V STUDY ON TECHNICAL ASPECTS OF WATER RESOURCES MANAGEMENT

V.1 Meteorology and Hydrology

V.1.1 Flood Analysis

In order to review the design flood discharge distribution recommended in the previous master plan study (Widas flood control and drainage project), rainfall data for the recent 13 years; year 1984 through 1996 are additionally included in the present study. The previous study used rainfall data for the period of 1960 through 1983. Daily rainfall data of the 23 stations shown in Figure V.1 which are available presently in PJT and have rather continuous observation period. Out of above daily rainfall data collected in the Study, annually three day rainfall which is an amount of a sequence of three days' data were selected every year. It is considered that three day rainfall could cover one flood period in the catchment of the Brantas river and the duration.

The following table shows the probable three day rainfall by Gumbel method of the New Lengkong Dam catchment, which is studied in the previous master plan study and the present study.

Return Period (Year)	Previous Study (1960~1983) (mm)	Present Study (1960~1996) (mm)
2	76	73
5	88	86
10	96	94
25	106	105
50	114	113
100	121	121

Estimated probable rainfall in the table show that the present value is almost the same as the previous study.

The recent big flood were observed in March 1984 and March 1992. The maximum discharge at Ploso station were 1,228 m^3/s and 1,078 m^3/s respectively. The discharge of 1228 m^3/s at Ploso station is less than 1,500 m^3/s of the present design flood discharge. The present design flood distribution is not changed and utilized in this study by the reasons mentioned above.

V.1.2 Estimation of the Sedimentation in the Future

The estimation of the effective storage capacity of the Sutami and Lahor reservoir towards year 2020 is required to analyze water availability during drought season. The storage in the future is estimated based on the change of sediment volume as follows:

Sutami reservoir

Year	Gross Storage (Mil.m^3)	Effective Storage (Mil.m^3)	Storage between El.260m and H.W.L (Mil.m^3)
2000	180.72	144.76	94.18
2005	176.23	141.64	93.74
2010	171.73	138.52	93.29
2015	167.24	135.40	92.85
2020	162.74	132.28	92.40

Source : Estimated by the Study Team based on the change of the sediment volume from 1987 to 1997.

Lahor reservoir

Year	Gross Storage (Mil.m^3)	Effective Storage (Mil.m^3)	Storage between El.260m and H.W.L (Mil.m^3)
2000	31.99	25.75	20.33
2005	31.09	24.95	19.62
2010	30.20	24.16	18.92
2015	29.30	23.36	18.21
2020	28.41	22.57	17.51

Source: Estimated by the Study Team based on the change of the sediment volume from the original to 1995.

Present H-V curve of the Sutami and Lahor reservoirs based on the latest survey and estimated ones in 2020 are shown in Figure V.2

V.1.3 Lowflow Analysis

(1) General

Observed discharge are affected by various river structures such as dam and barrages, intakes, sluices and so forth. In order to examine low flow balance under various conditions of demand, reservoir capacity etc., a simulated runoff (hereinafter called as "natural flow") is computed assuming no intake or supply from storage.

The New Lengkong dam site located immediately downstream of the fork of the Surabaya river and the Porong river is selected as the check point for the natural flow in the Brantas river basin.

Since almost all the tributary flow is consumed by irrigation fields in the drought season, the inflow from the tributaries where irrigation field exists to the Brantas river is very small. Since the inflow from the tributaries will not be expected for the time being, the calculation of the natural flow is limited to the main stream of the Brantas river.

(2) Natural Flow at the New Lengkong Dam

The 10-day base natural flow at the New Lengkong dam from 1977 to 1996 is calculated based on the observed discharges at the New Lengkong dam by adding the following intakes/storage/discharge :

(a) Irrigation intakes

(b) Industry intake

(c) Storage capacity of the Sutami and Lahor reservoirs

(d) Discharge to the Surabaya river (at the Mrilip gate)

The schematic diagram of the concept of natural flow calculation is illustrated in Figure V.3 in which return flow from the irrigation area is also incorporated.

(3) Drought Year

To work out available discharge during a drought season in the Brantas river basin, total discharge in drought season is analyzed and the drought season is defined as the six months from June to November in the present Study. The total natural flow at the New Lengkong dam during the drought season is compared for the late 20 years. The table shown below includes total natural flow in the drought season, the rank of the runoff in the late 20 years and the water level in the Sutami reservoir.

Year	Potential Flow in drought season (Million m^3)	Rank In 20 years	Water level in Sutami reservoir		
			1 June (Daily average)	30 November (Daily average)	Minimum water level in the drought season
1977	818.90	2	269.61	248.90	247.81
1978	3,927.99	20	273.05	261.21	260.84
1979	1,736.72	12	272.82	261.25	260.59
1980	992.21	4	271.92	N.A.	(257.54)
1981	2,316.85	19	271.13	262.96	257.87
1982	741.05	1	272.34	250.01	249.89
1983	1,846.52	13	272.21	258.82	256.66
1984	1,891.80	14	272.41	261.10	260.00
1985	1,656.38	11	272.44	260.90	260.62
1986	2,063.86	16	272.44	261.56	261.81
1987	891.25	3	270.84	264.03	259.29
1988	1,382.38	8	272.34	261.78	257.86
1989	2,254.38	18	272.80	N.A	(262.81)
1990	1,211.62	7	272.23	259.91	259.83
1991	1,053.75	6	272.36	261.58	261.03
1992	2,135.94	17	272.34	262.74	260.73
1993	1,492.73	9	272.43	260.51	256.60
1994	1,033.85	5	272.50	259.18	257.86
1995	2,008.16	15	272.40	266.12	263.23
1996	1,597.57	10	272.42	259.64	259.42

Source : Potential flow is calculated by the Study Team. Water level is from PJT.

Remarks : Minimum water level in 1980 and 1989 are the lowest water level within the available data.

Based on the above table, the year 1977 that is the second droughtiest year in the late 20 years is adopted as a 10-year drought year.

V.2 Watershed Conservation, Sabo and Flood Control

This section presents main results of the study on the master plan of the watershed conservation, sabo and flood control. Detailed discussions and data not incorporated in this section are presented in the ANNEX-9 "WATERSHED CONSERVATION, SABO AND FLOOD CONTROL" of the Supporting Report.

V.2.1 Proposed Projects and Their Outlines

V.2.1.1 Watershed Conservation

(1) Reforestation and Terracing

The reforestation of 170 km^2 and construction of terracing works of 3,070 km^2 are proposed in the critical area of erosion as shown in Table V.1 in order to mitigate soil erosion, decrease flood discharge and improve environment condition in the mountainous areas. Target year of this watershed conservation will be set on the year of 2020. Sub-BRLKT would implement these projects.

(2) Experimental Research

It is recommended that experimental research basin is established in the river basins of Konto, Lesti and Ngrowo to investigate land use, runoff and sediment yield for the river management in the future. Neighboring basic basin and basin having critical area of erosion will be selected and relationship of rainfall amount, runoff-rate and sediment yield is clarified. Then reforestation will be carried out stepwise in the critical area of erosion and effect of reforestation will be investigated compared with those of basic basin. PJT would implement these projects, in cooperation with Sub-BRLKT.

The outline of the experimental research is as follows:

a. Area	:	1 km2 for a basin
b. Meteorology and Hydrology	:	Temperature and Humidity; 1 set, Evaporimeter and Rain-gauge; 1set
c. Hydraulics	:	Water level gauge; 2 sets, Temporary bridge for discharge observation (wood and bamboo); 2 bridges, Current meter; 2 sets, Sediment sampler; 2 sets
d. Rented land	:	25 ha

V.2.1.2 Sabo

(1) Mt. Kelud Basin

Sabo works are proposed for next eruption assumed in 2005. The proposed volume to be controlled is estimated under an assumption of 1990 eruption scale as follows.

(1)Total eruption volume	142 million m^3
(2)Volume fly off basin	37 million m^3
(3)Volume to be transported into river channels	46 million m^3
(4)Volume to be transported into river for three years after eruption (short-term volume)	7 million m^3
(5)Long-term volume to be controlled: (5)=(1)-(2)-(3)-(4)	52 million m^3

The above (4) short-term volume 7 million m^3 will be controlled by an urgent works immediately after eruption.

(2) Upper Brantas River and Lesti River Basins

In order to mitigate sediment transported to reservoirs of the Senggruh and Sutami dams, 17 sabo dams are proposed to construct in the upper basin of the Senggruh dam as presented in Figure V.4. Total storage capacity is 15.1million m^3.

V.2.1.3 Flood Control

(1) Widas River

Since no remarkable change is observed in the Widas river basin, it is recommended that ongoing and remained flood control works be continuously carried out in accordance with the scheme developed in the 1985 Master Plan. The locations of proposed flood control works are presented in Figure V.5.

Work Item	Unit	Upper Widas And Lower Ulo	Kuncir river	Upper Ulo
Excavation	1000 m^3	1,207	164	248
Embankment	1000 m^3	255	234	150
Treatment of old river	1000 m^3	280	-	51
Reclamation	1000 m^3	11	70	47
Wetmasonry	m^2	1,510	1,600	14,500
Gabion	m^3	755	800	1,800
Bridge	Bridge	6	7	1
Culvert	Nos	4	7	-
Sluice	Nos	1	1	1
Syphone	Nos	1	1	-
Drop structure	Nos	1	-	-
Overflow dike	m	550	-	-
Collector channel	m^3	6,000	-	-

Work Item	Unit	Upper Widas And Lower Ulo	Kuncir river	Upper Ulo
Head works	Nos	-	2	-
Submergible weir	Nos	-	-	1

(2) Lodoyo Diversion Tunnel

The Lodoyo diversion tunnel project is indispensable one in the viewpoint of the present river channel improvement and disaster prevention measures of Mt. Kelud. It is recommended to commence this project after completion of the Widas project. The location of proposed diversion tunnel and its feature are presented in Figure V.6.

- Design discharge : 600 m^3/s
- Length of open channel : 4,700 m
- Length of tunnel and diameter : 5,500 m, 7.5 m
- Control gate : 3 gates
- Excavation volume : 250,000 m^3
- Revetment : 13,000 m^2

(3) Hazard Map

As a part of flood control project, non-structural measures are requisite. In this study, it is recommended to prepare the hazard map and to announce it to people. For reference, the Study team selects the Porong River as a model and the hazard map along the Porong river is prepared for 50 year probable flood as shown in Figure V.7.

(4) Flood Control Manual

There are several manuals related to the flood control in Indonesia as shown below, but so far PJT does not use these manual in actual works.

	Name of Manual	Published year	Published by
(1)	Pedoman Penanggulangan Banjir (Guidance of Flood Fighting)	1987	Ir.Sudaryoko DPU
(2)	Pedoman Siaga Banjir Kali Brantas	1997/1998	PJT
(3)	Flood Control Manual	1993	CIDA DPU
(4)	Irrigation Design Standards	1987	DPU
(5)	Irrigation Design Manual	1986	DPU

Note, CIDA: Canadian International Development Agency

There are some discrepancies in these manuals, therefore it is difficult to use. PJT should request to DGWRD to make flood control manual based on materials above and to

standardize the technique of river works as a fundamental tool. In addition to the above, it is recommended that design standard on eco-friendly river works be described in the manual in order to restore the natural river functions.

(5) Retarding Basin

Natural retarding basins are located in the upstream reaches of Kediri City, and in the main stream of the Widas river. Storage capacities of the basins are shown below and those locations are presented in Figures V.8 and V.9.

Name of river	Location	HWL (m.SHVP)	Area (Km^2)	Volume ($\times 10^6 m^3$)	Remarks
Brantas	Kediri to Tulungagung	-	-	-	-
Ngrowo	Tulungagung	-	-	4.5×10^6	Confluence of Ngrowo and Brantas R.
Widas	Nganjuk	38.4	12.5	11.6	Confluence of Brantas and Widas R.
Ulo	Nganjuk	44.4	6.3	4.7	Confluence of Widas R and Ulo R.

The retarding basins are indispensable for the flood control in the Brantas river basin. Therefore, the precise management of land use is prerequisite. At present, natural retarding basins are not designated legally.

Natural retarding basins should be designated legally by DGWRD as soon as possible. PJT should perform to survey to drive in stakes and to set up signboards.

V.2.2 Required Cost and Benefit

The required cost consists of construction cost including administration cost, engineering services cost, contingency, O/M cost, and land compensation.

The cost estimate is carried out based on the following condition.

(a) Condition of Cost Estimate

- Construction cost: unit construction cost basis
- Compensation cost : unit construction cost basis
- Consultant service cost : 5% of the above total
- O/M cost : 1% of construction cost
- Contingency : 15% of the above total

(b) Unit Cost of Construction and Compensation

The unit costs employed in the past flood control works are modified by converting price level in 1997.

V.2.2.1 Watershed Conservation

(a) Construction cost

Reforestation and terracing : Rp. 162,294 million
(implemented by Sub-BRLKT and Perum Perhutani)
Experimental research site : Rp. 6,984 million
(implemented by PJT in cooperation with Sub-BRLKT)

(b) Benefit

Benefit is counted as decrease of cost of riverbed excavation owing to decreased sediment discharge by watershed conservation measures. Benefit by watershed conservation is calculated at Rp. 1,643 million per year.

a. Critical land of erosion: 3,296 km^2
b. Specific sediment discharge in critical land: 3,200 $m^3/yr/ km^2$
c. Specific sediment discharge in standard area: 1,100 $m^3/yr/ km^2$
d. Effect: 2,100 $m^3/yr/ km^2$
e. Sediment load in total volume: 44%
f. Unit cost of excavation: 10,793 Rp/m^3
g. Benefit (a x d x e x f / 20 yr): 1,643 million Rp/yr

V.2.2.2 Sabo Works

(a) Construction Cost

Mt. Kelud basin : Rp. 470,373 million
Lesti and upper brantas basin : Rp. 133,235 million

(b) Benefit

Mt.Kelud basin:

Benefit is estimated at Rp. 29,539 million per annum as decrease of channel excavation for the design storage capacity (52 mullion m^3).

52 million x 10,793 Rp/m^3 / 19 yr = 29,539 million Rp/year

Upper Brantas and Lesti river basins:

Benefit is considered the reduction of dredging cost owing to decrease of sediment inflow into the of Sengguruh reservoir. The benefit is Rp.10, 600 million per year under an assumption that the total storage capacities of 17 dams are filled in 22 years.

Item	Unit	Quantity	Unit Cost	Amount
Sengguruh Reservoir				233,093,264,000
1. Land aquisision	Sqm	3,020,000	10,000	30,200,000,000
2. Dredging				202,893,264,000
2.1 Dredging around intake				
(1) Dredging incl. Transport	Cum	15,100,000	11,197	169,077,720,000
(2) Miscelaneous (20% of (1))	L.S			33,815,544,000
Per 22 year				10.6 mil.Rp/yr

V.2.2.3 Flood Control Works

(a) Construction Cost

Widas river : Rp. 135,761 million
Brantas and Lodoyo diversion tunnel : Rp. 421,998 million

(b) Benefit

The economic internal rate of return had been estimated at 15.0% in the 1985 Master Plan.

V.2.2.4 Project Implementation Plan

The implementation schedule is shown in Figure V.10, and they are summarized below. Sabo works are firstly carried out, that is, those of the Lesti and Upper Branras river basins, and Mt. Kelud basin are proceeded.

Implementation Schedule

Project Name	Detailed Design	Land Compensation	Works Commence	Work Completion	Remarks
(1) Watershed Conservation					
- Reforestation	2000	-	2001	2020	BRLT,
- Experimental research	2000	2001	2002	2020	Perum
(2) Sabo					Perhutani
- Mt. Kulud	2000	2001	2002	2020	
- Brantas R. & Lesti R.	1999	-	2000	2006	
(3) Flood Control					
Widas River					
- Widas R. & Ulo R. down	1999	2000	2001	2003	
- Kuncir river	2002	2003	2004	2005	
- Ulo river Upstream	2008	2009	2010	2011	
Lodoyo diversion tunnel	2005	2016	2017	2020	

V.2.3 Action Program

In order to prepare New PJT by consolidation of PKB, PGKS and PJT in 2002 and change of status to Persero in 2005, the following activities will be required.

1999 – 2001

(a) Preparation for land use map which is drawn in detail erosion area and forestry zone, for the purpose of the watershed conservation.
(b) Preparation for sediment control master plan based on the detailed investigation on the debris run-off from the Mt. Kelud basin.
(c) Review of master plan on watershed conservation based on the recent basin conditions.
(d) Preparation of implementation program for watershed conservation plan and recommendation on its execution to administrator.
(e) Investigation on present condition of sabo facilities.
(f) Preparation on quality improvement and transportation measures for product made from deposit materials in sand-pocket.
(g) Preparation for the ledgers of the rivers.
(h) Survey and setting out the boundary sticks of retarding basin which was recommended in the 1985 master plan.

2002 – 2004

(a) Preparation of flood control manual by mutual consent with related agencies.
(b) Preparation and announcement of hazard map in the whole basin.

1999 – 2004 (continuous Investigation)

(a) Investigation on actual conditions of illegal sand mining on riverbed.
(b) Investigation on actual conditions of flood damage.

The required costs of the above action plan are shown in Figure V.11.

V.3 Water Quality

V.3.1 Necessity of Water Quality Management

V.3.1.1 Problems on Water Quality Management

The outstanding issues and significant focal points for the present water quality management are deterioration of water quality, shortage of pollution control, facilities and basic data. The improvement of monitoring system and demarcation of responsibilities are necessary. With regard to pollution control, attention should be paid on pollution control for agriculture sources and other non-point sources in addition to domestic and industrial waste waters especially during the rainy season.

V.3.2 Water Quality Improvement Plan

V.3.2.1 Basic Principles for Formulating of Water Quality Improvement Plan

(1) Characteristics

The plan of the Study integrates countermeasures to improve water quality in the Brantas river basin assuming a well organized and systematic forms of implementation. It consists of pollution control strategies which show long-term directions towards the year 2020 and action plans clarifying detailed activities to be implemented by 2004.

(2) Components of water quality improvement plan

The plan for water quality improvement can be broken down into three categories : 1) water quality monitoring, 2) pollution control of such sources as domestic, industrial, agricultural and others (on-site and off-site handling) and 3) direct purification. In addition, supporting activities to promote and accelerate implementation of the countermeasures and research and development are also required.

(3) Target of water quality in 2020

The target level of river water quality in 2020 is set at less than 6 mg/l of BOD, considering the water quality standards of the East Java province and existing objectives. It is recommended that present objectives should be upgraded in the stretches being classified as C.

(4) Waste water treatment level in 2020

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 economic aspects. Among the cases as calculated in III.3.5.4, Case-III is most effective activities. Therefore, Case III is adopted for formulating water quality improvement plan.

V.3.2.2 Water Quality Monitoring

To make data more reliable and useful for management decisions, addition of monitoring points, items and frequency are necessary. As for facilities, expansion of existing laboratories and construction of a new laboratory in upper stream area in Malang is recommendable for proper timing monitoring. For the continuous monitoring, it is necessary to maintain the measuring instruments in their best condition. Costs for the recommended monitoring are estimated at Rp. 550 million per year.

V.3.2.3 Domestic Pollution Control

In order to attain the target of the river water quality, countermeasures (treatment of domestic waste water) to decrease domestic pollution load is considered. The following three(3) systems are considered to be appropriate for the treatment of domestic waste water.

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, Turungagung,Others	80-90	10	-
Rural areas	Others	55-85	-	-

Note : CTPSTS: Combined Type Private Sewage Treatment System

Required costs for the waste water treatment systems including sanitation facilities are estimated by assuming both full development of the facilities of each site and the maximum number of sanitation facilities to be installed. The estimated investment costs (in 1990 constant prices) are Rp 1,050 million in total.

V.3.2.4 Industrial Waste Water Control

Considering the magnitude of impacts, "major producers" should meet the effluent standards. The required waste water treatment levels of industries are summarized 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%

The costs are estimated indicatively assuming full development of the facilities of each site for the maximum number of industries to be treated. The estimated investment costs (in 1990 constant prices) are Rp.2,280,000 million in total.

V.3.2.5 Agricultural Pollution and Other Pollution Control

Taking into consideration the distribution of agricultural pollution 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. In addition, pollution loads from agricultural chemicals (fertilizer, pesticides, herbicides) which would be mainly brought by soil erosion should be considered.

Solid waste and sludge control are necessary as well as improvement of river environment. Solid waste collection and disposal system should be established. In addition, the pollution control for natural source is to be implemented as one of the tasks in watershed management.

V.3.2.6 Direct Purification

The water quality in the rivers depends on assimilative capacity of the rivers and magnitude of pollution load. While, the optimum allocation of water by operating the river maintenance flow is one element of water quality improvement activities. Necessary river maintenance flow to reach the river water quality target based on the recommended program/actions are 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

In addition, the accumulated sediments, domestic waste and sludge in the ditches should be cleared in order to minimize wash-out pollution loads. There are other ways to purify water in the streams such as a biological purification reactions, which deserve full consideration for research and development.

V.3.2.7 Supporting Activities

To carry out the water quality improvement plan, specific urgent topics have been identified as supporting activities which consist of strengthen the institutions concerned and human

resource development and so on. In addition, back-up projects are recommended to be initiated by public participation.

V.3.3 Management Organization

It is recommended for PJT to have a responsibility for the water quality management as a water supplier. It would be better to say that PJT should have leadership of the water quality management and a line management responsibility will be required. On the other hand, PJT can delegate its tasks to other agencies for implementation of the projects. Taking into consideration the functions of BAPEDALDA, execution of pollution control shall be done under the instructions and/or coordination of BAPEDALDA. The recommended water quality management organization is shown in Figure V.12.

V.3.4 Requirements to PJT

An independent department for the Water Quality Management is necessary for PJT in which a planning and coordination section, a water quality monitoring section, a research and development section and a laboratory are to be included. For the Department, environmental planners, water quality engineers, computer technicians will be required. And an additional preparation of a new work office and related facilities will be necessary. Necessary investment cost for establishment of the Department in PJT is estimated at Rp. 4,500 million.

V.3.5 Project Implementation Program

V.3.5.1 Projects Identification

The final goal of the proposed projects is to comply with the target by 2020 in the Brantas river basin. In order to accomplish this target, it is clarified through the water quality prediction that all the proposed countermeasures for each source and direct purification should be implemented.

Meanwhile, responsibilities for decreasing in pollution loads should be broken down into each sector. Most suitable and manageable countermeasures shall be applied based on magnitude of effects and technical and economic aspects in principle. Thus, countermeasures shall be focused on pollution sources which can be specified at first. In addition, in order to put priority for implementation on the proposed countermeasures, institutional and/or legislative necessity shall be taken into consideration.

Table V.2 shows countermeasures with priority divided into 4 groups : urgent, high, medium and low priorities.

V.3.5.2 Implementation Schedule

The required activities for the water quality management in the Brantas river basin fall under 10 categories. All these activities have to be prepared from now on in order to attain the target by 2020.

On the other hand, reconstituting the organizations and enhancement of legislation and/or regulation are required. Besides, the development schedule of PJT and establishment of new department for water quality management in PJT should be considered. Furthermore, affordability of inhabitants especially low income households should be taken into consideration.

V.3.5.3 Responsible Organizations

The implementation of the water quality improvement activities is proposed to be managed and administered by PJT through obtaining the cooperation of BAPEDALDA. The important matters for the water quality management are to make proper plan and program with clarified responsibilities and their activities. Responsible organizations for projects implementation are summarized in Table V.3.

V.3.5.4 Preliminary Project Cost

Preliminary project costs are estimated as described in previous sections.

V.3.6 Action Plan

The proposed water quality improvement plan in the previous sections is a desirable picture in 2020. The picture of an improvement plan in 2004 is shown below.

- Establishment of continuous water quality management system
- Strengthening of legislation and institutions
- Preparation of waste water treatment map
- Implementation of a model project of Gappei Johkaso
- Implementation of M/P and F/S

V.3.7 Recommendations

The following items are recommended for the water quality management in the Brantas river basin.

- Utilization of Pollution Charge System
- Improvement of Kampung
- Cleaner Production
- Research and development for appropriate technology in Indonesia
- Industrial audit (on-site industrial pollution inspection system)
- Environment impact assessment
- Utilization of ISO 14000

V.4 Water Demand Forecast

V.4.1 Concept for Water Demand Forecast

Demand projection is made for irrigation, brackish water fishery, domestic use, industrial ndemand and river maintenance flow towards the target year 2020. Projection of water demand is made for water use basically to be taken from the main Brantas river.

(1) Irrigation Water Demand and Supply System

(a) The objective irrigation area of the Study is figured out at 83,281 ha and water requirement to be taken from the main Brantas river has been estimated.

(b) It is presumed that annual reduction rate of irrigation area is some 0.38% from 1996 to 2020. In the Brantas basin, some 37,100 ha will be converted and 272,000 ha of irrigation area will remain in the basin.

(c) It is assumed that the future cropping patterns will principally follow the present prevailing patterns.

(d) Irrigation water requirements are estimated based on the climate data available in the basin, and criteria and recommendation in two publications namely, Irrigation Design Standards Design Criteria Volume Irrigation System Design KP-01 1st Edition December 1986 published by DGWRD and FAO Irrigation and Drainage Paper 24, Crop Water Requirements published by FAO in 1977.

(e) An overall irrigation efficiency is simply presumed at 50% based on information given by Cabang Dinas and the above publications.

(f) It is assumed that some 30% of the irrigation water requirements will come back to the Brantas river.

(g) Irrigation water demand is estimated on a 10 day average discharge basis by irrigation area.

(h) Water demand without any saving measure and that considering water saving by the canal concrete lining have been figured out in each irrigation sector.

(2) Brackish Water Fishery

(a) Fishery demand is based on the assumption of 50 % each for the intensive and extensive fishponds. Fishery water demand is assumed to be supplied by the return flow from the Delta Brantas irrigation area. In case no sufficient return flow from the Delta Brantas irrigation area, individual water demand is considered for the fishery.

(b) Provincial land use data shows reduction of the fishpond area from 15,700 to 11,500 ha. in 2020.

(c) Annual demand for the brackish water fishery is estimated in terms of water volume.

(3) Domestic Water Demand

(a) Domestic water demand is projected for urban and rural areas of each regency and municipality based on the following assumptions:

Item	Area	1996	2020
Population (x 1,000)	Urban	6,545	9,312
	Rural	7,263	8,385
PDAM pipe water service (%)	Urban	25	100
	Rural	0	0
Water consumption per capita (lcd)	Urban	70 - 224	120-250
	Rural	50-60	60
Un-accounted-for water (%)	Urban	19 - 54	20
	Rural	0	0

(b) The domestic water demand for 2020 in the whole Brantas river basin area is projected.

(c) Present supply capacity of other sources than the Brantas main river including other tributaries and ground water is assumed to be maintained. Increment of water demand shall be covered by the surface water of the Brantas main river only.

(d) Domestic water demand is estimated in terms of annual total requirement.

(4) Industrial Water Demand

(a) The industrial water demand is projected for three types of industries : sugar, paper and others. The sugar and paper industries combined account for 77% of the total industrial water use in the Brantas.

(b) The projection is based on the present water demand, the rate of change in production, the rate of change in water use amount, and water recycling rate. Gross industrial water demand is the demand before considering recycling and net industrial water demand is the demand after considering recycling.

(c) Present supply capacity of sources other than the Brantas main river including other tributaries and ground water is assumed to be maintained. Increment of water demand shall be covered by the surface water of the Brantas main river only.

(d) Water demand without any saving measure and that considering water saving by water recycling have been figured out in the industrial water demand.

(e) Estimation is on a monthly basis.

(5) River Maintenance Flow

(a) The river maintenance flow is defined as the minimum water flow which shall satisfy concurrently the compositions of water quality, recreation and ablution, aesthetics, preservation of biota and navigation for beneficial uses during the dry season

(b) River maintenance water demand is projected by respective monitoring points and by categories . Required water flow for the river maintenance flow at each control point in 2020 is as follows :

No.	Location	River or Canal	Required Water Flow (m^3/s)	Key Compositions
1	Bumiayu Bridge	Brantas river	21	Water quality*
2	Demangan Bridge	Brantas river	10	Water quality*
3	Jogbiru Bridge	Brantas river	16	Water quality*
4	Padangan Bridge	Brantas river	22	Water quality*
5	Canggu Tambangan	Surabaya river	10	Water quality*
6	Karangpilang	Surabaya river	14	Water quality*
7	Ngagel	Surabaya river	24	Water quality*
8	Kayoon	Mas river	8	Water quality*
9	Pelayaran	Pelayaran canal	3	Water quality*
10	Porong	Porong canal	0.3	Recreation

* Water quality : target level on water quality to be less than 6 mg/l of BOD.

Required water flow at Ngagel point is 24 m^3/sec and the minimum requirement of river maintenance flow is determined to be 20 m^3/sec incorporating another available water for the other purposes.

(c) Estimation is on average discharge basis.

V.4.2 Water Demand Projection in 2020

Peak irrigation water demand in the basin in 2020 is figured out at 67.2 m^3/sec in December. The annual irrigation requirement in the basin is 1,409 million m^3 .

The water demand for the intensive and extensive fishponds is estimated to be 1.7 l/sec/ha and 0.08 l/sec/ha, respectively.

The following figures show the total domestic water demand including those to be taken from the surface water of the Brantas main river, other tributaries, ground water and spring water.

(unit million m^3/year)

Area	1996	2020
Urban area *	104	819
Rural area	159	184
Total	263	1,003

* un-accounted-for water excluded in 1996 , included in 2020

The following figures show the total industrial water demand including those to be taken from the surface water of the Brantas main river, other tributaries, ground water and spring water.

Item	Unit	Sugar	Paper	Other	Total
Water demand in 1996	million m^3/year	117	49	49	215
Rate of change in production	%/year	0.0	6.3	8.3	8.3
Coefficient *	-	0.55	0.51	0.90	0.53
Rate of change in water use amount	%/year	0.0	3.2	7.5	4.4
Gross water demand in 2020	million m^3/year	117	104	278	499
Rate of recycling	%	45	43	52	48
Net water demand in 2020	million m^3/year	64	59	133	257

The following summarizes water demand projections by sector which need surface water of the Brantas main river as water sources:

(unit : million m^3)

		Present		2020	
		Annual	(Drought Season)	Annual	(Drought Season)
Irrigation	(no saving)	1,943.2	1,035.1	1,409.3	683.5
	(saving)	-	-	1,286.1	624.0
Fishery		40.8	20.4	268.7	134.3
Domestic/Business& Social		108.0	54.0	930.0	465.0
Industry	(no saving)	104.0	78.8	388.0	233.8
	(saving)	-	-	146.0	89.3
Maintenance Flow		-	-	632.5	316.2
Total	(no saving)	2,196.0	1,188.3	3,628.5	1,832.8
	(saving)	-	-	3,263.3	1,628.8

Note : Total above shows an accumulation of the respective demands.

The forecasted water demand of each sector are presented in Table V.5 on 10 day average basis. Summarized monthly water demand in present condition(1996) and 2020 are as follows:

(unit : million m^3)

Demand	Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Irrigation	1996	172.0	116.1	116.7	124.4	207.5	210.0	204.6	175.6	154.1	139.4	156.9	168.2	1,943.4
	2020 N.S.	159.4	93.4	46.4	101.3	166.6	155.2	141.4	104.1	115.3	85.1	85.7	156.7	1,409.3
	2020 Save	145.5	85.1	42.2	92.3	152.3	142.0	129.4	95.0	105.0	77.7	77.9	142.7	1,286.1
Fishery	1996	3.5	3.1	3.5	3.3	3.5	3.3	3.5	3.5	3.3	3.5	3.3	3.5	40.8
	2020	22.8	20.5	22.8	22.0	22.8	22.0	22.8	22.8	22.0	22.8	22.0	22.8	268.7
Domestic	1996	9.2	8.3	9.2	8.9	9.2	8.9	9.2	9.2	8.9	9.2	8.9	9.2	108.0
	2020	79.0	71.3	79.0	76.4	79.0	76.4	79.0	79.0	76.4	79.0	76.4	79.0	930.0
Industry	1996	4.0	3.6	4.0	3.9	5.4	13.2	14.4	14.4	13.6	14.4	9.3	4.3	104.0
	2020 N.S.	25.7	23.2	25.7	24.9	27.8	38.7	41.1	41.1	39.3	41.1	33.6	26.2	388.0
	2020 Save	9.4	8.5	9.4	9.1	10.3	14.8	15.8	15.7	15.0	15.7	12.7	9.6	146.1
Available	1996	45.8	29.4	29.8	32.3	55.5	66.0	65.2	58.2	50.5	44.4	43.0	45.3	565.4
Return	2020 N.S.	81.0	59.3	51.4	64.6	85.6	92.1	91.1	80.2	80.0	74.5	64.4	80.0	904.1
Flow	2020 Save	64.6	45.7	37.4	49.9	68.1	69.6	67.6	57.6	58.1	52.4	46.6	63.4	680.8
Mainte.	1996	-	-	-	-	-	-	-	-	-	-	-	-	-
Flow	2020	53.6	48.4	53.6	51.8	53.6	51.8	53.6	53.6	51.8	53.6	51.8	53.6	632.5
Basin Net	1996	154.2	106.0	105.7	111.3	181.1	189.2	188.1	165.0	146.9	135.7	145.8	142.7	1,768.5
Total	2020 N.S.	252.4	191.1	169.0	205.0	257.0	245.2	239.8	213.3	218.0	199.9	200.8	251.1	2,731.1
Demand	2020 Save	238.6	181.8	162.5	195.0	242.8	230.7	225.8	201.4	205.4	189.2	190.5	237.2	2,589.6

Note : N.S. shows water demand in case of no water saving measure, while Save means demand with saving measure.

Annual basin net total water demand in 1996(present condition) is approximately 2.4 billion ton, while forecasted water demand in 2020 are 2.6 billion ton in no saving case and 2.5 billion ton in saving case , respectively. Total demand is estimated not to increase much due to decrease of irrigation water demand.

V.5 Water Resources Available and Water Balance

V.5.1 Water Resources Available

Available water resources to meet respective water demands are the natural flow which is defined as the main river discharge to be estimated by assuming that there is no water supply from reservoir storage and no water intake to any water consumption on the main river of the Brantas river. In addition to the natural water resources available, the reservoir storage water could be considered as supplemental water resources during a drought season.

The natural flow computed from discharge records in 1977 which corresponds to 10 year drought discharge have been used as a basic discharge to study necessary development and other measures. Besides, natural flow series obtained from discharge records of several years have been studied to consider various drought situations. Available water resources in terms of the natural flow(potential flow) are shown in Table V.4. As seen in Table V.4, annual total of the natural flow ranges from 5,808 million m^3 to 10,400 million m^3, while a range of 740 million m^3 to 3,930 million m^3 in drought season of 6 months period.

Manageable water resources are reservoir storage and some water saving measures which decrease water demand. Water resources presently available, to be available and proposed are summarized as follows, and discussed in V.6.

(a)	Natural Flow (1977; million m^3)	:	Annual 5,808 Drought Season 819
(b)	Existing	:	Sutami and Lahor Dams
(c)	Under construction	:	Wonorejo Dam Project
			(1) Wonorejo Dam
			(2) Push-back Scheme
(d)	Committed	:	Umbulan Bulk Water Supply
(e)	Proposed Development	:	Beng Dam
			Kedungwarak Dam
			Genteng I Dam
(f)	Proposed Water Saving Measure	:	Irrigation(Canal Lining)
			Industry(Water Recycling)

V.5.2 Water Balance

V.5.2.1 Water Balance Study

(1) Basic Condition

(a) Natural flow

Natural flow is defined in the Study as the main river discharge assuming no intake water and no supply by reservoir storage on the main river stretch.

(b) Water Balance System

The water balance study is made incorporating various water intakes and return flows as shown in FigureV.13.

(c) Return Flow of Irrigation Water

(i) Return flow from each irrigation area is assumed to be 30 % of demand.

(ii) Return flow of a part of Lodoagung irrigation water would not come back to the Brantas river. While return flows of some irrigation areas would go to the Surabaya river directly and be available for downstream water demand.

(iii) The return flows of Irrigation and domestic waters in the downstream area from Mojokerto go directly to the sea except for the fishery water from the Brantas Delta irrigation.

(d) Return Flow of Domestic and Industrial Waters

(i) Return flow from the domestic and industrial water uses in the urban area is assumed to be 80 %.

(ii) Return flow of the domestic water for Tulungagung and Trenggalek regencies would not come back to the Brantas river.

(2) Water Balance Analysis

Water balance analysis studied in the Study are the combination of the following demands against natural flow of various year cases as follows:

(a) Demand in present condition(1996) and in 2020.

(b) Demand without or with water saving measures in irrigation and industrial water uses.

Table V.5 shows a summary of water balance calculation made for the above cases and 1977 flow.

V.5.2.2 Water Balance in the Past 20 Years

(1) Condition of 20 Years

In addition to the water balance analysis for 1977 which corresponds to 10 year drought year, the other 11 years have been analyzed by making computation out of 20 years. The following table shows expected water deficit of water resources covered by the natural flow for the following 12 years against the water demand in 2020.

		1982	1977	1987	1980	1994	1991	1988	1996	1979	1995	1981	1978
Drought Probability		1/20	2/20	3/20	4/20	5/20	6/20	8/20	10/20	12/20	15/20	19/20	20/20
Natural Flow in Drought Season (million m3)		741	819	891	992	1,034	1,054	1,382	1,598	1,737	2,008	2,317	3,928
Deficit in Drought Season (million m3)	No Saving	609	624	532	563	328	341	333	168	215	176	114	0
	With Saving	536	565	467	497	263	273	280	121	178	144	91	0
Nos. of Days to Suffer Water Deficit	No Saving	210 (30)	160 (10)	170 (10)	170 (10)	170 (10)	170	140	120	110	80	60	0
	With Saving	200 (20)	160 (10)	170 (10)	170 (10)	160 (10)	150	120	110	80	80	50	0

Note : A figure in a parenthesis shows a number of days to suffer water deficit in May or December.

Expected water deficit for the demands of the present(1996) and 2020 against 1977 natural flow are shown in Table V.6, respectively.

It is observed in the above that the year 1977 suffered the most severe drought condition in terms of total water deficit in the 6 month of drought season, though 1977 has been defined as 10 year drought year(2nd in 20 years) since it was defined in terms of the natural flow quantity in the same period.

For the five severest 5 years, water deficit occur even in May or December. While, for most years except 1980, 1982, 1987 and 1991, scarce water deficit occur in June according to Table V.6.

No deficit occurs at all by the natural flow throughout 1978, which is the most ample rainy year among the examined 20 years.

(2) Present and Future Water Balance

Further to the analysis mentioned above, the water supply capacity in drought season and water saving measures are taken into consideration in the water balance analysis. Development and saving capacities to be available in the drought season considered in the analysis are as follows:

(million m^3)

Year			1996	2010	2020
Existing					
Sutami and Lahor dams	(WL: 272.5 - 260.0 m)	:	115.3	104.6	97.0
	(WL: 260.0 - 246.0 m)	:	57.8	46.8	39.0
On-going					
Wonorejo Dam Project	(Wonorejo dam)	:	-	89.4	89.4
	(Push-back Scheme)	:	-	35.3	35.3
Committed					
Umbulan Spring		:	-	60.7	60.7
Saving					
Irrigation Water (canal lining)		:	-	44.6	44.6
Industrial Water(water recycling)		:	-	16.9	28.9
Proposed dams					
Beng Dam		:	-	147.0	147.0
Genteng I		:	-	-	70.0
Kedungwarak Dam		:	-	-	54.0

The water balance analyses for the respective 12 years have been undertaken and results are summarized in Table V.7. In the tables, water balance in 2010 and 2020 taking account of the proposed water resources developments are also incorporated for reference.

Main results obtained through the water balance analysis are enumerated as follows:

(a) Present demand

(i) No deficit is caused in 1978 without any storage water

(ii) Every 2 years, water deficit would be expected in case 20 m^3/s of river maintenance flow is considered

(iii) Water deficit would be expected every 5 years in case of no maintenance flow considered

(iv) As long as the present result is concerned, the storage capacity of the Sutami and Lahor dams over 260.0 in water level seems to be almost sufficient enough for the normal year except for some drought years which might be encountered once every 5 years.

(b) Year 2010 (20 m^3/s of river maintenance flow incorporated)

(i) Development of more than 2 dams will be necessary by 2010 if no water saving measures are taken up to cover drought condition which might be foreseen every 5 years.

(ii) Only one dam is necessary for construction if both water saving measures in irrigation and industry sectors are realized and storage up to El.246.0 m is used in the Sutami and Lahor dams.

(c) Year 2020 (20 m^3/s of river maintenance flow incorporated)

(i) Construction of 3 dams as well as water saving measures will be necessary for 2020 to cope with a 10 year drought condition.

(ii) By construction of two dams as well as realization of water saving measures, no water deficit will be expected at all for other drought cases.

V.6 Water Resources Development

V.6.1 Selection of Promising Projects

V.6.1.1 First Screening of Objective Projects

The Study of water resources development in terms of water supply toward year 2020 aims to select and recommend project(s) to be implemented after the Wonorejo Dam Project. For the selection of the most prospective project properly out of water resources development projects to be executed in or around the Brantas river basin, the Study deals with such projects that is related to the development of water supply for the Brantas river basin, especially domestic water for Surabaya and its vicinity area. The objective projects are only that the development plans formulated in the previous studies are followed in the Study and new project identification is not considered for water resources development. In order to meet with the above objectives, the following screening procedure is applied:

(a) Main objective of the proposed projects shall be of urban water supply.

(b) Other development scheme including Hydropower, Irrigation, and Flood control are not evaluated in the study. Several projects presented in the preceding chapter which may be prospective for the other development objectives are recommended to be studied in the other studies.

(c) Lead time of the project shall be considered.

(1) Projects of Existing Development Plan

Out of projects identified and studied in the previous studies, the following projects have the main objective of water supply development:

No.	Project Name	Status	River(Basin)	Objectives	Effective Storage(mil.m^3)
(1)	Beng Dam (pump up)	MP	Beng, (Brantas)	WS, IR, HP	147
(2-1)	Kedungwarak Dam(pump up)	MP	Kedungwarak(Widas)	WS, IR	54
(5)	Babadan Dam (interbasin)	MP	Bendokrosok	WS, FC, HP	84
(6)	Tugu Dam	FS	Keser(Ngrowo)	WS, IR, FC	21
(9)	Genteng I	MP	Genteng(Lesti)	WS, HP, SC	70

Note :WS:Urban water supply, IR:Irrigation, FC:Flood control, HP:Hydropower, SC:Sediment control, MP:Master plan study, FS:Feasibility study, DD:Detailed design

(2) Existing Dam and Reservoirs

In view of the development objective and storage capacity of the existing dam and reservoirs, only Sutami and Lahor dam and reservoirs are studied further in view of water supply. Other dam and reservoirs have no long-term regulating capacity which is required for water supply in the dry season.

(3) Projects Outside Brantas River Basin

It seems that the Umbulan Bulk Water Supply Project will commence its construction procedure soon however no definite time schedule for implementation is available for the Study, as well as no required project cost.

The Sembayat Barrage Project and the Jabun Retarding Basin and Floodway Project in the Lower Solo basin has finished its detailed design by local fund and being under detailed design, respectively. However, the Sembayat Barrage Project has only preliminary plan of water allocation and no definite design of water conveyance facility with water treatment plant are available. In view of this, the situation seems to be similar to proposed projects in the Brantas river basin.

The Umbulan Bulk Water Supply Project and the Sembayat Barrage Project are maintained in the list for further evaluation.

V.6.1.2 Second Screening for Selection of Candidate Projects

The prospective projects are selected on the unit water cost. The project with the minimum unit water cost could be recommended as the next project to the Wonorejo Dam Project.

(1) Proposed Projects in the Brantas River Basin

(a) Preliminary Cost Estimate

Preliminary estimate of the construction cost of dam scheme including water pump-up storage facilities is undertaken by the Study based on the work quantity worked out in the previous studies and unit prices updated to June 1997 price levels. The construction cost of water treatment plant is also included.

The annual operation cost is considered in this screening procedure including electricity rate required for pump-up facility and clean water production cost.

(unit : Rp.million in June 1997)

No.	Project Name	Construction Cost(Rp.mil. in 1997)				Annual Operation Cost		
		Dam etc.	Pump-up Facilities	Water Treatment Plant	Total	Electricity	Treatment	Total
(1)	Beng Dam(pump up)	87,114	46,260	269,410	399,948	2,538	44,323	46,861
(2)	Kedungwarak Dam (pump up)	18,512	62,440	99,257	180,209	3,259	16,330	19,589
(5)	Babadan Dam	427,454	-	153,139	580,593	-	25,194	25,194
(6)	Tugu Dam	152,804	-	60,972	213,776	-	10,031	10,031
(9)	Genteng I	271,542	-	127,617	399,159	-	20,995	20,995

Note : (1) Rp.118/kWh is applied for the electricity consumption cost
(2) Rp.300/m^3 is applied for clean water production cost

(b) Land Acquisition and Resettlement Requirement

Land compensation and resettlement costs are estimated referring to the previous studies as follows:

(unit : Rp.million)

		Beng Dam		Kedungwarak Dam		Genteng I Dam	
		Q'ty	Cost (Rp.mil.)	Q'ty	Cost (Rp.mil.)	Q'ty	Cost (Rp.mil.)
Land Compensation	Cultivated Field	650 ha	84,500	330 ha	42,900	40 ha	4,000
	Others	650 ha	32,500	330 ha	16,500	370 ha	14,800
	Total	1,300 ha	117,000	660 ha	59,400	410 ha	18,800
Resettlement		1,500 houses	15,000	350 houses	3,500	40 houses	320
Total			132,000		62,900		19,120

(c) Unit Water Cost

The unit water cost is worked out for the promising 5 projects applying a discount rate of 12% per annum. and price level as of June 1997. The unit water cost shown below considers the land compensation and resettlement costs of the project area.

No.	Project Name	Total Supply Capacity in mil. m^3	Total Const. Cost (Rp.mil.)	Land /Resettlement Cost (Rp.mil.)	Annual Operat'n Cost (Rp.mil.)	Unit Water Cost (Rp./ m^3)
(1)	Beng Dam(pump up)	147	399,948	132,000	48,905	889
(2)	Kedungwarak Dam(pump up)	54	180,209	62,900	21,541	1,091
(5)	Babadan Dam	84	580,593	19,120	26,980	1,403
(6)	Tugu Dam	21	213,766	16,240	10,795	2,177
(9)	Genteng I	70	399,159	7,680	22,374	1,199

(d) Selection of Candidate Projects for Implementation

According to the preliminary analysis, unit water costts presented in the preceding paragraph shows that the following projects are advantageous as implementation candidates in economic aspect:

(i) Beng Dam

(ii) Kedungwarak Dam

(iii) Genteng I Dam

(2) Projects Outside Brantas River Basin

The project to be evaluated are (i) the Umbulan Bulk Water Supply Project, and (ii) the Sembayat Barrage Project as projects outside the Brantas river basin.

(a) Development Cost

Total construction cost is approximately estimated at June 1997 price level and the operation costs of the pump facility is incorporated in the evaluation. Construction and operation cost for water treatment plant of the Umbulan Bulk Water Supply Project have been disregarded to make a cost comparison on same basis with other proposed projects since the Umbulan Bulk Water Supply Project has an advantage to develop clean water from the Umbulan Spring without treatment.

Project Name	Construction Cost(Rp.mil. in 1997)				Annual Operation/Maintenance Cost			
	Barrage	Pipeline	Treatment Plant	Total	O/M	Electricity	Treatment	Total
Umbulan Bulk Water Supply	-	270,500	(0)*	270,500	8,115	5,500	-	13,615
Sembayat Barrage	164,729	158,250	266,760	589,739	5,571	38,000	4,480	48,051

Note : * Water treatment cost of the Umbulan Bulk Water Supply Project is excluded for comparison.

(b) Unit Water Cost

Project Name	Total Supply Capacity (in mil. m^3)	Total Const. Cost (Rp.mil.)	Land /Resettlement Cost (Rp.mil.)	Annual Operat'n Cost (Rp.mil.)	Unit Water Cost (Rp./ m^3)
Umbulan Bulk Water Supply	60.7	270,500	3,380	13,615	907
Sembayat Barrage	108.8	589,739	85,058	48,051	1,387

(c) Selection of Candidate Projects

In addition to the economic aspect, the Umbulan Bulk Water Supply Project is recognized by the related agencies as a committed project for implementation with commissioning expected to be by 2005.

The Sembayat Barrage Project seems to be rather expensive for urban water supply due to long water conveyance pipeline. Furthermore in view of uncertainty of budget availability and construction schedule, its implementation will be considered in the program to be after the projects in the Brantas river basin.

(3) Committed and Recommended Projects

The committed and recommended(proposed) projects and their supply capacities are summarized as follows:

Priority	Project	Status	Supply Capacity(mil. m^3)	Discharge(m^3/sec)
1.	Wonorejo Dam	Under const.	89.4	5.75
1.	Wonorejo Push-back Scheme	Under const.	35.3	2.27
2.	Umbulan Bulk Water Supply	Committed	60.7	4.27
3.	Beng Dam	Recommended	147.0	9.45
4.	Kedungwarak Dam	Proposed	54.0	3.5
4.	Genteng I Dam	Proposed	70.0	4.5
5.	Sembayat Barrage	Proposed	108.8	7.0
Total			587.5	36.74

V.6.2 Recommended Development Projects

V.6.2.1 Next Project to Wonorejo and Other Promising Projects

The Beng dam project is recommended as the next project to be developed to meet increasing water demand especially in Surabaya area. The Beng dam project is the most prospective one in water supply aspect only. Out of the prospective projects, the Beng dam is the most economical in terms of unit water cost.

Other than the Beng dam project, the Kedungwarak dam and the Genteng I dam projects are evaluated as prospective ones out of the existing project plans in the Brantas river basin.

V.6.2.2 Construction and Operation/Maintenance Costs of the Projects

The construction cost of the prospective projects including Beng dam, Kedungwarak dam and Genteng I dam have been estimated as well as the operation and maintenance costs herein. The estimated construction costs of the respective projects are shown in Table A6-3 of Annex -6.

(Rp.million)

Construction Cost		Beng Dam	Kedungwarak Dam	Genteng I Dam
1.	Direct Dam Construction Cost	65,871	13,998	205,325
(1)	Civil Construction Cost	(54,857)	(13,646)	(193,225)
(2)	Mechanical Construction Cost	(2,056)	(352)	(3,099)
(3)	Electrical Construction Cost	(8,957)	(0)	(9,001)
2.	Engineering Cost (1. x 10 %)	6,587	1,400	20,532
3.	Administration Cost (1. x 5 %)	3,294	700	10,266
I	Base Cost for Dam (1.+2.+3.)	75,751	16,097	236,124
II	Physical Contingency (I x 10 %)	11,363	2,415	35,419
III	Total Construction Cost for Dam and Related Facilities (I+II)	87,114	18,512	271,542
IV	Pump-up Facilities	46,260	62,440	-
V	Water Treatment Facilities	269,410	99,257	127,617
VI	Total Construction Cost of the Project (III + IV + V)	399,948	180,209	399,159

Annual O/M Cost		Beng Dam	Kedungwarak Dam	Genteng I Dam
(1)	Dam Civil Works (1.(1) x 0.5 %)	270	67	957
(2)	Mechanical Works (1.(2) x 3 %)	69	12	104
(3)	Electrical Works ((1.(3)) x 3 %)	317	0	318
(4)	Pump-up Facilities (IV x 3 %)	1,388	1,873	-
(5)	Electricity	2,538	3,259	-
(6)	Total for Dam & Pump-up Facilities	4,582	5,211	1,379
(7)	Water Treatment Plant			
	(Clean Water Production Cost)	44,323	16,330	20,995
	Annual Total of O/M Cost ((6) + (7))	48,905	21,541	22,374

Note : (1) Rp.118/kWh is applied for the electricity consumption cost
(2) Rp.300/m^3 is applied for clean water production cost

V.6.3 Water Resources Development Plan

V.6.3.1 Water Demand in 2020

Total water demand in the Brantas river basin forecasted towards year 2020 is shown below in terms of annual total and half year total during June to November which period is defined as the drought season:

Annual Net Total Demand : 2,642 million m^3
Net Total Demand in Drought Season : 1,310 million m^3

V.6.3.2 Alternative Measures to Cope with Future Water Demand

The Study selected the discharge record for 1977 as the ten-year drought discharge for which conceivable measures shall be taken not to cause water supply deficit against forecasted water demand in 2020.

The naturalized river discharge in 1977 obtained through the hydrological analysis in the Study shows its general feature as follows:

Annual Total Naturalized Flow	:	5,808	million m^3
Naturalized Flow in Drought Season			
(Total vol. during Jun. to Nov.)	:	819	million m^3
(Vol. during Jun. to Nov.excluding excess)	:	716	million m^3

As seen in the above, annual flow volume greatly exceeds demand in 2020, while about 639 million m^3 of deficiency in 6 months is conceived in the drought season. In order to supply such deficit, the existing water storage dam and several projects are considered as countermeasures.

(1) Existing Dam (Sutami and Lahor reservoirs)

Estimated effective storage volume in 2020 of the Sutami and Lahor dams in total is as follows:

HWL:272.5 m - LWL 260 m	:	97 million m^3
HWL:272.5 m - LWL 246m(Sutami) /253 m(Lahor)	:	136 million m^3

(2) Wonorejo Multipurpose Dam Project and Umbulan Bulk Water Supply Project

The following project under construction and committed for implementation will be expected to supply water to Surabaya and other area as follows:

Wonorejo Multipurpose Dam Project	:	89.4	million m^3 in 2000
(under construction)		35.3	million m^3 in 2003
Umbulan Bulk Water Supply (Committed)	:	60.7	million m^3 by 2005

(3) Proposed Development Projects

The Study identified the following three prospective projects in the Brantas river basin. The capacity of those dams in terms of the supply capacity in the 6 months drought period and its construction cost excluding the water treatment facilities are as follows:

Project		Capacity		Construction Cost	
Beng Dam	:	147	million m^3	Rp. 133,374	million
Genteng I Dam	:	70	million m^3	Rp. 271,542	million
Kedungwarak Dam	:	54	million m^3	Rp. 80,952	million

(4) Water Saving Measure in Irrigation Water Demand

The Study has proposed water saving by concrete canal lining to decrease seepage loss in the main and secondary canals of the existing 11 irrigation systems. Canal lining is presumed to save 3.5% to 6.5% of irrigation water. The unit cost of canal lining has been calculated at Rp.2,735,000 per ha. It is expected that the gross total demand of irrigation water in drought season could be saved by about 59.5 million m^3 in 2020 demand basis by concrete lining of main and secondary canals in the Brantas basin as a whole.

Irrigation Area	:	75,947	ha
Demand in Drought Season	:	683.47	million m^3
Possible Saving in Drought Season	:	59.50	million m^3
Construction Cost	:	Rp. 236,581	million

(5) Water Saving Measure in Industrial Water Demand

The Study has examined possible water recycling to improve water use efficiency of industrial water referring to practices in Japan. Assumed water recycling rates by industry to be achieved by 2020 are shown below:

Industry	:	Sugar	Paper	General	Whole
Rate of Recycling	:	45 %	43 %	52 %	49 %

Gross demand of industrial water in 2020 is assumed to be decreased by about 242 million m^3 (annual) or 144.5 million m^3 (semi-annual; June to November). Required cost for improvement of water use efficiency is supposed to be shouldered by respective factories.

(6) Effective Water Resources Development and Water Saving Measures

Water demand in the drought season and supply measures including the existing, construction on-going, implementation committed and proposed are summarized as follows as well as water saving measures:

	Water Demand	Water Resources and Water Saving			
		Development Capacity (million m^3)	Capacity Accumulated (million m^3)	Construction Cost (Rp.million)	Unit Water Cost (Rp/ m^3)
Net Total Water Demand in Drought Season in 2020 (million m^3)	1,355				
Naturalized Flow in Drought Period (10-year drought year; Jun. - Nov. excld. Excess)		716	716		
Existing Dams (estimated capacity as of 2020)					
Sutami/Lahor Dams(WL:272.5 – 260.0)		97	813		
Sutami/Lahor Dams(WL:260.0 – 246.0)		39	(852)		
Wonorejo Multipurpose Dam Project					
Wonorejo Dam		89.4	902 (941)		
Push-back Scheme		35.3	938 (977)		
Umbulan Bulk Water Supply(Committed)		60.7	998(1,037)		
Water Saving Measures(Net saving Demand)					
Irrigation(Canal Lining : proposed)		44.6	1,043(1,082)	236,581	922
Industry(Water Recycling : proposed)		28.9	1,072(1,111)	-	
Water Resources Development(proposed)					
Beng Dam(dam & pump-up)		147	1,219(1,258)	133,374	889
Genteng I Dam(dam)		70	1,289(1,328)	271,542	1,199
Kedungwarak Dam(dam & pump-up)		54	1,343(1,382)	80,952	1,091

Note : (1) Naturalized flow in drought period shows total discharge during 6 months of drought period excluding discharge in excess of demand in every 10 days.

(2) Accumulated capacity shown in a parenthesis shows that including the reservoir storage capacity between El.260.0 m and El.246.0 m in the Sutami and Lahor dams.

(3) Construction costs above show those excluding water treatment plant.

(4) Unit water cost is estimated based on the total construction cost including that of water treatment plant, land acquisition and resettlement costs and operation and maintenance cost.

Water demand in 2020 is forecasted in the Study at 1,355 million m^3 as shown in the table. To cope with this demand, the water resources by the projects including existing, under construction and committed ones are available for 998 million m^3(or 1,037 million m^3 in case that storage in the Sutami dam would be used up to the waterlevel of 246 m). Insufficient supply capacity of about 320 million m^3 should be covered by the proposed water resources development projects and projects to implement water saving measures.

Development of the Beng dam project is firstly recommended to cover water deficit to be expected in the year 2020 in case of 10 year drought year. However the Beng dam project is still insufficient for the 2020 demand and another water resources development would be required. Either of the Kedungwarak dam project or the Genteng I dam project should be considered, however priority of development will be subject to the further stage study. The Genteng I dam project is tentatively proposed as the second one in the Study to develop after the Beng dam project, although it has economic disadvantage, according to the following reasons:

(i) Larger supply capacity than the Kedungwarak dam project

(ii) Hydropower development will be included in the project

(iii) Advantageous location of the dam which is at upstream reaches of the Sutami dam.

Water saving projects such as irrigation canal lining and industry water recycling have rather high costs for implementation, however those economic index in terms of the unit water cost is almost same as that of proposed water resources development in case of 10 year construction period.

The study recommend to implement not only water resources development projects but also projects to decrease future water demand.

Operation of the Sutami and Lahor dams is recommended to use storage capacity effectively until WL.246.0 m(Sutami) in case of severe drought condition. The storage between WL.260.0 m(present operating minimum waterlevel) and WL.246.0 m shall be effectively utilized in the later period of the drought season. In such case, storage capacity should be restored earlier in the succeeding rainy season.

While in the normal year, it is preferable to keep storage capacity under WL.260.0 m as reserve capacity for unforseen severe drought condition.

V.6.3.3 Project Implementation Program

The implementation program of the water resources development project consists of the following projects:

(1) Wonorejo dam project (under construction)

The project will be commissioned in 2000 and the push-back scheme will be in the year 2003.

(2) Umbulan bulk water supply project (construction committed)

The Umbulan Bulk Water Supply Project would be commissioned by year 2005.

(3) Beng dam project(proposed)

The Beng dam project should be completed within the year 2009 and be available in 2010 for water supply.

(4) Genteng I dam project and/or Kedungwarak dam project(proposed)

The project(s) should be implemented between the years 2010 and 2020.

(5) Canal lining project of the existing major irrigation systems(proposed)

The construction is proposed for 10 years starting from year 2010.

Required costs for the implementation of the proposed projects is summarized as follows:

(Unit : million Rp.)

	Construction Cost	Land and Resettlement	Annual Operation / Maintenance	Water Treatment Plant
Beng Dam	133,374	132,000	4,582/year	269,410
Genteng I Dam	271,542	19,120	1,379/year	127,617
Kedungwarak Dam	80,952	62,900	5,211/year	99,257
Canal Lining	236,581	-	2,366/year	-
Total	722,449	214,020	13,538/year	496,284

The implementation program of the above projects are presented in Figure V.14.

V.6.3.4 Action Plan

The action plan for the period of 1999 to 2004 for the projects included in the implementation program consists of the following activities:

(1) Preliminary investigation and survey for the Beng dam project

(a) Hydrological investigation in the project area : 1999 - 2005

(i) Waterlevel and discharge at dam site

(ii) Rainfalls in the catchment area

(iii) Waterlevel at the proposed intake site in the Brantas river

(b) Investigation of the intake site in the Brantas river and water pump-up line between the intake and Beng dam sites : 1999

(c) Investigation of land use and resettlement requirement in the project area : 1999 - 2000

(2) Pre-feasibility studies and Feasibility

(a) Arrangement of technical assistance for the Pre-feasibility studies and Feasibility : 1999

(b) Pre-feasibility studies for the Beng dam, Genteng dam and Kedungwarak dam projects and Feasibility study for the Beng dam project : 2000 - 2001

(3) **Implementation**

(a) Fund arrangement for implementation : 2002

(b) Selection of the consultants for the implementation : 2002 - 2003

(c) Detailed design services for the Beng dam project : 2003 - 2004

(d) Procurement of the contractor(s) for the Beng Dam project : 2005

V.7 River Facilities

This section presents main results of the study on the master plan of river facilities. Detailed discussions and data not incorporated in this section are presented in the ANNEX-7 "RIVER FACILITIES" of the Supporting Report.

V.7.1 Improvement of Operational Function of the Existing River Facilities

As mentioned in the Section III.6, there are some problems to hinder the original function of river facilities. Out of them, problems due to sediment in the Sengguruh, Sutami, Wlingi and Lodoyo reservoirs are most serious in consideration of water use.

V.7.1.1 Sediment in Sengguruh and Sutami Reservoirs

(1) Present Condition of Sediment

The original functions of the Sengguruh and Sutami dams and present storage capacities of two reservoirs are summarized as follows.

Name of dam	Function
Sengguruh dam	- Peak power generation (by daily use of storage capacity)
Sutami dam	- Flood control (by use of storage capacity from FHWL to HWL) - Peak power generation - Water supply for irrigation, domestic and industrial use

Unit: million m^3

Name of Reservoir	HWL	LWL	Compl.	Survey	Gross storage			Effective storage		
					Original	Survey	%	Original	Survey	%
Sengguruh	292.5	291.4	1988	Jul.1996	21.5	3.4	15.8	2.5	1.2	48.0
Sutami	272.5	246.0	1972	Oct.1997	343.0	*183.4*	*53.5*	253.0	*146.6*	*57.9*

Source: Perum Jasa Tirta. *Italic* figures are estimated by the Study Team.

Decrease of the effective storage capacity of the Sengguruh reservoir is causing decrease of the operation hours of the peak power generation. In addition, in case of silting up of the Sengguruh reservoir, sediment discharge from the upstream basin will flow in to the Sutami reservoir and be deposited therein. The Sutami dam is the only facility on the mainstream of the Brantas River, to enhance water in dry season and to control flood discharge in rainy season. Therefore, decrease of the storage capacity due to sediment in the Sutami reservoir is most serious problem of the water use in the Brantas river basin.

Based on the previous survey results and present dredging works, sediment condition of the reservoirs are estimated as follows:

Sediment inflow to Sengguruh reservoir:	3.14 million m^3/year
Sediment deposit in Sengguruh reservoir:	2.24 million m^3/year
Sediment trap efficiency of Sengguruh reservoir:	0.713
Sediment inflow to Sutami reservoir:	0.90 million m^3/year
Sediment deposit in Sutami reservoir:	0.90 m^3/year

(2) Measures for Sediment

To control sediment inflow into the Sengguruh and Sutami reservoirs, construction of sabo dams is indispensable in the upstream basin. Considering the sediment material and available sites of the sabo dams, it is proposed to construct 17 sabo dams with total sediment storage capacity of 15.1 million m3. Based on the construction of the sabo dams, the following three alternatives are studied as the measures for sediment in the reservoirs. Details of alternatives are illustrated in Figure V.15.

Alt. 1: To maintain existing storage capacities in the Sengguruh and Sutami reservoirs, sediment deposits in the reservoirs will be removed every year by dredging, and the dredged material will be discharged to the Indonesian Ocean by the tunnel. In this alternative, the effective storage volume of the Sutami reservoir is estimated at 146 million m^3 in the year 2020.

Alt. 2: To maintain existing storage capacity in the Sengguruh reservoir and to maintain existing sediment rate in the Sutami reservoir, sediment deposits in the Sengguruh reservoir will be removed every year by dredging, and the dredged material will be discharged to the Indonesian Ocean by tunnel. In this alternative, the effective storage volume of the Sutami reservoir is estimated at 135.3 million m^3 in the year 2020. Development of small dam will be required, instead of the increasing works of effective storage capacity of the Sutami reservoir.

Alt. 3: It is difficult to dispose the dredged material due to the vast volume. Measures for sediment in the reservoirs are not carried out. The Sengguruh dam will have limited hydroelectric power generation as the run-of-river type. To secure the hydroelectric power generation of the Sengguruh dam, maintenance dredging will be carried out around the intake of the generator. In this alternative, the effective storage volume of the Sutami reservoir is estimated at 113 million m^3 in the year 2020. Development of small dam will be required, instead of the decrease of effective storage capacity of the Sutami reservoir.

The study results of the alternatives are shown in Table V.8. The construction cost and the benefit compared with no control of the sediment are summarized below:

Unit: million Rp.

Item	Alt. 1	Alt. 2	Alt.3
Construction Cost	1,328,602	851,816	143,979
Benefit	1,043,113	920,975	612,053
Benefit – Construction Cost	-285,489	69,159	468,074

Based on this result, Alternative 3 is proposed as the measures of the sediment in the Sengguruh and Sutami reservoirs. Therefore, it is required to consider the new water resources development, instead of increasing works of effective storage capacity in the Sutami reservoir.

V.7.1.2 Sediment in Wlingi and Lodoyo Reservoirs

(1) Present condition of Sediment

The Wlingi and Lodoyo dams are located at the southern skirts of Mt. Kelud in the upstream stretches of the Brantas River. Two dams were constructed for the purpose of efficient use of discharge from the Sutami dam. The original functions of the dams and present storage capacities of two reservoirs are summarized as follows:

Name of Dam	Function
Wlingi dam	- Peak power generation (by daily use of storage capacity) - Creation of water head for irrigation - Temporary storage of the erupted material of Mt. Kelud.
Lodoyo dam	- Afterbay of the Wlingi and Sutami dam (by daily use of the storage capacity) - Power generation

Unit: million m^3

Name of Reservoir	HWL	LWL	Compl.	Survey	Gross storage			Effective storage		
					Original	Survey	%	Original	Survey	%
Wlingi	163.5	162.0	1977	Nov.1996	24.00	4.97	20.7	5.20	1.41	27.1
Lodoyo	136.0	125.5	1983	Nov.1996	5.80	2.35	40.5	4.20	1.91	45.5

Source: PJT

Mt. Kelud, which is the main source of the sediment yield to the Wlingi and Lodoyo reservoirs, erupted in February 1990. After this eruption, the sediment filled up the Wlingi reservoir. As the solution measures, the sediment bypass channel from the Putih River to the downstream site of the Lodoyo dam is being constructed. And removal works of sediment deposits in the Wlingi reservoir were implemented through several stages of dredging and flushing.

Based on the previous survey results and previous reports, sediment conditions of the reservoirs are estimated as follows:

Item		Remarks
Upper Basin		
(1) Sediment yield:	2.07 mil.m3/year	
Wlingi reservoir		
(2) Sediment inflow:	1.43 mil. m3/year	
(3) Sediment deposit:	0.43 mil. m3/year	1993 – 1996: record
(4) Trap efficiency:	30 %	(3)/(2)
Lodoyo reservoir		
(5) Sediment inflow	1.00 mil. m3/year	(2)-(3)
(6) Sediment deposit	0.30 mil m3/year	(5)*(7)
(7) Trap efficiency	30 %	same as (4)
Bypass channel (incl. Extension to downstream site of Lodoyo reservoir)		
(8) Sediment discharge	0.64 mil. m3/year	K. Putih +K. Ganggangan

(2) Measures for Sediment

Considering the roles of the Wlingi and Lodoyo dams in the Brantas river basin, the following measures are studied. Details of the alternatives are illustrated in Figure V.16.

Alt. 1: Present role of each reservoir will be secured by mechanical dredging. That is, the effective storage volumes of two reservoirs will be restored for 5 years and will be maintained thereafter.

Alt. 2: In addition to the Alt. 1, the sediment bypass channel will be extended to the Semut river to reduce sediment inflow into the reservoirs. Proposed route of the sediment bypass channel is presented in Figure V.17.

Alt. 3: The sediment bypass channel will be extended to the Semut river. Until completion of construction of the bypass channel, dredging works in two reservoirs will be continued. After that, function of the afterbay for the Sutami reservoir will be converted from the Lodoyo reservoir to the Wlingi reservoir. That is, the effective storage capacity of the Wlingi reservoir will be maintained by the dredging works.

The study results of the alternatives are presented in Table V.9. Cost and benefit up to the year 2020 are summarized below:

Unit: Million Rp.

Item	Alt. 1	Alt. 2	Alt. 3
Cost (C)	494,548	404,636	256,245
Benefit (B)	1,317,259	1,317,905	1,154,248
B – C	822,711	913,269	898,003

Based on this result, Alternative 2 is proposed as the countermeasure against the sediment of the Wlingi and Lodoyo reservoirs in this study. However, the dredging volumes of the reservoirs are huge amount. In order to decrease of dredging amount, it is recommended to

study the actual sediment flushing effect of the Lodoyo reservoir and to establish the operation rule for the sediment flushing.

V.7.1.3 Project Implementation Program

To perform the above countermeasures, the implementation program shall be as follows.

(1) Construction of sabo dams in Upper Brantas basin.

To decrease sediment inflow into the Sutami dam, this project shall be carried out as soon as possible. The implementation program of this project is shown in the section of V.2 of this report.

(2) Maintenance Dredging in the Sengguruh reservoir.

To maintain the electric power generation, the maintenance dredging should be start in the year 1999 and be carried out in rainy season every year. In addition, to implement the works, it will be urgently required to establish the new operation rule of the Sengguruh dam as the run-of-river type hydroelectric power generation facility by mutual consent with PT PLN.

(3) Extension of sediment bypass channel to the Semut river

To decrease sediment inflow into the Wlingi reservoir and to save the dredging cost in the Wlingi and Lodoyo reservoirs, this project shall be completed within the year 2003. And to implement the works, it will be urgently required to make the detailed design of the bypass channel extension.

(4) Dredging in the Wlingi reservoir.

The restoration of the original effective storage capacity of the Wlingi reservoirs shall be completed within the year 2003. After completion of the restoration of reservoir and completion of extension of the sediment bypass channel, the dredging work for the reduced sediment inflow shall be carried out to maintain the effective storage capacity. For the implementation of the works, it is urgently required to make the dredging plan of the reservoir.

(5) Dredging in the Lodoyo reservoir.

The restoration of the original effective storage capacity of the Lodoyo reservoirs should be completed within the year 2003. After completion of the restoration, the dredging work shall be carried out to maintain the effective storage capacity. For the implementation of the works, it is urgently required to make the dredging plan of the reservoir. In addition, to decrease of dredging amount, it is recommended to study the actual sediment flushing effect of the Lodoyo reservoir and to establish the operation rule for the sediment flushing.

Required costs for the implementation of the proposed works are summarized as follows:

Unit: million Rp.

	Period	Construction Cost	Annual O/M cost
Senggunuh reservoir	1999 -- 2020	649/year	-
Sediment Bypass Channel	1999 – 2003	50,729	381/year
Wlingi Reservoir	1999 – 2003	14,428/year	-
	2003 – 2020	7,679/yaer	-
Lodoyo Reservoir	1999 – 2003	9,215/yaer	-
	2003 – 2020	8,933/year	-

The implementation programs of the above works are presented in Table V.10.

V.7.2 OMR Works After Consolidation of PKB, PGKS and PJT

(1) Demarcation on Management of River Facilities

After consolidation of PKB, PGKS and PJT, the consolidated body (hereinafter tentatively referred to New PJT) will be authorized as the authority of rivers in the Brantas river basin by the Ministry of Public Works and be fully responsible for implementing water resources management in the Brantas river basin.

Since there are so many rivers and river facilities in the Brantas river basin, those may not be managed thoroughly by only agency, that is, New PJT. Therefore, it is recommendable that a part of the management of rivers and river facilities in the Brantas river basin be delegated to the other agencies, except a kind of important works. Criteria on demarcation are recommended as follows:

Works not to be delegated to the other agencies

The following works should not be delegated from New PJT to the other agencies:

(a) Responsibility for making and keeping of the ledgers of the rivers (ledger of river facilities and ledger of water right).
(b) Responsibility for establishing of river basin master plan.
(c) Responsibility for technical recommendation to the Minister of Public Works for approval of water right.

Rivers

River management shall be executed by dividing them into following three stretches and delegating responsibilities for the management of their various subdivisions, except responsibilities described above.

(a) River stretches directly managed by New PJT
(b) River stretches managed by provincial governor
(c) Rivers stretches managed by the head of regencies

River facilities

The river facilities shall be classified into two (2) categories, namely the managed facilities and the permitted facilities.

(a) Managed facilities mean the facilities directly operated and maintained by the river authority.

(b) Permitted facilities mean the facilities constructed and managed by the other authorities, parties or persons to achieve the own purposes, under permission of the river authority.

In accordance with the above criteria, the rivers and river facilities to be managed by the New PJT are proposed as presented in Figure V.18. In addition of these rivers and facilities, the sabo facilities constructed and managed by PGKS are also proposed to manage.

(2) Organization and Staffing

In order to perform the OMR works of the proposed rivers and facilities including sabo facilities surely, site operation units and assistance and monitoring units are required within New PJT.

Proposed organization of New PJT is described in the later section VI.5. Within this organization, implementation units and required manpower directly to operate and maintain the rivers and facilities are estimated and summarized below:

Directorate/Division	Required Manpower (persons/year)
Directorate of Infrastructure/ Division of OM	
- Division of Up-Stream:	102.0
- Division of Down-Stream	118.0
Directorate for Technical Affair:	
- Bureau of Research and Development:	3.0
- Bureau of Technical Planning:	9.5
- Bureau of design	14.5
Total	247.0

Note: Manpower for indirect works is not included.

(3) Annual OM cost

To operate and maintain the rivers and facilities managed by PJT sufficiently, PJT estimated standard annual OM budget based on frequencies of OM works, unit prices of the works and accumulated experiences.

Annual OM cost for New PJT is studied by the Study team based on the PJT's estimate. Estimated cost without personnel expenses and indirect cost is presented in Table V.11. Therefore, total OM cost is summarized below:

Unit: Million Rp./year

Item	Amount	Remarks
Direct OM cost:	23,335	
Personnel expenses:	2,470	10.0 Million Rp/person/year
Indirect cost:	5,161	(1 + 2) x 20%
Total:	30,966	

Considering the total investment cost in 1977, required cost of the OM works will be corresponded to one percent of the investment cost.

V.7.3 Action Plan

In order to prepare New PJT by consolidation of PKB, PGKS and PJT in 2002 and change of status from Perum to Persero in 2005, the followings will be required to the OMR of the river facilities:

1999 - 2001

(a) Making of the ledgers of the rivers (ledger of river facilities and ledger of water right) in the whole Brantas river basin: 1999-2001.
(b) Preparation of OM method and arrangement of manpower for OM of the Wonorejo dam: until 2000.
(c) Establishment of demarcation of the river stretches and river facilities among related agencies based on the ledgers of the rivers: 2000-2001.
(d) Establishment of standard for approval on the construction of river facilities by mutual consent with related agencies: 2000-2001.

2002 – 2004

(a) Stipulation of the operation rules for all river facilities in the Brantas river basin by mutual consent with related agencies, to avoid the conflicts and disputes on the water resources management: 2002-2003.
(b) Establishment of authorized method of the budget estimates for OMR activities: 2002-2003.
(c) Making of a consensus among beneficiaries about allocation of OMR cost: 2003-2004

V.8 Effective Operation of Water Resources

This section presents main results of the study on effective operation of water resources. Detailed discussions and data not incorporated in this section are presented in the ANNEX-8 "EFFECTIVE OPERATION OF WATER RESOURCES" of the Supporting Report.

V.8.1 Reservoir Facilities in the Basin and its Present Conditions

At present, There are four dams for purpose of water supply and flood control in the Brantas river basin. Catchment areas, design effective storage volume and design functions of those dams are shown below:

Dam Name	River	Catchment Area (km^2)	Completed Year	Effective storage V (Million m^3)	Function
Sutami	Mainstream	2,050.0	1972	253.0	F/C, W/S & P/G
Lahor	Lahor	160.0	1977	29.4	Auxiliary dam for Sutami dam
Selorejo	Konto	89.5	1970	50.1	F/C, W/S & P/G
Bening	Bening(Widas)	236.0	1982	28.4	W/S & P/G

Remarks, F/C: Flood Control, W/C: Water Supply, P/G: Power Generation

Out of them, the Sutami and Lahor dams are connected by tunnel channel and the both dams are functioning as one dam in the mainstream of the Brantas River. The Selorejo and Bening dams are located in the tributaries, so that the water supply ability is limited in the respective tributary basin. Therefore, the Sutami dam with the Lahor dam are the only facility for water supply and flood control in the mainstream of the Brantas River.

The reservoir operation in the Brantas river basin is executed based on the reservoir operation patterns (POLA) dividing into the dry and rainy seasons. The patterns are determined by Provincial Water Management Committee among the patterns prepared by PJT on the basis of water allocation forecast for wet season water, normal water and low-water. Performance of the practical operation based on POLA is monitored by PJT through the telephone and/or observation equipment of the flood forecasting and warning system (FFWS).

V.8.2 Reallocation of Water

At present, the water supply from the Sutami and Lahor dams has been executed to satisfy the water allocation determined by POLA. Actual intake discharges of the major intake facilities are summarized below:

Unit: Million m^3

Name of Intake	1995		1996	
	Pola	Actual	Pola	Actual
Voor I and II canals	685.79	1153.43	653.09	1161.98
Mlirip	630.72	1581.06	632.45	1326.21

Menturus	53.44	49.32	54.12	84.28

Unit: Million m^3

Name of Intake	1995		1996	
	Pola	Actual	Pola	Actual
Jatimlerek	30.28	29.09	29.08	35.14
Warujayeng	235.14	256.89	231.15	232.29
Turitunggorono	226.14	250.91	246.98	250.55
Lodagung	242.42	239.82	245.17	246.39

As the results, excessive water is allocated to the intake at the downstream site as the residual water. This result indicates the following matters:

(a) In case of that the basin's run-off flow in the downstream stretch from dam is more than the forecast run-off discharge at the time of preparation of POLA, much water is actually taken at the downstream intake as the residual water.

(b) In reverse case of the above which is less basin's run-off inflow, shortage of water at the downstream intake is covered owing to water reserved in the allowable range of change of reservoir water level.

(c) Accordingly, the intake discharge at the downstream intake is always excessive than run-off flow from the upper basin. That is different from the water allocation determined by POLA.

It is difficult to cultivate land immediately, however, it is efficient to reallocate the excessive intake discharge at the downstream side to the other intakes with potentially cultivated area in the upstream basin. At present, PJT is able to grasp the low-water flow utilizing observation equipment of FFWS, and the major irrigation water in the mainstream of the Brantas River is taken by the weir with gate facilities. Considering the above, it is possible to change the water allocation to the most suitable one on the way of actual operation of a POLA, technically.

The water demand will be increased in future, and proper water allocation is indispensable. Therefore, it is recommended to perform the water reallocation flexibly and properly on the way of actual operation of a POLA.

V.8.3 Operation of Sutami Dam

The existing water supply of the Sutami dam, in principal, has been executed on the basis of POLA determined by water allocation utilizing reservoir volume from reservoir water level EL.272.0m to EL.260.0m. That is, reservoir volume from EL.260.0m to EL.246.0m (LWL) is not used for extra room except an example which the said volume was used in the low-water year in the past. According to the record from 1977 to 1996, the lowest water level in the reservoir was EL.247.81m in November 1977.

With regard to operation rule of the Sutami dam, essentially, it is desired to set up to the range of LWL. However, at the present time, since the proper forecast of reservoir inflow is not

established yet, it is worry to empty the reservoir volume for water supply in the case of POLA to use the reservoir volume up to LWL.

Based on the above circumstances, it is recommended to prepare the water allocation and reservoir operation pattern applying the same method of POLA preparation assuming that reservoir volume from HWL to LWL is used on the basis of 1977 year flow data which is low-water with 10-year return period. In the practical operation, this water allocation and reservoir operation pattern will be used as a reference, in order to judge the condition of drought quickly, to make the measures for drought precisely and to use the reservoir storage effectively.

The above proposal is tentative proposal until establishment of proper inflow forecast. Therefore it is desired to prepare operation rule which is used the reservoir volume up to LWL based on proper inflow forecast.

V.8.4 Integrated Operation of Wonorejo and Sutami Dams

At present, the Wonorejo multipurpose dam project is under implementing in the Ngrowo river basin. The purpose of the project is as follows:

(a) to supply raw water for Surabaya and its vicinity in dry season for municipal and industrial use with supplementary maintenance water for the Surabaya River,

(b) to control floods from the Song and Gondang Rivers, and

(c) to generate electric power for local use.

The water conveyance system of in the Ngrowo river basin after completion of construction of the project is presented at Figure III.19. According to the plan, totally 31.5 million m^3 of municipal and industrial water will be supplied to Surabaya from the Wonorejo reservoir through the Tiudan diversion canal and from the Parit Agung Canal pushed back by the Tulungagung pump station (completion in the year 2003). Therefore, two facilities will be used for water supply in future, that is, the Sutami dam and the Wonorejo dam. However, the integrated operation rule of two facilities is not yet formulated.

In this study, from the view of the integrated operation of two facilities, simple simulation study is carried out about following three cases by using the water balance study model described in previous section V.5:

Case 1: Priority to the water supply from the Sutami dam. Deficit of water will be supplied from the Sutami dam and the Tulungagung pump station, firstly. After empty of the Sutami reservoir, deficit of water will be supplied from the Wonorejo dam and the Tulungagung pump station. Water supply capacity of the Tulungagung pump station is considered 1.18 m^3/s as the dependable firm discharge of the push back scheme.

Case 2: Priority to the water supply from the Wonorejo dam. Deficit of water will be supplied from the Wonorejo dam and the Tulungagung pump station, firstly. After empty of

the Wonorejo reservoir, deficit of water will be supplied from the Sutami dam and the Tulungagung pump station.

Case 3: Effective storage capacity basis: Deficit of water will be supplied from the Tulungagung pump station, firstly. Remained deficit of water will be supplied from the Sutami dam (62%) and Wonorejo dam (38%) at the same time on the basis of ratio for the effective storage volumes.

Simulation results for various natural flow conditions in dry season under the present demand in 1996 are shown in Table III.8.*. This simulation is the roughly estimate, however, the following matters can be considered and recommended.

(a) As drought condition becomes serious, it is not recommended to give the priority to the water supply from the Sutami dam. In case of empty storage of the Sutami reservoir, deficit of water will not be supplied from the Wonorejo dam sufficiently, because the maximum water supply from the Wonorejo dam is limited to 15.0 m^3/s by the Tiudan diversion canal.

(b) Considering benefit of power supply in the stretches from the Sutami dam to the confluence of the Ngrowo River, it is not recommended to give the priority to the water supply from the Wonorejo dam.

(c) Based on the above, therefore, it is recommended to give the priority to the water supply from the Sutami dam in the ordinary drought condition and to allocate the water supply to both dams on the basis of the storage capacities, during the decision of POLA and on the way of actual operation.

(d) The low flow forecasting is the basic matter of the integrated operation of the reservoirs, therefore, it is desirable to study and formulate the low flow forecasting method.

V.8.5 Action Plan

In order to prepare establishment of New PJT by consolidation of PKB, PGKS and PJT in 2002 and change of it's status from Perum to Persero in 2005, the followings will be required for the effective use of the water resources:

1999 - 2001

(a) Set up of tentative rule for water allocation and reservoir operation of the Wonorejo dam by mutual consent with related agencies: 1999.

(b) Establishment of proper water allocation rule including water reallocation during operation by mutual consent with related agencies, and monitoring of reallocation of water: 1999 – 2001.

(c) Set up of the study for POLA to prepare the water allocation and operation pattern for the low-water pattern with 10-year return period as a reference of the practical operation: 1999 – 2000.

2002 – 2004

(a) Set up of tentative rule for water allocation and operation of the Wonorejo dam system including the Tulungagung pump station by mutual consent with related agencies: 2002.

(b) Establishment of the proper low flow forecast in the Brantas river basin including the Ngrowo river basin: 2002 –2003.

(c) Detailed study on the integrated operation method of the Wonorejo dam system and the Sutami dam: 2002 – 2003.

(d) Establishment of the integrated operation rule of the Wonorejo dam system and the Sutami dam by mutual consent with related agencies: 2003 – 2004.

V.9 Monitoring and Information System

This section presents main results of the study on the master plan of the Monitoring and information systems. Detailed discussions and data not incorporated in this section are presented in the ANNEX-9 "MONITORING AND INFORMATION SYSTEM" of the Supporting Report.

V.9.1 Improvement Plan of Existing FFWS

Improvement plan of the FFWS is proposed hereunder.

V.9.1.1 Improvement of Observation System

(1) Water Level Gauge

Improvement of five water level gauging stations, which do not function well in dry season under influence of sedimentation and river bed erosion, is proposed as follows:

- Three stations should be shifted (Gadang, Jeli, Kertosono).
- Two stations should be lowered the lowest limit of gauging range (Ploso, Porong).

(2) Manual Operation for Outflow data

Improvement plan, which will reduce the delay of manual typing into the Setting Panel for automatic data polling, is proposed from two points of view; deepening operator's awareness mentioned in **V.9.1.2 (1)** and supporting the discharge calculation.

For supporting the discharge calculation, Equipment for calculation should be prepared. A personal computer should be set up at the dam and weir offices and software for discharge calculation will be installed. The software, which has formula and coefficient required for discharge calculation, can make the manual operation short.

(3) H-V Curves in FFWS

It is required that H-V curves can be changed easily and inexpensively without changing of the ROM. For this requirement, FFWS should be modified to be able to change H-V curve by input on keyboard.

(4) Effective Use of Telemetering Data

Problem, which is obstructive to the effective use of telemetering data like use for the verification of flood forecasting program and use for required hydrological analysis, are caused by capacity of memory of FFWS and a limited use of the stored data. To solve this problem, conceivable countermeasures are as follows:

- To establish the database system with large storage capacity for hydrological data from FFWS. For this purpose, modification of FFWS is required to adapt the new database system.
- Analysis system for flood forecasting of FFWS should be modified to use the past hydrological data from the new database system.

The hydrological database system should include other hydrological data (not FFWS) for effective use.

V.9.1.2 Improvement of Ability of FFWS's Staff

(1) On the Job Training for Deepening Operator's Awareness about FFWS

For deepening operator's awareness, FFWS operator at sites should be educated about necessity and importance of FFWS through on-the-job training at M/S in PJT head office. At the same time, the staff of M/S is to be sent to the sites to know well the actual condition of the operation.

(2) Basic Training of Flood Forecasting

To deepen their understanding of flood forecasting and the program, training of staffs are required regarding the following matters.

- Learning of a knowledge of flood forecasting
- Learning of a foundational knowledge of programming

(3) Trial Operation of FFWS

A trial operation of FFWS should be done in every year before rainy season. Purpose of the trial operation is to get skilful of the required action by the all staffs for flood control (contents of the trial operation are mentioned in Annex 9).

V.9.2 Improvement Plan of Low Water Management

V.9.2.1 Information System for Low Water Management

In view of the situation of the existing low water management, it is recommendable that clear standards on water allocation against drought be established and the committee get the information on discharge of river and water volume in reservoir habitually so that the committee could take a proper and prompt action against the drought.

For that reason, the information monitored and managed by PJT shall be given to all the agencies concerned. Establishment of Information system for low water management is required. This system is included in the Inter-agency Information System described in the next sub-section **V.9.3.**

V.9.2.2 Water Quality Database System

To avoid the duplication of water quality monitoring and to manage the water quality monitoring efficiently, the intensive monitoring under supervision by one agency is required. Based on this consideration, it is recommended that the water quality monitoring should be supervised by PJT and the monitored data should be managed by PJT.

Furthermore, the Study team has recommended to establish a laboratory in Malang. And automatic water quality monitoring stations will be established at the Wonorejo project.

The above situations mean that water quality data and data user will increase. Accordingly, management of water quality data by PJT will become more important.

To manage the monitoring data of the water quality efficiently and to keep water quality data as a common property with related agencies, establishment of water quality database system connected to the Internet are required. This system is included in the Inter-agency Information System described in the next sub-section V.9.3.

V.9.3 Establishment of Inter-agency Information System

V.9.3.1 Background

This Study team proposes to reorganize the water resources management system. Proposed management system will be required to be operated through cooperation of all the agencies concerned.

At present, there are much useful information under many agencies concerned with the water resources management in the Brantas river basin. However, it seems that the information of one agency is not used effectively by other agencies, due to the problems of information management in each agency and problems of information exchange between agencies.

In consideration of the above matters, the unified management of data and information will be essential for the water resources management with cooperation of agencies concerned. Therefore, it is required to establish the information management (exchange) system linking all the agencies concerned with water resources management (= Inter-agency Information System).

V.9.3.2 Basic Principle of Inter-agency Information System

Basic principles of Inter-agency Information System are as follows:

- New PJT (or PERSERO Jasa Tirta) should be able to grasp the situation of management and information related to the management by all agencies concerned with the water resources management in Brantas river basin.
- The agencies concerned should be able to get necessary information quickly through New PJT for their activities for water resources management.

V.9.3.3 Outline of Inter-agency Information System

(1) Agencies and Information Flow of Inter-agency Information System

(a) Members

Members of this system are selected as related agencies to the water resources management and as water users in Brantas river basin listed below.

	Management	ol Management	lity Management/ rces Development	ty Management	onment Management	
	utanan	ible agency)	iran, anian, DPRIND	BBLH(BAPEDALDA), Karya,		cooperative

(b) Information Management

Information, which are collected, managed and used by New PJT (or PERSERO Jasa Tirta) and agencies concerned, are shown in Table V.9.1. The information are categorized into two kinds. One is information to be accumulated and used like the results of river survey. Another is information to be monitored in real-time like river discharge.

i) Management of information accumulated

PJT should collect and arrange the information from agencies concerned for supervising the overall water resources management in the Brantas river basin.

And, PJT should manage the information and make them utilizable as common information open to all agencies concerned for the effective use of information for each agency's activities.

Related agencies should arrange their information to provide for the system.

New PJT (or PERSERO Jasa Tirta) should manage the essences of the information by the following reasons:

- To avoid excessive centralization of huge amount of data and information.
- Each competent agency can manage each sector's data and information from their expertise viewpoint and consequently updating data and information will be easier.

Accordingly, each agency should continue to manage the detailed information they have. In addition, each agency should make summaries of the information.

ii) Management of information monitored in real-time

The monitoring data which are collected in real-time by PJT, should be provided to agencies concerned understanding the water situation in the Brantas river basin. At that time, visualization of the data is desirable.

Information management at each agency are shown in Table V.9.2.

(c) Information Flow

Information flow of the Inter-agency Information System is shown in Figure V.20.

(2) System facilities

In accordance with the information flow mentioned above, network for information management system should be built up.

(a) Network Structure

New PJT (or PERSERO Jasa Tirta) offices, dam/weir offices and offices of agencies as constituent of the network are scattered all over the place in Brantas river basin.

The Study Team proposes Wide Area Network (WAN) using dedicated service lines(refer to Annex 9 about the decision).

Local Area Network(LAN) in New PJT (or PERSERO Jasa Tirta) head office and branch office, terminal computers of WAN in each agency's are proposed to install.

In addition, New PJT (or PERSERO Jasa Tirta) should send information to agencies of ministry concerned in DKI Jakarta using Internet.

(b) Hardware and Software

Major facilities of LAN in New PJT and, major facilities in each agency concerned, dam/weir office of New PJT (or PERSERO Jasa Tirta) and regency's office are proposed. Details of facilities are mentioned in Annex 9.

(3) Operation and Maintenance

Required staffs for operation and maintenance of Inter-agency Information System in New PJT (or PERSERO Jasa Torta) are proposed as system manager, coordinator, computer system engineer and operator.

System manager, computer system engineer will work at the head and branch offices of New PJT, but work for technical support of other offices.

Electrical and electronic devices like personal computer of the system will be updated to keep the function of the system once per 5 years on the assumption that life span of the devices are 5 years under the normal use.

(4) **Tasks to be Conducted upon Introduction**

(a) Coordination with Agencies Concerned

Coordination between New PJT and agencies concerned is required about management of Inter-agency Information System. The coordination should be done through a committee consisting of responsible unit of New PJT and representative of each agency concerned. Under this committee, policy and rule of this system management should be agreed.

(b) Training of Staff

For effective use of Inter-agency Information System, end users should be skilful in using Inter-agency Information System. Accordingly all staff should be trained for the system.

(c) Risk Management of Inter-agency Information System

Against conceivable crises, measures should be prepared (refer to Annex 9 about details).

V.9.4 Cost estimate and Implementation Program

Cost estimate and implementation program of proposed works are as follows.

V.9.4.1 Cost Estimate

Project cost are estimated as construction cost, additional equipment and software cost, engineering services cost and administration for these activities.

Estimated cost are listed below.

Project	Preliminary project cost (million Rp.)
Improvement of existing FFWS	938
(a) Improvement of WL gauging stations	323
(b) Installation of PC for outflow calculation	135
(c) Modification of FFWS	357
(d) Engineering services (10% of the total (a)+(b)+(c))	82
(e) Administration cost (5% of the total (a)+(b)+(c))	41

(continued)

Project	Preliminary project cost (million Rp.)
Establishment of Inter-agency Information System	5,729
(including Information system for low water management, water quality database system)	
(a) Equipment	4,982
(b) Engineering services (10% of (a))	498
(c) Administration cost (5% of (a))	249

Physical contingency (15% of the total cost of each items) is considered to the respective cost items.

V.9.4.2 Project Benefit

(1) FFWS and LWMS

One of functions of FFWS is to provide accurate information on a flood before the flood comes. By this information, following benefits are brought about.

- Effective operation of flood control facilities
- Effective flood fighting activities
- Decrease of damage to human life and household goods by taking refuge

New PJT can monitor accurate and actual water supply at intakes from the Brantas river by LWMS. Obtained information will be useful for proper water reallocation.

(2) Inter-agency Information System

The expected effects of this system are as follows:

- Time and trouble for collection, processing and utilization of information will be saved because of common information managed and digitization of basic information. Accordingly, quick implementation is expected.
- Communication expense for information exchange will be saved.
- Agencies will implement each sector's work effectively to utilize information from the result of other agencies studies.

V.9.4.3 Implementation Program

(1) Implementation Program of FFWS

Improvement of FFWS which is managed by PJT at present, should be completed before the consolidation of PKB, PGKS and PJT.

In order to improve FFWS, the following sequence of implementation is needed.

- Improvement of water level gauging stations	
Survey and detailed design	1st year
Construction	2nd – 3rd year
- Installation of personal computers for outflow calculation	
Preparation of conditions for outflow calculation	1st year
Development of the software and installation	2nd – 3rd year
- Modification of FFWS	
Investigation of existing conditions of FFWS	1st year
Modification and training	2nd – 3rd year

Implementation schedule is shown in Figure V.21.

In the figure, operation and maintenance cost is estimated as the replacement cost of the whole electric and electronic facilities of FFWS and personal computers.

Here, electric facilities of FFWS will be updated once per 10 years on the assumption that life span of the equipment is 10 years. The updating will be conducted in 3 years on the assumption that the requirement of the updating will not spring up at the same time. Similarly, personal computer and automatic water quality monitoring facilities will be updated once per 5 years for their life spans.

The cost of the electric facilities of FFWS is estimated based on the cost of the existing facilities of FFWS.

(2) Establishment of Inter-agency Information System

Inter-agency Information System is one of the required functions of New PJT(or PERSERO Jasa Tirta) for water resources management. The operation of the system should be started after the consolidation of PKB, PGKS and PJT as soon as possible.

In order to establish Inter-agency Information System, the following sequence of implementation is needed.

- Coordination with agencies concerned	1st year
- Investigation of present information management and evaluation for general design of the System	2nd year
- Detailed design of the system	3rd year
- Installation, test and training	4th – 6th year

Implementation schedule is shown in Figure V.21.

In the figure, operation and maintenance cost is estimated as the replacement cost of the hardware of this system.

Here, hardware of this system will be updated once per 5 years based on the life span of the equipment. The updating will be conducted in 2 years on the assumption that the requirement of the updating will not spring up at the same time.

V.9.5 Action Plan

In order to prepare New PJT by consolidation of PKB, PGKS and PJT in 2002 and change of status from Perm to Persero in 2005, the following will be required to the best use of FFWS and the suitable Inter-agency Information System introduction and effective use of the system.

1999-2001

(a) Improvement of facilities and preparation of competent operation staff to make the best use of FFWS and LWMS.

(b) Preparation for establishment of Inter-agency Information System in cooperation with agencies concerned under the guidance of the specialist.

- Decision of basic policy of Inter-agency Information System.
- Analysis and evaluation of present information management.
- Design of the optimum system plan.

2002-2004

Introduction of Inter-agency Information System.

- Installation of equipment for the system and test of operation.
- Training of the system manager of New PJT and end users.