CHAPTER 5. PROJECT EVALUATION

5.1 Project Cost Estimation

5.1.1 Estimation Bases

The estimated project cost, which covers construction cost as well as operation and maintenance cost for all components of the optimum drainage plan, is based on the following premises:

(1) Basic Unit Cost

Unit costs are estimated from the data published by the Department of Statistics, Ministry of Finance and the DID district offices. According to these data, there is no significant difference in the prevailing market prices in the study areas of Sungai Petani and Melaka. Therefore, the cost estimate applies the same basic unit costs as shown in Table 5-1.

(2) Materials and Equipment

All construction materials and equipment employed in this study are expected to be manufactured and/or available at the construction stage in Malaysia. Therefore, all prices of materials and equipment are estimated in Malaysian Ringgit.

(3) Components of Construction Cost and Currency Conversion Rate

Construction cost is composed of direct cost, indirect cost and compensation cost. The assumed indirect cost which consists of engineering services cost, administration cost and contractor's profit is 20% of the direct cost.

(4) Currency Conversion Rate

All costs are estimated in Malaysian Ringgit (RM) using the currency conversion rates of US$1.00 = RM 3.8 = 121.4 Yen prevailing in May 1999.

5.1.2 Construction Work Volume

The estimated construction work volume of proposed drainage facilities has its basis on the preliminary design of facilities described in Subsection 4.5. The results of estimation are summarized below.

Work Item	Unit	Work Volume		
		Sg. Petani	Melaka	Total
1. Channel Improvement				
Number of Channels		44	24	68
Channel Length	km	42.0	36.5	78.5
Earth Works	$1000m^3$	651.5	832.3	1,483.8
Concrete Works	$1000m^3$	145.2	172.0	317.1
Number of Box Culverts to be Reconstructed		14.0	14.0	28.0
Number of Bridges to be Reconstructed		101	57	158
2. Rehabilitation of Existing Detention Pond				
Number of Ponds		12	1	13
Area of Pond	ha	18.2	2.6	20.8
Catchment Area	ha	802.7	61.1	863.8
Earth Works	$1000m^3$	55.2	54.8	110.0
Surface Protection (Turfing and stone pitching)	$1000m^2$	394.2	33.1	427.3
Concrete Works	$1000m^3$	6.7	0.2	6.9
Metal Works	ton	36.0	2.8	38.8
Road Works	$1000m^2$	39.2	5.7	44.9
3. Construction of New Detention Pond				
Area of Pond	km^2	1.8	2.5	4.3
Catchment Area	km^2	46.0	63.6	109.6
Earth Works	$1000m^3$	7,141.4	9,869.8	17,011.2
Stone-pitching	$1000m^2$	410.8	567.8	978.6
Turfing	$1000m^3$	1,695.0	2,942.6	4,637.6
R.C. Structure	$1000m^3$	62.4	86.2	148.6
Metal Works	ton	207.0	286.0	492.0
Road Works	$1000m^2$	512.3	708.0	1,220.3
4. Construction of Storage Facility in Public Open Space				
Area of Open Space	km^2	0.3	1.4	1.7
Earth Works	$1000m^3$	80.2	422.0	502.2
Bottom Surface Protection (Turfing)	$1000m^2$	267.2	1,406.9	1,674.0
R.C. Structure	$1000m^3$	4.8	25.3	30.1
Metal Works	ton	3.3	17.6	20.9

5.1.3 Project Cost

The estimated project cost of the optimum drainage plan has its basis on the aforesaid work volume and basic unit cost. The results of estimation are summarized below.

(Unit: RM million out of Parentheses and Million Yen in Parentheses)

Item	Sungai Petani		Melaka		Total	
1. Construction Cost						
Channel Improvement	46.60	(1,489)	56.35	(1,800)	102.95	(3,289)
Rehabilitation of Existing Detention Pond	5.57	(178)	0.45	(14)	6.02	(192)
Construction of New Detention Pond	120.92	(3,863)	167.11	(5,339)	288.03	(9,202)
Storage Facility in Public Open Space	3.05	(97)	16.04	(512)	19.09	(609)
Total	176.13	(5,627)	239.95	(7,665)	416.08	(13,292)
2. Annual Operation and maintenance Cost						
Drainage Channel	0.20	(6)	0.22	(7)	0.42	(13)
Detention Pond	1.93	(62)	2.67	(85)	4.61	(147)
Total	2.13	(68)	2.89	(92)	5.02	(160)

5.2 Financial Affordability

5.2.1 Budget Allocated to Urban Drainage Improvement

The proposed urban drainage improvement project requires a budget for its construction as well as operation and maintenance. To evaluate the financial viability of the proposed project, clarified was the recent budget allocated to urban drainage improvement in Malaysia.

Budgetary allocations for urban drainage in Malaysia are in three (3) tiers of government: Federal, State and Local. Federal and state funds are allocated independently for different urban drainage works. A major part of the local funds is, however, dependent on the federal funds. Among the government agencies in the Federal and State governments, the Department of Irrigation and Drainage (DID) is the principal implementing agency responsible for urban drainage improvement. The Federal DID has undertaken the "Master Drainage Plans" for 26 regional town centers in the country since the "Third Five-Year Malaysia Plan" starting in 1976. The State DID had also implemented the urban drainage improvement for major towns located within its jurisdiction area. As for the local governments, the local authorities have the responsibility for prevention of flash floods that may occur due to clogging of drains by rubbish and silt.

As stated above, the principal implementation agencies for urban drainage improvement are the Federal DID, the State DID and the Local Authority. Their budgetary allocations for urban drainage works are as described below.

(1) Budget for Federal DID

The total federal budget as well as the budget allocated to Federal DID are as listed below:

(Unit: RM million)

Item	1994	1995	1996	1997	1998	Ave.
Federal Budget						
Total Budget	46,341	50,624	58,493	60,415	62,687	55,712
For Infrastructure Development	790	654	733	1,496	1,968	1,128
Budget of Federal DID						
Total Budget	218	239	285	268	312	264
For Flood Mitigation	87	99	140	141	166	127

As listed above, the federal budget allocated for infrastructure development has considerably increased from RM 790 million in 1994 to RM 1,968 million in 1998, which could be attributed to the Government's intention for building up a better living condition for the people. In conformity with this trend, the total budget of Federal DID

has also increased from RM 218 million in 1994 to RM 312 million in 1998. The budget for flood mitigation and urban drainage had also drastically increased from RM 87 million in 1994 to RM 166 million in 1998.

(2) Budget for State DID

The budgets of DID Kedah and DID Melaka for the recent five years (1995-1999) are as listed below:

(Unit: RM million)

Item	1994	1995	1996	1997	1998	Ave.
Budget of DID Kedah						
Total Budget	6.4	6.1	7.5	7.3	8.1	7.1
For Infrastructure Development	n.a.	0.5	0.5	0.7	1.1	0.7
Budget of DID Melaka						
Total Budget	7.3	4.5	4.2	1.0	1.5	3.7
For Flood Mitigation	2.3	2.8	2.1	2.1	2.1	2.3

Out of the state budget, DID Kedah had secured the average annual budget of RM 7.1 million, while DID Melaka had RM 3.7 million. Thus, DID Melaka had a far smaller budget than the DID Kedah. In spite of its smaller budget, DID Melaka allocated an annual budget for urban drainage works larger than that of DID Kedah. That is, the average annual budget for the State of Kedah was RM 0.7 million for the period 1995-1999, while that for the State of Melaka was RM 2.3 million. It is however noted that the budget for DID Kedah tended to increase and reached RM 1.1 million in 1999. On the other hand, the budget for DID of Melaka fluctuated only within a small range.

(3) Budget for Local Authority

The following table gives a summary of the budget for the local authorities of Sg. Petani and Melaka allocated to drainage development and maintenance works.

(Unit: RM million)

Item	1994	1995	1996	1997	1998	Ave.
Budget for L. A. of Sg. Petani						
Drainage Development	0.25	0.25	0.20	0.55	0.25	0.30
Drainage Maintenance	0.40	0.40	0.45	0.10	0.40	0.35
Total	0.65	0.65	0.65	0.65	0.65	0.65
Budget for L. A. of Melaka						
Drainage Development	2.00	7.00	5.00	4.00	3.40	4.28
Drainage Maintenance	1.70	1.70	1.70	3.70	2.20	2.20
Total	3.70	8.70	6.70	7.70	5.60	6.48

As shown above, the annual budget for the Local Authority of Sg. Petani was rather regular and constant at RM 0.65 million throughout the period 1995-1999. This was divided into RM 0.30 million for drainage development and RM 0.35 million for drainage maintenance on the average. In contrast, the Local Authority of Melaka could have secured more active and affordable budget for urban drainage works. That is, its average annual budget for the period 1995-1999 was RM 6.5 million, out of which RM 4.3 million was for drainage development and RM 2.2 million for drainage maintenance.

5.2.2 Budgetary Affordability for Urban Drainage Works

The project cost of the optimum drainage improvement plan is classified into the following two (2) components: (a) construction cost and (b) operation and maintenance cost. These cost components have been compared with the budget allocated for urban drainage improvement mentioned above, and financial affordability is evaluated as described hereinafter.

(1) Affordability of Construction Cost

The construction cost of the proposed optimum urban drainage improvement plan is estimated at about RM 416 million, as described in Subsection 5.1.3. The construction cost is further divided into the following four (4) items:

Item	Cost (RM million)
(a) Channel improvement cost	102.95
(b) Rehabilitation cost of existing flood detention ponds	6.02
(c) Construction cost of new flood detention ponds	288.03
(d) Construction cost of storage facilities in public open space	19.09
Total	416.08

Among the above items, Items (a) to (c) are oriented to basin-wide drainage improvement, and need to be shouldered in principle by the government budget. On the other hand, Item (d) is associated with new land development and a substantial part of the cost could be charged against the private land developers. Thus, the cost to be shared by the government budget is estimated at about RM 128 million, the sum of Items (a) to (c).

In comparison with the required construction cost to be shared by the government budget, the recent average budget allocated for flood control and urban drainage improvement is as summarized below.

Tier of Government		Annual Average Budget (RM million)	Remarks
Federal DID		127.00	The annual budget tended to increase and reached the maximum of RM 166 million in 1998.
State DID	Kedah	0.70	The annual budget tended to increase and reached the maximum of RM 1.1 million in 1999.
	Melaka	2.26	The annual budget is rather constant with a small fluctuation.
Local Authority	Sg. Petani	0.65	The annual budget is constant.
	Melaka Tengah	6.48	The annual budget has a rather large fluctuation ranging from RM 3.7 to RM 7.7 million.

Note: The budget for Federal DID is the average value for the period 1994–1998, while those for State DID and Local Authority is the average of 1995–1999.

As listed above, the budget for Federal DID is far larger than the others, and will be the major source to recover the construction cost.

The implementation of the optimum drainage improvement plan will continue for about 20 years until 2020, and the aforesaid construction cost of RM 128 million could be converted to the annual average disbursement cost of RM 6.4 million. This annual average disbursement cost corresponds to 5.0% of the average annual budget of Federal DID.

Federal DID had allocated about 33.0% of its total budget for flood control and urban drainage to the objective states of Kedah and Melaka in the 5th Malaysia Plan (1986-1991) and 22.2% in the 6th Malaysia Plan (1991-1995). The allocation was based on the ad-hoc level, and therefore, the percentages allocated to the states could fluctuate according to the necessity of flood control projects. Nevertheless, the percentages allocated to the flood control project for Kedah and Melaka is far larger than the above value of 5.0% estimated as the percentage of average disbursement cost for the proposed optimum drainage improvement plan to the annual average annual budget of Federal DID. Moreover, the percentage of 5.0% is likely to reduce since the annual budget for Federal DID tends to increase. Judging from this available budget of Federal DID, it is concluded that the construction cost for the proposed drainage improvement plan could be financially affordable.

(2) Operation and Maintenance Cost

The major part of the necessary operation and maintenance cost is to be shouldered under the budget of the local authorities of Sg. Petani and Melaka. The required annual operation and maintenance cost for the optimum drainage improvement plan is estimated at RM 2.1 million for Sg. Petani and RM 2.9 million Melaka, respectively (refer to Subsection 5.1.3). On the other hand, the local authorities of Sg. Petani and

Melaka have allocated the budged for drainage maintenance of RM 0.35 million and RM 2.2 million on the average for the recent five years as described above. Thus, the necessary operation and maintenance cost exceed the previous average budget allocated for the operation and maintenance of drainage facilities. The Local Authority of Sg. Petani, in particular, will encounter a significant shortage in operation and maintenance cost. However, such less operation and maintenance cost for Sg. Petani is because Sg. Petani constructed no major drainage facility.

The current budget for the local authorities could not cover the operation and maintenance cost of proposed urban drainage improvement works, and the following actions will be required:

(a) A major part of the budget for the Local Authority is dependent on the Federal Fund. In this connection, the Local Authority should coordinate with the Federal Government (i.e., the Ministry of Housing and Local Government) to secure the necessary operation and maintenance cost.

(b) The Local Authority should also attempt to reinforce its power under the present acts related to urban drainage such as the "Street Drainage and Building Act" and the "Local Government Act". It should look for incremental revenue for operation and maintenance cost through the "Drainage Improvement Charges" and "Drainage Rates" (refer to Sector III, Institutional Setup Plan, Vol. 3, Supporting Report on Drainage Structure Plan).

5.3 Environmental Evaluation

5.3.1 Environmental Issues

The major environmental issues related to the proposed urban drainage improvement are clarified hereinafter:

(1) Environmental Issues on Basin-Wide Water Quality

The water quality noted here concerns the typical urban areas where surface runoff collects a wide range of pollutants especially organic matter and brings them into the proposed drainage channels and the flood detention ponds. The pollutants may deteriorate streams, and cause eutrophication of the ponding water with eventual clogging by water lilies. Thus, the water pollution problem is the fundamental issue concerning the urban drainage improvements works.

Domestic wastewater comprising sewage and sludge is a significant source of pollution especially in the town center. At present, most of the study area is served by septic tanks, but most of them tend to overflow to the surrounding drainage channels and thus flow into the flood detention ponds. The effluent is a significant source of BOD load in streams and ponding water.

Other sources of pollution are squatter areas along the riverbanks. Most of the houses are temporary wooden structures discharging garbage and raw sewage into the river indiscriminately. The discharge is highly polluted with *E. coli*, an indicator of sewage pollution.

The other associated water quality problem is brought about by industrial effluent. The main industry types in the study area are electronics, manufacture of rubber and plastic products, food and beverage, tobacco and timber products. The main impacts from these industries are toxins with a variable group of contaminants. The commonest toxins are the heavy metals, cyanides and phenols. The continual discharge of these effluents will contaminate the water body and the soil that may eventually produce dead stretches of drainage channels and flood detention ponds in extreme circumstances.

(2) Issues on Rehabilitation and Construction of Flood Detention Pond

There exist twenty-one (21) flood detention ponds in the study area. These existing ponds have been poorly maintained with related problems such as water stagnation due to eutrophication and water lilies. These ponds also receive rubbish and sewage from the surrounding areas, thus compounding the problem.

Under the current conditions, the existing ponds deteriorate water quality and may pose health hazards due to accumulation of scum and sludge. These may cause proliferation of infectious microorganisms and pests that will eventually contaminate the surrounding water bodies. Algae bloom and proliferation of water lilies reduce the water flow as well as the retention capacity of the ponds. This inevitably reduces the effective function of these ponds and as such, in the long term, may pose problems leading to flooding. The proposed drainage improvement plan involves rehabilitation of the existing flood detention ponds as well as the construction of new flood detention ponds. Similar environmental issues could arise for the proposed flood detention ponds unless proper countermeasures are planned.

(3) Issues on Proposed Channel Improvement Works

Dredging works are made as a part of the proposed drainage channel improvement. The dredging could increase the channel flow capacity and at the same time, clean the channel through removal of a large volume of sludge which contains organic materials such as rotting vegetation and toxic compounds of heavy metals. However, the organic materials tend to bind with sediment in the channel bed and when disturbed by dredging could release foul odor and gases adsorbed by the aquatic flora and fauna. Therefore, the sludge once removed must be disposed at a proper site that will not cause further environmental pollution. Indiscriminate disposal on land may cause contamination into the surrounding waterways. Options to dispose in sea may also cause adverse impacts to marine biological life forms.

Channel embankment works also are made in line with the channel improvement. The embankment works tend to lead to destruction of trees and shrubs growing beside the channels, which may tend to increase the direct sunshine to the channels and accelerates weed growth. The embankment works could also lead to loss of instream and riparian habitat and ecosystems. The improved channel would be relatively uniform along its length, and in turn have a water flow with uncomplicated characteristics. As the result, the simple environmental conditions around the channels would produce an ecosystem that is unstable and lacking in diversity.

5.3.2 Proposed Environmental Improvement Measures

Based on the aforesaid initial screening of environmental impacts, the following preliminary improvement measures are proposed and incorporated into the proposed drainage improvement plan:

(1) Basin-wide Improvement Measures for Water Quality

The Government of Malaysia awarded the national sewerage privatization project to "Indah Water Konsortium (Indah Water)" under control of the Department of Sewerage Service, Ministry of Housing and Local Government for developing and managing a modern and efficient connected sewerage system. The services of Indah Water could be effective to treat the domestic sewage originating from the residential areas prior to discharge into the drainage channels and flood detention ponds. Accordingly, it is a crucial issue to promote the services. It is, however, virtually difficult to expand the new sewerage system in the existing residential area within a

short term, and the system may be provided only to new residential areas for the time being. As the results, the polluted wastewater from the existing residential areas could still flow into the drainage channels and the flood detention ponds, although the Indah Water also provides a service to desludge the individual septic tanks. From this viewpoint, other countermeasures will be required to prevent the polluted wastewater from flowing into the flood detention ponds in particular. The countermeasures are as described in the following section.

Industrial effluents should be controlled to prevent degradation of water quality. The rising trend in growing industrial areas may not prove to be beneficial to the drainage channels as well as the flood detention ponds that receive the waste effluent. Strategies in tackling these issues will have to involve both management and technological measures. Management measures will include the proper siting of industries as well as screening of polluting industries. Technological measures will include the implementation of cleaner technology such as zero discharge of wastewater and good housekeeping practices.

(2) Countermeasures for Environmental Issues on Channel Improvement Works

Proper dredging and disposal of sludge from the drainage channels will be required. Dredging should be made taking the potential impacts on fisheries and other aquatic life into account. Dredging activities and impacts should be minimal along stretches sensitive to aquatic life, so that temporary diversion should be made, if necessary.

The dredged sludge will need to be assessed to determine its toxicity and contaminants. The sludge, if found to be non-toxic, could be disposed offshore approximately 30 km from land. The material also may be composted and subsequently applied for agricultural purposes, unless it contains high levels of sodium chloride. Moreover, the sludge could be used as embankment materials along the drainage channels, unless it may cause odour problems in the initial stages. In the event that the sludge material is found to be toxic, then the only recourse will be to dispose the sludge material, as hazardous waste, through the company in Malaysia that is licensed to treat toxic waste. The cost will be high depending on the type of toxic contaminants detected in the sludge material but other methods of disposal may still cause environmental contamination.

Utmost effort should be also given to "natural river engineering" on channel alignment and embankment whereby wildlife conservation and natural beauty are

enhanced. This encourages the formation of a rich and stable ecosystem. A natural river should contain the following characteristics:

(a) There should involve the construction of low flood banks set back from the river or retarding basins that allow for overflow onto land used for recreational purposes.

(b) There should be areas for flora and fauna to exist in large numbers especially in certain conditions along the drainage channels.

Along stretches of drainage channels where vegetation clearing is necessary for channel improvement, it is essential to replace similar or suitable flora in order to re-establish nature's system and filter pollutants from surface runoff.

(3) Countermeasures for Environmental Issues on Flood Detention Ponds

Countermeasures should be given to protect the environment of proposed flood detention ponds against recurrence of the present unfavorable environmental deterioration of the existing ponds. The following are the proposed countermeasures already incorporated in the preliminary design of the proposed ponds in the study:

(a) The existing wet detention ponds should be converted to dry detention ponds, as proposed in Subsection 4.5.2. This will reduce or eliminate the current problem on the accumulation of scum and rubbish as well as the potential outbreak of waterborne diseases in the area. The full buffering capacity of these ponds will also be achieved since they will no longer be affected by eutrophication and infestation by water lilies that reduce their retention capacity. Furthermore, the conversion of these ponds into dry detention ponds would also enable the area for other purposes such as recreational or parking area.

(b) The existing retention ponds should also be desludged and cleared of accumulated rubbish and scum. The rubbish traps at the inlet of these retention ponds should be cleared more frequently as compared to the current frequency of twice a year.

(c) Wet retention ponds should also be utilized for fish breeding since they function to control mosquito breeding.