Inner	cu.m.	58,900	L=900 m , mooring area
2) Maintenance Dredging			
Outer	cu.m.	47,900	assume siltation return
Inner	cu.m.	7,500	0.9m outer, 0.3m inner
2. Shiping Jetty Works			
1) Clearing and Grubbing	sq.m.	2,000	
2) Embanhment	cu.m.	300	
3) Reddish sand	cu.m.	300	t=0.15 m
4) Gravel Pavement	sq.m.	2,800	t=0.2 m
5) Wooden Works for Jetty	sq.m.	720	(40.0m*6.0m*3 jetties)
6) Jetty House	L.S.	1	
3. Bank Protection			
1) Stone Masonry	cu.m.	42	with concrete
2) Gabion Mattress	sq.m.	1,050	used gabion mattress (3.0m*1.5m*0.5m)

Table 7.2-2 WORK ITEMS AND QUANTITIES OF MARANG RIVER MOUTH IMPROVEMENT PROJECT

Item		Unit	Quantity	Remarks
1. Dredging Works				
1) 20 GRT	Sand	cu.m.	42,000	Boat clearlance 0.6 m
	Rock	cu.m.	9,800	
2) 30 GRT	Sand	cu.m.	75,500	Boat clearlance 0.8 m
	Rock	cu.m.	15,900	
3) 40 GRT	Sand	cu.m.	109,000	Boat clearlance 1.0 m
	Rock	cu.m.	22,000	
2. Structure Works				
1) Breakwater				L= 200 m
	Armor Stone 1	cu.m.	15,700	3-5 t
	Secondary stone	cu.m.	11,200	300-500 kg
	Core Stone 1	cu.m.	11,300	100-300 kg
	Geo-Textile Mat	sq.m.	2,200	440 m * 5 m
2) Jetty				
North Jetty				L= 490 m
	Armor Stone 2	cu.m.	19,600	1-3 t
	Core Stone 2	cu.m.	18,800	10-100 kg
	Geo-Textile Mat	sq.m.	2,450	490 m * 5 m
South Jetty				L= 450 m
	Armor Stone 2	cu.m.	12,600	1-3 t
	Core Stone 2	cu.m.	10,900	10-100 kg
	Geo-Textile Mat	sq.m.	2,250	450 m * 5 m
3) River Groin				L= 40 m * 2
	Armor Stone 2	cu.m.	1,840	1-3 t
	Core Stone	cu.m.	720	10-100 kg
4) Coastal Groin				L= 200 m * 2
	Armor Stone 2	cu.m.	9,900	1-3 t
	Core Stone 2	cu.m.	7,800	10-100 kg
5) Reservoir		m	4,100	Excavation & Bank Works

Table 7.2-3 COMPARISON OF DREDGING METHOD

Particular	Method 1 Cutter Suction Dredger	Method 2 Dredging Machine (Cutter Suction)	Method 3 Grab (Clamshell) Dredger	Method 4 Trailing Suction Hopper Dredger
Operation of dredger and Water depth and Waves	Approach from the offshore sea is required due to the deep draft of the dredger.	Not applicable against big waves. Employed only in inner channel.	Approach from the offshore sea is required due to the deep draft of the dredger.	The nearshore zone is too shallow for this dredger to pass during low tide.
Dumping Site of Dredged Materials	Disposal by pipeline to the spoil bank provided on the coastal area.	Disposal by pipeline to the spoil bank provided on the coastal area.	Offshore sea more than 3 km away from the river mouth.	Offshore sea far away from the river mouth. It takes a lot of time.
Impact on Fishing Boats	Pipeline Might be obstructive to the passage of fishing boats.	Pipeline Might be slightly obstructive to the passage of fishing boats.	Almost no problem.	Fishing boats will be affected in the inner channel.
Disposal of Dredged material and Environmental Impact	About 9 ha. of mangrove swamp will be converted into spoil bank. Impact study is neccessary.	About 6 ha. of mangrove swamp will be converted into spoil bank. Impact study is neccessary.	No serious problem will be expected. Investigation on fishing zone is neccessary.	No serious problem will be expected. Investigation on fishing zone is neccessary.
Economical Aspect	Most efficient method. Usually economical, but pipeline setting is costly.	Usually economical, unless dumping site is very far from dredging site.	A little higher than method 1.	Can be economical if the water depth is deep enough and volume is big.
Assesment	This can be a alternative plan for both inner and outer channel dredging. Environmental impact study on the area around spoil bank is neccessary.	Not applicable for the outer channel dredging. Suitable for the mainten-nance dredging of the inner channel.	This can be a alternative plan for both inner and outer channel dredging. Investigation for the dumping site at sea is neccessary.	Not preferable.

Table 7.2-4 DETAILED COMPARISON OF CUTTER SUCTION DREDGING AND GRAB (CLAMSHELL) DREDGING

	Particular	Cutter Suction Dredger (Method 1)	Grab (Clamshell) Dredger (Method 3)
1.	Dredging Capacity		
	– Dredger	1350 HP (Diesel) Class	Grab Dredger 320 HP,3 m3
	– Hourly Production	390 m3	115 m3
	– Daily Production	5,460 m3	1,150 m3
2.	Working and Operation Hour	18 hours (2 shifts) 14 hours Operation	11 hours 10 hours Operation
3.	Dumping Site of Dredged Material	Spoil Bank on the coastal area A = 90,000 m2 (600m x 150m)	Offshore Sea more than 3 km away from river mouth
4.	Conveyance Method of Dredged Material	Discharging by Pipeline Length = 2,000m – 700m (Average 1,500 m)	Dumping by Hauling Barge Hauling Distance = 2,000 – 4,000 m (Average 3,000 m)
5.	Necessary Equipment,Machines and Vessels	Discharging Pipe,Floater, Support of Pipe , Anchor Barge (1), Tug Boat (1)	Anchor Boat (1),Tug Boat (2) Hauling Barge 90m3 (3) Lighting Equipment and others
6.	Cost of Dredging V=100,000 m3		
	– Operation of Dredger	100,000 m3 x 6.2 RM/m3 = 620,000 RM	100,000 m3 x 8.5 RM/m3 = 850,000 RM
	– Pipeline Setting(1,500 m)	205,000 RM	––
	– Spoil Bank Treatment	140,000 RM	––
	– Others	––	70,000 RM
		Total Cost 965,000 RM	Total Cost 920,000 RM
7.	Required Time for Dredging Works		
	– Operation Time of Dredger	0.8 Month	3.5 Month
	– Other Works	2.0 Month	0.5 Month
		Total 2.8 Month	Total 4.0 Month
8.	Impact on Navigation of Fishing Boats	Pipeline may be obstructive to the passage of fishing boats.	No serious problem is expected.
9.	Impact on Surrounding Environment	About 9 ha. of mangrove area will be converted into spoil bank but discharged water from spoil bank will not affect surrounding ecology.	Slight sea water contamination is expected but not serious, judging from the other cases.
10.	ASSESSMENT	Total cost is estimated to be a little higher than Grab Dredger. Not preferable for the navigation of fishing boats and preservation of mangrove.	Economically advantageous and preferable from the environmental aspect. To be recommended.

Table 7.2-5 LIST OF PURCHASED MATERIALS

Purchased Materials	Unit	Unit Price (RM)
1. Fuel and Lubricant		
Gasoline	ltr.	1.15
Diesel oil	ltr.	0.68
Heavy oil	ltr.	2.50
Engine oil	ltr.	2.50
Grease	kg.	5.25
2. Cement		
Portland Cement (40 kg / bag)	bag	10.00
3. Stone and Sand		
Fine aggregate (Washed sand) Haul.dis. < 30 km	cu.m.	16.00
Sand for filling (Hauling dis.< 5 km)	cu.m.	12.00
Gravel (River run)	cu.m.	15.00
Crushed rock (50 - 100 kg) Haul.dis.<30 km	cu.m.	32.00
Crushed rock (200 - 300 kg) Haul.dis.<30 km	cu.m.	34.00
Crushed rock (2 - 5 t) Haul.dis. < 30 km	cu.m.	38.00
4. Steel Material		
Reinforcement bar (Round bar)	t	1,250.00
Reinforcement bar (Deformed bar)	t	1,300.00
Steel sheet pile	t	1,600.00
Steel menbers (I,H-shape)	t	1,845.00
Steel plate	t	900.00
Steel pipe pile (dia.600-700mm)	m	480.00
5. Wood		
Timber , Pile 150mm x 150mm	m	16.00
Timber , Plank	cu.m.	550.00
Timber , Square	cu.m.	700.00
Plywood	cu.m.	40.00
6. Concrete Products		
R.C. Pile (400mm x 400mm)	m	100.00
P.C. Pile (400mm x 400mm)	m	
R.C. Pipe (600mm dia.)	m	105.00
R.C. Pipe (300mm dia.)	m	55.00
Concrete block (500mm x 500mm)	pc	
Brick	pc	0.25
7. Asphalt		
Cutback	t	90.00
8. Others		
Geotextile mat	sq.m.	12.00
Gabion Mattress (3.0m x 1.2m x 0.5m)	pc.	120.00
P.V.C. Pipe 50mm dia.	m	4.50
Gas Pipe 50mm dia.	m	
Vinyl sheet	sq.m.	

NOTE :

Source: Department of Statistics, Department of Public Works, Department of Irrigation and Drainage and Private Contractors

Price level: November,1992

Table 7.2-6 LABOUR WAGES

Description	Daily Rate (RM)
1. Foreman	70
2. Operator for Dredger	60
3. Operator for Equipment	50
4. Assistant Operator	45
5. Dredging Crew	45
6. Driver	35
7. Mechanic	50
8. Electrician	50
9. Welder	45
10. Carpenter	45
11. Concrete Mason	45
12. Mason	40
13. Steel worker	45
14. Skilled laborer	45
15. Common laborer	30
16. Plumber	45
17. Rigger	50
18. Blaster	50
19. Surveyor	55
20. Diver	60

Note:
1) Labourer's daily rate includes living allowance, leaves, bonus, medical care and others.
2) Assuming 8 working hours per day.
3) Price level : November 1992

Table 7.2-7 BASIC RENTAL RATES OF CONSTRUCTION EQUIPMENT

Equipment and Barges	Capacity	Economic Life (year)	Daily Rate (RM)	Operation Time (hour)
1. Bulldozer	11 ton	6	400	8
2. Bulldozer	15 ton	6	500	8
3. Bulldozer	21 ton	6	650	8
4. Swamp Bulldozer	16 ton	6	600	8
5 Hydraulic Backhoe	0.60 m3	5	300	8
6. Clamshell	0.60 m3	5	250	8
7. Dump Truck	8 ton	5	300	8
8. Dump Truck	11 ton	5	350	8
9. Crawler Crane	16 ton	7	400	8
10. Crawler Crane	25 ton	7	480	8
11. Crawler Crane	35 ton	7	600	8
12. Truck Mounted Crane	16 ton	8	350	8
13. Tractor Shovel	1.8 m3	6	300	8
14. Wheel Loader	0.6 m3	6	350	8
15. Wheel Loader	0.8 m3	6	400	8
16. Motor Grader	3.1 m	5	400	8
17. Road Roller	8 ton	8	350	8
18. Diesel Hammer	4.5 ton	5	350	8
19. Water Truck	3000 lit.	8	150	8
20. Concrete Mixer	0.6 m3	5	150	8
21. Concrete Bagger Mixer		5	90	8
22. Concrete Vibrater	4PS	5	80	8
23. Vibrating Roller	3 ton	5	220	8
24. Water Pump	d=200mm	6	120	8
25. Air Compressor	5 m3/min.	5	300	8
26 Cutter Suction Dredger A	1350 HP	9	12,000	14
27. Cutter Suction Dredger B (Watermaster)	162 HP	10	1,300	14
28. Anchor Boat A	3 ton	13	800	11
29. Anchor Boat B	5 ton	13	1,000	11
30. Pontoon Barge A	20 ton	14	100	8
31. Pontoon Barge B	100 ton	14	300	8
32. Tug Boat A	100 PS	16	600	11
33. Tug Boat B	200 PS	16	1,000	11
34. Crane Barge	25 ton	10	1,200	8
35. Discharge Pipe L= 6.0m	d=400mm	4	10	
36. Float L=4.5m	d=900mm	4	20	
37. Grab Dredger	2.0 m3	9	3,600	11
38. Soil Hauling Barge	60 m3	13	600	11

Table 7.2-8 SUMMARY OF UNIT CONSTRUCTION COST

	Work Item	Unit	Calculated Unit Cost (RM)
1.	Dredging by Grab (Clamshell) Dredger for Muddy Soil (Average Hauling Dis. 3.0 km)	cu.m.	8.50
	- for Outer Channel (Hauling dis. = 2.0 km)	cu.m.	7.60
	- for Inner Channel (Hauling dis. = 3.5 km)	cu.m.	9.50
2.	Dredging by Cutter Suction Dredger for Loose Sand (Average Hauling Dis. 600 m)	cu.m.	6.44
3.	Dredging by Breaker and Grab Dredger for Soft Rock	cu.m.	20.00
4.	Excavation for Structure	cu.m.	3.68
5.	Embankment for Bund (Using excavated material nearby Bund)	cu.m.	3.08
6.	Embankment by Using Borrow Pit Material	cu.m.	16.36
7.	Clearing and Grubbing	sq.m.	0.78
8.	Sodding	sq.m.	5.51
9.	Gravel Pavement	sq.m.	4.63
10.	Stone Masonry with Concrete	cu.m.	137.04
11.	Supply,Delivery and Placing Gabion mattress (1.5m x 1.2m x 0.5m)	sq.m.	58.81
12.	Supply,Delivery and Placing Geo-textile Mat	sq.m.	29.34
13.	Concrete without Reinforcing Bar	cu.m.	195.00
14.	Supply,Delivery and Placing Rock/Stone		
	1) Armor Stone 1 , 3 - 5 ton	cu.m.	87.94
	2) Armor Stone 2 , 1 - 3 ton	cu.m.	84.79
	3) Secondary Stone , 300 - 500 kg	cu.m.	63.48
	4) Core Stone 1 , 100 - 300 kg	cu.m.	60.10
	5) Core Stone 2 , 10 - 100 kg	cu.m.	55.31
15.	Wooden Works for Jetty	ea.	16,200
16.	Bank protection for River Mouth Reservoir	m	10.00

NOTE:

1) Unit costs are composed of direct cost and indirect cost. Direct cost includes material, labor and equipment costs, and indirect cost covers overhead contingencies, miscellaneous and profit of the contractor.
2) Unit cost of dredging does not include spoil bank treatment cost.
3) Assumed that rock materials are locally available (within 30 km).
4) Price level is based on the late 1992.

Table 7.2-9 DREDGING CAPACITY OF GRAB (CLAMSHELL) DREDGER

Hourly Dredging Capacity : q (m3/hour)

Soil Property		S.P.T	Standard	Capacity of Backet										
Clasification	Condition	N-value	Change Factor	m3 0.8	m3 1.2	m3 2.0	m3 3.0	m3 4.0	m3 6.0	m3 8.0	m3 10.0	m3 13.0	m3 16.0	m3 20.0
Cohesive Soil	Muddy	N < 4	1.00	41.7	60.0	100.8	152.3	216.0	304.9	384.0	454.7	557.1	654.5	750.0
	Soft	4 – 10	0.95	37.7	54.2	91.2	131.5	171.0	241.4	319.2	396.0	486.9	572.1	655.5
	Median	10 – 20	0.90	26.3	37.8	69.1	99.7	129.6	205.8	273.6	341.1	421.2	518.4	594.0
	Hard	20 – 30	0.85	–	–	53.0	76.5	99.5	151.2	217.6	273.8	341.0	422.8	484.5
Sandy Soil	Soft	N < 10	0.90	30.1	43.2	73.4	118.4	153.9	217.3	288.0	358.1	441.3	518.4	594.0
	Median	10 – 20	0.85	23.1	33.2	61.2	88.3	114.8	162.0	217.6	289.9	359.9	445.1	510.0
	Hard	20 – 30	0.80	–	24.0	46.1	66.5	86.4	122.0	166.4	212.2	267.4	335.1	384.0
Clay with stones	Soft	N < 30	0.85	–	–	24.5	41.2	61.2	97.2	136.0	177.2	227.3	267.1	306.0
Sand with Stones	Soft	N < 30	0.85	–	–	28.6	47.1	68.9	108.0	149.6	193.3	246.3	289.3	331.5
Sand with Stones	Loose		0.90	33.8	48.6	82.1	118.4	153.9	217.3	273.6	–	–	–	–
	Hard		0.75	–	–	36.0	57.1	81.0	133.4	192.0	–	–	–	–

Daily Dredging Capacity (Q)

Q = q * E * n * T

q : Hourly Dredging Capacity (m3/hr.)
E : Site Condition Factor (0.95 – 0.60)
n : Rate of Actual Working Hour (0.85 – 0.70)
T : Operation Hour of Dredger per Day (hour)

Table 7.2-10 PROJECT COST OF TG. PIANDANG RIVER MOUTH IMPROVEMENT

Work Items	Unit	Quantit	Unit Cost (RM)	Total (RM)
I. Main Construction				1,471,000
1. Preparatory Works (10% of Main & Miscel. Works including Mobilization/Demobil.)	l.s.	1		134,000
2. Main Works				1,215,000
(1) Navigation channel Dredging				
1) Dredging for Muddy Soil (Outer)	cu.m.	56,500	7.60	429,000
2) Dredging for Muddy Soil (Inner)	cu.m.	58,900	9.50	560,000
3) Lighting Equipment and others	l.s.	1	70,000	70,000
(2) Jetty Works for Fishing Boat				
1) Clearing and Grubbing	sq.m.	2,000	0.78	2,000
2) Filling (Using Job Site Materials)	cu.m	300	3.08	1,000
3) Embankment(Using Borrow Pit Materials)	cu.m	300	16.36	5,000
4) Gravel Pavement 20 cm thick	sq.m.	2,800	4.63	13,000
5) Wooden Works for Jetty	ea.	3	16,200	49,000
6) Jetty House	l.s.	1	18,000	18,000
(3) Bank Protection				
1) Stone Masonry (Using concrete)	cu.m	42	137.04	6,000
2) Gabion Mattress (3.0m x 1.2m x 0.5m)	sq.m.	1,050	58.81	62,000
3. Miscellaneous Works (10% of Main Works)	l.s.	1		122,000
II. Compensation	sq.m.	0		0
III. Engineering and Administration Cost (10 % of Main construction)	l.s.	1		147,000
IV. Physical Contingencies (10 % of (I + II + III))	l.s.	1		162,000
Sub - Total				1,780,000
V. Price Escalation				129,000
TOTAL				1,909,000

Note:
- All costs are expressed based on the price level of late 1992 and an annual escalation rate is assumed at 2.4%.
- Assuming that engineering services will commence in 1994 and construction will terminat in 1995.

Table 7.2-11 PROJECT COST OF MARANG RIVER MOUTH IMPROVEMENT

Work Items	Unit	Quantity	Unit Cost (RM)	Total (RM)
I. Main Construction				11,722,000
1. Preparatory Works (10% of Main & Misce. works including Mobilization and Demobilization of Dredger & Vessels)	l.s.	1	1,066,000	1,066,000
2. Main Works				10,149,000
(1) Breakwater				
1) Armor Stone 1 , 3 - 5 ton (Supply,Delivery and Placing Rock)	cu.m.	15,700	87.94	1,381,000
2) Secondary stone , 300 - 500 kg (Supply,Delivery and Placing Rock)	cu.m.	11,200	63.48	711,000
3) Core Stone 1 , 100 - 300 kg (Supply,Delivery and Placing Rock)	cu.m.	11,300	60.10	679,000
4) Supply, Delivery and Placing Geotextile Mat	sq.m.	2,200	29.34	65,000
(2) North Jetty				
1) Armor Stone 2 , 1 - 3 ton (Supply,Delivery and Placing Rock)	cu.m.	19,600	84.79	1,662,000
2) Core Stone 2 , 10 - 100 kg (Supply,Delivery and Placing Rock)	cu.m.	18,800	55.31	1,040,000
3) Supply, Delivery and Placing Geotextile Mat	sq.m.	2,450	29.34	72,000
(3) South Jetty				
1) Armor Stone 2 , 1 - 3 ton (Supply,Delivery and Placing Rock)	cu.m.	12,600	84.79	1,068,000
2) Core Stone 2 , 10 - 100 kg (Supply,Delivery and Placing Rock)	cu.m.	10,900	55.31	603,000
3) Supply ,Delivery and Placing Geotextile Mat	sq.m.	2,250	29.34	66,000
(4) Coastal Groin				
1) Armor Stone 2 , 1 - 3 ton	cu.m.	9,900	84.79	839,000
2) Core Stone , 10 - 100 kg	cu.m	7,800	55.31	431,000
(5) River Groin				
1) Armor Stone 2 , 1 - 3 ton	cu.m.	1,840	84.79	156,000
2) Core Stone , 10 - 100 kg	cu.m.	720	55.31	40,000
(6) Navigation channel Work				
1) Dredging for Loose Sand	cu.m.	109,000	6.44	702,000
2) Dredging for Soft Rock	cu.m.	22,000	20.00	440,000
3) Pipe Line Setting	l.s.	1	133,000	133,000
4) Spoil Bank Treatment	l.s.	1	20,000	20,000
(7) Reservoir	m	4,100	10.00	41,000
3. Miscellaneous Works (5% of Main Works)	l.s.	1		507,000
II. Compensation	sq.m.	0	-	0
III. Engineering and Administration Cost (10 % of Main Construction)	l.s.	1	1,172,000	1,172,000
IV. Contingencies (10 % of I + II + III)	l.s.	1	1,289,000	1,289,000
Sub-Total				14,183,000
V. Price Escalation				1,183,000
TOTAL				15,366,000

Table 7.2-12 ANNUAL DISBURSEMENT SCHEDULE OF MARANG RIVER MOUTH IMPROVEMENT PROJECT

Unit : RM

Description	Amount	First Year (1994)	Second Year (1995)	Third Year (1996)
I. Main Construction	11,722,000	-	6,753,000	4,969,000
1. Preparatory Works	1,066,000	-	614,000	452,000
2. Breakwater				
Armor Stone 1	1,381,000	-	1,381,000	-
Armor Stone 2	0	-	0	-
Secondary Stone	711,000	-	711,000	-
Core Stone 1	679,000	-	679,000	-
Geotextile	65,000	-	65,000	-
3. North Jetty				
Armor Stone 2	1,662,000	-	1,662,000	-
Core Stone 2	1,040,000	-	1,040,000	-
Geotextile	72,000	-	72,000	-
4. South Jetty				
Armor Stone 2	1,068,000	-	-	1,068,000
Core Stone 2	603,000	-	-	603,000
Geotextile	66,000	-	-	66,000
5. Coastal Groin				
Armor Stone 2	839,000	-	-	839,000
Core Stone 2	431,000	-	-	431,000
6. River Groin				
Armor Stone 2	156,000	-	156,000	-
Core Stone 2	40,000	-	40,000	-
7. Navigation Channel Work				
Dredging (Sand)	702,000	-	-	702,000
Dredging (Soft Rock)	440,000	-	-	440,000
Pipe Line Setting	133,000	-	-	133,000
Spoil Bank Treatment	20,000	-	-	20,000
8. Reservoir	41,000		41,000	
9. Miscellaneous Works	507,000	-	292,000	215,000
II. Compensation	-	-	-	-
III. Engineering and Administration Cost	1,172,000	469,000	387,000	316,000
IV. Physical Contingencies	1,289,000	47,000	714,000	529,000
Sub-Total	14,183,000	516,000	7,854,000	5,814,000
V. Price Contingencies	1,183,000	25,000	579,000	579,000
TOTAL	15,366,000	541,000	8,433,000	6,393,000

Note:

(1) All costs are expressed at on the price level of late 1992 and an annual escalation rate is assumed at 2.4%.

(2) Annually recurrent O & M cost after the year 1997 is estimated to be RM 227,000 including administration cost of RM 21,000.

Table 7.2-13 ANNUAL DISBURSEMENT SCHEDULE OF MARANG RIVER MOUTH IMPROVEMENT PROJECT
(Case 2 : Phased dredging 20 GRT, 30 GRT, 40 GRT) Unit : RM

Description	Amount	Firat Year (1994)	Second Year (1995)	Third Year (1996)	(2000)	(2005)
I. Main Construction	12,127,000	-	6,706,000	4,235,000	593,000	593,000
1. Preparatory Works	1,149,000	-	610,000	385,000	77,000	77,000
2. Breakwater						
Armor Stone 1	1,381,000	-	1,381,000	-	-	-
Armor Stone 2	0	-	0	-	-	-
Secondary Stone	711,000	-	711,000	-	-	-
Core Stone 1	679,000	-	679,000	-	-	-
Geotextile	65,000	-	65,000	-	-	-
3. North Jetty						
Armor Stone 2	1,662,000	-	1,662,000	-	-	-
Core Stone 2	1,040,000	-	1,040,000	-	-	-
Geotextile	72,000	-	72,000	-	-	-
4. South Jetty						
Armor Stone 2	1,068,000	-	-	1,068,000	-	-
Core Stone 2	603,000	-	-	603,000	-	-
Geotextile	66,000	-	-	66,000	-	-
5. Coastal Groin						
Armor Stone 2	839,000	-	-	839,000	-	-
Core Stone 2	431,000	-	-	431,000	-	-
6. River Groin						
Armor Stone 2	156,000	-	156,000	-	-	-
Core Stone 2	40,000	-	40,000	-	-	-
7. Navigation Channel Work						
Dredging (Sand)	702,000	-	-	270,000	216,000	216,000
Dredging (Soft Rock)	440,000	-	-	196,000	122,000	122,000
Pipe Line Setting	399,000	-	-	133,000	133,000	133,000
Spoil Bank Treatment	60,000	-	-	20,000	20,000	20,000
8. Reservoir	41,000			41,000		
9. Miscellaneous Works	523,000	-	290,000	183,000	25,000	25,000
II. Compensation	-	-	-	-	-	-
III. Engineering and Administration Cost	1,213,000	485,000	400,000	328,000	52,000	52,000
IV. Physical Contingencies	1,334,000	49,000	711,000	456,000	65,000	65,000
Sub-Total	14,674,000	534,000	7,817,000	5,019,000	710,000	710,000
Price Contingencies	1,505,000	26,000	576,000	499,000	148,000	256,000
GRAND TOTAL	16,295,000	560,000	8,393,000	5,518,000	858,000	966,000

Note:

(1) All costs are expressed at the price level of late 1992 and annual escalation rate is assumed at 2.4%.

(2) Annually recurrent O & M cost for the year of 1997 to 1999, 2001 to 2004, and the years after 2006 are estimated at RM171,000, RM199,000 and RM227,000, respectively.

Table 7.2-14 ANNUAL CASH FLOW IN CASE 1 OF MARANG RIVER MOUTH IMPROVEMENT PROJECT

Unit : '000 RM

No.	Year	Economic Project Cost					Benefit			Annual Cash Flow
		Construction	Eng. & Admi.	Physical Conti.	Maintenance	Total	Fishery	Sea Trans.	Total	
1	1994		469.0	46.9		515.9				-515.9
2	1995	5,942.6	387.0	633.0		6,962.6				-6,962.6
3	1996	4,372.7	316.0	468.9		5,157.6				-5,157.6
4	1997		21.0	2.1	181.3	204.4	1,152.6	281.0	1,433.6	1,229.2
5	1998		21.0	2.1	181.3	204.4	1,186.4	286.0	1,472.4	1,268.0
6	1999		21.0	2.1	181.3	204.4	1,220.2	292.0	1,512.2	1,307.8
7	2000		21.0	2.1	181.3	204.4	1,254.0	298.0	1,552.0	1,347.6
8	2001		21.0	2.1	181.3	204.4	1,287.6	304.0	1,591.6	1,387.2
9	2002		21.0	2.1	181.3	204.4	1,321.2	310.0	1,631.2	1,426.8
10	2003		21.0	2.1	181.3	204.4	1,354.8	316.0	1,670.8	1,466.4
11	2004		21.0	2.1	181.3	204.4	1,388.4	322.0	1,710.4	1,506.0
12	2005		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
13	2006		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
14	2007		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
15	2008		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
16	2009		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
17	2010		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
18	2011		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
19	2012		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
20	2013		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
21	2014		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
22	2015		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
23	2016		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
24	2017		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
25	2018		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
26	2019		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
27	2020		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
28	2021		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
29	2022		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
30	2023		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
31	2024		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
32	2025		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
33	2026		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
34	2027		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
35	2028		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
36	2029		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
37	2030		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
38	2031		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
39	2032		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
40	2033		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6

Internal Rate of Return (IRR) = 10.4%

B/C (annual discount rate : 8%) = 1.24

Table 7.2-15 ANNUAL CASH FLOW IN CASE 2 OF MARANG RIVER MOUTH IMPROVEMENT PROJECT

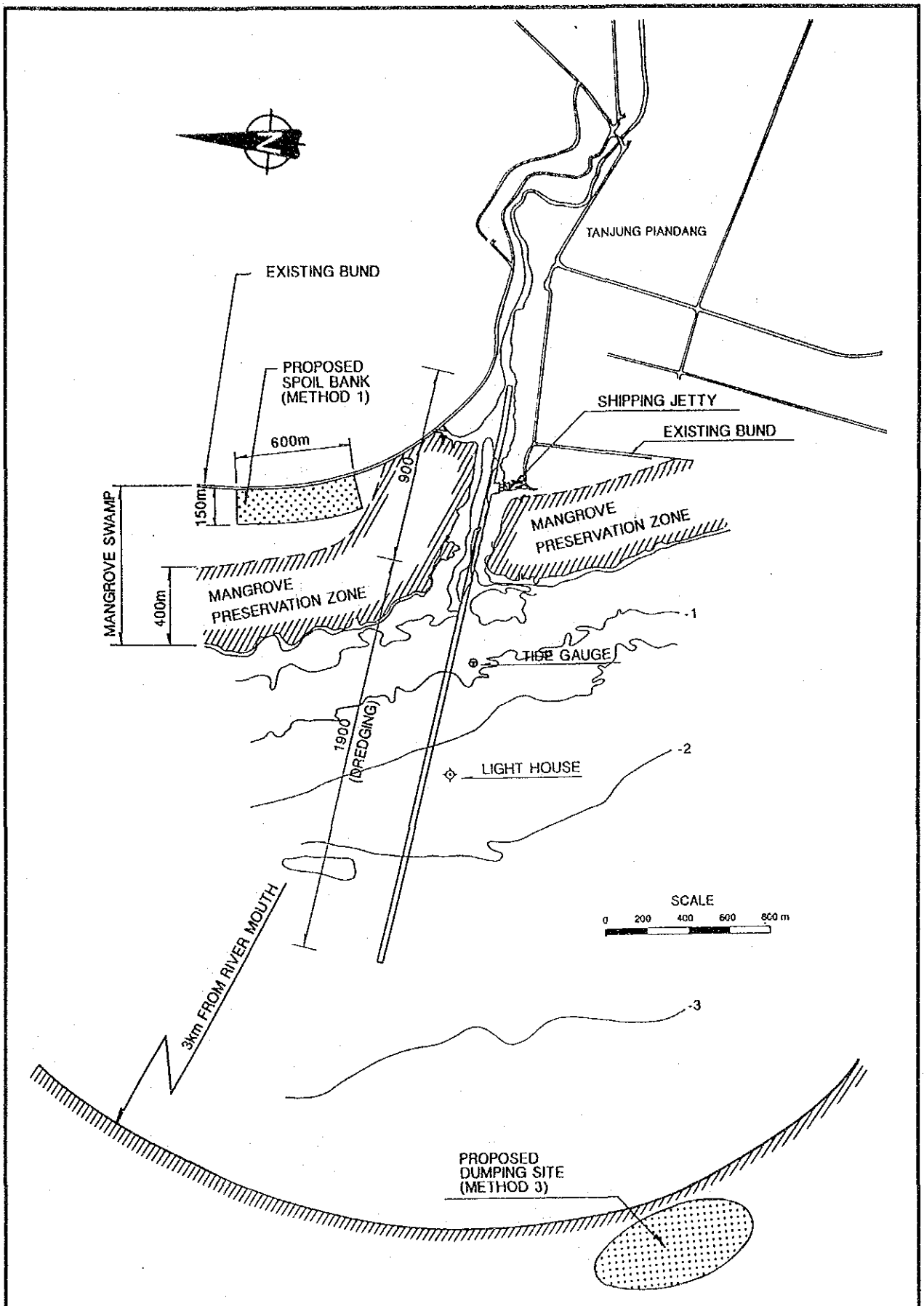
Unit : '000 RM

No.	Year	Economic Project Cost					Benefit			Annual Cash Flow
		Construction	Eng. & Admi.	Physical Conti.	Maintenance	Total	Fishery	Sea Trans.	Total	
1	1994		485.0	48.5		533.5				-533.5
2	1995	5,901.3	303.0	620.4		6,824.7				-6,824.7
3	1996	3,726.8	425.0	415.2		4,567.0				-4,567.0
4	1997		21.0	2.1	132.0	155.1	1,122.8	281.0	1,403.8	1,248.7
5	1998		21.0	2.1	132.0	155.1	1,149.2	286.0	1,435.2	1,280.1
6	1999		21.0	2.1	132.0	155.1	1,175.6	292.0	1,467.6	1,312.5
7	2000	521.8	73.0	59.5	132.0	786.3	1,202.0	298.0	1,500.0	713.7
8	2001		21.0	2.1	156.6	179.7	1,246.0	304.0	1,550.0	1,370.3
9	2002		21.0	2.1	156.6	179.7	1,290.0	310.0	1,600.0	1,420.3
10	2003		21.0	2.1	156.6	179.7	1,334.0	316.0	1,650.0	1,470.3
11	2004		21.0	2.1	156.6	179.7	1,378.0	322.0	1,700.0	1,520.3
12	2005	521.8	73.0	59.5	156.6	811.0	1,422.0	329.0	1,751.0	940.0
13	2006		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
14	2007		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
15	2008		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
16	2009		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
17	2010		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
18	2011		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
19	2012		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
20	2013		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
21	2014		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
22	2015		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
23	2016		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
24	2017		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
25	2018		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
26	2019		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
27	2020		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
28	2021		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
29	2022		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
30	2023		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
31	2024		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
32	2025		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
33	2026		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
34	2027		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
35	2028		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
36	2029		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
37	2030		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
38	2031		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
39	2032		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
40	2033		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6

Internal Rate of Return (IRR) = 10.4%

B/C (annual discount rate : 8%) = 1.24

FIGURES



THE NATIONAL RIVER MOUTHS STUDY IN MALAYSIA	PROPOSED DUMPING SITE OF DREDGED MATERIAL
JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. 7.2-1

Fig. 7.2-2 IMPLEMENTATION SCHEDULE FOR TG.PIANDANG RIVER MOUTH IMPROVEMENT PROJECT

Description	Unit	Quantity	First Year (1994)	Second Year (1995)	Third Year (1996)	After Third Year
Survey and Study		-				
Detailed Design		-				
Financing		-				
P/Q and Tendering		-				
Construction						
Mobilization	L.S.	1				
Preparatory Work	L.S.	1				
Capital Dredging	m3	115,400				
Bank Protection	L.S.	1				
Jetty Works	L.S.	1				
Maintenance Dredging	m3	55,400				

THE NATIONAL RIVER MOUTHS STUDY IN MALAYSIA

JAPAN INTERNATIONAL COOPERATION AGENCY

IMPLEMENTATION SCHEDULE FOR TG. PIANDANG RIVER MOUTH IMPROVEMENT PROJECT Fig. 7.2-2

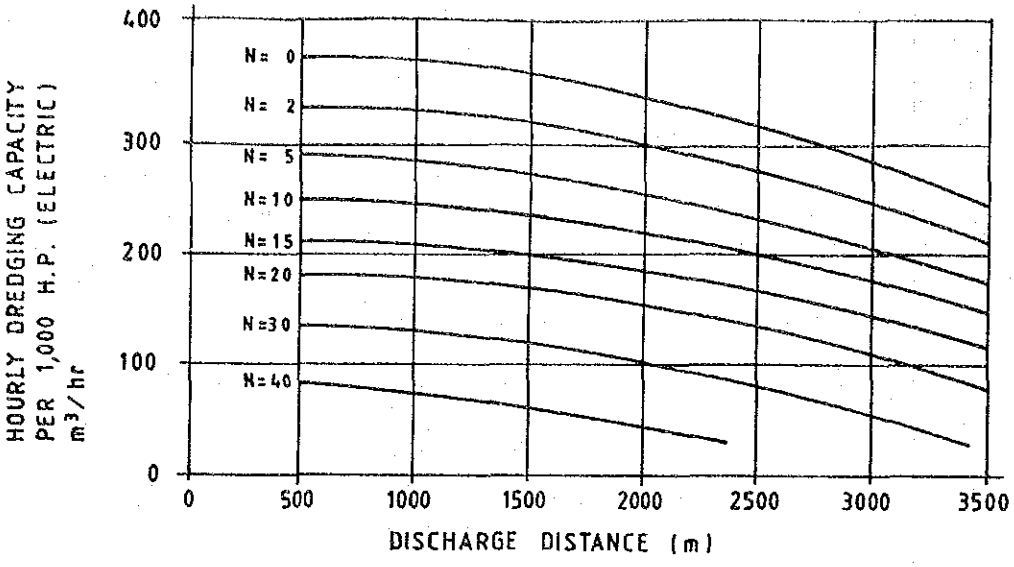
Fig. 7.2-3 IMPLEMENTATION SCHEDULE FOR MARANG RIVER MOUTH IMPROVEMENT PROJECT

Description	Unit	Quantity	First Year (1994)	Second Year (1995)	Third Year (1996)	Fourth Year (1997)	After Fourth Year (1998)
Survey and Study		-					
Detailed Design		-					
Financing		-					
P/Q and Tendering		-					
Construction							
Mobilization	L.S.	1					
Preparatory Work	L.S.	1					
North Jetty	m3	38,400					
South Jetty	m3	23,500					
Breakwater	m3	38,200					
Coastal Groin	m3	17,700					
River Groin	m3	2,560					
Reservoir	m	4,100					
Dredging (Sand)	m3	109,000					
Dredging (Soft rock)	m3	22,000					
Operation and Maintenance Works							

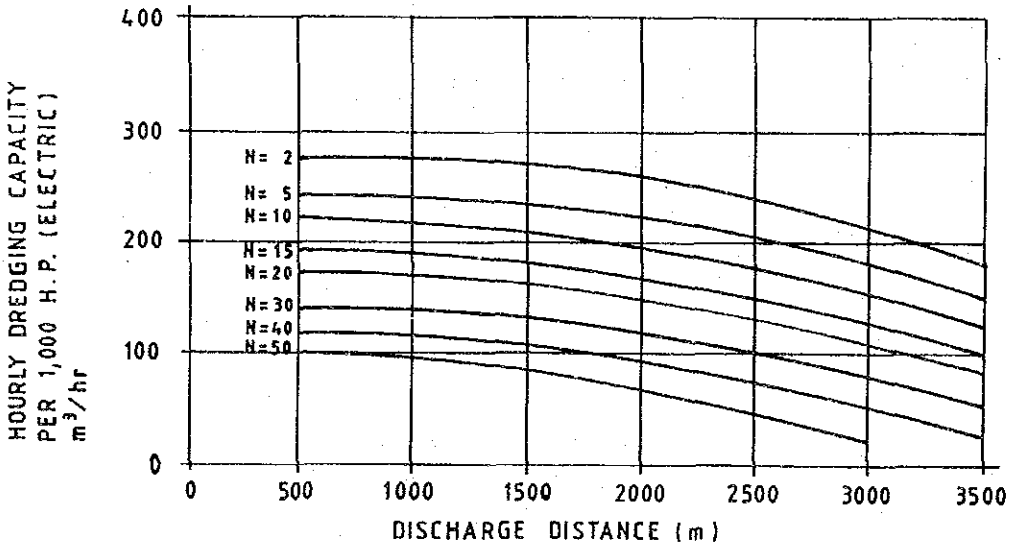
THE NATIONAL RIVER MOUTHS STUDY IN MALAYSIA
JAPAN INTERNATIONAL COOPERATION AGENCY

IMPLEMENTATION SCHEDULE FOR MARANG RIVER MOUTH IMPROVEMENT PROJECT
Fig. 7.2-3

CLAY AND CLAY SILT



SAND AND SANDY SILT



NOTE:

1. Power conversion is applied by the following ratio:

Electric	=	Specified horsepower	x	1.0
Diesel	=	Specified horsepower	x	0.8
Turbine	=	Specified horsepower	x	0.9

THE NATIONAL RIVER MOUTHS STUDY IN MALAYSIA	HOURLY DREDGING CAPACITY OF CUTTER SUCTION PUMP DREDGER Fig. 7.2-4
JAPAN INTERNATIONAL COOPERATION AGENCY	

IMPLEMENTATION SCHEDULE FOR MARANG RIVER MOUTH IMPROVEMENT PROJECT

(Case 2 : Phased dredging 20, 30, 40 GRT)

Description	Unit	Quantity	(1994)	(1995)	(1996)	(1997)	(1998)	(1999)	(2000)	(2001)	(2002)	(2003)	(2004)	(2005)
Survey and Study		-												
Detailed Design		-												
Financing		-												
P/Q and Tendering		-												
Construction														
Mobilization	L.S.	1												
Preparatory Work	L.S.	1												
North Jetty	m3	38,400												
South Jetty	m3	23,500												
Breakwater	m3	38,200												
Coastal Groin	m3	17,700												
River Groin	m3	2,560												
Reservoir	m	4,100												
Dredging (Sand)	m3	109,000												
Dredging (Soft rock)	m3	22,000												
Operation and Maintenance Works														

THE NATIONAL RIVER MOUTHS STUDY IN MALAYSIA

JAPAN INTERNATIONAL COOPERATION AGENCY

IMPLEMENTATION SCHEDULE FOR MARANG RIVER MOUTH IMPROVEMENT PROJECT (CASE 2: PHASED DREDGING 20, 30, 40 GRT) Fig. 7.2-5

8. PROJECT EVALUATION

THE NATIONAL RIVER MOUTHS STUDY
IN MALAYSIA

SUPPORTING REPORT NO. 8

PROJECT EVALUATION

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SUPPORTING REPORT NO. 8

PROJECT EVALUATION

1. INTRODUCTION

Numerous rivers and creeks exist in Malaysia which has a land of 329,750 km^2 in total area and a coastal line of 4,840 km in total length. River mouths have problems of siltation due to heavy sediment deposition from the upper streams coupled with longshore drift. This results in obstruction to the smooth navigation of ships and the reduction of flow area for river discharge during floods.

The National River Mouth Study has been carried out to formulate a Master Plan of river mouth improvement and to conduct a Feasibility Study for urgent projects selected out of the Master Plan.

The Master Plan Study covers 75 river mouths which are classified into 10 groups in accordance with physical characteristics. A representative river mouth is selected from each group considering the availability of data, seriousness of problems and others.

The Master Plan is formulated with the target year 2005. Detail studies were made for the representative river mouths and the study results were applied to other river mouths in the same group. Out of 75 river mouths, 35 river mouths which have more serious problems than others were selected for the formulation of First Phase Project. For the Master Plan First Phase Project, the Tg. Piandang and Marang river mouth improvement were economically evaluated through detail study on economic viability.

The Feasibility Study was carried out for Tanjung Piandang River Mouth in the West Coast and Marang River Mouth in the East Coast. Both of them are considered to be significant from the socio-economic viewpoint.

This sectoral report deals with basic study and analysis related to the benefit calculation, methodology of benefit calculation, economic viability and evaluation of each project.

2. BASIC STUDY AND ANALYSIS

Fishing boats exist at all the objective river mouths of this Study, and river mouth siltation causes enumerable economic losses to the fishing activities because the activities completely depend on tidal conditions. In other words, project benefit accrues mainly from the fishery sector when the project is implemented. In this context, the basic study and analysis focussed on the fishery, tidal condition and navigation of fishing boats.

2.1 Fishery in Malaysia

2.1.1 Registration of Fishing Boats

The registration of fishing boats in Malaysia started in 1978 under classification "A", "B", "C" and "C2" as defined by the type of gear, size of boat and fishing zone, as follows:

Class	Type of Gear	Boat Size (GRT)	Fishing Zone (nautical mile)
A	Traditional	---	less than 5
B	Commercial	less than 40	5 or more
C	Commercial	40.0 to 69.9	12 or more
C2	Commercial	70.0 or more	30 or more (deepsea)

Since Class "A" boats are not defined with boat size, they can be more than 70 GRT in case of anchovy purse seiners. Commercial gears consist mainly of trawl and purse seine. Trawl gear is towed on the sea bottom to catch fish in the trawling path, while purse seine net is shot in an encircling form around the school of fish. Both "C" and "C2" boats conduct fishing offshore, but deepsea fishing boats are also classified as "C2".

2.1.2 Number of Fishing Boats and Fishermen

Licensed fishing boats totalled 39,541 units in 1990, consisting of 24,015 inboard-powered boats (61%), 13,869 outboard-powered (35%) and 1,657 non-powered (4%), and by area, 16,994 (43%) in the West Coast of the Peninsula, 6,140 (16%) in its East Coast, 9,200 (23%) in Sabah, 7,066 (18%) in Sarawak and 141 in Labuan. The total number has slightly decreased by 1.1% compared with 1989. In the aspect of boat size, the bulk of fishing boats consists of small boats (less than 10 GRT), sharing 76% of the total, and the remaining consists of 20% for medium (10-39.9 GRT) and 4% for 40.0 GRT and above.

The number of persons engaged in marine fisheries amounted to 88,494 in 1990. The average number of fishermen per boat was 2.2 for Malaysia and 3.4 for the East Coast of the Peninsula, much exceeding the national average, while the 1.3 persons/boat in Sabah is lower than the average. Compared with the wholesale value of landings, the average product per capita is calculated at RM 22,155 per annum. Table 8.2-1 gives the number of fishing boats and fishermen by state in 1990.

Fishing boats at the 75 objective river mouths of the Master Plan Study are classified into GRT boat sizes of 4 categories: less than 10.0 GRT, 10.0 to 39.9 GRT, 40.0 to 69.9 GRT, and 70.0 GRT and above, which are referred to as "Small", "Medium", "Large" and "Deepsea", respectively. The number of these boats is given in Table 8.2-2.

2.1.3 Marine Fish Landing

Marine fish landings in Malaysia reached 951,307 tons in 1990 with an annual growth of 7.8% compared with 1989, to which the East Coast of the Peninsula much contributed with a growth of 20.1%. In the states of Sabah and Sarawak including Labuan, landings in 1990 resulted in negative growth (-3.1%) compared with 1989, especially those in Sarawak State which decreased by as much as 6.5% (refer to Table 8.2-3). The wholesale and retail values of marine landings in Malaysia for 1989 and 1990 are summarized as follows, and the average wholesale and retail prices in 1990 are calculated at RM 2,061/ton and RM 2,734/ton, respectively.

	Wholesale (million RM)	Retail (million RM)
1989	1,665.8	2,123.5
1990	1,960.6	2,601.5
Increase Rate	17.7%	22.5%

Major fishing gears licensed in Malaysia are trawl nets (pukat tunda) and purse seines (pukat jerut), sharing 61% and 14% of the total of marine fish landings, respectively. The annual average landing per boat and fisherman is estimated at 24.1 tons and 10.7 tons with the wholesale value of RM 49.600 and RM 22,200, respectively, as given in Table 8.2-4.

2.1.4 Unit Values on Fishery

Unit values required for benefit calculation have been examined with data from the Annual Fisheries Statistics in 1990, the answers to questionnaires with DOF, the results of interview survey with LKIM officials and fishermen concerned, as given in Table 8.2-5, covering the following items:

(a) Number of trips per year
(b) Fishing duration per trip
(c) Number of fishermen per boat
(d) Annual catch in RM per boat
(e) Boat running cost per hour
(f) Fish Refrigeration cost per hour
(g) Opportunity cost per fisherman per hour
(h) Fish value decrease ratio per hour

Average annual catch of each boat size is calculated from the data on fish landings and wholesale values of trawl and purse seine in the Peninsula which share 78% and 75%

of the total of Malaysia, respectively, as given in Table 8.2-6. Calculation of boat running cost per hour is presented in Table 8.2-7.

Fisherman's opportunity cost is calculated from the average wage (RM 2.0/hour) multiplied by the conversion factor to shadow wage (0.85). When fishermen miss the prime marketing time, they have to wait for the subsequent marketing time for a maximum of about 20 hours with value decrease of 10 to 20%. In this situation, the value decrease ratio of 1% per hour is applied for the quantification of preservation of fish quality.

2.2 Tidal Fluctuation and Unnavigable Duration

2.2.1 *Frequency Distribution of Tidal Level*

Tidal fluctuation is a key factor to estimate the unnavigable duration of sea vessels which is essential for benefit calculation, but this differs place by place. Hence, the tidal records of each tide station in 1990 have been studied to identify the features of tidal fluctuation. To estimate the unnavigable duration at the representative river mouths, the tidal records at the following stations were made as reference:

Station	Representative River Mouth
Pulau Langkawi	Perlis and Kedah
Kedah Pier	Tg. Piandang
Lumut	Beruas
Tg. Gelang	Kuantan and Kerteh
Chedering	Marang and Terengganu
Kota Kinabalu	Oya and Papar

The differences of frequency distribution of hourly tidal levels at these stations are presented in Fig. 8.2-1.

2.2.2 Boat Size and Required Water Depth

Fishing boats are grouped into four sizes: small (less than 10.0 GRT), medium (10.0 to 39.9 GRT), large (40.0 to 69.9 GRT) and deepsea (70.0 GRT and above). The number of small and medium size boats were figured out from the available data, while those for large and deepsea boats were estimated from the data on boats of more than 40.0 GRT by applying the distribution ratio in the state where the river mouth is located. The minimum water depth required by boats with the draft of 10, 40, 70 and 150 GRT to pass through a river mouth has been determined respectively as follows: 1.0 meter for small, 1.7 meters for medium, 2.2 meters for large, and 3.0 meters for deepsea boats.

2.2.3 Duration of Water Depth Affecting Navigation

Unnavigable hours are basically dependent on the accumulative percentage of the duration of water depth affecting navigation (Ap), which varies at each river mouth according to the following factors: the tidal fluctuation, the present riverbed or seabed height, the required water depth, or the boat size. The actual, average waiting time per day per boat is calculated by the formula [(Ap) x 24 hours x 50% x 50%], considering that the river mouth is used only in the daytime (50% of a day) and assuming that boats stay in the deep sea for normal fishing activities for about 50% of the duration affecting navigation at river mouths. Table 8.2-8 shows the unnavigable duration of fishing boats at the representative river mouths.

2.3 Navigation Survey

2.3.1 Tanjung Piandang River Mouth

The number of boats passing through Tg. Piandang River Mouth has been surveyed in a time range of 30 minutes from 0:00 to 24:00 in the classification of outboard engine, inboard engine (below 10 GRT; 10 GRT and above) fishing boats and tourist boats.

At Tg. Piandang, the survey was carried out together with the measurement of tidal levels for 8 days on June 30, July 2, 4, 14, 18, 21, 23, and 25, 1993, and the survey results showed that fishing efforts and the fishermen's livelihood are considerably

subject to tidal conditions. On the day of favorable tidal conditions, outgoing and incoming boats abound from the hours of 6:00 to 8:00 and 13:00 to 15:00, respectively, as shown in Table 8.2-9 and Fig. 8.2-2. Fishing can be made offshore for about 7 to 8 hours a day, which is equivalent to the average one-day trip duration of small fishing boats, and hence, catch amount possibly reaches the expected level.

In case that the low tide comes at 4:00 to 5:00, fishing boats delay their out-going time for one or two hours to wait for higher tide, and the outgoing boats abound around 8:00 with a very sharp peak as shown in Table 8.2-10 and Fig. 8.2-3. Boats densely return to the river mouth in three hours from 12:00 to 15:00 before the tidal level drops down. The fishermen are forced to reduce the fishing duration on this day, five or six fishing hours on an average, possibly resulting in insufficient catch.

On the day when the low tide comes around 8:00, the peak of outgoing boats appear three times a day; 5:00, 11:00 and 17:00, and accordingly the boat incoming time varies widely from 12:00 to 17:00 and midnight as shown in Table 8.2-11 and Fig. 8.2-4. Although the fishing duration of about eight hours seems to be attained on this day, the low tide is the most unfavorable tidal condition from the viewpoint of fishermen's livelihood.

2.3.2 Marang River Mouth

The number of boats passing through Marang River Mouth has been surveyed in a time range of 30 minutes from 0:00 to 24:00 on June 16, 18 and 20, 1993 in the classification of outboard engine, inboard engine (below 10 GRT; 10 GRT and above) fishing boats and tourist boats. The survey was attempted again on November 2 and 3, 1993, but no fishing and tourist boats were allowed to navigate on those dates because of high waves caused by the monsoon.

According to the three-day survey results, outgoing and incoming fishing boats abound from the hours of 17:00 to 19:00 and from 6:00 to 8:00, respectively. On the survey dates, catching of squid was briskly carried out offshore at midnight.

The observed tidal levels on the same days at the Chedering Port located about 8 km north of Marang show that peaks of high tide appear from 8:00 to 10:00 and the tidal

level rapidly drops down after 19:00. It seems that the outgoing fishing boats attempted to avoid the tidal drop-down, as shown in Table 8.2-12 and Fig. 8.2-5.

The tourist boats provide ferry service (60 to 70 trips/day) mainly between Marang and Kapas Island in the day time. The service hours were from 8:00 to 19:00 under the favorable tidal conditions on the days of the survey.

According to the LKIM officials at the Marang river mouth, both fishing and tourist boats are seriously affected by tidal conditions. They often change the outgoing or incoming time so as to pass the river mouth safely while adequate water depth is ensured.

3. METHODOLOGY OF BENEFIT CALCULATION

3.1 General

River mouth treatment works are proposed to solve existing problems such as the inconvenience to navigation of sea-going vessels and the flooding in the vicinity of river mouths that could cause economic losses. Here, project benefit is defined as the difference between "without-the-project" and "with-the-project" situations, and can be categorized broadly into two: "tangible" and "intangible" benefits.

In this study, tangible benefits may accrue in the areas of fishery, sea transport and flood mitigation. It has been verified from the site investigation, interview-survey and basic analysis that the fishery benefit is dominant and common to all the objective river mouths of the master plan, while the other benefits are expected at only a limited number of river mouths.

Intangible benefits, though unquantifiable, include favorable effects in social and environmental aspects such as the enhancement of safety to navigation, the stabilization of living standards of fishermen and residents in the flood-prone areas and so on.

The without-the-project situation generally denotes the existing condition, but the following definitions are given to this master plan study on the 75 objective river mouths.

(1) For river mouths where no countermeasure for the problems has been undertaken, the present condition is considered as the without-the-project situation.

(2) In case that dredging works have been carried out at a river mouth, the previous condition without dredging is presumed to be the without-the-project situation, because the effects of dredging remain for only one or two years.

(3) The without-the-project situation at river mouths with other related projects under construction is the improved condition after those related projects are completed.

3.2 Fishery Benefit

Fishery benefit is brought about through the improvement of fishing activities which depend on the smooth and safe navigation of fishing boats. As discussed in Subsection 2.1.2, fishing boats are classified into four groups in terms of size (GRT); namely, small (less than 10 GRT), medium (10 to 39.9 GRT), large (40 to 69.9 GRT) and deepsea (70 GRT and above).

3.2.1 Small Size Fishing Boat (less than 10 GRT)

The major problem of small size fishing boats is the suspension of fishing activities with a catch lesser than the capacity so as to return to the port within a period of high tide or to wait for the high tide when they go out to sea. In both cases, river mouth siltation causes reduction of fishing duration resulting in lesser fish catch. In this context, the benefit for small boats is defined as the increase of fish catch which is calculated proportionately with the extension of fishing effort duration, although incremental boat running cost and refrigeration cost should be subtracted from the incremental catch amount; i.e., [(increase of catch (Ic)] - [(incremental running

cost (Ir)] + [incremental refrigeration cost (If)], which are calculated by the following formulae:

Ic = [annual catch] x [(average trip duration + unnavigable hours) /(average trip duration) - 1]

Ir = [running cost per hour] x [unnavigable hours per trip] x [no. of trips per year]

If = [refrigeration cost per hour] x [unnavigable hours per trip] x [no. of trips per year]

The unit values necessary for the calculation were obtained as mentioned in Subsection 2.1.4, and those on the small fishing boats are as follows:

No. of Trips per Year	:	265
Duration per Trip (hrs.)	:	8
Annual Catch (RM)	:	20,000
Boat Running Cost (RM/hr.)	:	0.97
Refrigeration Cost (RM/hr.)	:	0.20

The annual benefit per small fishing boat, depending on the unnavigable hours (Uh), can be calculated as follows: RM 20,000 x [(8+Uh)hrs./8hrs. - 1] - [RM 0.97/hr. x Uh hrs./trip x 265 trips + RM 0.20/hr. x Uh hrs./trip x 265 trips], and it makes RM 2,190 per hour/boat.

3.2.2 Medium Size Fishing Boat (10.0 to 39.9 GRT)

Medium size fishing boats are supposed to keep on fishing until they gain a full catch, and the problem is the wasted time waiting for the tide level to rise. The benefits may accrue in the areas of:

(a) Savings on fishermen's opportunity cost;

(b) Savings on fish refrigeration cost; and

(c) Preservation of fish quality.

Unit values necessary for the benefit calculation of the medium size fishing boats are as follows.

Number of Trips per Year	:	266
No. of Fishermen per Boat	:	4
Annual Catch (RM)	:	101,000
Refrigeration Cost (RM/hr.)	:	1.20
Fisherman's Opportunity Cost (RM/hr.)	:	1.7
Value Decrease Ratio per Hour	:	0.01

Annual savings on fishermen's opportunity cost per boat can be calculated by the formula [(no. of trips) x (no. of fishermen) x (unnavigable hours (Uh)) x (opportunity cost)]; i.e., 266 trips/boat x 4 persons/boat x (Uh) hours/trip x RM 1.7/hour/person, and it makes RM 1,808.8 per hour/boat.

Annual savings on refrigeration cost is obtained from the formula [(no. of trips) x (unnavigable hours (Uh)) x (unit cooling cost)]; i.e., 266 trips/boat x (Uh) hours/trip x RM 1.20/hour, and it makes RM 319.2 per hour/boat.

Preservation of fish quality is quantified by the formula [(annual catch) x (unnavigable hours (Uh)) x (value decrease ratio)]; i.e., RM 101,000/boat x (Uh) hours/boat x 0.01/hour, and it makes RM 1,010 per hour/boat. The annual benefit per boat is the total of these values; namely, RM (1,808.8 + 319.2 + 1,010) = RM 3,138 per hour/boat.

3.2.3 Large Size Fishing Boat (40.0 to 69.9 GRT)

Large size fishing boats have the same problem as the medium size boats. The benefits are thus expected in the areas of:

(a) Savings on fishermen's opportunity cost;
(b) Savings on fish refrigeration cost; and
(c) Preservation of fish quality.

The annual benefit for large fishing boats is calculated in the same methodology and conditions as the medium size boats, as discussed above. The unit values necessary for the calculation are as follows:

No. of Trips per Year	:	92
No. of Fishermen per Boat	:	9
Annual Catch (RM)	:	399,000
Refrigeration Cost (RM/hr.)	:	5.26
Fisherman's Opportunity Cost (RM/hr.)	:	1.7
Value Decrease Ratio per Hour	:	0.01

The annual benefits of the above three categories are calculated at RM 1,407.6, RM 483.9 and RM 3,990 per hour/boat, respectively, totaling RM 5,882 per hour/boat.

3.2.4 Deepsea Fishing Boat (70 GRT and above)

Deepsea fishing boats are also supposed to continue fishing until full catch regardless of tidal conditions, and assumed to divert to other ports with additional time and costs when they come across low tide. The benefits for deepsea fishing boats thus include:

(a) Savings on running cost;
(b) Savings on fishermen's opportunity cost;
(c) Savings on fish refrigeration cost; and
(d) Preservation of fish quality.

The beneficial items are similar to those of medium and large boats, but benefit calculation is based on the additional time, which should be less than the waiting time for high tide. (It would be much better to wait for high tide if they spend more time to divert than the waiting time.) The additional time is assumed to be 80% of the unnavigable duration at the river mouth. The unit values necessary for the calculation are as follows:

No. of Trips per Year	:	18
No. of Fishermen per Boat	:	15
Annual Catch (RM)	:	363,000
Refrigeration Cost (RM/hr.)	:	73.82
Running Cost (RM/hr.)	:	23.19
Fisherman's Opportunity Cost (RM/hr.)	:	1.7
Value Decrease Ratio per Hour	:	0.01

Under the without-the-project situation, additionally required is a running cost which is calculated by the formula [(no. of trips) x (80% of unnavigable hours (Ud)) x (running cost)]; i.e., 18 trips x (0.8Ud) hours/trip x RM 73.82/hour. It makes RM 1,063.0 per hour/boat, and this will be saved by the project.

Other benefits are calculated on the same methodology as the medium and large size boats, applying 80% of the unnavigable hours. The annual benefit for the other three categories are calculated at RM 367.2, RM 333.9 and RM 2,904.0 per hour/boat, respectively, totaling, together with the annual saving of running cost, RM 4,668 per hour/boat.

3.3 Sea Transport Benefit

Commercial boats include passenger ferry, cargo ferry and cargo boats which are available at Perlis, Kedah, Marang, Mersing and Terengganu, and river mouth siltation causes restriction on service hours. The sea transport benefit is therefore calculated in the same manner as the small fishing boats, but only at the river mouths where these services are available; i.e., the benefit at the representative river mouth will not be

applied to the other river mouths in the group. Details of calculation are summarized in Table 8.3-1, but discussed below are the calculation processes of sea transport benefit at Marang River Mouth as an example.

Tourist boats are available between Marang River Mouth and Kapas Island except the monsoon season. Small size fishing boats have been refitted into tourist boats with a maximum capacity of 12 passengers. Navigation survey was carried out for three days in June 1993, and it shows that about 60 round trips are available daily on an average.

Annual sales are estimated at RM 5,832,000, calculated by the formula [RM 30/passenger x 12 passengers/trip x 60 trips/day x 30 days/month x 9 months]. Assuming that 60% of direct costs are included, the net annual product is RM 2,332,800 (i.e., RM 5,832,000 x 40%).

The operation of tourist boats is affected by low tide, similar to fishing boats. Under the present conditions, these boats have unnavigable hours at the river mouth with a probability of about 10% on average, and the net annual product increases to RM 2,592,000 (RM 2,332,800 x 1/90%) under the with-the-project situation. Hence, the annual benefit is calculated at RM 259,200 (i.e., RM 2,592,000 - RM 2,332,800). The benefit is assumed to increase until 2005 at the annual growth rate of 2%, considering the estimated annual population growth rate from 1990 to 2000 in the Peninsula.

3.4 Flood Control Benefit

Flood control benefit is defined as the reduction of potential flood losses attributed to the designed works. The reduction is obtained as the difference between the estimated flood losses under the "with-" and the "without-the-project" situations.

Flood losses are in general calculated in the concept of [(unit value of property) x (quantity) x (damage rate)], which are applied for flooding conditions under several cases of flood probability. Annual average benefit is also calculated by the following formula:

$$B = \sum_{i=1}^{n} 1/2 \cdot [D(Q_r\text{-}1) + D(Q_i)] \cdot [P(Q_r\text{-}1) - P(Q_i)]$$

where;

B	:	annual average benefit
$D(Q_r\text{-}1)$, $D(Q_i)$	:	flood losses caused by flood with $Q_r\text{-}1$ and Q_i discharge, respectively.
$P(Q_r\text{-}1)$, $P(Q_i)$	:	probabilities of occurrence of $Q_r\text{-}1$ and Q_i discharges, respectively.
n	:	number of floods applied.

Among the representative river mouths, only the Terengganu River Mouth may suffer from flooding due to river mouth siltation. The flood-prone area has been fully developed as a residential area, so that future increase of benefit is disregarded.

4. MASTER PLAN STUDY

4.1 Benefits of Representative River Mouth

Annual benefits of the 10 representative river mouths (Perlis, Kedah, Tg. Piandang, Beruas, Kuantan, Kerteh, Marang, Terengganu, Oya and Papar) have been individually calculated in line with the concepts and methodology described in Section 3.

4.1.1 Perlis River Mouth

The Kuala Perlis Port located at the Perlis River Mouth is the largest fishing port in Perlis State with a total of 432 fishing boats registered. It is also used briskly for sea transport including passenger and cargo ferries, and the number of ferry passengers to Langkawi Island has reached as much as 1,382,000 in 1991. Flooding problems in the vicinity of the river mouth have not been reported. Benefits are, therefore, expected in the areas of fishery and sea transport.

The without-the-project situation is assumed, as discussed in Subsection 3.1, to be the previous, inherent condition without the dredging works being carried out in almost every year to assure stable navigation.

The annual fishery benefit at the Perlis River Mouth is RM 6.61 million, including RM 1.02 million for small, RM 3.19 million for medium, RM 1.56 million for large and RM 0.84 million for deepsea fishing boats, as presented in Table 8.4-1.

Ferry service to Langkawi Island is available through 11 passenger boats with an average of 150 GRt, and the number of trips in 1991 was recorded at about 5,500. As for cargo ferries, about 580 trips were reported in the same year. The annual benefit in the area of sea transport, calculated in the same manner as the fishery, amounts to RM 1.28 million, as given in Table 8.3-1.

The annual average benefit therefore amounts to RM 7.88 million under the present conditions, as shown in Table 8.4-2.

4.1.2 Kedah River Mouth

The Kedah River Mouth is used for fishery with a total of 536 fishing boats registered, and also for sea transport including passenger and cargo ferries. As in the Perlis River Mouth, ferry service is available between Langkawi Island and the Kedah River Mouth with about 190,000 passengers a year, and about 1,500 cargo vessels anchor at the Kedah Port. Flooding problems in the vicinity of the river mouth have not been reported. Benefits are therefore expected in the areas of fishery and sea transport.

As discussed in Subsection 3.1, the without-the-project situation is assumed to be the previous, inherent conditions without dredging works which are being carried out almost every year to assure stable navigation. The design boat size, one of the crucial conditions for the benefit calculation, is determined at 150 GRT for the Kedah River Mouth.

The annual fishery benefit at the Kedah River Mouth is RM 6.86 million, including RM 0.53 million for small, RM 3.04 million for medium, RM 2.13 million for large and RM 1.17 million for deepsea fishing boats, as presented in Table 8.4-1.

Ferry service to Langkawi Island is available through 10 passenger boats of 150 GRT on an average, and the number of trips in 1991 was recorded at about 1,870. As for cargo ferries, medium and large sized vessels are using the port with annual trips numbering about 670 and 840, respectively. The annual benefit in the area of sea transport amounts to RM 1.52 million, as given in Table 8.3-1.

The annual average benefit therefore totals RM 8.38 million under the present conditions, as shown in Table 8.4-2.

4.1.3 Tanjung Piandang River Mouth

The Tanjung Piandang River Mouth has a number of fishing boats (485 in total), although most of them are small in size and a few commercial boats are observed. No flooding problem due to river mouth siltation has been reported. Benefits are therefore expected to accrue from the fishery.

At the Tanjung Piandang River Mouth exist 480 small size (less than 10 GRT) and 5 medium size (10.0 to 39.9 GRT) boats. The annual benefit is RM 0.96 million, as given in Table 8.4-1.

4.1.4 Beruas River Mouth

Benefits at the Beruas River Mouth will accrue only in the area of fishery, since the mouth is used exclusively for fishery with a total of 653 fishing boats registered, and no flooding problem has been reported.

At the Beruas River Mouth exist 283 small size (less than 10 GRT), 357 medium size (10.0 to 39.9 GRT), 10 large size (40 to 69.9 GRT) and 3 deepsea (70 GRT and above) boats. The annual benefit is RM 2.27 million, as given in Table 8.4-1.

4.1.5 Kuantan River Mouth

Benefits at the Kuantan River Mouth will accrue only from the fishing activities of the 163 boats registered. Commercial boats anchor at the Kuantan Port located at Tg. Gelang 25 km north of the river mouth, so that no sea transport benefit is expected and the vicinity of the river mouth is not vulnerable to flooding.

At the Kuantan River Mouth exist 1 small size (less than 10 GRT), 38 medium size (10.0 to 39.9 GRT), 61 large size (40.0 to 69.9 GRT) and 63 deepsea fishing (70 GRT and above) boats. The annual benefit is RM 2.66 million, as given in Table 8.4-1.

4.1.6 Kerteh River Mouth

The Kerteh River Mouth is used as a fishing port for 51 small size boats. No particular sea transport services has been observed, although the industrial estate of Petronas has been developed about 10 km upstream of the river mouth. The vicinity of the river mouth is not vulnerable to flooding. In this context, only the fishery benefit is expected at the Kerteh River Mouth.

At the Kerteh River Mouth exist 44 small size (less than 10 GRT) and 7 medium size (10.0 to 39.9 GRT)boats. The annual benefit is RM 0.23 million, as given in Table 8.4-1.

4.1.7 Marang River Mouth

The Marang River Mouth is used for fishery with a total of 187 fishing boats registered, and also for passenger ferry to Pulau Kapas. No flooding problem in the vicinity of the river mouth has been reported. Benefits are therefore expected in the areas of fishery and sea transport.

At the Marang River Mouth exist 139 small size (less than 10 GRT) and 48 medium size (10.0 to 39.9 GRT) boats. The annual benefit is RM 1.46 million, as given in Table 8.4-1.

Ferry service to Kapas Island is available through 16 passenger boats of about 40 GRT, and the number of trips per annum is estimated at about 10,800. The annual benefit in the area of sea transport amounts to RM 0.23 million, as given in Table 8.3-1.

The annual average benefit therefore totals RM 1.69 million under present conditions, as shown in Table 8.4-2.

4.1.8 Terengganu River Mouth

A number of fishing and commercial boats are utilizing the Terengganu River Mouth where the capital city of Terengganu State is located. Of the representative river mouths, only the Terengganu River Mouth is vulnerable to flooding. Benefits are therefore expected in the areas of fishery, sea transport and flood mitigation.

At the Terengganu River Mouth exist a total of 107 fishing boats, consisting of 38 small size (less than 10 GRT), 49 medium size (10.0 to 39.9 GRT), 10 large size (40.0 to 69.9 GRT) and 10 deepsea fishing (70 GRT and above) boats. The annual benefit is RM 0.26 million, as given in Table 8.4-1.

Large size vessels are using the port for international, home and local trades with an annual trip number of about 680. The annual benefit in the area of sea transport amounts to RM 0.75 million, as given in Table 8.3-1.

The Terengganu river channel has a flow capacity of 2,600 m^3/s near the river mouth, which corresponds to a 2.4-year return period flood. In other words, flood discharge of more than 2,600 m^3/s would cause flooding in the areas along the river course, but the possible maximum flood discharge (3.8-year return period) is estimated at 3,500 m^3/s because huge flood discharges overtop the river banks in the upper and middle reaches and do not reach the downstream.

The flood-prone area at the river mouth is estimated at 45 ha, and 530 houses could be possibly submerged. The value of properties including houses and their interior effects is estimated at RM 15.9 million (530 x RM 30,000). Losses caused by a 3.8-year return period flood are calculated at RM 477,000 by multiplying the damage rate of 3% with the value of properties. The annual average benefit of flood mitigation is RM 37,000, as given in the following table:

		Without Project	With Project
(a)	Loss by 2.4-yr flood ('000 RM)	0	0
(b)	Loss by 3.8-yr flood ('000 RM)	477	0
(c)	Reduction of loss by project ('000 RM)	-	477
(d)	Average reduction ('000 RM)	-	239
(e)	Expectation (1/2.4 - 1/3.8)	-	0.1535
(f)	Annual average benefit (d x e)	-	37

The annual average benefit therefore amounts to RM 1.05 million under present conditions, consisting of RM 0.26 million for fishery activities, RM 0.75 million for sea transport and RM 0.04 million for flood control, as shown in Table 8.4-2.

4.1.9 Oya River Mouth

The number of fishing boats registered at the Oya River Mouth is more than one hundred. The river mouth is used also for the transportation of timber, construction materials and other commodities, but the frequency is so limited that benefit from sea transport may be negligibly small. Flooding may not occur in the vicinity of the river mouth. Benefits are therefore expected to accrue only from the fishery.

At the Oya River Mouth exist a total of 104 fishing boats, consisting of 80 small size (less than 10 GRT), 22 medium size (10.0 to 39.9 GRT) and 2 large size (40.0 to 69.9 GRT) boats. There are no deepsea fishing boats. The annual benefit is RM 0.27 million, as given in Table 8.4-1.

4.1.10 Papar River Mouth

The number of fishing boats registered at the Papar River Mouth is more than one hundred, although all of them are less than 10 GRT, but the river mouth is not used briskly for sea transport. Flooding may not occur in the vicinity of the river mouth. Benefits are therefore expected to accrue only from the fishery.

At the Papar River Mouth exist 123 small size fishing boats (less than 10 GRT) and the annual benefit is RM 0.24 million, as given in Table 8.4-1.

4.2 Benefits of Objective River Mouth

Annual benefit for river mouths other than the representative river mouths is estimated, as presented in Table 8.4-3, based on the concepts and methods described as follows.

Fishery Benefit

Fishery benefit is basically subject to the existing minimum water depth and the number and size of fishing boats at each river mouth. The relationship between water depth and benefit per boat is obtained by the size of boats at the representative river mouth as shown in Fig. 8.4-1, and, in line with the grouping of the 75 objective river mouths, the annual benefit at the other river mouths is estimated by applying the existing minimum water depth to the above-said relationship of their representative river mouth, multiplying the number of boats by each boat size.

The fishing industry is assumed to augment by 2% per annum in the future until 2005, the target completion year of the Master Plan, which is derived from the annual average growth rate in the total number of powered fishing boats from 1970 to 1990.

Sea Transport Benefit

Sea transport benefit is expected at four representative river mouths, but it is not practicable to apply those benefits to the other river mouths where commercial boats are not available as discussed in Subsection 3.3. In this context, the benefit at Mersing is calculated separately. The benefit is also expected to increase until 2005 at the annual rate of 2%, considering the estimated annual population growth rate from 1990 to 2000 in the Peninsula.

Flood Mitigation Benefit

Flooding problems due to river mouth siltation are recognized only at Terengganu, one of the representative river mouths. Since flooding conditions are considerably related to the physical condition of river channels, flood mitigation benefit can be expected at

the other river mouths in the same group. (Grouping of river mouths is based on the physical conditions.)

The magnitude of flood loss depends mainly on the value of properties in the flood-prone area and the inundation water depth, and so is the benefit, because the reduction of loss is counted as benefit. In applying the Terengganu's benefit to the other river mouths in the group, however, the areal ratio of urban areas along the river course near the river mouth is used as a parameter which is most related to the benefit amount, and considered to be the best method within the availability of data.

4.3 Economic Evaluation of Master Plan

Cost-benefit ratio (B/C) for each river mouth is calculated using the above-said cost and benefit assuming that project life is 30 years and the discount rate is 8%. The ratio at each river mouth is shown in Table 8.4-4, and the following matters are pointed out:

(1) Most of the representative river mouths well known for having a critical river mouth problem are higher in rank; especially, Kuantan, Perlis and Kedah which are expected to have a high economic return.

(2) Although a high economic return is not expected in most of the river mouths, the B/C ratio of 0.72 as a whole is not so low.

(3) For comparison of priority between river mouths in Category 1 (Critical) and those in Category 2 (Significant), the B/C ratio of the former category is 0.98, while that of the latter is only 0.23. Thus, the adequacy of categorization can be verified as a whole.

As identified in the cost-benefit ratio, the economic viability of the Master Plan is not so high. However, the economic viability for the critical group shows a high economic return with a B/C ratio of 0.98. Consequently, the Master Plan puts emphasis on the critical group, while project execution for the significant group considers the future development of the area surrounding the river mouth.

4.4 Economic Evaluation of First Phase Project

In accordance with the principle of master plan formulation, countermeasures for each of the 75 objective river mouths have been selected and costs and benefits have also been calculated. Since the number of river mouths for the Master Plan is too large that it may be difficult to simultaneously execute a project covering all the objective river mouths, a First Phase Project has been formulated to facilitate project realization.

4.4.1 Formulation of First Phase Project

The First Phase Project has been formulated under the following conditions:

(1) The objective river mouths for the First Phase Project are the 35 river mouths under critical condition, where early project implementation is urgently necessary.

(2) The 35 river mouths are classified into groups of 3 and 4 for priority of project execution. The prioritization is made considering economic efficiency, regional income distribution, social need, etc.

(3) It is assumed that the First Phase Project is completed within the target year 2005 which corresponds to the last year of the 8th Malaysia Plan. As alternative cases, those with target years extending up to the end of the 9th and the 10th Malaysia Plans are examined for comparison.

4.4.2 Prioritization of River Mouth

Prioritization has been made considering several aspects such as economic efficiency, regional income distribution, social need and so on. For the purpose, the following considerations have been made:

(1) For the economic efficiency, cost and benefit ratio is applied.

(2) For the regional income distribution, the State where the river mouth is located is considered.

(3) For the social needs, the development strategy of the fishing industry is considered, especially the LKIM complex and the fishing base of the Department of Fisheries. The design boat size for river mouth improvement also is considered.

Table 8.4-5 shows the considerations for prioritization. In accordance with these considerations, the prioritization has been made, as presented in Table 8.4-6, in the following principles:

(1) The number of river mouths to be implemented in each stage is basically the same, but cost adjustment is made considering the financial burden; i.e., initial and maintenance costs. In this cost adjustment, two cases are considered; namely, (1) the total cost consisting of initial and maintenance costs is equally distributed; and (2), only the initial cost is equally distributed. Consequently, six cases are considered in combination with three cases of different target years.

(2) Considering the regional income distribution, at least one river mouth in each State is implemented in the early stage.

(3) Prioritization among the river mouths in each State is to be made considering the economic efficiency, the design boat size, the LKIM complex and the DOF base. Among these, more emphasis is put on the LKIM complex which is regarded as the development strategy of the fishing industry. Furthermore, the Tg. Piandang and Marang river mouths which have been selected as the objective river mouths for the Feasibility Study are to be given high priority.

4.4.3 Implementation Schedule and Construction Cost

As mentioned above, it is assumed that the First Phase Project is to be completed within the target year 2005 starting from 1996, after the feasibility study and detail design of the river mouth improvement are completed. This period corresponds to the 7th and 8th Malaysia Plan.

The implementation schedule including alternative cases which follows the principles of prioritization is as shown in the following table:

Case	Priority	Malaysia Plan			
		7th	8th	9th	10th
Case 1-1 and 2-1	First, Second	---------	*	*	*
	Third, Fourth		---------	*	*
Case 1-2 and 2-2	First	---------	*	*	*
	Second		---------	*	*
	Third			---------	*
Case 1-3 and 2-3	First	---------	*	*	*
	Second		---------	*	*
	Third			---------	*
	Fourth				---------

* Maintenance work

The construction cost required for the First Phase Project has been estimated considering the implementation schedule. In this connection, it was assumed that the annual disbursement of cost for each priority group is to be distributed equally for each year in each construction stage. (Refer to Table 8.4-7.)

4.4.4 Selection of Optimum Case

For the selection of the optimum case, the following are considered:

(1) To satisfy the people concerned in navigation, it is desirable to adopt a project with a short period of implementation because it may not be realistic to have a first project with a long implementation period of over 20 years.

(2) In case the project with a short period of implementation is adopted, the main issues are the capability for project execution and the financial restriction of agencies concerned.

(3) The main agencies responsible for river mouth improvement are MD and DID. MD is mainly concerned with 6 river mouths out of the 35, while the remaining river mouths are managed by DID. Judging from the current capability of these agencies, which are handling improvement works for more than 10 river mouths a year, it seems to be possible to gradually increase their capability within 10 years to handle the 35 river mouths.

(4) In general, maintenance cost is shouldered by the beneficiaries, while the initial cost is by the Government. In this connection, it may be possible to allocate the initial cost of about RM 170 million within 10 years judging from the current budget allocation and future economic development.

(5) On the other hand, it may be possible to require the beneficiaries to shoulder the maintenance cost of about RM 890 per year per capita, which corresponds to about 4% of the wholesale price of fish of RM 2.1 per kilogram. Since it may not be fair to require all beneficiaries to shoulder the maintenance costs equally, it is necessary to carefully examine the collection system of maintenance cost from the institutional point of view.

Based on the above considerations, it is recommended that Case 2-1 be selected as the Implementation Schedule of the First Phase Project. Table 8.4-8 shows the prioritization of river mouths for implementation, together with the agencies involved in the implementation.

4.4.5 Economic Evaluation

The economic viability of the First Phase Project is assessed by means of internal rate of return (IRR) based on the cash flow presented in Table 8.4-9. The IRR is figured out at 11.5%, which is higher than the generally understood borderline of 10% for this kind of infrastructure project. Furthermore, expected are intangible benefits such as enhancement of safety to navigation and stabilization of living standards of people concerned.

It is evaluated that the First Phase Project has enough economic viability to promote it for implementation, and that the Project can provide favorable socio-economic impacts for thousands of people.

5. TANJUNG PIANDANG RIVER MOUTH IMPROVEMENT PROJECT

5.1 *Project Benefit*

Project benefit is defined as the difference between "without-the-project" and "with-the-project" situations. River mouth siltation at Tg. Piandang causes economic losses to the fishing activities of small boats (less than 10 GRT), the number of which is expected to be 476 in 1995, 456 in 2000 and 438 in 2005. Hence, project benefit may accrue in the areas of fishery, but it has been verified by the site investigation, interview survey and basic analysis that sea transport and flood mitigation benefits are not expected.

5.1.1 Unnavigable Duration

The shallowest bed of Tg. Piandang River Mouth has been surveyed at LSD -1.5 m, and this hampers navigation at low tide. The 1990 tidal records at the Kedah Pier Station, the nearest station from Tg. Piandang, has been studied to calculate the unnavigable hours for small boats which require a minimum water depth of 1.0 m to navigate as shown in Fig. 8.5-1. The water depth of less than 1.0 m takes place for 14.5% on an average. The actual average unnavigable hours is calculated at 0.87 hour per day/boat, i.e., 14.5% x 24 hours x 50% x 50%, considering that river mouths are used only in the daytime (50% of a day) and assuming that boats stay offshore for normal fishing activities for about 50% of the duration affecting navigation at river mouths, as discussed in Subsection 2.2.3.

5.1.2 Benefit Calculation

The benefit for small boats is calculated in accordance with the methodology mentioned in Subsection 3.2, based on the following unit values on fishery:

No. of Trips per Year	:	265
Duration per Trip (hrs.)	:	8
Annual Catch (RM)	:	20,000
Boat Running Cost (RM/hr.)	:	0.97
Refrigeration Cost (RM/hr.)	:	0.20

The annual benefit can be calculated by the formula [(increase of catch) - (incremental running cost + cooling cost)]; i.e., the annual benefit per small fishing boat is as follows: RM 20,000 x [(8+0.87)hrs./8hrs. - 1] - [RM0.97/hr. x 0.87hrs./trip x 265 trips + RM0.20/hr. x 0.87hrs./trip x 265 trips], and it makes RM 1,905 per boat. The annual benefits are thus calculated as follows:

	1995	2000	2005
No. of Boats	476	456	438
Annual Benefit ('000 RM)	907	869	834

5.2 Economic Viability

The Tg. Piandang river mouth improvement project is designed to assure navigation with adequate safety for small fishing boats. The economic evaluation for this project was made by figuring out the economic viability in terms of internal rate of return (IRR) and cost-benefit ratio (B/C), comparing the economic project cost and annual average benefit which may accrue in accordance with the expected cost-benefit flow in the project life. To calculate the IRR and B/C, the following basic conditions were set up:

(1) Target completion year is set at 2005, and project life is assumed to be 40 years including the construction period, which considers the durable life of structures to be installed.

(2) All the monetary calculations are expressed in Malaysian Ringgit (RM) at the price level of the later part of 1992.

(3) The annual benefit starts to accrue fully after the completion of construction works, and vary until 2005 in line with the changes in number of boats as discussed in the preceding section, and keep the same level after then.

(4) Economic construction cost is estimated from the financial cost by multiplying a social conversion factor of 0.88, which is derived from the National Parameters for Project Appraisal in Malaysia, and price contingencies are disregarded for the calculation of economic viability, as given below.

Item	Financial ('000 RM)	Economic ('000 RM)
Construction Cost	1,471	1,294
Compensation Cost	0	0
Engineering and Administration Cost	147	147
Physical Contingencies	162	144
Price Contingencies	129	0
Annual O&M	600	538

(5) A discount rate of 8% is applied for the calculation of B/C, considering the base lending rates in the recent years.

A cash flow of annual benefit and economic cost has been prepared to figure out the values of IRR and B/C as presented in Table 8.5-1, and the results are as follows:

Internal Rate of Return (IRR)	:	17.0%
Cost-Benefit Ratio (B/C)	:	1.173

5.3 Sensitivity Analysis

The Tg. Piandang project involves only dredging works without structural protection, and thus the annual maintenance cost required to assure the design navigation channel accounts for as much as 41% of the capital costs. As reflected in Fig. 8.5-2, the economic viability is sensitive to the change of construction cost and also maintenance cost. On the other hand, the fishery benefit is calculated to a possible maximum extent within its potential, and it cannot be denied that the calculation involves assumptions with unknown factors. Sensitivity analysis was therefore carried out on various cost and annual benefit, and the change of economic viability was examined as follows.

	Case	IRR	B/C
(a)	Construction Cost, 10% up	15.5%	1.154
(b)	Maintenance Cost, 10% up	13.4%	1.094
(c)	Annual Benefit, 10% down	11.0%	1.056
(d)	Combination of (a) + (c)	10.0%	1.039

5.4 Economic Evaluation

IRR is a reliable tool to evaluate a project in economic terms, and the borderline is generally around 10% in this kind of infrastructure project, although the IRR of the Tg. Piandang project is very sensitive to the increase of maintenance cost as mentioned in the preceding subsection. Even in the case of 10% up in the construction cost and 10% down in the annual benefit, the project is evaluated to maintain adequate economic viability.

Consideration should also be given to intangible benefits to be brought about by the project, especially the enhancement of safety to navigation and the stabilization of fishermen's livelihood. Fishery is the most important economic activity at Tg. Piandang River Mouth, and it contributes much to the regional economy to which the project will afford favorable socio-economic impacts.

In view of the high economic viability and favorable socio-economic impacts, as well as the necessity of assuring the safe navigation of fishing boats at Tg. Piandang River Mouth, river mouth improvement works should be implemented at the earliest opportunity.

6. MARANG RIVER MOUTH IMPROVEMENT PROJECT

6.1 Project Benefit

Project benefit is defined as the difference between "without-the-project" and "with-the-project" situations. River mouth siltation at Marang causes economic loss to fishing boats and the tourist boats commuting to Kapas Island, 5 km away from the river mouth. Hence, project benefit may accrue in the areas of fishery and sea transport, but it has been verified by the basic analysis that flood mitigation benefits are not expected.

Based on the future distribution of fishing boat size presumed by DOF, the number and size in the future are projected for benefit calculation, in which the medium size boats are further classified into 10.0 to 19.9 GRT (Medium 1) and 20.0 to 39.9 GRT (Medium 2). The estimated number by boat size are as follows:

	1995	2000	2005
Small	130	110	90
Medium 1	30	15	0
Medium 2	10	15	20
Large	0	10	20
Total	170	150	130

6.1.1 Unnavigable Duration

The shallowest bed of Marang River Mouth has been surveyed at minus 0.9 m LSD, and this hampers navigation of sea boats at low tide. The 1990 tidal records at the Chedering Station, the nearest station from Marang, has been studied to calculate the unnavigable hours as shown in Fig. 8.6-1. Unnavigable water depth takes place by 39.4% for small fishing and tourist boats (less than 10 GRT), 82.3% for medium fishing boats (10 to 39.9 GRT), and 97.0% for large fishing boats (40.0 to 69.9 GRT) on an average.

The actual average unnavigable hours are calculated by the formula [(unnavigable hours' percentage) x 24 hours x 50% x 50%] as mentioned in Subsection 2.2.3. The unnavigable hours calculated are as follows:

Small Fishing and Tourist Boat	:	2.36 hours
Medium Size Fishing Boat	:	4.94 hours
Large Size Fishing Boat	:	5.82 hours

6.1.2 Benefit Calculation

Small Fishing Boat (less than 10.0 GRT)

The annual benefit for small fishing boats is calculated in the same methodology and conditions as Tg. Piandang, but there is a difference in unnavigable duration; 2.36 hours. The annual benefit is thus calculated at RM 5,168 per boat.

Medium Size Fishing Boat (10.0 to 39.9 GRT)

The benefits of medium size fishing boats may accrue in the areas of:

(a) Savings on fishermen's opportunity cost;
(b) Savings on fish refrigeration cost; and
(c) Preservation of fish quality.

Unit values necessary for the calculation are as follows.

No. of Trips per Year	:	266
No. of Fishermen per Boat	:	4
Annual Catch (RM)	:	101,000
Refrigeration Cost (RM/hr.)	:	1.20
Fisherman's Opportunity Cost (RM/hr.)	:	1.7
Value Decrease Ratio per Hour	:	0.01

Annual savings on fishermen's opportunity cost per boat can be calculated by the formula [(no. of trips) x (no. of fishermen) x (unnavigable hours) x (opportunity cost)]; i.e., 266 trips/boat x 4 persons/boat x 4.94 hours/trip x RM1.7/hour/person, and it makes RM 8,935 per boat.

Annual savings on refrigeration cost is obtained from the formula [(no. of trips) x (unnavigable hours) x (unit cooling cost)]; i.e., 266 trips/boat x 4.94 hours/trip x RM 1.20/hour, and it makes RM 1,577 per boat.

Preservation of fish quality is quantified by the formula [(annual catch) x (unnavigable hours) x (value decrease ratio)]; i.e., RM 101,000/boat x 4.94 hours/boat x 0.01/hour, and it makes RM 4,989 per boat. The annual benefit per boat is the total of these values; namely, RM 8,935 + RM 1,577 + RM 4,989 = RM 15,501 per boat.

Large Fishing Boat (40.0 to 69.9 GRT)

Large size fishing boats have the same problem as the medium size boats. The benefits are thus expected in the areas of:

(a) Savings on fishermen's opportunity cost;
(b) Savings on fish refrigeration cost; and
(c) Preservation of fish quality.

The annual benefit for large fishing boats is calculated in the same methodology and conditions as the medium size boats, as discussed above. The unit values necessary for the calculation are as follows:

No. of Trips per Year	:	92
No. of Fishermen per Boat	:	9
Annual Catch (RM)	:	399,000
Refrigeration Cost (RM/hr.)	:	5.26
Fisherman's Opportunity Cost (RM/hr.)	:	1.7
Value Decrease Ratio per Hour	:	0.01

The annual benefits of the above three categories are calculated at RM 8,192, RM 2,816 and RM 23,222, respectively, totaling RM 34,230 per boat.

Tourist Boat (less than 10.0 GRT)

Tourist boats are available between Marang River Mouth and Kapas Island except in the monsoon season. Small size fishing boats have been rebuilt into tourist boats with a maximum capacity of 12 passengers. Navigation survey was carried out for three days in June 1993, and it shows that about 60 round trips are available daily on an average.

Annual sales are estimated at RM 5,832,000, calculated by the formula [RM 30/passenger x 12 passengers/trip x 60 trips/day x 30 days/month x 9 months]. Assuming that 60% of direct costs are included, the net annual product is RM 2,332,800 (i.e., RM 5,832,000 x 40%).

The operation of tourist boats is affected by low tide, similar to fishing boats. Under the present conditions, these boats have unnavigable hours at the river mouth with a probability of about 10% on average, and the net annual product increases to RM 2,592,000 (i.e., RM 2,332,800 x 1/90%) under the with-the-project situation. Hence, the annual benefit is calculated at RM 259,200 (i.e., RM 2,592,000 - RM 2,332,800). The benefit is assumed to increase until 2005 at the annual growth

rate of 2%, considering the estimated annual population growth rate from 1990 to 2000 in the Peninsula.

Total Project Benefit in the Future

The annual benefit for Medium 2 is estimated from those of Small and Medium 2 to be RM 8,612 per boat. The project annual benefit consisting of fishery and sea transport benefits is thus calculated as follows:

	1995	2000	2005
Fishery	1,085	1,254	1,422
Sea Transport	270	298	329
Total	1,355	1,552	1,751

6.2 Economic Viability

The Marang river mouth improvement project is designed to assure navigation with adequate safety for fishing and tourist boats. The economic evaluation for this project is made by figuring out the economic viability in terms of internal rate of return (IRR) and cost-benefit ratio (B/C), comparing the economic project cost and annual average benefit which may accrue in accordance with the expected cost-benefit flow in the project life. The calculation of IRR and B/C are made on the same basic conditions as Tg. Piandang, described in Subsection 5.2.

The economic project cost is calculated as given in Table 8.6-1. A cash flow of annual benefits and economic costs is prepared to figure out the values of IRR and B/C, as presented in Table 8.6-2, and the results are as follows:

Internal Rate of Return (IRR)	:	11.1%
Cost-Benefit Ratio (B/C)	:	1.302

6.3 Sensitivity Analysis

The Marang project involves many structural works such as breakwater and jetty, and requires little maintenance cost compared with the construction cost. On this point, it is different from the Tg. Piandang project; namely, the economic viability is sensitive to the change of capital cost. On the other hand, the project benefits are calculated to the possible maximum extent within the project potential, and it cannot be denied that the calculation involves assumptions with unknown factors. Sensitivity analysis is therefore carried out under various construction costs and annual benefits, and the change of economic viability has been examined as follows:

	Case	IRR	B/C
(a)	Construction Cost, 5% up	10.6%	1.255
(b)	Construction Cost, 10% up	10.2%	1.211
(c)	Annual Benefit, 5% down	10.5%	1.237
(d)	Annual Benefit, 10% down	9.8%	1.172
(e)	Combination of (a) and (c)	10.0%	1.192

Since the design boat size is 40 GRT, it may be difficult for large boats to use the river mouth all the time. In this connection, sensitivity analysis was also made for the case where future boat distribution by size is altered with no change in the total number, as follows:

	1995	2000	2005
Small	130	110	90
Medium 1	30	15	0
Medium 2	10	25	40
Total	170	150	130

The economic viability in this case is 9.2% in IRR and 1.108 in B/C.

6.4 Economic Evaluation

IRR is a reliable tool to evaluate a project in economic terms, and the borderline is generally around 10% in this kind of infrastructure project. Even in the cases of increase of construction cost and decrease of annual benefit, the project is evaluated to maintain adequate economic viability as mentioned in the preceding subsection.

Consideration should also be given to intangible benefits to be brought about by the project, especially the enhancement of safety to navigation and the stabilization of living standards of people living on the fishery and tourism industries. Fishing boats at Marang River Mouth is on the way toward up-sizing to realize more offshore fishery in line with the national policy as witnessed in the change of boat size distribution, and the state government also puts emphasis on tourism development at the river mouth, which may be highly related to passenger ferry services between the river mouth and Kapas Island. Under these circumstances, intangible benefits, though unquantifiable, are expected to accrue to a considerable extent.

In view of the high economic viability and favorable socio-economic impacts, as well as the necessity of assuring the safe navigation of fishing boats at Marang River Mouth, river mouth improvement works should be implemented at the earliest opportunity.

TABLES

Table 8.2-1 NUMBER OF LICENSED FISHING BOATS AND FISHERMEN BY STATE, 1990

State	Number of Licensed Fishing Boats				Total Number of Fishermen	Number of Fishermen Per Boat
	Non-Powered	Outboard-Powered	Inboard-Powered	Total		
Malaysia	1,657	13,869	24,015	39,541	88,494	2.2
Peninsular Malaysia	779	7,029	15,326	23,134	59,801	2.6
- Perlis	0	174	601	775	4,223	5.4
- Kedah	11	918	1,371	2,300	7,403	3.2
- Pulau Pinang	49	1,226	876	2,151	4,484	2.1
- Perak	171	947	3,901	5,019	10,767	2.1
- Selangor	138	451	2,175	2,764	5,755	2.1
- Negeri Sembilan	18	151	51	220	447	2.0
- Melaka	78	560	236	874	1,557	1.8
- West Johor	212	1,607	1,072	2,891	4,418	1.5
Sub-total (west coast)	677	6,034	10,283	16,994	39,054	2.3
- Kelantan	9	236	932	1,177	3,784	3.2
- Terengganu	28	84	2,298	2,410	9,461	3.9
- Pahang	18	152	863	1,033	3,587	3.5
- East Johor	47	523	950	1,520	3,915	2.6
Sub-total (east coast)	102	995	5,043	6,140	20,747	3.4
Sabah	800	5,000	3,400	9,200	12,197	1.3
Sarawak	77	1,711	5,278	7,066	16,082	2.3
Labuan	1	129	11	141	414	2.9

Source : Annual Fisheries Statistics 1990, Department of Fisheries

Table 8.2-2 NUMBER OF FISHING BOATS AT 75 OBJECTIVE RIVER MOUTHS

GROUP	No.	Serial No.	Name	Design Boat Size		Shallowest Seabed in LSD(m)	No. of Fishing Boat by Size (in GRT) Small <10	Medium 10-39.9	Large 40-69.9	Deepsea >=70	Total
A	1	45	Mersing	150	#	1.9	153	101	25	11	290
A	2	48	Rompin	70	#	2.8	39	51	8	9	107
A	3	61	Marang	40 *	#	0.9	139	48	0	0	187
A	4	81	Mukah	70	#	2.0	150	43	3	0	196
A	5	82	Balingian	40		1.7	24	7	1	0	32
A	6	84	Tatau	40		2.0	147	60	11	0	218
B	7	44	Sedili Bes	150	#	2.9	53	40	0	0	93
B	8	46	Endau	200	#	2.4	17	67	94	39	217
B	9	50	Nenasi	70	#	2.8	40	25	5	5	75
B	10	52	Terus	40		1.5	32	2	0	0	34
B	11	53	Kuantan	200 *	#	2.0	1	38	61	63	163
B	12	55	Kemaman	100	#	3.0	62	21	5	6	94
B	13	58	Paka	40	#	2.7	60	22	0	0	82
B	14	59	Dungun	100	#	2.4	31	33	2	0	66
B	15	60	Mercang	40		1.0	18	4	0	0	22
B	16	92	Tuaran	40		1.4	120	0	0	0	120
C	17	56	Kemasik	40		1.1	30	11	0	0	41
C	18	57	Kerteh	40 *		1.1	44	7	0	0	51
C	19	87	Sibuti	40		2.4	18	1	0	0	19
D	20	1	Perlis	150 *	#	1.5	151	205	46	30	432
D	21	25	Langat	40		3.2	32	1	0	0	33
D	22	99	Umas-umas	40		3.4	15	0	0	0	15
E	23	2	Baru	40	#	1.5	75	25	4	0	104
E	24	3	Sanglang	40	#	2.1	178	17	1	0	196
E	25	4	Jerlun	40	#	2.4	53	10	0	0	63
E	26	6	Yan	40	#	1.4	149	3	0	0	152
E	27	8	Cenang	40	#	1.3	44	0	0	0	44
E	28	12	Pinang	40	#	1.0	180	0	0	0	180
E	29	13	Bayan Lepa	40		1.3	32	25	4	0	61
E	30	14	Tg. Pianda	40 *	#	1.0	480	5	0	0	485
E	31	20	Batu	40		1.1	16	0	0	0	16
E	32	22	Lekir	40		1.0	24	0	0	0	24
E	33	24	Kapar Besa	40		1.0	71	0	0	0	71
E	34	26	Sepan Keci	40		2.8	23	0	0	0	23
E	35	27	Sepang	40		3.6	92	13	0	0	105
E	36	30	Linggi	40	#	1.0	31	0	0	0	31
E	37	31	Baru	40		1.0	82	0	0	0	82
E	38	32	Melaka	40	#	2.2	111	0	0	0	111
E	39	33	Duyong	40		1.6	29	0	0	0	29
E	40	34	Umbai	40		1.5	35	0	0	0	35
E	41	35	Merlimau	40		1.4	35	0	0	0	35
E	42	37	Parit Jawa	40		1.5	102	11	0	0	113
E	43	40	Senggarang	40		1.6	31	0	0	0	31
E	44	41	Rengit	40		1.5	19	38	0	0	57
E	45	42	Benut	40		1.8	44	14	0	0	58
E	46	43	Pontian Ke	40	#	2.0	111	136	0	0	247
E	47	98	Tawau	40	#	0.9	60	0	0	0	60
F	48	69	Sematan	40		2.3	43	2	0	0	45
F	49	70	Kayan	40		2.5	44	2	0	0	46
F	50	80	Oya	40 *	#	1.8	78	22	2	0	102
G	51	11	Kerian	40	#	2.8	235	2	8	0	245
G	52	15	Gula	40	#	2.1	197	0	0	0	197
G	53	16	Sangga	40		2.6	39	0	0	0	39
G	54	17	Larut	40		2.2	44	20	0	0	64
G	55	18	Terong	40		3.9	4	0	0	0	4
G	56	19	Beruas	100 *	#	1.4	283	357	10	3	653
G	57	23	Selangor	40	#	2.2	176	6	0	0	182
G	58	36	Muar	40		3.1	151	1	0	0	152
G	59	39	Batu Pahat	40		2.0	59	2	0	0	61
G	60	76	Buntal	40		1.4	107	12	0	0	119
G	61	77	Bako	40		2.0	81	9	0	0	90
G	62	78	Sadong	40	#	2.2	62	2	0	0	64
G	63	89	Padas	40	#	1.7	387	13	0	0	400
G	64	100	Kalabakan	40		3.1	5	0	0	0	5
H	65	51	Pahang	70	#	2.9	93	52	7	7	159
H	66	62	Terengganu	150 *	#	2.5	38	49	10	10	107
H	67	67	Kelantan	100	#	2.5	101	78	13	14	206
H	68	95	Sugut	40		3.5	196	15	0	0	211
I	69	38	Sarang Bua	40		2.1	33	0	0	0	33
I	70	63	Merang	40		1.0	32	2	0	0	34
I	71	66	Pak Amat	40		0.9	23	2	1	0	26
I	72	90	Papar	40 *		1.0	123	0	0	0	123
J	73	5	Kedah	150 *	#	1.9	154	266	73	42	535
J	74	9	Muda	40	#	2.3	197	4	0	0	201
J	75	88	Lawas	40		1.9	161	0	0	0	161

Note * : Representative river mouths
: River mouths in the critical group

Source : Department of Fishery, Malaysia

Table 8.2-3 LANDINGS OF MARINE CAPTURED FISHERIES, 1989 AND 1990

Unit : Metric Tonnage

State	1989	1990	% Change
Malaysia	882,492	951,307	7.8%
Peninsular Malaysia	746,884	819,903	9.8%
- Perlis	42,360	46,206	9.1%
- Kedah	75,615	86,408	14.3%
- Pulau Pinang	38,624	52,278	35.4%
- Perak	198,974	219,044	10.1%
- Selangor	112,646	86,966	-22.8%
- Negeri Sembilan	221	349	57.9%
- Melaka	1,989	2,363	18.8%
- West Johor	18,905	16,857	-10.8%
Sub-total (west coast)	489,334	510,471	4.3%
- Kelantan	32,982	31,557	-4.3%
- Terengganu	78,815	97,236	23.4%
- Pahang	68,730	105,370	53.3%
- East Johor	77,023	75,269	-2.3%
Sub-total (east coast)	257,550	309,432	20.1%
Sabah	44,000	44,760	1.7%
Sarawak	84,356	78,878	-6.5%
Labuan	7,252	7,766	7.1%

Source : Annual Fisheries Statistics 1990, Department of Fisheries

Table 8.2-4 MARINE FISH LANDING PER BOAT BY STATE, 1990

Fisheries Districts	Number of Boats	Number of Fishermen	Marine Fish Landing		Landing Per Boat		Landing Per Fisherman	
			('000ton)	(mil.RM)	(ton)	(mil.RM)	(ton)	('000RM)
Malaysia	39,541	88,494	951.31	1,960.60	24.1	49.6	10.7	22.2
Pen. Malaysia, West Coast	16,994	39,054	510.47	882.72	30.0	51.9	13.1	22.6
Perlis	775	4,223	46.21	85.48	59.6	110.3	10.9	20.2
Kedah	2,300	7,403	86.41	137.59	37.6	59.8	11.7	18.6
Pulau Pinang/Penang	2,151	4,484	52.28	90.54	24.3	42.1	11.7	20.2
Perak	5,019	10,767	219.04	362.32	43.6	72.2	20.3	33.7
Selangor	2,764	5,755	86.97	141.45	31.5	51.2	15.1	24.6
Negeri Sembilan	220	447	0.35	1.76	1.6	8.0	0.8	3.9
Melaka/Malacca	874	1,557	2.36	11.68	2.7	13.4	1.5	7.5
Johor Barat	2,891	4,418	16.86	51.91	5.8	18.0	3.8	11.7
Pen. Malaysia, East Coast	6,140	20,747	309.43	468.22	50.4	76.3	14.9	22.6
Johor Timur	1,520	3,915	75.27	92.34	49.5	60.7	19.2	23.6
Pahang	1,033	3,587	105.37	131.31	102.0	127.1	29.4	36.6
Perengganu	2,410	9,461	97.24	189.61	40.3	78.7	10.3	20.0
Kelantan	1,177	3,784	31.56	54.97	26.8	46.7	8.3	14.5
Peninsular Malaysia	23,134	59,801	820	1,351	35.4	58.4	13.7	22.6
Sarawak	7,066	12,197	78.88	358.19	11.2	50.7	6.5	29.4
Sabah & Labuan F.T.	9,341	16,496	52.53	251.46	5.6	26.9	3.2	15.2

Source : Annual Fisheries Statistics 1990

Table 8.2-5 UNIT VALUES ON FISHERY

Item	Boat Size *1			
	Small	Medium	Large	Deepsea
(1) No. of trips per year	265	266	92	18
(2) Hours per trip	8	10	38	68
(3) No. of fishermen per boat	1.5	4	9	15
(4) Annual catch (RM/boat)	20,000	101,000	399,000	363,000
(5) Running cost per hour (RM/hr.)	0.97	4.11	14.42	73.82
(6) Fish refrigeration cost per hour (RM/hr.)	0.20	1.20	5.26	23.19
(7) Opportunity cost per fisherman (RM/hr.)	1.7	1.7	1.7	1.7
(8) Value decrease ratio per hour	0.01	0.01	0.01	0.01

Note *1 Small size : less than 10.0 GRT
Medium size: 10.0 - 39.9 GRT
Large size : 40.0 - 69.9 GRT
Deepsea : 70.0 GRT or above

Source : *Annual Fisheris Statistics, 1990*
Interview to LKIM and local fishermen

Table 8.2-6 ANNUAL AVERAGED LANDING PER BOAT BY BOAT SIZE IN PENINSULA

Class of Fishing Boat (GRT)	No. of Fishing Boat	Landing (tonnes)	Wholesale Value (mil.RM)	Landing per Boat (tonnes)	Wholesale Value per Boat (mil.RM)
(All Gears, Total)	23,134	819,902	1,350.95	35	0.058
(Trawl)					
9.9 or less	283	42,479	55.96	150	0.198
10.0 - 39.9	3,055	259,369	341.70	85	0.112
40.0 - 69.9	602	145,682	191.92	242	0.319
70.0 or above	278	69,196	91.16	249	0.328
Sub-total	4,218	516,726	680.74	123	0.161
(Purse Seine)					
9.9 or less	954	1,597	4.12	2	0.004
10.0 - 39.9	332	35,111	90.66	106	0.273
40.0 - 69.9	286	63,868	164.91	223	0.577
70.0 or above	136	23,731	61.27	174	0.451
Sub-total	1,708	124,307	320.96	73	0.188
(Trawl + Purse Seine)					
9.9 or less	1,237	44,076	60.09	36	0.049
10.0 - 39.9	3,387	294,480	432.35	87	0.128
40.0 - 69.9	888	209,550	356.83	236	0.402
70.0 or above	414	92,927	152.43	224	0.368
Sub-total	5,926	641,033	1,001.70	108	0.169
(% to the Total ===>		78.18%	74.15%)		
(Others)					
9.9 or less	15,554	141,468	271.60	9	0.017
10.0 - 39.9	1,635	36,286	75.03	22	0.046
40.0 - 69.9	9	542	1.30	60	0.144
70.0 or above	10	573	1.32	57	0.132
Sub-total	17,208	178,869	349.25	10	0.020
(All Gears)					
9.9 or less	16,791	185,544	331.68	11	0.020
10.0 - 39.9	5,022	330,766	507.38	66	0.101
40.0 - 69.9	897	210,092	358.13	234	0.399
70.0 or above	424	93,500	153.76	221	0.363

Source : Annual Fisheries Statistics, 1990

Table 8.2-7 CALCULATION OF BOAT RUNNING COST PER HOUR

Item	Fishing Boats by Size (in GRT)				Total / Average
	Small 0.0-9.9	Medium 10.0-39.9	Large 40.0-69.9	Deep sea >=70.0	
I. Data on Trawl Nets and Purse Seines Gears in the Peninsular Malaysia					
1.1 No. of Trips	327,545	899,876	81,897	7,490	1,316,808
1.2 No. of Days	337,546	993,617	183,117	26,540	1,540,820
1.3 No. of Fishing Boats	1,237	3,387	888	414	5,926
II. Annual Running Cost of Fishing Boats ('000 RM)					
2.1 Capital Cost	8.70	42.00	201.40	450.00	87.44
2.2 Annual Average Cost of 2.1 *1	1.30	6.26	30.01	67.06	13.03
2.3 Annual Fuel and Oil Cost	0.66	4.26	17.00	20.00	6.52
2.4 Annual Maintenance Cost	0.09	0.42	2.01	3.00	0.77
2.5 Annual Running Cost	2.05	10.94	49.02	90.06	20.32
III. Boat Running Cost per Hour					
3.1 Days per Trip (1.2/1.1)	1.0	1.1	2.2	3.5	1.2
3.2 Trips per Boat (1.1/1.3)	265	266	92	18	222
3.3 Hours per Trip (estimated from 3.1)	8	10	37	68	15
3.4 Annual Operation Hours (3.2x3.3)	2,120	2,660	3,400	1,220	3,330
3.5 Running Cost per Hour in RM (2.5/3.4)	0.97	4.11	14.42	73.82	6.10

Note *1 : [capital cost] x [capital recovery factor]
(capital recovery factor = $1 / \Sigma\ 1/(1+i)^n$; i=8%, n=10 years)

Source : Annual Fisheries Statistics, 1990

Table 8.2-8 UNNAVIGABLE DURATION OF FISHING BOATS BY SIZE

Representative River Mouths	Boat Size *1			
	Small	Medium	Large	Deepsea
I. % of hours with water depth affecting navigation				
1. Perlis	51.1%	82.7%	99.3%	100.0%
5. Kedah	26.0%	60.7%	92.0%	99.3%
14. Tg. Piandang	40.9%	83.3%	99.8%	99.8%
19. Beruas	18.5%	54.9%	92.7%	99.5%
53. Kuantan	2.4%	20.7%	64.6%	84.8%
57. Kerteh	29.1%	69.6%	95.0%	99.4%
61. Marang	39.4%	82.3%	97.0%	100.0%
62. Terengganu	0.0%	1.7%	33.1%	67.3%
80. Oya	3.9%	40.9%	95.8%	100.0%
90. Papar	40.9%	92.6%	100.0%	100.0%
II. Hours with water depth affecting navigation in the daytime (hrs./boat/day) [I. x 24 hours /2]				
1. Perlis	6.13	9.92	11.92	12.00
5. Kedah	3.12	7.28	11.04	11.92
14. Tg. Piandang	4.91	10.00	11.98	11.98
19. Beruas	2.22	6.59	11.12	11.94
53. Kuantan	0.29	2.48	7.75	10.18
57. Kerteh	3.49	8.35	11.40	11.93
61. Marang	4.73	9.88	11.64	12.00
62. Terengganu	0.00	0.20	3.97	8.08
80. Oya	0.47	4.91	11.50	12.00
90. Papar	4.91	11.11	12.00	12.00
III. Unnavigable Duration (hrs./boat/day) [II./2]				
1. Perlis	3.07	4.96	5.96	6.00
5. Kedah	1.56	3.64	5.52	5.96
14. Tg. Piandang	2.45	5.00	5.99	5.99
19. Beruas	1.11	3.29	5.56	5.97
53. Kuantan	0.14	1.24	3.88	5.09
57. Kerteh	1.75	4.18	5.70	5.96
61. Marang	2.36	4.94	5.82	6.00
62. Terengganu	0.00	0.10	1.99	4.04
80. Oya	0.23	2.45	5.75	6.00
90. Papar	2.45	5.56	6.00	6.00

Note *1: Small size : less than 10.0 GRT
Medium size : 10.0 - 39.9 GRT
Large size : 40.0 - 69.9 GRT
Deepsea : 70.0 GRT and above

Table 8.2-9 NAVIGATION SURVEY AT TG. PIANDANG RIVER MOUTH
ON JUNE 30, 1993

Time		No. of In-coming Boats			No. of Out-going Boats		
from	to	Sampan	Below 10 GRT	Total	Sampan	Below 10 GRT	Total
0 :00	0 :30			0		5	5
0 :30	1 :00		4	4		12	12
1 :00	1 :30		5	5		3	3
1 :30	2 :00		2	2		2	2
2 :00	2 :30			0		6	6
2 :30	3 :00			0			0
3 :00	3 :30			0			0
3 :30	4 :00			0			0
4 :00	4 :30			0			0
4 :30	5 :00			0			0
5 :00	5 :30			0			0
5 :30	6 :00			0			0
6 :00	6 :30			0	1		1
6 :30	7 :00			0	6	6	12
7 :00	7 :30			0	8	66	74
7 :30	8 :00		2	2	17	103	120
8 :00	8 :30			0	2	6	8
8 :30	9 :00	1		1	2	4	6
9 :00	9 :30	1	1	2	1	1	2
9 :30	10 :00	1		1	2	4	6
10 :00	10 :30	2	2	4	3	4	7
10 :30	11 :00	2	6	8	4	5	9
11 :00	11 :30	9	13	22	1	3	4
11 :30	12 :00	3	27	30		5	5
12 :00	12 :30	3	16	19		2	2
12 :30	13 :00	3	13	16			0
13 :00	13 :30	1	23	24			0
13 :30	14 :00		47	47		1	1
14 :00	14 :30	2	47	49		1	1
14 :30	15 :00	4	5	9		3	3
15 :00	15 :30		4	4	1	5	6
15 :30	16 :00	1	1	2		2	2
16 :00	16 :30		2	2	4	4	8
16 :30	17 :00	1	1	2			0
17 :00	17 :30	1	2	3			0
17 :30	18 :00	3	2	5			0
18 :00	18 :30			0			0
18 :30	19 :00		2	2	1		1
19 :00	19 :30			0		1	1
19 :30	20 :00			0			0
20 :00	20 :30			0		2	2
20 :30	21 :00	1	3	4			0
21 :00	21 :30		2	2	1		1
21 :30	22 :00	1		1			0
22 :00	22 :30		4	4			0
22 :30	23 :00		1	1			0
23 :00	23 :30			0			0
23 :30	24 :00			0			0
Total		40	237	277	54	256	310

Table 8.2-10 NAVIGATION SURVEY AT TG. PIANDANG RIVER MOUTH
ON JUNE 30, 1993

Time		No. of In-coming Boats			No. of Out-going Boats		
from	to	Sampan	Below 10 GRT	Total	Sampan	Below 10 GRT	Total
0 :00	0 :30			0		5	5
0 :30	1 :00		4	4		12	12
1 :00	1 :30		5	5		3	3
1 :30	2 :00		2	2		2	2
2 :00	2 :30			0		6	6
2 :30	3 :00			0			0
3 :00	3 :30			0			0
3 :30	4 :00			0			0
4 :00	4 :30			0			0
4 :30	5 :00			0			0
5 :00	5 :30			0			0
5 :30	6 :00			0			0
6 :00	6 :30			0	1		1
6 :30	7 :00			0	6	6	12
7 :00	7 :30			0	8	66	74
7 :30	8 :00		2	2	17	103	120
8 :00	8 :30			0	2	6	8
8 :30	9 :00	1		1	2	4	6
9 :00	9 :30	1	1	2	1	1	2
9 :30	10 :00	1		1	2	4	6
10 :00	10 :30	2	2	4	3	4	7
10 :30	11 :00	2	6	8	4	5	9
11 :00	11 :30	9	13	22	1	3	4
11 :30	12 :00	3	27	30		5	5
12 :00	12 :30	3	16	19		2	2
12 :30	13 :00	3	13	16			0
13 :00	13 :30	1	23	24			0
13 :30	14 :00		47	47		1	1
14 :00	14 :30	2	47	49		1	1
14 :30	15 :00	4	5	9		3	3
15 :00	15 :30		4	4	1	5	6
15 :30	16 :00	1	1	2		2	2
16 :00	16 :30		2	2	4	4	8
16 :30	17 :00	1	1	2			0
17 :00	17 :30	1	2	3			0
17 :30	18 :00	3	2	5			0
18 :00	18 :30			0			0
18 :30	19 :00		2	2	1		1
19 :00	19 :30			0		1	1
19 :30	20 :00			0			0
20 :00	20 :30			0		2	2
20 :30	21 :00	1	3	4			0
21 :00	21 :30		2	2	1		1
21 :30	22 :00	1		1			0
22 :00	22 :30		4	4			0
22 :30	23 :00		1	1			0
23 :00	23 :30			0			0
23 :30	24 :00			0			0
Total		40	237	277	54	256	310

Table 8.2-11 NAVIGATION SURVEY AT TG. PIANDANG RIVER MOUTH
ON JULY 4, 1993

Time		No. of In-coming Boats			No. of Out-going Boats		
from	to	Sampan	Below 10 GRT	Total	Sampan	Below 10 GRT	Total
0 :00	0 :30		4	4		14	14
0 :30	1 :00			0			0
1 :00	1 :30			0			0
1 :30	2 :00			0			0
2 :00	2 :30			0			0
2 :30	3 :00			0		5	5
3 :00	3 :30			0		14	14
3 :30	4 :00			0	2	53	55
4 :00	4 :30	2		2		47	47
4 :30	5 :00		3	3	1	44	45
5 :00	5 :30		3	3		29	29
5 :30	6 :00		3	3	3	15	18
6 :00	6 :30	3		3	1	1	2
6 :30	7 :00			0	10	9	19
7 :00	7 :30			0	7		7
7 :30	8 :00			0	1		1
8 :00	8 :30	3		3	1		1
8 :30	9 :00			0	2		2
9 :00	9 :30	1		1	7		7
9 :30	10 :00		3	3	12	3	15
10 :00	10 :30		3	3		11	11
10 :30	11 :00	1	27	28	4	30	34
11 :00	11 :30		59	59	1	25	26
11 :30	12 :00	2	30	32		6	6
12 :00	12 :30	2	9	11		2	2
12 :30	13 :00	7	16	23		2	2
13 :00	13 :30	9	19	28		2	2
13 :30	14 :00	6	17	23			0
14 :00	14 :30	6	23	29			0
14 :30	15 :00	6	8	14			0
15 :00	15 :30	3	8	11		1	1
15 :30	16 :00	1	9	10		6	6
16 :00	16 :30	2	15	17		18	18
16 :30	17 :00	2	17	19	1	24	25
17 :00	17 :30	1	11	12		4	4
17 :30	18 :00		5	5			0
18 :00	18 :30		1	1			0
18 :30	19 :00			0			0
19 :00	19 :30			0			0
19 :30	20 :00			0			0
20 :00	20 :30			0			0
20 :30	21 :00			0			0
21 :00	21 :30			0			0
21 :30	22 :00			0			0
22 :00	22 :30			0			0
22 :30	23 :00			0	1		1
23 :00	23 :30			0			0
23 :30	24 :00	2	31	33			0
Total		59	324	383	54	365	419

Table 8.2-12 NAVIGATION SURVEY AT MARANG RIVER MOUTH ON JUNE 18,1993

Time		No. of In-coming Boats						No. of Out-going Boats					
		Fishing Boats				Tourist Boats	Total	Fishing Boats				Tourist Boats	Total
from	to	Sampan	Below 10 GRT	10 GRT or more	Total			Sampan	Below 10 GRT	10 GRT or more	Total		
0 :00	0 :30				0		0				0		0
0 :30	1 :00				0		0				0		0
1 :00	1 :30				0		0				0		0
1 :30	2 :00				0		0				0		0
2 :00	2 :30				0		0				0		0
2 :30	3 :00				0		0				0		0
3 :00	3 :30		3		3		3				0		0
3 :30	4 :00				0		0				0		0
4 :00	4 :30				0		0				0		0
4 :30	5 :00		1		1		1				0		0
5 :00	5 :30				0		0				0		0
5 :30	6 :00		3		3		3				0		0
6 :00	6 :30		3	2	5		5				0		0
6 :30	7 :00		7	4	11		11	2			2		2
7 :00	7 :30	1	7	2	10		10	1			1		1
7 :30	8 :00		3	2	5	2	7	1			1		1
8 :00	8 :30	1		2	3		3			2	2	1	3
8 :30	9 :00	1			1	1	2	3	1	3	7	3	10
9 :00	9 :30		2		2	1	3		2	1	3	7	10
9 :30	10 :00				0	1	1	2		1	3	8	11
10 :00	10 :30				0	4	4				0	7	7
10 :30	11 :00				0	9	9	1			1	4	5
11 :00	11 :30			1	1	9	10			1	1	6	7
11 :30	12 :00	1			1	4	5			1	1	3	4
12 :00	12 :30	2			2	4	6			1	1		1
12 :30	13 :00				0		0				0		0
13 :00	13 :30				0	1	1				0	1	1
13 :30	14 :00				0	2	2				0		0
14 :00	14 :30				0		0				0	6	6
14 :30	15 :00				0		0	1			1	3	4
15 :00	15 :30	1			1		1	4			4	4	8
15 :30	16 :00	2	1		3	6	9	1	1		2	7	9
16 :00	16 :30				0	2	2	1		4	5	3	8
16 :30	17 :00				0	8	8	1	1	7	9	7	16
17 :00	17 :30	2			2	4	6	1	3	10	14	1	15
17 :30	18 :00				0	2	2		8	3	11	1	12
18 :00	18 :30				0	1	1		1		1		1
18 :30	19 :00				0	2	2		1		1		1
19 :00	19 :30				0	2	2				0		0
19 :30	20 :00				0		0				0		0
20 :00	20 :30				0		0				0		0
20 :30	21 :00				0		0				0		0
21 :00	21 :30				0		0				0		0
21 :30	22 :00				0		0				0		0
22 :00	22 :30				0		0				0		0
22 :30	23 :00				0		0				0		0
23 :00	23 :30				0		0				0		0
23 :30	24 :00				0		0				0		0
Total		11	30	13	54	65	119	19	18	34	71	72	143

Table 8.3-1 CALCULATION OF SEA TRANSPORT BENEFIT

River Mouths	Destination	Type	Hours Affected	Annual Net Product w/o Project (RM)	Annual Net Product w/ Project (RM)	Annual Benefit (RM)
Perlis	Langkawi	P.F.	21%	4,345,000	5,500,000	1,155,000
		C.F.	21%	453,460	574,000	120,540
					Total	1,275,540
Kedah	Langkawi	P.F.	15%	4,768,500	5,610,000	841,500
		C.F.	15%	3,850,500	4,530,000	679,500
					Total	1,521,000
Marang	Kapas	P.F.	10%	2,332,800	2,592,000	259,200
Mersing	Tioman	P.F.	10%	2,592,000	2,880,000	288,000
Terengganu	----	C.B.	12%	5,485,333	6,233,333	748,000

P.F. : passenger ferry C.F. : cargo ferry C.B. : cargo boat

Note :
Dredging works are briskly carried out at Perlis and Kedah river mouths to assure the navigation of ferry boats. The without project situation for these river mouths is thus assumed to be what would be without dredging. Net annual products are estimated as shown below.

River Mouth	*Type*	R. Trip *Charge* (RM)	Passengers, *Cars / Trip*	Annual R. *Trips*	Annual *Product* (RM)	Net Annual *Product (40%)* (RM)
Perlis (w/ Project)	P.F.	20	125	5,500	13,750,000	5,500,000
	C.F.	100	25	574	1,435,000	574,000
Kedah (w/ Project)	P.F.	60	125	1,870	14,025,000	5,610,000
	C.F.	300	25	1,510	11,325,000	4,530,000
Marang (w/o Project)	P.F.	30	12	16,200	5,832,000	2,332,800
Mersing (w/o Project)	P.F.	100	12	5,400	6,480,000	2,592,000
Terengganu (w/o Project)		---	---	680	13,713,333 *	5,485,333

* : Estimated from the figures of deep sea fishing boats which are similar to cargo boats in terms of size (running cost) and trip pattern.

Source : Marine Department (HQ, Perlis, Kedah and Terengganu)

Table 8.4-1 ANNUAL FISHERY BENEFITS OF THE REPRESENTATIVE RIVER MOUTHS

No.	River Mouth	Minimum Water Depth (m)	Unnavigable Hours				No. of Boats				Annual Benefit (thousand RM) *1				
			S	M	L	D	S	M	L	D	S	M	L	D	Total
1.	Perlis	1.0	3.07	4.96	5.77	6.00	151	205	46	30	1,015	3,191	1,561	840	6,607
2.	Kedah	1.5	1.56	3.64	4.96	5.96	154	266	73	42	526	3,038	2,130	1,168	6,862
3.	Tg. Piandang	1.5	0.87	3.21	5.00	5.99	480	5	0	0	915	50	0	0	965
4.	Beruas	1.8	0.35	2.03	3.29	5.73	284	357	10	3	218	2,274	194	80	2,766
5.	Kuantan	2.0	0.14	1.24	2.83	5.09	1	38	61	63	0	148	1,015	1,497	2,660
6.	Kerteh	1.2	1.48	3.88	5.09	5.95	44	7	0	0	143	85	0	0	228
7.	Marang	0.9	2.36	4.94	5.82	6.00	139	48	0	0	718	744	0	0	1,462
8.	Terengganu	2.5	0.00	0.10	1.00	4.04	38	49	10	10	0	15	59	189	263
9.	Oya	1.8	0.23	2.45	4.98	6.00	78	22	2	0	39	169	59	0	267
10.	Papar	1.5	0.90	4.15	5.75	6.00	123	0	0	0	242	0	0	0	242

S : Small boat (less than 10 GRT) M : Medium boat (10.0 - 39.9 GRT)
L : Large boat (40.0 - 69.9 GRT) D : Deep sea fishing boat (70.0 GRT and above)

Note
*1 : Calculation formulas are as follows:

Small boat; n*h*2190
Medium boat; n*h*3138
Large boat; n*h*5882
Deep sea boat;n*h*4668

where;
n : Number of boats
h : Unnavigable hours

Table 8.4-2 ANNUAL BENEFITS OF THE REPRESENTATIVE RIVER MOUTHS

Unit : '000 RM

No.	River Mouth	Annual Fishery Benefit *1					Sea Transport Benefit	Flood Mitigation Benefit	Total
		S	M	L	D	Total			
1.	Perlis	1,015	3,191	1,561	840	6,607	1,276	---	7,883
2.	Kedah	526	3,038	2,130	1,168	6,862	1,521	---	8,383
3.	Tg. Piandang	915	50	0	0	965	---	---	965
4.	Beruas	218	2,274	194	80	2,766	---	---	2,766
5.	Kuantan	0	148	1,015	1,497	2,660	---	---	2,660
6.	Kerteh	143	85	0	0	228	---	---	228
7.	Marang	718	744	0	0	1,462	230	---	1,692
8.	Terengganu	0	15	59	189	263	748	37	1,048
9.	Oya	39	169	59	0	267	---	---	267
10.	Papar	242	0	0	0	242	---	---	242

S : Small boat (less than 10 GRT) M : Medium boat (10.0 - 39.9 GRT)
L : Large boat (40.0 - 69.9 GRT) D : Deepsea fishing boat (70.0 GRT and above)

Table 8.4-3(1/2) BENEFITS OF THE MASTER PLAN OBJECTIVE RIVER MOUTHS
(under the present condition)

Group	No.	Serial No.	Name			Design Boat Size (GRT)	Annual Benefit ('000RM) Fishery	Sea Trans.	Flood Mit.	Total
A	1	45	Mersing		#	150	1,182	288		1,470
A	2	48	Rompin		#	70	143			143
A	3	61	Marang	*	#	40	1,462	259		1,721
A	4	81	Mukah		#	70	1,383			1,383
A	5	82	Balingian			40	63			63
A	6	84	Tatau			40	290			290
B	7	44	Sedili Besar		#	150	10			10
B	8	46	Endau		#	200	1,677			1,677
B	9	50	Nenasi		#	70	110			110
B	10	52	Terus			40	60			60
B	11	53	Kuantan	*	#	200	2,660			2,660
B	12	55	Kemaman		#	100	85			85
B	13	58	Paka		#	40	15			15
B	14	59	Dungun		#	100	88			88
B	15	60	Mercang			40	121			121
B	16	92	Tuaran			40	168			168
C	17	56	Kemasik			40	231			231
C	18	57	Kerteh	*		40	228			228
C	19	87	Sibuti			40	1			1
D	20	1	Perlis	*	#	150	6,607	1,276		7,883
D	21	25	Langat			40	0			0
D	22	99	Umas-umas			40	0			0
E	23	2	Baru		#	40	512			512
E	24	3	Sanglang		#	40	141			141
E	25	4	Jerlun		#	40	23			23
E	26	6	Yan		#	40	399			399
E	27	8	Cenang		#	40	169			169
E	28	12	Pinang		#	40	966			966
E	29	13	Bayan Lepas			40	485			485
E	30	14	Tg. Piandang	*	#	40	964			964
E	31	20	Batu			40	61			61
E	32	22	Lekir			40	110			110
E	33	24	Kapar Besar			40	325			325
E	34	26	Sepan Kecil			40	0			0
E	35	27	Sepang			40	0			0
E	36	30	Linggi		#	40	142			142
E	37	31	Baru			40	156			156
E	38	32	Melaka		#	40	17			17
E	39	33	Duyong			40	29			29
E	40	34	Umbai			40	50			50
E	41	35	Merlimau			40	67			67
E	42	37	Parit Jawa			40	243			243
E	43	40	Senggarang			40	31			31
E	44	41	Rengit			40	217			217
E	45	42	Benut			40	96			96
E	46	43	Pontian Kecil		#	40	631			631
E	47	98	Tawau		#	40	372			372
F	48	69	Sematan			40	4			4
F	49	70	Kayan			40	1			1
F	50	80	Oya	*	#	40	267			267
G	51	11	Kerian		#	40	31			31
G	52	15	Gula		#	70	152			152
G	53	16	Sangga			40	0			0
G	54	17	Larut			40	42			42
G	55	18	Terong			40	0			0
G	56	19	Beruas	*	#	100	2,765			2,765
G	57	23	Selangor		#	40	59			59
G	58	36	Muar			40	0			0
G	59	39	Batu Pahat			40	20			20
G	60	76	Buntal			40	314			314
G	61	77	Bako			40	49			49
G	62	78	Sadong		#	40	21			21
G	63	89	Padas		#	40	42			42
G	64	100	Kalabakan			40	0			0
H	65	51	Pahang		#	70	104		7	111
H	66	62	Terengganu	*	#	150	263	748	37	1,048
H	67	67	Kelantan		#	100	365		42	407
H	68	95	Sugut			40	0		0	0
I	69	38	Sarang Buaya			40	1			1
I	70	63	Merang			40	207			207
I	71	66	Pak Amat			40	223			223
I	72	90	Papar	*		40	242			242
J	73	5	Kedah	*	#	150	6,863	1,521		8,384
J	74	9	Muda		#	40	101			101
J	75	88	Lawas			40	162			162

* : Representative river mouth
\# : River mouths in critical category

All the river mouths --> 39,266
Critical category --> 34,969
Significant category --> 4,297

Table 8.4-3(2/2) BENEFITS OF THE MASTER PLAN OBJECTIVE RIVER MOUTHS
(in the target year 2005)

Group	No.	Serial No.	Name			Design Boat Size (GRT)	Annual Benefit ('000RM) Fishery	Sea Trans.	Flood Mit.	Total
A	1	45	Mersing		#	150	1,591	388		1,978
A	2	48	Rompin		#	70	192			192
A	3	61	Marang	*	#	40	1,968	349		2,316
A	4	81	Mukah		#	70	1,861			1,861
A	5	82	Balingian			40	85			85
A	6	84	Tatau			40	390			390
B	7	44	Sedili Besar		#	150	13			13
B	8	46	Endau		#	200	2,257			2,257
B	9	50	Nenasi		#	70	148			148
B	10	52	Terus			40	81			81
B	11	53	Kuantan	*	#	200	3,580			3,580
B	12	55	Kemaman		#	100	114			114
B	13	58	Paka		#	40	20			20
B	14	59	Dungun		#	100	118			118
B	15	60	Mercang			40	163			163
B	16	92	Tuaran			40	226			226
C	17	56	Kemasik			40	311			311
C	18	57	Kerteh	*		40	307			307
C	19	87	Sibuti			40	1			1
D	20	1	Perlis	*	#	150	8,892	1,717		10,609
D	21	25	Langat			40	0			0
D	22	99	Umas-umas			40	0			0
E	23	2	Baru		#	40	689			689
E	24	3	Sanglang		#	40	190			190
E	25	4	Jerlun		#	40	31			31
E	26	6	Yan		#	40	537			537
E	27	8	Cenang		#	40	227			227
E	28	12	Pinang		#	40	1,300			1,300
E	29	13	Bayan Lepas			40	653			653
E	30	14	Tg. Piandang	*	#	40	1,297			1,297
E	31	20	Batu			40	82			82
E	32	22	Lekir			40	148			148
E	33	24	Kapar Besar			40	437			437
E	34	26	Sepan Kecil			40	0			0
E	35	27	Sepang			40	0			0
E	36	30	Linggi		#	40	191			191
E	37	31	Baru			40	210			210
E	38	32	Melaka		#	40	23			23
E	39	33	Duyong			40	39			39
E	40	34	Umbai			40	67			67
E	41	35	Merlimau			40	90			90
E	42	37	Parit Jawa			40	327			327
E	43	40	Senggarang			40	42			42
E	44	41	Rengit			40	292			292
E	45	42	Benut			40	129			129
E	46	43	Pontian Kecil		#	40	849			849
E	47	98	Tawau		#	40	501			501
F	48	69	Sematan			40	5			5
F	49	70	Kayan			40	1			1
F	50	80	Oya	*	#	40	359			359
G	51	11	Kerian		#	40	42			42
G	52	15	Gula		#	70	205			205
G	53	16	Sangga			40	0			0
G	54	17	Larut			40	57			57
G	55	18	Terong			40	0			0
G	56	19	Beruas	*	#	100	3,721			3,721
G	57	23	Selangor		#	40	79			79
G	58	36	Muar			40	0			0
G	59	39	Batu Pahat			40	27			27
G	60	76	Buntal			40	423			423
G	61	77	Bako			40	66			66
G	62	78	Sadong		#	40	28			28
G	63	89	Padas		#	40	57			57
G	64	100	Kalabakan			40	0			0
H	65	51	Pahang		#	70	140		7	147
H	66	62	Terengganu	*	#	150	354	1,007	37	1,397
H	67	67	Kelantan		#	100	491		42	533
H	68	95	Sugut			40	0		0	0
I	69	38	Sarang Buaya			40	1			1
I	70	63	Merang			40	279			279
I	71	66	Pak Amat			40	300			300
I	72	90	Papar	*		40	326			326
J	73	5	Kedah	*	#	150	9,237	2,047		11,284
J	74	9	Muda		#	40	136			136
J	75	88	Lawas			40	218			218

* : Representative river mouth
\# : River mouths in critical category

All the river mouths --> 52,817
Critical category --> 47,033
Significant category --> 5,783

Table 8.4-4 COST-BENEFIT RATIOS OF THE MASTER PLAN OBJECTIVE RIVER MOUTHS

Group	Serial No.		Name			Design Boat Size (GRT)	Net Present Value (NPV) Project Benefit ('000RM)	Net Present Value (NPV) Economic Cost ('000RM)	B/C
A	1	45	Mersing		#	150	19,477	49,762	0.391
A	2	48	Rompin		#	70	1,895	20,307	0.093
A	3	61	Marang	*	#	40	22,802	15,254	1.495
A	4	81	Mukah		#	70	18,324	41,231	0.444
A	5	82	Balingian			40	835	45,320	0.018
A	6	84	Tatau			40	3,842	20,238	0.190
B	7	44	Sedili Besar		#	150	132	7,598	0.017
B	8	46	Endau		#	200	22,219	11,898	1.867
B	9	50	Nenasi		#	70	1,457	5,959	0.245
B	10	52	Terus			40	795	6,641	0.120
B	11	53	Kuantan	*	#	200	35,244	20,682	1.704
B	12	55	Kemaman		#	100	1,126	1,185	0.951
B	13	58	Paka		#	40	199	1,676	0.119
B	14	59	Dungun		#	100	1,166	4,949	0.236
B	15	60	Mercang			40	1,603	1,793	0.894
B	16	92	Tuaran			40	2,226	2,302	0.967
C	17	56	Kemasik			40	3,061	9,918	0.309
C	18	57	Kerteh	*		40	3,021	7,897	0.383
C	19	87	Sibuti			40	13	4,639	0.003
D	20	1	Perlis	*	#	150	104,446	43,468	2.403
D	21	25	Langat			40	0	156	0.000
D	22	99	Umas-umas			40	0	29	0.000
E	23	2	Baru		#	40	6,784	9,335	0.727
E	24	3	Sanglang		#	40	1,868	2,826	0.661
E	25	4	Jerlun		#	40	305	2,114	0.144
E	26	6	Yan		#	40	5,287	13,502	0.392
E	27	8	Cenang		#	40	2,239	13,129	0.171
E	28	12	Pinang		#	40	12,799	11,398	1.123
E	29	13	Bayan Lepas			40	6,426	12,417	0.517
E	30	14	Tg. Piandang	*	#	40	12,773	9,450	1.352
E	31	20	Batu			40	808	17,745	0.046
E	32	22	Lekir			40	1,457	13,399	0.109
E	33	24	Kapar Besar			40	4,306	8,663	0.497
E	34	26	Sepan Kecil			40	0	42	0.000
E	35	27	Sepang			40	0	0	0.000
E	36	30	Linggi		#	40	1,881	2,163	0.870
E	37	31	Baru			40	2,067	2,357	0.877
E	38	32	Melaka		#	40	225	868	0.259
E	39	33	Duyong			40	384	2,395	0.160
E	40	34	Umbai			40	662	2,396	0.276
E	41	35	Merlimau			40	888	1,610	0.552
E	42	37	Parit Jawa			40	3,220	3,610	0.892
E	43	40	Senggarang			40	411	3,201	0.128
E	44	41	Rengit			40	2,875	6,748	0.426
E	45	42	Benut			40	1,272	11,741	0.108
E	46	43	Pontian Kecil		#	40	8,360	5,871	1.424
E	47	98	Tawau		#	40	4,929	3,514	1.402
F	48	69	Sematan			40	53	1,472	0.036
F	49	70	Kayan			40	13	828	0.016
F	50	80	Oya	*	#	40	3,538	4,518	0.783
G	51	11	Kerian		#	40	411	3,285	0.125
G	52	15	Gula		#	70	2,014	25,142	0.080
G	53	16	Sangga			40	0	6,468	0.000
G	54	17	Larut			40	556	11,931	0.047
G	55	18	Terong			40	0	134	0.000
G	56	19	Beruas	*	#	100	36,635	16,422	2.231
G	57	23	Selangor		#	40	782	7,608	0.103
G	58	36	Muar			40	0	942	0.000
G	59	39	Batu Pahat			40	265	1,355	0.196
G	60	76	Buntal			40	4,160	12,096	0.344
G	61	77	Bako			40	649	8,080	0.080
G	62	78	Sadong		#	40	278	8,337	0.033
G	63	89	Padas		#	40	556	1,868	0.298
G	64	100	Kalabakan			40	0	145	0.000
H	65	51	Pahang		#	70	1,448	11,989	0.121
H	66	62	Terengganu	*	#	150	13,775	41,067	0.335
H	67	67	Kelantan		#	100	5,270	5,983	0.881
H	68	95	Sugut			40	0	358	0.000
I	69	38	Sarang Buaya			40	13	2,599	0.005
I	70	63	Merang			40	2,743	4,267	0.643
I	71	66	Pak Amat			40	2,955	7,162	0.413
I	72	90	Papar	*		40	3,206	3,293	0.974
J	73	5	Kedah	*	#	150	111,084	38,917	2.854
J	74	9	Muda		#	40	1,338	9,299	0.144
J	75	88	Lawas			40	2,146	5,338	0.402
			All the river mouths -->				519,998	724,299	0.718
			Critical category -->				463,065	472,575	0.980
			Significant category -->				56,933	251,723	0.226

Note
* : Representative river mouth
# : River mouths in critical category

Table 8.4-5 FACTORS FOR PRIORITIZATION

Serial No.	Name	State	Design Boat Size (GRT)	B/C Ratio	No. of Fishermen	Existence of LKIM Complex	Existence of DOF Fishing Base	Existence of Commercial Boat Jetty
1	Perlis	Perlis	150	2.40	2,333	yes		yes
2	Baru	Perlis	40	0.73	561			
3	Sanglang	Kedah	40	0.66	762			
4	Jerlun	Kedah	40	0.14	202			
5	Kedah	Kedah	150	2.85	1,716	yes	yes	yes
6	Yan	Kedah	40	0.39	493			
8	Cenang	Kedah	40	0.17	141			
9	Muda	P.Pinang	40	0.14	504			
11	Kerian	P.Pinang	40	0.13	693	*1		
12	Pinang	P.Pinang	40	1.12	700			
14	Tg. Piandang	Perak	40	1.35	1,042	*1		
15	Gula	Perak	70	0.08	308			
19	Beruas	Perak	100	2.23	1,595	*1		
23	Selangor	Selangor	40	0.10	397	*1		
30	Linggi	N.Sembilan	40	0.87	120	*1		
32	Melaka	Melaka	40	0.26	311	*1	yes	yes
43	Pontian Kecil	Johor	40	1.42	370	yes		
44	Sedili Besar	Johor	150	0.02	467	yes	yes	
45	Mersing	Johor	150	0.39	435	yes	yes	yes
46	Endau	Johor	200	1.87	327	yes		
48	Rompin	Pahang	70	0.09	405	yes		
50	Nenasi	Pahang	70	0.24	228	yes		
51	Pahang	Pahang	70	0.12	666	yes		
53	Kuantan	Pahang	200	1.70	570	yes	yes	yes
55	Kemaman	Terengganu	100	0.95	1,338	yes		yes
58	Paka	Terengganu	40	0.12	267	yes		
59	Dungun	Terengganu	100	0.24	848	yes		yes
61	Marang	Terengganu	40	1.49	715	yes		yes
62	Terengganu	Terengganu	150	0.34	417	yes	yes	yes
67	Kelantan	Kelantan	100	0.88	666	yes	yes	yes
78	Sadong	Sarawak	40	0.03	751			
80	Oya	Sarawak	40	0.78	292			
81	Mukah	Sarawak	70	0.44	556	yes		
89	Padas	Sabah	40	0.30	509			
98	Tawau	Sabah	40	1.40	400			
				Total	22,105			

Note *1 : LKIM complex is to be constructed.

Table 8.4-6(1/4) INITIAL AND ANNUAL O&M COSTS OF CRITICAL GROUP RIVER MOUTHS IN ORDER OF PRIORITY
(Case 1-1 & 1-3)

(Total costs in 5 years are equalized.) (Unit: '000 RM)

Priority	Serial	Name	State	Initial Cost	O&M Cost (Per Year)
	1	Perlis	Perlis	10,134	2,526
	5	Kedah	Kedah	8,437	2,327
	14	Tg. Piandang	Perak	2,668	508
	19	Beruas	Perak	4,465	897
	46	Endau	Johor	1,726	785
First	51	Pahang	Pahang	10,024	59
	61	Marang	Terengganu	12,639	73
	67	Kelantan	Kelantan	4,810	28
	81	Mukah	Sarawak	35,080	204
				89,983	7,407
	2	Baru	Perlis	1,396	613
	8	Cenang	Kedah	2,092	850
	9	Muda	P.Pinang	1,044	641
	12	Pinang	P.Pinang	1,817	738
	15	Gula	Perak	3,241	1,696
	23	Selangor	Selangor	920	519
Second	32	Melaka	Melaka	118	58
	43	Pontian Kecil	Johor	795	393
	44	Sedili Besar	Johor	841	525
	53	Kuantan	Pahang	3,706	1,302
	62	Terengganu	Terengganu	26,452	943
	59	Dungun	Terengganu	534	343
				42,956	8,621
	3	Sanglang	Kedah	382	189
	6	Yan	Kedah	2,086	880
Third	30	Linggi	Melaka	345	140
	45	Mersing	Johor	42,322	241
	55	Kemaman	Terengganu	94	85
				45,229	1,535
	4	Jerlun	Kedah	286	141
	11	Kerian	P.Pinang	397	224
	48	Rompin	Pahang	16,614	98
Forth	50	Nenasi	Pahang	474	428
	58	Paka	Terengganu	122	122
	78	Sadong	Sarawak	1,008	568
	80	Oya	Sarawak	2,107	168
	89	Padas	Sabah	226	127
	98	Tawau	Sabah	560	228
				21,794	2,104

Table 8.4-6(2/4) INITIAL AND ANNUAL O&M COSTS OF CRITICAL GROUP RIVER MOUTHS IN ORDER OF PRIORITY
(Case 1-2)

(Total costs in 5 years are equalized.) (Unit: '000 RM)

Priority	Serial	Name	State	Initial Cost	O&M Cost (Per Year)
	1	Perlis	Perlis	10,134	2,526
	2	Baru	Perlis	1,396	613
	5	Kedah	Kedah	8,437	2,327
	9	Muda	P.Pinang	1,044	641
	12	Pinang	P.Pinang	1,817	738
	14	Tg. Piandang	Perak	2,668	508
First	15	Gula	Perak	3,241	1,696
	19	Beruas	Perak	4,465	897
	23	Selangor	Selangor	920	519
	46	Endau	Johor	1,726	785
	51	Pahang	Pahang	10,024	59
	61	Marang	Terengganu	12,639	73
	67	Kelantan	Kelantan	4,810	28
	81	Mukah	Sarawak	35,080	204
				98,401	11,614
	3	Sanglang	Kedah	382	189
	30	Linggi	Melaka	345	140
	32	Melaka	Melaka	118	58
	43	Pontian Kecil	Johor	795	393
Second	44	Sedili Besar	Johor	841	525
	45	Mersing	Johor	42,322	241
	48	Rompin	Pahang	16,614	98
	55	Kemaman	Terengganu	94	85
	59	Dungun	Terengganu	534	343
	78	Sadong	Sarawak	1,008	568
				63,053	2,640
	4	Jerlun	Kedah	286	141
	6	Yan	Kedah	2,086	880
	8	Cenang	Kedah	2,092	850
	11	Kerian	P.Pinang	397	224
	50	Nenasi	Pahang	474	428
Third	53	Kuantan	Pahang	3,706	1,302
	58	Paka	Terengganu	122	122
	62	Terengganu	Terengganu	26,452	943
	80	Oya	Sarawak	2,107	168
	89	Padas	Sabah	226	127
	98	Tawau	Sabah	560	228
				38,508	5,413

Table 8.4-6(3/4) INITIAL AND ANNUAL O&M COSTS OF CRITICAL GROUP RIVER MOUTHS IN ORDER OF PRIORITY (Case 2-1 & 2-3)

(Initial costs are equalized.) (Unit: '000 RM)

Priority	Serial	Name	State	Initial Cost	O&M Cost (Per Year)
	1	Perlis	Perlis	10,134	2,526
	5	Kedah	Kedah	8,437	2,327
	14	Tg. Piandang	Perak	2,668	508
	19	Beruas	Perak	4,465	897
	30	Linggi	Melaka	345	140
First	46	Endau	Johor	1,726	785
	53	Kuantan	Pahang	3,706	1,302
	59	Dungun	Terengganu	534	343
	61	Marang	Terengganu	12,639	73
	67	Kelantan	Kelantan	4,810	28
				49,464	8,929
	9	Muda	P.Pinang	1,044	641
	23	Selangor	Selangor	920	519
	32	Melaka	Melaka	118	58
	43	Pontian Kecil	Johor	795	393
Second	44	Sedili Besar	Johor	841	525
	51	Pahang	Pahang	10,024	59
	55	Kemaman	Terengganu	94	85
	81	Mukah	Sarawak	35,080	204
	98	Tawau	Sabah	560	228
				49,476	2,712
	2	Baru	Perlis	1,396	613
	3	Sanglang	Kedah	382	189
	8	Cenang	Kedah	2,092	850
	12	Pinang	P.Pinang	1,817	738
Third	45	Mersing	Johor	42,322	241
	50	Nenasi	Pahang	474	428
	80	Oya	Sarawak	2,107	168
	89	Padas	Sabah	226	127
				50,816	3,354
	4	Jerlun	Kedah	286	141
	6	Yan	Kedah	2,086	880
	11	Kerian	P.Pinang	397	224
	15	Gula	Perak	3,241	1,696
Forth	48	Rompin	Pahang	16,614	98
	58	Paka	Terengganu	122	122
	62	Terengganu	Terengganu	26,452	943
	78	Sadong	Sarawak	1,008	568
				50,206	4,672

Table 8.4-6(4/4) INITIAL AND ANNUAL O&M COSTS OF CRITICAL GROUP RIVER MOUTHS IN ORDER OF PRIORITY
(Case 2-2)

(Initial costs are equalized.) (Unit: '000 RM)

Priority	Serial	Name	State	Initial Cost	O&M Cost (Per Year)
	1	Perlis	Perlis	10,134	2,526
	2	Baru	Perlis	1,396	613
	5	Kedah	Kedah	8,437	2,327
	9	Muda	P.Pinang	1,044	641
	12	Pinang	P.Pinang	1,817	738
First	14	Tg. Piandang	Perak	2,668	508
	15	Gula	Perak	3,241	1,696
	19	Beruas	Perak	4,465	897
	23	Selangor	Selangor	920	519
	46	Endau	Johor	1,726	785
	51	Pahang	Pahang	10,024	59
	53	Kuantan	Pahang	3,706	1,302
	61	Marang	Terengganu	12,639	73
	67	Kelantan	Kelantan	4,810	28
				67,027	12,712
	3	Sanglang	Kedah	382	189
	8	Cenang	Kedah	2,092	850
	30	Linggi	Melaka	345	140
	32	Melaka	Melaka	118	58
	43	Pontian Kecil	Johor	795	393
Second	44	Sedili Besar	Johor	841	525
	45	Mersing	Johor	42,322	241
	48	Rompin	Pahang	16,614	98
	50	Nenasi	Pahang	474	428
	55	Kemaman	Terengganu	94	85
	59	Dungun	Terengganu	534	343
	78	Sadong	Sarawak	1,008	568
	98	Tawau	Sabah	560	228
				66,179	4,146
	4	Jerlun	Kedah	286	141
	6	Yan	Kedah	2,086	880
	11	Kerian	P.Pinang	397	224
Third	58	Paka	Terengganu	122	122
	62	Terengganu	Terengganu	26,452	943
	80	Oya	Sarawak	2,107	168
	81	Mukah	Sarawak	35,080	204
	89	Padas	Sabah	226	127
				66,756	2,809

Table 8.4-7 COST DISBURSEMENT SCHEDULE OF THE FIRST PHASE PROJECT

(Unit : '000 RM)

Case	Item	Malaysia Plan 7th	8th	9th	10th
(Total costs are equalized.)					
Case 1-1	No. of River Mouths	21	35	35	35
	Initial Cost	132,939	67,023		
	Maintenance Cost	40,070	89,238	98,335	98,335
	Total Cost	173,009	156,261	98,335	98,335
Case 1-2	No. of River Mouths	14	24	35	35
	Initial Cost	98,401	63,053	38,508	
	Maintenance Cost	29,035	64,670	84,803	98,335
	Total Cost	127,436	127,723	123,311	98,335
Case 1-3	No. of River Mouths	9	21	26	35
	Initial Cost	89,983	42,956	45,229	21,794
	Maintenance Cost	18,518	58,588	83,978	93,075
	Total Cost	108,501	101,544	129,207	114,869
(Initial costs are equalized.)					
Case 2-1	No. of River Mouths	19	35	35	35
	Initial Cost	98,940	101,022		
	Maintenance Cost	29,103	78,270	98,335	98,335
	Total Cost	128,043	179,292	98,335	98,335
Case 2-2	No. of River Mouths	14	27	35	35
	Initial Cost	67,027	66,179	66,756	
	Maintenance Cost	31,780	73,925	91,313	98,335
	Total Cost	98,807	140,104	158,069	98,335
Case 2-3	No. of River Mouths	10	19	27	35
	Initial Cost	49,464	49,476	50,816	50,206
	Maintenance Cost	22,323	51,425	66,590	86,655
	Total Cost	71,787	100,901	117,406	136,861

Note : No. of fishermen : 22,105
Maintenance cost per capita : RM98,335 / 22,105 / 5years = RM 890/person
Average product per capita : RM 22,155
Burden for maintenance : 890 / 22,155 = 4%
Per kilogram of product : RM 2.1/kg x 4% = RM 0.084/kg

Table 8.4-8 PRIORITIZATION OF RIVER MOUTHS FOR FIRST PHASE PROJECT

(Unit: '000 RM)

Priority/ Expected Construction Period	Serial	Name	State	Initial Cost	O&M Cost (Per Year)	Agency Concerned
	1	Perlis	Perlis	10,134	2,526	MOT
	5	Kedah	Kedah	8,437	2,327	MOT
First Priority	14	Tg. Piandang	Perak	2,668	508	MOA
	19	Beruas	Perak	4,465	897	MOA
(The First Half	30	Linggi	Melaka	345	140	MOA
of the 7th	46	Endau	Johor	1,726	785	MOA
Malaysia Plan)	53	Kuantan	Pahang	3,706	1,302	MOA
	59	Dungun	Terengganu	534	343	MOT
	61	Marang	Terengganu	12,639	73	MOA
	67	Kelantan	Kelantan	4,810	28	MOT
				49,464	8,929	
	9	Muda	P.Pinang	1,044	641	MOA
Second Priority	23	Selangor	Selangor	920	519	MOA
	32	Melaka	Melaka	118	58	MOA
(The Latter Half	43	Pontian Kecil	Johor	795	393	MOA
of the 7th	44	Sedili Besar	Johor	841	525	MOA
Malaysia Plan)	51	Pahang	Pahang	10,024	59	MOA
	55	Kemaman	Terengganu	94	85	MOA
	81	Mukah	Sarawak	35,080	204	MOA
	98	Tawau	Sabah	560	228	MOA
				49,476	2,712	
	2	Baru	Perlis	1,396	613	MOA
Third Priority	3	Sanglang	Kedah	382	189	MOA
	8	Cenang	Kedah	2,092	850	MOA
(The First Half	12	Pinang	P.Pinang	1,817	738	MOA
of the 8th	45	Mersing	Johor	42,322	241	MOT
Malaysia Plan)	50	Nenasi	Pahang	474	428	MOA
	80	Oya	Sarawak	2,107	168	MOA
	89	Padas	Sabah	226	127	MOA
				50,816	3,354	
	4	Jerlun	Kedah	286	141	MOA
Forth Priority	6	Yan	Kedah	2,086	880	MOA
	11	Kerian	P.Pinang	397	224	MOA
(The Latter Half	15	Gula	Perak	3,241	1,696	MOA
of the 8th	48	Rompin	Pahang	16,614	98	MOA
Malaysia Plan)	58	Paka	Terengganu	122	122	MOA
	62	Terengganu	Terengganu	26,452	943	MOT
	78	Sadong	Sarawak	1,008	568	MOA
				50,206	4,672	

Table 8.4-9 ANNUAL CASH FLOW OF THE FIRST PHASE PROJECT

Unit : '000 RM

No.	Year	Economic Project Cost*1			Benefit			Annual Cash Flow
		Capital	Maintenance	Total	1st & 2nd Group	3rd & 4th Group	Total	
1	1996	24,240	0	24,240	0	0	0	-24,240
2	1997	24,240	2,852	27,091	6,828	0	6,828	-20,263
3	1998	24,240	5,703	29,943	13,930	0	13,930	-16,013
4	1999	24,240	8,556	32,796	21,312	0	21,312	-11,484
5	2000	24,240	11,408	35,648	28,983	0	28,983	-6,665
6	2001	24,749	14,260	39,009	36,952	0	36,952	-2,057
7	2002	24,749	16,226	40,975	37,690	1,395	39,086	-1,889
8	2003	24,749	18,192	42,941	38,443	2,846	41,289	-1,651
9	2004	24,749	20,159	44,908	39,211	4,354	43,565	-1,343
10	2005	24,749	22,125	46,874	39,994	5,921	45,916	-959
11	2006		24,091	24,091	39,994	7,023	47,017	22,926
12	2007		24,091	24,091	39,994	7,023	47,017	22,926
13	2008		24,091	24,091	39,994	7,023	47,017	22,926
14	2009		24,091	24,091	39,994	7,023	47,017	22,926
15	2010		24,091	24,091	39,994	7,023	47,017	22,926
16	2011		24,091	24,091	39,994	7,023	47,017	22,926
17	2012		24,091	24,091	39,994	7,023	47,017	22,926
18	2013		24,091	24,091	39,994	7,023	47,017	22,926
19	2014		24,091	24,091	39,994	7,023	47,017	22,926
20	2015		24,091	24,091	39,994	7,023	47,017	22,926
21	2016		24,091	24,091	39,994	7,023	47,017	22,926
22	2017		24,091	24,091	39,994	7,023	47,017	22,926
23	2018		24,091	24,091	39,994	7,023	47,017	22,926
24	2019		24,091	24,091	39,994	7,023	47,017	22,926
25	2020		24,091	24,091	39,994	7,023	47,017	22,926
26	2021		24,091	24,091	39,994	7,023	47,017	22,926
27	2022		24,091	24,091	39,994	7,023	47,017	22,926
28	2023		24,091	24,091	39,994	7,023	47,017	22,926
29	2024		24,091	24,091	39,994	7,023	47,017	22,926
30	2025		24,091	24,091	39,994	7,023	47,017	22,926
31	2026		24,091	24,091	39,994	7,023	47,017	22,926
32	2027		24,091	24,091	39,994	7,023	47,017	22,926
33	2028		24,091	24,091	39,994	7,023	47,017	22,926
34	2029		24,091	24,091	39,994	7,023	47,017	22,926
35	2030		24,091	24,091	39,994	7,023	47,017	22,926
36	2031		24,091	24,091	39,994	7,023	47,017	22,926
37	2032		24,091	24,091	39,994	7,023	47,017	22,926
38	2033		24,091	24,091	39,994	7,023	47,017	22,926
39	2034		24,091	24,091	39,994	7,023	47,017	22,926
40	2035		24,091	24,091	39,994	7,023	47,017	22,926

*1 : Conversion rate = 0.88

Internal Rate of Return (IRR) = 11.52%

B/C (annual discount rate ; 8%) = 1.138

Table 8.5-1 ANNUAL CASH FLOW OF TG. PIANDANG RIVER MOUTH IMPROVEMENT PROJECT

Unit : '000 RM

No.	Year	Economic Project Cost					Fishery Benefit	Annual Cash Flow
		Construction	Eng. and Admi.	Physical Conti.	Maintenance	Total		
1	1994		88.0	8.8		96.8		-96.8
2	1995	1,294.5	59.0	135.3		1,488.8		-1,488.8
3	1996		60.0	6.0	528.0	594.0	899.4	305.4
4	1997		60.0	6.0	528.0	594.0	891.8	297.8
5	1998		60.0	6.0	528.0	594.0	884.2	290.2
6	1999		60.0	6.0	528.0	594.0	876.6	282.6
7	2000		60.0	6.0	528.0	594.0	869.0	275.0
8	2001		60.0	6.0	528.0	594.0	862.0	268.0
9	2002		60.0	6.0	528.0	594.0	855.0	261.0
10	2003		60.0	6.0	528.0	594.0	848.0	254.0
11	2004		60.0	6.0	528.0	594.0	841.0	247.0
12	2005		60.0	6.0	528.0	594.0	834.0	240.0
13	2006		60.0	6.0	528.0	594.0	834.0	240.0
14	2007		60.0	6.0	528.0	594.0	834.0	240.0
15	2008		60.0	6.0	528.0	594.0	834.0	240.0
16	2009		60.0	6.0	528.0	594.0	834.0	240.0
17	2010		60.0	6.0	528.0	594.0	834.0	240.0
18	2011		60.0	6.0	528.0	594.0	834.0	240.0
19	2012		60.0	6.0	528.0	594.0	834.0	240.0
20	2013		60.0	6.0	528.0	594.0	834.0	240.0
21	2014		60.0	6.0	528.0	594.0	834.0	240.0
22	2015		60.0	6.0	528.0	594.0	834.0	240.0
23	2016		60.0	6.0	528.0	594.0	834.0	240.0
24	2017		60.0	6.0	528.0	594.0	834.0	240.0
25	2018		60.0	6.0	528.0	594.0	834.0	240.0
26	2019		60.0	6.0	528.0	594.0	834.0	240.0
27	2020		60.0	6.0	528.0	594.0	834.0	240.0
28	2021		60.0	6.0	528.0	594.0	834.0	240.0
29	2022		60.0	6.0	528.0	594.0	834.0	240.0
30	2023		60.0	6.0	528.0	594.0	834.0	240.0
31	2024		60.0	6.0	528.0	594.0	834.0	240.0
32	2025		60.0	6.0	528.0	594.0	834.0	240.0
33	2026		60.0	6.0	528.0	594.0	834.0	240.0
34	2027		60.0	6.0	528.0	594.0	834.0	240.0
35	2028		60.0	6.0	528.0	594.0	834.0	240.0
36	2029		60.0	6.0	528.0	594.0	834.0	240.0
37	2030		60.0	6.0	528.0	594.0	834.0	240.0
38	2031		60.0	6.0	528.0	594.0	834.0	240.0
39	2032		60.0	6.0	528.0	594.0	834.0	240.0
40	2033		60.0	6.0	528.0	594.0	834.0	240.0

Internal Rate of Return (IRR) = 16.98%

B/C (annual discount rate ; 8%) = 1.173

Table 8.6-1 ECONOMIC COST OF MARANG RIVER MOUTH IMPROVEMENT PROJECT

(Unit : RM)

Description	Amount	Firat Year (1994)	Second Year (1995)	Third Year (1996)
I. Main Construction	10,315,360	-	5,942,640	4,372,720
1. Preparatory Works	938,080	-	540,320	397,760
2. Breakwater	2,495,680	-	2,495,680	0
3. North Jetty	2,441,120	-	2,441,120	0
4. South Jetty	1,528,560	-	0	1,528,560
5. Coastal Groin	1,117,600	-	0	1,117,600
6. River Groin	172,480		172,480	0
7. Navigation Channel Work	1,139,600	-	0	1,139,600
8. Reservoir	36,080	-	36,080	0
9. Miscellaneous Works	446,160	-	256,960	189,200
II. Compensation	-	-	0	0
III. Engineering and Administration Cost	1,172,000	469,000	387,000	316,000
IV. Physical Contingency	1,148,736	46,900	632,964	468,872
TOTAL	12,636,096	515,900	6,962,604	5,157,592

Table 8.6-2 ANNUAL CASH FLOW OF MARANG RIVER MOUTH IMPROVEMENT PROJECT

Unit : '000 Ringgit

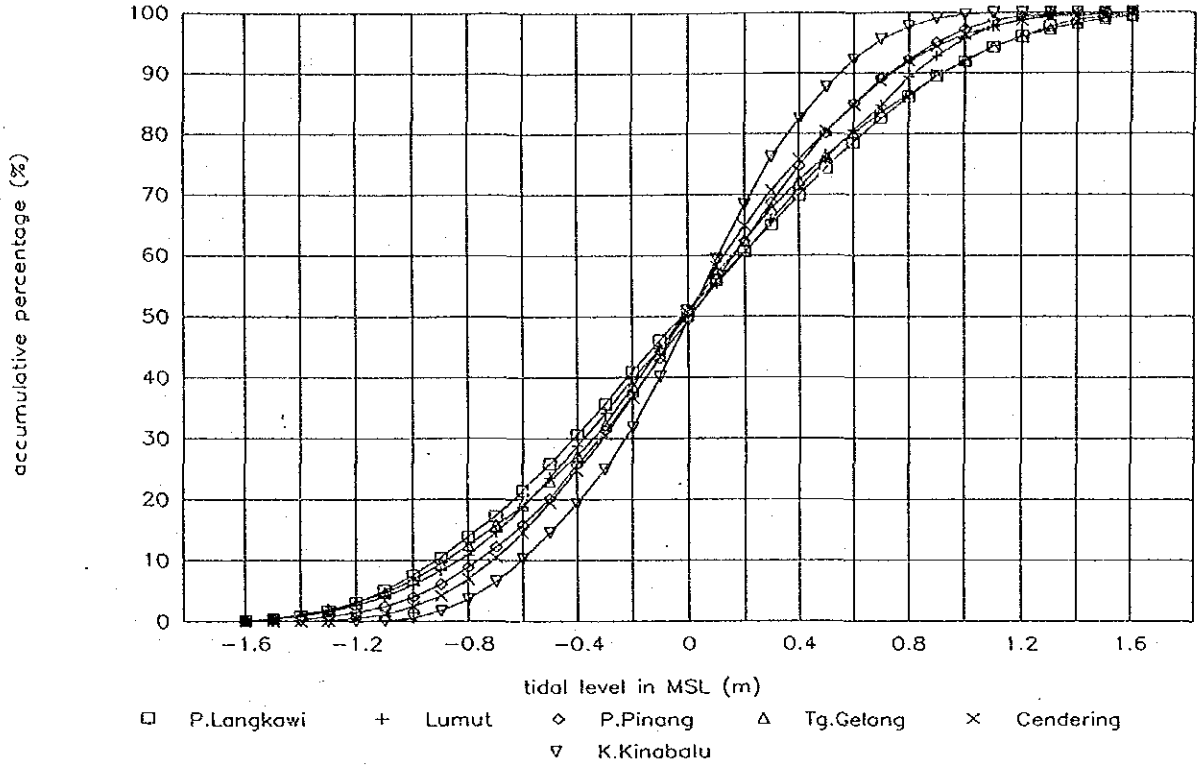
No.	Year	Economic Project Cost					Benefit			Annual Cash Flow
		Construction	Eng. & Admi.	Physical Conti.	Maintenance	Total	Fishery	Sea Trans.	Total	
1	1994		469.0	46.9		515.9				-515.9
2	1995	5,942.6	387.0	633.0		6,962.6				-6,962.6
3	1996	4,372.7	316.0	468.9		5,157.6	745.8	183.3	929.1	-4,228.5
4	1997		21.0	2.1	181.3	204.4	1,152.6	281.0	1,433.6	1,229.2
5	1998		21.0	2.1	181.3	204.4	1,186.4	286.0	1,472.4	1,268.0
6	1999		21.0	2.1	181.3	204.4	1,220.2	292.0	1,512.2	1,307.8
7	2000		21.0	2.1	181.3	204.4	1,254.0	298.0	1,552.0	1,347.6
8	2001		21.0	2.1	181.3	204.4	1,287.6	304.0	1,591.6	1,387.2
9	2002		21.0	2.1	181.3	204.4	1,321.2	310.0	1,631.2	1,426.8
10	2003		21.0	2.1	181.3	204.4	1,354.8	316.0	1,670.8	1,466.4
11	2004		21.0	2.1	181.3	204.4	1,388.4	322.0	1,710.4	1,506.0
12	2005		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
13	2006		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
14	2007		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
15	2008		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
16	2009		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
17	2010		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
18	2011		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
19	2012		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
20	2013		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
21	2014		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
22	2015		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
23	2016		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
24	2017		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
25	2018		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
26	2019		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
27	2020		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
28	2021		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
29	2022		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
30	2023		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
31	2024		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
32	2025		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
33	2026		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
34	2027		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
35	2028		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
36	2029		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
37	2030		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
38	2031		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
39	2032		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
40	2033		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6

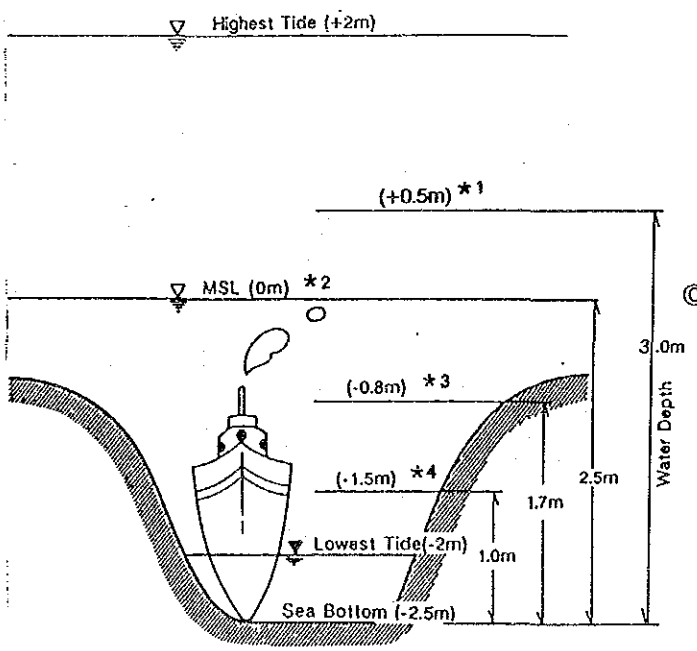
Internal Rate of Return (IRR) = 11.12%

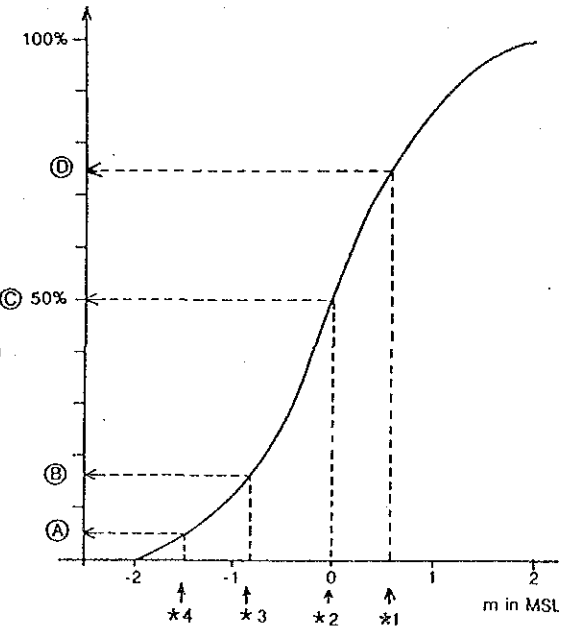
B/C (annual discount rate ; 8%) = 1.302

Note : It is assumed that 2/3 (66.6%) of the benefit in 1996 may accrue due to progress of dredging works.

FIGURES

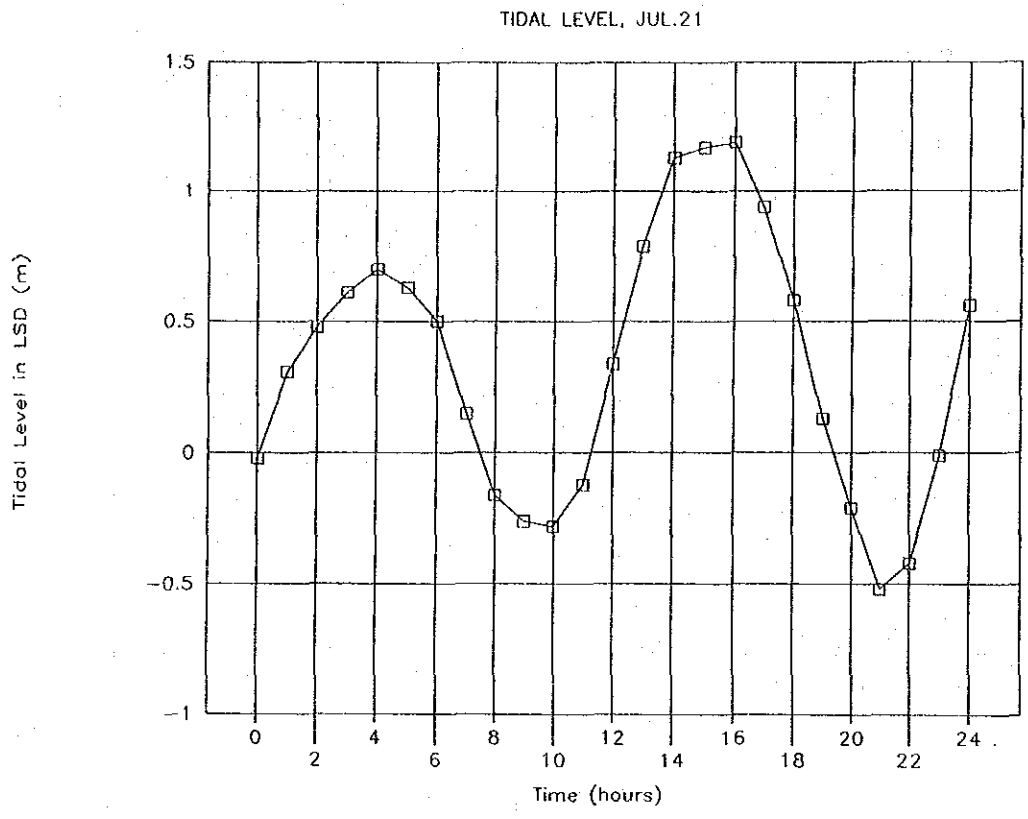


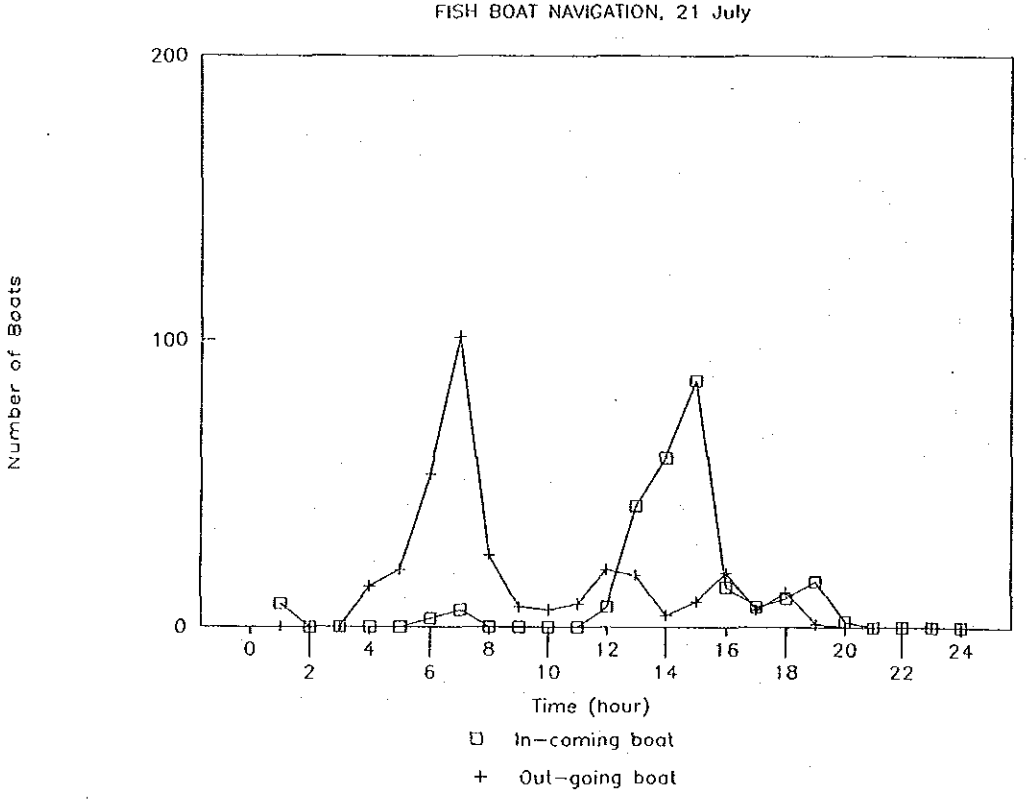




Boat Size	Required Water Depth	Period Affected (%)
Small	1.0 m	A
Medium	1.7 m	B
Large	2.2 m	C
Deepsea	3.0 m	D

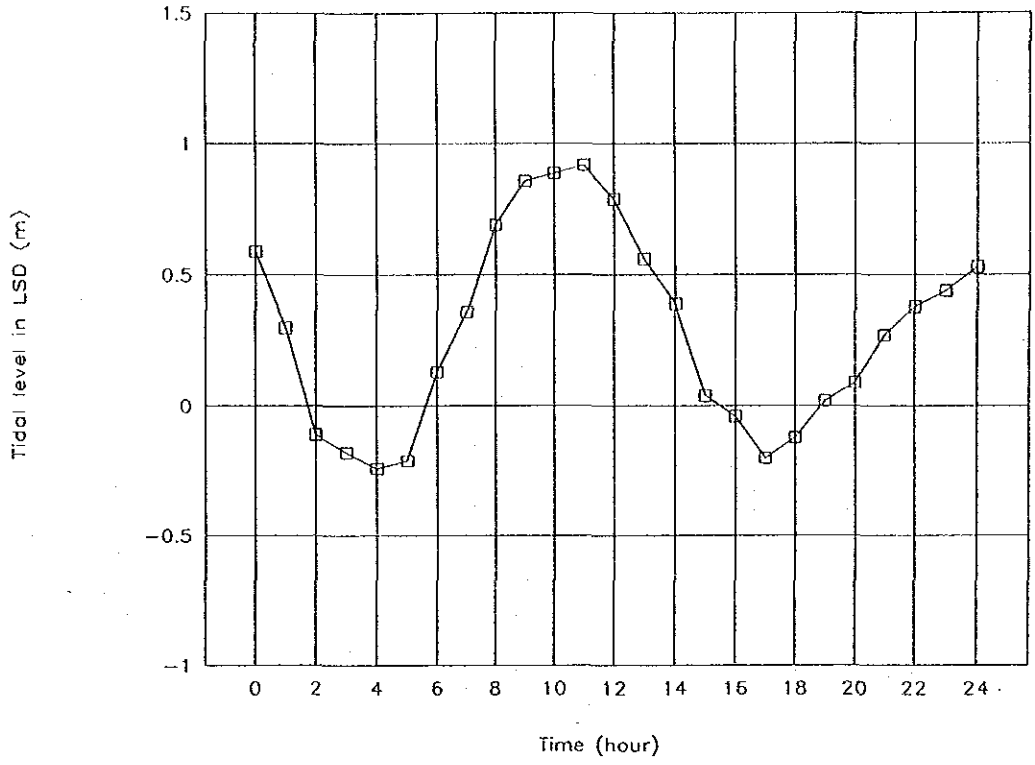
THE NATIONAL RIVER MOUTHS STUDY IN MALAYSIA JAPAN INTERNATIONAL COOPERATION AGENCY	FREQUENCY DISTRIBUTION OF HOURLY TIDAL LEVELS AT DIFFERENT STATIONS Fig. 8.2-1



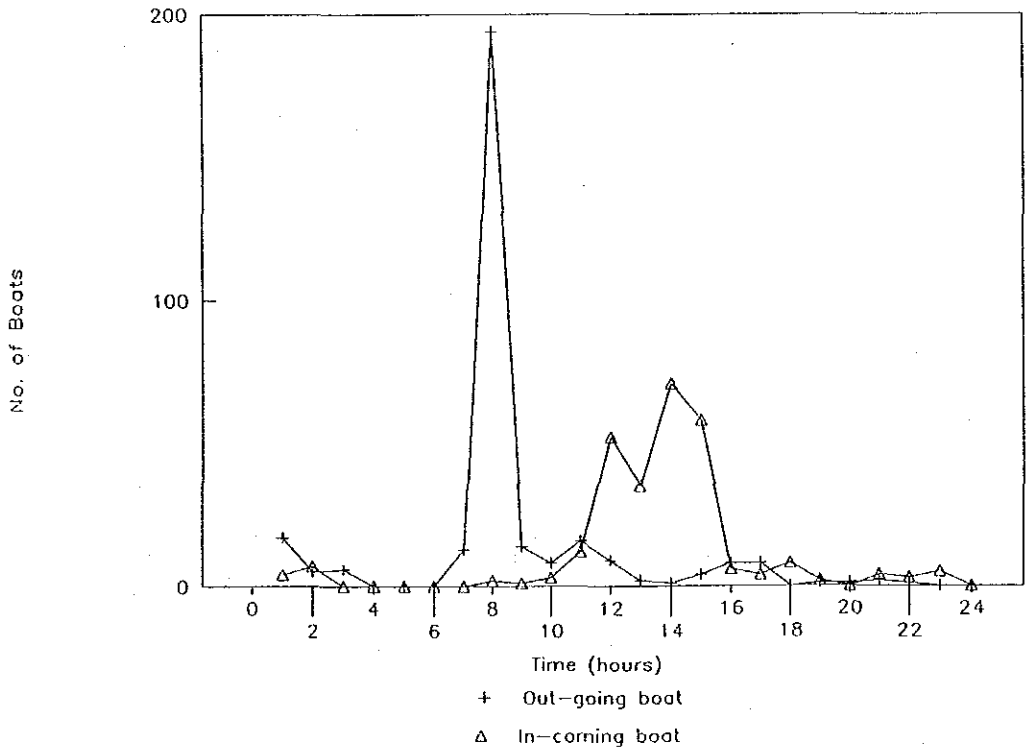


THE NATIONAL RIVER MOUTHS STUDY IN MALAYSIA	TIDAL LEVEL AND BOAT NAVIGATION AT TG. PIANDANG ON JULY 21, 1993 Fig. 8.2-2
JAPAN INTERNATIONAL COOPERATION AGENCY	

TIDAL LEVEL, JUN.30

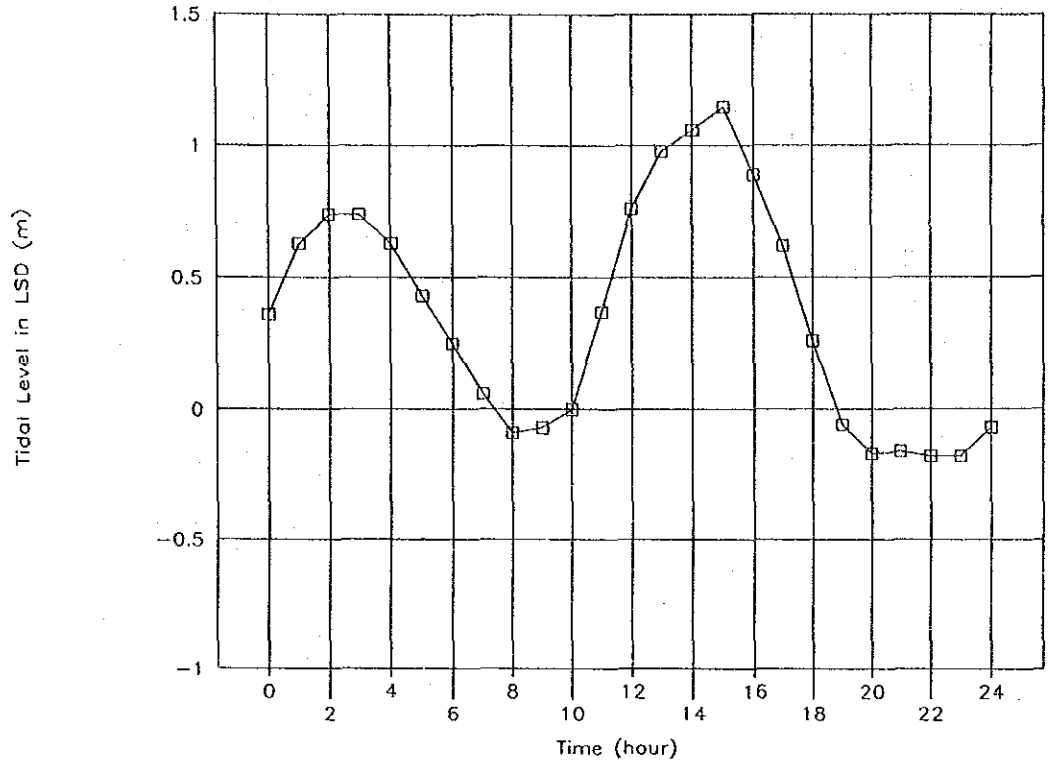


FISH BOAT NAVIGATION, JUN.30

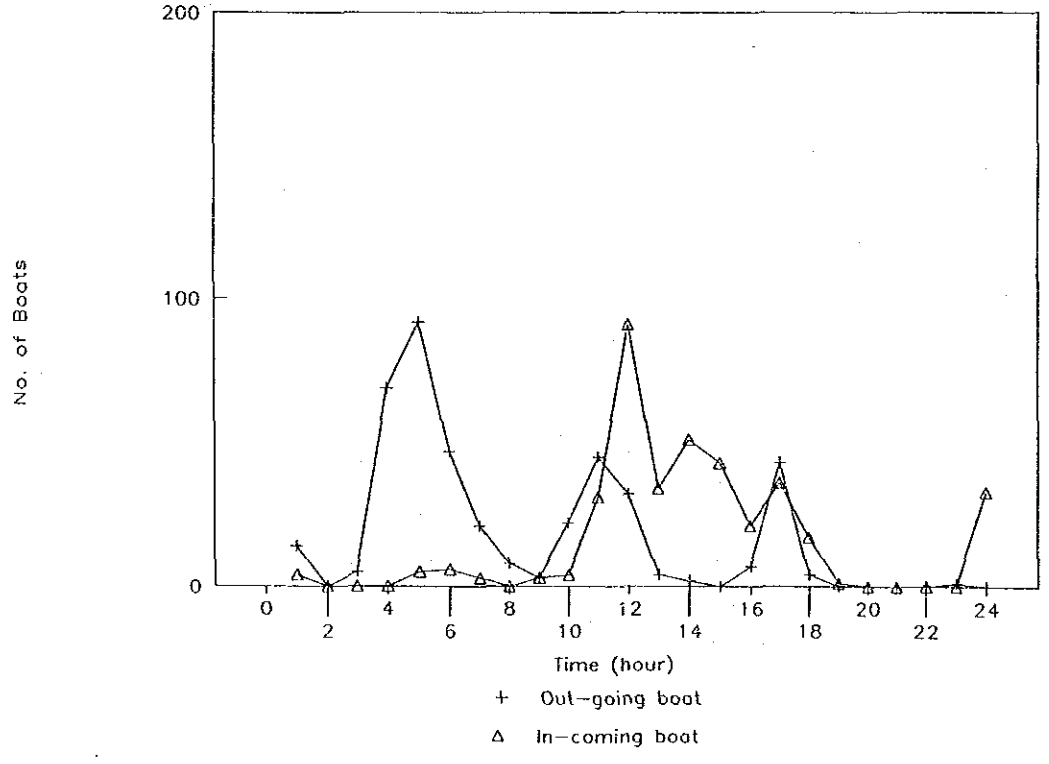


THE NATIONAL RIVER MOUTHS STUDY IN MALAYSIA	TIDAL LEVEL AND BOAT NAVIGATION AT TG. PIANDANG ON JUNE 30, 1993 Fig. 8.2-3
JAPAN INTERNATIONAL COOPERATION AGENCY	

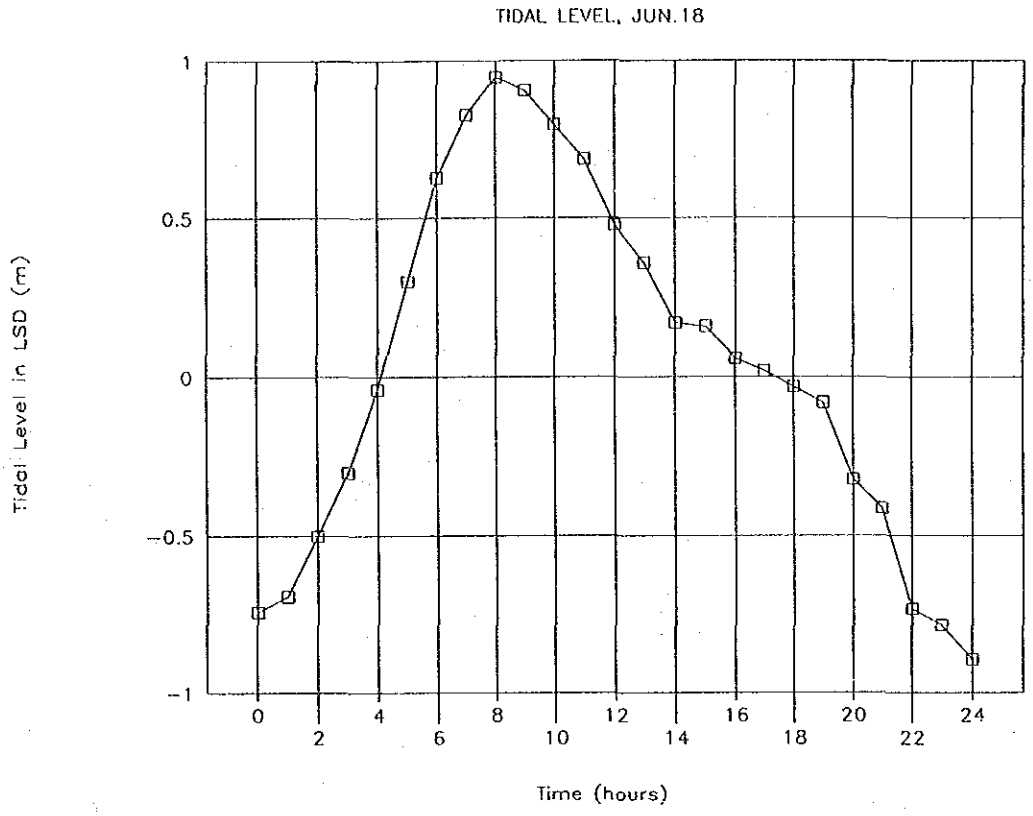
TIDAL LEVEL, JUL.4

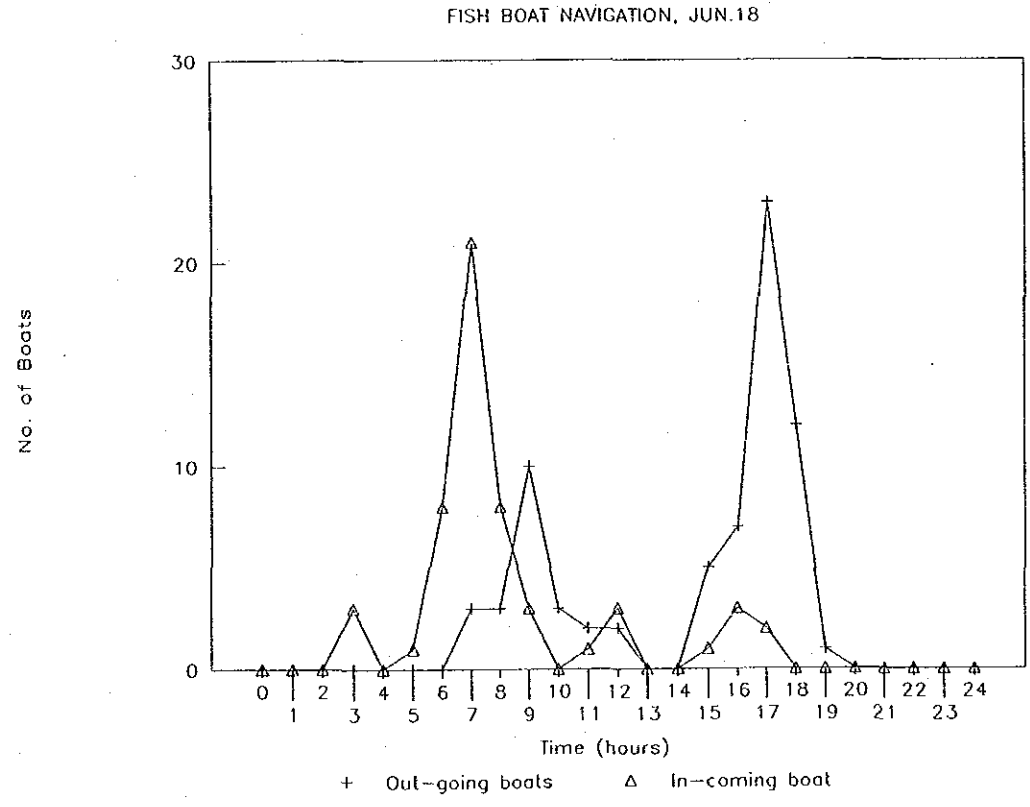


FISH BOAT NAVIGATION, JUL.4



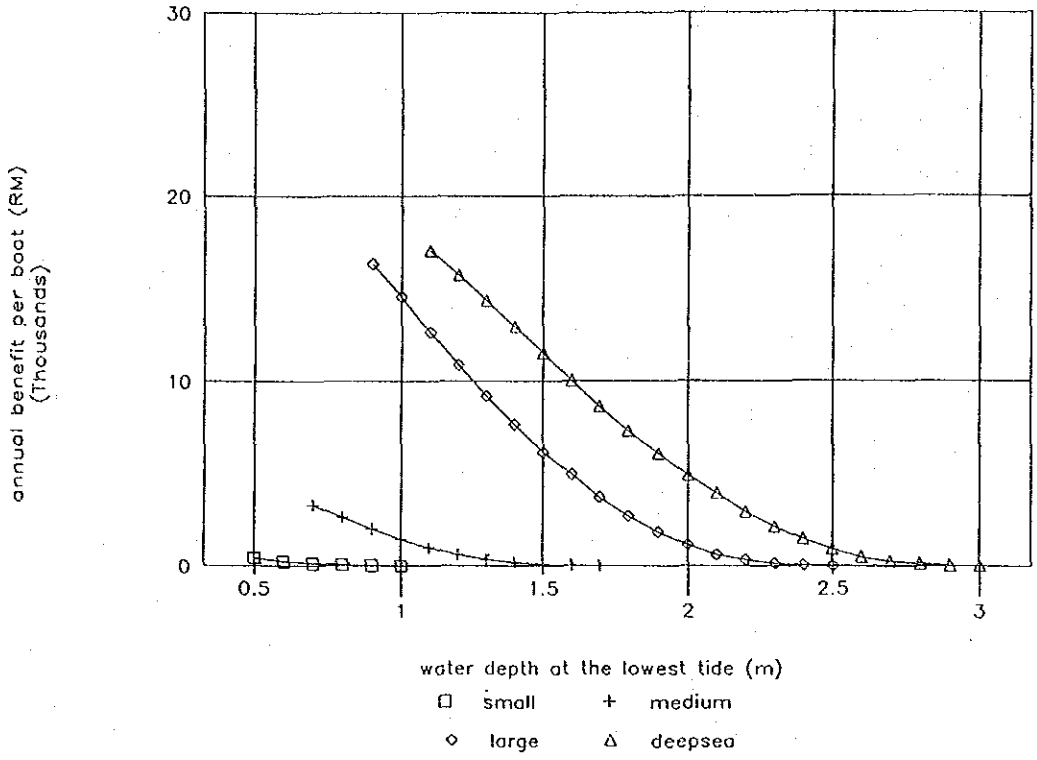
THE NATIONAL RIVER MOUTHS STUDY IN MALAYSIA	TIDAL LEVEL AND BOAT NAVIGATION AT TG. PIANDANG ON JULY 4, 1993
JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. 8.2-4



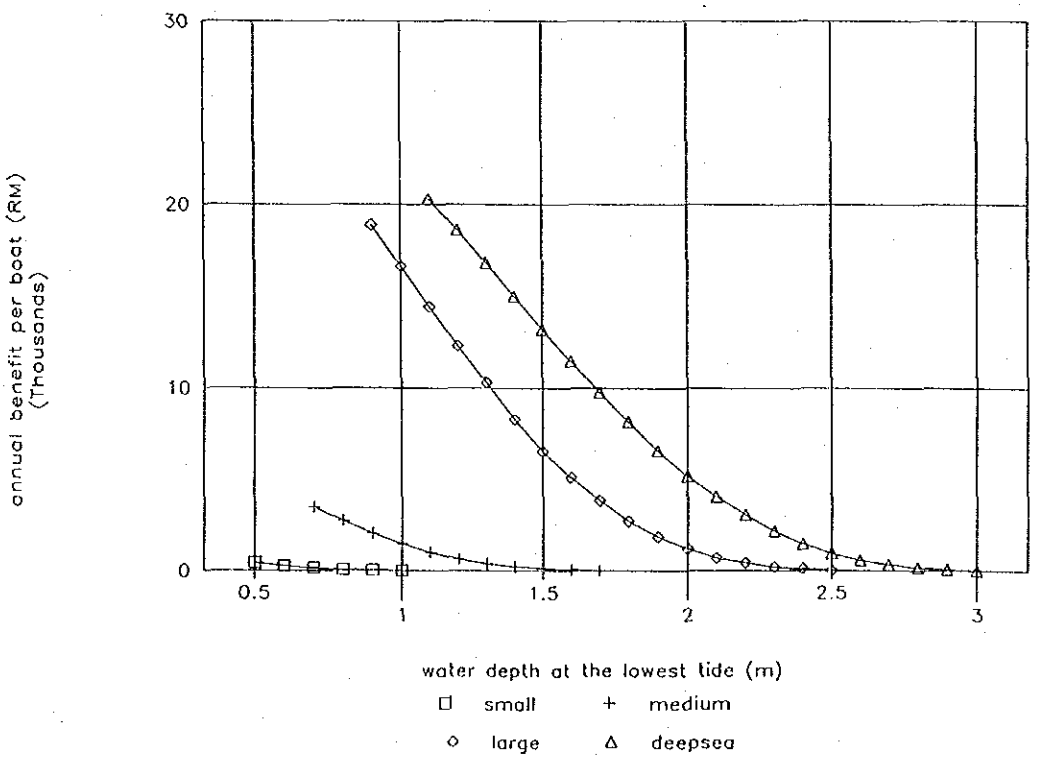


THE NATIONAL RIVER MOUTHS STUDY IN MALAYSIA	TIDAL LEVEL AND BOAT NAVIGATION AT MARANG RIVER MOUTH ON JUNE 18, 1993 Fig. 8.2-5
JAPAN INTERNATIONAL COOPERATION AGENCY	

Perlis & Kedah (Sta. P. Langkawi)

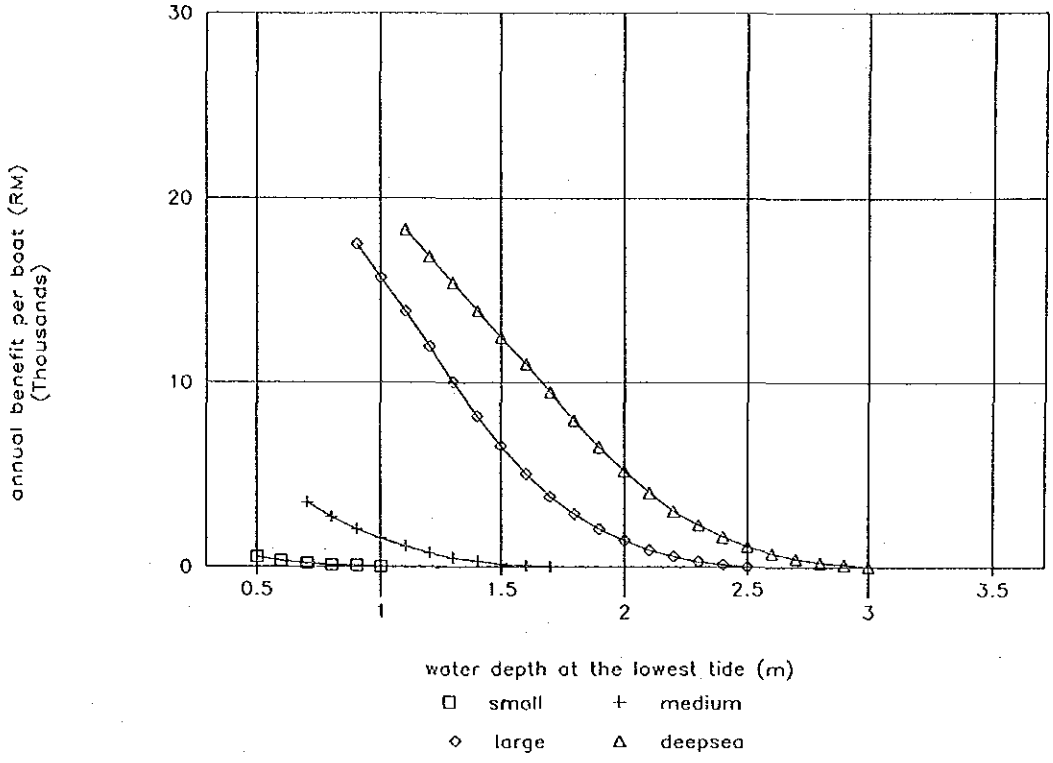


Tg. Piandang (Sta. P. Pinang)

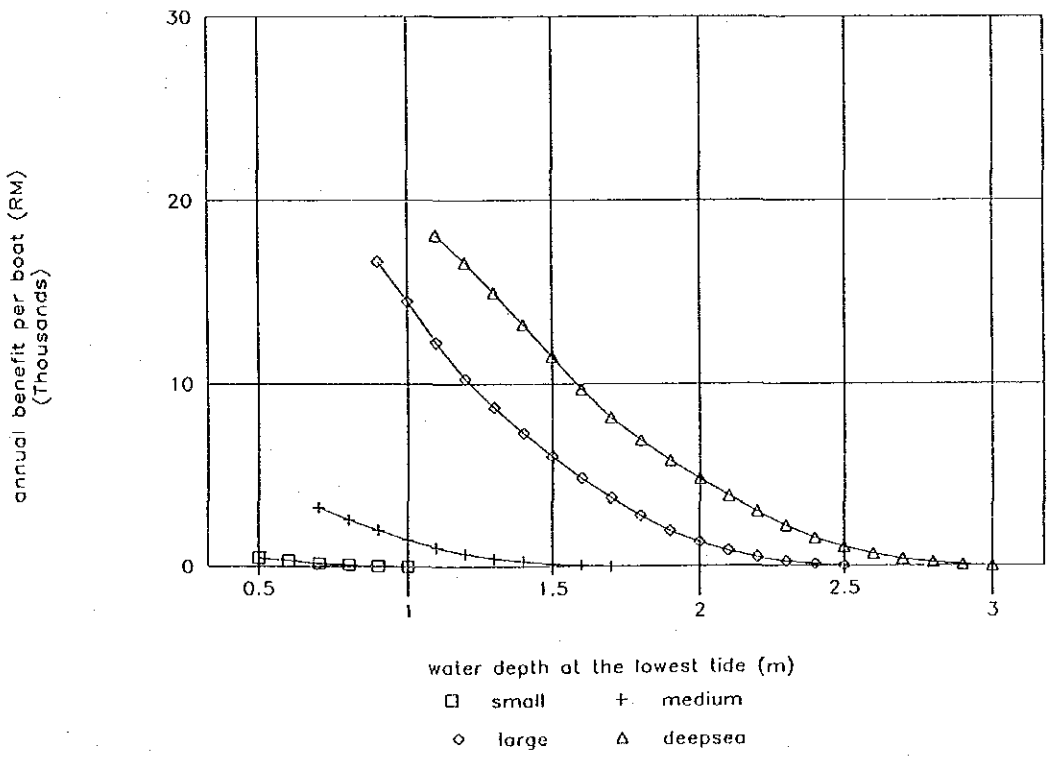


THE NATIONAL RIVER MOUTHS STUDY IN MALAYSIA	RELATION BETWEEN MINIMUM WATER DEPTH AND ANNUAL BENEFIT PER BOAT
JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. 8.4-1(1/3)

Beruas (Sta. Lumut)

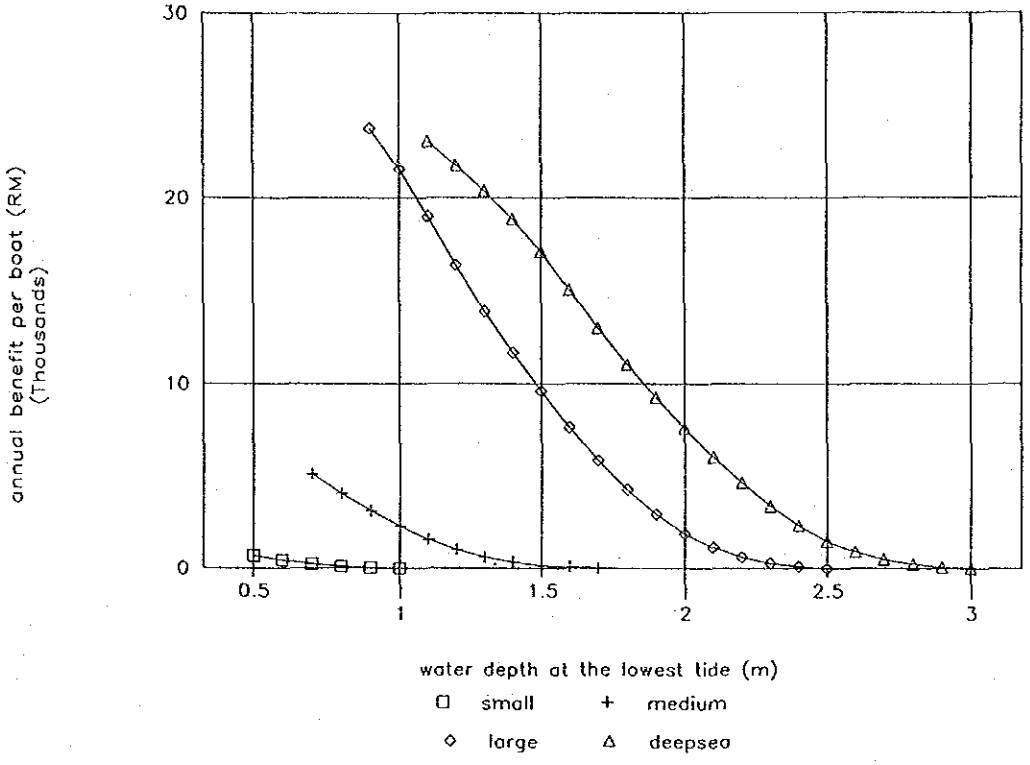


Kuantan & Kerteh (Sta. Tg. Gelang)

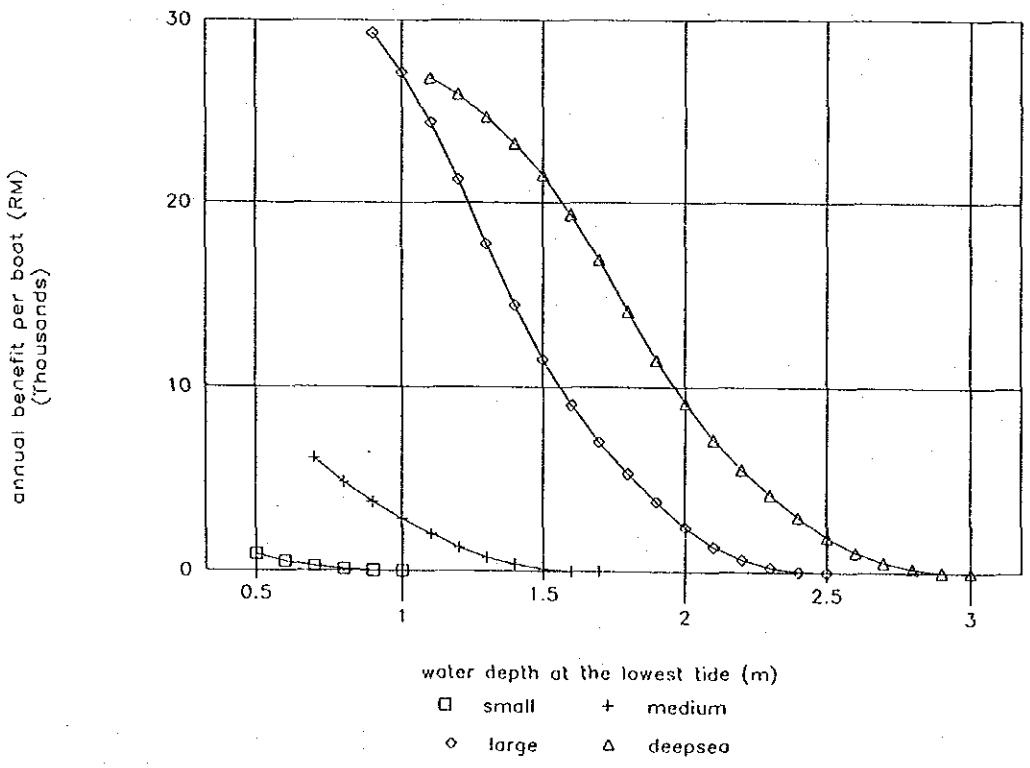


THE NATIONAL RIVER MOUTHS STUDY IN MALAYSIA JAPAN INTERNATIONAL COOPERATION AGENCY	RELATION BETWEEN MINIMUM WATER DEPTH AND ANNUAL BENEFIT PER BOAT Fig. 8.4-1(2/3)

Marang & Terengganu (Sta. Cendering)

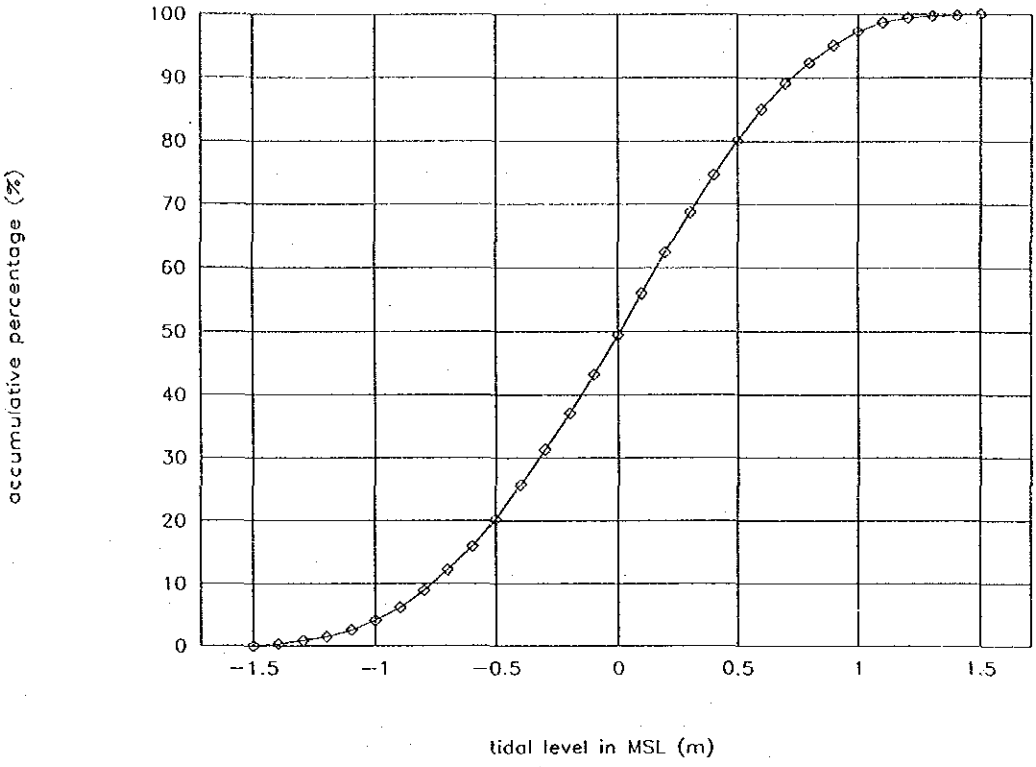


Oya & Papar (Sta. Kota Kinabalu)



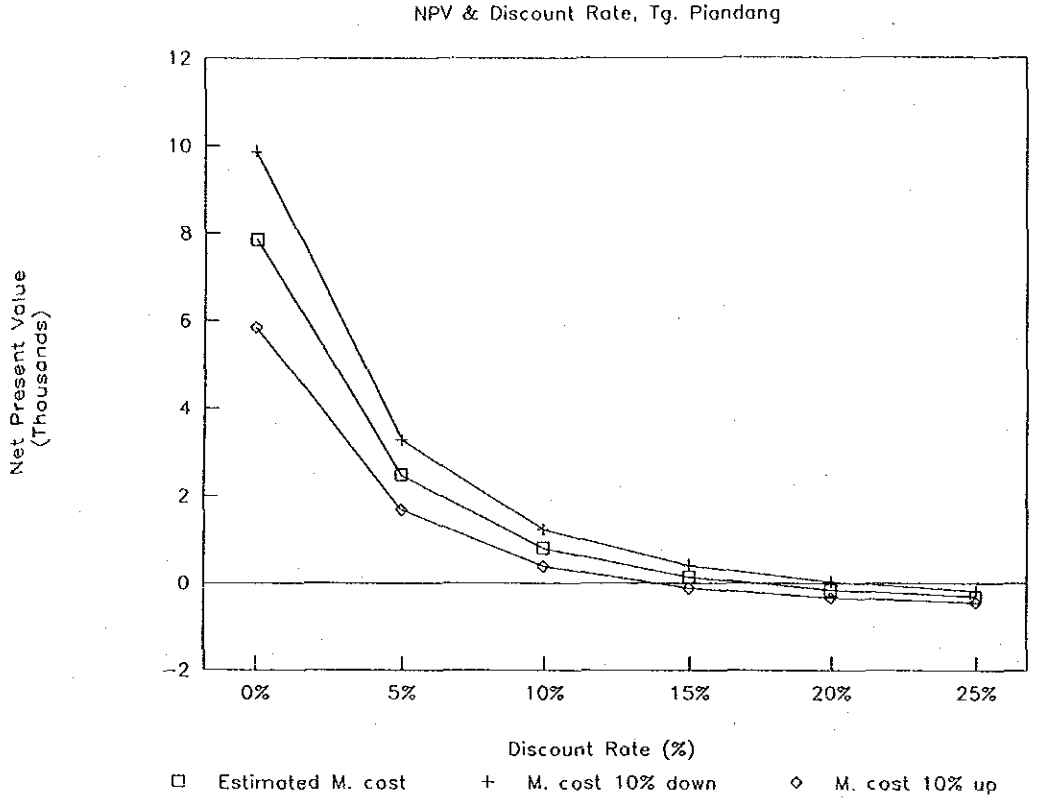
THE NATIONAL RIVER MOUTHS STUDY IN MALAYSIA JAPAN INTERNATIONAL COOPERATION AGENCY	RELATION BETWEEN MINIMUM WATER DEPTH AND ANNUAL BENEFIT PER BOAT Fig. 8.4-1(3/3)

FREQUENCY DISTRIBUTION OF TIDAL LEVELS



MSL (m)	Distribution (%)	Accumulation (%)
-1.5	0.00	0.00
-1.4	0.30	0.30
-1.3	0.50	0.80
-1.2	0.60	1.40
-1.1	1.10	2.50
-1.0	1.50	4.00
-0.9	2.10	6.10
-0.8	2.70	8.80
-0.7	3.40	12.20
-0.6	3.70	15.90
-0.5	4.30	20.20
-0.4	5.50	25.70
-0.3	5.60	31.30
-0.2	5.80	37.10
-0.1	6.10	43.20
0.0	6.20	49.40
0.1	6.60	56.00
0.2	6.40	62.40
0.3	6.30	68.70
0.4	6.00	74.70
0.5	5.40	80.10
0.6	5.00	85.10
0.7	4.00	89.10
0.8	3.20	92.30
0.9	2.80	95.10
1.0	2.20	97.30
1.1	1.40	98.70
1.2	0.70	99.40
1.3	0.30	99.70
1.4	0.10	99.80
1.5	0.20	100.00

THE NATIONAL RIVER MOUTHS STUDY IN MALAYSIA	FREQUENCY DISTRIBUTION OF HOURLY TIDAL LEVELS AT KEDAH PIER STATION IN 1990 Fig. 8.5-1
JAPAN INTERNATIONAL COOPERATION AGENCY	



IRR is a value (i) which can satisfy the following formula:

$$\sum_{n=1}^{N} \frac{B_n - C_n}{(1+i)^n} = 0$$

where;

B_n : Benefit in the n-th year
C_n : Cost in the n-th year
i : Annual discount rate (%)
N : Number of years (project life)

THE NATIONAL RIVER MOUTHS STUDY IN MALAYSIA	SENSITIVITY OF ECONOMIC VIABILITY BY CHANGES OF MAINTENANCE COST Fig. 8.5-2
JAPAN INTERNATIONAL COOPERATION AGENCY	