SECTOR IV

RIVER ENVIRONMENTAL MANAGEMENT PLAN

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1. WATER QUALITY OF MUDA RIVER

1.1 Water Quality Survey by the Malaysian Government

1.1.1 Present Water Quality Survey System

The water quality survey in Muda river system is carried out by the following agencies at present:

(1) Department of Environment (DOE)

The purpose of water sampling and tests is to monitor the water quality for pollution control. DOE has a branch office in Alor Star which was established in 1991 and in charge of environmental monitoring in the states of Kedah and Perlis. The branch office carries out water sampling generally 6 times a year at approximately 10 locations in Muda River besides the water sampling in three other rivers (Perlis, Kedah, and Merbok) and the sea. DOE itself started the water sampling in these rivers in 1978. The sampling methods are based on the DOE's manual. The sampling frequency and locations for Muda River have been changed since 1978 in accordance with the necessity and available manpower/budget. The water quality monitoring stations of DOE are listed in Table IV.1.1.1 and the locations are shown in Fig. IV.1.1.1. The water quality tests are carried out by the Penang Laboratory of the Department of Chemistry (DOC). Then the results are sent to DOE for the records arrangement and the evaluation.

(2) Department of Water Works (JBA) of Department of Public Works (JKR) and Department of Health (DOH)

The purpose of water sampling and tests is to monitor the water quality for domestic and industrial water supply. A cooperative team of JBA and DOH carries out water sampling at 9 major intake sites in Muda river as listed in Table IV.1.1.2 and shown in Fig. IV.1.1.2, in accordance with the "Manual on Drinking Quality Surveillance" prepared by the Ministry of Health. The water quality tests are carried out by the Penang Laboratory of DOC. Then the results are sent to JBA and DOH for the records arrangement and evaluation.

(3) Department of Irrigation (DID)

The purpose of water sampling and tests is to monitor the water quality for irrigation. MADA carries out water sampling fortnightly at Muda Reservoir and Pedu Reservoir from 0.5 m below water surface and send the water to the Penang laboratory of DOC for the water quality tests. DID for the State of Kedah carries out water sampling twice a month at one location in Muda River in accordance with "The Hydrological Procedure for River Water Quality Sampling" prepared by DID. The water quality tests are carried out by the Penang laboratory of DOC. The sampling locations of DID (including MADA) are listed in Table IV.1.1.3 and shown in Fig. IV.1.1.2.

It is noted that the Penang Water Authority (PWA) of the State of Pulau Pinang is in charge of domestic and industrial water supply for the State of Pulau Pinang of which major water source is Muda River . The water sampling by PWA is carried out in many rivers in the state, however, no sampling is carried out from Muda river system.

1.1.2 Present Water Quality Standards and Criteria in Malaysia

The water quality standards currently used by the government agencies concerned are as follows:

(a) Water Quality Standard/Criteria used by DOE composed of:

  (i) DOE Interim National Water Quality Standards for Malaysia

  (ii) DOE Water Quality Criteria for Malaysia

(b) Water Quality Standard used by JBA/JKR, PWA and DOH for National Guidelines for Drinking Water Quality including:

  (i) Recommended Raw Water Quality Criteria and Frequency of Monitoring

  (ii) Drinking Water Quality Standards and Frequency of Monitoring

  (iii) Standards for Sewage and Industrial Effluents

  (iv) Parameter Limit for Watercourse Discharge of Effluent from Prescribed Premises occupied or used for the production of Palm Oil or Its Associated Products

  (v) Parameter Limit for Watercourse Discharge of Effluent from Prescribed Premises occupied or used for the production of Latex or Its Associated Products

(c) Water Quality Standard used by DID practically for each irrigation scheme at present

Among the above, the DOE s standards/criteria are considered most representative ones for the evaluation of river water quality. The DOE s standards/criteria were first prepared in 1986. However, some revision was made in the final report on "Development of Water Quality Criteria and Standards for Malaysia (Phase IV, River Classification)" prepared in 1994 by the entrusted study team (mostly consisted of university professors) of DOE. The standards currently used in Malaysia and those used in other countries including Japan are basically not so much different although testing items and parameters are more or less different in accordance with the various conditions in each country. The standards will be occasionally revised in the future in accordance with the change of various requirements including those for the economic development and healthy living.

1.1.3 Collection of Existing Water Quality Records

The existing/past water quality records would present reliable and definite information to know and evaluate the status of water quality in Muda River. The data collection was made as follows:

(1) Water Quality Records of DOE

The water quality recording sheets of all the monitoring stations in these three years (1992-1994) for Muda River were obtained from DOE (Alor Star office). Besides these data, all the water quality records in the Muda river basin since 1978, compiled in the DOE's form, were separately obtained from DOE (Head office) .It was informed that the sampling frequency as well as test items has been decreased in these years mainly due to shortage of manpower.

(2) Water Quality Records of DOH and JBA/JKR

The water quality records of 1993 at 7 locations in the Muda river basin were collected from DOH office in Alor Setar. There were two groups of sampling. Group 1 carries out the sampling weekly throughout the year and Group 2, almost monthly at the same locations but with different test items.

(3) Water Quality Records of DID

The water quality records at one station in Muda River by DID in 1975-1978 and 1993 were obtained from the DID head office and the DID Kedah office, respectively. In addition, the water quality records in Pedu Reservoir in 1993 and 1994 were collected from MADA for reference.

(4) Water Quality Records by PKP Study Team

The water quality records by PKP (JICA) Study team in 1983 are also available in the reports prepared by the team.

The water quality records collected from the government offices were mostly copies of original recording sheets without compilation. Therefore, most records were compiled by the study team to make review the past records of different locations.

1.1.4 Water Quality Evaluation of Past Records

The detailed water quality evaluation is generally not carried out by the government agencies, although some checks of water quality test results are occasionally carried out at major intake sites. DOE is the only agency making evaluation of water quality test results, although the evaluation is quite on a general level to the know water quality of a river based on the DOE's classification.

According to the DOE's classification of water quality, the concentrations of BOD, COD, SS and NH4-N of Muda River are low. DOE classifies Muda River as a clean, slightly polluted river every year until the present, as seen in Table IV.1.1.4 and

Fig. IV.1.1.3. It seems that the index numbers have been slightly decreasing in a range of some years, however, the tendency is not yet definite.

According to the general rating scale for water quality index for each usage category by DOE shown in Table IV.1.1.5, the Muda river water is classified as follows:

(a) For public water supply, minor purification or conventional treatment is required.

(b) For recreation, the river water is acceptable for all water sports.

(c) For fish and wildlife, the river water is acceptable for all fishes.

1.2 Water Quality Survey by the JICA Study Team

1.2.1 General

The water sampling and water quality tests were carried out by a local consultant under the guidance of the JICA study team to obtain supplementary data in addition to those available from the government agencies concerned and to confirm the water quality condition of Muda River. The first survey was carried out in November and December 1994 and the second one, in May and June 1995.

1.2.2 Sampling Locations and Method

The water sampling sites were proposed at ten (10) sites in the Muda River and its tributaries in consideration of the following:

(a) To know the change of water quality from the upstream stretch to the downstream stretch.

(b) To know the effects of sand mining activities. (Locations of sand mining sites)

(c) To know the effects of effluent from the settlement areas, industrial areas and/or factories. (Locations of settlement/industrial areas and factories)

(d) To know the effects of Muda Barrage. (Location of Muda barrage)

(e) To know the water quality of river water for major water intakes such as Lahar Tiang Intake and Pinang Tunggal Intake. (Location nearby these intakes)

(f) Locations of stream gauging stations, bridges, and tributaries.

(g) Locations of sampling sites by DOE and other agencies.

(h) To know the effects of effluent from factories (Rubber and Oil-palm).

The sampling locations were selected through the synthetic study in the office and the field inspection as listed below and shown in Fig. IV.1.2.1.

(a) Stream near Nami town/bridge (No. M1 on Muda River)

(b) Stream near Jeniang town/bridge (No. M2 on Muda River)

(c) Downstream side of confluence with Ketil River(No. M3 on Muda River)

(d) Upstream side of Lahar Tiang Intake and Pinang Tunggal Intake (No. M4 on Muda River)

(e) Downstream side of Muda Barrage(No. M5 on Muda River)

(f) Downstream of Chepir River (No. C1)

(g) Downstream of Ketil River from the confluence of Tawar River (No. K1)

(h) Downstream of Sedim River (No. S1)

(i) Up and downstream of a rubber factory (Nos. F1 and F2 on Jerung River, a tributary of Muda River)

During the first survey, the sampling was carried out only one time at eight sites and two times at two sites (No. M3 and No. K1). The two sites were selected after the water quality test results of the first 10 sites were obtained. However, during the second survey, the sampling was carried out two times at all the 10 sites.

The exact locations of sampling spot for each site were selected from the viewpoints of stream flow conditions and the accessibility to the site. Samples were taken in the middle section of stream and at the depth of approximately twenty percent (20%) from the surface.

Samplers and containers were rinsed with water to be sampled prior to the sampling. Enough volume of water to perform the specified chemical tests was taken and the water samples were kept in air-tight containers. Type and quantity of containers were selected in accordance with test items, and the preservation measures by chemical water and ice were taken according to the parameters measured. Then all samples were properly labeled and recorded in accordance with the items. The in-situ measurements for DO, pH, temperature, turbidity, and conductivity as well as the observation of some common items were carried out in accordance with the standard methods.

1.2.3 Laboratory Tests of Sampled Water

The test items were selected after checking some Malaysian water quality standards, potential pollution sources and some other factors. The following items were tested in the laboratory in accordance with "The 17th Edition of the Standard Methods for the Examination of Water and Wastewater, APHA" or its equivalent international standards: (1) Suspended Solid (SS); (2) BOD (5 days); (3) Arsenic (As); (4) Cadmium (Cd); (5) Chromium (Cr); (6) Iron (Fe); (7) Lead (Pb); (8) Total

Mercury (Hg); (9) Phosphate (P); (10) Cyanide (Cn); (11) Fluoride (F); (12) Ammonia Nitrogen (NH4-N); (13) Total Coliform Groups; (14) Total Dissolved Solid*; (15) COD*; (16) Faecal Coliform*; (17) Total Nitrogen (T-N)*; and (18) Selenium (Se)* (Note:* Additional tests items included only in the second survey).

1.2.4 Results of Water Quality Survey by the JICA Study Team

It is noted that the frequency and locations (sites, section, depth, etc.) of water sampling and tests were limited. It would be difficult to make specific evaluation based only on the survey results at this time. However, the overall evaluation based on the water classification by DOE was made as summarized below.

(1) Water Quality Standard for the Evaluation of Test Results

The water quality classification (I, IIA, IIB, III, IV, and IV) by DOE standards is used for general evaluation. Although it is classified on the basis of the objective of water use, in general, Class I is the cleanest category and Class V is the most undesirable category. If it is considered that Muda River is the major source for water supply, Class I or II would be desirable and Class III could be acceptable. The DOE's standard for the items used by the water quality survey of the JICA Study Team is summarized, as shown in Table IV.2.1.1.

(2) Results of First Survey in November 1994

The results of the first survey were obtained, as summarized in Tables IV.1.2.2 and IV.1.2.3. The major findings from the water quality test were as follows:

(a) Many results of the water quality test are classified as I or II, however there are some results classified as III, IV, or V.

(b) There is no remarkable and definite difference of water quality between the upper stream and the lower stream as well as between the main stream and the tributaries.

(c) The test results classified as IV or V are listed as follows:

(i) The index of NH3-N at is evaluated as Class IV at 7 sampling points and as Class III at 5 points.

(ii) The index of Cr (VI) shows Class IV or V at 5 sampling points among 12 points in total.

(iii) The indices of Fe and P shows Class V at all sampling points.

(3) Second Survey in May and June 1995

The test results are summarized in Table IV.1.2.4 and the water quality classification based on the DOE's standard was made, as summarized in Table IV.1.2.5. In addition, the water quality tests for Nitrate, Nitrites, Hardness, Chloride, Copper, Zinc, and Manganese were carried out at the second sampling of location No. M-4 for getting additional reference data.

As shown in Table IV.1.2.6, the results of the second survey are generally the same as those of the first survey although some differences are found. That is, many results were classified as Class I or II (desired level) and some results were classified as Class III (acceptable level). It was, however, found that there were still some results classified as Class IV or V (or not within the limit of Class III).

(4) Overall Evaluation of Present Water Quality

The overall evaluation of the present water quality of Muda River was carried out based on the results of the first and second water quality surveys by the JICA Study Team with reference to the existing water quality data by DOE, DOH/JBA and DID. The findings on the present water quality conditions of Muda River are summarized as follows:

(a) It would not be reasonable to judge the water quality only by the temporary test results of the JICA team because water quality is changeable by various conditions such as discharge, rainfall, sampling location, time, etc. However, it is necessary to pay special attention to the test results which are not classified as Class I, II, or III. That is, careful monitoring will be required for the following parameters: Turbidity and SS, F.Coliform, NH3-N and Fe.

(b) The low quality at F2 (during the second survey) is caused by the effluent of a rubber factory since the water quality at F1 (upstream side of the factory in the same river) shows no-problematic result. The factory has a treatment system with some ponds, however a part of effluent is occasionally released directly into the river. The stream is not so much polluted when the factory does not release the effluent. There is a possibility that similar conditions may be found at some other factories.

(c) There are many water quality records already collected by DOE, DOH/JBA and DID which carries out the sampling periodically. However, there is no detailed assessment of this long-term data by the government agencies, although general and overall assessment is made by DOE. Checking of long-term data selected at random concluded that the present water quality of Muda River is generally not polluted and within the sufficiently acceptable level for domestic/industrial water as well as irrigation. However, it was found that the following parameters occasionally show undesirable results at some locations: T. Coliform and F.Coliform, NH3-N, SS, Phosphate. Similar results as those of the JICA survey were obtained from the review of government records.

(d) There were many parameters not included in the tests by JICA and the government survey. It would be necessary to carry out more detailed water quality surveys including the parameters of many kinds of chemical substances in the future.

1.3 Water Pollution Sources

1.3.1 Classification of Pollution Sources

The kinds of pollution sources in the future will be basically the same as the present sources. However, the potential of some sources will be much increased. For example, in the future, new industrial areas will be established or expanded and town areas will extend in accordance with the economic development in the future. The potential pollution sources are categorized as follows:

(a) Residential Waste

(b) Industrial Waste

(c) Commercial industry waste

(d) Livestock farm waste

(e) Irrigation/agricultural land drainage

(f) Others, including forest, atmospheric fallout, road, park, recreational site, sand-mining site, water intake site, groundwater and construction site nearby river

1.3.2 General Evaluation of Each Pollution Source

The general evaluation/comments on each category of potential pollution sources in the future are as follows (refer to Table IV.1.3.5.):

(1) Towns and Major Villages

Muda river basin is estimated to have a population of about 360,000 in the year 1993, which will increase to about 619,000 in the year 2010. The wastewater from the populated areas shown in Fig. IV.1.3.1 generally contain high levels of BOD as well as COD, SS, P, and N. It is expected that the quantity of pollution loads will increase much in accordance with the improvement of people's living standard and the increase of population in the future.

(2) Rubber and Oil Palm Processing Factories

The concentrations of BOD, COD, total solids, SS, dissolved solids, and N are generally high in the effluent of rubber and oil palm processing factories. There are 12 rubber factories and 2 palm oil factories in the basin (refer to Table IV.1.3.1 and Fig. IV.1.3.2). The treatment of effluent from these factories is already being carried out in accordance with the DOE's regulations. The effluent regulation is, however, only based on the quality but not considering the total quantity at present. In addition, it has been reported that some factories occasionally release polluted wastewater directly into a river without passing through treatment ponds.

(3) Industrial Estate

KSDC as well as KEDA has projected six industrial estates in the Muda river basin (refer to Fig. IV.1.3.3). Particular attention should be paid to the two other major industrial estates located at Sungai Petani and Kulim which are close to the basin border.

(4) Commercial Industry Waste

A considerable volume of wastewater as well as solid waste will be drained from restaurants, offices, stores/shops, hospitals, hotels, markets, etc.

(5) Livestock Breeding Farm

There are two major pig breeding farms in the basin. Many breeding farms for cattle, which may have more pollution load than pig breeding farms, are also located in the basin. The effluent from livestock breeding farms generally contain high levels of BOD, COD, SS, P and N. However, the discharged quantity of pollution loads could be remarkably reduced by improvement of the treatment system.

(6) Agricultural Land

The irrigation areas and other agricultural lands generally use many kinds of agricultural chemicals such as fertilizers and pesticides which generally have chemicals harmful to human health. Pesticides are generally classified into 80% of herbicides, 15% of insecticides, and 5% of others (rodenticides, fungicides, etc.). The types and quantities of pesticide used in Muda irrigation area are shown in Tables IV.1.3.2. to IV.1.3.4. The irrigation/agricultural areas will not increase, but the quantity of agricultural chemicals could increase due to more intensive production.

1.4 Estimation of Future Water Quality

1.4.1 Premises to Estimate Future Water Quality of Muda River

The water quality of Muda River are herein evaluated by the levels of BOD in the years 1993, 2000 and 2010. In addition to BOD, however, SS, T-N and T-P are further estimated in this Study as reference.

The checkpoints to evaluate the water quality are selected at the railway bridge of Muda River at Pinang Tuggal [hereinafter referred to as Point M(P)] and the downstream end of Ketil River Tuggal (hereinafter referred to as Point K) (refer to Fig. IV.1.4.1).

On the above assumptions, the water quality of Muda River is estimated by the following formula:

$$PL = PL(r) \times AR \times 1000 \div Q$$

where,

PL	:	Concentration of pollution load at the checkpoint (mg/l)
PL(r)	:	Gross weight of pollutant load released from each pollution source (mg/s)
AR	:	Arrival rate to the checkpoint
Q	:	River flow discharge (m^3/s)

1.4.2 Estimate of Pollutant Load Released from Each Pollutant Source

In due consideration of the present pollutant loads, the pollutant source is herein classified into six (6) categories mentioned below, and the dominant factor of each pollutant load was selected. The gross weight of pollutant loads released from each source is estimated by multiplying the quantity of the dominant factor of the pollutant load with its corresponding unit weight of pollutant load.

The unit weight of load released from them is assumed, as shown in Tables IV.1.4.1 to IV.1.4.3, while the quantities of pollutant load are described as below (refer to Tables IV.1.4.4 to IV.1.4.6).

(1) Category 1 (Residential Wastewater)

The dominant factor of pollutant load is expressed by the population in the upper reaches of two (2) checkpoints [Point M(P) and Point K]. The population in each *mukim* was estimated according to the projected figures for each *mukim* (refer to SECTOR VII, SOCIO-ECONOMY). Then, the population in the upper reaches of checkpoints was estimated in proportion to the area overlapped by the *mukim* (refer to Tables IV.1.4.7 to IV.1.4.9).

(2) Category 2 (Industrial Wastewater)

The dominant factor of pollutant load is expressed by the effluent volume from the rubber and palm oil factories as well as the industrial estates. As for rubber and palm oil factories, the effluent volume is assumed in due consideration of the production quantity and the type of factory. As for industrial estate, the effluent volume was estimated by assuming the unit effluent volume per hectare of the estate.

(3) Category 3 (Commercial Industry Wastewater)

The dominant factor of the pollutant load is assumed to be the population engaged in the commercial industry. The engaged population is herein assumed to be 30% of the population in the upper reaches from the checkpoints [Points M(P) and Point K].

(4) Category 4 (Livestock Farm Wastewater)

The dominant factor pollutant load is expressed by the number of livestock. The number of livestock per mukim was obtained from the Veterinary Department. Then, the number in the upper reaches of the checkpoints was estimated in proportion to its area overlapped with the mukim. The results of estimation are as shown in Table IV.1.4.10. It is further assumed that the number of livestock will not change in the future.

(5) Category 5 (Agricultural Land Runoff)

The dominant pollutant load was assumed to be the size of irrigation area and other farmlands. The size of irrigation area was estimated from the data on existing irrigation schemes in the basin, while the size of farmland is from the land use map in the basin.

(6) Category 6 (Others)

The dominant factor of pollutant load was assumed to be the catchment area of the checkpoints (refer to Table IV.1.4.11).

1.4.3 Evaluation of Pollutant Load at Checkpoints

The overall runoff ratio including the runoff ratios in tributaries and the mainstream was roughly assumed from the results of the previous actual investigation, and the concentration of pollutant loads at each checkpoint were estimated as below (refer to Tables IV.1.4.12 to IV.1.4.14).

(Unit: mg/l)

Discharge	Item	Checkpoint M(P)			Checkpoint K		
		1993	2000	2010	1993	2000	2010
Annual Average for 30-years from 1964 to 1993.		Discharge = 84 m^3/s			Discharge = 30 m^3/s		
	BOD	1.60	1.75	2.16	1.65	1.65	1.77
	SS	44.88	48.99	49.33	37.14	37.17	37.22
	T-N	1.01	0.97	1.04	0.68	0.65	0.65
	T-P	0.20	0.23	0.27	0.14	0.17	0.17
355-day discharge of the third lowest for 33-years from 1959 to 1993.		Discharge = 16 m^3/s			Discharge = 6 m^3/s		
	BOD	8.44	9.18	11.33	8.25	8.24	8.85
	SS	256.65	257.20	258.96	185.70	185.84	186.08
	T-N	5.31	5.11	5.48	3.38	3.23	3.25
	T-P	1.08	1.19	1.42	0.72	0.76	0.83

The actual water quality survey gives the following results at M(P) in 1993: 1-2 mg/l in BOD, about 50 mg/l in SS, about 1.0 mg/l, and 0.2-0.3 mg/l. In this context, it was evaluated that the water quality for the annual average river discharge is well consistent with the actual survey results.

The estimated water quality in the years 2000 and 2010 shows that the pollution level in the future will not remarkably increase. Furthermore, when the river channel flow discharge is around the annual average discharge, the water quality of the river is still within the allowable level (≅ 6 mg/l in BOD concentration) for use of domestic water.

However, when the river flow discharge falls to the level of the third lowest 355-day discharge (the value to exceed river flow discharge 355 days a year) for 33 years, the water quality will exceed the allowable level. Thus, the water quality of Muda River is, although generally evaluated to be clean, possibly to exceed the allowable level for domestic water supply during a dry season in the drought year.

2. RIVER MAINTENANCE FLOW

2.1 Purpose of River Maintenance Flow

The proposed structural plan on the water resource development for the Muda river basin contains the construction of Beris Dam, Jeniang Transfer Canal, Naok Dam and Reman Dam, which may cause a substantial change on the natural river flow regime. On the other hand, there does not exist any standard or regulation to set up the river maintenance flow that is defined as the minimum requirement of the river flow discharge and to be guaranteed by the water released from the proposed dam reservoirs.

The river maintenance flow is essential to maintain the appropriate river environment, particularly, on the river water quality during a period of the low flow regime. From this point of view, the future water quality of Muda River was clarified and the necessary river maintenance flow was determined.

2.2 Dominant Factors for the Determination of River Maintenance Flow

The river maintenance flow is essential for the maintenance of river water quality as well as other various factors. Among others, the following items were selected as dominant factors to determine the necessary river maintenance flow discharge in due consideration of the features of Muda River:

(a) To maintain the appropriate river water quality throughout the year;

(b) To conserve the natural low flow regime as before construction of the proposed dam;

(c) To conserve the river ecology system; and

(d) To conserve the river scenery.

Other than the above four items, the river maintenance flow contains various functions in general, but they are not considered in this Study. The functions not considered and the reasons are as discussed below.

(1) Maintenance Flow to Facilitate Water Abstraction from River

The difficulty to abstract water by intake facilities usually occur due to the lowering of river water level. However, the principal reason for the lowering of water level is the lowering of riverbed caused by the present excessive sand mining operations. Accordingly, river maintenance flow could not be the fundamental solution to maintain the water level for the intake facilities. Instead of the river maintenance flow, the construction of barrage or reconstruction of intake facilities will be the short-term remedy to maintain the water level for intake facilities. Furthermore, a long-term plan is indispensable to control the present sand mining operations and to check the tendency of lowering of the water level.

(2) Maintenance Flow to Prevent Clogging at River Mouth

The clogging of river mouth develops due to sedimentation of ocean drifting sand causing difficulty of navigation during low tide. However, it is not feasible to flush out the sediment by river maintenance flow. Instead of river maintenance flow, dredging works are recommended as the feasible measure against clogging of the river mouth.

(3) Maintenance Flow to Facilitate Navigation

Navigation is active only downstream from the Muda Barrage where the tidal level has a dominant influence on the available water level for navigation.

(4) Maintenance Flow to Prevent Saline Water Intrusion

The saline water intrusion is now being controlled and stopped by the Muda Barrage located about 10 km upstream from the river mouth. Therefore, no river maintenance flow is required to check the saline water intrusion.

(5) Maintenance Flow to Preserve Groundwater Level

The river maintenance flow is useful to maintain the groundwater level during a drought period. In the case of Muda river basin, however, the major water supply source is the river surface flow, and no particular requirement for river maintenance flow is indicated in this aspect.

2.3 Determination of Minimum Requirement of Discharge for River Maintenance Flow

The determination of minimum requirement of discharge for river maintenance flow has been carried in consideration of the following items:

(1) Checkpoint and Catchment Area for Estimation of River Maintenance Flow

The necessary discharges for each of the aforesaid dominant factors were estimated at the selected reference points, and the river maintenance flow was finally determined by synthetic evaluation. The selected reference points are herein enumerated as follows:

(a) Muda River at the existing Jeniang Gauging Station [Point M(JG)];

(b) Muda River at Jam S. Omar [Point M(JS];

(c) Muda River at Ldg. Victoria [Point M(LV)];

(d) Ketil River at Kuala Pegang [Point K (K)]; and

(e) Chepir River at Batu Lima [Point C(B)].

The catchment area of the above reference points is significant for the estimation of river maintenance flow. Among the above reference points, Jeniang, Jam. S. Omar and Ldg. Victoria are located downstream of Muda Dam.

All of the runoff discharge from the catchment area of Muda Dam (984 km^2) is diverted to Pedu Dam and does not flow down to these reference points. Accordingly, the catchment area of Muda Dam was excluded from that of the reference points in the estimation of river maintenance flow.

Thus, the following catchment areas were applied to the estimation for each reference point (refer to Table IV.2.2.1).

Catchment Area of Reference Point

Reference Point	Topographic Catchment Area (km^2)	Catchment Area Applied to Estimation (km^2)
Jeniang [M(JG)]	1,740	756
Jam S. Omar [M(JS)]	3,330	2,364
Ldg. Victoria [M(LV)]	4,010	3,026
Kuala Pegang [K (K)]	704	704
Batu Lima [C(B)]	233	233

(2) Necessary Discharge to Maintain the Appropriate River Water Quality

The river flow discharge was estimated by the following formula assuming that the discharge needs to dilute the BOD concentration to less than 6 mg/l, which is the allowable level for use of treated drinking water.

$$Qm = 1000 \times PL \div BOD(R)$$

Where,

Qm	:	Necessary river maintenance discharge (m^3/s)
PL	:	Gross weight of pollution loads generated at pollutant sources (mg/s)
BOD(R)	:	Required BOD concentration (assumed as 6 mg/l)

The estimated necessary discharges for reference points are as summarized below.

Necessary Discharge to Maintain River Water Quality

Checkpoint	River System	BOD Load (mg/s)	Discharge to Dilute (m^3/s)
Jeniang [M(JG)]	Muda	42,988	7.2
Jam S. Omar [M(JS)]	Muda	133,400	22.2
Ldg. Victoria [M(LV)]	Muda	172,066	28.7
Kuala Pegang [K(K)]	Ketil	43,087	7.2
Batu Lima [(C(B)]	Sic	14,260	2.4

(3) Necessary Discharge to Conserve Natural Low Flow Regime

The following two items are assumed to be guaranteed even after the construction of the proposed Beris Dam, Jeniang Transfer Canal, Naok Dam and Reman Dam:

(a) The specific discharge of 0.0069 m^3/s should be maintained even after the construction of water resources structures. The specific discharge is the average value of river maintenance flow guaranteed by dams in Japan and conventionally applied as the dam guarantee flow in the country.

(b) The present 355-day discharge also should be maintained even after the construction of water resources structures. The discharge was estimated as the third lowest among the values for a 33-year period from 1959 to 1991, approximately corresponding to a recurrence probability of 10-year return period.

The necessary discharge to conserve natural low flow regime is herein assumed as the larger value between the above items, and estimated as below.

Necessary Discharge to Conserve the Natural Flow Regime

Check Point	River System	Catchment Area (km^2)	Discharge of 0.0069 $m^3/s/km^2$ (m^3/s)	355-Day Discharge* (m^3/s)	Necessary Discharge (m^3/s)
Jeniang [M(JG)]	Muda	756	5.2	7.7	7.7
Jam S. Omar [M(JS)]	Muda	2,364	16.2	15.7	16.2
Ldg. Victoria [M(LV)]	Muda	3,026	20.9	20.3	20.9
Kuala Pegang [K(K)]	Ketil	704	4.8	4.7	4.8
Batu Rima [(C(B))]	Sic	233	1.6	1.5	1.6

* Refer to Table IV.2.2.2

(4) Necessary Discharge to Conserve River Ecology

There exist the freshwater fishes of less than 50 cm in length in the lower stretch and 20 cm in length in the middle and upper stretches of Muda River. To conserve water space for these freshwater fishes, the minimum requirement of river water depth was assumed as 50 cm at Jam. S. Omar [M(JS)] and Ldg. Victoria [M(LV)], 30 cm at Jeniang [M(JG)] and Kuala Pegang [K(K)] and 25 cm at Batu Lima [C(B)]. To maintain the said water depth, the following discharges are required as river maintenance flow (refer to Table IV.2.2.3).

Necessary Discharge to Conserve the Present River Ecology

Checkpoint	River System	Catchment Area (km^2)	Discharge (m3/s)
Jeniang [M(JG)]	Muda	756	1.9
Jam S. Omar [M(JS)]	Muda	2,364	4.6
Ldg. Victoria [M(LV)]	Muda	3,026	11.4
Kuala Pegang [K(K)]	Ketil	704	3.1
Batu Lima [(C(B)]	Chepir	233	2.1

(5) Necessary Discharge to Maintain River Scenery

In accordance with the ongoing "Love Our River Campaign," the requirement of beautiful river scenery has increased. With reference to the environmental guidelines in Japan, it is assumed that about 20% of the river channel has to be constantly covered with water to maintain a desirable river scenery. To guarantee this condition, the following constant discharges are required (refer to Table IV.2.2.4).

Necessary Discharge to Maintain the River Scenery

Checkpoint	River System	Catchment Area (km^2)	Discharge (m^3/s)
Jeniang [M(JG)]	Muda	756	6.5
Jam S. Omar [M(JS)]	Muda	2,364	4.2
Ldg. Victoria [M(LV)]	Muda	3,026	17.4
Kuala Pegang [K(K)]	Ketil	704	3.5
Batu Lima [(C(B)]	Chepir	233	0.9

(6) Optimum River Maintenance Flow

As tabulated below, the dominant factor to determine the river maintenance flow is the discharge to maintain the river water quality, which corresponds approximately to the specific discharge of 0.01 $m^3/s/km^2$. In other words, the specific discharge of 0.01 $m^3/s/km^2$ is the minimum requirement to cover the discharge required for the factors in (2) to (5).

Synthetic Evaluation on Necessary Discharge as River Maintenance Flow

Checkpoint	Necessary Discharge in Factors (m^3/s)				Applied (≈0.01 $m^3/s/km^2$)
	To Maintain River Water Quality	To Conserve Natural Flow Regime	To Conserve River Ecology System	To Maintain River Scenery	
M(JG)	7.2	7.7	1.9	6.5	7.7
M(JS)	22.2	6.2	4.6	4.2	23.4
M(LV)	28.7	20.3	11.4	17.4	30.3
K(K)	7.2	4.8	3.1	3.5	7.2
C(B)	2.4	1.6	2.1	0.9	2.3

Based on the above synthetic evaluation, the river maintenance flow is determined to correspond to the specific discharge of 0.01 m^3/s. This river maintenance flow is to be guaranteed from by the water released from the proposed dams and its supply plan is incorporated into the integrated dam operation rule described in SECTOR III.

The proposed dams such as Beris, Naok and Reman are constructed in the upper reaches of the confluence of Beris River. Accordingly, the proposed river maintenance flow could be guaranteed by the proposed dams for the main river stretch from the river mouth to the confluence of Beris River.

On the other hand, the tributaries as well as the upstream of main channel from the confluence of Beris River is not guaranteed. Particularly, the upstream from the confluence of Beris River will hardly have the low flow discharge, because Muda Dam which is located upstream from the confluence impounds almost all the basin runoff discharge and conveys it to Pedu Dam. Due to this, the river environment could be possibly aggravated should excessive basin development be induced. To cope with this issue, however, the monitoring and management of basin development is proposed as described SECTOR V, and no river maintenance flow is taken from the river stretch from the confluence of Beris Dam up to Muda Dam.

Nevertheless, the river maintenance flow is essential to preserve the appropriate river environment and therefore, whenever a new dam reservoir is proposed in other river basins in Malaysia, an attempt shall be made to secure the maintenance flow released from the dam. The minimum requirement of the river maintenance flow will be variable according to the particular conditions of each river basin, and shall be determined through scrutinizing all of the nine (9) factors described in subsection 2.2. The factors shall include the dominant four (4) items applied to Muda river (items (a) to (d) in subsection 2.2) as well as other five (5) items (items (1) to (5) in the same subsection).

3. RIVER CORRIDOR DEVELOPMENT PLAN

3.1 Present Conditions of River Corridor

3.1.1 Present Land Use and Land Ownership of River Corridor

The present land use in the river corridor is classified as shown in Table IV.3.1.1 on the basis of the aerial photographs taken by JICA in 1994, the topographic maps prepared by JICA in 1994 and the field reconnaissance. The river corridor along the lower and middle stretches is extensively developed as agricultural land. The dominant use of agricultural land is rubber plantation and mix horticulture. The river corridor along the upper stretch is, however, covered with natural forest and shrubs.

The present conditions of land ownership along the rivers were checked from cadastral maps with the scale of approximately 1/6400 or 1/3200. About 60 maps were obtained from the land offices in the states of Kedah and Pulau. As a result, the width of public land along the rivers is estimated as shown in Table IV.3.1.2, and the general findings of land ownership along the rivers are given as follows:

(a) The reserved area is proposed by the government (DID): 50 m on both banks in case of river with more than 40 m in width. However, private lands actually exist inside the proposed reserved area at many/most locations in general.

(b) In the lower reaches of Muda River from the confluence with Ketil River, the river corridor of less than 20-50 m in width is mostly owned by the government.

(c) In the middle reaches of Muda River between the confluence with Ketil River and Muda dam site, the width of government land is generally wide, however, the stretches with more than 50 m in width may be less than half (possibly nearly one-third). The stretch with more than 100 m is limited.

(d) Ketil River has wider public land in spite of rather narrow river width. A little less than 50% of the entire stretch has the government land of more than 50 m in width.

(e) Chepir River has comparatively wider government land only in the lower stretch. Stretches having the government land of more than 50 m wide are very limited in the middle reach including the Sik town area.

3.1.2 Existing Parks and Recreation Sites

There is no nature conservation area proposed under international conventions such as the Ramsar Convention and the Washington convention in and around the Muda river basin. There are, however, some important sites with historical, cultural and religious values, beautiful and unique landscape, and environmentally vulnerable areas like mangrove forest/wetlands, as enumerated below (refer to Fig. IV 3.1.1).

In the basin	(a) Muda dam and reservoir
	(b) Air Terjun Puncak Janing for waterfall and picnic spot
	(c) Lata Asam Jawa for recreational spot with waterfall)
	(d) Perangin Sik and Lata Mengkuang for picnic site
	(e) River side park at Pukula pumping station
	(f) River side park at the intake point for Iboi irrigation scheme
Around the basin	(a) Jerai mountain
	(b) Lembah Bujang (an archaeological area with ruins of the 7th century)
	(c) Pedu dam resort
	(d) Batu Hampar for picnic site with waterfall
	(e) Seri Perigi for waterfall from Gunung Jerai
	(f) Junjong for picnic park
	(g) Rimba Rekreasi Bukit Wang for park
	(h) Alor star (municipal town of the state with some historical and artistic sites)
	(i) Kuala Kedah as ancient port and present fishing port as well as the ferry terminal
	(j) Langkawi island as popular and famous tourist site in Malaysia

3.1.3 Landscape

The general image of landscape along the Muda River is greenish, clean, and gentle. In the low-lying area, the paddy is extensive and tree-lined roads are linked well. In the highland area, comparatively low mountains with forest (natural or planted) range in rows. The typical scenic and undesirable landscapes along Muda river are enumerated as below.

Scenic Landscape	Undesirable Landscape
Forest along the river	Sand mining sites
Jerai Mountain	Areas with rubbish either floating in the stream or scattered on the riverbank
Fishery village and fisherman's activities in the river mouth area	River stretch of bank erosion
Muda dam and reservoir area	Some river structures such as bridge and intake
Riverside park at right bank of Merdeka bridge	Dark and dirty riverside under and near a bridge
Waterfalls (Puncak Janing , Lata Asam Jawa)	Houses built close to river stream or on the high flow riverbed

3.1.4 Opinion of Relevant Agencies on River Corridor Development Plan

Questionnaires on river corridor development have been prepared to obtain comments on the matter from agencies concerned in planning. Most of the agencies responded and it seems that all of them are interested in the river corridor plan, expressing the necessity and importance of such plan. Comments on the river corridor planning are given as below:

(a) The river corridor development will increase the aesthetic value of river. Hopefully this will make people understand more about the beneficial functions of rivers (from DOE).

(b) Environmental characteristics need to be maintained and/or improved for the river corridor development and the concept of sustainable development need to be inculcated. Development guidelines for this area as specified in the local plan need to be followed. (from the Town and Country Planning Office).

(c) The corridor plan in Muda River has to be carried out with detail management planning and create an "Action Committee" to execute the development. An early study should be carried out to ensure that the planning is meaningful and useful to all the inhabitants. The development of tourism is also necessary to be considered. (from the Department of Forest).

(d) The river corridor will be a benefit to local communities as well as the state in terms of environmental conservation. It will provide areas for recreation as well as outdoor activities. (from a local consultant).

3.2 Proposed River Corridor Development Plan

3.2.1 Extent of Zoning Plan

The delineation of river reserve area is proposed along the river corridor to reserve the land for river improvement works and, at the same time, to preserve the natural flood retarding effect (refer to Sector II). It is further proposed that the river reserve area is under the jurisdiction of the river management body, and land development activities and alienation or temporary occupation of the land therein are subject to the approval of the river management body. To facilitate these public purposes of the river reserve area, the zoning plan for the river reserve area is essential. The zoning plan around the dam reservoirs is also indispensable to preserve the natural features of the dam reservoirs and to promote inland aquatic tourism.

From these viewpoints, the zoning plan was applied to the following four (4) blocks which are located within the limits of the proposed river reserve area and the lakeshore areas around the reservoirs of Muda and Beris dams (refer to Fig. VI.3.2.1).

(1) Lower Reach Block

The river improvement plan is formulated for the purpose of flood mitigation from the river mouth up to about 40 km upstream. The river corridor along the improvement section is subject to land acquisition by the Government. The zoning is formulated for the entire land acquisition area.

(2) Middle Reach Block

The river corridor is not subject to land acquisition by the Government. Accordingly, only a spot development plan is proposed. The objective area is along the Muda main stream starting from the upstream end of the above river improvement section up to the proposed site of Jeniang Barrage. The objective area is also placed along Ketil River starting from the confluence of Muda River up to the confluence of Kepang River.

(3) Muda Dam Reservoir Block

Spot development plans for the lake park and campsite are proposed on a small scale around the existing dam reservoir due to the steep slope of the lakeshore. The principal purpose of this development is to provide a resort space for the local residents in particular.

(4) Beris Dam Reservoir Block

An extensive plain land is located along the southern part of the lakeshore. The land will have easy accessibility via a proposed connection road and, further, an island located in front of the land could be used as a part of the resort spot. From this viewpoint, a large recreational park is proposed along the southern part of the lakeshore. There exist the international resort area called Pedu Resort along the shoreline of the Pedu dam reservoir. In this connection, the park proposed for Beris dam reservoir is expected to promote inland tourism development for the State of Kedah together with the Pedu Resort.

3.2.2 Alternative Land Development Types to be Applied to Zoning Plan

The river corridor development plan aims at harmonizing nature conservation with the human desire for land use in the waterfront. The people tend to desire living in comfort under naturally rich environment as the economic living standard improves. The river front area is generally rich in nature and landscape, and people would be comfortable to use such open spaces.

However, the land use along Muda River could be remarkably changed in the future according to the economic development, and such change could be made without consideration of appropriate use of river front space, unless no definite plan is prepared beforehand. From these viewpoints, the major attempt for the river corridor development plan is given to (a) conservation and restoration of nature in river and riverside areas, (b) enhancement of public utilization of river front, and (c) creation of naturally rich and vivid life through the river front activities. Based on the planing concept, the following alternative types for land use and/or development are applied to the proposed zoning.

(1) Type A (Land for Nature Reserve)

This type is applied to the area covered with natural vegetation such as trees, shrubs, and, weeds. The area is useful to preserve the scenery of the river and proposed as a natural reserve. No structure should be introduced in principle to the area except the minimum facilities for the conservation purpose. A typical layout of this type is illustrated in Fig. IV.3.2.2.

(2) Types B (Land for Nature Use)

This type is applied to the area used for nature-oriented recreation by utilizing the existing natural conditions as much as possible. Some facilities are provided in this zone but for the purpose of enjoying nature. The typical layout of this type is illustrated in Fig. IV.3.2.3.

(3) Type C (Land for Agriculture)

This type is applied to a quasi-natural area covered with agricultural land such as paddy field, vegetation garden, oil-palm and rubber plantation. This type aims at preserving the present agricultural activities, as well as the scenery of the river. At the same time, this type is used as a part of the recreational space for walking, jogging, cycling, etc. The typical layout of this type is illustrated in Fig. IV.3.2.4.

(4) Type D (Land for Recreation Development)

This type is for the area to be developed as a principal recreation space by structures and facilities with care on the natural resources. The typical layout of this type is illustrated in Fig. IV.3.2.5. The typical facilities required as well as the activities expected for this type are as shown in Tables IV.3.2.1 and IV.3.2.2. Some of these facilities may be used also for Types B and C.

3.2.3 Zoning Plan in Each Block

The following zoning plan is proposed for each of the aforesaid four (4) blocks in due consideration of the present land ownership, the existing parks and recreation sites, and the landscapes of the river as described in Section 3.1 (refer to Table IV.3.2.3).

(1) Zoning in Lower Reach Block

The zoning is made, in principle, for the space of the high water channel proposed in the river improvement plan assuming that the space is to be acquired by the Government. The objective area is located near the existing urban centers such as Sungai Petani and Butterworth. In due consideration of easy accessibility from the urban areas, the principal purpose of zoning is set in developing the recreation space along the river as well as the scenery of the river.

As shown in Fig. IV.3.2.6, the proposed zoning includes seven (7) areas for recreation development and two (2) for agricultural land. Among the areas for recreation development, those around Muda Barrage and Bumbong Lima are proposed as large-scale development areas containing a recreation complex. as shown in Figs. IV.3.2.7 to IV.3.2.9.

(2) Zoning in Middle Reach Block

The river corridor is not subject to land acquisition by the Government. Accordingly, the land development for recreation purpose is proposed to the limited spots currently owned by the Government. The total number of development areas is seven (7), and the principal purpose of development is to provide a riverside park for the neighboring local residents in particular (refer to Fig. IV.3.2.10).

In addition to the spot development areas, natural reserve areas and natural use areas are proposed at three (3) locations, respectively. These natural reserve and natural use areas cover the major river meandering extent containing a high flood damage potential as well as significant flood retarding effects. The selected natural reserve areas are far from the settlement areas, while the natural use area has easy accessibility containing potentials for a nature-oriented recreational area.

The conservation of the present extensive agricultural land is also proposed at the right bank upstream from the confluence of Ketil River. The area is presently owned by the Government and used as agricultural land and at the same time as recreation space for jogging, cycling and walking.

(3) Zoning in Muda Dam Reservoir Block

As described above, the lakeshore has a steep slope, and any large-scale resort development is judged to cause serious aggravation to the morphology of the dam reservoir. From these viewpoint, a nature use zone such as lake park and campsite is proposed on a small scale along the left bank about 2 km downstream from Muda Dam (refer to Fig. IV.3.2.11). A development zone as recreational area is also proposed on a small scale around the dam site. Aside from the above nature use zone and development zone, the entire lakeshore area is proposed as a nature reserve area.

(4) Zoning in Beris Dam Reservoir Block

As described above, there exists an extensive plain land of about 222 ha along the southern part of the lakeshore where a recreational park is proposed as the development zone on a rather large scale (refer to Fig. IV.3.2.12). The proposed development zone contains a recreation complex, as illustrated in Figs. IV.3.2.13 and IV.3.2.14. A development zone is also proposed around the proposed dam site containing a recreational park and a dam exhibition hall. A bird sanctuary area is also proposed as a nature use zone in the island (refer to Fig. IV.3.2.12). Aside from the development and nature use zone, the entire lakeshore is proposed as a nature reserve area.

4. MANAGEMENT PLAN FOR SAND MINING OPERATIONS

Muda River is the biggest source of sand for the states of Kedah and Pulau Pinang. About 1.0 million m^3 of sand are excavated annually for use as construction material on concrete buildings, roads and foundation works. However, riverbed subsidence due to sand mining is so serious that river structures or their functions are threatened to be damaged (refer to SECTOR II).

The present guideline for sand mining operations was reviewed, and field reconnaissance was also made on the present actual mining conditions. Based on these studies, the following items are proposed as major issues for controlling future sand mining operations.

4.1 Environmental Impact Assessment and Monitoring Work

According to the present regulation, Environmental Impact Assessment (EIA) is made for development activities with a land size of more than 50 ha. All of the present sand mining operations is, however, made within the limits of less than 50 ha and, therefore, are not subject to EIA. In consideration of the present various adverse effects of sand mining operations, the present regulation on EIA shall have to be amended and EIA should be required for all proposed mining works.

EIA for sand mining operations and the control of sand mining volume shall be made in the following manners:

(a) All river sand mining operations in one river basin shall be integrated into one package, and EIA on the basin-wide mining operation in the past one year shall be annually made for every river basin regardless of the mining size.

(b) An increment of basin-wide mining volume shall be permitted when EIA evaluates that the mining operations in the past one year could not affect any significant river environment. However, the maximum annual increment of basin-wide mining volume shall be limited to 10% of the present volume in order to avoid the drastic altemation on the river environments.

(c) Should EIA evaluate that the basin-wide mining volume in the past one year could cause the significant adverse effects on the river biology, morphology and other related environment aspects, any issue of further license for mining shall be frozen.

The monitoring of sand mining operations is also quite insufficient due to lack of manpower at the related government agencies, and should be improved with particular attention on the benefits to inhabitants. Moreover, a consistent gauging system on the basin sediment yield is urgently required to be established to clarify the relationship between the sand mining volume and the available sand supplied from the basin. Details of the proposed gauging system is described in SECTOR V.

4.2 Stepwise Reduction of Mining in Riverbed

The design riverbed profile is proposed in SECTION 6 to stabilize the riverbed and to increase the river channel flow capacity. To avoid any further adverse effects on the design riverbed profile, the future sand mining volume shall be taken from the layer between the original riverbed and the design riverbed. The available sand deposit in the allowable mining layer is estimated on the basis of the proposed design riverbed profile and the results of the river channel survey undertaken by JICA in 1994. As the results, the following volumes are taken as the allowable sand deposit for mining operations.

Sand Deposit Allowable for Mining

River System	Stretch	Length (km)	Sand Deposit (m^3)
Main Stream	River Mouth to Muda Barrage	10.4	620,000
Main Stream	Muda Barrage to Merdeka Bridge	2.7	160,000
Main Stream	43 to 50 km upstream from River Mouth	6.7	310,000
Main Stream	63 to 68 km upstream from River Mouth	2.0	130,000
Total		21.8	1,220,000

The above estimated sand deposit is almost equivalent only to the actual annual mining volume in 1993, and out of the total deposit, about 50% (620,000 m^3) is located downstream from Muda Barrage containing salinity. Moreover, the annual basin sediment yield is estimated at about 10,000 m^3 which is much less than the actual mining volume in 1993.

Since the sand deposit for allowable mining is quite limited, and sand supply from the upstream is hardly expected, the riverbed will subside as long as sand mining operations are pursued. In due consideration of these conditions, gradual reduction and finally freezing of sand mining from the riverbed is strongly recommended.

Mining operations shall not be allowed when any of the adverse effects mentioned below are detected and/or expected. Furthermore, whenever any adverse effect or damage happens at the site, the contractor/mining operator shall be required to remedy or repair them at his own expense.

(a) Reduction of river channel flow capacity;

(b) Great hindrance to navigation;

(c) Danger or serious inconvenience to inhabitants; and

(d) Serious influence to vegetation and aquatic life in and around Muda River.

4.3 Alternative Mining Source and Method of Sand Mining

It is indispensable to locate a new mining source aside from the riverbed. In this connection, ocean sand is regarded as the most probable alternative source for sand mining. In Japan, the present major source for sand mining is either the mountains or the ocean, and mining from rivers is less made because of erosion of the river channel. The ratio of sand mining volume from each source in Japan recorded in 1992 are as summarized below.

Sand from the Ocean	36.7%
Sand from the Mountain	36.2%
Sand from the River and Others	27.1%

The method of sand mining from the ocean is classified into two methods as mentioned below. Among them, the pumping method is for fine sand and useful to mine a large volume of sand. On the other hand, the clamshell method is adopted to mine the sand mixed with gravel and other rough materials.

(1) Clamshell Method

The sand is mined by clamshell crawler on pontoon barge. The loadage of the barge is some hundred tons, and the bucket capacity is 1.5 to 3.0 m^3. The sand with sea water is stored in storage container equipped on the pontoon barge, and the sea water is naturally drained into the sea after a certain volume of the sand is accumulated.

(2) Pumping Method

The sand is mind by either suction pump, booster pump or water pump equipped on a pontoon barge. The loadage of the barge is about 1,000 tons.

After mining, the salt (NaCl, KCl, CaCL, MgCl) is removed from the sand for use as concrete material. According to the Japanese Standard (JIS A5308), the sand after removal of salt must contain the salinity deposit (NaCl) of less than 0.04%. The methods for removal of salt are classified into the following four (4) groups:

(1) Pouring Method

Freshwater is poured through either spring cooler or pipe into the mining sand. The necessary water volume is about 0.2 m^3 per sand of 1.0 m^3. The pouring time is about 12 hours including the time to strain out the water from the sand.

(2) Soaking Method

The mining sand is soaked in freshwater. The necessary water volume is about 0.8 m^3 per sand of 1.0 m^3. The soaking time is 12 to 24 hours including the time to strain the water from the sand.

(3) Drying Method

The mining sand is dried under sunshine for more than two months.

(4) Mechanical Method

The mining sand is washed by a special plant. The plant developed in Japan requires a large volume of freshwater of about 1.5 m^3 per sand of 1.0 m^3, but the necessary time for treatment is short.

Shells and other deposits must be sucked out from the sand. When the mining sand is too fine and its particle size is rather uniform, crushed rock is mixed with the sand to make the appropriate distribution of particle size.

The mining for ocean sand will require additional treatment as well as mining cost as compared with river sand. Moreover, the material of ocean sand is not always applicable to the construction material. Detailed sampling test will be required in advance, and the appropriate area for mining will need to be selected, when ocean sand is applied.

5. PRELIMINARY ENVIRONMENTAL IMPACT ASSESSMENT

5.1 General

The preliminary environmental impact assessment (EIA) is carried out to clarify the provable environmental impact by the proposed projects. The general procedure for undertaking the preliminary EIA is to be as follows:

(a) Selection of objective projects for EIA and understanding of the features and activities of each project.

(b) Identification of probable issues imposed by activities or existence of each project.

(c) Preparation of general matrix used as a means to assess the cause-effect relationship between the various project activities and their impacts on the environmental components.

(d) Data collection and field reconnaissance.

(e) Preliminary assessment by the degree of significance of an impact. The results are to be summarized in the matrix and some explanations are prepared for the assessment.

(f) Proposal of appropriate countermeasures for the items with identified significant impact or unknown impact

5.2 Selection of Objective Projects for Environmental Impact Assessment

The following structural plans are selected as the objectives for EIA in consideration of their project scales and significance to socio-economic conditions (refer to Tables IV.5.2.1 to IV.5.2.6):

Sector	Objective Structures
Flood Mitigation	River Improvement of Lower Muda
Water Resources Management	Beris Dam Jeniang Transfer System including Naok and Reman dams
River Environment Management	Beris Dam Reservoir Recreation Park Muda Barrage Recreational Park Bumbong Lima Recreational Park

5.3 Preparation of Matrix

The basic form of assessment matrix for environmental components and works projects is prepared for the preliminary EIA. In the matrix, the assessment on the project activities are evaluated by dividing the progress of the project into the following three terms; (a) site investigation, (b) site preparation and construction and (c) operation and maintenance (refer to Table IV.5.3.1). Moreover, the assessment is made to evaluate the effects by the proposed structures after completion.

The environmental factors affected by the project activities as well as the existence of structures are selected as shown in Table IV.5.3.2, and the rating on the factors are made on the basis of the following indices:

Index	Classification
A1	Adverse impact - minor
A2	Adverse impact - medium/moderate
A3	Adverse impact - major/significant
U1	Unknown due to insufficient data but probably minor impact (A1) or no adverse impact.
U2	Unknown due to insufficient data but probably adverse impact (A2 or A3)
N	No adverse impact
B1	Beneficial/positive impact - minor
B2	Beneficial/positive impact - major

5.4 Results of Environmental Impact Assessment

5.4.1 Summary of Environmental Assessment

The preliminary EIA is made, and as a result, summarized below are the significant impacts classified as A2, A3 and U2 for each project component, their corresponding countermeasures and necessary monitoring items (refer to in Tables IV.5.4.1 to IV.5.4.11).

Significant Impact	Causes	Countermeasures	Necessary Monitoring Items
Resettlement	1. Beris Dam 2. Jeniang Transfer System 3. River Channel Improvement 4. Bumbong Lima Recreational Park	1. Coordination with inhabitants 2. Reasonable compensation for resettlement 3. Assistance and guidance for suitable income of inhabitant to be resettled 4. Preparation of resettlement land based on the desire of inhabitant	1. Living conditions of inhabitant to be resettled 2. Regional socio economy 3. Precedents of resettlement of similar projects 4. Conditions of resettlement land
Disruption of Community	Beris Dam	1. Compensation to non-resettled inhabitant 2. Construction of new transportation network 3. Reorganization of administrative division 4. Establishment of new telecommunication service	1. Regional socio economy 2. New transportation system 3. Living conditions of inhabitants including non-settled people
Soil Erosion	1. Beris Dam 2. Jeniang Transfer System	1. Dredging works 2. Plantation 3. Land use control	1. Topography, geology and soil 2. Vegetation
Water Pollution	1. Beris Dam 2. Jeniang Transfer System 3. Beris Recreational Park	1. Control and treatment of pollution loads 2. Removal of vegetation before dam impounding	1. Pollution source 2. Water use in dam reservoir and river channel 3. Water quality survey.

5.4.2 Assessment on Resettlement and Disruption of Communities

The resettlement is a serious issue for executing a project in Malaysia as often reported in newspapers. Under the proposed Beris Dam Project, village people of more than 1,000 families have raised an objection against resettlement after the details of the dam project was informed. At present, however, their activities are gentle and no anti-government activity is seen. According to the field investigation, the opposition families could be classified into the following three (3) groups.

Group 1	People really do not like to move from their home village in any case.
Group 2	People who may agree to move if the government shows sufficient compensation and prepares the resettlement area with good conditions for them.
Group 3	People who can move without strong requirement but at the same time can not show their honest intention in consideration of the unity of village society.

The people of Group 1 would be the majority and also have to change their mind, if many villagers agree to move to a resettlement area because they want to stay in the village "with village people." As far as the information obtained from some villagers is concerned, it seems that their disagreement to the resettlement is caused mainly by the following matters:

(a) They do not yet understand the necessity and importance of the project.

(b) They want to know the alternative plans including the alternative dam site.

(c) The government has not yet shown the definite compensation for resettlement.

(d) The government has not yet shown the definite plan of resettlement area.

(e) They have special affinity to the village and its peaceful society.

Therefore, it will be necessary for the government to understand the situation and sentiment of village people and take definite and reasonable measures to settle this significant issue in the early stage. For example, the people can start the preparatory works such as land clearing and planting before the resettlement, if the government could provide the resettlement areas a few years earlier than the commencement of construction works. In addition, close coordination between the federal government and the state government will be important for settling this matter.

A similar consideration will be required for the other projects and schemes such as the Jeniang Transfer Canal and the Naok and Reman dams, the Muda River Lower Reach Improvement works, and the Bumbong Lima Recreational Park where the resettlement is necessary.

5.4.3 Assessment on Soil Erosion

Soil erosion and slope failure would be one of significant environmental factors. A considerably wide area would generally be stripped of its natural vegetation including trees by the project activities. Once the area is stripped, it may cause environmentally adverse impacts such as the following:

(a) Slope failure due to low stability

(b) Lacking of nutrients for revegetation

(c) Increase of sedimentation volume in the reservoir

(d) Water pollution in the river as well as the reservoir

(e) Adverse impact to natural fauna & flora

To avoid or minimize the adverse impacts, the following countermeasures will be necessary:

(a) Minimize the land clearing area;

(b) Leave some vegetation or trees in the construction site;

(c) Construct drainage system;

(d) Implement slope protection works;

(e) Provide plantation in stripped area

(f) (f) Monitor water quality

(g) Replant important and/or valuable vegetation

(h) Relocate valuable species of wildlife

The soil erosion may cause a significant impact only in the dam construction site since the slope is generally steep and most areas are covered with natural vegetation at present.

5.4.4 Assessment on Water Pollution

The issues related to water quality in rivers or reservoirs are one of common concerns of environmental impacts for most development project with infrastructures. Should the water be once polluted, the adverse impact could expand to some different environmental fields such as human health, fauna ecology, flora ecology, fishery, soil contamination, odor, mal-colour, etc. However, in case of Muda River, it seems that the water pollution caused by a project would not be serious in rivers due to the self-purification of running water and aquatic vegetation. On the other hand, the pollution in reservoir needs special attention as the water generally stays in the same location for a long period of time.

In case of the reservoirs of Beris Dam, Naok Dam and Reman Dam, the problem caused by turbid water would be not be serious because the stream water coming into the reservoirs generally have less sediment.

Eutrophication is generally serious in many reservoirs. The possibility of occurrence of this phenomenon is not sure in the said reservoirs as no specific investigation and study has yet been carried out. A specific study will be required at the detailed design of these projects. There are some calculation methods to estimate the possibility of reservoir water pollution and some examples of the other existing reservoirs are available. Eutrophication would become worse once it happens, and it is difficult to recover the original conditions.

There are many measures against eutrophication and other water pollution problems. The most important measure would be those to minimize the pollution loads (especially N and P) coming into the reservoir. The typical measures for water quality conservation of rivers and reservoirs are summarized in Table IV.5.4.12.