SUPPORTING REPORT

PART-G

ENVIRONMENT

THE STUDY ON FLOOD CONTROL FOR AMBON AND PASAHARI AREA
IN THE REPUBLIC OF INDONESIA
SUPPORTING REPORT
PART-G

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CHAPTER 1 ENVIRONMENTAL SETTING IN THE STUDY AREA

1.1 Environmental Management

1.1.1 Environmental Legislation

(1) Government Policy on the Environment

In the Republic of Indonesia, the basic law on the environment is the Act No.4 of 1982 Concerning Basic Provisions for the Management of the Living Environment. As is stated in the introduction of this Act, establishment of the basic environmental law has been under a consideration of the importance of environmental protection, the effective use of natural resources for the improvement of welfare as stipulated in the Constitution of 1945, the necessity of protecting and developing the living environment in accordance and compatible with the growing awareness of environment in the world and the environmental management based on an integrated and comprehensive national policy. The Act consists of 9 sections including general provisions, principles and objectives, right, obligations and authorities, protection of the living environment, institutions, compensation and restoration, penalties, transitional provisions and concluding provisions.

The Act takes 'sustainable development' as a basic policy for environmental management. 'Sustainable development' can be defined as development which provides economic, social, and environmental benefits in the long term and for the future generation. Establishment of an environmental impact assessment system has therefore been stressed in the Act as one of the actions for environment protection.

(2) Environmental Regulations Related to the Study

Based on the Act No. 4 of 1982, the Government has put forward various regulations and decrees on environment management. Table-G.1.1 shows the regulations and decrees related to river engineering, water resource development and the environment. These shall be used as guidance for this Study.

Besides legislation of national level, there are regulations put forward by provincial government in consideration of regional development condition. Some related regulations of Maluku Province are also listed in Table-G.1.1.

1.1.2 Environmental Impact Assessment

(1) Procedures of Environmental Impact Assessment

Article 3.13 of the Act No. 4 of 1982 prescribes that every plan which is considered likely to have a significant impact on the environment must be accompanied with an environmental impact assessment. An environmental impact assessment system has been established accordingly to meet this requirement. Figure-G.1.1 shows a flow chart of environmental impact assessment (AMDAL). The type of businesses and activities to which AMDAL are required is specified in the Decree of the State Minister of Environment No. KEP-39/MENLH/1996 according to the scale of the projects.

Table-G.1.1 Environmental Regulations Related to the Study

(1) Government Act	
No. 11 of 1974	on Water Resources Development
No. 4 of 1982	on the Principles of the Management of Living Environment
No. 5 of 1990	on the Principles of the Conservation of Ecosystem and Natural Resources
No. 4 of 1992	on Housing and Settlement
No. 24 of 1992	on the Principles of the Spacing System
(2) Government Regulation	
No. 22 of 1982	on the Principles of the Water Management
No. 20 of 1990	on Water Pollution Management
No. 35 of 1991	on River
No. 51 of 1993	on Environment Impact Assessment
(3) Presidential Decree	
No. 32 of 1990	on Conservation Area Management
No. 55 of 1993	on Acquisition of Land for the Development of Public Interest
(4) State Minister of Environment Decree	
No. KEP-02/MENLH/1/1988	on Environmental Standard Quality
No. KEP-14/MENLH/3/1994	on the General Guidelines for AMDAL
No. KEP-39/MENLH/8/1988	on the Types of Businesses or Activities Required for AMDAL
No. KEP-03/MENKLH/1991	on Standard Quality of Industrial Wastewater
(5) Head of the Environmental Impact Management Agency Decree	
No. KEP-056/1994	on the Guidelines for the Determination of Significant Impact
(6) Ministry of Public Works Regulation	
No. 39/PRT/1989	on River Territory
No. 45/PRT/1990	on Water Pollution Control
No. 48/PRT/1990	on Water Management in the River Area
No. 49/PRT/1990	on Manner and Custom Concerning Using Water Resources
No. 63/PRT/1993	on the Boundary of River Limit, Benefit Area of River, Authorized Area of River and Oxbow Lake
No. 69/PRT/1995	on Technical Guidelines of AMDAL of Public Works Projects
(7) Ministry of Public Works Decree	
No. 458/KPTS/1986	on Sand Mining in the River
No. 58/KPTS/1995	on AMDAL Approval Guidelines
No. 147/KPTS/1990	on Technical Guidelines of KA-ANDAL of Public Works Projects
No. 148/KPTS/1995	on Technical Guidelines of RKL and RPL
(8) Minister of Health Regulation	
No. 258/HENKES/PER/II/1982	on Groundwater Quality
No. 416/HENKES/PER/IX/1982	on Water Quality Standard and Monitoring
(9) Minister of Agriculture / Head of National Land Agency Regulation	
No. 1 of 1994	on Land Acquisition
(10) Regulation of Maluku Province Government	
No. 07 of 1989	on Management and Monitoring of Groundwater Use
No. 02 of 1992	on Organization of Secretariat of Maluku Province
No. 63.13/SK/101/1993	Decree on Technical Guidance for Permission of Pumping Well and Groundwater Use and its Restriction
No. 63.13/INST/06/1992	Instruction on Technical Management and Monitoring of Using Groundwater

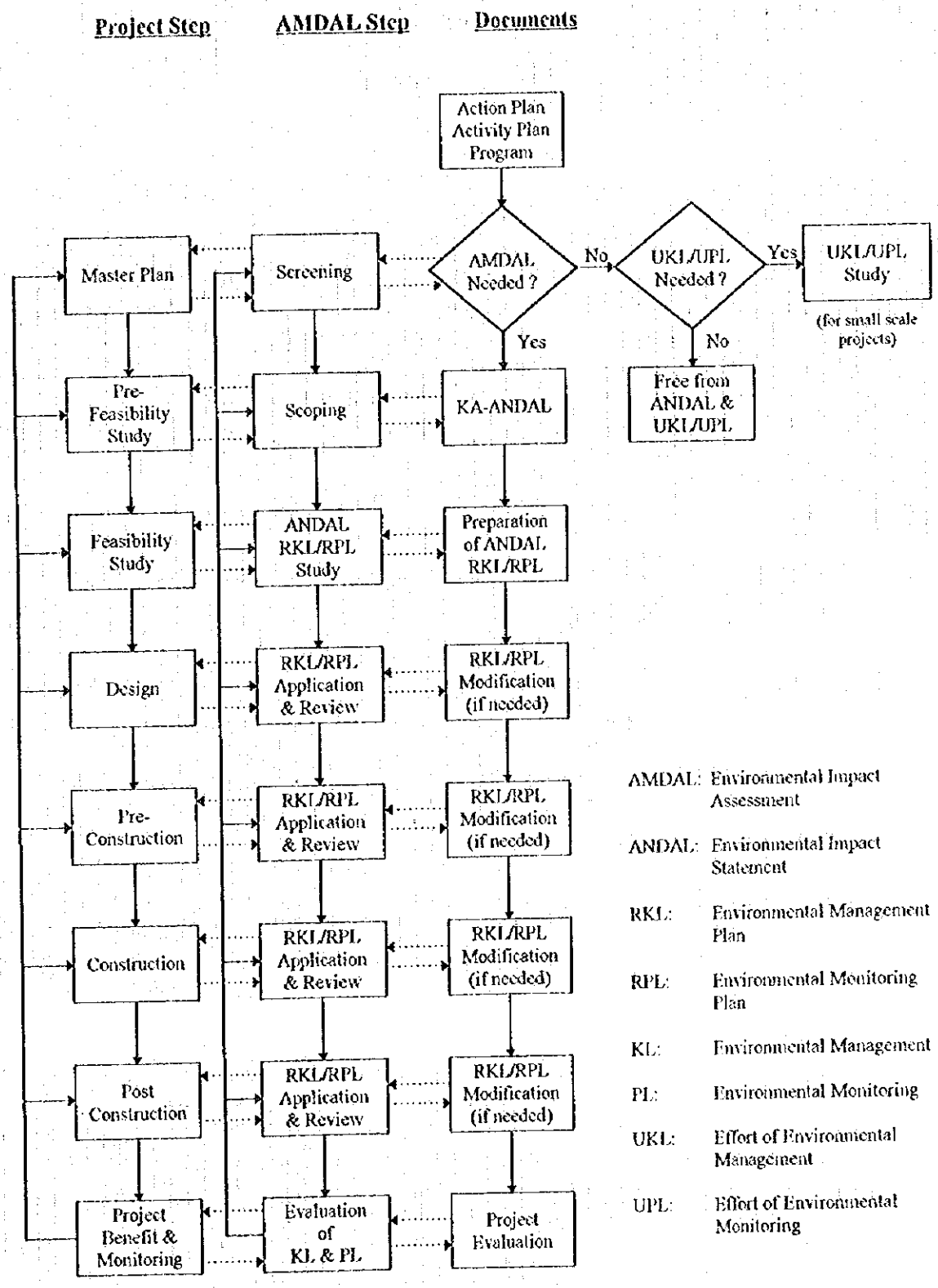

Figure-G.1.1 Flow Chart of Environmental Impact Assessment (AMDAL) in Relation with Project Step

For projects which need AMDAL, a Terms of Reference of Environmental Impact Assessment (KA-ANDAL) has to be submitted for approval before the AMDAL study. The output of the AMDAL shall include an Environmental Impact Statement (ANDAL), Environmental Management Plan (RKL) and Environmental Monitoring Plan (RPL). The general procedures for the approval of KA-ANDAL and AMDAL are shown in Figure-G.1.2 and Figure-G.1.3.

At national level, the Ministry of State for the Environment is responsible for environmental management along with the Ministry of Public Works for public works projects. The Central Commission of AMDAL is organized within the Ministry of Public Works with its chairman appointed by the Minister. At provincial level, this task is taken by the Bureau of Environment and the Department of Public Works and the Regional AMDAL Commission is organized within the provincial government with its chairman appointed by the Governor.

Regarding projects which do not need AMDAL, an Effort of Environmental Management (UKL) and Environmental Monitoring (UPL) may still be required according to the project scale.

(2) AMDAL Activity in the Study Area

Currently, most of the environmental studies in the Study Area are limited to UKL and UPL for comparably small scale development activities such as construction of residential buildings and hotels, development of poultry area and small scale processing industries, etc.

The only AMDAL conducted recently in the Study Area is that for the feasibility study of Pattimura Laha Airport Expansion project by the Dept. of Transportation in 1993. PT. INDIMECO (a consulting company from Jakarta) prepared the ANDAL and RKL/RPL and had them approved by the Ministry of Transportation. This AMDAL study focused on analyzing the physicochemical, biological and socio-economic impact of the airport construction on the environment in the vicinity area and the environmental benefit after the new airport's completion. The main items of analysis include demography, socio-economy, flight safety, air quality, noise, hydrology, hydrooceanology, water quality, biology etc. The construction work of a runway and auxiliary facilities will be started in later 1997 and completed within this century. Some other AMDAL studies in Maluku Province are for cement industry, harbor construction, forestry and fishery development, but all the project sites are in the other islands.

Some scientific institutes in the Study Area such as the Research Center of Environmental Study, University of Pattimura, the Research Center of Oceanology Development, Institute of Science Indonesia (LIPI) are carrying out fundamental studies on the environment in Ambon and the other Maluku areas. However, due to the limitation of regional development, environmental impact assessment is still not a common practice in the Study Area, and few documents and reports of this kind are available.

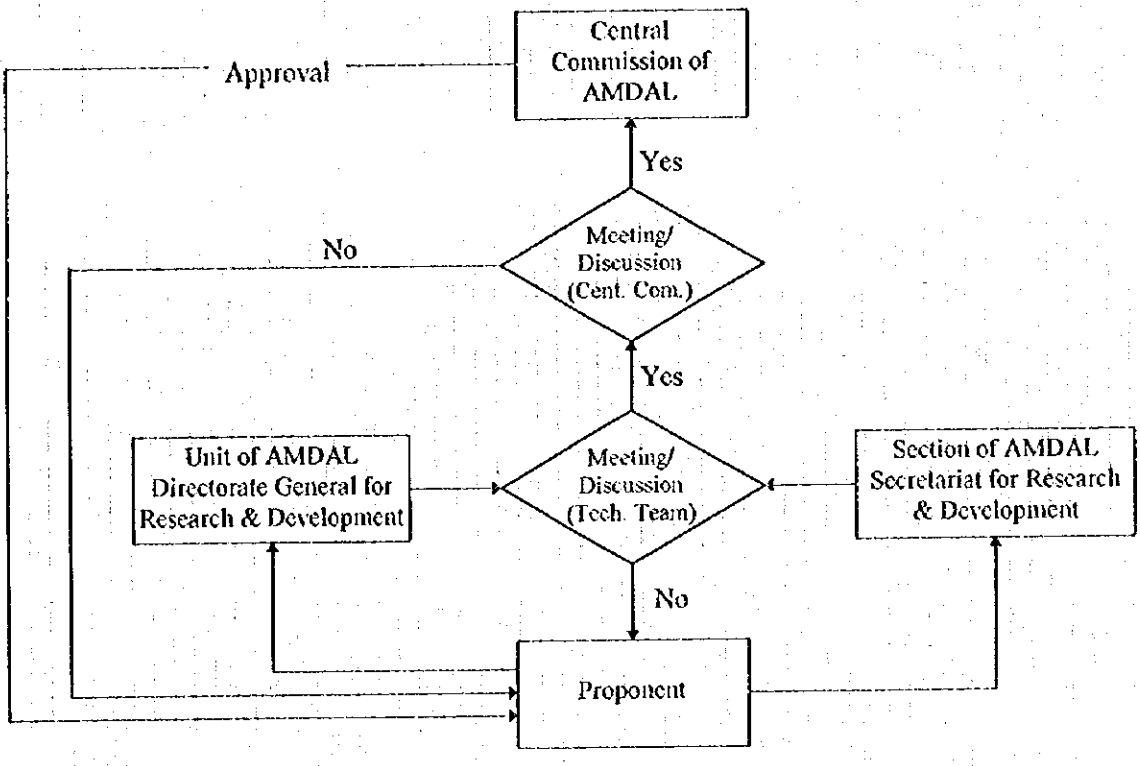

Figure-G.1.2 Flow Chart of Approval of the TOR for An Environmental Impact Assessment (KA-ANDAL)

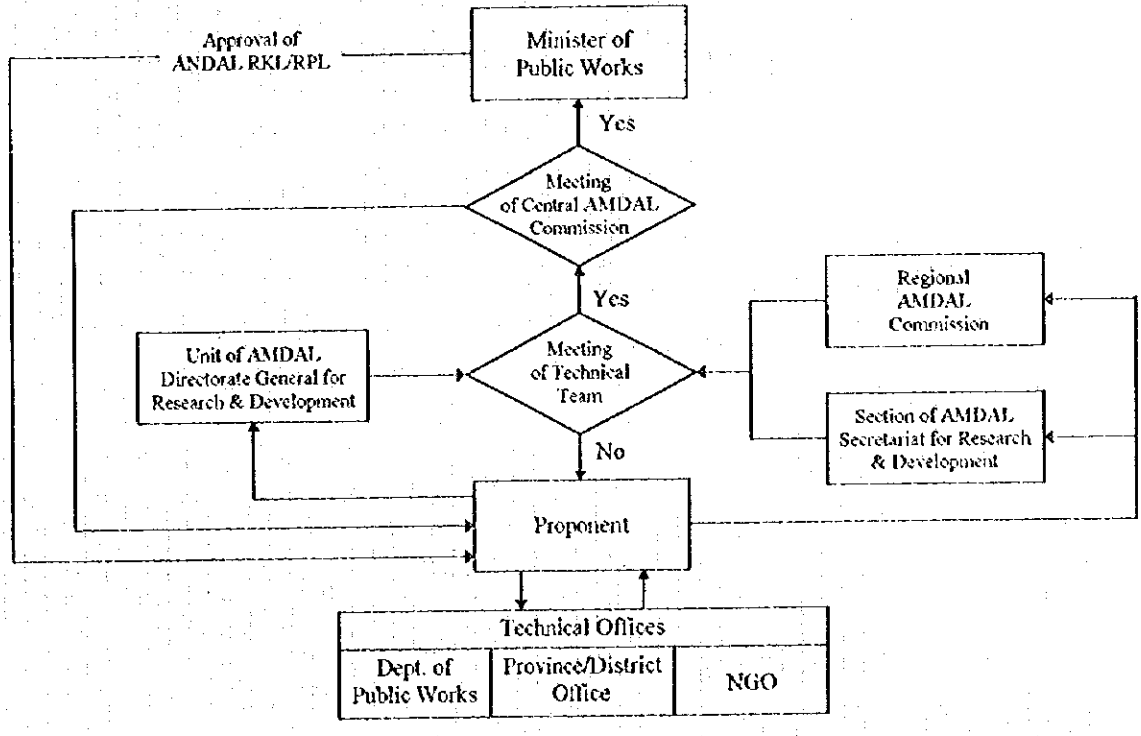

Figure-G.1.3 Flow Chart of Approval of Environmental Impact Assessment Documents (ANDAL-RKL/RPL) for Public Works Projects

1.2 Social Environment

See Part-A for fundamental factors on social environment - economic activities, social conditions and land use.

1.2.1 Resettlement and Land Acquisition

Ambon City has a couple experiences in land acquisition and resettlement. The largest resettlement took place for the construction of the fishery port in Pandan Kasturi (Kelurahan Batu Merah), implemented by the provincial level of the Directorate of Fishery, Ministry of Agriculture in the fiscal years 1985/86 and 1986/87. The project was initially financed by the national government, but the financing was eventually taken over by the Asian Development Bank due to budget constraints.

The project site is located in the center of Ambon City. It consisted of two communities (Desen), composed of 34 households and 174 households. Most of the villagers were small retailers and the housing environment was relatively poor. Mainly due to the budget constraints of the Government, the authorities could obtain substitute land for the small one of the communities (34 households) in Kebon Cengkeh in the same town (Kelurahan), which is located 2 km away from Pandan Kasturi. On the other hand, 174 households had to be displaced to Desa Wayheru, 20 km away from downtown Ambon where most of the villagers worked, regardless of villagers' wishes to stay closer to town. In order to avoid land speculations, the Government held a meeting to explain about the project only three months before the actual acquisition of the land. Compensation payment was also discussed in the same meeting, in the form of collective negotiations.

The following facts were learned from the interview with the Head of theDesen resettled to Waiheru. Although villagers had been requesting the issuance of land titles to the National Land Agency (BPN) for a long time before the project was decided, only three households had been issued the land titles due to slow administrative procedures. However, all the villagers were finally given the right for full land tenure since customary land tenure was commonly acknowledged in Ambon City. Housing and moving costs were paid in cash, and substitute land was given in Waiheru, where infrastructure was prepared by the Government. At first, the villagers were not content with the new living environment because: 1) it costs them Rp. 1,200 every day to commute between Waiheru and the downtown; 2) there was some friction between the resettlers and the existing community since the former were Muslims and the latter were Christians; and 3) public facilities such as electricity and water were not available immediately to each household. However, these problems were settled eventually. Around half of the resettlers bought farmlands close to their houses and as a result, their overall income has increased due to the sales of food crops such as cassava. Religious conflicts have been subdued after the heads of communities talked with each other and mutual understanding was attained. With their resettlement compensation, villagers could built houses that were bigger and nicer than their old houses in Pandan Kasturi.

1.2.2 Transportation and Public Facilities

The general condition of traffic and public facilities in Ambon Municipality is summarized in Table-G.1.2 based on the statistic data of 1995.

Table-G.1.2 Traffic and Public Facilities in Ambon Municipality

Item	Data	Remarks
Length of Road (km)	244.2	235.95 km are Class III
Bus in Operation	1184 289	within Ambon Municipality outside Ambon Municipality
Bus Stop	45	-
Beca (tricycle)	2000	-
Traffic Signal	1139	-
Ferry Port	2	-
Mosque	3.139	-
Church	192	-
Museum	1	-
Cinema	2	-
Power Plant	8	number of generator
Post Office	10	1 main office, 6 sub-offices, 3 mobile offices
Telecommunication Center	3	-
Telephone Service (WARTEL)	13	-
Sport Center	1	-
Tourist Spot	25	including beach, marine park, mountain, etc.
Hotel	40	-

Source: Ambon Municipality Statistics 1995

1.2.3 Historical Sites and Protected Areas

(1) Historical Sites

In the Study Area, there are three historical sites designated by Maluku Province Government as protected cultural properties: Victoria Fort, Devil Foot Print and Japanese Cave. Their locations are shown in Figure-G.1.4.

The Victoria Fort was built by Dutch more than 200 years ago when Indonesia was under the control of the colonialism government. Lies in the center of Ambon City, the Fort has become an important military fortress and kept heroic stories of fighting for independence.

The Devil Foot Print was found on a huge rock near the upper stream of Tomu River. Although there is no definite saying about this rock, local people believe that the Devil Foot Print is a sacred place.

The Japanese Cave is a cave used by Japanese Army in 1942-1945 during the Second World War. It has been preserved as a historical site for patriotic education.

(2) Protected Areas

Near the Study Area, two forest areas, Gunung Sirimau and Gunung Nona have been designated as protected areas by Maluku Province Government. As is shown in Figure-G.1.5, only a small part of the Gunung Sirimau Forest Area is within Ruhu River watershed but to the extremely upper stream side, and the Gunung Nona Forest Area is completely outside the Study Area.

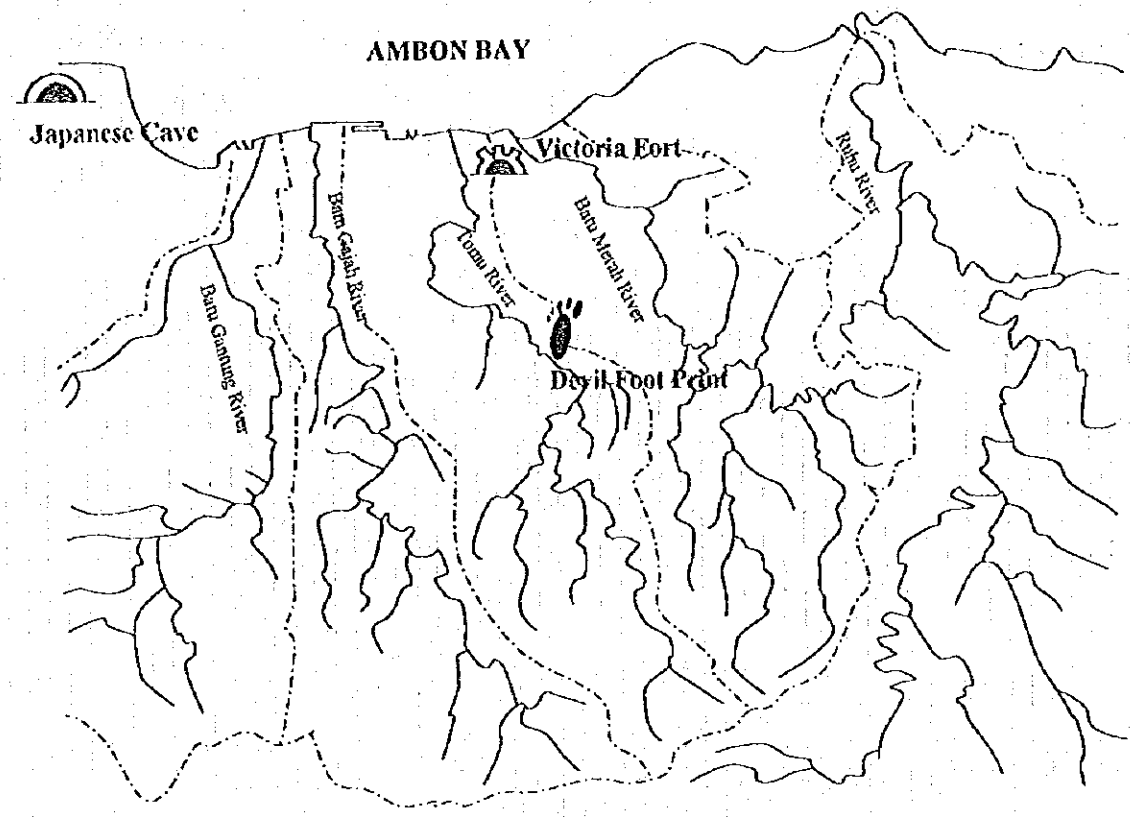

Figure-G.1.4 Locations of Historical Sites in the Study Area

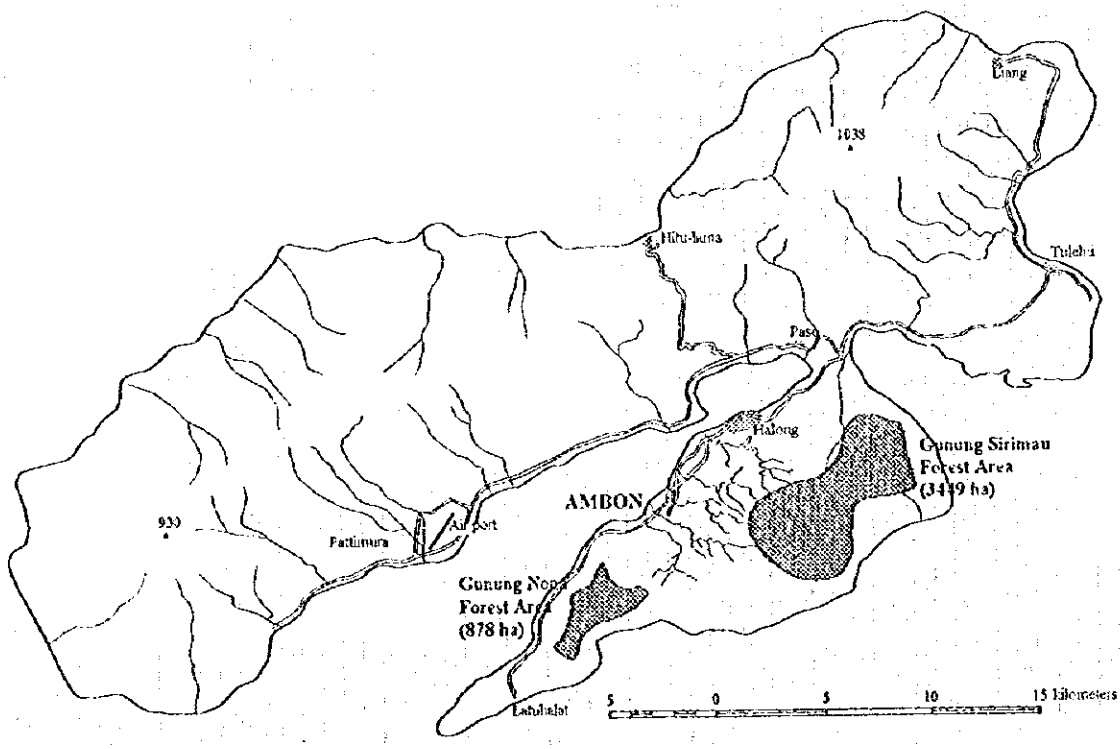

Figure-G.1.5 Locations of Protected Forest Areas

1.2.4 Public Health

In Ambon Municipality, there are 9 hospitals with a total number of 849 beds in 1995. Considering the total population of 286,475 (datum of 1995), the medical service is at a level of 337.5 persons/bed on average. There are also 17 community health centers and 30 sub-centers for simple medical care. There are totally 1,161 staff working for medical service, including 74 doctors and pharmacists and 625 nurses.

Table-G.1.3 shows the disease and illness treated in hospitals and health centers in Ambon Municipality from 1993 to 1995. Of the victims of diarrhea, the numbers of death in the 3 years are 13, 12 and 25 respectively. Since diarrhea is usually caused by contaminated food, drink, water etc., the comparatively high death rate is thought to be due to the poor sanitary condition. For example, 1995 was a year of fruits harvest in Ambon and the volume of garbage from fruits was far beyond the capacity of solid waste collection and disposal in the City. This resulted in emission of offensive odors and unusual growth of disease vectors such as flies and mosquitoes. This is thought to be the reason for the higher rate of death from diarrhea.

Table-G.1.3 Disease and Illness in Ambon Municipality

Disease	1993		1994		1995	
	a	b	a	b	a	b
Respiratory infection	43,723	15,519	25,686	9,050	29,460	10,284
Skin disease	5,529	1,962	8,490	2,991	5,849	2,042
Gastric disease	7,241	2,084	7,639	2,691	7,665	2,700
Vulva and periphery disease	9,413	3,341	11,237	3,959	10,887	3,800
Diarrhea	9,552	3,390	5,989	2,110	5,428	1,195
Ascariasis	4,567	3.1321	4,033	1,421	3,767	1,315
Oral and dental disease	3,236	1,149	4,763	3.1378	4,063	1,418
Influenza	2,662	945	3,984	1,002	3,652	989
Scabies	4,880	1,732	1,308	461	1,102	385
Conjunctivitis	385	137	2,172	765	2,010	702
Others	7,920	2,811	42,631	15,020	2,577	900

a - Number of victims b - Number of victims per 100,000 population

Source: Ambon Municipality Statistics 1995 and data from Health Office, Ambon Municipality

1.2.5 Disasters

In the Study Area, river flooding is the main natural disaster which has resulted in serious damage. The details has already been described in Part-D.

As for other natural disasters, there are no records at all. However, on December 31, 1996 earthquakes occurred in Ambon area several times with the magnitude of the biggest two quakes as 5.5 and 5.3 degrees on Richter scale and people in Central Ambon area experienced strong shake. Although there was no damage reported since the seismic center was 30 km south from Latuhalat Beach and 55 km below sea level, taking necessary measures to prevent earthquake damage may become a subject in the future.

Besides natural disasters, fire incidents happen in Ambon Municipality and the whole island very often. The total number of fire incidents in 1995 amounted to 19 and one big incident occurred in a residential area. 219 households lost their homes and transmigrated to Seram Island.

1.3 Environmental Sanitation

1.3.1 Water Supply

In the Study Area, domestic and industrial water is supplied by 1) Regional Water Supply Company (PDAM), 2) local water companies and 3) private wells and other facilities. Figure-G.1.6 shows the outline of PDAM water supply system including water resources (springs and wells), reservoirs and main water transfer pipes. Its distribution network mainly covers the central part of Ambon Municipality and serves about 30% of population in 1996. PDAM also has 5 mobile tankers for selling water to areas where the network does not cover.

There are 8 local water companies selling drinking water by 10 mobile tankers mostly with spring water. However, the capacity of water supply and population served are not clear. As for the number and capacity of private wells, no data are available. According to the data provided by the Health Office of Ambon Municipality, the population served by different type of drinking water supply can be summarized in Table-G.1.4.

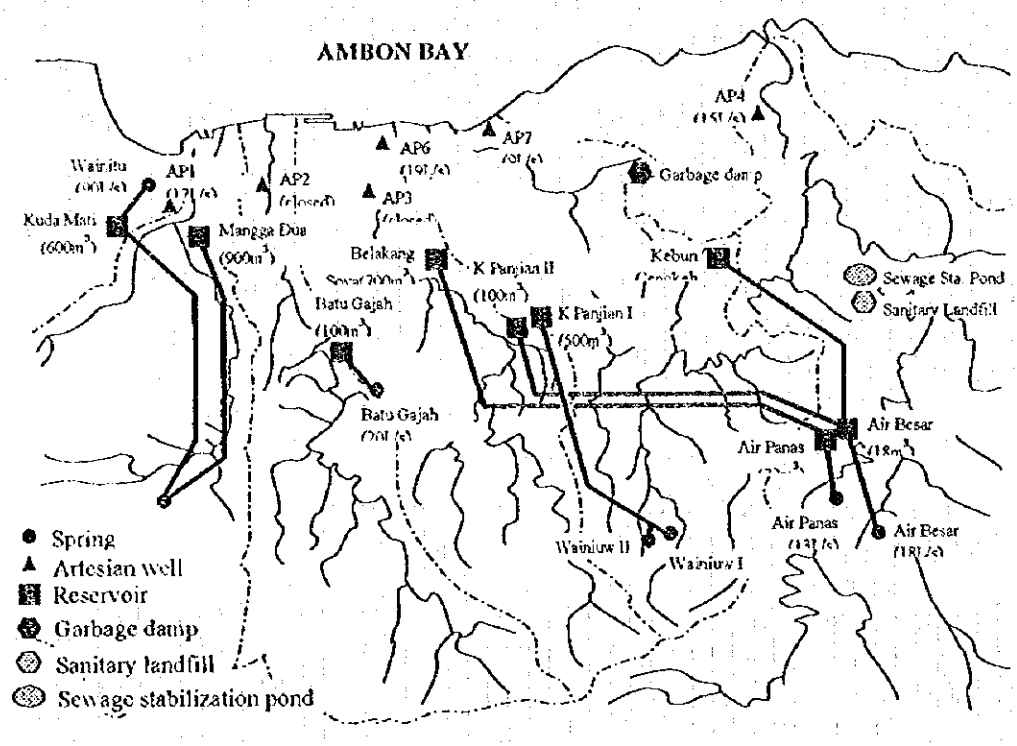

Figure-G.1.6 Locations of Water Resource Facilities and Main Transfer Pipes for PDAM Water Supply in Central Ambon Area

There is hardly any treatment conducted before water is supplied to the customers. PDAM has chlorination equipment at some of the water sources, but seldom being operated. As will be described in Section 1.5, water from many of the wells does not meet the drinking water quality standard especially for total coliform and/or fecal coliform. Although people usually drink boiled or bottled water, there is still considerable risk of bacterial infection through gargling, kitchen ware washing etc. using contaminated water.

Table-G.1.4 Population Served by Different Types of Water Supply in Ambon Municipality

Type of Water Supply	Pipe System	Well with Hand-pump	Well without Hand-pump	Spring Water	Rain Water	Others	Total
Population	87,137	6,417	165,307	9,450	11,085	12,604	292,000

Source: Health Office of Ambon Municipality

1.3.2 Sewerage

There is no public sewer system in Ambon and therefore natural rivers and streams receive most of the domestic sewage and even night soil from all residential areas and finally discharge them into the Ambon Bay. Many toilets are located directly on the rivers. The condition is worse at the downstream area where population concentrates and the pollutant amount far excesses the maximum allowable load that the river can perform self-purification functionally.

The only sewerage facility in Ambon Municipality is a sewage disposal plant newly built and put into operation in later 1996 (refer to Figure-G.1.6 for its location). There are 9 stabilization ponds to perform anaerobic and/or facultative decomposition of the sewage from septic tanks collected by 2 vacuum tankers from city area.

1.3.3 Sanitary Facilities

The condition of sanitary facilities used in Ambon Municipality in 1995 is shown in Table-G.1.5. About 36% of the population are served with water closets but about one third of the population do not have proper toilets to use.

Table-G.1.5 Population Served by Different Types of Sanitary Facilities

Type of Sanitary Facilities	Septic Tank	Water Closet	Traditional Toilet	Others	Total
Population	74,334	106,489	13,458	97,719	292,000

Source: Health Office of Ambon Municipality

1.3.4 Solid Waste

Table-G.1.6 shows the manpower and facilities employed in Ambon Municipality for solid waste collection and disposal. There had been only one open dump site for final disposal until 1995. A new sanitary landfill site was put into service in 1996 (refer to Figure-G.1.6 for its location). According to statistic data, about 95% amount of the solid waste is disposed daily. However, heaps of garbage are seen everywhere on road sides, river banks, sea shore and residential areas. Arbitrary dumping of garbage into the river is another reason of river water contamination.

Table-G.1.6 Solid Waste Disposal in Ambon Municipality

Man Power		Vehicle		Accumu-lation Site	Final Dis-posal Site	Waste Volume (m^3)	
Permanent	Temporary	Truck	Carriage			Generated	Disposed
76	216	14	500	50	2	1,155	1,095

Source: Ambon Municipality Statistics 1995

1.4 Natural Environment

1.4.1 Flora and Fauna

(1) Flora

Flora in the Study Area can be categorized as those in the protected forest, community forest, agroforestry area and gardening area. Table-G.1.7 is a list of the main species in these areas. There is no information on endangered flora species.

Table-G.1.7 Flora Species in the Study Area

Protected Forest	Community Forest & Agroforestry Area	Gardening Area
Kayu Bapa (*Shorea selanica*) Kayu Damar (*Agathis damara*) Kayu Kenari (*Canarium sp.*) Kayu Nani (*Metrozyderos sp.*) Kayu Cemara (*Cassuarina sp.*) Kayu Gondal (*Ficus sp.*) Kayu Lenggua (*Pterocarpus indicus*) Kayu Samama (*Anthocepallus Macrophylla*) Kayu Putih (*Melaleuca leucadendron*) Ekaliptas (*Eucalyptus sp.*) Akasia (*Acacia Auriculiformis*) Palmae Sp. (*Palmae sp.*) Bamboo (*Bamboceae*) Sago Palm (*Metroxyl sp.*) etc.	Clove (*Eugenia aromatica*) Jambu (*Eugenia sp.*) Nut Meg (*Palaquim aprutaneum*) Durian (*Durio zybethenus*) Sukun (*Artocarpus sp.*) Salak (*Salaca sp.*) Langzat (*Lanzones sp.*) Kocape (*Synamomum kocape*) Nangka (*Arthocairpus integra*) Nona (*Anona mauricata*) Ganemo (*Gnetum gnemon*) etc.	Cassava (*Ultizima manyhot*) Sweet Potatoes (*Ipomoa batata*) Keladi (*Colocacia sp.*) Vegetables Bananas Pineapples Spices Plants etc.

Source: JICA Study Team investigation data

(2) Fauna

Wildlife in the Study Area is dominated by several species of birds found in the forest area such as Lorry, Parrot, Bayan, Perkici, Wild chicken, Wild pigeon, Crested dove etc. There exist also Wild boar, Momitor lizard, Snake, Deer and Wild dogs. The number of species are decreasing gradually with the increase of human activity such as deforestation and hunting. Kus-kus, a kind of mammal, is specified as endangered fauna species.

1.4.2 Coastal Environment

The 5 rivers in the Study Area flow into the Ambon Bay which is a harvest area for fishery industry, functions as a passage for marine transportation and possesses tourist attractions, and therefore is very important to Ambon's development. The Research Center of Oceanology Development, LIPI has conducted a systematic investigation on the coastal environment of Ambon Bay. Study results show the characteristics of biodiversity of the Ambon Bay and its high potential of fishery production. Unfortunately the coastal environment has been deteriorated recently due to human activities with the development in

the relate areas, especially the coastal area near central Ambon. Deterioration of coral reefs and mangrove forests is the most serious result.

(1) Coral Reefs

The distribution of coral reefs in Ambon Bay area is shown in Figure-G.1.7. Of the 10 locations where there used to be well grown coral communities, only the 3 near the outlet of the Bay are still in good condition. The others have been damaged gradually and the coral reef at Pandan Kasturi, a location near the estuaries of Ruhu River and Batu Merah River, has already disappeared.

Damage on coral reefs is due to many natural and human related reasons. Generally speaking, coral reefs can only grow in warm salt water where sunlight can penetrate sufficiently. In an estuary area, sediment runoff causes sea water turbid, shuts out light penetration and therefore results in an environment unsuitable for corals to grow. This condition is observable in the Study Area. Of course human activities such as fishing using dynamite or cyanide, motor boat sailing, collection of coral stone, may cause physical and chemical damage on coral reefs.

(2) Mangroves

The distribution of mangroves is also shown in Figure-G.1.7. Of the 5 rivers in the Study Area, the estuary of Ruhu River (Galala) used to possess large area of mangroves. However, all mangrove trees were cut out in these 10 years before houses and workshops were built near the river mouth. The ruin of mangroves can still be found in that area. Similar thing occurs at other mangrove locations as well. Collection of firewood for everyday life and clearance of land for house construction are the main reasons of mangroves deterioration.

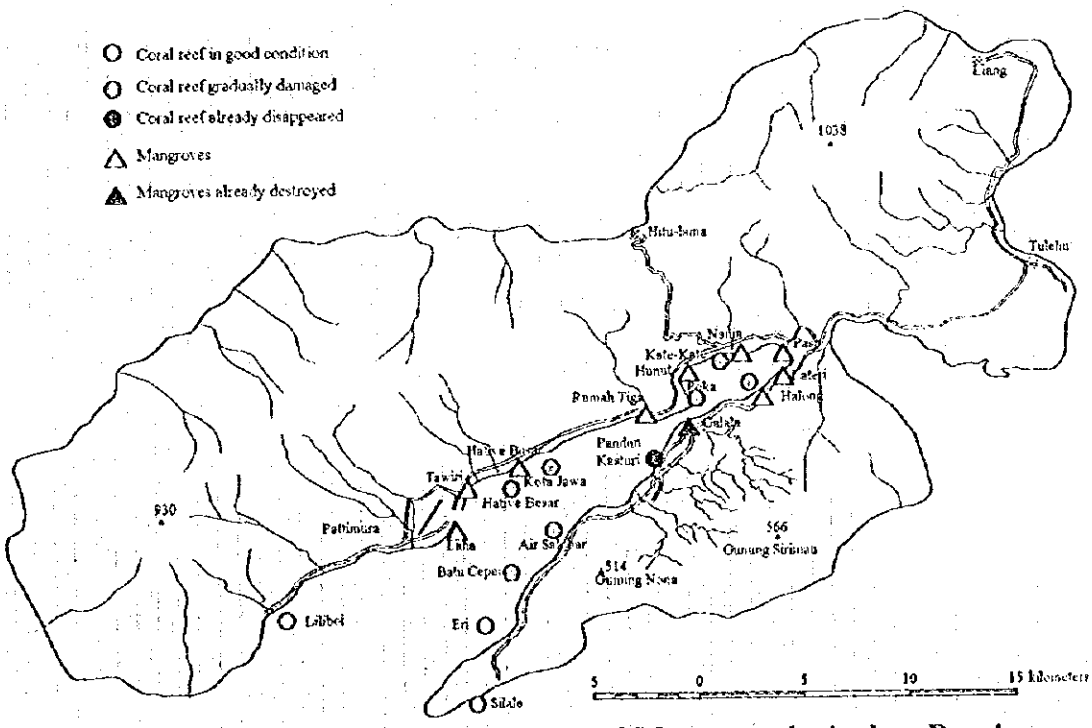

Figure-G.1.7 Locations of Coral Reefs and Mangroves in Ambon Bay Area

1.4.3 Landscape

Topographically the Central Ambon can be categorized to three zones: sea front, plateau and mountain zones. With different characteristics, the three zones composite a unique landscape of this area.

The sea front zone faces the Ambon Bay where rugged coastline bends counterclockwise to the inner bay side and extends to the outer bay side. Ambon Bay is famous for its beaches with various sand texture and beautiful coral reefs which attracts tourists from all the world for marine activities as diving, snorkeling etc. However, such kind of spots have gradually disappeared from Central Ambon area due to increasing development activities.

Most of the plateau zone is covered with tropical rain forests. Although deforestation has become a serious environmental problem recently, this zone is still a green area with trees, bushes and grasses. The government is starting a reforestation program to recover the deforested area.

Mountains behind the plateau rise to 400 - 500 meters above the sea. Near the southwestern boundary of the Study Area, the Nona Mount is an attractive spot from where one can take a paronama view of the Central Ambon and Ambon Bay.

1.5 Environmental Pollution

1.5.1 Water Pollution

(1) River Water

In the Study Area, there are few existing data on river water quality due to lack of water quality monitoring. Only one report of LIPI mentioned high concentration of heavy metals such as Pb, Cd, Cu and Zn discharged from some rivers into Ambon Bay. This is thought to be from the solid waste dumped to the river.

As has been mentioned in Section G.1.6. The results of water quality analysis conducted during this Study show that the 5 rivers in the Study Area have been severely polluted. By walking along the river side, it can be seen that sewage and night soil are flowing into the river from everywhere - houses, public facilities, toilets etc. Dumping garbage into the river is also a habit of the residents living near the river.

(2) Groundwater

Groundwater is the source of water supply in Ambon. Table-G.1.8 shows the data provided by the Dept. of Health, Maluku Province, concerning groundwater quality from some wells in the Study Area. For most of the wells, water is more or less contaminated and unsuitable to be used directly for drinking purpose according to the Ministry of Health Regulation No. 416/MENKES/PLR/IX/1990 for Drinking Water Quality, especially for total coliform bacteria. However, these wells are being used for domestic water supply without any treatment.

Table-G.1.8 Groundwater Quality in the Study Area

Location	Date	Parameter			
		Turbidity (NTU)	Color (TCU)	COD (as $KMnO_4$)	Coliform (/100 mL)
Tomu River (upstream)	Nov. 1993	14	10	3.2	> 240
Tomu River (midstream)	Nov. 1993	13	6	7	> 240
Tomu River (downstream)	Nov. 1993	20	3.13	8	40
Batu Gajah (upstream)	Nov. 1993	23	11	6	> 240
Batu Gajah (midstream)	Nov. 1993	21	13	5.3	50
Batu Gajah (downstream)	Nov. 1993	15	7	8	45
Hative Kecil (midstream)	Jun. 1996	0	0	1.16	8.8
Hative Kecil (downstream)	Jun. 1996	0	0	0.6	> 240
Batu Merah (downstream)	Jan. 1995	0.15	4	9	48
Batu Merah (midstream)	Jan. 1995	0.25	6	9	> 240
Pandan Kasturi	Jan. 1995	0.3	3.13	4	> 240
Silale	Mar. 1996	0.3	0.3	6	197
Rijali	May 1996	0.17	0	4	12
Karang Panjang	May 1996	0.14	0	4	38
Mangga Dua	Jun. 1996	0.7	0	1.3	38
Skip Kecil	Jun. 1996	0.33	9.5	5.1	71
Regulation No. 43.13/MENKES/IX/1990	-	5	15	10	0

Source: Dept. of Health, Maluku Province

1.5.2 Ocean Pollution

There are no monitoring data about water quality in the Ambon Bay. The only information available is from some reports of study conducted by the Research Center of Oceanology Development, LIPI in later 1980s and early 1990s.

Sediment from river runoff is the main pollutant for the Ambon Bay. In a dry season or during a period with no rainfall, sunlight can penetrate to a depth of 17-30 m, while in a rainy season sunlight penetration depth is only 0.7-2 m. In the estuary area, sea water often turns yellow or greenish and indicates a condition of pollution by both sediment and microorganism. There are not COD or BOD analysis data, but an measurement of dissolved oxygen shows an average value of 5.12 ppm in July, 1990 (monthly rainfall 373 mm) and 5.33 ppm in October of the same year (monthly rainfall 17 mm). Sea water may have been slightly organically polluted. However, nutrient and heavy metal analysis results do not show much problem.

Besides pollutant runoff from the river, dumping garbage and sewage directly into the sea is another reason for ocean pollution.

1.5.3 Others

(1) Air Pollution

There are no monitoring data on air quality in the Study Area. However, air quality is thought to be good because there is almost no source of exhaust fumes except automobiles on the street.

(2) Soil Pollution

Use of pesticides for agriculture is thought to be a problem to result in accumulation of toxic substances such as organic phosphate compounds etc. in the soil. However, there are no data available.

(3) Noise and Vibration

There is no source of intense noise or vibration in the Study Area.

(4) Offensive Odor

Offensive odor is often emitted from places where heaps of garbage are naturally decomposed or night soil and sewage are stagnated. The situation is serious in downstream area of the rivers. However, no data are available on offensive odor analysis.

1.6 River Water Quality

1.6.1 Water Sampling

In order to understand the present condition of river water quality in the Study Area, water quality survey was conducted from the end of November, 1996 to the middle of January, 1997 for the 5 target rivers of this Study. A total number of 15 water sampling sites were chosen from the upper, middle and down stream parts of these rivers. Figure-G.1.8 shows the locations of these sites.

Water samples were collected from each site for 2 times, one at low-water period when there was no rainfall and another at high-water period after a heavy local rain and each time 2 samples were collected from the same location.

1.6.2 Water Quality Analysis

(1) Analysis Items

Water quality analysis was conducted by a local subcontractor on the following items:

- Air temperature
- Water temperature
- Biological oxygen demand (BOD)
- Chemical oxygen demand (COD)
- Suspended solids (SS)
- Dissolved oxygen (DO)
- pH
- Total coliform/Fecal coliform
- Electric conductivity (EC)
- Total phosphorous (TP)
- Total nitrogen (TN)

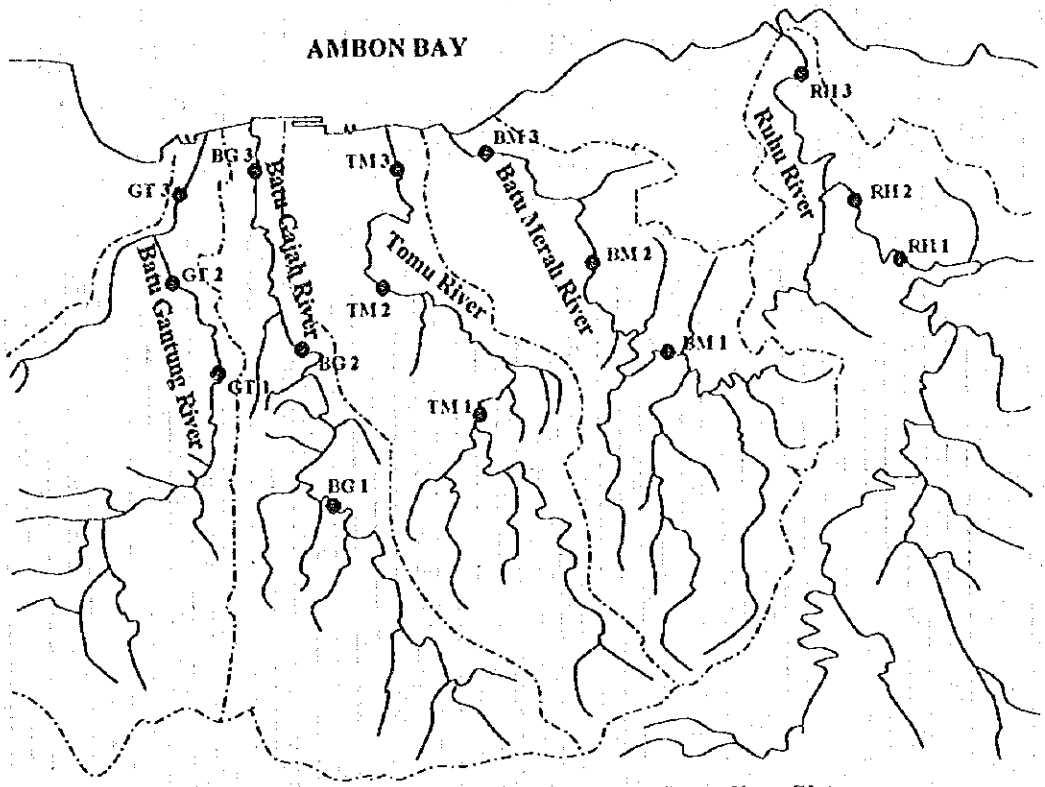

Figure-G.1.8 Locations of Water Sampling Sites

(2) Methods of Analysis

Table-G.1.9 summarizes the methods of water quality analysis for the above mentioned items.

Table-G.1.9 Methods of Water Quality Analysis

Item	Method	Remarks
Temperature	Thermometer	for air and water
BOD	5 day cultivation, titrimetric method	-
COD	Closed reflux, titrimetric method	digestion at 150 °C
SS	Filtration, gravimetric method	-
DO	Titrimetric method	-
pH	pH meter	-
Coliform	Multi-tube method	-
EC	EC meter	-
TP	Spectrophotometric method	-
TN	Spectrophotometric method	-

(3) Analysis Results

The results of water quality analysis are shown in Table-G.1.10 and can be summarized as follows.

Temperature: Water temperature is mainly affected by the air temperature. It ranges from 25 to 31 °C corresponding to the air temperature from 26 to 32 °C and does not show any abnormality.

Table-G.1.10 Water Quality Analysis Results

Site Name	Code of Sample	Temperature °C		pH	EC	DO	BOD	COD	SS	TP	TN	T. Coli	F. Coli
		Air	Water	-	µS/cm	mg/L						Colonies/100mL	
Ruhu River No.1	RH1-L-1	27	25	7.0	202	7.35	36.40	82.0	626	0.00	0.26	1.34E4	4.4E3
	RH1-L-2	27	25	7.0	205	7.35	43.30	114.0	672	0.02	0.28	1.34E4	4.4E3
	RH1-H-1	28	27	6.5	507	8.05	3.60	10.8	184	0.00	0.21	5.4E4	8.8E3
	RH1-H-2	28	27	6.4	604	8.30	2.20	13.0	162	0.00	0.00	5.4E4	8.8E3
Ruhu River No.2	RH2-L-1	29	28	7.5	204	7.20	53.60	174.0	74	0.00	0.32	1.05E5	8.0E4
	RH2-L-2	29	28	7.5	206	7.15	60.40	180.0	692	0.01	0.33	1.05E5	8.0E4
	RH2-H-1	28	28	6.3	989	7.05	57.00	160.0	193	0.00	0.52	1.35E5	1.05E5
	RH2-H-2	28	28	6.5	994	7.20	46.70	135.0	187	0.00	0.46	1.35E5	1.05E5
Ruhu River No.3	RH3-L-1	30	28	7.0	218	6.70	67.30	215.0	687	0.02	0.36	9.6E5	3.8E5
	RH3-L-2	30	28	7.0	214	6.90	63.80	205.0	859	0.07	0.46	9.6E5	3.8E5
	RH3-H-1	33	31	6.8	1160	7.55	33.00	94.0	194	0.00	0.58	9.6E5	9.6E5
	RH3-H-2	33	31	6.8	1120	7.05	57.00	153.0	182	0.00	0.52	9.6E5	9.6E5
Batu Merah River No.1	BM1-L-1	29	28	7.0	122	5.80	91.20	207.0	133	0.16	0.73	7.6E4	3.0E4
	BM1-L-2	29	28	6.8	118	5.80	94.20	210.0	132	0.18	0.52	7.6E4	3.0E4
	BM1-H-1	31	29	6.5	808	5.65	84.40	235.0	216	0.02	0.70	1.92E5	5.4E4
	BM1-H-2	31	29	6.3	752	5.85	77.50	225.0	185	0.11	0.0	1.92E5	5.4E4
Batu Merah River No.2	BM2-L-1	32	30	7.5	226	5.00	98.10	270.0	903	0.10	0.33	4.8E5	1.9E5
	BM2-L-2	32	30	7.0	229	5.10	91.20	260.0	1401	0.05	0.31	4.8E5	1.9E5
	BM2-H-1	28	27	7.0	192	4.25	132.30	431.0	144	0.15	0.77	9.6E5	4.8E5
	BM2-H-2	28	27	6.8	190	4.35	128.90	413.0	169	0.04	0.66	9.6E5	4.8E5
Batu Merah River No.3	BM3-L-1	30	29	7.5	459	1.30	324.10	994.0	172	0.30	0.00	9.6E5	4.8E5
	BM3-L-2	30	29	7.8	472	1.25	331.00	1030.0	128	0.28	3.32	9.6E5	4.8E5
	BM3-H-1	27	28	6.5	312	3.65	159.70	435.0	343	0.20	1.08	>2.4E6	9.6E5
	BM3-H-2	27	28	6.5	316	3.65	152.90	417.0	229	0.79	0.49	>2.4E6	9.6E5
Tonu River No.1	TM1-L-1	28	27	6.5	106	7.35	39.90	105.0	892	0.16	0.18	5.4E4	3.0E4
	TM1-L-2	28	27	6.5	109	7.50	29.60	99.0	628	0.03	0.21	5.4E4	3.0E4
	TM1-H-1	29	28	6.5	696	7.45	36.40	103.5	92	0.00	0.31	7.6E4	4.2E4
	TM1-H-2	29	28	6.5	702	7.35	39.90	106.5	88	0.04	0.01	7.6E4	4.2E4
Tonu River No.2	TM2-L-1	31	27	7.0	154	4.60	100.80	337.0	173	0.36	0.02	7.5E4	6.0E4
	TM2-L-2	31	27	7.0	148	4.65	98.10	331.0	189	0.29	0.02	7.5E4	6.0E4
	TM2-H-1	26	27	6.5	244	3.40	194.00	610.0	165	0.08	1.27	1.35E5	1.05E5
	TM2-H-2	26	27	6.8	238	3.40	180.30	566.0	154	0.37	0.00	1.35E5	1.05E5
Tonu River No.3	TM3-L-1	32	31	7.5	317	0.55	372.10	1222.0	144	0.09	2.51	9.6E5	2.7E5
	TM3-L-2	32	31	6.8	298	0.55	351.50	1212.0	140	0.60	2.28	9.6E5	2.7E5
	TM3-H-1	26	27	7.0	182	2.60	180.30	528.0	190	0.35	1.44	9.6E5	3.8E5
	TM3-H-2	26	27	6.6	206	2.50	200.80	632.5	278	0.25	0.33	9.6E5	3.8E5
Batu Gajah River No.1	GJ1-L-1	28	26	7.0	114	7.80	3.90	15.7	679	0.05	0.09	1.34E4	4.0E3
	GJ1-L-2	28	26	7.0	126	7.80	7.30	16.7	673	0.36	0.21	1.34E4	4.0E3
	GJ1-H-1	27	26	6.6	622	7.45	36.40	141.0	109	0.00	0.00	7.6E4	1.34E4
	GJ1-H-2	27	26	6.7	618	7.40	36.40	140.0	114	0.00	0.16	7.6E4	1.34E4
Batu Gajah River No.2	GJ2-L-1	30	28	7.6	174	6.30	81.00	247.0	99	0.23	0.02	8.0E4	4.4E4
	GJ2-L-2	30	28	6.8	190	6.30	70.70	245.0	12	0.24	0.22	8.0E4	4.4E4
	GJ2-H-1	29	27	7.0	324	6.45	74.10	252.0	1003	0.26	0.32	1.05E5	7.5E4
	GJ2-H-2	29	27	6.5	308	6.35	77.50	265.0	991	0.20	0.37	1.05E5	7.5E4
Batu Gajah River No.3	GJ3-L-1	30	28	7.2	294	2.10	303.00	885.0	122	0.12	0.00	9.6E5	3.8E5
	GJ3-L-2	30	28	7.2	311	2.05	310.40	902.5	177	0.19	0.00	9.6E5	3.8E5
	GJ3-H-1	27	28	7.0	302	2.50	207.60	606.0	72	0.29	1.01	>2.4E6	9.6E5
	GJ3-H-2	27	28	7.0	318	2.45	214.50	618.0	96	0.78	1.14	>2.4E6	9.6E5
Batu Gantung River No.1	GT1-L-1	33	31	7.5	310	8.20	2.90	12.8	656	0.28	0.15	1.84E5	7.6E4
	GT1-L-2	33	31	7.0	308	8.00	5.60	16.2	552	0.26	0.23	1.84E5	7.6E4
	GT1-H-1	28	27	7.0	1042	5.65	84.40	248.0	98	0.27	0.37	4.8E5	1.9E5
	GT1-H-2	28	27	6.8	988	5.75	91.20	280.0	109	0.28	0.23	4.8E5	1.9E5
Batu Gantung River No.2	GT2-L-1	28	26	6.5	304	4.20	139.20	465.0	651	0.19	0.87	1.2E6	4.8E5
	GT2-L-2	28	26	6.5	309	3.85	146.00	445.0	661	0.09	0.82	1.2E6	4.8E5
	GT2-H-1	28	27	6.8	1082	2.85	166.60	540.0	57	0.06	0.22	1.2E6	9.6E5
	GT2-H-2	28	27	6.8	1105	2.65	180.30	460.0	59	0.04	0.78	1.2E6	9.6E5
Batu Gantung River No.3	GT3-L-1	32	31	6.8	482	1.45	297.60	762.5	131	0.02	0.00	9.6E5	3.8E5
	GT3-L-2	32	31	7.0	506	1.80	248.80	707.5	132	0.06	000	9.6E5	3.8E5
	GT3-H-1	29	27	7.0	1322	1.25	331.00	962.5	304	0.15	2.57	>2.4E6	9.6E5
	GT3-H-2	29	27	7.2	1314	1.05	344.70	937.5	316	0.43	3.62	>2.4E6	9.6E5

Note: RH: Ruhu River; BM: Batu Merah River; TM: Tonu River; GJ: Batu Gajah Giver; GT: Batu Gantung River
L: Low water period; H: High water period; 1,2,3: Site number; 1,2: Sample number; E4: 10^4; ·····

pH: At all the water sampling sites, water shows a neutral pH from 6.3 to 7.8 that is normal for surface water.

EC: Since no water sample was taken during a high-tide period, there was not any influence of salinity from the sea water even at a down stream site. All the low water samples show an EC value lower than 500 μS/cm while some of the high water samples show a value near or a little higher than 1000 μS/cm which is probably caused by rainwater runoff. Anyway, the results do no indicate any salinity problem.

DO: DO is an important indicator of surface water pollution. For Ruhu River, the DO concentrations of all the samples are higher than 6.7 mg/L, and there is not a big difference among upper, middle and down stream parts of the river. For the other rivers, DO concentrations are about the same or just a little lower than that in Ruhu River at their upstream part, but decrease apparently at middle stream part and further at down stream part. DO values about or lower than 2.0 mg/L are detected from the downstream part of these rivers, and the lowest one is 0.55 mg/L from Tomu River. This indicates a condition of heavy organic pollution.

BOD & COD: These two parameters both show directly the concentration of organic pollutants in a water. A BOD lower than 5 mg/L is only detected from 3 samples from the upstream part of Ruhu, Batu Gajah and Batu Gantung Rivers, with a corresponding COD about 10 - 15 mg/L. All the other samples show a BOD higher than 30 mg/L and COD higher than 80 mg/L. The BOD at the downstream part of Batu Merah, Tomu, Batu Gajah and Batu Gantung Rivers is as high as 300-370 mg/L with a COD about 900 - 1200 mg/L. Even for Tomu River, the water quality of which is the best among all the rivers, the BOD and COD at the downstream part are about 60 and 200 mg/L, respectively. This indicates an extremely contamination condition of these rivers.

SS: Suspended solids in most of the water samples range from 100 to 1000 mg/L. There is no noticeable difference among rivers and sampling locations.

TP & TN: Phosphorus and nitrogen are nutrient substances related to the growth of microorganism in water area. In contrast with the very high BOD and COD in the river water, the concentrations of TP and TN are not so high. A TN higher than 1 mg/L is only found from the downstream part of Batu Merah, Tomu, Batu Gajah and Batu Gantung Rivers with a TN about 0.2 to 0.7 mg/L.

Total Coliform / Fecal Coliform: The number of coliform bacteria in a water shows the extent of pollution from feces of human beings or animals. All the water samples are found to contain very big numbers of total coliform and fecal coliform (an order of 10^4-10^6 for the former and 10^3-10^5 for the later). This indicates that these rivers have been heavily contaminated by sewage and night soils since it is the present condition that domestic wastes are directly dumped into the rivers in the Study Area.

(4) Discussion on the Results

From the above mentioned results, it can be concluded that organic pollution and bacterial pollution are the main problem with the 5 rivers. At the downstream part, BOD and COD are as high as that of raw sewage from a public sewer in some countries. (For example, in

Japan the influent BOD of a sewage treatment plant is usually 200 ppm.) Therefore, from a view point of water quality it can be said that they are no longer natural rivers, but open sewers for domestic sewage at least during the dry season when there is not enough water flow to dilute the sewage discharged into the river course. The present condition is that not only sewage (gray water) but also toilet effluent (night soil) and garbage are arbitrarily dumped into the river. The high content of total coliform and fecal coliform in the water is another evidence of such pollution.

In Indonesia, the standard quality of natural water is specified by the Government Regulation No. 20/1990 Concerning the Control of Water Pollution. There are criteria of water quality categories A, B, C and D according to their uses. From COD and coliform, it is apparent that all the rivers do not meet the criteria for category A (directly drinkable water) nor category B (raw water for water supply). Since the criteria for categories C and D do not include COD and coliform, it is difficult to judge if any of these rivers can be put into these two categories (category C: for fisheries/livestock; category D: for agricultural purposes.)

Figure-G.1.9 shows the relationship between DO and BOD (COD) based on the water quality analysis results and Figure-G.1.10 shows that of BOD and COD. As BOD or COD concentration increases, DO decreases in the water. COD and BOD have a good linear relation with a ratio of COD/BOD=3/1. In most of waters and sewage waters, COD/BOD ratio is usually about 2/1. The higher COD in the water may attribute to some reductive inorganic pollutants from the garbage dumped into the river.

It should be pointed out that although samples were collected in both low water and high water periods, there was not so much difference in the river flows before and after a local rain since rainfall is very limited in the dry season. The above mentioned results can only reflect the characteristics of river water quality in the dry season. To investigate the possibility of water supply through the flood control facilities in the future, it is necessary to understand the river water quality not only in the dry season, but also in the rainy season. Therefore, it is recommendable that a water quality survey be conducted in the coming rainy period. It can be composed into the program of the environmental impact assessment survey in Phase II of the Study for the priority project.

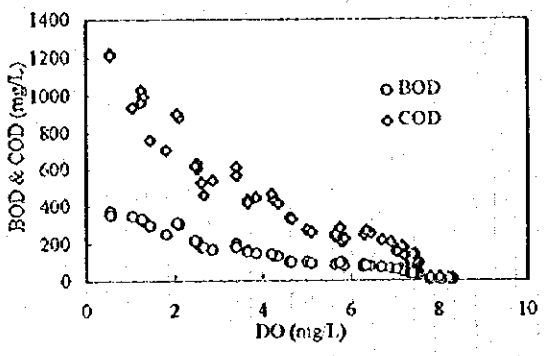

Figure-G.1.9 DO-BOD-COD Relation

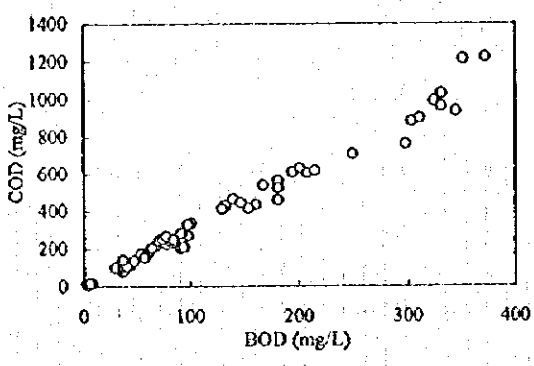

Figure-G.1.10 BOD-COD Relation

CHAPTER 2. INITIAL ENVIRONMENTAL EXAMINATION FOR THE MASTER PLAN

2.1 Environmental Examination Matrix

The objectives of the initial environmental examination (IEE) are to examine any possible impacts on the environment when the projects proposed in the Flood Control Master Plan are implemented, and to identify the environmental elements on which significant impacts are anticipated. The IEE was conducted by using an environmental examination matrix (Table-G.2.1) with its vertical axis consisting of rows for project activities that might cause environmental impacts, and horizontal axis consisting of columns of environmental elements grouped in 3 categories: social environment, natural environment and environment pollution.

As is shown in Table-G.2.1, the project activities consist of river improvement for the 5 rivers, construction of a diversion channels for Batu Merah River, check dams for 4 rivers (Ruhu, Tomu, Batu Gajah and Batu Gantung) and multipurpose dams for 3 rivers (Ruhu, Batu Gajah and Batu Gantung). For each of the project items, both the construction phase and operation phase are considered. The environmental elements are those specified in JICA Environmental Guidelines for River and Sabo Engineering. Three kinds of marks are used to identify the extent of impact of each project activity on each environmental item according to an analysis of environmental condition at the project sites. As a result, significant negative impact is identified on 3 environmental elements, and possible negative impact is envisaged on 11 environmental elements from some project activities. The following paragraphs give the rationale.

2.2 Social Environment

2.2.1 Resettlement, Economic Activity and Traffic & Living Facilities

Table-G.2.2 summarizes the general condition at the project sites related to resettlement and land acquisition, economic activity, traffic & living facilities. It is apparent that for each of these rivers, project implementation may require a resettlement program for a number of residential houses and some small scale public facilities, and all the river improvement and diversion channel construction activities may more or less affect traffic facilities in the related area.

The river improvement and diversion channel construction sites are all at the downstream area where residential houses are densely distributed. Although the local government has put forward a regulation that river banks with a width of 10-15 meters should be vacant as access road for river inspection, there are still many houses built very close to the river. This makes it difficult to plan river course widening and diversion channel route without impacts on any existing house. The multipurpose dam sites have been carefully located at the upstream sides of the Batu Gajah and Batu Gantung Rivers to eliminate large scale resettlement. However, about 20 houses will have inevitably to be relocated from the site of Batu Gajah River as will a public health center from the site of Batu Gantung River. Related to resettlement, certain impact on economic activity should also be considered.

During project construction, a large number of vehicles will be employed. This may influence the traffic condition of all the roads in and leading to the project area.

Table-G.2.1 Environmental Examination Matrix

Project Activities				Social Environment									Natural Environment									Environmental Pollution					
Project Area	Project Phase	River Basin	Project Item	Resettlement	Economic Activity	Traffic & Living Facilities	Community Separation	Archaeological & Cultural Properties	Water Right / Right of Common	Public Health & Sanitation	Solid Waste	Risk of Disaster	Topography & Geography	Soil Erosion	Groundwater	Lake and Rivers	Coastal Area	Flora & Fauna	Meteorology	Landscape	Air Pollution	Water Pollution	Soil Pollution	Noise & vibration	Ground Subsidence	Offensive Odor
Ambon Central Area	Construction Phase	Ruhu	River	×	△	△				△	×						△					△		△		△
			Dam								△		△	△								△		△		
			Check Dam			△					△											△		△		
		Batu Merah	River			△				△	×						△					△		△		△
			Diversion	×	△	△					△											△		△		
		Tomu	River			△				△	×						△					△		△		△
			Check Dam			△					△											△		△		
		Batu Gajah	River	×	△	△				△	×						△					△		△		△
			Dam	×	△	△					△		△	△								△		△		
			Check Dam			△					△											△		△		
		Batu Gantung	River	×	△	△				△	×						△					△		△		△
			Dam	△	△	△					△		△	△								△		△		
			Check Dam			△					△											△		△		
	Operation Phase	Ruhu	River																							
			Dam												×							△				
			Check Dam																							
		Batu Merah	River																							
			Diversion																							
		Tomu	River																							
			Check Dam																							
		Batu Gajah	River																							
			Dam												×							△				
			Check Dam																							
		Batu Gantung	River																							
			Dam												×							△				
			Check Dam																							

River: River Improvement Dam: Dam Constraction Check Dam: Chech Dam Construction △: Possible Negative Impact ×: Significant Negative Impact Shade: No Negative Impact

Table-G.2.2 Condition Related to Resettlement etc. at Project Sites

Project Sites	Land Acquisition Area (m^2)	Number of Houses	Public Facility	Traffic Facility
(1) Ruhu River				
River Improvement	9,900	40	none	small roads along the river
Dam (multipurpose)	411,000	30	none	none
Check Dam	33,000	none	none	none
(2) Batu Merah River				
River Improvement	350	10	none	small roads along the river
Diversion Channel	1,200	none	none	cross a main road and some small roads
(3) Tomu River				
River Improvement	none	none	none	small roads along the river
Check Dam	30,000	none	none	none
(4) Batu Gajah River				
River Improvement	none	none	none	small roads along the river
Dam (multipurpose)	93,000	20	a drinking water spring	none
Check Dam	16,000	none	none	none
(5) Batu Gantung River				
River Improvement	250	7	none	small roads along the river
Dam (multipurpose)	101,000	none	a public health center	a paved primary road
Check Dam	6,000	none	none	none

2.2.2 Solid Waste and Public Health & Sanitation

The construction work for river improvement, especially river bed excavation will result in generating large quantities of solid waste. Its transportation and final disposal have to be well planned. Similar problem may be encountered during the constructions of dams and diversion channels.

As has been described in Section 1.3.2, the 5 rivers currently act as sewage and garbage receivers due to lack of public sewers and insufficient garbage collection. Therefore, solid waste excavated from the river bed will include sewage sludge. Offensive odor may be emitted at the excavation site and during sludge transportation to a final disposal site.

2.3 Natural Environment

2.3.1 Topography/Geography and Soil Erosion

Dam construction may involve great scale excavation and banking of earth. Its impact on topography, geography and soil erosion should be further investigated.

2.3.2 Coastal Area

The 5 rivers flow directly into the Ambon Bay and sediment runoff has coursed coastal pollution. During river improvement, sediment content in the river stream will unavoidably increase and possible impact on coastal area should be considered.

2.3.3 Groundwater

During the operation phase, groundwater is the only environmental element on which impact is anticipated from the multipurpose dams.

In the Study Area, groundwater is the main source of water supply. Many wells and springs are scattered along the river and replenished by river water permeation. Since the dam will lift water level in the reservoir area, this will change the amount of replenishment from surface flow to groundwater aquifers. Groundwater at downstream side of the dam will also be influenced. Hydrogeological analysis will be necessary for an assessment of this impact.

2.4 Environmental Pollution

2.4.1 Water Pollution

Construction of the dams, check dams, diversion channels, and river improvement may somewhat affect river flow and increase pollutant load to the river, such as SS from construction work, oil and grease from construction machinery, BOD and other pollutants from workers at the work site etc.

When the multipurpose dams are also used for water supply, water quality conservation will be very important for the reservoirs. For the Ruhu Dam, since a sanitary landfill site is at the upstream side of the reservoir area, the effluent from that site may more or less affect the water quality in the reservoir in the future. This should be taken into consideration before project implementation. Well management of garbage dumping and treatment of the effluent emitted from the landfill site shall be required.

Similar consideration should also be given to the Batu Merah and Batu Gantung Dams. Further study shall be necessary for identifying the pollution sources to the reservoirs, predicting water quality in the future, and recommending measures for water quality protection and improvement.

2.4.2 Noise and Vibration

Noise and vibration from construction machinery and vehicles may more or less affect the life of residents near a work site and/or transportation road, for all the facility constructions and river improvement work.

2.4.3 Offensive Odor

Offensive odor may be emitted from the river bottom materials dredged out during the river improvement work, since large quantities of sewage sludge and garbage have been dumped to the rivers so far. This is related to the problem of public health mentioned above.

CHAPTER 3 ENVIRONMENTAL IMPACT ASSESSMENT FOR PRIORITY PROJECTS

3.1 Introduction

3.1.1 Objectives

The objectives of the environmental impact assessment (EIA) for the priority project are as follows:

1) To understand the present condition of the environment in the project area;
2) To identify the particular activities of the project which may induce significant impact on the environment;
3) To predict the environmental impacts and evaluate their magnitudes;
4) To propose countermeasures for a mitigation of the envisaged negative impacts;
5) To formulate plans for environmental management and monitoring.

3.1.2 *Guidelines*

The EIA basically follows the Indonesian environmental regulations with reference to JICA and OECF environmental guidelines. The main regulations/guidelines applied include the follows:

1) Regulation of the Ministry of Public Works, No. 69/PRT/1995 Concerning the Technical Guidelines of Environmental Impact Analysis (AMDAL) for the Public Works Projects
2) Decree of the Ministry of Public Works, No. 148/KPTS/1995 Concerning the Guidance of Environmental Management Plan (RKL) and Environmental Monitoring Plan (RPL)
3) Japan International Cooperation Agency (JICA), Environmental Guidelines for Infrastructure Projects, V. River and Erosion Control (1992)
4) The Overseas Economic Cooperation Fund (OECF), Environmental Consideration Guidelines (1996)

3.1.3 Scope of Work

(1) Project Activities

The EIA study covers all the project activities to be involved in the implementation of the priority projects for flood control in Ambon area. Table-G.3.1 shows the project components. In general, the project shall consist of three stages, namely pre-construction, construction and post-construction. The project activities at each stage are as follows:

1) Pre-construction stage

- Sectional and longitudinal survey, terrestrial mapping
- Inventory of land, houses and other properties, traffic and public facilities in the project area
- Land acquisition and compensation

2) Construction stage

- Mobilization of labor, construction machinery and equipment
- Preparation of access road
- Land clearing and stripping
- Transport of machinery and construction materials
- Earth work
- Civil work
- Construction waste disposal

3) Post-construction stage

- Facility operation
- Facility maintenance

(2) Environmental Elements

The environmental elements for the EIA study are shown in Table-G.3.2. These elements were identified by the initial environmental examination (IEE) conducted in Phase I for the Flood Control Master Plan as items on which significant or possible negative impacts are envisaged from the above mentioned project activities.

Table-G.3.1 Project Components Subject to EIA Study

River	Project Components
Ruhu	(1) River improvement (2) Check dam
Batu Merah	(1) River improvement (2) Diversion tunnel
Tonu	(1) River improvement (2) Check dam
Batu Gajah	(1) River improvement (2) Multipurpose dam (3) Check dam
Batu Gantung	(1) River improvement (2) Multipurpose dam (3) Check dam

Table-G.3.2 Environment Elements for EIA

(1) Social Environment	(2) Natural Environment	(3) Environmental Pollution
- Resettlement	- Topography & Geography	- Water Pollution
- Economic Activity	- Soil Erosion	- Noise & Vibration
- Traffic & Public Facilities	- Groundwater	- Offensive Odor
- Public Health & Sanitation	- Flora & Fauna	
- Solid Wastes	- Coastal Area	

3.2 Impact Analysis

3.2.1 River Improvement

(1) Project Activities and Environmental Impacts

Table-G.3.3 shows the project activities involved in the river improvement. These include river-bed formation, river-bed excavation, concrete channel, flood wall heightening, river widening and bridge improvement.

Table-G.3.3 River Improvement Items

Items		Ruhu	Batu Merah	Tomu	Batu Gajah	Batu Gantung
River-bed formation (m)		-	-	550	485	-
River-bed excavation (m)		1,600	1,500	2,150	2,100	1,450
Concrete channel (m)		-	1,100	1,600	-	200
Flood wall heightening (m):	Left	350	1,000	250	450	350
	Right	350	1,150	50	550	200
River-bed widening (m)		150	100	300	100	100
Bridge improvement (number)		4	5	10	13	4
Drainage improvement (number)		17	14	19	25	9

As has been identified by the IEE described in Chapter 2, the main impacts of river improvement on the environment include the following items:

1) Social environment

- Resettlement (pre-construction stage)
- Economic activities (pre-construction and construction stages)
- Traffic and public facilities (pre-construction and construction stages)
- Public health and sanitation (construction stage)
- Solid waste (construction stage)

2) Natural environment

- Coastal area (construction stage)

3) Environment pollution

- Water pollution (construction and post-construction stages)
- Noise and vibration (construction stage)
- Offensive odor (construction stage)

These impacts are analyzed in the following paragraphs.

(2) Social Environmental Impacts

Since the five rivers flow through a very densely populated area, certain impacts from the river improvement on the social environment are unavoidable though considerations have been fully given on eliminating the impacts as far as possible.

(a) Resettlement and Land Acquisition

Table-G.3.4 summarizes the number of houses needed to be relocated or temporarily moved and the area of land required for the river improvement.

Table-G.3.4 Resettlement and Land Acquisition for River Improvement

Items	Ruhu	Batu Merah*	Tomu	Batu Gajah	Batu Gantung	Total
Resettlement (number of houses)						
Total	5	21	10	19	26	81
Land Acquisition (area as m^2)						
Total	615	1,250	1,781	859	791	5,296
Others						
Pig/chicken farms	10	-	-	-	-	

* In accordance with Cipta Karya Plan for the development of Batu Merah area, widening of the river at its right side from 0k400 to 0k800 is also planned. However, since the area for river widening is within the Cipta Karya Plan area, the resettlement and land acquisition shall be considered in that plan. Therefore, the resettlement house number and land acquisition area for this section of Batu Merah River are not included in this table.

An interview survey was conducted to understand the status of the households who are possibly involved in the resettlement program. Figure-G.3.1 shows the locations of the survey sites, and Table-G.3.5 and Table-G.3.6 present the general condition of the interviewed households in Batu Merah and Tomu rivers, respectively.

The result shows that most of the households are government or company employees and some are retailers, all working in downtown Ambon. Most of the households have been living there for many years and own permanent or semi-permanent houses, and they are either owners of the land or tenants; no illegal occupants were observed. The annual income of these households is at about the average level in Ambon Municipality area: about half of them with per capita income more than Rp 1 million (US$ 400) per year. Being asked if they are satisfied with their living conditions, 93% answered in the affirmative. However, almost all the people showed their understanding of the importance of river improvement because they have been experiencing flood damage for a long time. They would not object to the government's decision on the resettlement when the project is implemented only if they could get satisfactory compensation on their houses, properties and/or land.

Pig and chicken farms along Ruhu River (RH-II), which are owned by nine Christian families, are more or less affected by the river improvement. They are relatively poor; 7 households have their per capita income below Rp 1 million per year, and 2 households between Rp 1 and 2 million. Five of them are depending only on pig/chicken farming for their living. Since river widening will need them to remove their pig/chicken houses, they want not only compensation but also means to earn their living. Some of them said they would rather go back to their home land - South Sulawesi, since it would not be easy to find another place to raise pigs in a mixed culture society.

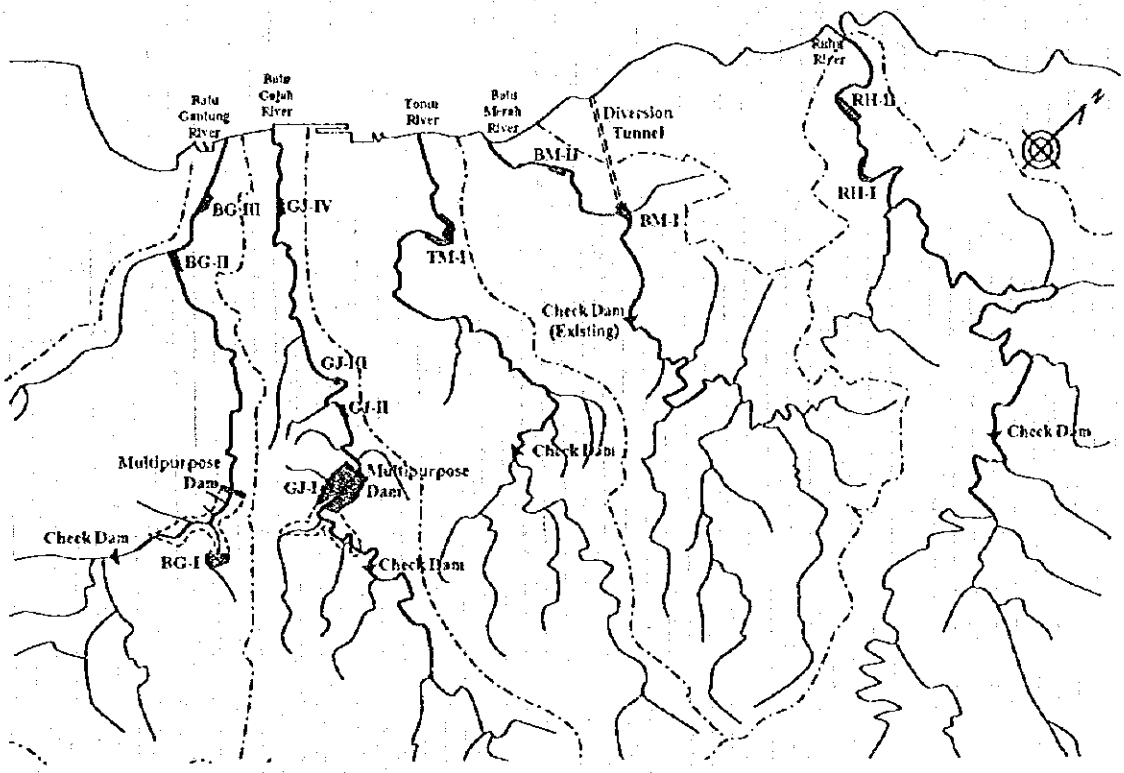

Figure-G.3.1 Sites of Interview Survey for Resettlement and Socioeconomic Study

Table-G.3.5 General Condition of the Households Involved in the Resettlement Program for River Improvement: Batu Merah River (BM-I,II)

Items	Share	Items	Share
(1) Occupation		(3) Housing condition [c]	
Government employee	43%	Permanent house	47%
Company employee	26%	Semi-permanent house	42%
Private business [a]	26%	Temporary house	11%
Labor [b]	5%	(4) Income level (per capita per year)	
Farmer	-	< 1 million Rupiah	53%
No regular job	-	1-2 million Rupiah	42%
(2) Religion		> 2 million Rupiah	5%
Islam	82%	(5) Land Tenure	
Christian	13%	Owner	68%
Hindu	5%	Tenant	32%

a Private business as retailers etc.
b Labor as porter etc.
c Housing condition: permanent houses are regular houses with good quality; semi-permanent houses are houses with simple structure; temporary houses are like shelters with irregular structure
* Average family members are 5.9 persons per household
** Total number of the interviewed households is 19.

Table-G.3.6 General Condition of the Households Involved in the Resettlement Program for River Improvement: Tomu River (TM-I)

Items	Share	Items	Share
(1) Occupation		(3) Housing condition [c]	
Government employee	47%	Permanent house	35%
Company employee	35%	Semi-permanent house	24%
Private business [a]	18%	Temporary house	41%
Labor [b]	-	(4) Income level (per capita per year)	
Farmer	-	< 1 million Rupiah	41%
No regular job	-	1-2 million Rupiah	41%
(2) Religion		> 2 million Rupiah	18%
Islam	20%	(5) Land Tenure	
Christian	80%	Owner	47%
Hindu	-	Tenant	53%

a Private business as retailers etc.
b Labor as porter etc.
c Housing condition: permanent houses are regular houses with good quality; semi-permanent houses are houses with simple structure; temporary houses are like shelters with irregular structure
* Average family members are 5.3 persons per household
** Total number of the interviewed households is 17.

(b) Economic Activities

The impact of the river improvement on the economic activities in the related areas is limited to 10 households in Ruhu River who are living on pig/chicken farming (Site RH-II in Figure-G.3.1). Among them, 5 households rely on raising pigs and chicken as their main source of income. Since river widening will need them to remove their pig/chicken houses, they want not only compensation but also means to earn their living.

For the other households including those to be involved in the resettlement program, the impact is minor because most of them are working in downtown Ambon and do not have much economic activity in the project sites. On the other hand, the river improvement and other project construction work may provide working opportunities to people in the related areas, especially to those who want to do secondary jobs for increasing their income. In this aspect, positive impacts are also anticipated.

(c) Traffic and Public Facilities

For the river improvement, no public facilities will be directly influenced except for part of an army dormitory in Tomu River (TM-I in Figure-G.3.1) which needs to be relocated for river widening.

Near the sites of river improvement, there are some mosques and churches. However, the impacts are thought to be minor if construction work is regulated during the period of prying activities. There are no government offices, clinics, schools in or near the project sites.

The main traffic roads along the coast extend across the five rivers. Along the middle and downstream part of these rivers where river improvement work is planned, there are only small paths as that in Batu Merah, Batu Gajah and Batu Gantung Rivers, or local roads capable for light vehicles to pass as that in Ruhu and Tomu Rivers. Due to limited space on the two banks of the river, preparation of new roads for the work is impossible. Therefore,

transport of machinery, construction material, excavated river sediment etc. will depend on the existing roads. This will increase the traffic volume of these roads to some extent. However, considering that river improvement will only be conducted simultaneously for two or more rivers and the work scale for only one river will not be very great (large scale machinery cannot be employed because of the comparatively narrow river course), no more than 20 vehicles/hour is estimated as the maximum hourly traffic flow for the river improvement work. This is only about 2.6 % of the traffic volume of the Jl. Tulukabessy, 795 vehicles/hour during the day time according to the survey results of this study. The impacts on the traffic condition in central Ambon area are negligible.

The local roads need to be strengthened if they are used for passing heavy vehicles for the river improvement work.

(d) Public Health and Sanitation

Table-G.3.7 summarizes the general condition of public health and sanitation in the populated area along the five rivers based on the field survey results.

Table-G.3.7 Public Health and Sanitation Condition Along the Five Rivers

Items	Ruhu	Batu Merah	Tomu	Batu Gajah	Batu Gantung
Population	7508	13507	12903	16809	17649
Main Diseases	*Respiratory infection, diarrhea, skin infection*				
Water Supply					
(1) Tap water (PDAM)					
Served population	32.9 %	84.3%	82.4%	64.2%	62.9%
(2) Wells					
Number	317	90	132	291	316
Served population	67.1%	15.7%	16.1%	22.1%	25.8%
(3) Springs					
Number	0	0	0	2	0
Served population	0%	0%	0%	1.3%	0%
(4) Rain water					
Served population	0%	0%	1.5%	12.4%	11.3%
Toilets					
(1) With septic tank	28%	50%	63%	26%	29%
(2) Without septic tank*	82%	50%	37%	74%	71%
Sewers					
(1) Open discharge	92%	89%	41%	42%	73%
(2) Closed discharge	8%	11%	59%	58%	27%
(3) Outlets to river	134	171	36	246	214
Garbage	Open dumping on river banks or directly to the river				

* Toilets without septic tank discharge directly to the river

For water supply, tap water supplied by PDAM is available for most of the residents except for Ruhu River where 67% of the population depend on private or community wells. The percent of toilets with septic tank is low in Ruhu, Tomu and Batu Gantung Rivers, and most of the night soil is discharged to the river directly (supernatant liquid from the septic tanks is also discharged to the river). Not only the outlets of all the sewers are at the river, but all the garbage dumps are on the river banks because the garbage collection system in Ambon Municipality has not yet extended to this area. This results in accumulation of sewage sludge

and garbage on the river bottom and pollution of river water especially in the downstream part of these rivers. But rivers are still function as washing and even bathing place for the residents there. This explains why skin infection is one of the common diseases in these areas.

Influence on sanitary condition is anticipated when the bottom materials which composes of river sediments and sewage sludge are excavated during the river improvement work. It is unavoidable that offensive smells may be emitted from the work site. In order to eliminate the impact, it is recommendable that 1) excavated solid waste shall be removed from the work site as quickly as possible, 2) liquid leakage shall be prevented during transporting the wastes to the final disposal site by using vehicles with water tight carriages, and 3) the waste shall be covered with soil after being dumped at a final disposal site near a populated area (refer to Section e below).

(e) Solid Waste

It is estimated that about 100,000 m^3 of solid wastes will be generated from the river improvement work for the five rivers. Several candidate sites have been proposed for the final disposal of solid wastes for all the project construction works. Figure-G.3.2 shows their approximate locations.

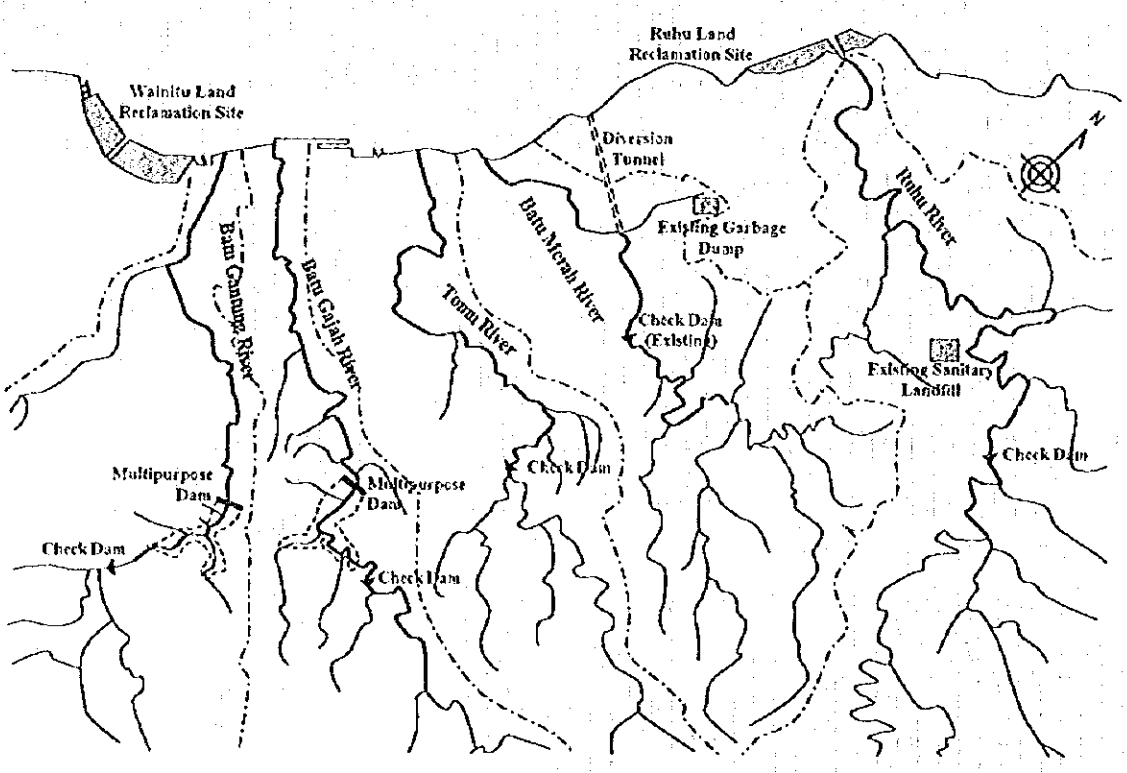

Figure-G.3.2 Locations of Candidate Sites for Solid Waste Disposal

Two land reclamation sites in the coastal area at Wainitu and Ruhu are proposed for this project (see Section 3.2.5 below for environmental assessment on these two sites). Two existing dumping sites in the mountain area are also considered to be available. The old open dump within Batu Merah River Basin is no longer used but needs about 60,000 m^3 soil for

leveling the site to make a terrace. The new garbage dumping site within Ruhu River Basin needs about 30,000 m^3 soil per year for sanitary landfill. All these sites are accessible for vehicles.

As has been mentioned in section d above, solid wastes from the river improvement work sites may contain sewage sludge and garbage. In order to prevent the possible impacts on sanitary condition to disperse widely, it is not recommendable that solid waste to be transported a long way. As far as possible an alternative disposal site near the river improvement site shall be used.

For the two land reclamation sites, because they are located near the central city area, the operation of dumping, leveling, compacting etc. shall need to be well organized and regulated with consideration on the quality of solid wastes dumped there. The wastes to emit offensive smells should be covered with those with a quality like plain soil or earth.

(3) Natural Environment Impacts

Regarding natural environment impacts from river improvement, coastal area is the most important factor to be considered in this study as has been suggested by the IEE described in Section 2.3. Because the river improvement will include a comparatively large scale excavation of the river bed, sediment runoff through the rivers into the Ambon Bay will unavoidably happen. In the estuaries of the five rivers, coral reefs and mangroves are no longer in existence. The main item to investigate is oceanic biota.

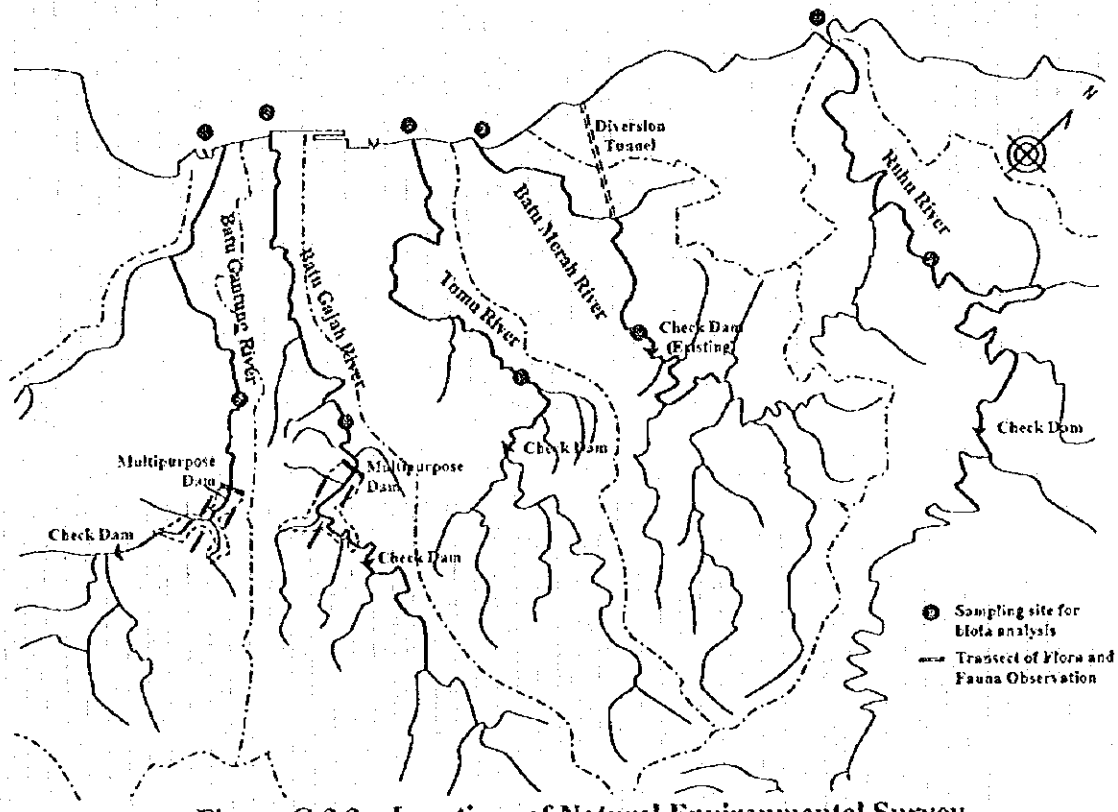

Figure-G.3.3 Locations of Natural Environmental Survey

In order to understand the present condition of aquatic biota in the five rivers and their estuaries, biotic analysis was conducted in this study. For each of the rivers, one sample was collected from the river at an upstream point and another from the estuary (see Figure-G.3.3 for the sampling locations).

Table-G.3.8 summarizes the results of biotic analysis. The analysis items include benthic species, necton, phytoplankton and zooplankton. The results show the worst aquatic biotic condition at most of the sampling sites - few species and very low Shannon Diversity Index values, except for Ruhu River where more species are detected and larger diversity index values are calculated. This coincides with the results of water quality analysis described in Section 1.6. River water contamination has already resulted in an aquatic condition unsuitable for biota to survive in both the river and estuary area.

Table-G.3.8 Biotic Analysis Results for Rivers and Estuaries

Items	Ruhu		Batu Merah		Tomu		Batu Gajah		Batu Gantung	
	R.	E.	R.	E.	R.	E.	R.	E.	R.	E.
(1) Benthic										
Species	2	11	1	2	2	2	3	2	3	2
Shannon Index	0.656	2.205	-	0.285	0.571	0.410	0.659	0.424	0.640	0.687
Evenness Index	0.989	0.919	-	0.411	0.824	0.592	0.599	0.612	0.583	0.991
Dominance Ind.	2.257	0.911	-	1.873	1.639	1.355	1.555	1.488	1.634	2.247
Density	12	34	34.7	13.3	103.7	1.3	152	14.7	108	12
(2) Nekton										
Species	2	7	2	1	5	2	2	1	2	1
(3) Phytoplankton										
Species	8	17	1	3	4	5	5	8	6	8
Shannon Index	1.785	2.130	-	0.011	0.038	0.319	0.900	0.870	1.107	1.326
(4) Zooplankton										
Species	5	9	4	4	2	2	1	6	3	3
Shannon Index	0.530	1.055	0.404	0.113	0.188	0.046	-	0.364	0.266	0.673

Note: (1) R. - River; E. - Estuary
(2) Shannon Index H'- is an index showing the species diversity. H' ≧ 1.0 is common and 0.6 is thought to be the minimum value.
(3) Evenness Index - is an index showing the species similarity.
(4) Dominance Index - is the species dominance ratio.
(5) For Batu Merah, only Benthic species and no phytoplankton were found. Therefore, the diversity, evenness and dominance indexes could not be evaluated.

The main pollutants which have damaged the biotic condition are the high BOD and COD from the sewage, garbage etc. During river improvement work especially river bed excavation, BOD and COD will be released from the excavated sludge. However, this amount will not be very big because most of the BOD and COD entrapped in the sludge are suspended matters but not dissolved matters. On the other hand, the excavation will be conducted in a way that river flow is guided to half of the river course while the other half is being excavated. As long as the excavated wastes are removed from the site as quickly as possible, the impact is thought to be minor.

(4) Environmental Pollution

(a) Water Pollution

The impacts of river improvement on water quality are anticipated in both construction and post-construction stages. At the construction stage, pollutants may include suspended solids (SS) from river bed excavation and other construction work, BOD and COD from the excavated sludge, certain amount of oil and grease from construction machinery. This may result in deterioration of water quality in the river or even the estuary area. The pollution by SS, BOD and COD shall be eliminated by regulating river flow during the work to separate the flow course from the work site as far as possible. As for oil and grease, since the number of the construction machinery at each of the work sites will not be very big, the impact will not be significant. However, it is recommendable that all machinery employed should be well maintained to prevent oil leakage.

After river improvement, the elevation of the river bottom will be 0.7-0.8 m lower than it is at present. Consequently, the distance of tidal influence will increase 200-300 m to the upper stream side. According to the University of Pattimura's survey, within a distance about 100 m from the coast, well water is salty because of sea water intrusion. Therefore, people are advised not to use well water for drinking purpose near the coast. Fortunately, this area has been covered by PDAM water supply system, and people there use the well water only for washing. Therefore, although certain impact on groundwater quality is envisaged, the direct influence on groundwater usage is considered to be minor.

(b) Noise & Vibration

The machinery to be employed for the river improvement will include the follows (for 1 river but at two separate work sites):

– Crawler crane (40 t)	6
– Truck crane (20 t)	2
– Excavator (1.2 m^3)	2
– Bulldozer (17 t)	1
– Generator (200 KVA)	2
– Dump truck (8 t)	20/hour

The noise level of a bulldozer at working is about 90 dB within a distance of 2 m, and that of the other machinery is about the same or lower. If 4-6 machines are working simultaneously at the same location, the resultant noise level is estimated to be 96-98 dB. Although the noise level may decay to less than 85 dB at a distance of 10 m, it is still higher than the standard value specified in Ministry of Health Regulation No. 718 which sets 45 dB as the maximum recommendable and 55 dB as the maximum allowable values for housing area (Zone B in Table-G.3.9). There is no regulation in Indonesia on construction work regarding noise level yet. Referring to the regulation in Japan, a construction work with a noise level higher than 85 dB is only permitted in day time.

Considering that there are mosques and churches on river banks, it is recommended that work should be ceased during the period of religious activities.

Table-G.3.9 Ministry of Health Reg. No. 718/HEN.KES/PER/XI/1987 on Noise

No.	Zone	Noise Level (dB)	
		Maximum Recommendable	Maximum Allowable
1	A	35	45
2	B	45	55
3	C	50	60
4	D	60	70

Zone A: Zone for research, hospital;
Zone B: Housing, education complex, recreation area;
Zone C: Office area, shopping area, commercial area, market area;
Zone D: Industrial area, factory, railway station, bus terminal.

(c) Offensive Odor

Offensive odor is considered to be from the excavated river bottom materials at the river improvement site, during their transport and at the final disposal site. This has been discussed in Section (2)-(d) for public health and sanitation.

3.2.2 Multipurpose Dams

(1) Project Activities and Environmental Impacts

The main specifications of the two multipurpose dams are as follows:

1) Batu Gajah Dam

- Dam height: 50.0 m
- Dam top elevation: El. 75.0 m
- Storage capacity: 1,532,000 m^3
- Water supply capacity: 8,000 m^3/day

2) Batu Gantung Dam

- Dam height: 36.6 m
- Dam top elevation: El. 106.6 m
- Storage capacity: 1,337,000 m^3
- Water supply capacity: 2,500 m^3/day

As has been identified by the IEE described in Section 2, the main impacts of dam construction on the environment include the following items:

1) Social environment

- Resettlement (pre-construction stage)
- Economic activities (pre-construction and construction stages)
- Traffic and public facilities (pre-construction and construction stages)
- Solid waste (construction stage)

2) Natural environment

- Topography and geology (construction stage)
- Soil erosion (construction and post-construction stage)
- Groundwater (post-construction stage)

3) Environment pollution

- Water pollution (construction and post-construction stages)
- Noise and vibration (construction stage)

These impacts are analyzed in the following paragraphs.

(2) Social Environmental Impacts

(a) Resettlement and Land Acquisition

Table-G.3.10 shows the number of houses needed to be relocated and the area of land required for the dam construction.

Table-G.3.10 Resettlement and Land Acquisition for Dam Construction

Items	Batu Gajah Dam	Batu Gantung Dam
Resettlement (number of houses)	41	1
Public Facilities	None	1 health center*, 1 bridge**
Land Acquisition (area as m^2)	147,000	146,000

* Urimesing health center

** Bridge on Jl. Urimesing at Kusu-kusu

The number of houses needed to be relocated from the Batu Gajah Dam site is 41, while that from Batu Gantung Dam site is only 1. However, because the bridge on Jl. Urimesing which crosses one tributary of the Batu Gantung River at Kusu-kusu is at an elevation lower than the dam top, it has to be heightened for 5-6 meters. In this case, the Urimesing Health Center just beside the bridge has to be relocated as well.

Interview survey was conducted with the households who are possibly involved in the resettlement program (GJ-I and BG-I in Figure-G.3.1). The general condition of the interviewed households is summarized in Table-G.3.11.

Different from the interviewed households at the river improvement sites, the living conditions of those at the dam sites (mainly the Batu Gajah Dam site) are poorer. This can be seen from their housing condition and annual income level. About 64% of the households are from Sulawesi Tenggara (southeast Sulawesi) and half of them are new comers to the present place (2-7 years). Many of them do not have a stable employment condition and possess no permanent or semi-permanent houses. About 90% of these households have very low annual income (less than 1 million Rp. per capita per year). Tap water is not available in this area, and people get water from wells and rainfall. However, all the people answered yes when asked if they are satisfied with their life. They are relaxed with the very simple living condition. Regarding the frequent flooding in this area, about 73% of the people said that they are very worry or worry about it. Most of them would not object to the government's

decision on their resettlement if they could get satisfactory compensation. There are also some household worrying about losing their basic living condition, especially those relying on small scale farming as their secondary income source.

Table-G.3.11 General Condition of the Households Involved in the Resettlement Program for Batu Gajah Dam Construction (GJ-1)

Items	Share	Items	Share
(1) Occupation		(3) Housing condition [c]	
Government employee	20%	Permanent house	10%
Company employee	17%	Semi-permanent house	47%
Private business [a]	20%	Temporary house	43%
Labor [b]	36%	(4) Income level (per capita per year)	
Farmer	-	< 1 million Rupiah	90%
No regular job	7%	1-2 million Rupiah	10%
(2) Religion		> 2 million Rupiah	-
Islam	77%	(5) Land Tenure	
Christian	23%	Owner	-
Hindu	-	Tenant	100%

a Private business as retailers etc.
b Labor as porter etc.
c Housing condition: permanent houses are regular houses with good quality; semi-permanent houses are houses with simple structure; temporary houses are like shelters with irregular structure
* Average family members are 5.44 persons per household

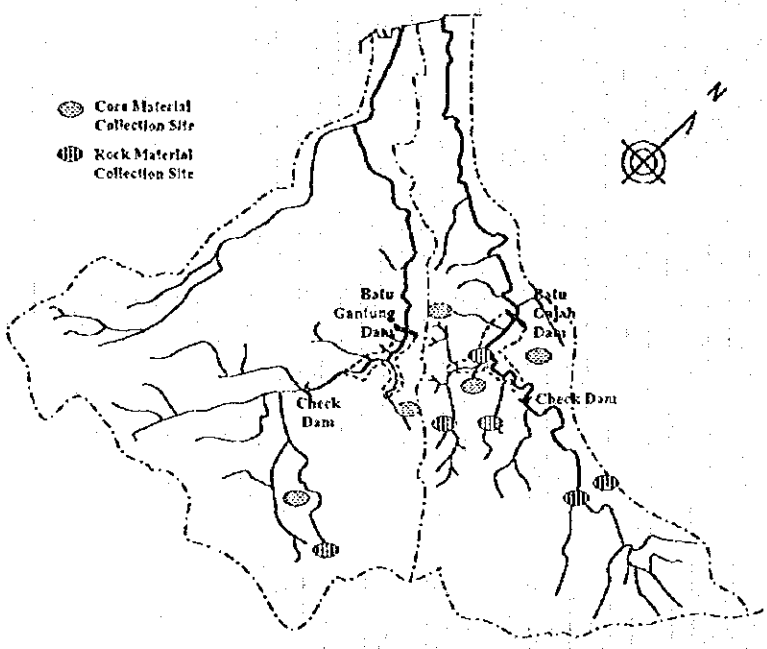

Figure-G.3.4 Locations of Sites for Construction Materials

For the dam construction, a large amount of construction materials will be acquired from the area near the dam sites. Figure-G.3.4 shows the locations of the sites planned for core materials (clay, quarrels etc.) and rock materials. Land acquisition will also include these areas.

(b) Economic Activities

The two dam sites are in the mountain area where agriculture is the only economic activity but not in a great scale. The land acquisition area includes small pieces of farm land and gardens with fruit trees etc. This may affect people's income to some extent. However, all these people are not farmers and farming or gardening is only their secondary job.

On the other hand, positive impacts are also anticipated since the dam construction work may provide working opportunities to people in the related area.

(c) Traffic and Public Facilities

The direct impact on traffic and public facilities will be from heightening the bridge in Kusu-kusu and relocating Urimesing Health Center. Jl. Urimesing is not a busy traffic road but is the only road from Kusu-kusu area to downtown. In order to eliminate the influence during bridge heightening, temporary bypass should be prepared, or roads for Batu Gantung Dam construction should be constructed before the bridge heightening, so people can use them as alternative ways to downtown. The place for relocating the health center should be carefully selected with a consideration on its service area and the accessibility for people.

In and around the dam construction sites, roads shall be prepared for transport among dam sites, construction materials sites, base camps etc. This will not affect the traffic condition of existing roads in and connecting to central Ambon area. Impact may only occur during transport of machinery to the dam sites and when construction wastes are transported to the coastal land reclamation site for final disposal. However, machinery transport will be in a short period of time, and the maximum number of vehicles for waste disposal will be no more than 20 per hour. As long as the work is well planned in consideration of rushing period in downtown area, elimination of the impact to the minimum is possible.

Around the dam sites, there is almost no other public facilities such as religious buildings, schools etc.

(d) Solid Waste

The volume of construction wastes from the dam construction is great - about 300,000 m^3 for one dam. These include excavated soils, rocks, cements and some bulky wastes such as concrete piles etc. As is shown in Figure-G.3.2, several disposal sites have been proposed for this project, but their capacity may not be enough to contain the solid wastes from the two dams. Therefore, it is recommendable that waste reuse should be considered. There are possibly two ways: 1) refilling soils, rocks back to the sites from where construction materials have been taken, and 2) providing construction materials to local companies and people.

Unlike the wastes from river improvement, the construction wastes from the dam site are of better quality and easy to be classified for different purpose of usage. In Ambon, many people buy soils for land preparation, rocks and other usable materials for house building. The amount of such requirement is not clear, but when dam construction begins, requests for provisions will certainly rush in. Therefore, a good arrangement for selling construction materials is considered to be necessary. This is not only from a viewpoint of wastes

decreasing, but also natural resource utilization.

Even for disposal in the land reclamation sites and existing damping sites, classification of the construction wastes is still necessary. For example, the two existing garbage damping sites are not capable for disposal of bulky items, but plain soils are more preferable.

(3) Natural Environmental Impacts

(a) Topography and Geology

For topography and geology at the dam and reservoir areas, see Part-B for detailed explanation. Generally speaking, the two dam sites are geologically the quaternary limestone area with a high permeability. Therefore, consideration has to be given to the dam structure and construction method regarding water storage and influence on groundwater (refer to Section c below for the impact on groundwater).

With the dams constructed and water stored in the reservoirs, the topography in the related area will be changed. This change will make the river course more stable because river flow will be more stable after flood regulation by the dam and the possible damage on the topography of the river basin will be eliminated.

From the locations shown in Figure-G.3.4, large amount of soils, quarrels and rocks will be collected as construction material. This needs a large scale excavation and the topography in these areas will be changed. In order to erase any negative impact on the topography and geology, it is recommendable that excavation for acquiring construction material shall be under suitable regulations, and effort be made to restore or improve the topographic condition at these sites.

(b) Soil Erosion

It is noticeable that the two dam sites are at the bottom of steep valleys with a slope as large as 60-70 degrees - a slope at which soil erosion is liable to occur. In the dam and reservoir and their outskirts area, all the places with a danger of land sliding or soil erosion shall have to be checked and improved. Similar consideration should be given to the construction material sites.

Another important measure to prevent soil erosion is reforestation. This is also important for improvement of biological condition and water resource conservation (refer to Section (d) and Section (4)-(a) below).

(c) Groundwater

Water storage in the reservoirs of the two dams will influence the groundwater aquifers at the downstream side. In Batu Gajah and Batu Gantung River Basins, there are shallow aquifers with groundwater flows from upper to downstream and from maintains to the valleys, which is the same as the surface flows. Because the geology in the river basins especially the middle stream areas is characterized by limestone with a high permeability, the groundwater level in most places near the river is the same as the river. On the other hand, since the upstream mountains take larger catchment area, groundwater recharge is thought

to be mainly from the upstream area, and there exist places where groundwater level is higher than the river but decreases as approaching the river. There are definitely several springs along the river showing a higher pressure.

After dam construction, water level will be raised. Generally speaking, the influence on the groundwater at the downstream side is an increase in well water level. But in the case of shallow aquifers near a river, because the river can buffer the fluctuation in groundwater pressure, the actual change in the well water level may not be significant. Therefore, well water utilization in the downstream side of the two dams may not be influenced much.

(d) Flora and Fauna

Flora and fauna is not an item identified by the IEE but is required by the Indonesian environmental guidelines. A survey for flora and fauna was conducted at the dam sites by taking 3 transect lines for sampling and observation (see Figure-G.3.3 for the survey locations). The sampling items include vegetation, reptiles, mammals, amphibians and birds. For vegetation, there are mainly secondary forest vegetation grown by people, because the two dam sites are not at the natural forest area. For wildlife, 4 species of reptiles, 3 species of mammals, 2 species of amphibians and 22 species of birds were observed. Among them, there are endemic species in Indonesia or Maluku, including Kus-kus, an endangered mammals species in Indonesia.

The results do not show a high diversity for both flora and fauna. However, it is still recommendable that during dam construction vegetation cutting should be avoided or reduced, and reforestation should be considered as a measure to restore or improve the biological condition.

(4) Environmental Pollution

(a) River Water Quality

Because the multipurpose dams will be used for water supply in the future, it is necessary to understand the water quality of the river flow at and upstream the dam sites. For this purpose, water sampling and water quality analysis were conducted in this study. Figure-G.3.5 shows the sampling locations and Table-G.3.12 shows the water quality analysis results. From each of the sampling locations, water samples were collected two times on different date. Methods of analysis were the same as that mentioned in Table-G.1.8 for water quality survey in Phase I. The results indicate that although at the downstream part of Batu Gajah and Batu Gantung Rivers water has been severely polluted (see Table-G.1.9), the water quality at the two dam sites and their upper stream side are much better. This can be seen from the parameters of DO, BOD/COD indicating organic pollutants, TP and TN indicating nutrient level, total and fecal coliform indicating microorganic matters.

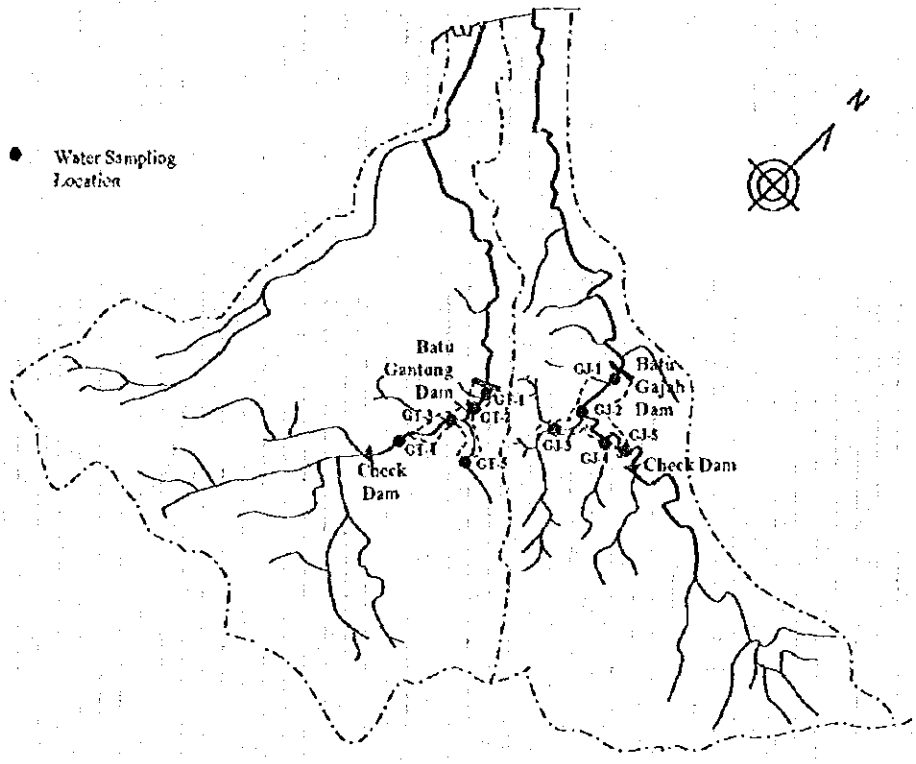

Figure-G.3.5 Locations of Water Sampling Sites

Table-G.3.12 Water Quality Analysis Results

River Name	Sample Code	Temperature °C		pH	EC	DO	BOD	COD	SS	TP	TN	T. Coli	F. Coli
		Air	Water	-	µS/cm	mg/L						Colonies/100mL	
Batu Gajah	GJ-1	25.5	24.8	6.3	60.5	8.79	2.49	8.72	367	0.005	0.00	2.40	2.40
		27.4	27.2	6.5	93.5	8.89	0.87	3.05	400	0.025	0.25	0.28	0.22
	GJ-2	25.5	24.7	6.0	63.4	8.84	1.49	5.22	461	0.005	0.00	2.40	0.54
		27.1	26.8	6.0	69.4	8.63	2.37	8.30	405	0.025	0.25	2.40	0.22
	GJ-3	25.5	23.8	5.5	94.0	8.84	1.74	6.09	452	0.005	0.00	1.60	0.54
		25.5	25.2	5.5	84.6	8.68	1.62	5.67	365	0.025	0.25	0.08	0.02
	GJ-4	25.5	25.1	5.8	75.0	8.52	5.23	18.3	365	0.003	0.00	2.40	0.24
		25.1	24.7	6.0	62.8	8.79	0.87	3.05	405	0.025	0.25	0.06	0.02
	GJ-5	25.5	24.7	5.4	100.2	8.73	2.99	8.72	379	0.030	0.00	2.40	1.60
		25.1	24.5	6.0	60.2	8.94	0.87	3.05	345	0.050	0.25	0.17	0.13
Batu Gantung	GT-1	25.0	24.0	6.5	40.2	8.63	1.00	3.45	417	0.005	0.00	2.40	1.60
		25.8	24.3	6.2	65.1	8.52	0.87	3.05	450	0.020	0.32	0.14	0.03
	GT-2	25.0	24.0	7.0	60.5	8.59	1.00	3.45	268	0.003	0.00	1.60	1.60
		25.0	24.2	6.0	60.5	8.89	0.12	0.42	468	0.025	0.25	0.08	0.02
	GT-3	25.0	24.0	6.5	47.8	8.58	1.25	4.38	315	0.005	0.00	2.40	0.14
		25.2	24.5	6.2	47.8	8.37	2.17	7.60	420	0.025	0.25	1.60	0.05
	GT-4	25.0	24.0	6.5	40.8	8.37	1.74	6.09	239	0.003	0.00	2.40	0.54
		26.7	24.7	6.5	40.2	8.37	1.87	6.55	368	0.025	0.25	0.92	0.92
	GT-5	25.0	24.0	6.0	65.1	8.10	2.00	7.00	164	0.005	0.00	1.60	0.35
		25.1	24.7	6.7	40.8	8.42	1.37	4.80	385	0.020	0.31	2.40	1.60

Note - EC: Electric conductivity DO: Dissolved oxygen
BOD: Biological oxygen demand COD: Chemical oxygen demand
SS: Suspended solids TP: Total phosphorous
TN: Total nitrogen T. Coli: Total coliform
F. Coli: Fecal coliform

In Indonesia the standard quality of natural water is specified by the Government Regulation No. 20/1990 Concerning the Control of Water Pollution. Comparing with the standard values, the river water at the dam area is thought to be suitable as raw water for water supply, except for the SS (suspended solids) which is measured as high as about 400 mg/L. However, it is not considered to be a problem for water supply since SS are easy to settle when water is stored in the reservoir.

River water pollution during dam construction is not significant because a bypass tunnel will be prepared for leading river flow directly from the dam's upstream side to the downstream side.

(b) Noise and Vibration

The two dam sites are in the less populated mountain area. The influence of noise and vibration from the construction machinery is thought to be minor in comparison with the river improvement work site.

3.2.3 Diversion Tunnel for Batu Merah River

(1) Project Activities and Environmental Impacts

The main specifications of the diversion tunnel for Batu Merah River are as follows:

–	Length	900 m
–	Standard section	Width 6.0 m
		Height 6.0 m

The impacts of diversion tunnel construction have been identified by the IEE as shown in Table-G.2.1. During the EIA study, some environment elements such as soil erosion, groundwater were also thought to be important. Consequently, the following items were studied:

1) Social environment

- Resettlement (pre-construction stage)
- Economic activities (pre-construction and construction stages)
- Traffic and public facilities (pre-construction and construction stages)
- Solid waste (construction stage)

2) Natural environment

- Soil erosion (construction and post-construction stages)
- Groundwater (construction and post-construction stages)

3) Environmental pollution

- Water pollution (construction stage)
- Noise and vibration (construction stage)

These impacts are analyzed in the following paragraphs.

(2) Social Environmental Impacts

(a) *Resettlement, Land Acquisition and Economic Activities*

The number of resettlement households for the diversion tunnel construction is estimated as 12, all at the site of the tunnel's inlet (*BM-1* in Figure-G.3.1). Land acquisition area is 3000 m^2, including that at both the inlet and outlet of the tunnel.

The general condition of the households involved in the resettlement is similar to those at the river improvement sites (see Table-G.3.5). Because the tunnel's inlet site is at the confluence of a mountain stream to the Batu Gantung River, people there are more worrying about flood damage. During the interview survey, people mentioned their past experience when flood came from both the upper stream of the river and the mountain stream at the same time. One small house near the river was even smashed by the flood. Therefore, they realized the importance of flood control project, and would follow the government's decision on their resettlement if they could get satisfactory compensation.

All these people are working in downtown area and there is not any economic activity in and near the project sites at both the inlet and outlet sides.

(b) Traffic and Public Facilities

At the outlet side, there is one main road along the coast, Jl. Pandan Kasturi. No traffic obstacle will be caused by the tunnel construction there, except an increase in traffic volume during transport of machinery, construction material and excavated wastes. The maximum number of vehicles employed will be no more than 10 per hour. Therefore, the impact will not be significant.

There are no public facilities at the inlet and outlet sites.

(c) Solid Waste

The total volume of solid wastes generated will be about 40,000-50,000 m^3 including soils, rocks from tunnel excavation and other cutting at the inlet and outlet sites. It is recommended that these wastes shall be disposed in the coastal land reclamation sites to prevent a long distance transport.

(3) Natural Environmental Impact

(a) Soil Erosion

The diversion tunnel will go through a part of one mountain with a height of about 110 m. At the inlet and outlet sites, slopes are very steep and some houses are at the surroundings especially at the inlet site excluding those required for resettlement. All the places with a danger of land sliding or soil erosion shall have to be checked and improved. Advises should also be given to the residents near the tunnel for preventing any activity that may damage the

tunnel or cause soil erosion from happening.

(b) Groundwater

There are some wells on the coast near the outlet area of the diversion tunnel. They are very rich in water volume and good quality for water supply. It is considered that the mountain that the tunnel will go through is a passage of groundwater aquifers of high potential from where the well water is coming. Along Batu Merah River downstream the tunnel inlet site, there are also more than 20 wells which are suggested to be from the same source. From the geological characteristics in this area, the groundwater is thought to flow from the higher mountain area in the northeast through the tunnel area toward the coast and the river.

The impacts of tunnel construction on groundwater have to be considered. During tunnel construction, loss of groundwater from the excavated tunnel is unavoidable, because it will be constructed by blasting method and to prevent groundwater flow is difficult. In this case, well water usage will be more or less influenced.

After tunnel construction, continuous loss of groundwater will not happen since the bottom and walls of the tunnel are cemented. However, recovery of groundwater will take a long period of time.

Although countermeasures will be taken in planning the construction work and during the work, the above mentioned impacts are not possibly to be completely erased. Therefore, prevision of new sources for supplying drinking water to the residents in the related area have to be considered.

(4) Environmental Pollution

(a) Water Pollution

At the inlet site, the tunnel construction may increase the amount of SS flowing to the river, and at the outlet site, possible influence is on the sea water. These impacts are very limited because work at the inlet and outlet is just a smaller part of the construction work. Most of the work will be inside the tunnel where excavated solid wastes will be transported directly by vehicles through the coastal road without any influence on the sea or river.

(b) Noise and Vibration

For the work inside the tunnel, the noise generated by construction machinery may not have influence on the surroundings, but dynamite explosion may result in noise and vibration especially when it is done near the inlet and outlet. In order to eliminate the impacts as far as possible, times of explosion should be regulated and notice should be given to the residents in the related area.

3.2.4 Check Dams

(1) Project Activities and Environmental Impacts

Table-G.3.13 shows the main specifications of the four check dams to be constructed. For Batu Merah River, the existing check dam is thought to function well and no construction is needed.

Table-G.3.13 Specifications of Check Dams

Item	Rubu	Tomu	Batu Gajah	Batu Gantung
Dam Height (m)	8.3	3.9	5.1	2.5
Dam Length (m)	40.0	70.0	50.0	60.0
Land Acquisition Area (m^2)	30,000	35,000	8,200	44,500

Because the check dam sites are all at the upstream mountain area where few people are living around, the impacts on the environment are thought to be minor in comparison with the other project construction work. The main environment items considered in the EIA are as follows:

- Land acquisition
- Traffic facilities
- Solid waste
- Water pollution
- Noise and vibration

These impacts are analyzed in the following paragraphs.

(2) Discussion on Impacts

The land acquisition area for the check dam construction is shown in Table-G.3.11. There is no problem of resettlement since each of the locations has been carefully selected. The land acquisition area does not include any agricultural farms nor vegetable gardens but only hilly grass land with a few fruit trees. Therefore, there will be almost no impacts on economic activities.

In and around the check dam sites, there is not any existing road. Roads shall have to be prepared for the construction. The only impact on the traffic in central Ambon area is during transport of machinery and construction materials to the work site. However, the vehicle number and duration are very limited in consideration of the much smaller scale than the multipurpose dams.

From each of the check dam site, about 1,000 m^3 of solid waste, mainly soil and rocks, will be generated during construction. It is recommendable to dispose these wastes at places near the work site but not to transport them a long way to the coastal land reclamation sites.

Check dam construction may more or less increase the SS content of the river. This impact can be minimized by providing bypass for the river flow during the construction. As for noise and vibration generated from the construction, no impacts are envisaged since the work sites are remote from the residential area.

3.2.5 Land Reclamation Plan

As shown in Figure-G.3.2, two sites, one at Wainitu and another at Ruhu, have been proposed as candidates for land reclamation using the solid wastes from the project construction. This is considered to be a part of this project, and environmental consideration should be given to the two proposed sites.

(1) Land Reclamation Site at Wainitu

(a) Present Environmental Setting

The Wainitu land reclamation site is at the southwest side of the Batu Gantung river mouth. This is an old harbor area but no longer used for many years. Several old ships are left there waiting for disposal. Up to about 100 m from the shore, the water depth is lower than 5 m but becomes deeper suddenly to about 20 m in front. The Port Authority tried to do land reclamation years ago and constructed dikes about 40 m from the shore but did not succeed. The dikes have already collapsed under wave action and left only a ruin there.

As in all the offshore area in central Ambon, sea water is seriously polluted at the site by direct discharge of domestic sewage, dumping of garbage etc. Few benthic, nekton and phytoplankton species can exist under such a environment (refer to Table-G.3.6 for the biotic analysis results in Batu Gantung estuary).

To the land side, there is the densely populated area. Without coastal constructions or public buildings in between the residential area and seashore, housings expand in this 'ocean desert' - about 100 illegal houses, actually shelters, have been built by people coming from outside Ambon above the sea just in front of the permanent houses already at the seashore, making this place a special slum area in Ambon. These illegal residents live on the sea, discharge sewage and night soils to the sea and dump garbage into the sea. This makes the coastal environment worse.

(b) Site Availability

Regarding the above mentioned condition, the Ambon Municipality has already considered to improve this slum area and a new road (RTBL Block Plan) is planned to be constructed through this area along the coast. Therefore, the Government welcome the land reclamation and expect a cooperation between the two plans. The Port Authority are also willing to cooperate because they have planned land reclamation for long.

The land reclamation area is 8-10 ha, and the depth of solids damping is about 5 m on average. Therefore, the applicable volume will be 400,000-500,000 m^3 as a potential final disposal site for this project.

(c) Environmental Impacts

Regarding social environment, the about 100 shelters at the land reclamation site is an issue which has to be coped with carefully. Although they are illegal residents, it is not recommendable to force them to move away without providing them suitable places to live. However, Ambon Municipality have considered this problem in the new road construction

plan, and agreed to construct low cost houses near the site for renting to these residents.

As for natural environment, a significant impact anticipated is the change of coastal line. Generally speaking, an alter in coastal line will disturb the equilibrium condition of the existing coastal environment. It will take a long period for a new equilibrium to be reached and coastal erosion will possibly happen in the surrounding area. However, the extent of impact depends on the oceanographic condition.

The Wainitu site is at the outer Ambon Bay where the strait is broad. The influence may not reach to the opposite side of the bay, but consideration should be given to the surroundings at the same coastal side. A survey on coastal erosion condition within the possibly influence area will be necessary before the construction work to find the locations needed to be strengthened.

Land reclamation will not result in water pollution because the main composition of the solid wastes dumped will be soils and rocks from the dam construction sites.

(d) Recommendations

At present time, people at the site are using the sea as a vast receiver of domestic wastes. When land reclamation begins, their access to the sea will become a problem and wastes may be discharged directly to the reclaimed land and result in continuous deterioration of the sanitary condition in this area. In order to prevent such things from happening, sanitary facilities should be provided to this area. All toilets should be connected to septic tanks and sewers should be constructed to discharge sewage to the nearby drainage systems.

Since the land reclamation is not a garbage dumping site, there may not be the problem of scavengers coming to the site for the recovery of useful items as what happens in other garbage disposal sites. However, people may want to get construction materials from the dumped construction wastes. Such kind of activities may affect the work at the site, damage the reclaimed land and also deteriorate the environmental condition. Therefore, regulation and management of the land reclamation work is very important.

It is also recommendable that environmental improvement plan shall be included in the utilization of the reclaimed land. When the new road is built along the coast, the space between the road and seashore should be used as green belt but not a place for housing area expansion. Otherwise, similar problem will arouse again to what has happened in that area now.

(2) Land Reclamation Site at Ruhu

(a) Present Environmental Setting

The Ruhu land reclamation site at the southwest side of Ruhu river mouth. This area used to be rich with mangrove trees but were completely cut when land was cleared for construction of some workshops. Actually most part of the former mangrove area has not been utilized because it is under sea water at the high tidal period. To the landward of this site these is a newly developed green area, and to the northeast of the river mouth there is the Halong naval base. This site is located at a place where Ambon Bay is divided into two parts namely

the inner bay and outer bay. Just less than 1 km opposite the bay, there is Rumah Tiga seaside park. Being less populated and with more green lands, this site is one of the beautiful locations in Ambon Bay. The biotic survey results show a better biological condition in this area (see Section 3.2.1(3) and Table-G.3.6). Sea water is shallow in this area with a maximum depth about 10 m at the center of the relatively narrow strait.

(b) Site Availability

The land reclamation area is about 7 ha with a depth of 3-4 meters. Therefore, the applicable volume will be 200,000-300,000 m^3.

There is a dispute among government agencies and scientific institutions on the development in this area, and some questions remain on the site availability.

(c) Environmental Impacts

Different from the Wainitu site, almost no residential houses are in and near the Ruhu site. The naval base in Halong and the seaside park in Rumah Tiga are two important places to be possibly under the influence of land reclamation.

Regarding natural environment, possible impacts are anticipated on the stability of coastal lines in both sides of the Ambon Bay near the site. Because the strait is narrow in this area, the current action is thought to be stronger than the other part of the bay under a high tidal flow velocity toward and from the inner bay.

(d) Recommendations

Land reclamation at Ruhu site should be taken as a secondary alternative following the Wainitu site in consideration of the environmental impacts and the dispute on its availability.

If land reclamation is conducted at Ruhu sites, further studies shall be required on the current action and coastal line condition on both bay sides to identify the locations needed to be protected.

3.3 Considerations on Environmental Management and Monitoring

3.3.1 Environmental Management

Environmental management is important from the pre-construction stage to the post-construction stage. This includes not only the management of environmental issues related to the project, but also those related to environmental improvement in the whole central Ambon area. Recommendations can be given as followings.

(1) Organization for Environmental Management

Under the project office which is supposed to be organized by Ministry of Public Works, there should be a branch with at least one acting officer in charge of environmental management. This environment branch shall make plans for environmental protection and improvement, and manage all activities related to the environment. A good coordination among the project office, local government and environment agencies are also very important.

(2) Management of Resettlement and Land Acquisition

Resettlement and land acquisition are very sensitive to social impacts and have to be well managed. Totally 97 households will possibly be involved in the resettlement program. Careful inventory of their houses, lands and properties, hearing on their opinion and desire are indispensable. Besides compensation, provision of locations for them to get new residential houses are also very important.

(3) Environmental Surveillance of Construction Work

Construction work should follow environmental regulations. This needs a well organization of the work and also surveillance during the work. Dispute may occur with local residents on environment related issues, or complaints may come to the project office or local government. These issues need to be resolved on the basis of environmental laws and regulations.

(4) River Environment Management

As one of the non-structure measures, river environment management has been proposed in the flood control master plan. This includes restriction on garbage dumping to the river, installation of sanitary facility such as septic tanks and public sewers. After the project, if people still use the river as a waste disposal site, not only environmental condition will be deteriorated, but also flood control will be affected. For example, garbage accumulation in the river will reduce the river flow capacity.

In the downstream part to the five rivers, dense population causes many problems related to flood control and the environment. From a viewpoint of eliminating social impacts, resettlement is only planned at the locations where residential houses are obstacles to flood control structures. The necessary space along the river banks for river surveillance has not been taken into account. This is an unsolved problem and should be considered in the urban development plan for the future.

(5) Coastal Environment Management

The environmental condition in the coastal area of Ambon Bay is similar to that at the river. Condition is worse near the estuaries of Batu Merah, Tomu, Batu Gajah and Batu Gantung. In addition to wastes carried in to the bay by the rivers and drainage channels, people dispose wastes from residential and market areas directly to the sea. It is recommendable that coastal environment management and improvement shall be considered during and after the project. This includes garbage collection, sewerage and drainage system improvement, and regulating market and other business activities.

(6) Dam Area Protection

In order to improve the biological condition and protect reservoir water quality for water supply, it is recommended that in Batu Gajah and Batu Gantung the dams and reservoirs and their surrounding areas shall be taken as natural protection areas. Reforestation around the reservoir is an important measure for this purpose.

(7) Environmental Education

For an effective environment management, environmental and sanitary education is indispensable for raising public awareness of the importance of environment protection. The habit of using rivers and coastal area as receivers for all kinds of wastes should be completely abandoned, and creation of a comfortable and beautiful environment should become the target of all the residents in central Ambon area. This needs a long term education program for people of all ages and strong administrative measures such as proposing new regulations including strict penalties for environmental contamination.

3.3.2 Environmental Monitoring

Environmental monitoring is important for understanding the environmental conditions before, during and after the project. At the pre-construction stage, environmental monitoring aims to a understanding of the environmental settings as what has been done in the IEE and EIA for this project; during project construction, monitoring is for controlling the impacts on the environment; and after the project, for good maintenance of facilities and expanding the effect of the project. The followings are the main monitoring items.

(1) Traffic Volume Monitoring

At the pre-construction stage, the traffic volume of the main roads should be monitored for making a reasonable transportation plan for the project, and during the construction monitoring is still necessary to check the project impacts and raise working efficiency.

(2) Noise and Vibration

Noise and vibration levels should be monitored during the project construction especially at the locations where people complain about the impact. Following monitoring results, work plan should be modified and countermeasures be taken.

(3) *Groundwater Level*

The diversion tunnel construction may result in decrease in well water level in the related area. Therefore, groundwater level should be monitored, and according to the results necessary countermeasures should be considered.

After water storage in the multipurpose dams, groundwater level at the downstream side of the rivers should be monitored continuously.

(4) Water Quality

Because the multipurpose dams will be used for water supply, water quality should be monitored, and accordingly, conservation measures should be taken.

(5) Soil Erosion Surveillance

Soil erosion surveillance should be conducted during and after project construction at the dam sites, diversion tunnel sites and along the rivers. Necessary measures should be considered for all the locations where soil erosion may happen.

(6) Post Resettlement Survey

As has been mentioned above, resettlement is a sensitive issue related to social impacts. The impacts will not only be significant until people relocate to a new place but also continue for long period of time. Whether people are satisfied with their new living condition, what kind of problem they are facing and what do they want the government to do for them should be understood. It is recommendable that post resettlement survey shall be conducted to investigate these people's condition after the resettlement and hear on their opinion and requests. The information should be reported to the related governmental organization.