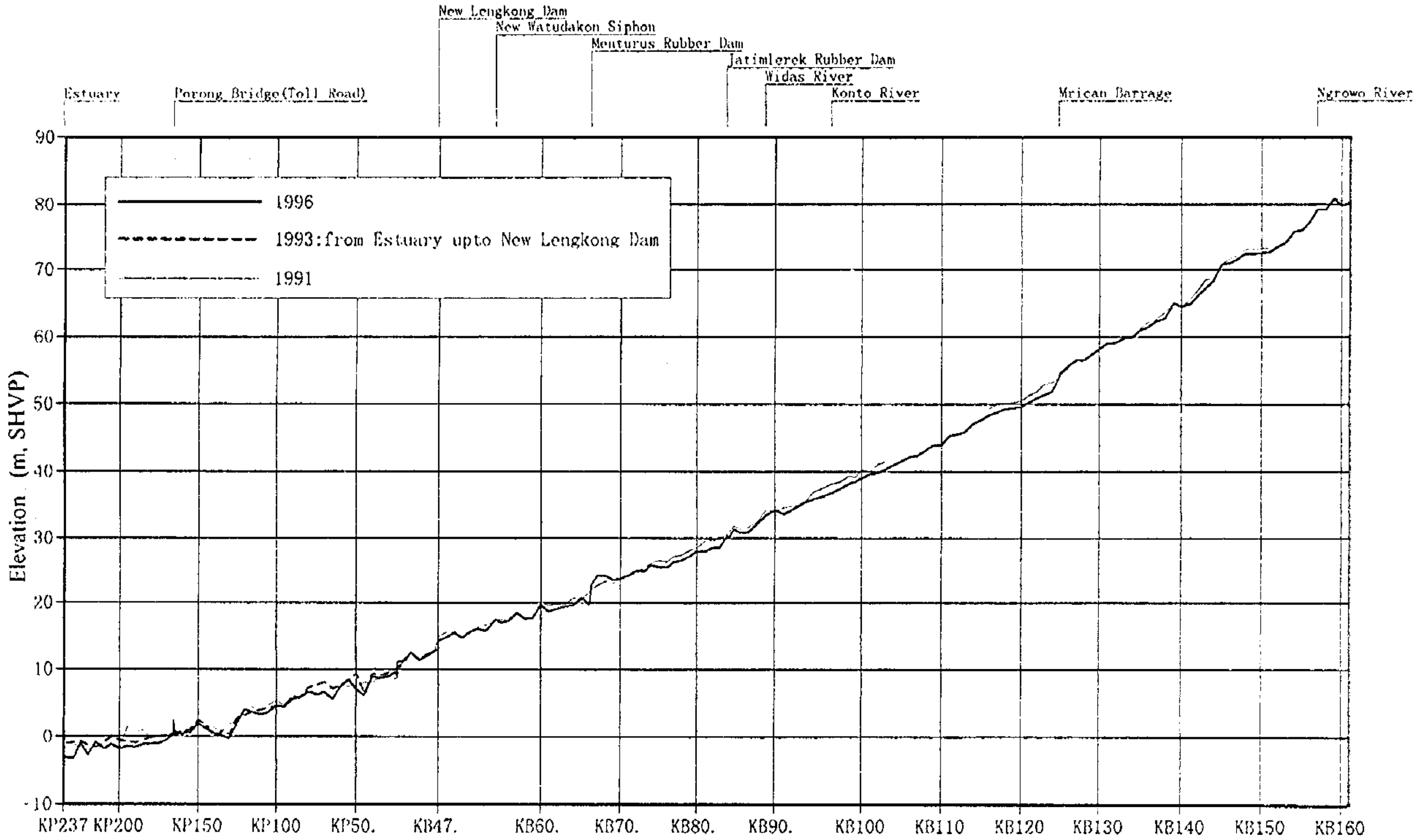


Figure A2-18 Averaged River Bed of Brantas River

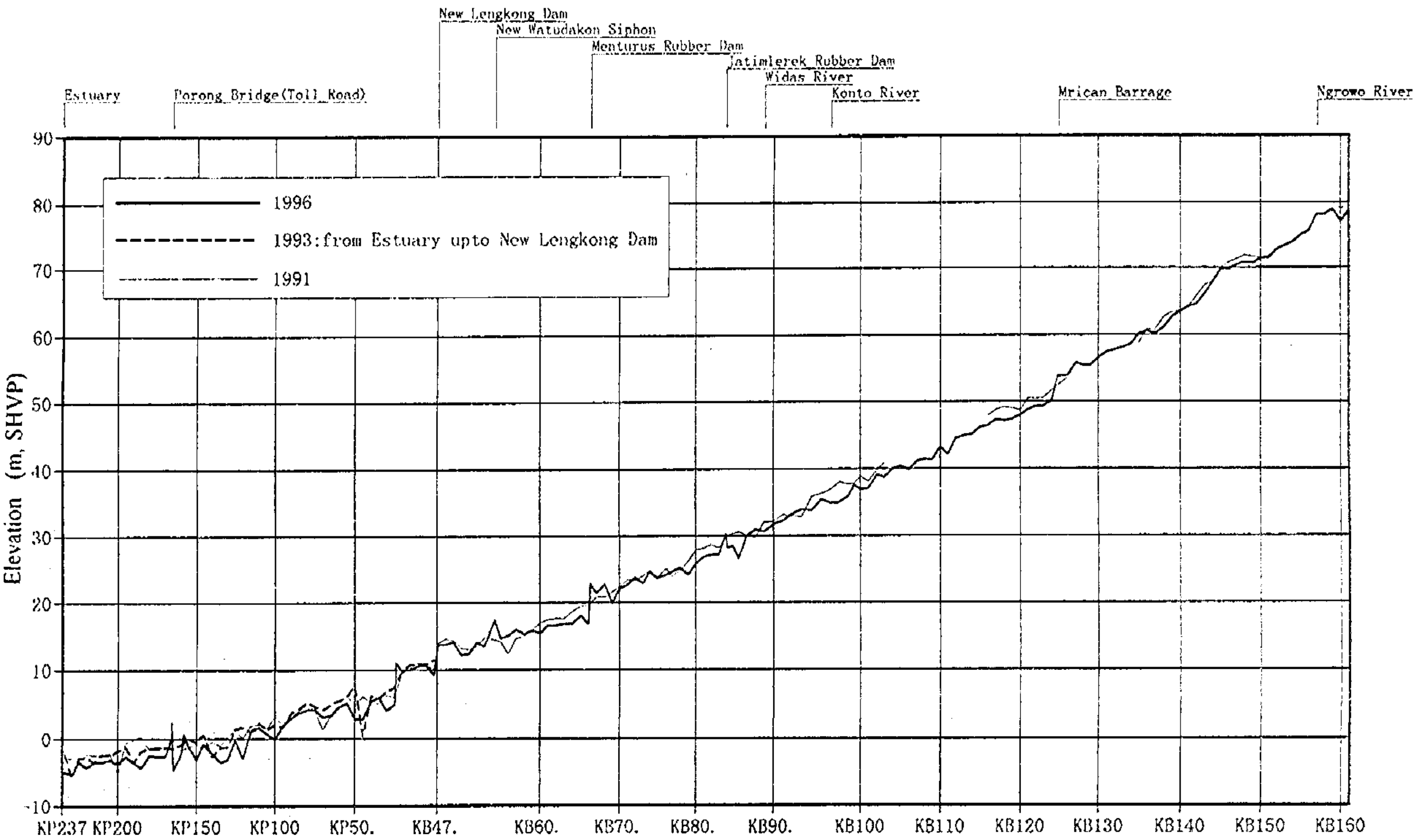


Figure A2-19 Deepest River Bed of Brantas River

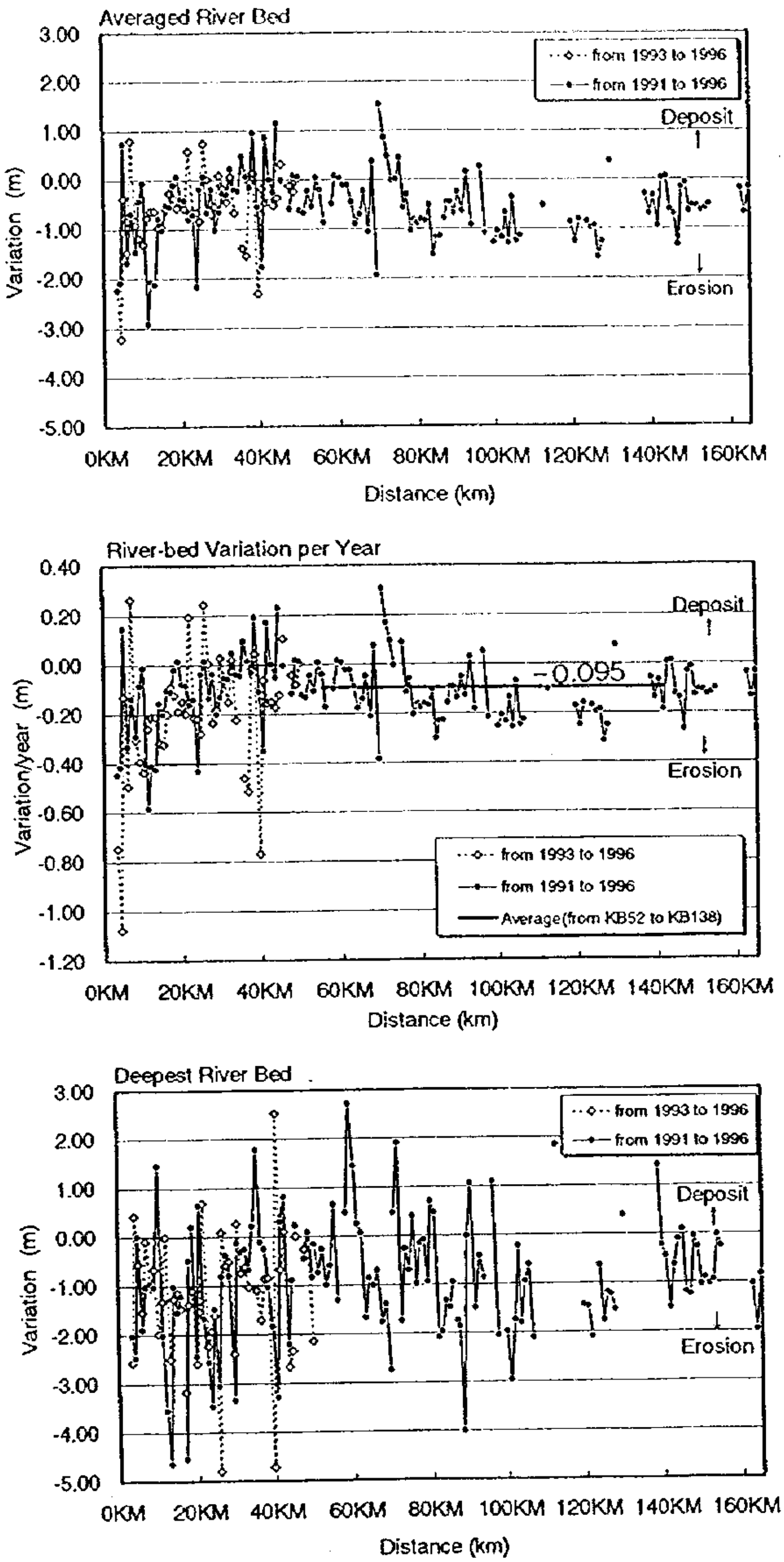


Figure A2-20 River Bed Variation of Brantas River

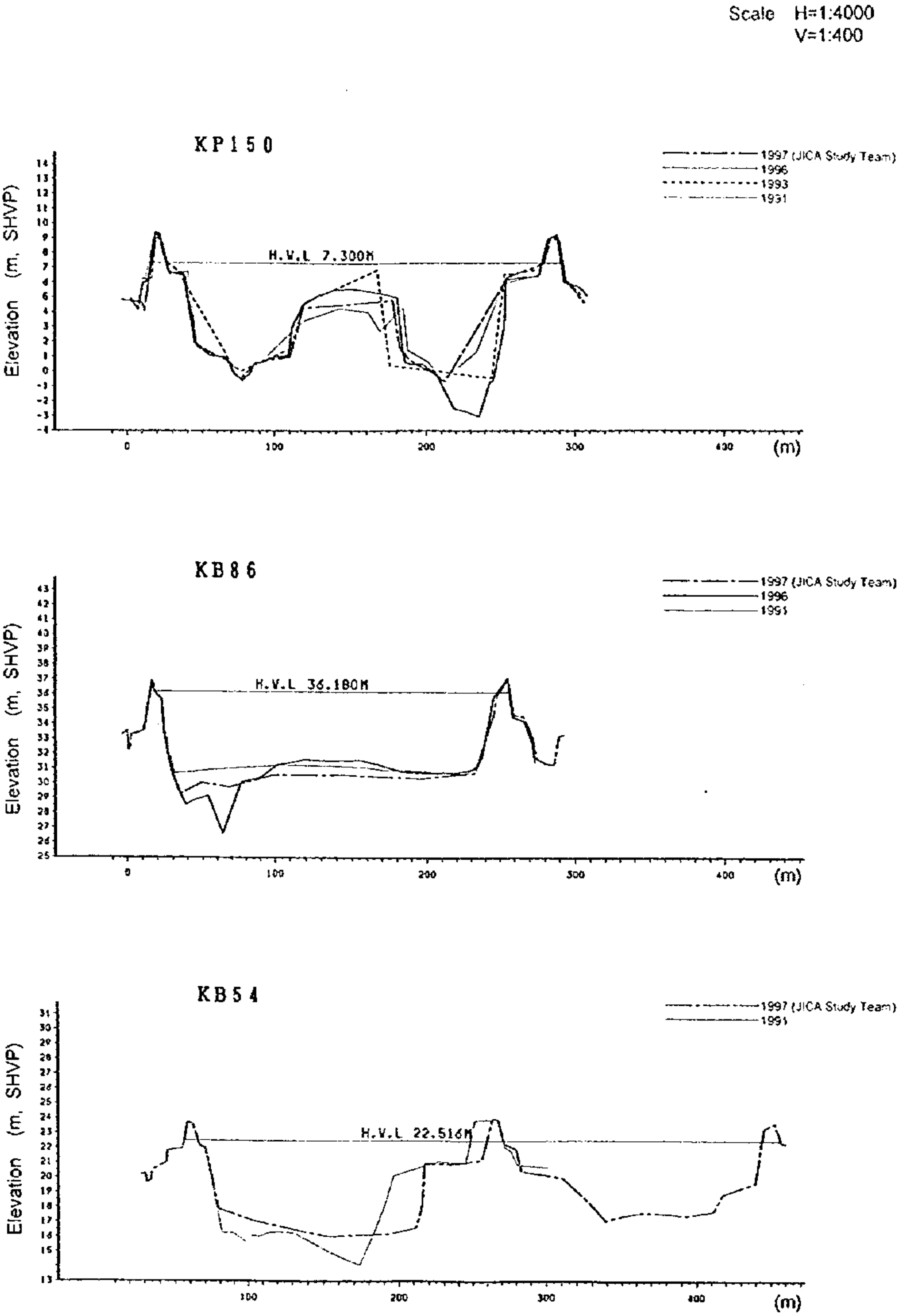
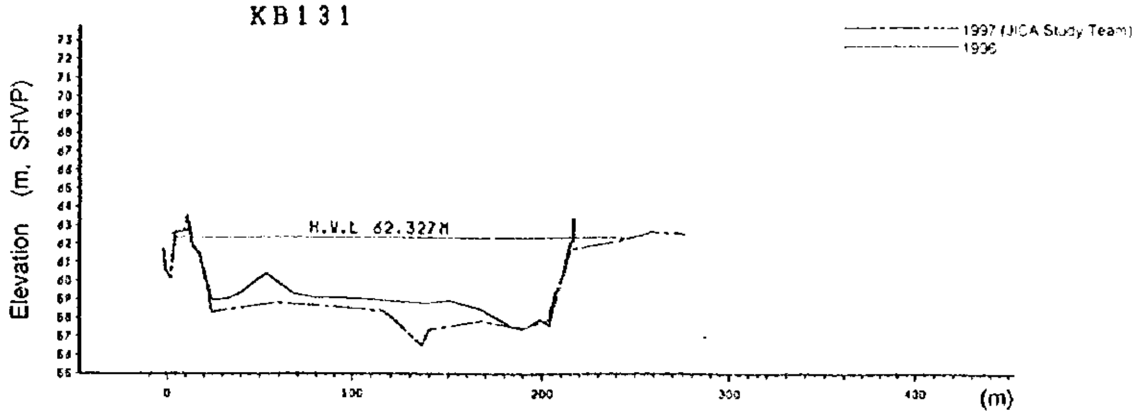


Figure A2-21 (1) Cross Section of Brantas River

Scale H=1:4000
V=1:400



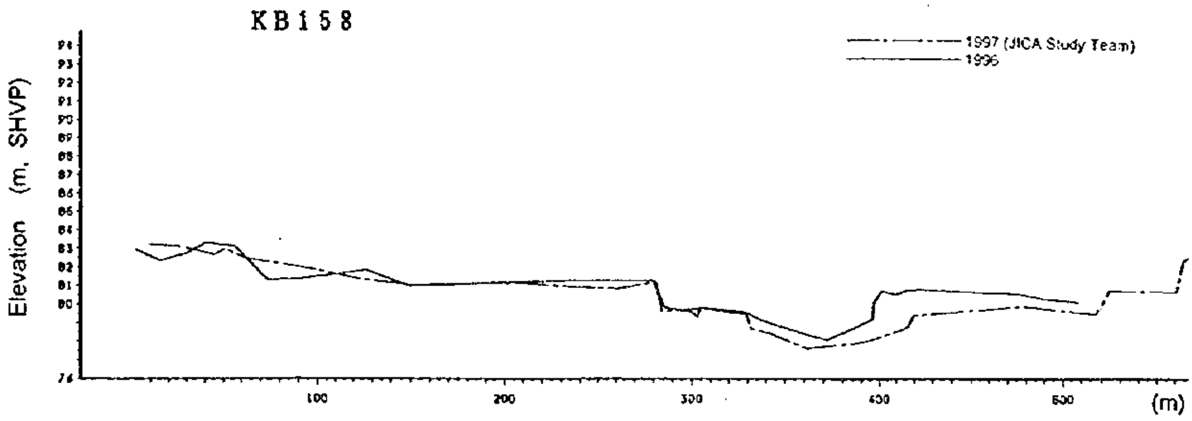


Figure A2-21 (2) Cross Section of Brantas River

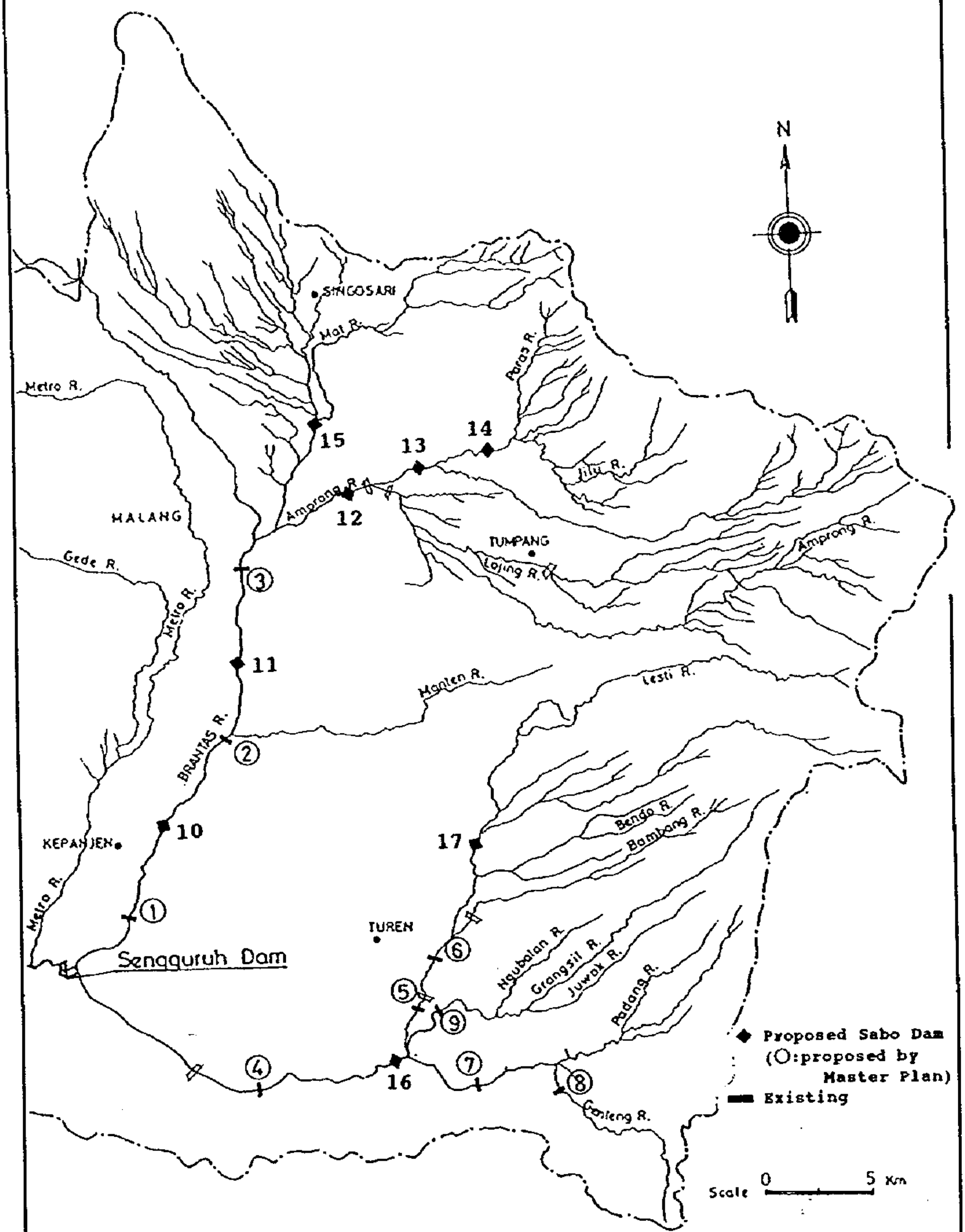


Figure A2-22 Location Map of Proposed Sabo Dam in the Upper Basin of Sengguruh Dam

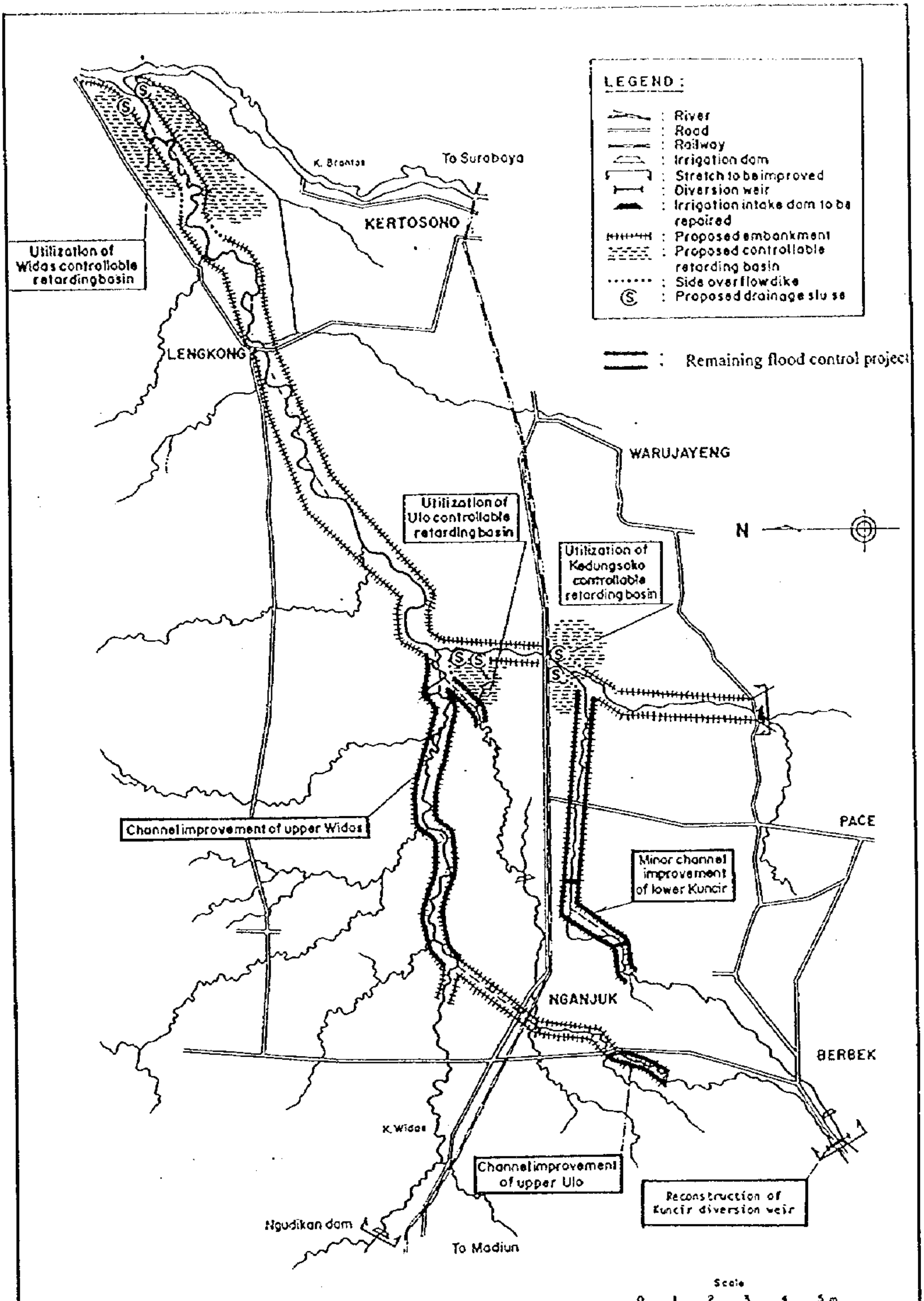


Figure A2-23 Location of Proposed Widas River Flood Control Project

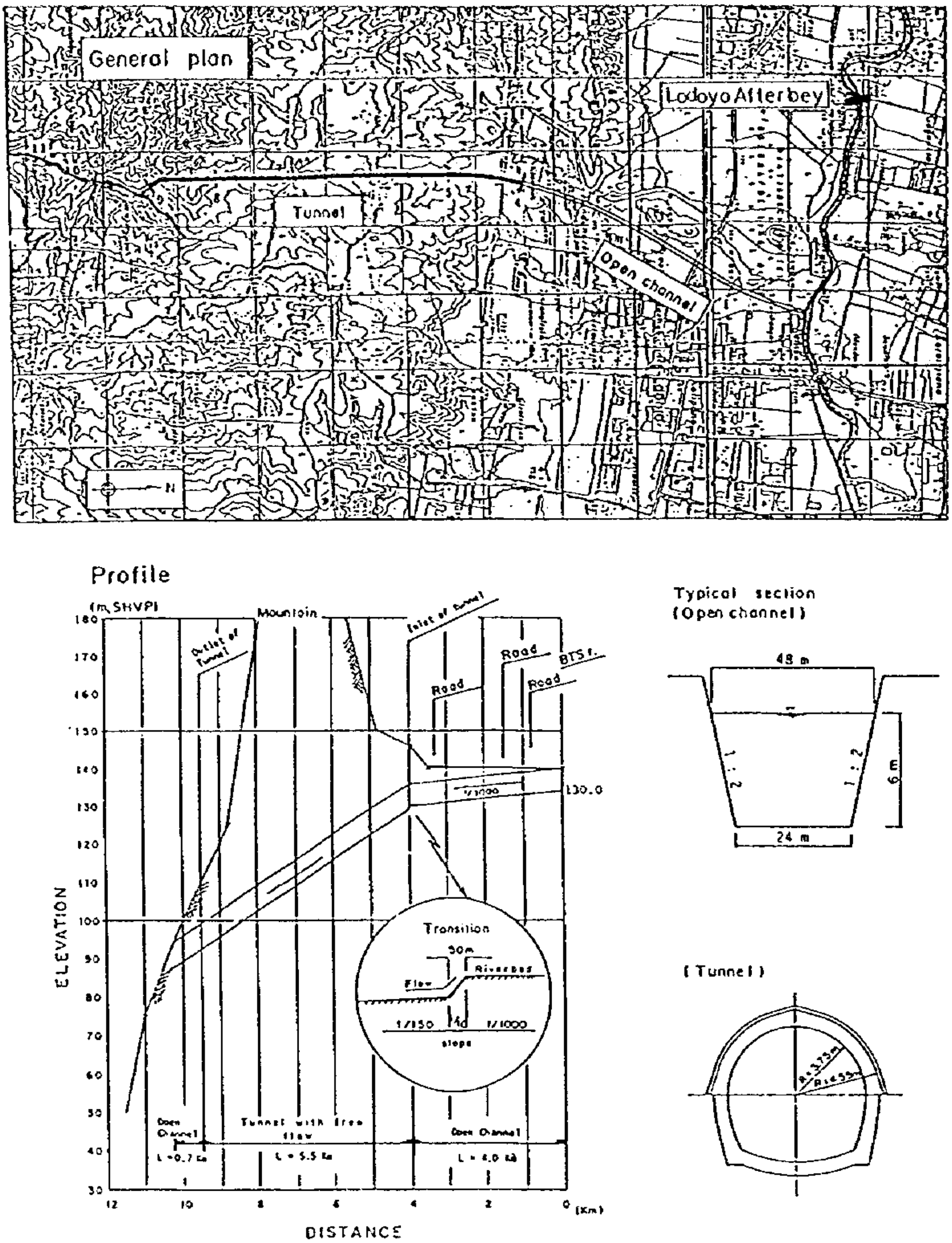
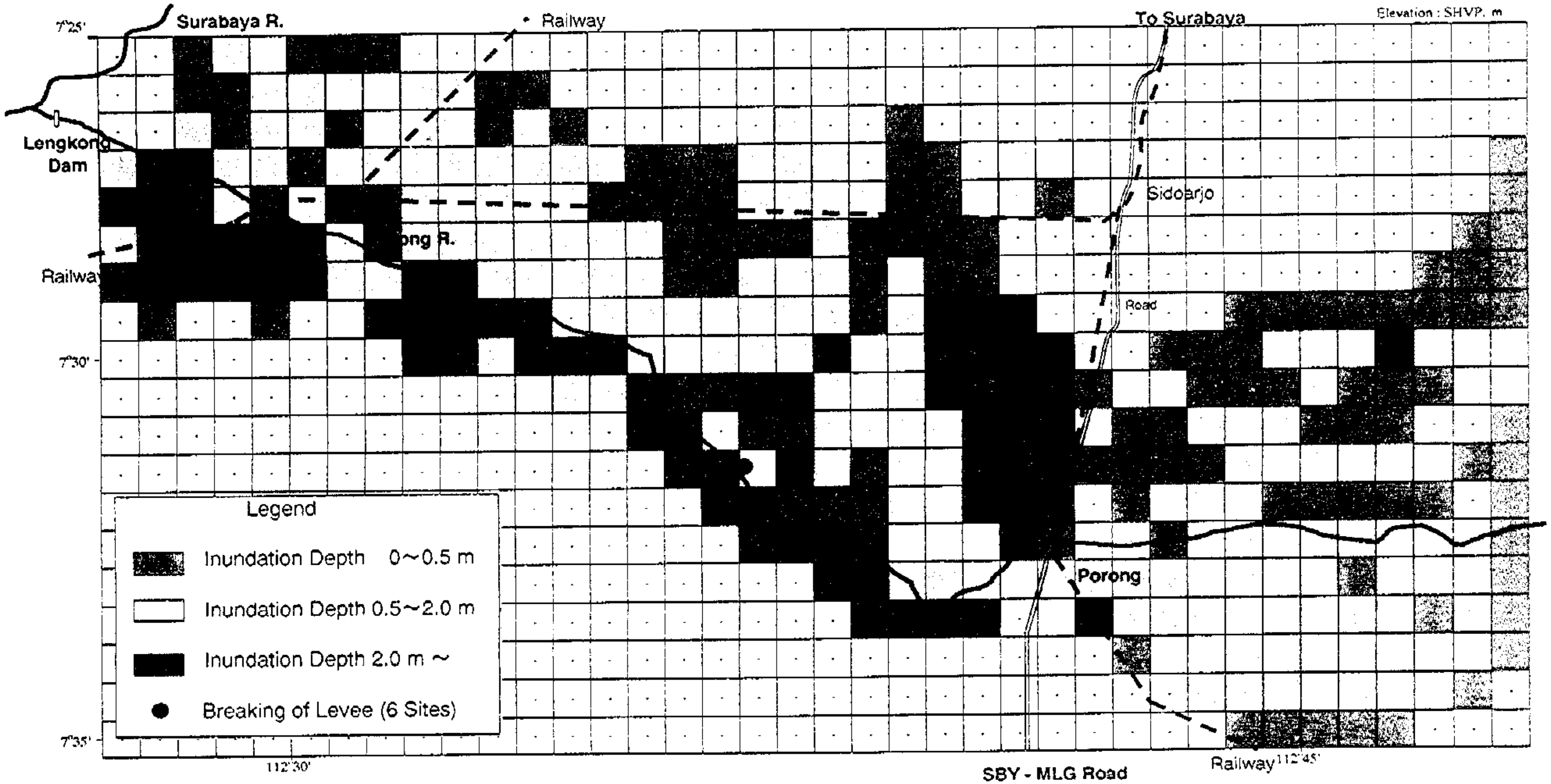


Figure A2-24 Location of Proposed Diversion Channel Project



Source : Peta Garis Surabaya Phase II in 1986, Scale 1:2,500
Topographic map reviced by US Army in 1945, Scale 1 : 50,000

Scale : 1 Km x 1 Km

Figure A2-25 Hazard Map

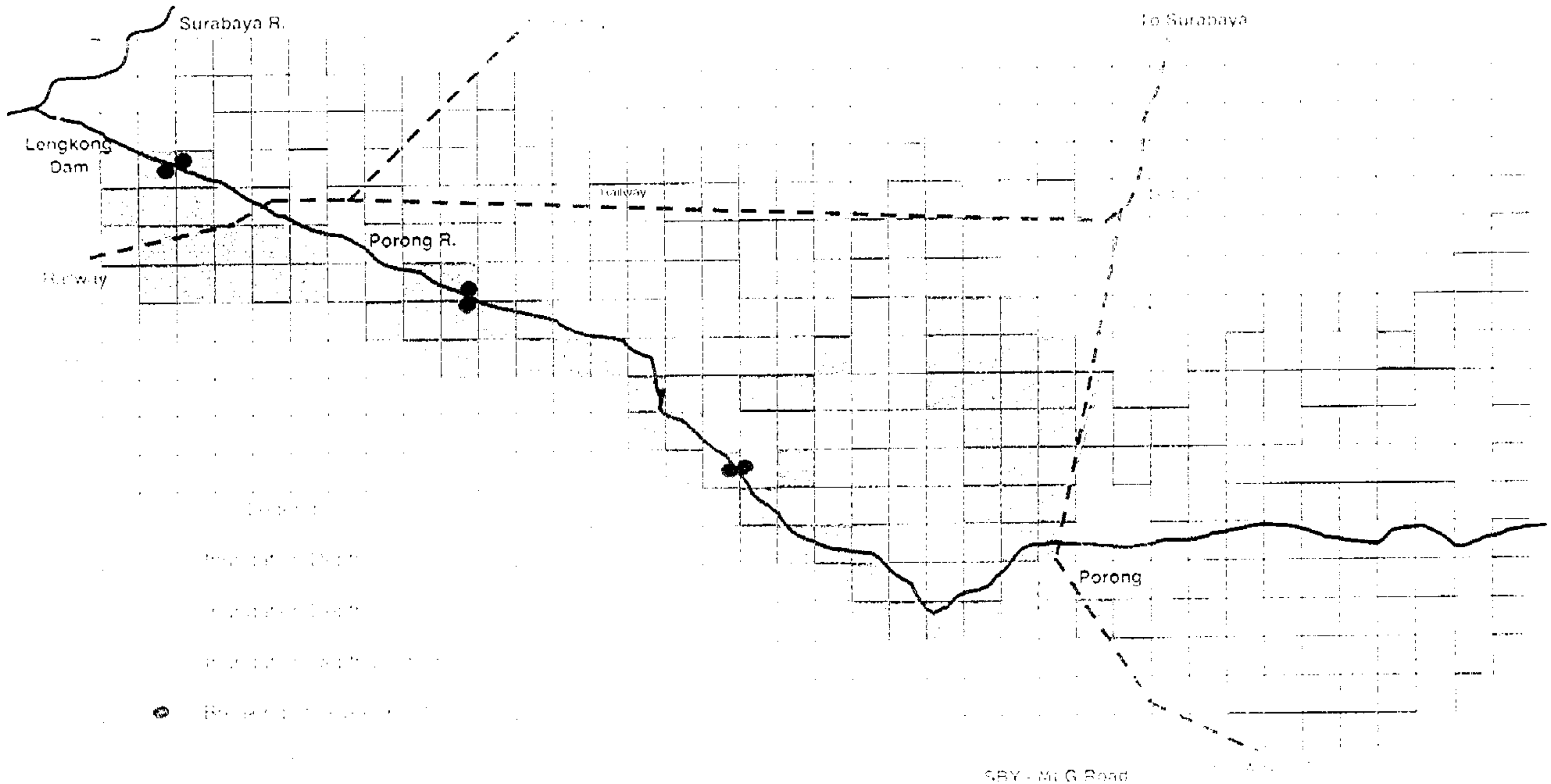


Figure [illegible] Hazard Map

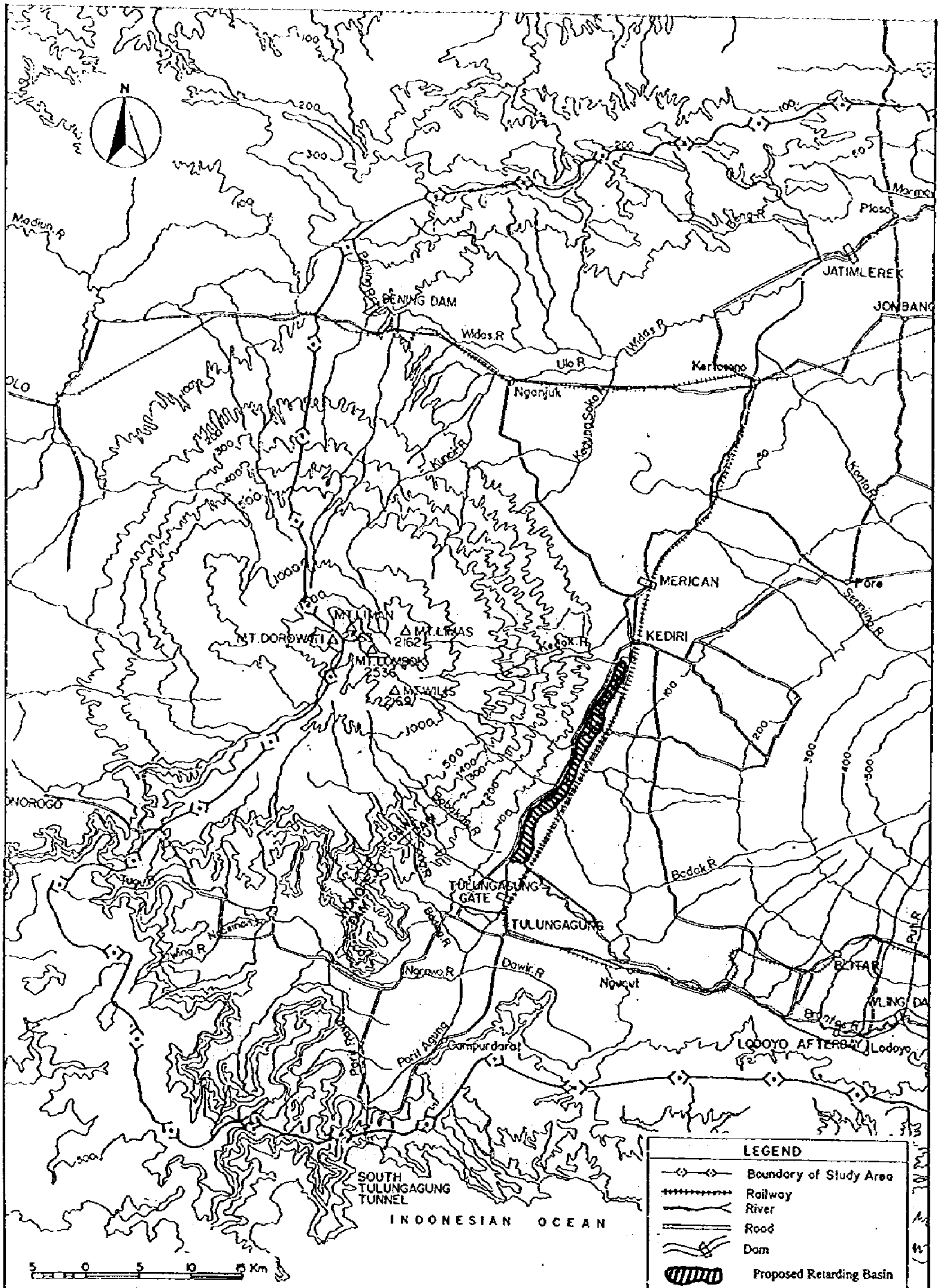


Figure A2-26 Location of Natural Retarding Basin of Brantas Middle Reach and Confluence of Ngrowo River

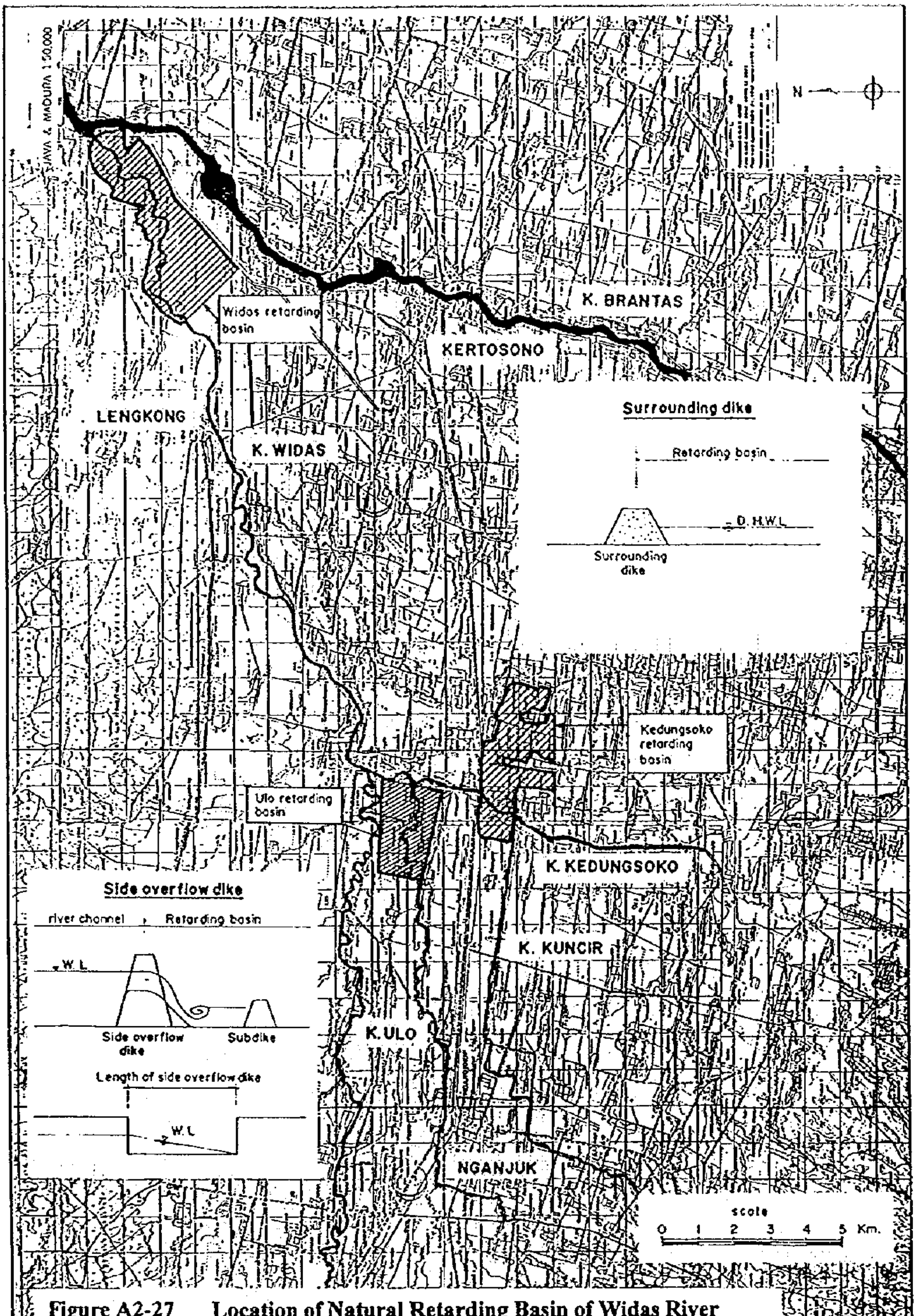


Figure A2-27 Location of Natural Retarding Basin of Widas River

Project	Work Item	Amount (mil. Rp.)	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1. Watershed Conservation 1.1 Watershed Conservation by BRLKT	- Reforestation and terracing	(141,125)																						
	- Land compensation	-																						
	-Engineering	(14,113)																						
	-Administration	(7,056)																						
1.2 Experimental Research by PJT	-Installation/Running	2,078																						
	-Land compensation	1,304																						
	-Engineering	2,988																						
	-Administration/OM	614																						
2. Sabo (1) G. Kelud basin	-Construction	380,980																						
	-Land compensation	5,503																						
	-Engineering	38,098																						
	-Administration	19,324																						
	-Operation and maintenance	26,468																						
(2) Upper Brantas & Lesti basin	-Construction	100,940																						
	-Land compensation	-																						
	-Engineering	10,094																						
	-Administration	5,047																						
	-Operation and maintenance	17,154																						
3. Flood Control (1) Widas River	Widas river + Lower Ulo river																							
	-Construction	38,532																						
	-Land compensation	13,766																						
	-Engineering	3,853																						
	-Administration	2,615																						
	-Operation and maintenance	6,545																						
	Kuncir																							
	-Construction	23,906																						
	-Land compensation	9,833																						
	-Engineering	2,391																						
	-Administration	1,687																						
	-Operation and maintenance	3,585																						
	Upper Ulo river																							
	-Construction	15,463																						
	-Land compensation	9,401																						
	-Engineering	1,546																						
	-Administration	1,243																						
	-Operation and maintenance	1,395																						
(2) Lodoyo diversion tunnel	-Construction	362,689																						
	-Land compensation	4,672																						
	-Engineering	36,269																						
	-Administration	18,368																						
	-Operation and maintenance	-																						

Figure A2-28 Implementation Program for Water Resources Development Project

Action Plan	Amount (mil.Rp.)	PJT			New PJT		2002 - 2004
		1999	2000	2001	2002	2003	2004
1999 - 2000							
(1) Preparation of land use map, which is drawn in detail erosion area and forestry zone, for the purpose of water resources management.	-	━	━				
(2) Review of master plan investigated in detail the debris run-off from the Mt. Kulud basin.	16,692	━	━	━			
(3) Review of master plan on water reosurces management considered the recent basin conditions.	16,692	━	━	━			
(4) Preparation of basin conservation plan and recommendation on its execution to administrator.	1,300	━	━				
(5) Investigation on actual conditions of the existing sabo facilities.	1,000	━					
(6) Preparation on quality improvement and transportation measures for product made from deposit materials in sand-pocket.	-	━					
(7) Preparation of basic data on objective tributaries (topographical data and profile investigation).	-	━	━				
(8) Survey and setting out the boundary stick of retarding basin which was recommended by the existing master plan.	500			━			
2002 - 2004							
(1) Continuous investigation on actual conditions of illegal sand mining on riverbed.	-	━	━	━	━	━	━
(2) Investigation on actual conditions of flood damage (grasp of major damage area).	-	━	━	━	━	━	━
(3) Preparation of proposed flood control manual.	-				━	━	━
(4) Preparation and announcement of flood risk area map in the whole basin.	-				━	━	━

Figure A2-29 Required Cost for Action Plan

ANNEX – 3

WATER QUALITY

ANNEX - 3 WATER QUALITY

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Page

1 Water Quality Monitoring System

The present water quality monitoring systems in the Brantas river basin are summarized in Table A3-1, and details of them are given in the following sections.

1.1 Existing Monitoring Points

(1) River water

The comprehensive water quality monitoring in the Brantas river basin has been conducted by PJT since 1988. As of 1997, 51 specified points which cover the essential river segments of the Brantas river and its major tributaries, including reservoir of dams and sluices, are being monitored as a part of "Water Quality Monitoring and Pollution Control System (hereinafter referred to as WQMPCS)" by PJT (see 3). The monitoring points by PJT are shown in Table A3-2 and Figure A3-1.

In addition to the above, the Program Kali Bersih (referred to as PROKASIH) which is the nation wide clean river campaign program, has started in 1989. The work team of PROKASIH under the Committee for Environmental Pollution Control and Abatement, East Java province (referred to as KPPPLH) is monitoring the river water quality at 29 points in the Brantas river basin at present.

Furthermore, Kanwil PU also monitors the river water quality.

As of 1996/97, the number of monitoring points of the rivers and irrigation canals in the Brantas river basin by each organization are summarized as follows.

Rivers and	Organizations		
Irrigation canals	PJT	PROKASIH	Kanwil PU
Brantas river	25	8	6
Surabaya river	9	11	4
Mas river	1	-	1
Porong river	1	2	-
Other rivers	15	3	1
Irrigation canals	-	5	-
Total	51	29	12

Note : 1) PROKASIH means work team of PROKASIH
2) Rivers include reservoirs of dams and sluices

(2) Industrial waste water

The monitoring of industrial wastewater by PJT has been implemented every month since 1990. The monitoring is being made as a part of WQMPCS. The number of industries monitored in 1996 is 41. Location of industries monitored by PJT is shown in Figure A3-2.

The work team of PROKASIH is also monitoring waste water from industries, called "priority industries" which have a high possibility of producing pollution load, in order to provide instructions to the industries to take appropriate countermeasures for decreasing pollution loads entering the rivers. The number of "priority industries" selected by PROKASIH in Brantas river basin in 1996/97 are 58.

The industries monitored by above organizations are tabulated in Table A3-3. As a matter of fact, the laboratory of Kanwil PU is in charge of analyzing industrial waste water. But the analysis is carried out for industries' uses only.

(3) Domestic waste water

The monitoring of domestic waste water, such as hotels, hospitals, supermarkets, and restaurants, is implemented by the Ministry of Health (referred to as Dep.KEU). In the Brantas river basin, the Agency of Environmental Health Techniques of Surabaya Laboratory Unit, Ministry of Health (referred to as BTKL) engages in monitoring the domestic waste water. The data monitored, however, are not for publication at present.

1.2 Present Monitoring Method

(1) Monitoring method

The sampling and analytical methods being used for the monitoring by each organizations are as per the standard method of water sampling published by the National government. The East Java province also published the standard method of water sampling and analysis of waste water, the Provincial Decree of the Governor of East Java, No.40/41,1996.

(a) Monitoring by PJT

Existing monitoring method

The samples from each monitoring point of rivers and industries are taken by PJT laboratory staff. The samples taken are tested at the laboratory of PJT in Mojokerto. The samplings of water from the rivers are carried out monthly, weekly, and daily according to the importance of locations. For the industries, these are monthly. The sampling from the rivers are conducted based on following schedules.

- Daily monitoring : 2 points (Karangpilang and Ngagel)
- Weekly monitoring : 9 points (Mostly in the downstream reaches of the Brantas river basin)
- Monthly monitoring : 40 points (Mostly in the middle and upstream reaches of the Brantas river basin)

Twenty-one parameters are tested for the rivers except for water flow, for example water temperature, pH, DO (Dissolved Oxygen), BOD (Biochemical Oxygen Demand), COD (Chemical Oxygen Demand measured by dichromate oxygen demand), SS (Suspended Solids) and so on. The parameters for the industries are 13 items except for discharge. In addition, oil and grease are monitored at some industries. As for the water flow (discharge), it is not measured at the time of sampling. The water flow (discharge) included in the PJT's reports are data from existing water gauging stations or related surveys.

The result of the tests are sent to PJT head office from the laboratory and are compiled there. Important parameters are selected for compilation, the compiled reports are distributed to the several related organizations such as KPPPLH, BBLH, PKB and so on, monthly.

Extension of the monitoring System

In the study of the Wonorejo Multipurpose Dam Construction Project, an extension of telecommunication system is proposed for the low flow management in the Brantas river basin. Automatic water quality monitoring stations has been proposed to install in that system in order to observe real time water quality of the rivers. The data tested at the each station will be sent to the dam center via on-line telemeter system. The proposed stations are near the intakes of PDAM Water Supply Treatment Plants (hereinafter referred to as WSTP) as follows :

- Karangpilang : Surabaya river (near Karangpilang PDAM WSTP)
- Pelayaran : Pelayaran canal (near Tawangsari PDAM WSTP)

The water quality parameters monitored by the sensors will be water temperature, pH, DO, conductivity, and turbidity.

(b) Monitoring of PROKASIH

Under the activities of PROKASIH, the samples from the rivers are taken by the Dians Pekerjaan Umum Pengairan (hereinafter referred to as DPU Pengairan) and sent to BTKL for analyzing them. The samples from the industries are taken by the Municipal Industrial Services (Tingkat II) and tested at BTKL, the laboratory of Kanwil PU and the Agency of Industrial Research and Development, Surabaya (hereinafter referred to as BPPI).

The samplings of water from the rivers and industries are being carried out monthly. The parameters being tested for the rivers can be found in the PROKASIH reports that they are DO, BOD and COD. The parameters reported for the industries in the PROKASIH reports are BOD and COD with amount of discharge, but the parameters are selected based on type and/or possibility of producing pollution load of the each industry. Examples of this are as follows :

Name of industries	Main products	Number of monitoring items
PT. Jaya Keratas	Paper	5 items
PT. Ajinomoto Indonesia	Mono sodium glusomat	6 items
PT. Wastra Indah	Textile	10 items
PT. Gudang Garam Kediri	Cigarette	32 items

Source : DPRIND

Results of the monitoring of PROKASIH are reported every 3 months to the Environmental Impact Management Agency (hereinafter referred to as BAPEDAL). The each result is compiled by the Bureau of Environmental Guidance, East Java (hereinafter referred to as BBLH), and the annual reports are published yearly with an evaluation of data, by the East Java province.

(c) Monitoring by Kanwil PU

For the water quality monitoring of the rivers, the samples are taken by the Municipal or Regional Water Resources Services (Tingkat II) and tested at the laboratory of Kanwil PU.

The samplings and tests are being carried out monthly. Number of parameters being tested are about 60 including heavy metals and microbiological parameters. The results of tests are compiled in annual report with technical suggestions from the view point of water resources issues.

(2) Monitoring organization and staffing

(a) Monitoring by PJT

The division of D/S Water Service has a responsibility for the monitoring of water quality in PJT. The laboratory of PJT in Mojokarto which is in charge of the sampling and analysis of water belongs to the sub division of D/S I/2 of PJT. The data tested at the laboratory are send to the Bureau of Program & Control through the division of D/S Water Service, and are compiled there. Total coordination of water quality monitoring is being made by the Bureau of Research & Development and Quality Management Unit of PJT.

As of 1997, there are 14 staff in the laboratory of PJT in Mojokarto, and 5 staff in PJT head office for coordinating and reporting. Detailed staffing are as follows :

- Laboratory	Analysts	: 7
	Sampling staff and Drivers	: 5
	Administrators	: 2
- PJT head office	Coordinators	: 2
	Reporter	: 1
	Other staff	: 2

(b) Monitoring of PROKASIH

KPPPLH has been established in accordance with the Decree of the Governor of the Province of East Java No.35, 1993, in order to enhance the implementation of control and overcome environmental pollution in East Java. To ensure smooth implementation of KPPPLH's activities, 4 work teams has been organized as follows :

- Work Team for Clean River Program (PROKASIH)

- Work Team for Clean City (ADIPURA)
- Work Team for Controlling and Overcoming Domestic Waste Pollution (PPPLD)
- Work Team for Controlling and Overcoming Industrial Waste Pollution (PPPLI)

Monitoring of river water and industrial waste water under PROKASIH is implemented by the work team of PROKASIH consists of BBLH, DPU Pengairan, PJT, PBS, BKPMD, BAPEDA, Dinas Kesehatan (DKES), DPU cipta Karya, BPPI and BTKL.

(c) Monitoring by Kanwil PU

The laboratory of Kanwil PU consists of 3 sections, water quality test, soil test and raw building material test. As of 1997, staff for water quality test are 8 among total staff of 45 in the laboratory.

(3) Present state of laboratories

There are 4 accredited laboratories in the Brantas river basin, that is BTKL, the Laboratory of Kanwil PU, BPPI and the Health Laboratory Center (HLC), which have a certification from BAPEDAL. The accredited laboratories from BAPEDAL are permitted to analyze the samples of PROKASIH. Thus, the samples of PROKASIH are analyzed by BTKL, the laboratory of Kanwil PU and BPPI.

Up to now, although the laboratory of PJT has had a certification from the Minister of Public Works since 1993, a certification from BAPEDAL has not been published yet. The laboratory is taking proceedings for obtaining the certification and is planning expansion and/or enhancement of the facilities and staff.

(4) Annual O&M cost for monitoring

(a) Monitoring by PJT

Annual costs for water quality monitoring of PJT in 1996 are about 75 millions Rp./year for O&M (direct expenses) and 78 millions Rp./year for personnel expenses. O&M costs include sampling, analysis and reporting. These costs are imposed on the budget of PJT.

(b) Monitoring by PROKASIH

The costs of implementing of PROKASIH are imposed on the budget of regional income and expenses of the East Java province and the budget of related institutions. The budget for PROKASIH can be seen in the annual report of PROKASIH as shown in Table A3-3, but they are not all for the Brantas river basin. The budget includes the costs for administration, sampling from the rivers and industries, laboratory analysis, training of staff, data arrangement and examination, and supports for river cleaning activities, river bank ordering, catchment area greening.

(c) Monitoring by Kanwil PU

Annual budget of the laboratory of Kanwil PU is about 10 millions Rp./year. Among them, 3 millions Rp./year is allotted to monitor water quality. In addition, the laboratory is earning analysis charge for private water samples, about 40 or 60 thousand Rp. per sample. The analysis charges paid by clients are pooled in the Kas Negara in JKT at once. The pooled money is distributed to the laboratory on yearly basis. This kind of system can be seen for BTKL.

2 Present Condition of Water Quality

2.1 Profiles of Water Quality

The condition of water in the Brantas river basin varies with seasons and locations. In general, the rivers have a high pollution assimilation capacity during the rainy season, due solely to the higher water flow rate and dilution effect. However, a tendency to decline on water quality during rainy season can be seen in the Brantas river basin. The profiles of water quality in the rivers, reservoirs and irrigation canals are summarized below.

(1) Water quality in the rivers

(a) Seasonal variation

As typical of rivers in tropical regions, the Brantas river is very silty during rainy season which accounts for 6 months of the year, primarily due to the high erosion in the deforested upper catchment areas. This together with domestic solid waste thrown in and around the rivers and sludge from the industries, often fiber from paper mills, result in a very high solids load in the rivers. The content of SS during rainy season are exceptionally high with ranges from 70 to 500 mg/l approximately comparing with that of dry season ranging from 20 to 150 mg/l. Values of organic pollutants and nutrients represented by BOD, T-N, T-P are also higher than these of during the dry season.

During the dry season, when the dilution effect of monsoonal water flows does not occur, a very poor water quality as indicated by standard parameters of organic pollutant such as BOD and so on can be seen for the most part of the rivers, in spite of relatively low values compared with during rainy season. BOD is ranging from 5 to 12 mg/l in terms of 5 years average. It is for this reason that the low flow conditions combined with the high pollution loads from industries and domestic sewage is leading to that the rivers are overloaded with soluble and insoluble organic pollutants.

On the other hand, the water quality at the beginning of rainy season which accounts for 3 months of the year, from December to February, shows the highest value of both organic and inorganic parameters. Values of BOD and SS are ranging from 6 to 15 mg/l, and from 70 to 500 mg/l in terms of 5 years average respectively, often more than 1,000mg/l of SS.

These figures shown at the beginning of rainy season are of such high that the conclusion can be reached is that the accumulated sediments, domestic waste, sludge and other soluble and insoluble pollutants during the dry season, together with the highly polluted water from drains and irrigation canals, are washed out from the upper catchment areas. To put the matter simply, a "flow-out ratio" which is a percentage of pollution load entering the river streams from the catchment area, is high at the time of rains. It can be called a "washout effect".

The seasonal variation represented by BOD and SS in terms of 5 years average from PJT's data can be seen in Figure A3-3.

(b) Geographical distribution

The Surabaya river is one of the most contaminated river in the Brantas river basin by organic pollutant, with always high BOD values of 10 to 20 mg/l. In particular, the section of the Surabaya river running parallel to the Mastrip road is heavily contaminated largely due to the pollution loads from about 10 kilometers intensely industrialized strip. The next worst stream is upstream of the Brantas river, near Malang city, with 8 to 15 mg/l of BOD.

By seeing the present geographical distribution figure of BOD and SS as shown in Figure A3-3, it is likely that the dams arranged consecutively in the upstream of the Brantas river would be playing a certain role on retrival in water quality with a self-purifying function of the rivers. This is mainly because SS contains a rich organic components would be settled during a storage period. This subject deserves more than a passing notice.

(2) Water quality in the reservoirs

The reservoirs being monitored periodically by PJT are that of the Sengguruh dam, the Sutami dam, the Wlingi dam, the Lodoyo dam and the Bening dam. Judging from the monitoring data, seasonal variation of the each reservoir is not clear compared with that of the rivers, especially in the Sutami dam with ranges from 8 to 12 mg/l of COD, and 15 to 105 mg/l of SS.

On the other hand, the Sengguruh dam has the most contaminated reservoir among them, with relatively high values of 14.1 mg/l of COD, 0.29 mg/l of T-P, 0.42 mg/l of T-N in terms of 5 years average. The main reason is that pollution load is flowing into the reservoir from upstream cities and villages, mainly Malang city, and paper mills and tapioca factories along the Lesti river and the Juwok river. The pollution loads from the paper mill, PT. Eka Mas Fortuna, located near the reservoir, can be estimated from the PJT's data that they are approximately 9,000 kg/day of COD, 2.8 kg/day of T-P, 6.3 kg/day of T-N in 1996. In addition, it is noted that the deterioration of water quality in the reservoir could be indicated indirectly by thick growth of water hyacinth in and around the reservoir.

In order to grasp water quality in the reservoirs including that are not monitored by PJT, and in the rivers flowing into the reservoirs, water quality tests were made by the Study Team with PJT, on August 6th and 7th in 1997. In addition to the routine parameters, transparency in the reservoirs was measured by means of a secchi disk and COD and phosphorous phosphate (PO4-P) were analyzed by using a handy instrument, the Kyoritsu Chemocal-Check Lab.,Corp. COD measured by the handy instrument is a potassium permanganate (KMnO4) consumed differing from method by PJT. The results of water quality test are shown in Table A3-5.

This is an important to stress that water quality in the New Lengkong Dam reservoir is a serious condition largely due to the waste water being discharged from the alcohol industry, PD.Aneka Kimia. Color of water in the reservoir is changed into reddish brown and offensive odor stinks around the dam, especially during the dry season. The pollution load flowing into the reservoir from the alcohol industry are approximately 600 kg/day of BOD, 1,500 kg/day of COD. The water quality in the reservoir monitored by PJT are ranging from 5.6 to 63.2

mg/l of BOD, from 13.7 to 128.9 mg/l of COD on monthly averages, from August in 1996 to July in 1997.

(3) Water quality in the irrigation canals

There are not more than 5 water quality monitoring points in the irrigation canals in the Brantas river basin. The points monitored under PROKASIH are located in the Mangetan canal and the Pelayaran canal. The water quality in these irrigation canals in 1996/97 are ranging from 2.0 to 48.0 mg/l of BOD in the Pelayaran canal, from 2.1 to 8.6 mg/l of BOD in the Mangetan canal.

In order to grasp water quality in the irrigation canals, the Study Team with PJT made additional water quality tests mainly focusing on the canals in the Brantas Irrigation Delta, on August 15th and 16th in 1997. The reasons why these points were selected that there were 4 intakes of PDAM WSTPs along the canals and many brackish fishery ponds downstream of the Delta. The points tested and result of tests are in Table A3-6.

2.2 Water Quality Standard

Official recognition of an environmental issue in Indonesia came in 1982 with the ratification of the basic Environmental Law. This law was to serve as the foundation of environmental policy making. At the national level, the water quality standards have been prepared by the Dep.KES and the Dep.PU. In addition, in the field at the provincial level, the standards are provided through the Provincial Government.

The ambient water quality standards of the East Java province have been published by the Governor, the Head of the Regional Government of East Java province as the decree of the Governor of East Java No.413/1987 dated 5th December, 1987. The water quality standards have been established with emphasis on water quality and its suitable for specific water utilization purposes. According to the functions, water is classified as follows.

- Class A : water which can be used directly as drinking water without treatment
- Class B : water which can be used as raw water for drinking and other household necessities after treatment
- Class C : water which can be used for fishery or husbandry purposes
- Class D : water which can be used for irrigation, industries, hydropower plants and municipal water supply services
- Class E : water which cannot be used for the purposes in group A, B, C and D

The standards consist of group of parameters such as physical, chemical, microbiological and radio-activity parameters as allowable limits. The standards are set for each of the categories as given in Table A3-7.

2.3 Evaluation of Present Water Quality

(1) Water quality in the rivers

According to the functions of water quality standards of the East Java province, the rivers have been classified as follows :

- Class B : The Brantas river (from confluence with the Widas river to bifurcation with the Surabaya and the Porong rivers)

  The Surabaya river

  The Porong river (from the New Lengkong dam to bifurcation with the Bangil Tak spill way)
- Class C : Other remaining stretches of the Brantas river and its main tributaries

As the result of comparison between the river water quality and the standards, to say the least of it, most of the parameters indicating organic matters and nutrients in the rivers such as BOD, COD, NH_4, NO_2 and so on are exceeding the standards for the most part of the Brantas river and its tributaries during the year. In particular, near the intake of PDAM WSTPs, Karangpilang and Ngagel, water quality are serious condition from a viewpoint of raw water for drinking.

With regard to heavy metals and other harmful substances, judging from the data monitored by Kanwil PU, the water quality levels of them does not become a subject of discussion at present. Microbiological parameters such as most probable number of coliform group and fecal coliform group, however, are a most high. This subject will be considered in the study of pollution control from domestic sewage.

(2) Water quality in the reservoirs

Although a spotlight has not been focused on an eutrophication phenomenon in the reservoirs yet in the Brantas river basin, it is certain that an eutrophication is in progress with increasing nutrients flowing into the water body in the reservoirs. The obvious indications of which is observed on the high value of phosphorus and low transparency.

The potential of an eutrophication normally depends on the inflow of nutrients, i.e. total phosphorus (T-P) and characteristics of the reservoir such as a retention time. Therefore, preliminary assessment was made by using Vollenweider Model given by the following equation :

$$Lc=[Pc]\,(Zx@+ZxVp)$$

where :

Lc ($gP/m^2 \cdot yr$)	: Annual phosphate surface load,
Pc (g/m^3)	: Concentration of total phosphate of inflow,
Z (m)	: Average depth of the reservoir, given by V/A,
V (m^3)	: Active storage volume,

A (m^2)	: Surface area of the reservoir,
@ (times/yr)	: Retention time, given by Q/V,
Q (m^3/yr)	: Annual inflow to the reservoir,
Vp (m)	: Sedimantation velocity coefficient, normally given by 10/Z.

For the assessment, the Sengguruh, the Sutami, the Lahor, the Wlingi and the Selorejo dams are selected in view of the present situation and water uses, such as a potential of nutrients inflow into the reservoirs, and recreational and aesthetic uses.

The result of plotting the estimated ranges on Vollenweider Model figure as shown in Figure A3-4 reveals that the studied reservoirs are likely eutrophicated already. Thus, the attention should be paid that some effects on uses of water and on operation of reservoirs would be caused by the exceeding eutrophication.

(3) Water quality in the irrigation canals

According to the tested water quality data by the Study Team with PJT, BOD concentrations at the intakes of PDAM are 12.9mg/l at Tawangsari, 12.1mg/l at Tambak Sumur, 17.6mg/l at Pepe, 9.3mg/l at Porong. They are not considered to be in the acceptable levels as a source of raw water for WSTP.

A single sample and measurement taken at a given moment of time, however, cannot be taken as representative of the real water quality over a longer time period. It is common that drastic changes of water flow regime would be happened due to the operation manner of irrigation weirs and/or sluices. Thus, it is recommended that the water quality tests in the irrigation canals should be implemented continuously.

3 Existing Program and Plan

(1) PROKASIH

As of 1997, PROKASIH is going on by the local governments under BAPEDAL for specified 40 river systems in 17 provinces in order to improve river water quality by means of decreasing pollution load entering the rivers and increasing the assimilative capacity of the rivers. The main objectives of PROKASIH are to secure the river environment for sanitation and human welfare.

PROKASIH in East Java province has been implemented since 1989. The program is being implemented for 2 river basins including 5 rivers in the Brantas river basin, firstly focusing on point-sources such as industrial waste water. The program includes monitoring of waste water quality and quantity from factories and provides instructions to the factories to take appropriate countermeasures to decrease pollution load to the rivers.

As a result of 8 years implementation of PROKASIH, pollution loads has been decreased into the rivers through the annual reports of monitoring for river water and industrial waste water. Major activities of PROKASIH consist of :

- development of masterplan on control for the Brantas river basin,
- updating existing regulations and establishment of regulations,
- establishment of KPPPLH,
- promotion of public participation in river cleaning activities.

(2) Water Quality Monitoring, Pollution Control System (WQMPCS)

PKB and DGWRD have implemented the technical management projects for water quality monitoring and pollution control in the whole Brantas basin under two successive grant from French Government, between 1986 and 1989. These projects are commonly called BRANTAS I (June 1986 - May 1988) and BRANTAS II (June 1988 - May 1989) Projects, which consist of 5 stages of implementation.

Under the implementation since 1986, the Water Quality Monitoring, Pollution Control System (WQMPCS) had been set up at PKB, whose system was transferred to PJT after establishment in 1990. Based upon the run of the system, PKB established "A Water Quality Monitoring and Pollution Control Program for Brantas River Basin Master Plan" in 1989.

As a continuation, the implementation of BRANTAS III started, consisting of a year study called the first stage of BRANTAS III and two years study called the second stage of BRANTAS III. The first stage regards technical matters and the second one administrative matters. The scope of works for the first stage of BRANTAS III are summarized as follows :

- Additional development of WQMPCS
- Transfer of know-how in the operation and maintenance of WQMPCS

- Training of technical personnel based on technical and decision issues related to the operation of WQMPCS
- Review, update and prepare recommendation concerning a pollution charge system for the Brantas river basin

4 Existing Pollution Sources

(1) Domestic waste water

Domestic waste water is one of the important source of organic materials, nutrients and microbiological water pollution. The rapid population development and urbanization caused concentrated settlement especially in urban area, such as Surabaya with 8,371 inhabitants/km^2 of population density in 1994, Malang with 5,902 inhabitants/km^2 and other Kotamadya. The amount of pollution load from the densely populated areas is more than that of assimilative capacity in the rivers during the dry season. This condition has not been handled yet sufficiently.

In semi-urban and rural areas, where infrastructure is rarely as well developed as in urban area, sanitation facilities are usually insufficiency and less maintained, if any. The lack of effective measures in small towns and villages also threatens surface water for domestic uses.

As of 1994, population on the whole Brantas river basin is estimated at about 11 millions without taking into account of the some edges of the administrative district. Urban population in terms of that of Kotamadya for 25% of the entire population in the Brantas river basin. Domestic pollution load produced can be estimated by multiplying domestic pollutant load per capita by the population of the area. Total domestic pollution load being produced is about 380 t/day of BOD on the whole Brantas river basin.

(2) Industrial waste water

The development of economic will bring industrial development, which is also in progress in the Brantas river basin as well as in Indonesia. The number of industries are increasing year by year, from 373,553 to 489,263 over a period of 1980/81 to 1995/96, in the East Java province (East Java in Figures 1995). The industries can be classified 2 categories, large & medium scale and small scale, based on their investment cost. As of 1995/96, percentages of large & medium scale industries are 1.9% in terms of number of establishments, 38.3% in terms of number of workers, in the East Java province. As for sub sector, industries are divided into basic metal and chemical industries, agro-industries and others.

A list of industries in the Brantas river basin prepared based on the result of statistical survey in 1994 has bee provided by PJT. The list contains 1,054 industries with their address, main product and number of employee. It is realized that not all of 1,054 industries directly discharges their effluents into the rivers. Some of their effluents, mostly sugar cane factories, are discharged into the irrigation canals (see Table A3-2) or into the sea.

Based on the Brantas III Project, the main polluting industry activities in the Brantas river basin can be clustered as follows :

- Pulp and paper
- Sugar (sugar from cane) factory
- Chemistry (including alcohol distillery)

- Agriculture and derivatives
- Textile industry
- Oil and detergent (including soap making)
- Food industry
- Planting and metallurgy industry

As far as pollution load regarding BOD being produced at each sit of industries, following industries are high producers, i.e. yeast and derivative, sugar from cane, paper production from pulp, starch or sugar from tapioca. Taking into account of number of sites too, the top 2 categories producing BOD are yeast and derivatives (5 factories), and sugar (10 factories). Total BOD produced from top 2 categories are about 158 t/day, 128 t/d, respectively.

The geographic area of Surabaya is heavily industrialized due to the availability of river water and of labor, and its proximity to the port and toll road and to Surabaya itself. Number of industries at each category in Surabaya municipality are 81 of metal, 10 of chemical, 742 of various industries and 9,845 of small scale industries in 1995/96 (Surabaya in Figures 1995). In particular, the strip of land along the Mastrip road is one of the most intensely industrialized areas in the Brantas river basin, which accommodates more than 60 operating industries. As the result of waste water entering the Surabaya river from them, with about 108 kg/day of BOD, water quality is being deteriorated.

In order to confirm the pollutant load being produced from the industries, questionnaire and/or field surveys were implemented by the Study Team. The surveys were focused on production process, water quality and quantity of waste water, waste water treatment plant and its performance. The water quality tests were made by the Study Team with PJT at the same time with the surveys. The samples were taken at the intakes and outlets of treatment plants, i.e. before treatment and after treatment, to grasp performance of the plants. The result of the surveys are summarized in Table A3-8.

(3) Agricultural sources

Although the return flow to the rivers from the irrigated areas is often nil especially during the dry season, this sector is one of important pollution source of the rivers and reservoirs through fertilizer and agrochemical uses. Pollutant from livestock, such as houses, cows, carabaos and pigs, are considered to be playing a certain role in the river water pollution too.

The pollution load being brought from livestock would be roughly estimated at 2,500 t/day of BOD by multiplying population of livestock by pollution load per head of livestock in Japan, including that from livestock houses.

(4) Other sources

Although ADIPURA (Clean City) is implemented by each local government (Tingkat II) under the direction of KPPPLH and BAPEDAL, the extent of garbage collection manner and capacity seems not sufficient at present. Uncontrolled solid waste disposal and dumping of garbage can be seen in and around the rivers. And seepage from improperly stored materials and poorly maintained storage of waste can not be ignored. Thus, there is no doubt that a relatively large amount of organic pollutant from solid waste are also deteriorating the river water. However, there is no useful data to estimate degree of role of them.

In addition, other pollutant load flowing into the river streams can be considered. It is called "natural source" which is mainly brought by forest, rainfall and so on. The pollutant load brought from natural source would be roughly estimated at 100 t/day of BOD by using pollutant load unit in Japan.

5 Domestic Waste Water Control and Treatment System

5.1 Present System

(1) Domestic effluent standard

The effluent standards for hotels and hospitals have been issued through Ministerial Decree No: KEP-52, 58/MENLH/10/1995.

The Provincial Government of East Java has published the regional industry or other businesses effluent standard, "Decree on Quality Standard of Waste Water for Industry or Other Businesses in East Java", based on the Govemor's Decree No.136/1994 dated 21st November, 1994, which replace the No.414/1987 on effluent standards of waste water. The Decree is applicable to not only industry but also to economic activities producing waste water. The standards are classified into 4 categories according to discharge places, classification of water. Limits or values of substance or pollutant are stipulated in the standard.

(2) Sanitation facilities

(a) Black water

Sanitation facilities in the Brantas river basin can be classified into 4 main groups. The one is a private toilet (in house toilet), that is on-site facility. There are other 2 kinds of facilities, they are shared (communal) and public sanitation facilities, sometimes called semi-off-site facility. The shared facilities are named "Jamban-Keluarga" or "MCK-Keluarga", which are usually used by a few families. The public facilities are named "Jamban-Jamak" or "MCK-Umum", which are located near a market or a bus terminal. MCK is short for "Mandi, Cuci, Kakus", i.e. bath room, washing room and toilet. Percentage of household by types of sanitation facilities can be available in the Statistic Indonesia. According to the Statistic, type of sanitation facilities in the East Java province are as follows :

Unit : %

Years/Types	Private	Shared	Public	Others
1994	36.6	12.2	2.1	49.0
1995	42.8	14.7	5.8	37.0

Source : Statistic Indonesia 1995

The Brantas III Project shows municipal sanitation levels in the Brantas river basin. Among Kotamadya in the basin, the best equipped is Mojokerto with about 88% of the population provided with sanitary facilities, but the least equipped is Malang with about 55%. On average in urban area, about 70 -80 % of the inhabitants are served, but the remaining 20-30 % are not. Above all, even if in urban area, it is noted that "open air defecation" can be seen in and around the river streams. There is a habit of residence to discharge their waste directly to the river streams, that is classified as others.

A leaching pit connecting with pour-flush toilet directly or by way of septic tank are common sanitation facility for treatment of human waste water, known as "black water". Normally, the black water percolates through underground via a leaching pit. The residue of the pit and/or tank, namely "septage", is collected on about 5 or 10 yearly basis by means of a vacuum truck (a septage hauling truck). However, because of these relatively low frequency of desludging, the pit and/or tank are apt to be clogged by remaining sludge. Consequently, "black water" overflowed from clogged pit and/or tank enters the drains, often open sewage drains, or the rivers.

(b) Gray water

As for another kind of living waste water known as "gray water", which is mainly from washing, kitchen, bashing, sometimes including urine, no treatment facility exists in or out each house at all. Most of gray water goes to the drains or the rivers directly.

(3) Night soil treatment plant

A centralized waste water treatment plant for the domestic waste water like a sewage system does not exist in the Brantas river basin. The only existing off-site type of treatment system concerning domestic waste water is the plant for treating night soil, "septage", located on Surabaya, Keputih Sukolio nearby the final disposal landfill site of solid waste.

An oxidation ditch with clarifier tank and sludge sump is used for the night soil treatment with capacity of $300m^3$/day, but about $400m^3$/day of night soil is being brought into the plant at present. BOD load flowing into the plant is about 2,400kg/day, SS is about 6,000kg/day. In the long term, the proposed night soil treatment plant is expected to be able to treat $400m^3$/day of night soil.

5.2 Plans

(1) Sewerage and Sanitation Development Program for the City of Surabaya (Surabaya SSDP)

(a) Project features

The situation poses specific problems concerning sewerage and sanitation in the region of Surabaya, with the densest urban and industrial development in the Brantas river basin. To cope with this situation, studies have been carried out by PT.INDULEXCO in association with PT.Mott MacDonald under the Healthy Municipal Environment Project (PPLP).

According to the information from PPLP, an "imhoff tank" has been proposed as a modular of sanitation facility for the short term plan. An imhoff tank is similar to a septic tank, which consists of a two-story tank in which sedimentation is accomplished in the upper compartment and digestion of the settled solids is accomplished in the lower compartment. An improvement of existing drains into sewer culverts by covering them up has been considered too. For the long term plan until 2020, a construction of centralized treatment system of domestic waste water, with some technical alternatives such as conventional sewer, shallow sewer and small bore sewer, has been proposed. Area will be served with sewage works is around the Mas river and the Wonokromo river where is the high densely populated area with more than 15 thousand inhabitants / km^2 of population density in Surabaya city. Start of the project is scheduled for 2000 in the study.

(b) Cost estimate

Up to now, 3 scenarios based on annual investment cost are being considered on a centralized treatment system as shown below :

Scenarios	Annual Investment Cost (Billion Rp./ Year)	Sewered Area in 2020 (ha)	Sewered Population in 2020 (inhabitants)
I	6-7	2,130	620,800
II	8-9	2,590	902,200
III	12-13	4,030	1,210,400

Source : PPLP (Healthy Municipal Environment Project)

Besides, in case of scenario III which is the highest investment case, the total estimated cost to construct the facilities (not included land acquisition cost) are as follows :

- Sewer pipes 66 billion Rp.
- Final sewage treatment plant 243 billion Rp.
- Tanks (imhoff tanks) 155 million Rp./ 1,000 inhabitants

(2) REPELITA VI

According to the Sixth Five Year Development Plan in Indonesia, REPELITA VI with target years between 1994/95 and 1998/99, the installation of waste water treatment or sanitation facilities will be made in 9 metropolitan and big cities, 200 medium-sized and small cities, and 7,000 villages serving 13 million urban inhabitants and 4 million rural inhabitants. Target levels on percentage of population served with sanitation facilities can be seen in the sanitary sector report of REPELITA VI as shown below :

Regions / System	On-site	Off-site	Present percentage
Metropolitan and big cities	60 %	Sewerage : 10 % Sewage drain: 15 %	55 %
Medium cities	60 %	Sewerage : 5 % Sewage drain: 10 %	45 %
Small cities	70 %	-	45 %
Rural areas (Villages)	60 %	-	40 %

Source : Sector report of REPELITA VI

6 Industrial Waste Water Control and Treatment System

6.1 Present System

(1) Industrial effluent standard

The effluent standards for industries were issued through Ministerial Decree No: KEP-51/MENLH/10/1995, which replace the KEP-03/MENLH/II/1991 on effluent standards for existing operations.

As mentioned in 5, the East Java province has published the effluent standards. The conditions of waste water indicated by the volume, concentration and pollution load for 32 categorized industries are stipulated for the industries. It should be noted that pollution loads are defined by the amount of pollutant weigh produced by every weight or production volume, or every weight usage volume of raw material. The standards are also applicable to industrial estate and centralized waste water treatment plant. The extracted effluent standards are summarized in Table A3-9.

According to the information from DPRIND, the standards are being reviewed and will be revised before long, especially for sugar factories.

(2) Waste water audit of industries

The audit is implemented for the industries which are discharging a high pollution load. The main aim of the audit is to obtain an accurate assessment of the quantity and quality of waste water being produced in the area and of production process. Usually, the audit is implemented in about 4 or 5 consecutive days by PPPLI under KPPPLH. As a result of the audit, some instructions from the view point of reduction of pollution load will be provided by PPPLI. If the industry does not concede the instruction, a suspension of discharge of waste water would be made by PPPLI under KPPPLH.

(3) On-site waste water treatment plants

All "priority industries" of PROKASIH have their own waste water treatment plant, i.e. on-site waste water treatment plant, respectively. Usually, these treatment plants were designed by consultants and/or BPPI. Designed treatment plants were examined by PPPLI under KPPPLH. Industries can construct the plants after the permission from KPPPLH.

As the result of hearings and/or questionnaire surveys by the Study Team, effective treatment plants were observed at some industries. For example, chemical coagulation or flocculation followed by physical clarification, and aerobic biological treatment process (activated sludge system, aerated lagoon) were observed.

However, some plants are not adequate to produce effluent of acceptable quality because of rudimentary treatment (sedimentation pond only or that with floating aerators) or that they are not being operated correctly. This condition would be worse by the old constructed industries. Some industries has been built years ago when the river water pollution had not yet become a serious problem, so they did not realize the necessity of a waste water treatment.

According to the information from DPRIND, about 45% among the priority industries does not meet the industrial effluent standards in the Brantas river basin, as of 1996.

As for the sludge produced in the waste water treatment process, a band or belt filter press or drying bed is used for the handling it. Some industries are selling and/or handing over the sludge for a raw material of egg cases, roofing tiles, ground compacting and so on.

On the other hand, most of industries which are not included in the priority industry dose not have an efficient waste water treatment plant except industries included in centralized treatment facilities. Even if the pollutant load from these each industry is lower than that from the priority industries, the waste water is discharged into the rivers, drains and irrigation canals without any proper primary treatment.

(4) Off-site waste water treatment plants

Existing off-site type waste water treatment plants for the industrial waste water are located on Surabaya, Sidoarjo and Malang.

The exclusive industrial district in Surabaya, PT.SIER (Surabaya Industrial Estate Rungkut), containing some manufacturing industries has a centralized waste water treatment plant. The oxidation ditch is installed for waste water treatment with capacity of 7,500m^3/day, but about 9,000m^3/day of waste water is being produced actually. BOD load of waste water flowing into the plant is about 5,400kg/day, after treatment, it is about 900kg/day. The effluent is being discharged into the Tambak Oso river and finally into the sea.

The other off-site type waste water treatment plants in Sidoarjo and Malang are for the small scale factories. The plant in Sidoarjo is constructed at the expense of DPRIND including pipes. O&M of the plant is being made by the industries. However, O&M cost is little, because the plant is so designed that the waste water can flow by itself by gravity in plant as well as in pipes.

Name (Location)	Number of factories	Products	Capacity (m3/day)	Method of Treatment	Water Quality (BOD:mg/l)	Constriction Cost (Rp.)
Gondamglega (Malang)	8-10	Tofu (bean curd)	8	-	In : - Out : 400	12 millions
Sepande (Sidoarjo)	32	Tempe (fermented bean curd)	60	UASB	In : 3,000 Out : 100	40 millions

Note : UASB means Upflow Anaerobic Sludge Blanket
Source : DPRIND

6.2 Plans

(1) Centralized waste water treatment plant along the Surabaya river

(a) Project features

The water quality of the Surabaya river deteriorates largely due to pollution load from 10 kilometer heavily industrialized section of the Mastrip road running parallel to the Surabaya river, where located upstream of intake of Karangpilang PDAM WSTP. To initiate action to alleviate the water contamination cased by this region, a centralized waste water treatment plant to accept and treat waste water from these more than 60 industries has been studied by Bukit Jaya Abadi (BJA) and Environmental Solutions International Ltd. (ESI) consortium with assistance from PJT and PDAM Surabaya.

The proposed facility is to accept not only industrial waste water but also domestic septage. The final treatment plant will be located near Karangpilang PDAM WSTP with capacity of 115,000 m3/day in total. The proposed treatment method of waste water is a physical and chemical treatment, such as conventional clalifier, followed by an activated sludge process, sequencing batch reactor (SBR). Discharge point of treated water will be located downstream of the intake of Karangpilang PDAM WSTP with about 20 mg/l of BOD.

(b) Cost estimate

The capital and O&M costs of the plant has been estimated on the two options, i.e. a full capacity plant or a staged approach one. The estimated costs including loan repayments for a full capacity plant are tabulated below :

Items	Piping Network (million US $)	Treatment Plant (million US $)
Total capital	11.4	24.2
Annual O&M cost	1.4	7.4

Source : F/S report of Unit Pengolah Limbah Komunal (UPLK)

(2) Pollution charge system

A system of pollution charge as an economic approach of pollution control has been proposed by PJT in accordance with related agencies. Participant agencies in this system will be PJT, DPRIND, Dispenda, BAPEDA and so on. The factors being proposed in this system are volume of waste water, tariffs based on concentration and pollution load, river coefficient determined by assimilation capacity, and administration cost.

According to the information from BBLH, a simulation of the system will be made soon for the Surabaya river. These kinds of systems are being considered in each provinces in Indonesia and presentation of the result of simulations from the each province to BAPEDAL will be done before long. The best system of pollution charge will be selected by BAPEDAL.

(3) Others

There is not other concrete plan for the waste water treatment of the industries. But an establishment of new organization for the small scale factories is being considered by DPRIND and PPPLI.

7 Water Quality in 2020 during the Dry Season

During the dry season, the low flow conditions combined with the high pollution load leads to a very poor water quality. The rivers overloaded with soluble and insoluble organic pollutants can be seen due to the lower water flow and dilution effect. Thus, in addition to the pollution control from industries and domestic sewage, river maintenance flow would be necessary in order to improve the water quality in the rivers. Therefore, the dry season accounting for 6 months from June to November is selected for the study at first.

7.1 Water Quality Control Points

Judging from present distribution of water quality in the rivers in terms of organic pollution, the attention should be paid on high densely populated areas, i.e. Kotamadya, which concentrates living quarters and industrial activities center together. In addition, the assessment should be made from the view point of the water uses, especially near intake of PDAM WSTPs at present and in the future.

Therefore, 7 water quality control points for the study are selected among the existing water quality monitoring points in consideration of importance of locations, such as downstream of Kotamadya and near intake of PDAM WSTPs which are taking raw water from the rivers, including that being constructed and proposed. Added to them, 3 control points near intake of PDAM WSTPs in the Mas river, the Pelayaran and the Porong canals are also selected respectively.

Selected control points are summarized as below.

No.	Location	River or Canal	Remarks
1	Bumiayu Bridge	Brantas river	Downstream of Kotamadya Malang
2	Demangan Bridge	Brantas river	Downstream of Kotamadya Blitar
3	Jogbiru Bridge	Brantas river	Downstream of Kotamadya Kedili
4	Padangan Bridge	Brantas river	Near Mojokarto WSTP (under construction)
5	Canggu Tambangan	Surabaya river	Downstream of Kotamadya Mojokerto (Near New Lengkong Dam)
6	Karangpilang	Surabaya river	Near Karangpilang WSTP (Near proposed WSTP for Gresik)
7	Ngagel	Surabaya river	Near Ngagel WSTP
8	Kayoon	Mas river	Near Kayoon WSTP
9	Pelayaran	Pelayaran canal	Near Tawangsari WSTP
10	Porong	Porong canal	Near Polong WSTP

Note: WSTP means Water Supply Treatment Plant

In fact, there are two other PDAM WSTPs which are taking the raw water from the surface water in Sidoarjo, downstream side of the Brantas Delta irrigation area. One is Tambark Sumur WSTP in Kecamatan Waru taking water from the Buntong canal. The other is Pepe WSTP in Kecamatan Sedati taking water from the Pepe canal. The water body for these intakes, however, has a high potential of contamination by human, livestock and irrigation, so that it is difficult to take proper countermeasures. Thus, it is recommended that these intakes and plants be relocated to the upstream of the Delta.

7.2 Method of Water Quality Calculation

(1) Parameter

BOD is biological oxygen demand at 5 days at 20 °C, which measures the amount of biodegradable organic matters in the water. Thus, BOD shows a self-purification function in the rivers. In addition, the use of BOD permits comparison of assessment results with international data. Therefore, BOD is used as a typical parameter of organic pollution in the rivers in this study.

(2) Study water flow

The water quality standards in the East Java province as well as that of others in Indonesia, are defined in terms of admissible and permitted concentrations. However, their definition does not specify the variability in time, frequency, variance of the parameters values during the year.

In Japan, the judgment of river water quality to the environment standard is made based on 75% probability of BOD. This method recommended now by the Japan Environment Agency is based on attaining the water quality standard at the time of low flow condition, 275-day discharge. In accordance with this method, BOD 75% value, i.e. the second highest value during the dry season, is used for the evaluation of water quality in this study.

(3) Approach

Following steps are taken for the calculation of water quality (BOD) at the each control point.

- to estimate pollution load produced at each pollution source
- to estimate pollution load enters environment in each catchment (sub-basin)
- to estimate "flow-out ratio" (percentage of pollution load entering a receiving water body in the studied river segments from each sub-basin)
- to estimate "flow-down ratio" (percentage of pollution load flowing into the control point)
- to estimate run-off pollution load at each control point

(4) Sub-basin

In the study of Brantas III project, the Brantas river basin has been divided into sub-basins (hydrological zone) in order to estimate pollution load. Since the divided sub-basin characterize water regime, it can be applied to this study. Selected sub-basins for each control point are as shown in Figure A3-4.

(5) Key indicators

(a) Domestic pollutant load

In the study of Brantas III project, domestic pollutant load per capita has been estimated by taking into account the JICA Study, the Urban Drainage and Waste Water Disposal Project in 1991 and so on. Considering these studies, domestic pollutant load per capita are set as shown in Table A3-10, for black water and gray water respectively. Increase rates of pollution load of grey water are assumed to be same as those of water consumption.

For the calculation of domestic pollution load in the future, adopted population growth rates in the Brantas river basin are 0-2.02% for municipalities and 0.36-1.93% for regencies, respectively.

(b) Industrial pollutant load

First of all, the "major producers" consisting of industries which are monitored by PJT and PROKASIH are set up by the Study Team in order to calculate pollution loads from the industries. The monitoring data by PJT and/or PROKASIH are used for the calculation. Major producers at each sub-basin are tabulated in Table A3-11.

However, effluent monitoring is currently carried out for only above industries out of more than a thousand site and a bit in the Brantas river basin. In addition, water quality and/or related data for remaining industries, such as a monetary value of the production output on site-by-site which is normally used for Japanese methodology are not available at present. In particular, such kind of data for small scale industries is inaccessible.

Accordingly, average output value per area, in the East Java province (to be used for rural area) and Surabaya area (to be used for urban area) and pollution load units based on output value are used in this study. The former is calculated by using statistic data as shown in Table A3-12. The latter is available from previous JICA Study, the Study on Urban Drainage and Waste Water Disposal Project in the City of Jakarta, 1991. The weighted average of units are taken by the Study Team as shown in Table A3-13. The output value times above unit makes pollution load produced by remaining industries at each sub-basin, large and medium scale industries, and small scale industries, respectively.

For the estimation of industrial pollution loads in the future, adopted average industrial growth rate in terms of output value in the Brantas river basin are 8.7 %. In addition to this, change of industrial formation and modernization of production process of industries for improving productivity are taken into consideration. Final increase rates used are 4.4% on average as well as that of water demand.

(c) Other sources

Pollution load from livestock could be considered in this study because some of them are living near the rivers or livestock houses. Population of livestock and pollution load per area established by the Study Team are shown in Table A3-14. Pollution load produced at each sub-basin is shown in Table A3-15.

On the other hand, it is difficult to calculate pollution loads from fields including irrigated areas, natural sources and so on, respectively. Sometimes, some of them would be negligible or almost nil during the dry season. Therefore, they are assumed by means of the mass balance study, between produced and run-out pollution loads during the rainy season, considering pollution load unit from fields in Japan. Assumed pollution load is about 100kg/km^2 on average.

(6) Flow-out ratio and flow-down ratio

In the process of calibrating the model, establishment of flow-out ratio and flow-down ratio is made. Flow-out ratio is set up by considering land uses, area of sub-basin and type of pollution sources. Flow-down ratio is set up based on the distance between sub-basins and control points. Each ratio which is set up in the model is shown in Annex.

7.3 Water Quality without Project

(1) Pollution load

Estimated pollution load being produced (including pollution load from up stream) and run out in 1994 and 2020 without project at each sub-basin of control point is as shown below :

No.	Control Points	Area of Sub-basin (km^2)	Present 1994 (t/day)	2020 Forecast (t/day)
1	Bumiayu Bridge	679	84 (8.7)	113 (18)
2	Demangan Bridge	205	270 (18)	273 (18)
3	Jogbiru Bridge	352	918 (39)	920 (39)
4	Padangan Bridge	728	118 (14)	129 (17)
5	Canggu Tambangan	15	62 (13)	39 (10)
6	Karangpilang	138	136 (23)	179 (31)
7	Ngagel	66	54 (11)	93 (31)
8	Kayoon	5.8	4.4 (1.4)	31 (7.9)
9	Pelayaran	1.5	186 (3.4)	444 (7.8)
10	Porong	0.5	0.1 (0.05)	0.2 (0.01)

Note : 1) Parenthesized numbers show run-out pollution load.
2) Details are shown in Table A3-16-19 (for domestic pollution load, present progress on installation of sanitation facilities as shown in Table A3-20).

(2) Water quality

Water quality (BOD) at each control point in 2020 when 10 year drought water flow (allowing for 8.02m^3/s from the Wonorejo Dam project) would occur, are estimated without any project (countermeasures). The estimated water quality are as follows :

No.	Location	River or Canal	Present Water Quality (mg/l)	Water Quality in 2020 (mg/l)
1	Bumiayu Bridge	Brantas river	8.4	21 (10 m³/s)
2	Demangan Bridge	Brantas river	4.3	4 (62 m³/s)
3	Jogbiru Bridge	Brantas river	7.7	7 (58 m³/s)
4	Padangan Bridge	Brantas river	7.6	5 (36 m³/s)
5	Canggu Tambangan	Surabaya river	6.1	9 (13 m³/s)
6	Karangpilang	Surabaya river	14.0	28 (13 m³/s)
7	Ngagel	Surabaya river	8.0	20 (13 m³/s)
8	Kayoon	Mas river	6.2	11 (8 m³/s)
9	Pelayaran	Pelayaran canal	12.9	29 (3 m³/s)
10	Porong	Porong canal	9.3	18 (0.06 m³/s)

Note : 1) Present water quality are BOD 75% value during the dry season in 1994 (Kayoon, Pelayaran, Porong are on August 15th and 16th ,1997).
2) Parenthesized numbers show 10 year drought water flow.

7.4 Water Quality with Projects

In order to set treatment levels of domestic and industrial waste water in 2020, the scheduled program is considered. In addition, prerequisite cases for the pollution control in view of economic level in Indonesia and new methodology proposed by the Study Team are examined.

(1) Case I : Present scheduled progress - A

(a) Domestic waste water

Based on the schemes of REPELITA VI and its percentage of increasing ratio in terms of inhabitants, percentage of sewered population in 2020 are estimated as shown below (see Table A3-20). An on-site system includes shared (communal) and public sanitation.

In Surabaya, SSDP (high investment case) is requisite for an off-site system. Comparing the plotted relationship between percentage of sewered population in urban area and GNP per capita as shown in Figure A3-6 with GRDP per capita of Indonesia (880 US $ in 1994), it could be said that sewered population in urban area would be around 20-40%. Accordingly, 30% of sewered population in Malang is considered. On the other hand, population served sewage drain only is not included in sewered population. Because pollution reduction magnitude by it is negligible small.

District	Region	On-site (%)	Off-site (%)	Remarks
Metropolitan	Surabaya	35	30	SSDP for off-site system
Big city	Malng	35	30	CWTS for off-site system
Medium cities	Blitar, Kediri, Mojokerto	75-85	5	CWTS for off-site system
Small cities	Sidoarjo, Gresik	65-80	-	
Rural areas .	Others	55-90	-	

Note : CWTS means Centralized Waste Water Treatment System

Treatment methods are supposed that a leaching pit and/or a septic tank which are common in Indonesia would be installed for on-site system and an aerated lagoon or an oxidation ditch process would be used for off-site system.

(b) Industrial waste water

With regards to industrial waste waster, it could be said that major producers would attain the effluent standards of the East Java province. Above all, it is considered that number of major producers would increase year by year, because increase in number of industries monitored and in new industries. These industries also should attain the effluent standards according to the functions. In addition, remaining industries (large and medium scale industries) could be reduced 10 % of their pollution load by means of on-site and/or off-site treatment system, such as a centralized waste water treatment system. Following assumed ratios are considered in Case - I.

- Major producers (include new industries) : Percentage of attaining Standards 100%
- Remainig industries (large and medium scale industries) : Pollution load reduction ratio 20%

As a result of interview survey by the Study Team, the proposed centralized waste water treatment along the Surabaya river is not accepted by the industries at present, because major producers have already installed their own waste water treatment facilities. Thus, it is not considered in Case I.

(2) Case II : Present scheduled progress - B

(a) Domestic waste water

The centralized waste water treatment which has been proposed along the Surabaya river is taken into consideration. As for remaining sub-basin, percentages of sewered population in 2020 are same as Case I.

(b) Industrial waste water

The centralized waste water treatment which has been proposed along the Surabaya river is taken into consideration. As for industries located remaining sub-basin, pollution load in 2020 are same as Case I.

(3) Case III : New methodology by the Study Team

(a) Domestic waste water

This case is studied on the same percent as Case-I and II. However, since a leaching pit and/or a septic tank which are common in Indonesia can treat a black water only, a facility which can treat black and gray waters should be taken into consideration. Therefore, a combined type private sewage treatment system, "Gappei Johkaso", is recommended for on-site system in order to treat both black and gray waters. The experiences in Japan show that normal optimum efficiency of a Gappei Johkaso is more than 80% removal ratio of BOD.

In Case-III, instead of a leaching pit and/or septic tank, a Gappei Johkaso is considered to be as a sanitation facility installed anew. Assumed percentages of provided population with each sanitation facility are tabulated below :

District	Reagion	On-site (%) [Sanitation]	On-site (%) [Gappei Johkaso]	Off-site (%) [Sewerage]
Metropolitan	Surabaya	25	10	30
Big city	Malang	10	35	30
Medium cities	Blitar, Kediri, Mojokerto	75-85	15-25	5
Small cities	Sidoarjo, Gresik	80-90	10	-
Rural areas	Others	55-85	-	-

(b) Industrial waste water

As seen in the effluent standards of the East Java province as well as Indonesian Government standards, a concept of Cleaner Production (CP) has been considered as the amount of pollutant weight produced by every weight or production volume and so on (see 4.6.1). This concept should be enforced more together with an economization of water uses. Besides, more stringent aerial standards would be added-on and inducement for industrial relocation to the industrial district would be recommended, especially along the Suravaya river and its tributaries, and in Malang. Among them, following actions are selected and its reduction ratios would be assumed as follows in Case III.

- Enforcement of CP (for major producers) : Pollution load reduction ratio 20%
- Stringent standard : Pollution load reduction ratio 20%

(along the Surabaya river and its tributaries, in Malang)

(c) Other sources

In the process of calibration of the model against the rainy season, some miscellaneous pollutant can be seen at some control points. Some of them, it would be caused by the organic garbage or sludge thrown into the rivers. This cloud be reduced by restricting of dumping them into the rivers. Assumed pollution reduction ratio of 10% would be considered in Case-III.

(3) Predicted water quality

The estimated pollution loads at each case are shown in Table A3-17-19 and 21.

The river water quality at each control point in 2020 when 10 year drought water flow (allowing for 8.02m³/l from the Wonorejo Dam project) would occur, are predicted if the implementation of the scheduled or the recommended projects would be carried out. The predicted water quality (BOD) are summarized as follows :

No.	Contral points	Water Quality (mg/l)		
		Case-I	Case-II	Case-III
1	Bumiayu Bridge	14	14	13
2	Demangan Bridge	2	2	7
3	Jogbiru Bridge	3	3	3
4	Padangan Bridge	5	5	5
5	Canggu Tambangan	5	5	5
6	Karangpilang	17	8	6
7	Ngagel	14	14	11
8	Kayoon	6	6	6
9	Pelayaran	7	7	6
10	Porong	14	14	13

8 Water Quality during the Rainy Season

(1) Approach of examination of water quality during the rainy season

The most of previous studies concerning water quality in the Brantas river basin has been focused on the water quality during the dry season, because the considerations concerning assimilative capacity in the rivers was required as well as pollution control. On the other hand, water quality during the rainy season should not be overlooked, because concentration of organic and inorganic parameters are higher than those of during the dry season.

In order to ascertain the reasons, following examinations were made by the Study Team. The examinations were focused on upstream area in the Brantas river basin, Bumiayu Bridge, because it is easy to specify the run-off pollution load from sub-basin.

- to estimate run-off pollution load
- to take correlation between SS and other parameters (BOD, T-P)
- to estimate run-off pollution load of each pollution source

(2) Run-off pollution load

The changes of run-off pollution loads during the year were estimates. Figure A3-7 shows seasonal variations of water flow and run-off pollution loads of BOD and SS at Bumiayu Bridge, in terms 5 years average. Correlation between BOD or SS pollution loads and water flow are taken. Taking into consideration of these figures, it is possible to build up an asuuption that SS is concerned in river water quality during the rainy season.

(3) Correlation between SS and other parameters

Correlation between SS and other parameters (BOD, T-P) during the rainy season are taken as shown in Figure A3-8. The figures showing 0.5-0.6 correlation coefficients between them could manifest above-mentioned assumption. In addition, one possibility is to assume that there is a large amount of pollution load related to soil erosion. That is to say, SS contains organic components. Another possibility is an existence of insoluble organic pollutants such as solid waste and/or sludge disposed or dumped in and around the rivers.

In particular, correlation between SS and T-P indicates that SS would contain agricultural chemicals and/or livestock excreta. Therefore, non-point source including agricultural activities is considered to play an important role on the water quality during the rainy season.

(4) Change of run-off pollution loads

In order to clarify the magnitude of each pollution source, pollution load produced at each source was calculated by means of pollution load units, domestic pollution load per capita, industrial pollution load units based on output values.

Another basic factor is run-off ratio which is a percentage of pollution load flowing into the point from source. Run-off ratio consists of flow-out and flow-down ratios, it can be obtained by multiplying them. In the process of calibrating the model, flow-out ratio is considered to be increased comparing with that of the dry season mainly due to a washout effect. Flow-down ratio is also considered to be increased together with increase in velocity of water flow during the rainy season.

In the course of examinations, setting up pollution loads from agricultural activities and non-point source could not be avoided, because even if run-off ratios related to domestic and industrial pollution loads were set up at high values such as 0.8-0.9, unidentified pollution load remained. Thus, agricultural pollution load (livestock) and non-point source were set up by using pollution load units in Japan.

The results of calculations of pollution loads produced at each source and run-off pollution loads at Bumiayu Bridge in 1994 are summarized below:

Sources/Items	Dry season (BOD t/day)		Rainy season (BOD t/day)	
	Sources	Run-off	Sources	Run-off
Domesticities	16.2	4.4	16.2	7.6
Industries	10.4	3.2	10.4	4.7
Agriculture (livestock)	21.3	0.6	21.3	13.6
Other non-point sources	36.6	1.1	36.6	30.0
Total	84.5	9.3	84.5	55.9

Note : Pollution load from fields is included in non-point sources.

(5) Recommendations on activities

Even if any doubt remains about pollution load units and run-off ratios, they do not affect the validity of the assumptions. Therefore, it seems reasonable to conclude that agricultural activities and non-point source impacts the river water quality especially during the rainy season. Thus, attention should be paid on pollution control for agriculture sources and other non-point source in addition to domestic and industrial waste water, in order to improve water quality through the year.

9 Necessity of Water Quality Management

9.1 Problems on Water Quality Management

Based on the findings from the above studies, the outstanding issues and significant focal points for formulating a water quality management system and water quality improvement plan are summarized below as problems on the present management.

(1) Fundamental problems

(a) Water quality

The river water quality in the Brantas river basin presently deteriorating especially in Malang and Surabaya areas. The water quality values exceeding the standards have been monitored during the year. The water quality in reservoir of dams is likely eutrophicated already. The water quality without project in 2020, is forecasted to exceed the target at most of control points. Total pollution loads produced in 2020 compared with 1994 will be 1.6 times for households, 2.8 times for industries. They would cause many impacts on water uses, living environment, human health, and aquatic biota. Therefore, countermeasures against these situations are required.

(b) Pollution control

At present, there is no centralized waste water treatment facility for domestic sewage in the Brantas river basin. To make matters worse, population provided with sanitation facilities is not more than 65%. Since a septic tank which is common sanitation facility in Indonesia treats black water only, most gray water is discharged into the drains or channels without treatment.

Although all priority industries have their own waste water treatment facilities, about half of them are exceeding the effluent standards because they only have a rudimentary treatment plant or they do not operate their plant correctly. In addition, most of remaining industries do not have efficient waste water treatment plants.

Furthermore, control of pollution loads from agricultural activities and other non-point sources has not been tackled yet. Therefore, an overall pollution control system should eventually be established.

(2) Technical issues

(a) Monitoring methods

Although there are many monitoring points in the Brantas river basin, monitoring frequency and items being made by PJT and/or other organizations are limited from a viewpoint of entire understanding of the river water conditions. In particular, harmful substances such as heavy metals, microbiological parameters have not been focused on the monitoring program. Little monitoring for the quality of river bottom sediment which would cause some impacts on the river water quality has been implemented.

The same instances as the rivers can be seen in the monitoring of the industrial waste water, such as dearth of timely monitoring of the amount of discharge. Therefore, the present monitoring methods, as a whole, should be revised.

(b) Facilities

There are 4 laboratories accredited by BAPEDAL in the Brantas river basin, they are all located in Surabaya. PJT also has a laboratory for water quality tests in Mojokerto. Locations of these laboratories incline toward the downstream area of the Brantas river basin. For well-timed execution of the monitoring, a laborarory should be established in the upper stream area of the Brantas river basin is recommended.

(c) Basic data

For pollution control, basic data such as pollution load units, mechanism of the water pollution in the basin and pollution sources inventory are not enough. Therefore, research and development to establish basic data, and implementation of inventory survey is required.

(3) Managerial aspects

(a) Monitoring system

The monitoring of river water quality has been conducted by PJT, Kanwil PU, and the work team of PROKASIH. The monitoring of industrial waste water has been conducted by PJT, BPPI and the work team of PROKASIH. There are many duplications among the monitoring activities. To avoid such duplications, reconstituting the present monitoring systems should be done soon.

(b) Demarcation of responsibilities

There are many agencies and organizations involved in the water quality management at present. DPU Cipta Karya is responsible for treatment of domestic waste water and installation of sanitation facilities. DPRIND is responsible for industrial pollution control. Night soil management (collection, treatment and disposal) is under the responsibility of the cleansing service at each local government. MOE and BAPEDAL are responsible for overall environmental management.

The problem is that it can not be determined clearly where the responsibility lies. In addition, there are many duplications and some shortage of tasks which are not obligated to any agency. The demarcation of their tasks are not defined clearly.

The water quality management must be integrated on the whole Brantas basin. In order to manage effectively and strategically, the line of demarcation among the agencies and organizations needs to be drawn, and a leading agency needs to be established..

(4) Problems in PJT

The Water Quality Monitoring, Pollution Control System (WQMPCS) has been set up in PJT as a foundation for water quality management in the Brantas basin. PJT, however, has no technical information exchange channels with related agencies. No feed back system of monitoring results for taking countermeasures for actual management exists. Consequently, WQMPCS dose not work well for pollution control.

In addition, up to now, the laboratory of PJT does not have a certification from BAPEDAL, mainly because of shortage of facilities and well trained staff. That is one of the reasons why the results of monitoring by PJT have not been utilized for pollution control.

Therefore, improvement in confidence of the government and related agencies, clarification of the position and responsibility of PJT concerning the water quality management is needed.

9.2 Recommendation on Water Quality Management

To cope with the such situations in the Brantas river basin, an integrated and overall water quality management is necessary. The well managed water quality as well as quantity will guarantee not only living environment, human health and aquatic biota but also the sustainable development in the basin.

10 Water Quality Improvement Plan

10.1 Basic Principles for Formulating of Water Quality Improvement Plan

(1) Characteristics

The water quality improvement plan is to clarify directions and target, formulate pollution control strategies, consolidate priorities, and allocate responsibilities. The plan is a key element of water quality management system and is defined as shown in Figure A3-9.

The plan of the Study integrates countermeasures to improve water quality in the Brantas river basin in a well organized and systematic form. It consists of pollution control activities which show long-term directions towards the year 2020 (should be picture), and action plans clarifying detailed activities to be implemented by 2004 (on the way picture).

(2) Components of water quality improvement plan

The water quality improvement plan can be broken down into three categories, such as water quality monitoring, pollution control activities of each source in that domestic, industrial, agricultural and other pollution control (on-site and off-site handling) are included, and direct purification. In addition, supporting activities to promote and accelerate implementation of the countermeasures, and research and development are also required activities.

(3) Target of water quality in 2020

To establish the target of water quality in 2020 in the Brantas river basin, following related standards, plan, and policy are taken into consideration.

(a) The Water Quality Standards in the East Java Province (see 2.1 and 2.2)

(b) Under WQMPCS, "A Water Quality Monitoring and Pollution Control Program for Brantas River Basin Master Plan" was established in 1989. In the run of this system, the river quality objectives has been established on the Brantas river basin based on the water Quality standards in the East Java province. The parameters applied were BOD, COD and others selected as representative indicators of organic matters and nutrients, and microbiological one. The proposed BOD on each class are as follows :

- Class A : less than 3 mg/l
- Class B : within 3-[6] mg/l
- Class C : within [6]-10 mg/l

*Note : [ ] are fixed by the Water Quality Standard in the East Java province

(c) According to PROKASIH 2005 Vision prepared by BAPEDAL, June 1996, the river water will be allocated in accordance with river functions based on the Water Quality Standards in the National Government as follows :

- Upper stretch of the river : Class A
- Rural area : Class B or C
- Urban area : Class B
- Lower stretch of the river : Class C

In addition to the above, for raw water of PDAM WSTP, sanitary and human welfare reasons (swimming, ablution, fishing or fish capture, sometimes domestic uses etc.), it is recommended that the present water quality objectives should be upgraded in the stretches where are classified as C, especially in Malang, Blitar, Kediri and in the Mas river.

Consequently, it seems reasonable to conclude that the target of water quality at each control point in 2020 is as given below :

- BOD : less than 6 mg/l

(4) Waste water treatment level in 2020

The water quality improvement activities should be balanced according to the main issues of the pollution sources impacting on the river water quality and to the assimilative capacity of the rivers. While, the plan is formulated based on the water quality during the dry season, in principle.

In this plan, considering the possibility of implementation of countermeasures in Indonesia, most suitable and manageable countermeasures shall be applied on each sector, depending on the technical, social, and economical aspects. Among the cases as calculated in 7.4, Case-III is most effective activities. Therefore, Case-III is adopted for formulating water quality improvement plan.

10.2 Water Quality Monitoring

(1) Objectives of water quality monitoring

Water quality monitoring is an important tool of water quality management. Water quality information provided by monitoring supports sound decision-making for water quality management at all levels of organizations. In order to establish a proper pollution control plan and program, and to take effective countermeasures, that is indispensable for grasping of important and basic data. The objectives of water quality monitoring are :

- to identify the condition of river water
- to identify and inspect waste water at each pollution source, and
- to review and evaluate countermeasures taken

(2) Necessary activities and consideration

Considering the existing management problems, the following points should be paid attention for the execution of water quality monitoring.

(a) Monitoring methods (sample collection, analytical procedures)

The existing monitoring manner is not enough to understand the river water and waste water conditions. There is considerable room for improvement in the monitoring methods. To make data more reliable and useful for management decisions and for enforcement of regulations, the following programs are recommended.

- to add monitoring points (rivers, reservoirs, irrigation canals, pollution sources)
- to add monitoring items at specific points (ex. harmful components, microbiological parameters, river bed sediment)
- to review monitoring frequency
- to review sampling manner including transportation

Proposed monitoring points in the rivers and reservoirs are shown in Figure A3-10. As for irrigation canals, periodical monitoring in the Mangetan and Porong canals should be implemented, especially near intakes of Tawangsari, Tambak Sumur, Porong WSTPs. As for pollution sources, in addition to the major producer, other industries include medium and small scale industries, agriculture and domestic waste water should be implemented.

It is noted that the amount of discharge should be monitored at the sampling time in order to evaluate magnitude of pollution load from each source. For the efficient measuring, installation of a flow gagging weir with flow rating curve, or a flow meter (current meter) at waste water outlets shall be obligated at each industry.

(b) Monitoring facilities

Laboratories

The facilities of laboratories will become scarce from a viewpoint of the future expansion of the monitoring points, items and frequency. In addition, locations of laboratories incline toward the downstream area of the Brantas river basin. Therefore, enhancement of existing laboratories and foundation of new laboratory, especially in upper stream area in the Brantas river basin is necessary for well-timed monitoring.

After the establishment of new laboratory in Malang, proposed demarcation of responsibilities of other accredited laboratories in the Brantas river basin are as follows :

Laboratories	Present monitoring locations	Proposed monitoring locations
PJT in Mojokerto	River water, Industrial waste water	*Down stream area of the Brantas river basin* River water Domestic waste water (Sewage system), Industrial waste water (major producers), Agricultural waste water (major producers)
PJT in Malang (New)	None	*Up stream area of the Brantas river basin* -ditto-
BTKL	Industrial waste water (PROKASIH), Domestic waste water	Domestic waste water (hotel, hospital, restaurant, etc.)
Kanwil PU	River water, Industrial waste water (PROKASIH),	Domestic waste water (hotel, hospital, restaurant, etc.), Industrial waste water (medium and small scale industries)
BPPI	Industrial waste water (PROKASIH)	Industrial waste water (medium and small scale industries)
HLC	Domestic waste water	Water supply, Sanitation facilities

Automatic water quality monitoring system

Automatic water quality monitoring stations which has been proposed by the Wonorejo Multipurpose Dam Construction Project will be installed in the Surabaya river and the Pelayaran canal. The proposed stations will be near intakes of PDAM Water Supply Treatment Plants (hereinafter referred to as WSTP). The system could be used for continuous monitoring and watching sudden aggravation of water quality that would be caused by illegal waste dumping and so on.

In the continuous monitoring, it is necessary to maintain the measuring instruments in the better condition. Therefore, periodic inspection and overhaul are very important. In addition, well-timed compilation and arrangement of data sent from the stations should be made. For the future, an addition of parameters such as heavy metals is recommendable for effective monitoring.

(3) Recommended monitoring procedure

For the implementation of water quality monitoring, the following activities should be conducted annually (some of them monthly or daily).

- sampling of water, measurement of related data at each sampling point
- analysis of samples

- data compilation and evaluation
- reporting and publication, and
- others (calibration, maintenance and overhaul of equipment, emergent inspection, if necessary)

In order to implement a proper and entire water quality monitoring, the system and procedure should be integrated and organized methodically. Thus, present monitoring systems should be reorganized before long.

(4) Required costs

The estimated costs (constant values as of 1996) for execution of the monitoring in 2020 are estimated as shown below (O&M cost, not include depreciation of equipment for analysis) :

- river water quality and river bed sediment: 300 million Rp./year
- domestic waste water : 50 million Rp./year
- industrial waste water : 150 million Rp./year
- agricultural waste water : 50 million Rp./year

As of 1996, about 1,100 million Rp./year is being spent for water quality monitoring (river water, industrial waste water) in the Brantas river basin. In the light of this cost, required cost for the proposed monitoring could be covered by reconstituting existing systems.

10.3 Pollution Control Activities

(1) Domestic Pollution Control

(a) Waste water treatment measures

In order to attain the target on the river water quality, countermeasures (treatment of domestic waste water) to decrease domestic pollution load are considered. In the countermeasures, improvement of sanitary conditions on the communities is also developed as well as abatement of water contamination, because sanitary conditions will be worse accordingly as population densities increase. Under such present conditions, gray water is discharged into the neighboring ditches, channels or lands without treatment.

Therefore, the following three systems are appropriate for treatment of domestic waste water.

- Centralized waste water treatment system (sewerage system) : treat both black and gray water
- On-site treatment system : treat both black and gray water
- Sanitation facility : treat black water only

On-site treatment system includes a combined type private sewage treatment system (referred to as CTPSTS), such as a "gappei johkaso" common in Japan (see Figure A3-11). This system is composed of sedimentation, contact aeration, and disinfection systems, and ranges in size from single-family unit to one that serves over 1,000 people. In this plan, two sizes of systems, a single-family (4 inhabitants) unit and multi-family unit (100 inhabitants), are set up.

With regard to commercial and institutional activities such as hotels, hospitals, public facilities and so on, the waste water shall be treated by the same systems as domestic waste water, as well as those of small scale industries. Large or medium scale industrial waste water, however, shall be treated individually or communally by appropriate treatment system, in principle.

(b) Application of waste water treatment systems

Waste water treatment level of each area is determined based on its population. In addition, attention should be paid on population density to select the economical system, because unit cost of the sewerage system varies according to magnitude of service area and its population density. Then, costs of the sewerage system and the on-site treatment system are compared.

In the comparative study, CTPSTS is considered as the on-site treatment system to treat wast water with BOD removal ratio of 80%. Conventional sewerage system consisting of house connections, reticulate collection networks with a treatment plant like an oxidation ditch is considered as sewerage system. Plotting the estimated costs as shown in Figure A3-12 reveals that the sewerage system is more economical than the on-site system in the area with population density of more than 50 inhabitants/ha.

After some modifications, the following waste water treatment systems are proposed among the above-mentioned three alternatives.

District	Region	On-site (%) [Sanitation]	On-site (%) [CTPSTS]	Off-site (%) [Sewerage]
Metropolitan	Surabaya	25	10	30
Big city	Malang	10	35	30
Medium cities	Blitar, Mojokerto, Kediri, Sidoarjo	75-85	15-25	5
Small cities	Gresik, Turunga-gung, Others	80-90	10	5
Rural areas	Others	55-85	-	-

Note : Judging from field reconnaissance by the Study team, it is necessary to install off-site waste water treatment system in Sidoarjo and Turungagung.

(c) Recommended sewerage systems

As a result of the above study, recommended sewerage systems would cover about 50 km^2, with a total sewered population of about 310,000 inhabitants in 2020. The waste water generation including domestic, commercial and institutional, and small scale industrial waste water would be estimated at 62,000 m^3/day.

A separate collection system is considered to be applied, because the monsoonal water flow could be drained mainly by the open drainage networks. On the other hand, the collection system should be considered based on the land conditions. There are densely populated areas such as "Kampung", which could not be covered by conventional system. In these areas, a shallow sewer, a small bore sewer or an interceptor system would be recommendable.

With regard to treatment plant, the systems should be compared for adaptability to overload, technology level of O&M, sludge disposal and land acquisition and so on. An oxidation ditch or an aerated lagoon system is considered to be suitable in the basin as far as land space is available. However, for the areas where available land is limited, conventional activated sludge system would be introduced.

(d) Necessary related activities

In accordance with the expansion of waste water treatment systems, sludge produced by the systems and sanitation facilities will be increased inevitably. At present, only one sludge (septage) treatment plant exists in the Brantas river basin. Therefore, the plants as well as septage hauling trucks for desludging and transportation, and final disposal sites should be prepared in advance of the waste water treatment systems.

(e) Required costs

Required costs for the waste water treatment systems including sanitation facilities are estimated by assuming full development of the facilities of each site and maximum number of sanitation facilities to be installed.

The estimated investment costs (constant values as of 1990) from unit costs prepared by the Study Team are summarized hereunder. The costs consist of one based on amount of waste water and/or one based on sewered area. These costs should be revised based on the detailed study.

- Sewerage systems : 350,000 million Rp (including SSDP)
- CTPSTS : 200,000 million Rp
- Sanitation facilities : 500,000 million Rp

(2) Industrial waste water control

(a) Waste water treatment measures

In order to attain the target on the river water quality, countermeasures (treatment of industrial waste water) to decrease industrial pollution loads are considered. In the course of establishing countermeasures, magnitude of impact, conditions of location, technology level of O&M and so on are taken into consideration.

In particular, the strip of land along the Mastrip road which is the most intensively industrialized area in the Brantas river basin. It is defined as a "hot zone" because a volley of pollution load from the industries together with other sources causes water quality deterioration and intake of PDAM WSTP locates on its downstream side.

Most small scale industries consist of home industries. Sometimes they institute a cooperative association and gather intensively, which is a common case for tofu or tempe factories. This is just like an industrial park. These small scale industries will be treated by centralized waste water treatment facilities, with economy and efficiency. In addition, the waste water from an exclusive industrial district, namely an industrial park, will be treated by centralized waste water treatment facilities too.

Therefore, the following systems are considered to be appropriate for treatment of industrial waste water (see Figure A3-13).

- on-site waste water treatment systems
- off-site waste water treatment systems

  centralized waste water treatment systems for small scale industries

  centralized waste water treatment systems for industrial parks

  centralized waste water treatment system for hot zone

In case of small scale industries which locate on areas planned to be served with sewerage systems, they will be treated by the systems, in principle.

(b) Waste water treatment level

Waste water treatment level of industries are summarized as delineated below.

- major producers : percentage of attaining the standards 100%
- remaining industries : pollution load reduction ratio 20 %
- industries in hot zone : percentage of connecting with the system 100%
- industries in industrial estates : percentage of attaining the standards 100%

In the light of magnitude of impacts on water quality by "major producers" consisting of 65 factories (as of 1997), they should meet the effluent standards of the East Java province.

(c) Recommended waste water treatment systems

The basic system selection factors are characteristics of waste water, availability of land, local environment, skilled manpower, and economics. Normally, available alternatives for the system are enormous as it encompasses both on-site based and off-site based.

In general, characteristics of industrial waste water are all in disorder. They depend on types of industries and/or production process, raw materials (processed or not) being used. The examples of grouping of industries based on the characteristics of waste water and International Standard Industrial Code (ISIC) are as follows :

- industries mainly discharging organic waste water

  ex) food, pulp and paper, textile, garment, organic chemicals, etc.

- industries mainly discharging inorganic waste water

  ex) wood, inorganic chemicals, cement, basic or fabricated metal, etc.

- industries having waste water contains harmful substances

  ex) leather tanning, metal plating, electrical machinery, etc.

Basically, biochemical treatment (aerobic and/or anaerobic treatment) is suitable for organic waste water and physical and chemical treatment is suitable for inorganic waste water and harmful substances. Typical treatment methods or combination of them which could be applied in the Brantas river basin are as follows:

- organic waste water :activated sludge process
  USAB (Upflow Anaerobic Sludge Blanket)
  RBC (Roating Biological Contactor)
  SRB (Sequencing Batch Reactor)
  oxidation pond or ditch
  areted lagoon, trickling filter
  imhoff tank, etc.
- inorganic waste water :screen, pH control (neutralization)
  coagulation sedimentation
  floatation, etc.

There are many kinds of flow routes of waste water at each factory from production process to the treatment plants or the outlets. To cope with this matter, drain systems of factories should be made corresponding to production processes and/or pollutants types or concentration levels. Appropriate drain systems could minimize the water consumption by reusing or recycling one, consequently, could reduce the amount of waste water to be treated.

(d) Necessary related activities

Similar to that of domestic waste water treatment system, sludge produced from the systems will Inevitably be increased i. At present, no appropriate sludge treatment and disposal system exists in the Brantas river basin. Therefore, the system should be developed soon.

Sludge produced at each industry should be treated on-site by means of thickening, dewatering, digestion and so on. Treated sludge should be collected to the final disposal sites. Considering the characteristics of sludge, controlled landfill site (least type, strict type) should be developed. Recyclable resources such as residue in the paper production process which can be used for raw materials of egg cases, roofing tiles and so on should be transported to next users.

(e) Required costs

To estimate required costs for waste water treatment of each industry, it is very difficult to fix uncertainties related, such as kinds of facilities which industries have, conditions of the existing facilities and so on. In this study, therefore, the costs are estimated indicatively assuming full development of the facilities of each site for the maximum number of industries to be treated.

The investment costs (constant values as of 1990) are estimated from formulas prepared by the Study Team and are summarized hereunder. Four kinds of formulas are made based on capacities and kinds of treatment level, example of the formula is shown in Figure A3-14. The costs should be revised based on the detailed audit for industries and discussion of requirements with the industries.

- major producers (all industries meet the standards) : 1,000,000 million Rp.
- remaining industries

other large and medium scale industries	:	400,000 million Rp.
small scale industries	:	80,000 million Rp.

- centralized treatment facility (hot zone) : 800,000 million Rp.
- centralized treatment facility in industrial park : already commenced

(3) Agricultural Pollution Control

Agricultural sector is one of important pollution sources of the rivers as mentioned in the previous section 4.1. Among agricultural pollution sources, pollutants from livestock such as cows, carabaos and household an important place in the river water deterioration, especially during the rainy season. Taking into consideration of distribution of sources, it is easy to specify the livestock houses as pollution sources. Thus, the waste water from livestock houses should be treated before all other agricultural pollution sources. The following activities are necessary.

- water treatment of livestock houses

  waste water treatment facilities for major producers (5 livestock houses)

  waste water treatment facilities for remaining livestock houses

In addition, pollution loads from agricultural chemicals (fertilizer, pesticides, herbicides) which would be mainly brought by soil erosion should be considered too. In general, agricultural chemicals are made to remain the soils by attaching to particles. However, once the particles are removed by erosion, soil cloud not keep the chemicals well. Consequently, the amount of chemicals used by farmers become increase. Therefore, following approaches and combination of them are necessary.

- agricultural chemicals uses control
- improvement of farming practices
  - technical approaches
    - terracing, contouring (contour farming), buffer strip cropping, mulching, storm-water retention reservoir, etc.
  - vegetative approaches
    - mixed crop system, change of cultivation patterns
    - agroforestry cultivation, etc.
- watershed management (afforestation, greening, sediment control dams, etc.)
- others (appropriate zoning, establishment of buffer zone, etc.)

(4) Other Pollution Control

At present, the extent of garbage collection and its capacity is not sufficient. Uncontrolled solid waste and sludge disposal, and dumping of garbage can be seen in and around the rivers. Besides, seepage from improperly stored materials or waste can not be ignored. Therefore, solid waste and sludge control is necessary for pollution control as well as improvement of river environment. In order to control them, solid waste (garbage) collection and disposal system should be established. The following well-organized and managed systems are required.

- domestic and industrial solid waste (garbage) collection and disposal system
- septage and sludge collection and disposal system

In addition, other pollutant load flowing into the river streams can be considered. It is called "natural source" which is mainly brought by forest, rainfall and so on. The pollution control for natural source will be implemented as watershed management, that is soil erosion control. This control activity will be made by agricultural sector.

10.4 Direct Purification

(1) River maintenance flow

The river water quality depends on assimilative capacity of the rivers and amount of pollution load. While, countermeasures should be balanced between a decrease in pollution load and an increase in assimilative capacity, especially during the dry season.

Providing required water flow for increasing the receiving stream's assimilative capacity can be made by modifying the time pattern and/or water flow locations or some combination of the two. The optimum allocation of river maintenance flow is one of water quality improvement activities.

Necessary river maintenance flow to reach the river water quality target based on the recommended program/actions is as follows :

No.	Control points	River maintenance flow (m^3/s)
1	Bumiayu Bridge	21
2	Demangan Bridge	10
3	Jogbiru Bridge	16
4	Padangan Bridge	22
5	Canggu Tambangan	10
6	Karangpilang	14
7	Ngagel	24
8	Kayoon	8
9	Pelayaran	3
10	Porong	0.1

(2) Dredging and clearing

In general, river bed sediment impacts on the river water quality, because accumulated organic and inorganic pollutants on the river bed return into the river water. Thus, in order to minimize wash-out pollution load, accumulated sediments from domestic waste and sludge should be cleared. Therefore, dredging and clearing should be made periodically.

(3) Utilization of biological purification reaction

There are other ways to purify water in and around the stream directly, such as a contact aeration process with stone beds, a soil treatment with trenches and a plant treatment. However, a biological purification in the rivers or lands in tropical regions is considered to be high compared with that of the temperate and frigid regions, because a concentration of dissolved oxygen (DO) is high for entering pollution loads, which would be brought by a lively photosynthetic activity of plankton and other phototroph, and high water temperature.

In addition to the above, water hyacinth which can be seen in the rivers and reservoirs could be used to improve water quality, because it intakes a nutrient onto its body. The experiences in Japan reveal that a removal efficiency of nutrient by water hyacinth is 1~3 g/m^2/day of total nitrogen (T-N), 0.2~0.5g/m^2/day of total phosphorus (T-P). Furthermore, water hyacinth could be used as a raw material of feed for livestock, fertilizer and bio-gass, and it could be used to treat waste water.

Therefore, they deserve full consideration for the research and development for an appropriate technology in the Barntas river basin as well as in Indonesia.

- research and development for direct purification methods

10.5 Supporting Activities

To carry though the water quality improvement plan, it is necessary to strengthen the institutions concerned. Specific urgent topics have been identified as supporting activities, which need immediate attentions. In addition, back-up projects are recommended to be initiated by beneficiaries' participation. Improvement of pollution sources could be approached by community participation through public awareness campaign or promotion activities.

To promote and/or accelerate execution of the actual projects and programs specified in the water quality improvement plan, following supporting activities should be prepared.

- Human resource development
- Research and Development
- Assistance systems (subsidy, low-interest loan, bounty, tax privilege, etc.)
- Encouragement of environmental engineering industries
- Promotion of public participation and environmental education

Detailed discussions for specified supporting activities are made in implementation program. Legislation or regulation and organization aspects which are prerequisite for the commencement of activities are discussed in each sector concerned.