DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT
MINISTRY OF PUBLIC WORKS
REPUBLIC OF INDONESIA

TUNTANG/JRAGUNG RIVERS BASINS

INTEGRATED DEVELOPMENT PLAN

SPECIAL REPORT I

MUNICIPAL AND INDUSTRIAL WATER SUPPLY

NOVEMBER 1979

SUBMITTED BY

PRC ENGINEERING CONSULTANTS, INC.
ENGLEWOOD, COLORADO, U.S.A. SEMARANG, INDONESIA

TUNTANG/JRAGUNG RIVERS BASINS INTEGRATED DEVELOPMENT PLAN - SPECIAL REPORT I - MUNICIPAL AND INDUSTRIAL WATER SUPPLY - PRC/ECI

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PREFACE

The Directorate General of Water Resources Development (DGWRD) of the Ministry of Public Works, Government of Indonesia (GOI) contracted PRC Engineering Consultants, Inc. (PRC/ECI) to provide consulting engineering service for preparing an integrated development plan for the Tuntang/Jragung Rivers in the Jratunseluna Basin. The study for the preparation of the plan started on May 16, 1979 and was scheduled to be completed on November 30, 1979.

An Interim Report on the study was submitted by PRC/ECI on August 15, 1979 which was reviewed by all the concerned agencies and later discussed on September 24, 1979 in a meeting held by the DGWRD at Jakarta. In that meeting and in subsequent discussions between PRC/ECI and DGWRD, it was the consensus of opinion of all the participants that it would be very beneficial if the study on the Tuntang/Jragung Rivers could be modified by including the entire Jratunseluna Basin in certain aspects of the study. In that modified study the interrelationships of the existing, proposed and the potential development works of the Tuntang/Jragung subbasins and those of the adjoining subbasins within the Jratunseluna Basin should be examined. Thus, the master plan for the development of the Jratunseluna Basin which was prepared earlier by NEDECO in the year 1973, would be reviewed and updated. The changes in criteria and constraints which have occurred and the large amount of new data which has become available since preparation of the original master plan would be incorporated in the modified study for formulating a conceptual optimized development plan.

For the preparation of the integrated development plan for the Tuntang/Jragung Rivers, as contemplated originally, reports were prepared in all the related fields for supporting the proposed plan. Those reports were to become appendices to the final report on the integrated development plan. However, due to the proposed modification

of the study to increase its scope in certain aspects to include the entire Jratunseluna Basin it has become necessary to either rewrite or modify some of the supporting reports related to the specific fields of the modified study. Those modified reports will then be appended to the final report for the updated Jratunseluna Basin development plan.

There were certain such supporting reports which were written exclusively for the originally proposed integrated development plan for the Tuntang/Jragung subbasins. The subjects covered by those reports will not be studied further in the modified study for updating the Jratunseluna Basin Development Plan. It was, therefore, decided to produce and document those reports as Special Reports. This Special Report I on Municipal and Industrial Water Supply is one of the three such reports thus produced.

Semarang, November 1979 PRC Engineering Consultants, Inc.

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SPECIAL REPORT I

MUNICIPAL AND INDUSTRIAL WATER SUPPLY

I.1. GENERAL

The municipal and industrial water supply in Semarang has historically been less than the demand. In recent years this has been due mainly to limited resources of raw water, but has also been aided by a shortage of treatment, transmission and distribution facilities. The water shortage has forced a large percentage of the population to use canals, shallow wells, streams and drainage ditches not only for bathing and cleaning, but in many cases, for their cooking needs and drinking water also. The use of these water sources within a densely populated area such as the city of Semarang causes health problems due to pollution of the water. This shortage has likely curtailed industrial growth in the city as well.

In recent years, the demand for municipal and industrial water in Semarang has increased, and is expected to increase substantially in the future as well. This increase in demand will be heightened by annexations to the city accomplished in 1976 and intentions to develop Semarang as an industrial center with an international harbor.

This report will project water demands for the city of Semarang to the year 2000. This will be done by making population projections to the year 2000 based upon acquired population data to 1978 and analysis of anticipated growth. The analysis of anticipated growth will be based substantially upon historic growth data, development plans set by the Regional Government of Semarang, projections made by the Central Java Government Census and Statistical Section, and a knowledge of efforts by the Indonesian government to reduce birth rates on the island of Java.

This water demand projection is not intended to lessen the usefulness of previous water projections made for the Semarang area, specifically those made in the Water Supply Master Plan for the City of Semarang, Indonesia, Burns and McDonnell/Trans-Asia, 1976 [1]. In fact, information contained in that report was utilized heavily in preparation of this projection. Rather, this study is designed to present an additional independent evaluation of water demand for Semarang, utilizing the most recent available data.

Following development of the projected demands for the city of Semarang, potential water supplies to meet the demands will be analyzed. This report will concentrate mainly on potential supplies from the Tuntang and Jragung River Basins, although all water sources will be analyzed to some extent. The results of the operation study being done concurrently will determine the availability of the various surface supply alternatives within the optimized water development plan of the Tuntang and Jragung River Basins.

This report will also analyze projected demands and supplies for other water users within the service area or basins of the Tuntang and Jragung Rivers. By taking into account these demands, together with the demands of the city of Semarang, the total potential water requirements for municipal, industrial and rural water users within the Tuntang and Jragung River Basins can be developed.

I.2. STUDY AREA FOR THE CITY OF SEMARANG

The area analyzed is the land within the boundaries of the city of Semarang, as shown on Figure I-1. This area was increased by the May 19, 1976 annexation of five outlying districts. These districts, Genuk, Ungaran, Gunung Pati, Mijen, and Tugurejo, were added to the original city of Semarang, which also was divided into districts, known as Timur, Utara, Tengah, Barat and Selatan. The total area of Semarang is now 354 square kilometers following the annexation of 255 square kilometers.

Population data acquired from the Semarang Municipal Office of Regional Government now include the population of the annexed area of Ungaran with the population of the original city. To be consistent with the acquired data, and to make this projection as useful as possible for city officials, Ungaran will be considered with the 5 districts of the original city in all analyses in this report.

I.3. POPULATION PROJECTIONS FOR THE CITY OF SEMARANG

The future population of Semarang is heavily dependent upon the accomplishment of the goals set forth by the Regional Government of Semarang Municipality. These goals are presented in Main Policies of City Planning, Regional Government of Semarang Municipality, Master Plan for Semarang 1972-1992 [2].

The policies are essentially designed to develop Semarang as an industrial center. Planning and promoting industry in the Semarang area is the major impetus of the policy. To aid in implementing the goals for the Semarang area, a land-use plan was developed. The plan is designed to be utilized as a guide for future city development. The plan, given in Figure I-2, identifies locations within the Semarang area for various land uses, and gives the total area to be occupied for each land use. To aid in attracting industry, improvements for the traffic flow, drainage patterns, and substandard housing are proposed. New housing areas are to be constructed, along with additional parks, open areas and amusement centers. City officials hope that these improvements and new construction will help encourage the development of industry in the area.

Any population projection must analyze the proposed development of a given area to be accurate. In the particular case of Semarang, the proposed development plans are extensive in scope, and ambitious in nature. To properly analyze this community, it is felt to be necessary to propose two projections, one based upon development of the community in accordance with the Master Plan policies and goals, and another based upon less ambitious development.

At the present time the two projections may cause confusion. However, in the years to come the development of the city in comparison with the Master Plan policies will become known, and one of the two projections will demonstrate a higher degree of accuracy.

I.3.1. Population Data

Population data were obtained from the Semarang Municipal Office of Regional Government. The population for the original city of Semarang was provided for the years 1965 to 1976. For the years 1976 to 1978 the population was given for the original city, plus Ungaran, and for the other 4 areas annexed in 1976. These data are given on Table I-1. Also included in Table I-1 are several figures used in a previous report [1]. These data were derived from a different source, and, therefore, its accuracy cannot be verified. However, the figures correspond closely to the obtained data, and serve to supplement the overall population data.

Table I-2 computes the growth rate percentages between the population presented in Table I-1. These percentages were useful in computing future growth rates. Some apparent discrepancies were found in the acquired data, and some selectivity was used in applying the data to future growth rates. The years from 1969 to 1970 show a population decrease, with a rapid increase from 1970 to 1971. This decrease and subsequent rapid increase are doubtful, and are not used in the evaluation. The growth rate figures which appear to be most useful are those from 1974 to 1978 and 1965 to 1978 for the original city, and the figures from 1976 to 1977 and 1977 to 1978 for the annexed areas.

I.3.2. Projected Growth Rates for Projection A

Table I-3 gives the projected growth rates for Projection A for the years 1978 to 1980 and for 5-year periods from 1981 to 2000. These growth rates are predicted based upon an analysis of existing data and future plans and policies as outlined in [2].

The original city is predicted to grow for the next two years at a rate of 2.60 percent. In the years 1981 to 1985, the growth will increase to 3.35 percent due to the plans for industrial growth which will create jobs. Following 1985, the rate of population growth will begin to decrease to the year 2000. This is due primarily to high population density in the area which will prevent continued rapid growth. By the year 1985, most available open areas that can be developed will be utilized. Enough area will remain to allow moderate growth, but the rapid growth experienced in the past years and to 1985 will decrease. The average growth rate for the 22-year period is predicted at 2.91 percent.

The surrounding 4 annexed areas should grow at an increased rate throughout the planning period. This is due to the new jobs resulting from the planned industrial growth, together with the open areas remaining for development. Two major industrial zones are shown in the master plan in the districts of Tugurejo and Genuk. Housing development is planned and expected in the districts of Mijen and Gunungpati.

The population will continue to grow at a moderate rate through the year 1985, while the industry is developing. Following 1985, the growth will accelerate toward the year 2000, reaching a maximum rate of 5.00 percent for the years 1996 to 2000. The average growth rate for the 22-year period for the newly annexed areas is predicted to be 4.09 percent.

I.3.3. Projected Growth Rates for Projection B

Table I-4 gives the projected growth rates for Projection B for the planning period. Projection B gives the population based upon a more conservative development plan for the Semarang area.

The growth rates are somewhat lower than the growth rates of Projection A. The slower growth in the years 1978 to 1980 prevents the population saturation of the original city which occurred in Projection A, and allows a population increase throughout the entire time period to the year 2000. The annexed areas will also experience an increased growth for the entire period, and the growth rates for the years 1981 to 2000 will be larger than those in the existing city due to the larger percentage of undeveloped land in these areas. The maximum growth rate will be 3.00 percent, and will occur from 1991 to 2000.

It should be emphasized that these growth rates are also based upon considerable industrial growth in the Semarang area. This will be demonstrated later during analysis of the water demand projections. However, the industrial growth, and appurtenant population and commercial development, are projected at a slower rate, and with a smaller amount of total development by the year 2000.

I.3.4. Projected Populations

Table I-5 gives the populations for Projection A for the years 1980, 1985, 1990, 1995 and 2000 of the original city and the annexed areas. These are developed by applying the growth rates in Table I-3 to the existing population in 1978. The population in the year 2000 are 1,504,000 for the original city, and 379,000 in the annexed areas. This gives a total population of 1,883,000 for the Semarang area in the year 2000.

Table I-6 gives the populations for Projection B, using the growth rates in Table I-4. The populations in the year 2000 are 1,429,000 for the original city and 289,000 for the annexed areas, for a total population of 1,718,000.

TABLE I-1

POPULATION DATA[1]

CITY OF SEMARANG

ITEM	ORIGINAL CITY	DISTRICTS ANNEXED IN 1976	TOTAL
POPULATION (1930)	217,800[2]	-	
POPULATION (1965)	591,214	-	
POPULATION (1966)	605,279	-	
POPULATION (1967)	615,501	-	
POPULATION (1968)	631,936	-	
POPULATION (1969)	640,491	-	
POPULATION (1970)	614,269	-	
POPULATION (1971)	646,508	189,168[2]	
POPULATION (1972)	668,845	-	
POPULATION (1973)	692,060	-	
POPULATION (1974)	712,541	198,832[2]	911,373[2]
POPULATION (1975)	735,539	-	-
POPULATION (1976)	766,869[3]	149,339	916,208
POPULATION (1977)	785,659[3]	152,931	938,590
POPULATION (1978)	800,494[3]	156,535	957,029

1. Data from Semarang Municipal Office of Regional Government except where noted.
2. Data from [1]
3. Includes Ungaran-Ungaran population currently counted with original city by Municipal Office.

TABLE I-2

GROWTH RATE PERCENTAGES-POPULATION DATA

CITY OF SEMARANG

ITEM	ORIGINAL CITY	DISTRICTS ANNEXED IN 1976
1930 - 1965	2.894 %	
1965 - 1966	2.379	
1966 - 1967	1.689	
1967 - 1968	2.670	
1968 - 1969	1.354	
1969 - 1970	(4.094)[1]	
1970 - 1971	5.248	
1971 - 1972	3.456	
1972 - 1973	3.471	
1973 - 1974	2.959	
1974 - 1975	3.228	
1975 - 1976	4.259	
1976 - 1977	2.450	2.405
1977 - 1978	1.888	2.357
1965 - 1978	2.359	-
1974 - 1978	2.953	-

1. Numbers in parentheses denotes a negative rate.

TABLE I-3

PROJECTED ANNUAL GROWTH RATES - PROJECTION A

CITY OF SEMARANG

ITEM		ORIGINAL CITY (5 DISTRICTS + UNGARAN)	DISTRICTS ANNEXED IN 1976 LESS UNGARAN
Percentage Projected Annual Growth Rates			
Years:	1978 - 1980	2.60 %	2.50 %
	1981 - 1985	3.35	3.50
	1986 - 1990	3.10	4.00
	1991 - 1995	2.80	4.50
	1996 - 2000	2.50	5.00
	1978 - 2000	2.91	4.09

TABLE I-4

PROJECTED ANNUAL GROWTH RATES - PROJECTION B

CITY OF SEMARANG

ITEM		ORIGINAL CITY (5 DISTRICTS + UNGARAN)	DISTRICTS ANNEXED IN 1976 LESS UNGARAN
Percentage Projected Annual Growth Rates			
Years:	1978 - 1980	2.50 %	2.40 %
	1981 - 1985	2.60	2.70
	1986 - 1990	2.65	2.80
	1991 - 1995	2.75	3.00
	1996 - 2000	2.75	3.00
	1978 - 2000	2.67	2.83

TABLE I-5

POPULATION PROJECTION A

CITY OF SEMARANG

ITEM	ORIGINAL CITY (5 DISTRICTS + UNGARAN)	DISTRICTS ANNEXED IN 1976 LESS UNGARAN	TOTAL
EXISTING POPULATION (1978)	800,494	156,535	957,029
PROJECTED POPULATION			
Years: 1980	843,000	164,000	1,007,000
1985	994,000	196,000	1,190,000
1990	1,158,000	238,000	1,396,000
1995	1,329,000	297,000	1,626,000
2000	1,504,000	379,000	1,883,000

TABLE I-6

POPULATION PROJECTION B

CITY OF SEMARANG

ITEM	ORIGINAL CITY (5 DISTRICTS + UNGARAN)	DISTRICTS ANNEXED IN 1976 LESS UNGARAN	TOTAL
EXISTING POPULATION (1978)	800,494	156,535	957,029
PROJECTED POPULATION			
Years: 1980	841,000	164,000	1,005,000
1985	956,000	187,000	1,143,000
1990	1,090,000	215,000	1,305,000
1995	1,248,000	249,000	1,497,000
2000	1,429,000	289,000	1,718,000

I.4. WATER DEMAND PROJECTION FOR THE CITY OF SEMARANG

I.4.1. Water Use Data

Water use data for the city of Semarang were supplied by the Semarang Municipal Water Enterprise (Perusahaan Umum Air Minum Kodya Semarang). These data are given in Tables I-7 through I-21 of this report.

The data in Table I-7 provide the total water supplied, which includes metered water and unaccounted-for water, the number of customers, and the usage per customer for the years 1966 to 1978. The water supply was from three sources, the Kali Garang, deep wells, and springs. Table I-8 gives the breakdown of the water supplied from each of the three sources for the years 1970 through 1978. This table shows that the total water supplied to the potable water system was 805.2 liters per second in 1978.

To get an indication of the various types of metered water usage for the city of Semarang, the information given in Tables I-10 through I-21 was requested and received. These tables provide water usage information for the various customer types utilized for record keeping purposes by the Semarang Municipal Water Enterprise. These classifications are Residential, Military Offices and Army Barracks, Enterprises, Orphanages and Religious Buildings, Public Hydrants, Semarang Regional Government, Semarang City Offices, and Private Well Users. The data provided for each classification include the water rate, number of services, quantity of metered water, and consumption per service. These data were received for each month for the year 1978. The monthly data were then averaged to obtain the average monthly metered water consumption for 1978. This information, given on Table B-9, is felt to be the most accurate data available for the current usage of metered water by user classifications in the city of Semarang.

It should be noted that the data given on Tables I-7 through I-21 are the precise data provided by the Semarang Water Enterprise. No attempts were made to modify or refine the data provided.

I.4.2. Analysis of Data

The data provided are felt to give a satisfactory indication of the water usage trends for the city of Semarang.

Table I-7 gives the total water supplied for the years 1966 to 1978, and the distribution of metered water and unaccounted-for water. The growth in the number of customers, and the increase in the usage per customer is also demonstrated. The usage per customer increased an average of 8 percent per year from 1966 to 1978.

Table I-8 shows the increase in water supply for the years 1970 to 1978. The decrease in 1975 was due to a large flood which damaged the treatment plant facilities, causing an outage of service for a period of one week. The rise in water supplied in 1977 over 1976 was due to longer operation of the treatment plant in 1977 because of an increased power supply. The plant is now being operated 24 hours a day, 365 days a year.

The supply has remained constant in 1977 and 1978, and will remain at that level until a new raw water supply or an increase in treatment capacity is obtained. Conversation with water enterprise officials indicated that the plant is now treating water at the maximum capacity, and no known springs or deep wells are anticipated to be developed in the near future.

Tables I-9 through I-21 provide various information for each customer classification used for record keeping by the Semarang Municipal Water Enterprise. The average for the 12 months of 1978

is given on Table I-9. The usage is currently dominated by residential customers. Residential usage accounted for 65.5 percent of the total water used for 1978. The next largest user is the Military Offices and Army Barracks, which accounts for 12.9 percent of the total water used. These two customer classifications account for 78.4 percent of the total water used. The remaining 21.6 percent is divided between the other user classifications, with the larger users being enterprises and private well users. The quantity of water used by private well users is approximate due to an absence of working meters on the pump discharge of the private well users.

It should be noted that the city of Semarang has not had an adequate water supply to fulfill consumer demands for many years, if ever. This tends to decrease the validity of the consumption data obtained. It must be assumed that potable water consumption would be somewhat higher if more water had been available for consumption. This consumption would be higher not only due to an increased usage per customer, but also due to a larger number of customers desiring to connect to the system if a satisfactory supply of water was guaranteed.

I.4.3. Projected Demands

I.4.3.a. Projection A

Table I-22 gives the water demand projection of population Projection A for the years 1980 to 2000 for the city of Semarang. The projection is made based upon applying predicted water usages for the various customer classifications to the estimated number of customers in each classification. Residential usage is predicted based upon the population projection made in this section. As stated previously, the projected demands take into account the ambitious industrial growth proposed for the Semarang area.

The consumption from private service connections is predicted to reach a total usage of 2,040 liters per second by the year 2000. The private domestic consumers are divided into three categories. These categories are On Road for Cars, with No Roads for Cars, and Orifice Connections. The first two categories are currently utilized in the existing Semarang Data. The consumption per service in 1978 was found to be 1,476 liters per day for the On Roads for Cars, and 1,053 liters per day for the With No Roads for Cars classification. These per service uses are expected to increase only slightly to the year 2000. This is due primarily to two reasons. First, it is predicted that as a greater percentage of the population is served by private connections, the number of persons utilizing each service connection will decrease. Second, the price rises which will undoubtedly occur will tend to depress the demand for potable water. The cost for potable water is currently a relatively large percentage of total income, and this situation is likely to continue.

The percentage of population served by the On Roads for Cars and the With No Roads for Cars consumer classifications is predicted to increase substantially to the year 2000. This is based primarily on the goals proposed by the Ministry to serve 90 percent of the population with potable water by the year 2000, with 70 percent served from private connections. Based upon this goal, it is predicted that 45 percent of the population will be served by these two classifications by the year 2000.

A third consumer classification under private service connections is proposed by the Ministry to aid in meeting the 70 percent goal described above. This is called an Orifice Connection, and is essentially a flow-restricting device which limits usage to a total amount of water equal to 60 liters per capita per day. Customers in the classification are assumed to include a lower income group than

found in the previous two classifications. The predicted amount of water usage per service for this classification is 600 liters per day, or a total of 10 persons utilizing each connection. It is predicted that 15 percent of the population will be served by this consumer classification, which provides for a total of 60 percent of the population served by private connections. This falls short of the 70 percent goal proposed by the Ministry, but is felt to be realistic. Applying the percent of population served to the predicted usage per service gives a total quantity of water used by private service connections of 370, 570, 910, 1,350 and 2,040 liters per second for the years 1980, 1985, 1990, 1995 and 2000, respectively.

The remainder of the population served potable water will be served by public service connections, consisting of public hydrants. These public hydrants will be used by a poorer segment of the population. The water from these hydrants will be utilized primarily for drinking water and cooking. It is expected that this segment of the population will utilize water from traditional sources for their other needs.

It is predicted that 30 percent of the population will use water from this source by the year 2000. This will enable the goal of potable water service to supply at least a part of the individual needs for 90 percent of the population by the year 2000. The per capita usage of this customer group is expected to double by the year 2000. This is due to the assumption that an improvement in income levels and a growing awareness of the health aspects of potable water will increase demand from this source. The addition of this water consumption to the private service domestic consumption gives the total water usage for domestic service to be 380, 590, 950, 1,430 and 2,160 liters per second by the years 1980, 1985, 1990, 1995 and 2000, respectively.

Non-domestic consumption is divided into 7 different customer types of classifications. One customer type is Military Offices and Army Barracks. This classification had 171 services in 1978 which used an average total of 5,274 cubic meters per day. It is predicted that the usage of these facilities will stay constant. However, a new facility for military and police training which will have 10,000 to 12,000 people is planned to be in operation in the early 1980's. The demand for this facility is estimated based upon the same per capita use as the existing facility. The water demands for a total military population of 35,000 enlisted personnel and dependents is included for the years 1980 to 2000.

Enterprises, or businesses, are currently listed as large or small. This classification includes only these businesses located outside of the industrial estate planning area.

The number of large businesses in the Semarang area are expected to grow at a rate of 3 percent for the years 1978 to 2000. The usage per service for the large businesses are predicted to grow at an average rate of 2.2 percent over the planning period.

Small enterprises are predicted to increase at a rate of 8 percent per year for the years 1978 to 2000. This increased number of small businesses is due to the added demand for services for the increased population expected in the area and for distribution of the products which are a result of the increased industry. Most small businesses are expected to be started outside of the planned industrial areas, but will be necessary to provide services to these industries and the people employed by them. The water used per service for the small businesses is expected to increase at a rate of 2 percent annually for the planning period, which is nearly the same figure as used for the increased usage per service for the large

businesses. By the year 2000, a total of 10,810 small enterprises are predicted in the Semarang area.

The harbor at Semarang currently uses mostly private wells for its water supply. A connection is made to the city system, but water is used only intermittently when water is available. Since plans are for an international harbor to be developed at Semarang, water from the city system is projected to be used in 1985 and to the year 2000. The maximum amount of water estimated to be required will be 7,000 cubic meters per day in the year 2000.

The expected growth in the Semarang Regional Planning Area is predicted to produce a rapid increase in social, or non-commercial institutions. This classification includes churches, orphanages and other service organizations. The rate of growth for this classification is primarily on service criteria established in the Master Plan for Semarang [2]. The total usage required by this classification is estimated at 6,900 cubic meters per day in the year 2000.

It is predicted that the regional government facilities will increase as the number of people in the area increase. Additional services will probably also be added, however, the usage is considered to be taken from one service as in the present situation. The total usage is estimated to double by the year 2000, to a total usage of 2,000 cubic meters per day.

Local government water usage is expected to increase at a rate of 7.5 percent per year for the planning period. Most of this increase is in the form of additional services, expected to grow at a rate of 7 percent annually. Water usage per service is expected to increase only slightly over the planning period.

The total water usage predicted for the non-domestic service will be dominated by the expected usage of the industrial estates. The location and related size of these estates are shown on Figure I-2.

According to Burns and McDonnell/Trans-Asia [1], city officials in original estimates predicted that a total of 1,300 hectares of land would develop in the industrial estates by the year 2000, with a development rate of 300 hectares by 1980, 500 by 1985, 800 by 1990, 1,000 by 1995, and 1,300 by 2000. This estimate is felt to be overly optimistic. For the purposes of this projection, a total of 1,000 hectares is predicted to be developed by the year 2000. The rate of development will be 100 hectares by the year 1980, 200 by 1985, 400 by 1990, 700 by 1995 and 1,000 by 2000. Industrial development at this rate will also take considerable effort, but is felt to be realistic.

The quantity of water used per hectare is estimated at 130 cubic meters per day, or 1.5 liters per second. This figure is felt to be a good estimate based upon water usages for industrial estates in similar areas. The lack of information as to the type of industry proposed limits somewhat the ability to accurately estimate the water usage.

Applying the area of industrial estates developed to the water usage per area gives a total water requirement of 130,000 cubic meters per day, or 1,505 liters per second by the year 2000. The majority of the water usage occurs between the years 1990 and 2000. In 1990, the water demand for the industrial usage is only a rate of 600 liters per second.

The total non-domestic service for the year 2000 is 180,060 cubic meters per day, or a rate of 2,090 liters per second. The water usage is predicted to increase rapidly between the years 1990 and 2000. In 1990, the total usage for non-domestic service is 910 liters per second.

The addition of the domestic consumption gives the total water requirement of potable water for the city of Semarang under Projection A for the years 1980 to 2000. The requirements are summarized below:

Total Metered Water Demand - Projection A

Item	Year				
	1980	1985	1990	1995	2000
Total Demand (m^3/d)	60,645	96,380	160,540	250,260	379,260
Total Demand (l/s)	705	1,120	1,860	2,900	4,240

In 1978, the unaccounted-for water was 45 percent of the total supplied to the system. This 45 percent includes the water used by private well users. Since 1966, the unaccounted-for water has ranged from a high of 66 percent to a low of 41 percent, which occurred in 1976. Based upon this data, it appears that the unaccounted-for water will continue to be a relatively large percentage of the total water supply. To significantly lower this percentage, a comprehensive and effective operation and maintenance program must be undertaken. It is felt that a reduction of the unaccounted-for water will be essential to fulfill user demand requirements in the city of Semarang.

The unaccounted-for water will likely remain high for 1980, but then a gradual reduction is anticipated to the year 1995, when a figure of 25 percent of the total supply will be unaccounted-for. Obtaining a figure lower than 25 percent will be extremely difficult with the present distribution system, and this figure is expected to remain through the year 2000.

Taking into consideration this unaccounted-for water, the total water supply requirements for Projection A were computed for the year 2000, and are given below:

Total Water Supply Requirement - Projection A

Item	Year				
	1980	1985	1990	1995	2000
Total Water Supply Required (l/s)	1,215	1,720	2,660	3,870	5,650

This projection shows the total water supply required for the city of Semarang to be 5,650 liters per second by the year 2000. By 1990, 2,660 liters per second will be required, and a demand of 1,215 liters per second by the year 1980. It is realized that the 1980 supply cannot be met, and the consumption will be approximately 800 liters per second in the year 1980. However, the 1,215 liters per second figure represents the demand, indicating the amount of water which, if available, would be consumed.

I.4.3.b. Projection B

Table I-23 gives the water demand projection of Projection B for the years 1980 to 2000. This projection is made in basically the same manner as Projection A. The major difference is the lower

number of hectares of industrial estates predicted to be developed by the year 2000. This decrease in the quantity of industrial development, of course, affects the population projection and the number of enterprises and non-commercial institutions providing services to the industries and employees of those industries.

The areas of industrial estates developed is predicted in Projection B to be 50, 100, 250, 500 and 750 hectares for the years 1980, 1985, 1990, 1995 and 2000, respectively. All of the customer classifications are affected to some degree by the reduced area of industrial development, with the exception of the Military Offices and Army Barracks and the Regional Government. The usage for the harbor is reduced somewhat, this being due to the decrease in the amount of shipping required to transport manufactured products.

The total water supply requirement for Projection B is given below:

Total water Supply Requirement - Projection B

Item	Year				
	1980	1985	1990	1995	2000
Total Water Supply Required (l/s)	1,070	1,420	2,200	3,230	4,770

This projection gives the total water supply required for the city of Semarang to be 4,770 liters per second by the year 2000. This represents 84 percent of the demand requirement of Projection A for the years 1995 and 2000. The demands for the years 1985 and 1990 are somewhat greater than 80 percent of the Projection A demands.

I.4.4. Analysis of Demand Projections

Projection A and Projection B provide two alternatives projections for the potential water demand of the city of Semarang. It is impossible to say at this time the quantity of industrial development which will occur in the Semarang area.

The table below presents the additional water supply requirement to the year 2000 for each projection. These figures are obtained by subtracting the total water supply requirement from the existing supply of 800 liters per second.

Additional Water Supply Requirements Projection A and B
City of Semarang

	Year				
	1980	1985	1990	1995	2000
Projection A	415	920	1,860	3,070	4,850
Projection B	270	620	1,400	2,430	3,970

It is felt that the supply requirements for Projection B are the absolute minimum quantity of water which should be supplied to the Semarang area. For planning purposes, the supply requirements in Projection A should be used at this time. In the future the industrial growth in the Semarang area will be known, and the more accurate projection for water demand will become apparent. The water supply for future years can then be adjusted accordingly. Failure to plan for the proposed growth in Semarang, represented by the demands of Projection A, is not felt to be the proper approach at this time.

I.4.5. Maximum Day Demands

The water demand projections are for average daily demands, giving the total water consumption for the year indicated. These demands are

the most useful in determining the required water supplies for the city of Semarang. The utilization of the water supply to meet maximum day and peak hour demands is in many cases most economically handled by use of potable water storage within the distribution system. In any event, this study will determine demands and discuss supplies based upon providing to the city of Semarang the water supply required to meet the annual consumption.

TABLE I-7

WATER USE DATA[1]

Year	Total Water Supplied (m^3)	Metered Water (m^3)	Unaccounted-For Water (m^3)	Unaccounted-For Water (%)	Number of Customers	Usage of Metered Water Per Customer (l/d)
1966	15,129,000	5,371,300	9,757,700	64	21,973	670
1967	15,545,000	5,549,900	9,995,100	64	22,285	682
1968	14,281,700	5,651,800	8,629,900	60	22,348	693
1969	14,727,400	4,991,600	9,735,800	66	22,631	604
1970/71	14,982,600	5,799,300	9,183,300	61	22,843	695
1971/72	17,604,100	5,934,300	11,669,800	66	22,302	729
1972/73	18,614,900	9,486,700	9,128,200	49	22,387	1,161
1973/74	21,643,500	11,771,000	9,872,500	46	22,293	1,447
1974/75	22,117,900	12,557,400	9,560,500	43	22,749	1,512
1975/76	21,411,242	12,603,949	8,807,293	41	23,200	1,488
1976/77	23,629,828	13,237,124	10,392,704	47	23,350	1,553
1977/78	25,255,933	14,460,238	10,795,695	43	23,775	1,666

Note:

1. Data supplied by Semarang Municipal Water Enterprise.

TABLE I-8

AVERAGE ANNUAL WATER SUPPLY[1]

Year	Spring[2] m^3/Yr (l/s)	Wells m^3/Yr (l/s)	Kali Garang m^3/Yr (l/s)	Total m^3/Yr (l/s)
1970	7,709,109 (244.5)	119,827 (3.8)	7,153,685 (226.8)	14,982,621 (475.1)
1971	8,242,784 (261.4)	283,824 (9.0)	9,079,537 (287.9)	17,606,145 (558.3)
1972	8,531,487 (270.5)	315,097 (10.0)	9,768,308 (309.8)	18,614,892 (590.3)
1973	8,916,832 (282.8)	518,750 (16.4)	12,207,856 (387.1)	21,643,438 (686.3)
1974	9,339,871 (296.2)	517,049 (16.4)	12,261,027 (388.8)	22,117,947 (701.4)
1975	9,222,721 (292.5)	544,341 (17.3)	12,072,597 (382.8)	21,839,659 (692.6)
1976	9,081,573 (288.0)	512,906 (16.2)	12,950,945 (410.7)	22,545,424 (714.9)
1977	9,330,586 (295.9)	497,772 (15.7)	15,380,425 (487.7)	25,208,783 (799.3)
1978	9,594,184 (302.7)	524,717 (16.6)	15,324,740 (485.9)	25,393,641 (805.2)

Notes:

1. Data supplied by Semarang Municipal Water Enterprise.
2. Spring flow meter is believed to be over recording actual flow in 1972, 1973 and 1974
3. Flow meter recorder at water plant does not record maximum flow; figures shown are estimates made by the water department.

TABLE I-9

METERED WATER CONSUMPTION

AVERAGE MONTHLY CONSUMPTION FOR 1978[1]

Customer Type	Water Rate (Rp/m^3)	Number of Services	Metered Water (m^3)	Consumption by Customer Type (%)	Consumption Per Service (l/d)
Residential					
a. On Roads for Cars	Rp. 40	12,028	540,276	43.5	1,476
b. With No Roads for Cars	20	8,524	273,163	22.0	1,053
Military Offices & Army Barracks	40	171	160,424	12.9	30,843
Enterprises					
a. Large	120	675	48,892	3.9	2,381
b. Small	90	1,990	56,095	4.5	926
Orphanages & Religious Buildings	10	81	8,300	0.7	3,368
Public Hydrants	40	152	19,188	1.5	4,150
Semarang Regency Government	20	1	28,713	2.3	943,989
Semarang City Offices	40	77	33,120	2.7	14,141
Private Well Users	10% of Rate Indicated	39	66,816	5.4	56,325
Account of Previous Month	-	50	7,841	0.6	5,156
Total:		23,788	1,242,828	100.0	

Total Consumption Per Service = 1,718 l/d

Note:
1. Data Supplied by Semarang Municipal Water Enterprise.

TABLE I-10

METERED WATER CONSUMPTION (JANUARY, 1978)

Customer Type	Water Rate (Rp/m^3)	Number of Services	Metered Water (m^3)	Consumption Per Service (l/d)
Residential				
a. On Roads for Cars	Rp. 40	11,979	528,202	1,422
b. With No Roads for Cars	20	8,577	275,472	1,036
Military Offices & Army Barracks	40	764	157,973	31,072
Enterprises				
a. Large	120	648	46,802	2,330
b. Small	90	1,958	55,404	912
Orphanages & Religious Buildings	10	81	5,968	2,377
Public Hydrants	40	138	12,231	2,859
Semarang Regency Government	20	1	18,926	610,516
Semarang City Offices	40	79	41,128	16,794
Private Well Users	10% of Rate Indicated	39	70,806	58,566
Account of Previous Month	-	52	910	565
Total:		23,716	1,213,822	

Total Consumption Per Service = 1,651 l/d

Note:
1. Data supplied by Semarang Municipal Water Enterprise.

TABLE I-11

METERED WATER CONSUMPTION (FEBRUARY, 1978)

Customer Type	Water Rate (Rp/m^3)	Number of Services	Metered Water (m^3)	Consumption Per Service (l/d)
Residential				
a. On Roads for Cars	Rp. 30	12,014	528,001	1,569
b. With No Roads for Cars	20	8,558	269,881	1,126
Military Offices & Army Barracks	40	163	158,371	34,700
Enterprises				
a. Large	120	642	44,923	2,499
b. Small	90	1,953	54,256	992
Orphanages & Religious Buildings	10	80	6,280	2,804
Public Hydrants	40	142	11,606	2,919
Semarang Regency Government	20	1	17,072	609,714
Semarang City Offices	40	81	37,489	16,529
Private Well Users	10% of Rate Indicated	39	71,483	65,461
Account of Previous Month	-	27	270	357
Total:		23,700	1,199,630	

Total Consumption Per Service = 1,808 l/d

Note:
1. Data supplied by Semarang Municipal Water Enterprise.

TABLE I-12

METERED WATER CONSUMPTION (MARCH, 1978)

Customer Type	Water Rate (Rp/m^3)	Number of Services	Metered Water (m^3)	Consumption Per Service (l/d)
Residential				
a. On Roads for Cars	Rp. 40	12,011	522,454	1,403
b. With No Roads for Cars	20	8,555	265,226	1,015
Military Offices & Army Barracks	40	171	149,104	28,120
Enterprises				
a. Large	120	654	46,961	2,316
b. Small	90	1,958	55,530	915
Orphanages & Religious Buildings	10	82	6,019	2,384
Public Hydrants	40	139	15,281	3,546
Semarang Regency Government	20	1	18,917	610,226
Semarang City Offices	40	82	37,436	14,727
Private Well Users	10% of Rate Indicated	39	71,359	59,023
Account of Previous Month	-	22	7,635	11,195
Total:		23,712	1,199,902	

Total Consumption Per Service = 1,632 l/d

Note:
1. Data supplied by Semarang Municipal Water Enterprise

TABLE I-13

METERED WATER CONSUMPTION (APRIL, 1978)

Customer Type	Water Rate (Rp/m^3)	Number of Services	Metered Water (m^3)	Consumption Per Service (l/d)
Residential				
a. On Roads for Cars	Rp. 40	12,018	479,142	1,328
b. With No Roads for Cars	20	8,553	233,166	908
Military Offices & Army Barracks	40	177	142,695	26,873
Enterprises				
a. Large	120	665	38,520	1,930
b. Small	90	1,972	59,336	1,002
Orphanages & Religious Buildings	10	79	4,617	1,948
Public Hydrants	40	140	16,414	3,908
Semarang Regency Government	20	1	17,775	592,500
Semarang City Offices	40	82	36,689	14,914
Private Well Users	10% of Rate Indicated	39	72,095	61,619
Account of Previous Month		27	1,501	1,853
Total:		23,753	1,101,950	

Total Consumption Per Service = 1,546 l/d

Note:
1. Data supplied by Semarang Municipal Water Enterprise.

TABLE I-14

METERED WATER CONSUMPTION (MAY, 1978)

Customer Type	Water Rate (Rp/m^3)	Number of Services	Metered Water (m^3)	Consumption Per Service (l/d)
Residential				
a. On Roads for Cars	Rp. 40	12,051	589,522	1,578
b. With No Roads for Cars	20	8,594	289,309	1,092
Military Offices & Army Barracks	40	176	181,095	33,190
Enterprises				
a. Large	120	683	49,203	2,280
b. Small	90	1,978	56,995	930
Orphanages & Religious Buildings	10	80	7,520	3,032
Public Hydrants	40	146	17,153	3,790
Semarang Regency Government	20	-	-	-
Semarang City Offices	40	81	40,642	16,190
Private Well Users	10% of Rate Indicated	39	70,894	58,640
Account of Previous Month	-	60	2,720	1,463
Total:		23,838	1,304,053	

Total Consumption Per Service = 1,770 l/d

Note:
1. Data supplied by Semarang Municipal Water Enterprise.

TABLE I-15

METERED WATER CONSUMPTION (JUNE, 1978)

Customer Type	Water Rate (Rp/m^3)	Number of Services	Metered Water (m^3)	Consumption Per Service (l/d)
Residential				
a. On Roads for Cars	Rp. 40	12,067	572,829	1,582
b. With No Roads for Cars	20	8,547	292,656	1,141
Military Offices & Army Barracks	40	176	172,985	2,762
Enterprises				
a. Large	120	671	57,346	2,848
b. Small	90	1,993	59,702	998
Orphanages & Religious Buildings	10	81	6,440	2,650
Public Hydrants	40	150	16,365	3,636
Semarang Regency Government	20	-	-	-
Semarang City Offices	40	83	45,437	18,247
Private Well Users	10% of Rate Indicated	39	71,862	13,987
Account of Previous Month	-	78	2,120	905
Total:		23,885	1,297,742	

Total Consumption Per Service = 1,811 l/d

Note:
1. Data supplied by Semarang Municipal Water Enterprise.

TABLE I-16

METERED WATER CONSUMPTION (JULY, 1978)

Customer Type	Water Rate (Rp/m^3)	Number of Services	Metered Water (m^3)	Consumption Per Service (l/d)
Residential				
a. On Roads for Cars	Rp. 40	12,063	521,750	1,395
b. With No Roads for Cars	20	8,549	266,897	1,007
Military Offices & Army Barracks	40	171	174,772	32,969
Enterprises				
a. Large	120	684	44,473	2,097
b. Small	90	2,008	55,908	898
Orphanages & Religious Buildings	10	81	6,176	2,460
Public Hydrants	40	164	15,281	3,006
Semarang Regency Government	20	1	37,042	1,194,903
Semarang City Offices	40	74	34,823	15,180
Private Well Users	10% of Rate Indicated	39	72,290	59,793
Account of Previous Month	-	14	71,049	163,707
Total:		23,848	1,300,461	

Total Consumption Per Service = 1,760 l/d

Note:
1. Data supplied by Semarang Municipal Water Enterprise.

TABLE I-17

METERED WATER CONSUMPTION (AUGUST, 1978)

Customer Type	Water Rate (Rp/m^3)	Number of Services	Metered Water (m^3)	Consumption Per Service (l/d)
Residential				
a. On Roads for Cars	Rp. 40	12,040	539,359	1,445
b. With No Roads for Cars	20	8,537	266,997	1,009
Military Offices & Army Barracks	40	171	162,278	30,613
Enterprises				
a. Large	120	685	53,689	2,528
b. Small	90	2,019	54,847	872
Orphanages & Religious Buildings	10	83	6,487	2,521
Public Hydrants	40	166	19,764	3,840
Semarang Regency Government	20	1	39,961	1,289,064
Semarang City Offices	40	74	32,720	14,241
Private Well Users	10% of Rate Indicated	39	71,582	59,207
Account of Previous Month	-	117	6,386	1,211
Total:		23,932	1,254,070	

Total Consumption Per Service = 1,690 l/d

Note:
1. Data supplied by Semarang Municipal Water Enterprise.

TABLE I-18

METERED WATER CONSUMPTION (SEPTEMBER, 1978)

Customer Type	Water Rate (Rp/m^3)	Number of Services	Metered Water (m^3)	Consumption Per Service (l/d)
Residential				
a. On Roads for Cars	Rp. 40	12,001	559,165	1,553
b. With No Roads for Cars	20	8,488	285,191	1,119
Military Offices & Army Barracks	40	171	175,097	34,131
Enterprises				
a. Large	120	697	56,947	2,723
b. Small	90	2,002	55,264	920
Orphanages & Religious Buildings	10	83	6,426	2,580
Public Hydrants	40	159	43,229	9,060
Semarang Regency Government	20	1	36,051	1,201,700
Semarang City Offices	40	74	37,557	16,920
Private Well Users	10% of Rate Indicated	39	71,520	61,128
Account of Previous Month	-	8	80	333
Total:		23,723	1,326,527	

Total Consumption Per Service = 1,864 l/d

Note:
1. Data supplied by Semarang Municipal Water Enterprise.

TABLE I-19

METERED WATER CONSUMPTION (OCTOBER, 1978)

Customer Type	Water Rate (Rp/m^3)	Number of Services	Metered Water (m^3)	Consumption Per Service (l/d)
Residential				
a. On Roads for Cars	Rp. 40	12,005	556,076	1,494
b. With No Roads for Cars	20	8,466	274,430	1,045
Military Offices & Army Barracks	40	171	160,141	30,210
Enterprises				
a. Large	120	701	51,015	2,350
b. Small	90	2,007	55,079	885
Orphanages & Religious Buildings	10	83	6,210	2,413
Public Hydrants	40	162	21,932	4,367
Semarang Regency Government	20	1	37,154	1,198,516
Semarang City Offices	40	74	34,755	15,150
Private Well Users	10% of Rate Indicated	39	69,742	57,685
Account of Previous Month	-	13	451	1,119
Total:		23,722	1,266,975	

Total Consumption Per Service = 1,722 l/d

Note:
1. Data supplied by Semarang Municipal Water Enterprise.

TABLE I-20

METERED WATER CONSUMPTION (NOVEMBER, 1978)

Customer Type	Water Rate (Rp/m^3)	Number of Services	Metered Water (m^3)	Consumption Per Service (l/d)
Residential				
a. On Roads for Cars	Rp. 40	12,012	561,041	1,556
b. With No Roads for Cars	20	8,469	288,546	1,135
Military Offices & Army Barracks	40	174	145,497	27,872
Enterprises				
a. Large	120	693	52,813	2,540
b. Small	90	2,015	57,605	952
Orphanages & Religious Buildings	10	83	6,871	2,759
Public Hydrants	40	161	18,300	3,788
Semarang Regency Government	20	1	35,526	1,184,200
Semarang City Offices	40	74	30,780	13,864
Private Well Users	10% of Rate Indicated	39	69,996	59,825
Account of Previous Month	-	68	1,268	621
Total:		23,789	1,268,243	

Total Consumption Per Service = 1,776 l/d

Note:
1. Data supplied by Semarang Municipal Water Enterprise.

TABLE I-21

METERED WATER CONSUMPTION (DECEMBER, 1978)

Customer Type	Water Rate (Rp/m^3)	Number of Services	Metered Water (m^3)	Consumption Per Service (l/d)
Residential				
a. On Roads for Cars	Rp. 40	12,083	525,699	1,403
b. With No Roads for Cars	20	8,459	266,179	1,015
Military Offices & Army Barracks	40	174	145,083	26,897
Enterprises				
a. Large	120	687	45,026	2,114
b. Small	90	2,028	53,595	852
Orphanages & Religious Buildings	10	82	6,358	2,501
Public Hydrants	40	162	16,005	3,186
Semarang Regency Government	20	-	-	-
Semarang City Offices	40	74	24,817	10,768
Private Well Users	10% of Rate Indicated	39	73,671	60,935
Account of Previous Month	-	108	1,214	363
Total:		23,896	1,157,647	

Total Consumption Per Service = 1,562 l/d

Note:
1. Data supplied by Semarang Municipal Water Enterprise.

TABLE I-22

WATER DEMAND PROJECTION A

CITY OF SEMARANG

YEAR	1978	1980	1985	1990	1995	2000
POPULATION PROJECTION (x 10^3)	957	1,007	1,190	1,396	1,626	1,883
A. Domestic Consumption						
1. Private Service Connections						
a. On Roads For Cars						
Population Served (%)	9.5	10	12	14	16	20
Population Served (x 10^3)	91	101	143	195	260	377
Number of Services	12,028	13,600	19,070	26,000	34,700	50,300
Consumption per Service (l/d)	1,476	1,500	1,550	1,600	1,650	1,700
Quantity of Water Used (m^3/d)	17,753	20,400	29,560	41,600	57,260	85,510
b. With No Roads For Cars						
Population Served (%)	7	8	10	15	20	25
Population Served (x 10^3)	67	81	119	209	325	471
Number of Services	8,524	10,000	14,880	26,130	40,630	58,880
Consumption Per Service (l/d)	1,053	1,080	1,100	1,150	1,200	1,250
Quantity of Water Used (m^3/d)	8,976	10,800	16,370	30,050	48,760	73,600
c. Orifice Connection						
Population Served (%)	-	.5	4	8	11	15
Population Served (x 10^3)	-	5	48	112	179	282
Number of Services	-	500	4,800	11,200	17,900	28,200
Consumption Per Service (l/d)	-	600	600	600	600	600
Quantity of Water Used (m^3/d)	-	300	2,880	6,720	10,740	16,920
Total Private Service						
Population Served (%)	16.5	18.5	26	37	47	60
Population Served (x 10^3)	158	187	310	516	764	1,130
Number of Services	20,552	24,100	38,750	63,330	93,230	137,380
Quantity of Water Used (m^3/d)	26,729	31,500	48,810	78,370	116,760	176,030
Quantity of Water Used (l/s)	310	370	570	910	1,350	2,040

TABLE I-22 (Cont.)

WATER DEMAND PROJECTION A

CITY OF SEMARANG

YEAR	1978	1980	1985	1990	1995	2000
2. Public Service Connections (Public Hydrants)						
Population Served (%)	8	10	15	20	25	30
Population Served (x 10^3)	77	101	179	279	407	565
Number of Services	152	200	325	465	675	950
Per Capita Use (l/d)	8	10	12	14	16	18
Quantity of Water Used (m^3/d)	615	1,010	2,150	3,910	6,510	10,170
Total Domestic Service						
Population Served (%)	24.5	28.5	41	57	72	90
Population Served (x 10^3)	235	288	489	795	1,171	1,695
Quantity of Water Used (m^3/d)	27,344	32,510	50,960	82,280	123,270	186,200
Quantity of Water Used (l/s)	317	380	590	950	1,430	2,160
B. Non-Domestic Consumption						
1. Military Offices & Army Barracks						
Enlisted Personnel & Dependents	23,000	35,000	35,000	35,000	35,000	35,000
Number of Services	172	270	270	270	270	270
Quantity of Water Used (m^3/d)	5,274	8,000	8,000	8,000	8,000	8,000
2. Enterprises						
a. Large						
Number of Services	675	730	850	985	1,140	1,320
Usage per Service (l/d)	2,381	2,650	2,920	3,220	3,550	3,920
Quantity Of Water Used (m^3/d)	1,607	1,935	2,480	3,170	4,050	5,170
b. Small						
Number of Services	1,990	2,320	3,410	5,010	7,360	10,810
Usage per Service (l/d)	926	980	1,080	1,190	1,310	1,450
Quantity of Water Used (m^3/d)	1,843	2,270	3,680	5,960	9,640	15,670

TABLE I-22 (Cont.)

WATER DEMAND PROJECTION A

CITY OF SEMARANG

YEAR	1978	1980	1985	1990	1995	2000
3. Harbor						
Quantity of Water Used (m^3/d)	-	-	1,000	2,500	4,500	7,000
4. Non-Commercial Institutions						
Number of Services	81	125	300	600	1,000	1,500
Usage Per Service (l/d)	3,368	3,500	3,750	4,000	4,300	4,600
Quantity of Water Used (m^3/d)	273	440	1,130	2,400	4,300	6,900
5. Regional Government						
Number of Services	1	1	1	1	1	1
Usage Per Service (l/d)	943,989	1,200,000	1,400,000	1,600,000	1,800,000	2,000,000
Quantity of Water Used (m^3/d)	944	1,200	1,400	1,600	1,800	2,000
6. Local Government						
Number of Services	77	90	120	180	250	350
Usage Per Service (l/d)	14,141	14,200	14,400	14,600	14,800	15,200
Quantity of Water Used (m^3/d)	1,089	1,280	1,730	2,630	3,700	5,320
7. Industrial Estates						
Area Planned (ha)	-	100	200	400	700	1,000
Quantity of Water Used (m^3/d/ha)	-	130	130	130	130	130
Quantity of Water Used (m^3/d)	-	13,000	26,000	52,000	91,000	130,000
Total Non-Domestic Service						
Quantity of Water Used (m^3/d)	11,030	28,125	45,420	78,260	126,990	180,060
Quantity of Water Used (l/s)	128	325	530	910	1,470	2,090
C. Total Metered Water Service						
Quantity of Water Used (m^3/d)	38,374	60,635	96,380	160,540	250,260	366,260
Quantity of Water Used (l/s)	444	705	1,120	1,860	2,900	4,240

TABLE I-22 (Cont.)

WATER DEMAND PROJECTION A

CITY OF SEMARANG

YEAR	1978	1980	1985	1990	1995	2000
D. Unaccounted-For Water & Private Wells						
Percent of Supply	45	42	35	30	25	25
Quantity of Water (l/s)	361	510	600	800	970	1,410
E. Total Water Supply Requirement						
Quantity of Water (l/s)	805	1,215	1,720	2,660	3,870	5,650

TABLE I-23

WATER DEMAND PROJECTION B

CITY OF SEMARANG

YEAR	1978	1980	1985	1990	1995	2000
POPULATION PROJECTION (x 10^3)	957	1,005	1,143	1,305	1,497	1,718
A. Domestic Consumption						
1. Private Service Connections						
a. On Roads For Cars						
Population Served (%)	9.5	10	12	14	16	20
Population Served (x 10^3)	91	100	137	183	240	344
Number of Services	12,028	13,300	18,270	24,400	32,000	45,870
Consumption per Service (l/d)	1,476	1,500	1,550	1,600	1,650	1,700
Quantity of Water Used (m^3 /d)	17,753	19,950	28,320	39,040	52,800	77,980
b. With No Roads For Cars						
Population Served (%)	7	8	10	15	20	25
Population Served (x 10^3)	67	80	114	196	299	430
Number of Services	8,524	10,000	14,250	24,500	37,380	53,750
Consumption Per Service (l/d)	1,053	1,080	1,100	1,150	1,200	1,250
Quantity of Water Used (m^3/d)	8,976	10,800	15,680	28,180	44,860	67,190
c. Orifice Connections						
Population Served (%)	-	.5	4	8	11	15
Population Served (x 10^3)	-	5	46	104	165	258
Number of Services	-	500	4,600	10,400	16,500	25,800
Consumption Per Service (l/d)	-	600	600	600	600	600
Quantity of Water Used (m^3/d)	-	300	2,760	6,240	9,900	15,480
Total Private Service						
Population Served (%)	16.5	18.5	26.0	37.0	47.0	60.0
Population Served (x 10^3)	158	185	297	483	704	1,032
Number of Services	20,552	23,300	37,120	59,300	85,880	125,420
Quantity of Water Used (m^3/d)	26,729	31,050	46,760	73,460	107,560	160,650
Quantity of Water Used (l/s)	309	360	540	850	1,240	1,860

TABLE I-23 (Cont.)

WATER DEMAND PROJECTION B

CITY OF SEMARANG

YEAR	1978	1980	1985	1990	1995	2000
2. Public Service Connections (Public Hydrants)						
Population Served (%)	8	10	15	20	25	30
Population Served (x 10^3)	77	100	171	261	374	515
Number of Services	152	195	310	435	625	860
Per Capita Use (l/d)	8	10	12	14	16	18
Quantity of Water Used (m^3/d)	631	1,000	2,050	3,650	5,980	9,270
Total Domestic Service						
Population Served (%)	24.5	28.5	41	57	72	90
Population Served (x 10^3)	235	285	468	744	1,078	1,547
Quantity of Water Used (m^3/d)	27,360	32,050	48,810	77,110	113,540	169,920
Quantity of Water Used (l/s)	317	370	560	890	1,310	1,970
B. Non-Domestic Consumption						
1. Military Offices & Army Barracks						
Enlisted Personnel & Dependents	23,000	35,000	35,000	35,000	35,000	35,000
Number of Services	172	270	270	270	270	270
Quantity of Water Used (m^3/d)	5,274	8,000	8,000	8,000	8,000	8,000
2. Enterprises						
a. Large						
Number of Services	675	725	830	950	1,090	1,250
Usage per Service (l/d)	2,381	2,650	2,920	3,220	3,550	3,920
Quantity of Water Used (m^3/d)	1,607	1,920	2,420	3,060	3,870	4,900
b. Small						
Number of Services	1,990	2,230	2,980	3,990	5,340	7,150
Usage per Service (l/d)	926	980	1,080	1,190	1,310	1,450
Quantity of Water Used (m^3/d)	1,843	2,180	3,220	4,750	6,990	10,370

TABLE I-23 (Cont.)

WATER DEMAND PROJECTION B

CITY OF SEMARANG.

YEAR	1978	1980	1985	1990	1995	2000
3. Harbor						
Quantity of Water Used (m^3/d)	-	-	500	1,500	3,000	5,500
4. Non-Commercial Institutions						
Number of Services	81	125	275	500	900	1,400
Usage Per Service (l/d)	3,368	3,500	3,750	4,000	4,300	4,600
Quantity of Water Used (m^3/d)	273	440	1,030	2,000	3,870	6,440
5. Regional Government						
Number of Services	1	1	1	1	1	1
Usage Per Service (l/d)	943,989	1,200,000	1,400,000	1,600,000	1,800,000	2,000,000
Quantity of Water Used (m^3/d)	944	1,200	1,400	1,600	1,800	2,000
6. Local Government						
Number of Services	77	90	115	160	220	300
Usage Per Service (l/d)	14,141	14,200	14,400	14,600	14,800	15,000
Quantity of Water Used (m^3/d)	1,089	1,280	1,660	2,340	3,260	4,500
7. Industrial Estates						
Area Planned (ha)	-	50	100	250	500	750
Quantity of Water Used (m^3/d/ha)	-	130	130	130	130	130
Quantity of Water Used (m^3/d)	-	6,500	13,000	32,500	65,000	97,500
Total Non-Domestic Service						
Quantity of Water Used (m^3/d)	11,030	21,520	31,230	55,750	95,790	139,210
Quantity of Water Used (l/s)	128	250	360	650	1,110	1,610
C. Total Metered Water Service						
Quantity of Water Used (m^3/d)	38,390	53,570	80,040	132,860	209,330	309,130
Quantity of Water Used (l/s)	444	620	920	1,540	2,420	3,580

TABLE I-23 (Cont.)

WATER DEMAND PROJECTION B

CITY OF SEMARANG

YEAR	1978	1980	1985	1990	1995	2000
D. Unaccounted For Water & Private Wells						
Percent of Supply	45	42	35	30	25	25
Quantity of Water (l/s)	361	450	500	660	810	1,190
E. Total Water Supply Requirement						
Quantity of Water (l/s)	805	1,070	1,420	2,200	3,230	4,770

I.5. WATER SUPPLY TO MEET FUTURE DEMANDS OF THE CITY OF SEMARANG

I.5.1. General

The previous section evaluated the future water demands for the city of Semarang to the year 2000. The additional supplies required to meet these demands are summarized on the table in I.4.4. of this report. This section will discuss the available alternatives for supplying the additional municipal and industrial water required by the city of Semarang.

I.5.2. Existing Water Supply

The current water supply for the city of Semarang consists of water from three sources, the Kali Garang, deep wells, and local springs. Details of these current sources are discussed below.

I.5.2.a. Kali Garang

Tributaries of the Kali Garang originate on the slopes of Mt. Ungaran, approximately 25 kilometers south of Semarang. Several tributaries, including the Kali Kreyo and Kali Kripik, combined to form the Kali Garang.

The Kali Garang flows basically through the center of the city of Semarang, finally discharging into the Java Sea. The river becomes increasingly turbid as it flows toward the sea from Mt. Ungaran, and is very polluted near its discharge into the sea. The flow of the river treated for the city of Semarang is obtained from a river intake located 1.2 km above a river diversion structure known as the Simongan Dam. The treatment plant is located 0.5 kilometer east of the river intake, on a hill above the city.

The rated capacity of the treatment plant is 500 liters per second. Since 1977 the plant has been treating essentially its maximum capacity of water.

I.5.2.b. Deep Wells

Since 1973, deep wells in the Semarang area have been supplying an average annual rate of 16.4 liters per second to the water supply system. This supply includes only those wells operated by the Semarang Municipal Water Enterprise.

The water from the wells is disinfected by the use of hypochlorite solutions applied to the water. The water from the majority of the wells is currently pumped into the water distribution system, however, approximately one half of the 19 wells are not connected to the system. These wells are dispersed for public use through hydrants. The wells not connected to the distribution system are in areas that are far removed from the water distribution pipe network.

I.5.2.c. Springs

In 1978 springs supplied a total rate of flow of 302.7 liters per second to the water supply system, although it is possible that the actual flow had been over recorded. This flow was produced from a total of 6 springs, Ancar, Mudal Besar and Kecil, Lawang, Kalidoh Besar, Kalidoh Kecil, and Seleases. Seleases was added to the system in 1978. The capacity of this spring had been estimated in two reports, Burns and McDonnell/Trans-Asia [1] and Metcalf and Eddy [3], as 150 liters per second. However, production of the spring yielded a firm supply of only 32 liters per second.

Development of water from the springs is accomplished by use of a collection chamber and flow control structure, with water being transported through cast iron piping systems. Water department employees perform operation and maintenance functions at each spring.

I.5.2.d. Quantity of Existing Water Supply

Table I-8 gives the total water supply for the city of Semarang from these sources since 1970. In 1978 the breakdown was 302.7 liters per second from the springs, 16.6 liters per second from wells, and 485.9 liters per second from the Kali Garang. The water supply has gradually increased since 1970, but has leveled off at approximately 800 liters per second for the past two years. This 800 liters per second is maximum water that can be supplied from current raw water resources and treatment capacity.

I.5.3. Alternatives for Additional Water Supply

I.5.3.a. Groundwater from Deep Wells

(i) Geology of Jratunseluna Basin

Geological conditions which have operated to form the present groundwater system started about Plio-Pleistocene age (about 1 million years ago). Uplift and warping of the Tertiary marine sediments above the early seas, withdrawal of the seas because of loss of water to continental glaciation, and subsequent return of the higher sea levels on glacial melting prepared the basin for water storage. Uplift occurred concurrently with volcanic activity around Rawa Pening. The rising uplands provided energy to high gradient streams that flowed across the coastal plains carving deep canyons along their path. Rising seas changed the gradients and caused the river canyons to choke with thick layers of clastic sediments.

These sediments were deposited as gravel within a few kilometers of Glapan on the Tuntang, possibly as far seaward as Demak. Continued rise of sea level pushed coarse clastic deposition into the present canyons and silt and finegrained sand was deposited on top of the coastal canyons. Impermeable slope wash from the uplands interfingered and capped the coarse sediments to form localized artesian conditions.

As the past glacial seas stabilized at their present level, sediments have been deposited along the shoreline as river deltas. Past exploration indicates that the recent marine sediments overlying the folded Tertiary marine sediments are 50 to 90 meters thick. These sediments consist of complexly interlayered fine sand, silt and clay.

Exploration has shown that sediment permeability has allowed leaching of the near surface zones and lateral zones near the volcanic uplands. Fresh-water lenses were found east of Semarang pinching out into the coastal plain; near Kudus, again pinching out into the plain; and in a narrow lense practically beneath the Tuntang (and possibly Serang) River. The latter lense is probably recharged from the overlying river. The former lenses are recharged from the volcanic upland. Careful geophysical investigation will possibly find similar fresh water lobes in front of all of the large streams below the foothills.

The volcanic uplands exhibit a very high percentage of pyroclastic, scoriaceous and clastic sediment in addition to basaltic flows. This material should act as a sponge to absorb large quantities of rainfall. The potential for groundwater in these areas is good. This is especially true because the downslope areas are underlain by southward

dipping (towards the volcanic source against the dip of the volcanics) impermeable marine sediments. The marine sediments should cause the groundwater to form a partial artesian effect in order to pass over the sill downslope.

Ring faulting induced by collapsing volcanic calderas are evident on Ungaran. These faults may trap groundwater in the volcanics.

Future investigations for groundwater should be concentrated along the volcanic lined margins of the coastal basin and in the volcanic uplands above the spring line of the short coastal rivers.

(ii) Geology of Semarang Area and Mount Ungaran

The geology of the Semarang area has been studied in much detail. The area along the coast of the Java Sea is a coastal plain of recent alluvium consisting of clay, sandy clay and sand, with small amounts of gravel and conglomerate. This alluvial layer has a variable thickness, but 50 meters or more is common. East of Semarang toward Demak the coastal plain consisting of recent alluvium is extensive, extending many kilometers into Java.

Adjacent to the recent alluvium toward Mt. Ungaran, having an average width of approximately seven kilometers, is the Damar Formation of the late Pleistocene. This formation consists of tuffaceous sandstone, conglomerate, volcanic breccia and tuff.

Farther in from the sea and adjacent to the Damar Formation lies volcanic breccia, lava flows, tuffaceous sandstone and claystone, also of late Pleistocene age.

This unit ranges from a thickness of 50 meters to a thickness of over 200 meters. Tertiary marine beds of the Miocene and Pliocene age, composed of marl, claystone, limestone with some tuff, sandstones and volcanic agglomerates lie between the Damar Formation and the volcanic breccia in some areas.

Adjacent to the volcanic breccia are the late Pleistocene age volcanics. The volcanics are cinder cone deposits and lava flows, with the rock types being tuff, breccia, and andesite and basalt lava flows. These volcanics, forming the slope of the volcano, extend 15 kilometers from the cone of Mt. Ungaran toward Semarang.

(iii) Existing Well Data

Data on existing wells in the Jratunseluna Basin, and especially in the Semarang area, are quite extensive and fairly well documented.

A report entitled Jratunseluna Basin Development Plan, Supporting Report III, Groundwater Resources, NEDECO, July 1973 [4], compiled data from the Geological Survey at Bandung on 75 deep wells, mostly located in the coastal plains of the Jratunseluna Basin. Although some important information concerning the wells is not available, the data were satisfactory to develop some basic conclusions.

The waterbearing sandy layers were found to be thin and discontinuous, generally not exceeding several meters in thickness. The sand beds were usually found to be intercalated between thick layers of clay with low permeabilities, therefore not allowing a large vertical exchange of water between the sandy layers. This characteristic of the sandy layers is not conductive to high groundwater recovery.

The yields of the existing wells were found to be small, typically ranging from 0.5 liters per second to 2 liters per second. None of the wells had a yield of over 5 liters per second. The quality of the groundwater was not always satisfactory. The groundwater in the upper 50 meters of basin sediments was usually very saline and unsuited for domestic purposes; however, some exceptions were found in foothill regions. The quality of the groundwater at depths greater than 50 meters varied greatly between areas.

The conclusion of the report was that based upon the existing data, the resources of good quality water are very limited in the alluvial valleys and coastal plains of the Jratunseluna Basin. The local bodies of fresh groundwater which do exist have limited recharge potential due to the confining clay beds coupled with the thin, discontinuous sand layers.

A significant amount of groundwater exploration has been conducted in the coastal plain beneath Semarang. Over 100 wells have been drilled in this area. The locations of 116 of these wells have been plotted on a map provided in a report by Hadi Darmawan Said of the Geologic Survey of Indonesia in Bandung [5].

Data on these wells were also provided, which include the yield of the wells. The yields were typically 3 to 4 liters per second.

The report indicates that the groundwater supply potential beneath Semarang lies mainly in sands of the Garang delta that are overlain by 30 to 90 meters of clayey and silty alluvial material. Because of the confining clayey beds, the

sands of the delta are frequently artesian. Recharge for this acquifer system is believed to enter at the point where the Garang valley meets the coastal plain. The report indicates that the water yield potential of the Kali Garang delta is 331 liters per second and that the existing groundwater use in the area is approximately 100 liters per second.

A report by Metcalf and Eddy International [3] collected data from existing wells in the hilly area south of Semarang between Semarang and Gunung Ungaran, and adjacent areas to the east and west. Data were gathered for 8 wells owned by industries and commercial establishments along the Semarang - Ungaran Highway. Six of the wells were deep wells, ranging from a depth of 66 to 90 meters. These wells had a reported yield of 54 to 288 liters per minute. Two of the wells were shallow, and reportedly had negligible yields.

This report [3] also discussed a contact with a local drilling contractor who indicated that yields from deep wells in the coastal plains immediately west of Semarang is low, but that an area of artesian wells exists in an area 16 km to 40 km west of Semarang. A new well in Kendal, located 25 km west of Semarang, is reportedly yielding 10 liters per second of high quality water.

Metcalf and Eddy also found some groundwater having poor quality in the coastal plain. A sampling of nine wells show high concentrations of total dissolved solids and chloride. The quality of groundwater within the Kali Garang and adjacent river basins was reported to be highly variable. The deep groundwater associated with cinder cones will tend to be more highly mineralized than waters circulating at shallower depths along shorter flow paths.

A drilling program undertaken by the SEMARANG MUNICIPAL WATER ENTERPRISE in the vicinity of Semarang has found mostly low yielding wells. Recent wells drilled in the hills immediately south of the city have been yielding from 0 to 3 liters per second. A reconnaissance survey was made in 1976 and 1977 by Mr. Soenarno Tandyopranoto, a geologist for the Semarang Water Enterprise, covering the administrative districts and villages of Pagerwunung, Mijen, Semak Watukangkang, Gunung Pati, Gunung Mundingan, and Ngijo. No high capacity sources or large excesses water were found in the area.

The Tentative Groundwater Map of Java and Madura, completed by M.M. Purbohadiwidjojo in 1960, shows the area beneath the city of Semarang to have "groundwater deficiency or relatively deep water table". The coastal plain northeast of Semarang and west of Demak is shown to be a zone of salty groundwater. The area in the vicinity of Mt. Ungaran is shown to be in a zone of spring emergence, while just east of this area shallow groundwater is shown to exist. This map accurately represents the results of the well data described in this section.

(iv) Groundwater Study in Progress

A detailed study of groundwater potential in the upper watershed of the Kali Garang and the adjacent rivers named Kali Kreyo and Kali Kripik is currently underway. The work is being done by Nihon Suido Consultants Co., Ltd. Tokyo, Japan, working with Cipta Karya. An inception report entitled Semarang Groundwater Investigation and Development Project, Nihon Suido Consultants, Co., Ltd. June 1979 [11] was recently completed.

The report agrees with the geology described earlier

for the Semarang and Mt. Ungaran area given in Section I.5.3.a. (ii). It states that groundwater exploration in the Damar Formation will generally be unpromising. The volcanic breccia which lies adjacent to the Damar Formation is mostly highly cemented, and much groundwater could not be expected from these beds. However, loosely bound breccia or volcanic sand layers may contain a relatively good acquifer. The Ungaran volcanic rocks involve lava flows and pyroclastic materials and potentially contain the most significant acquifer. These rocks are found on the lower slopes of Mt. Ungaran.

The source of groundwater in the lava flows will be mainly precipitation on the upper slopes of the volcanic cone where it soaks underground to form groundwater flow. The groundwater will be transported chiefly through cracks which have been developed in the thin interbeds of lava.

The alluvial deposits along reaches of the major rivers are reported to be poor potential sources. The field survey identified four reaches of alluvial areas worth investigating.

The conclusion of the field reconnaissance survey was that groundwater may occur in 4 areas within the study area 1) lava flows in the Ungaran volcano, 2) volcanic sand and gravel in Ungaran volcanic rock area, 3) weakly cemented volcanic breccia in the upper and middle hilly area, and 4) selected alluvial basins along reaches of the Kali Garang and adjacent rivers.

The proposed method to acquire more information on these sources of groundwater is by geoelectric prospecting. A total of 400 points is proposed to be examined in an area

of 100 square kilometers.

Following analysis of the data obtaining during the geoelectric survey, 4 sites will be chosen for testing by development of a test well and observation well. It is expected that testing of the sites from wells will enable determination of potential groundwater supplies in the study area. Final results of the study will be known sometime in 1980.

(v) Groundwater Potential of the Jratunseluna Basin

The potential for the development of groundwater to supply a sizable portion of the future water requirements for the city of Semarang is still largely unknown. Existing wells fail to yield flows of sufficient rate to justify the development of large well fields. The geology indicates a possibility of useful acquifers in the volcanic uplands, but tends to eliminate the potential for developable fresh water acquifers in the coastal plains. One problem with the development of large well fields is the lack of power supply in rural areas, coupled with significant power requirement of a well field.

Several reports suggest the possibility for the development of up to 1,500 liters per second of groundwater from well fields strategically located throughout the basin. Burns and McDonnell/Trans-Asia [1] reported a groundwater potential of 1,000 to 1,500 liters per second from the basins of the Kali-Babon, Kali Garang, Kali Mangkang, and Kali Blorong. Metcalf and Eddy [3], estimated a quantity of 1,300 liters per second available within the Kali Garang, Kali Pengkol, and Kali Lana basins.

The study currently in progress on the upper watershed of the Kali Garang should provide valuable information as to the groundwater potential of this area. Programs of groundwater exploration similar to this will be necessary to determine the availability of groundwater in potential areas throughout the Jratunseluna Basin. Based upon the results of this study, further groundwater exploration programs in other areas of the basin demonstrating groundwater potential will likely be undertaken.

Investigation for groundwater resources should be concentrated in the volcanic uplands. It is possible, if not likely, that some developable sources of water will be located in these areas through groundwater investigations. However, based upon existing studies and data, it is felt that the postponement of the development of surface water sources until the possibility of groundwater supplies is known would be a mistake, especially in light of the quantities of water demonstrated to be required in the year 2000. Even if a supply of 1,000 liters per second of groundwater is developed, additional water will be required by 1986. It is inconceivable to presume that the total requirement of the city of Semarang in the year 2000, or even 1990, can be met exclusively from groundwater resources.

I.5.3.b. Springs

A number of springs exist in the vicinity of Semarang. A list of these springs is given as Table I-24 in this appendix. The list, taken from a previous report [3], gives the name, elevation and estimated flow of the springs. Additional small springs are likely to exist throughout the area. The majority of the springs which can be utilized by the city of Semarang

for water supply are already in use. The other springs listed are either too small, too remote, or are currently being used by local residents. The springs which are not currently in use and which can be added to the water supply system of Semarang include Sloko, Banyumanik 2, and Dandang. The total available water estimated from these springs is only 65 liters per second.

One potential source of water for the city of Semarang is Muncul Springs. Muncul Springs is located approximately 45 km south of Semarang at the foot of Mount Telomoyo.

Discharge at the springs was measured in 1973 and 1974 as part of a study by NEDECO for the feasibility of Glapan Dam. The spring flows given below are taken from Jratunseluna Basin Development Plan, Central Java, Glapan Dam Irrigation, Flood Control, and Hydropower Project, NEDECO 1975 [6].

Data	Spring Flow (m^3/sec)
8-15-73	2.46
9- 1-73	2.25
10- 3-73	2.26
12- 1-73	2.05
1-18-74	2.07
2-23-74	2.19
5- 4-74	2.44
7-11-74	2.38
8- 1-74	2.15
9 -4-74	2.38
10 -2-74	2.11
11 -1-74	2.00
12-17-74	2.07

Muncul Springs consist of 7 springs contained in an area of 10,000 square meters. The ground elevation at the springs is between 465 and 470 meters above sea level. The largest of the springs currently feeds a swimming pool.

Discharge from the springs flow into the Muncul River, which in turn flows into Rawa Pening. Rawa Pening is a natural depression in the upper course of the Tuntang River, having water stored by means of a weir constructed near the outlet into the Tuntang River. The resulting lake has a surface area of $\pm$ 2,500 hectares at El.463.4 meters above sea level, and a storage volume of 42.5×10^6 cubic meters. The source of water for Rawa Pening is 14 small rivers and 5 springs, however, Muncul Springs is major source of water for the lake. The only outflow from Rawa Pening is through the Tuntang River.

The quality of water at Muncul Springs appears to be good. The results of the tests done [1] indicate a water of good bacterial quality, low hardness, and high carbon dioxide content. More analyses are necessary before a final determination of the quality can be made, but it appears likely that only chlorination will be required prior to use as potable water.

Field analysis, supported by [3], indicated that the source of water for Muncul Springs is likely an artesian groundwater system underlying the Rawa Pening Basin. The groundwater is confined by fine-grained sediments, consisting of alluvial silt and clays, but rises to the ground surface where stream erosion has cut through the confining beds. The artesian system is likely fed by the entire Upper Tuntang watershed, which includes parts of three cinder cones, Ungaran, Telomoyo, and Merbabu. The area of the Upper Tuntang watershed is 287 square kilometers [3].

The water flowing from Rawa Pening into the Tuntang River is currently being utilized for hydropower generation and irrigation. The water at the springs is being utilized for domestic water consumption, fishing and recreation at the Muncul Spring swimming pool.

Hydropower generation on the Tuntang River is accomplished at the Jelok and Timo power plants. The existing Jelok power plant was constructed in 1938, with three units of 5.12 MW each. An additional 5.12 MW unit was added in 1967. The Timo power Plant was constructed in 1963, and consists of 3 units of 4 MW each. For a number of reasons, the plants are limited to maximum power outputs of approximately 15.0 and 10.5 MW, respectively.

Downstream of the power plants, water in the Tuntang River from Rawa Pening is diverted at the Glapan Weir for irrigation. The majority of the water is directed toward the plain of Demak, on the right bank of the Tuntang River. The remainder is diverted into the Western Glapan Canal, serving a part of the plain of Semarang. The existing use of the Muncul Springs water is the major problem with development of the water as a potable water source for the city of Semarang. All studies on the subject agree that taking the full flow of Muncul Springs to Semarang would adversely affect the existing water users on the Tuntang River. The only quantification of the costs of lost benefits was found in Burns and McDonnell/Trans-Asia [1]. This report presented 1976 costs of lost irrigation at U.S.$ 951,800 annually and of lost power at U.S.$ 1,015,000 annually. A cost of U.S.$ 34,000 is included for purchase of land at Muncul Springs and demolition and reconstruction of the swimming pool.

The amount of flow which can be taken at Muncul Springs in the present situation without adversely affecting downstream users has not been determined. A report [7], entitled Muncul Springs Water for the Supply of Principal Water for Semarang City, written by a Work Team for the investigation of Rawa Pening operation under direction of Cipta Karya, presented preliminary findings showing that 640 liters per second could be diverted to Semarang without significantly affecting downstream water users. The report states, however, that additional study is required to determine the optimal usage of Rawa Pening water for all competing demands.

At the present time, the Directorate of Sanitary Engineering claims that a water right of 250 liters per second has tentatively been granted to the city of Semarang by the Directorate General of Water Resources, Ministry of Public Works. This water right is shown on a chart dated February 13, 1979 published by that Directorate. It is doubtful that economics can justify the construction of the system required to transport water over a distance of 45 kilometers from Muncul Springs to Semarang for a supply of only 250 liters per second. A minimum amount in the range of 1,000 liters per second will likely be required before development of the Muncul Springs water will be feasible.

The elevation of Muncul Springs enabling gravity flow to most of Semarang, and the apparent high quality of the water which would require only chlorination makes this source of water extremely attractive. However, the existing uses of the water for hydropower and irrigation prevent the development of the water source without damage to downstream users. The operation study for the integrated use of the waters of the Tuntang and the Jragung Rivers being reported in Part I of Appendix D to report on Updated Jratunseluna Basin Plan (currently in preparation) determine the quantity of

water which can be provided to the city of Semarang from Muncul Springs, and its effects on the downstream users, for the alternatives studied in this report. Since Muncul Springs water becomes part of the flow of the Tuntang River, the availability of this service is discussed further in Section I.5.3.c.

I.5.3.c. Surface Water Sources

(i) Tuntang and Jragung Rivers

Excess water is known to exist in the combined Tuntang and Jragung Rivers basins. The average annual yield of the Tuntang River at the Glapan Weir and of the Jragung River at the Jragung Damsite is 1,015 million cubic meters. The irrigation requirement for this water for the defined service area, which includes 35,000 hectares of land, is about 365 million cubic meters, leaving an excess of 650 million cubic meters. These values are developed in other appendices of the updated report currently being prepared on the Jratunseluna Basin Development Plan. The Muncul Springs water is, of course, included in the 650 million cubic meters of excess water. Muncul Springs will be discussed in this section for comparison with surface sources within these basins.

The determination of the optimized usage of this excess water is the basis of this study and report. Without storage capacity at strategic locations, the water cannot be taken from the basins without damage to existing downstream users. The results of the operation study will be discussed in detail in the relevant report being prepared separately; however, it is important in this report to discuss the results of the study in relation to the water supply for the city of Semarang.

The two most feasible sites to take water to the city of Semarang from the Tuntang and Jragung River basins are at the Jragung Diversion Weir or Muncul Springs. The completed design of Jragung Dam allocates 2,000 liters per second to the city of Semarang, which would be supplied either at the tailrace of the power house or would be collected from the Jragung Diversion Weir. Out of this quantity of water, only about 1,000 liters per second could be obtained from the Jragung Watershed if all the Jragung service area were to receive irrigation supplies. The remaining water would be diverted from the Tuntang watershed through the transbasin diversion.

The locations from where water could be supplied from Jragung are much closer to the city of Semarang than Muncul Springs, requiring less than 30 kilometers of pipe as opposed to 52 kilometers of pipe from Muncul Springs. However, the elevation at Jragung would necessitate pumping the water to the city. In addition, treatment of the water taken at Jragung will definitely be required prior to use as potable water in the city of Semarang. Muncul Springs has the advantage of a sufficient elevation to allow gravity flow to most of Semarang. Also, the water possibly will be found to require only chlorination prior to use as potable water.

The operation study showed that a dam at the Gunung Wulan site or increasing the storage capacity at Rawa Pening would allow 2,000 liters per second to be taken at Muncul Springs without harm to the downstream irrigation users. A reduction in the hydroelectric power produced at Jelok and Timo, in addition to a possible loss of power at a proposed power plant called Sambirejo would still occur.

Taking the 2,000 liter per second water supply to the city of Semarang from the Gunung Wulan Damsite has no apparent

advantage over the Jragung Damsite. The cost would be higher due to an increased length of pipe, approximately 15 kilometers, and the pumping requirement to get water to Semarang would be higher due not only to the losses in the increased pipe length, but also an elevation difference between the proposed water intakes at Jragung and Gunung Wulan. Taking water at Gunung Wulan would of course, have the advantage over Muncul Springs of eliminating the hydropower losses at Jelok and Timo power plants, however, construction cost and pumping requirements will be substantially higher.

Another damsite on the Tuntang River which has been the topic of feasibility studies by NEDECO [6] is Glapan. The proximity to Semarang of Glapan is similar to Gunung Wulan. It, therefore, has the same disadvantage as Gunung Wulan. Water supply from Glapan will likely only be seriously considered if for some reason the supply is not provided from Jragung Dam or Muncul Springs.

Table I-25 gives the present worth cost comparison between taking water at Muncul Springs or Jragung. The construction costs used are December, 1979 costs arrived at by updating the costs developed in [1]. The costs are not water supply development costs but are merely comparative costs. Storage is not added to either construction cost because it is assumed that storage will be required for either alternative to prevent harm to irrigation users in the basin service area. Results of the operation study will show whether the storage is required at Gunung Wulan or Jragung, or both.

The cost for lost power from use of Muncul Springs water is added to the comparative cost of the Muncul Springs source. The estimated loss of 6,650 kilowatts of power is conservatively used for the estimated power losses at Jelok, Timo and a proposed plant at Sambirejo. The cost for 1,830 kilowatts of power to pump water from Jragung to Semarang is added to the Jragung cost.

The difference in present worth costs between development of the Jragung and Muncul Springs water sources was found to be U.S.$ 13,460,000.

(ii) Outside of Tuntang - Jragung Watershed

A large number of potential dams in the Jratunseluna Basin have been studied to some degree. These dams have been listed, and basic information provided for them in the report by Burns and McDonnell/Trans-Asia, 1976 [1]. This data has been updated for this report, with the dams in the Jragung and Tuntang Rivers removed, and is given as table I-26.

Three of these damsites have had feasibility studies for irrigation, power and flood control prepared by NEDECO for the Ministry of Public Works and Electric Power, Directorate of Water Resources Development. These reservoirs are Penggaron, Dolok, and Ngrambat. The Ngrambat Damsite on the Kali Serang has since been moved to the Kedungombo Damsite, and design has been completed on this dam by Snowy Mountains Engineering Corporation in association with Sinclair Knight and Partners Pty. Ltd. and Agricultural Consultants Inc. Ltd.

A detailed analysis of the water supply potential of reservoirs outside of the Tuntang-Jragung River Basins is beyond the scope of this study. Burns and McDonnell/Trans-Asia, 1976 [1] analyzed in some detail these reservoir sites for water supply potential. The results of their study concluded that Penggaron Dam was the most feasible source of water outside of Muncul Springs and Jragung Reservoir. Penggaron has the advantage of an estimated yield potential of 2,700 liters per second [1] . Even if a supply of 2,000 liters per second from the Jragung-Tuntang River Basins is developed an additional supply of 2,850 liters per second is projected to be required by the city of Semarang by the year 2000. It is possible, if not likely, that another surface water source will be necessary to provide this supply.

The proximity of the Penggaron Damsite to Semarang and the projected high yield of the reservoir, are several advantages which warrant further consideration for this source. It is recommended that a feasibility study to determine the potential of Penggaron Dam to supply the water needs of the years 1990 to 2000 be undertaken in the near future.

I.5.4. Summary of Water Supply Sources

To supply the additional water requirement of the city of Semarang by the year 2000, 4,850 liters per second, several large sources of water must be developed. It is felt that the most feasible source for a large water supply which can be developed within a reasonable period of time is from the excess water on the Tuntang and Jragung River basins. This water can be taken from either Muncul Springs or Jragung Reservoir, depending upon the development schemes chosen for the Tuntang/Jragung River basins, and the coordination and concessions of various other users.

A quantity of 4,000 liters per second is the maximum amount of water which can be economically developed without significant harm to existing irrigation and hydropower users provided reservoirs having necessary storage capacities are built on both the Tuntang and Jragung Rivers. However, because of its high cost of construction the Jragung Dam cannot become a part of the optimum plan for the integrated development of the water resources of the Tuntang/Jragung Rivers basins. Therefore, if this dam is not built then the abovesaid quantity of water cannot be drawn from the system without adversely affecting irrigation in the potential service areas on both the Tuntang and the Jragung Rivers. In that case, only a quantity of 2,000 liters per second could be supplied from the Tuntang River basin (with storage provided on the system) to the city of Semarang. This 2,000 liters per second will fulfill water demands to the year 1991.

The additional supply requirement of 2,850 liters per second in the year 2000 will be provided from a combination of two sources, groundwater and another surface water source. The rate of groundwater in fulfilling future water demands for the city of Semarang can be determined only by comprehensive groundwater investigations such as the one now in progress. Even the most optimistic projection of groundwater potential does not foresee the development of over 1,500 liters per second, therefore, another surface water source will be eventually required. The Penggaron Damsite appears to be the most feasible source for the supply. The advantages of the Penggaron Damsite are close proximity to the city of Semarang and a large potential yield.

TABLE I-24

SPRING DATA

Name	Elevation (m)	Estimated Average Flow (l/s)
Kalidoh Besar[1]	418	49
Kalidoh Kecil[1]	418	13
Ancar[1]	431	17
Mudal Besar & Kecil[1]	337	138
Lawang[1]	329	45
Babadan	1,350	100
Banyumanik 2	150	25
Beji	25	4
Dandang	300	25
Glagah	400	20
Jati Ombo	325	40
Kajar	550	15
Limbangan	475	14
Limbul	225	10
Medini	1,450	100
Parakan	350	20
Prigen	850	100
Sedruyu	400	30
Seleases[1]	500	150
Sandangrejo	350	200
Semirang	1,200	20
Sloko	325	15
Taman Lele	25	5
Tugu	25	5
Ungaran	325	10
Watuceper	1,100	300
Muncul	464	2,000 +

Note:
1. Springs used by Semarang Municipal Water Enterprise for public water supply.

TABLE I-25

COST COMPARISON OF WATER SUPPLY

MUNCUL SPRINGS SOURCE	COST
Construction Cost (Treatment and Transmission Facilities)	$ 24,400,000[1]
Present Worth of Operation Cost @ 12% for 50 years, $ 180,000[1] x 8.3045 =	1,490,000
Present Worth of Lost Power at Jelok, Timo, and Sambirejo @ 12% for 50 years,	
Capacity Value = 6,650 Kw @ $ 120/Kw[2] x 8.3045 =	6,630,000
Firm Energy Value = 58.3 Gwh @ $ 33,200/Gwh[2] x 8.3045 =	16,070,000
Total Present Worth Comparative Cost =	$ 48,590,000

JRAGUNG RESERVOIR SOURCE	
Construction Cost (Treatment and Transmission Facilities, Including Pumping Plant)	$ 40,740,000[1]
Present Worth of Operation Cost (Less Pumping) @ 12% for 50 years $ 1,815,000[1] x 8.3045	15,070,000
Present Worth of Power Cost For Pumping to Semarang @ 12% for 50 years	
Capacity Value = 1,830 Kw @ $ 120/Kw x 8.3045	1,820,000
Firm Energy Value = 16,036 Gwh @ $ 33,200/Gwh x 8.3045	4,420,000
Total Present Worth Comparative Cost =	$ 62,050,000

1. Updated Costs From [1]
2. Based on Oil @ $ 20/Bareel

I.6. WATER DEMANDS AND SUPPLIES FOR TOWNS AND RURAL AREAS POTENTIALLY SERVED BY THE TUNTANG AND JRAGUNG RIVERS

I.6.1. General

There are, of course, other potable and industrial water users or potential users in the Jratunseluna Basin outside of the city of Semarang. The most obvious of these are other smaller towns within the basin.

An urban water supply program in Indonesia is administered by the Directorate of Sanitary Engineering, Cipta Karya, of the Central Government. The program was sub-divided into three Pelitas (5-year plans) to administer provisions of the program. The urban water supply policy for Pelita I was rehabilitation of existing water supply systems by means of provision of subsidies to local governments which undertook implementation of rehabilitation works. The policy for Pelita II is to extend existing systems for large cities and to construct new systems for medium and small cities. Pelita III, which will begin in the early 1980's, has two main objectives according to Program Pelita III and Years 1979-1980, Directorate General Cipta Karya, February 1979 [8]. One objective is to finish construction activities initiated in Pelita II, and the other is to provide clean water supplies for 150 medium and small towns, 40 of which are in Central Java.

The quantity of the new supplies of drinking water are to be provided according to the following table [9].

Population	Water Demand
20,000	20 l/s
20,000 - 50,000	40 l/s
50,000 - 75,000	60 l/s
75,000 - 100,000	80 l/s
100,000 - 500,000	As required
500,000 - 2,000,000	As required

This is based upon a design base of 60 liters per capita per day.

The other potential water users are the rural water users, most of whom live in small villages. According to [10], about 61 percent of the rural water sources in Central Java are contaminated to some extent. In 1971, 70 percent of the rural households in Central Java did not have water sources in their yards. Quoting from [10], the "water situation in rural areas is far more critical than in urban areas in Central Java".

It should be noted that the demands discussed in this section pertain to the consumptive use of water for potable or industrial use. Utilization of the rivers and canals for bathing or washing clothes is not a consumptive use of the water supply.

I.6.2. Water Demand of Towns Within the Jratunseluna Basin

The Fresh Drinking Water Project, Central Java, Department of Public Works, Cipta Karya [9], has identified specific towns in Central Java to be supplied water under Pelitas II and III. Two towns, Salatiga and Demak, were under Stage I - Emergency and had supplies completed in 1974 and 1977, respectively. Salatiga's supply, from springs, was 90 liters per second, while Demak's supply was 25 liters per second from the Tuntang River.

The towns in Pelita II with construction of new water supplies to be completed in the early 1980's located in the Jratunseluna Basin include Purwodadi and Juana. The supply of Purwodadi is currently 10 liters per second, and a capacity of 90 liters per second is scheduled to be completed by 1981. Juana's current supply of 4 liters per second is to be increased to 44 liters per second by 1982. Purwodadi's supply is to be obtained from springs, while Juana will obtain its water from an adjacent river.

Pelita II also includes towns which are to have master plan or feasibility studies performed. These towns include Kudus, Pati, Ungaran, Ambarawa, Juana, and Purwodadi. Juana and Purwodadi are presumably included to study further needs for water supplies following the consumption of the supply which will be completed in the early 1980's. The projected demands of several of these towns are given in the report [9] and are listed below.

Town	Present Water Supply	Demand 1985	Demand 2005
Kudus	0	65	260
Pati	0	90	150
Juana	4	20	80
Purwodadi	10	90	150

As mentioned earlier, Pelita III is a five-year development plan which will have feasibility studies, detailed design, and construction of water supplies for an additional 40 small towns in Central Java. The towns in Pelita III - First Stage Construction Period within the Jratunseluna Basin include Pati, Blora, Jepara, Ungaran, Ambarawa, and Kudus. All of these towns except Blora and Ungaran have wells as their projected source. Blora and Ungaran are shown to have spring water. Stage II construction during the Pelita III period includes

only one town in the Jratunseluna Basin, Grobogan. Grobogan is projected to be supplied by spring water.

The total water demand for the towns in the Jratunseluna Basin included in the Cipta Karya planning report can be estimated. The estimate for the demand of some of the towns has been made in the planning report, as given above. The demand for the remainder of the towns can be estimated by projecting the population to the year 2005, and using the chart given earlier to obtain the water demand for a town with a given population. Using this procedure, Table I-27 gives the fresh water requirement of the towns in the Jratunseluna Basin included in Pelitas I, II and III, excluding Semarang, to the year 2005. The demands were found to be 580 liters per second in 1985, and 1,150 liters per second in 2005.

The Fresh Drinking Water Report only specifies towns to be provided water during Pelitas I, II, III. It is predicted that other towns within the Jratunseluna Basin will also be provided with water supplies by the year 2005. These towns are generally smaller towns currently not experiencing as immediate a need for water as the towns specified in the report. A list of towns located within the Jratunseluna Basin which will likely require water supplies by the year 2005 is given below.

1. Mranggen
2. Tengaran
3. Karanggede
4. Wonosegoro
5. Juwangi
6. Ampel
7. Gubug
8. Godong
9. Dempet
10. Purwosari
11. Karangtengah
12. Jakenan
13. Kajen
14. Jekulo
15. Ngawen
16. Ngaringan
17. Wirosari
18. Kuwu

This list of towns was developed entirely based upon current population, and no attempt was made to analyze each town individually.

The demand for each town based upon their population will be 20 liters per second in 1985 and 40 liters per second in 2005. The total water requirement for these towns is 360 liters per second by 1985 and 720 liters per second by 2005. The total for these towns plus the towns specified in the Fresh Drinking Water Report [9] is 940 liters per second in 1985 and 1,870 liters per second in 2005.

It should be noted that these demands are very approximate, as it was not possible to analyze each town in detail. The population was projected using an annual growth rate of 3.00 percent for the planning period for each town. The water demands were either taken from [9] or projected based exclusively on population, not taking into account the other factors which affect water demand. In addition, other towns within the region will possibly need a potable water supply. The figures given for the total water demand should merely be used as a rough estimate of the quantity of water in the basin which may be required by small to medium sized towns for drinking water in future years.

I.6.3. Water Demand of Towns Potentially Served From Tuntang or Jragung River Basins

The previous section determined demands for towns within the Jratunseluna Basin. Of the towns given in Section B.6.2. many do not have the potential to be served by waters within the Tuntang or Jragung River Basins. Below is given a list of towns which may be served by water of the Tuntang and Jragung River Basins. All of these towns are not within the service area or the watershed of the two rivers, but would possibly utilize water either from the rivers or their watershed.

1. Demak
2. Salatiga
3. Ambarawa
4. Juwangi
5. Mranggen
6. Dempet
7. Gubug
8. Purwosari
9. Ungaran
10. Karangtengah

The total demand of these 10 towns are estimated as 315 liters per second by 1985 and 550 liters per second by 2005. Of these demands, a total of 115 liters per second is already being used by Salatiga and Demak.

I.6.4. Source of Water Supply for Towns

The Fresh Drinking Water Project report [9] lists the projected water source for the 40 towns in Central Java to be provided drinking water under Pelita III. The sources listed for all but 4 of these towns are either springs or well water. In addition, the supply for all towns within the Jratunseluna Basin to be supplied or studied during Pelita II, with the exception of Demak and Juana, are proposed to have either springs or wells. This is undoubtedly due to the prohibitive economics which typically occurs in attempting to provide storage, transmission and treatment for surface water sources of such small quantities.

The water demands from the Tuntang or Jragung River Basins, given in I.6.3. as 315 liters per second by 1985 and 550 liters per second by 2005, are not large in comparison to the demands of Semarang. The demands are also spread out over a large area. It appears reasonable that either springs or wells should be able to supply the majority of the total water requirement.

I.6.5. Water Demands of Rural Areas Within the Tuntang or Jragung River Basins

According to [10], 87 percent of the rural households are dependent upon wells or springs for their potable water supply, and 11 percent upon rivers or rain. These percentages vary, and in one kabupaten (regency), namely Demak in the Jratunseluna Basin, 48 percent of the rural households depend upon rivers or rain. Many kabupaten officials suggest that rural water supply is the first priority issue in health services.

Water supply plans for rural areas generally are aimed at eliminating the use of rivers and canals for potable water. The INPRES/ HEALTH program, which has the largest supply of funds and is under the control of the kabupaten governments, plans rural water supplies from one of four alternate sources. These sources are 1) hand pumps, 2) artesian wells, 3) pipeline from a spring source, and 4) rain collectors. The recommendation made in [10] for rural water supply states "special emphasis should be placed on avoiding the use of river water".

For this reason, the future water demand of rural areas from surface waters of the Tuntang and Jragung Rivers is not expected to increase over present usage. It is likely that dependence by inhabitants of rural areas upon rivers and canals for bathing and cleaning will continue for many years, however, the trend will be away from this water source. For potable uses, the provision of flushing flows in the rivers equal to the current flows should be sufficient to supply the consumptive use demands of rural areas. A flow rate of 250 liters per second has been used in this study for flushing flows.

A determination of the current and potential demands from groundwater by rural users in the Tuntang and Jragung River Basins is difficult. An approximation can be made by estimating the current population

within the river basins, projecting the population growth, and applying a per capita consumption to the projected population. Using a 1980 population of 300,000 persons, a growth rate of 2.5 percent annually, and a consumption of 60 liters per capita per day, the table given below projects the water demand to the year 2000.

Water Demand of Rural Areas Within
the Tuntang and Jragung River Basins

Items	Years				
	1980	1985	1990	1995	2000
Population	310,000	350,700	396,800	448,900	507,900
Per Capita Consumption (l/d)	60	60	60	60	60
Water Demand (l/s)	215	245	275	310	350

Since this water requirement is spread out over a large area, and the individual demands are low, it is anticipated that groundwater will be able to supply these water demands.

I.6.6. Summary of Water Demands and Supplies Other than City of Semarang

This section discusses future potential water demands of towns (excluding Semarang) and rural areas to be supplied from water within the Tuntang and Jragung River Basins. This demand was found to be small in comparison with the demands of the city of Semarang. A water supply of 560 liters per second will be required in 1985, and a supply of nearly 900 liters per second will be required in the year 2000.

It is predicted that virtually all of this requirement will be supplied from groundwater or springs, thereby eliminating the necessity of allocating a part of the flow in the Tuntang and Jragung rivers, in addition to the current flushing requirement, to this demand. The large area in which this water supply will be taken should alleviate the effect of the wells upon the surface flow in the two rivers. The groundwater usage by these users should also not appreciably affect the ability of the city of Semarang to develop groundwater resources.

TABLE I-26

PRELIMINARY DATA SUMMARY

DAMS & RESERVOIRS

Dam Name: River:	Penggaron Penggaron	Dolok Dolok	Kedungombo Serang	Wungkal-Kasap* Garang	Patemon*** Garang	Kreyo Kreyo	Kripik Kripik	Blorong Blorong	Putih*** Putih	Bodri*** Bodri
Drainage Area (sq km)	76	35	614	68	72	48	35	77	115	380
Reservoir Storage										
Normal Pool ($10^6 m^3$)	49	21	655	5±	18±	12±	48±	17±	352±	177±
Dead ($10^6 m^3$)	5	2	94	4±	4±	3±	2±	5±	8±	23±
Total ($10^6 m^3$)	54	23	749	9±	22±	15±	50±	22±	360±	200±
Max. Surface Area (ha)	600	190	4.700	190±	85±	100±	260±	145±	1,220±	1,130±
Expected Yield (l/s)	2,700	1,100	23,000	500±	1,500±	700±	1,100±	1,400±	6,000±	9,000±
Dam										
Height (m)	22	35	66	50±	70±	55±	40±	40±	65±	65±
Length (m)	865	-	1,600	75±	-	480±	800±	-	-	-
Volume ($10^6 m^3$)	1.0	0.9	7.1	0.5±	-	2.4±	1.8±	-	-	-
Base Elev. (m)	28	70	37	250±	125±	135±	50±	175±	175±	125±
Distance to Semarang (km) **	10	15	55	12	8	11	7	17	30	28

* Based on 2% chance of deficiency, using available hydrological data.
** Direct distance from Simpang Lima (downtown Semarang) to damsite.
*** Yields shown are based on only one dam per drainage basin.

TABLE I-27

WATER DEMAND FOR MAJOR TOWNS OF
JRATUNSELUNA BASIN (EXCLUDING SEMARANG)

TOWN	POPULATION			CURRENT WATER SUPPLY (l/s)	PROPOSED WATER DEMAND (l/s)		PROPOSED SOURCE
	1978	1985	2005		1985	2005	
Demak	23,572[1]	29,000	52,400	25[2]	25[3]	40[3]	River
Salatiga	75,162[1]	92,400	166,900	90[2]	90[3]	150[3]	Springs
Purwodadi	31,169[1]	38,300	69,200	10[2]	90[2]	150[2]	Well
Juana	7,113[1]	8,750	15,900	4[2]	20[2]	80[2]	River
Kudus	83,978[1]	103,300	186,600	0[2]	65[2]	260[2]	Well
Pati	47,095[2]	57,900	104,600	0[2]	90[2]	150[2]	Well
Ungaran	25,205[2]	31,000	56,000		40[3]	60[3]	Springs
Ambarawa	24,870[2]	30,600	55,300		40[3]	60[3]	Well
Jepara	38,685[2]	47,600	86,000		40[3]	80[3]	Well
Blora	43,002[2]	52,900	95,500		60[3]	80[3]	Springs
Grobogan	18,114[2]	22,300	40,300		20[3]	40[3]	Springs
Total Water Demand					580	1,150	

Notes:
1. Data Obtained from Central Java Statistical Office.
2. Data Obtained from Fresh Drinking Water Project-Cipta Karya.
3. Water demand projected based on water requirement table in above report.

I.7. CONCLUSION

Definite plans must be made and implemented soon to solve the existing and future water shortage problems of the city of Semarang. Due to increases in population and heavy anticipated industrial growth, the city will have a large demand for additional water supplies in the years to come. These water demands are calculated to be 1,215, 1,720, 2,660, 3,870, and 5,650 liters per second by the years 1980, 1985, 1990, 1995, and 2000, respectively. Failure to provide these water requirements will inhibit the accomplishment of the planning goals for the city of Semarang, specifically proposed industrial growth, as well as reduce the standard of living and health of its inhabitants.

The conclusion of this report, which is supported by a previous report prepared for the city of Semarang [1], is that the most feasible source for a large first-phase water supply will be from the waters of the Tuntang and Jragung River Basins, taken either at Muncul Springs or at Jragung Dam. Advantages and disadvantages occur for each source. The economics favor Muncul Springs, but the existing uses of this water is a problem which must be addressed. Storage on the Tuntang River will alleviate the damage to downstream irrigation users from taking water at Muncul Springs, but will not prevent a possible loss of power generation at existing and future hydroelectric power plants. A total of 2,000 liters per second can be allocated to Semarang from either of these two sources.

It is anticipated that groundwater will supply some water to the city of Semarang in the future, but the quantity cannot be predicted at this time. Extensive groundwater investigations, such as the one currently in progress, will be necessary before a determination of the role of groundwater in supplying future water requirements can be made. However, even the most optimistic projection of groundwater

potential does not envision this source being able to supply the remaining 2,850 liters per second following development of the recommended first-phase water supply of 2,000 liters per second. This will force the development of an additional surface water supply. The Penggaron Damsite appears to be the most feasible source for this supply. The major advantages of the Penggaron Damsite is the close proximity to the city of Semarang and a large potential yield. A feasibility study of this damsite, which should emphasize its municipal and industrial water supply capability, should be initiated.

The future water requirements of other towns and rural areas which would potentially be served from waters of the Tuntang and Jragung Rivers Basins was studied briefly. The total demand was not found to be large, and can likely be met from groundwater sources. The fact that the points of demands are spread out over a large area, and that the demand at each point is small, makes the use of groundwater possible and practical.

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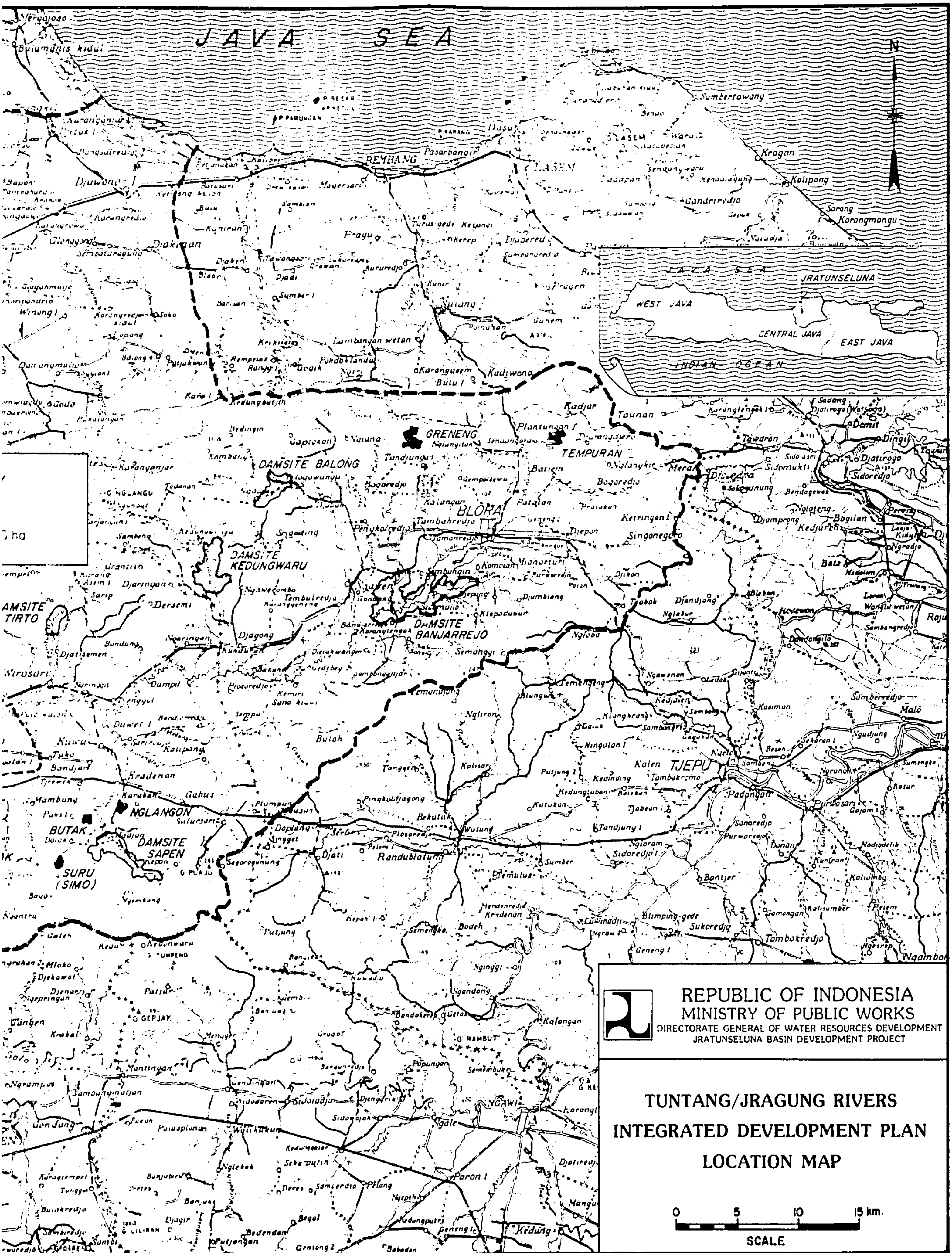
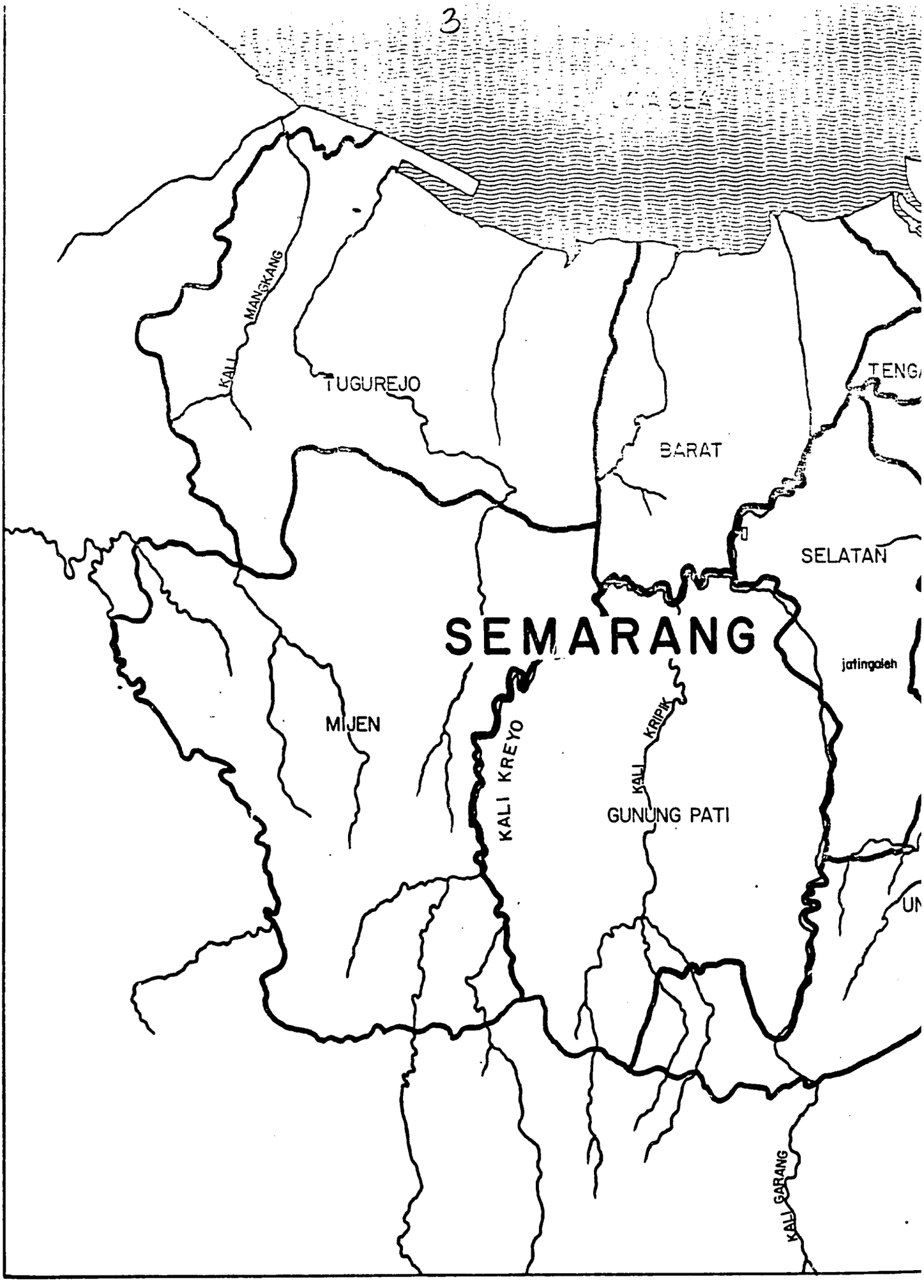
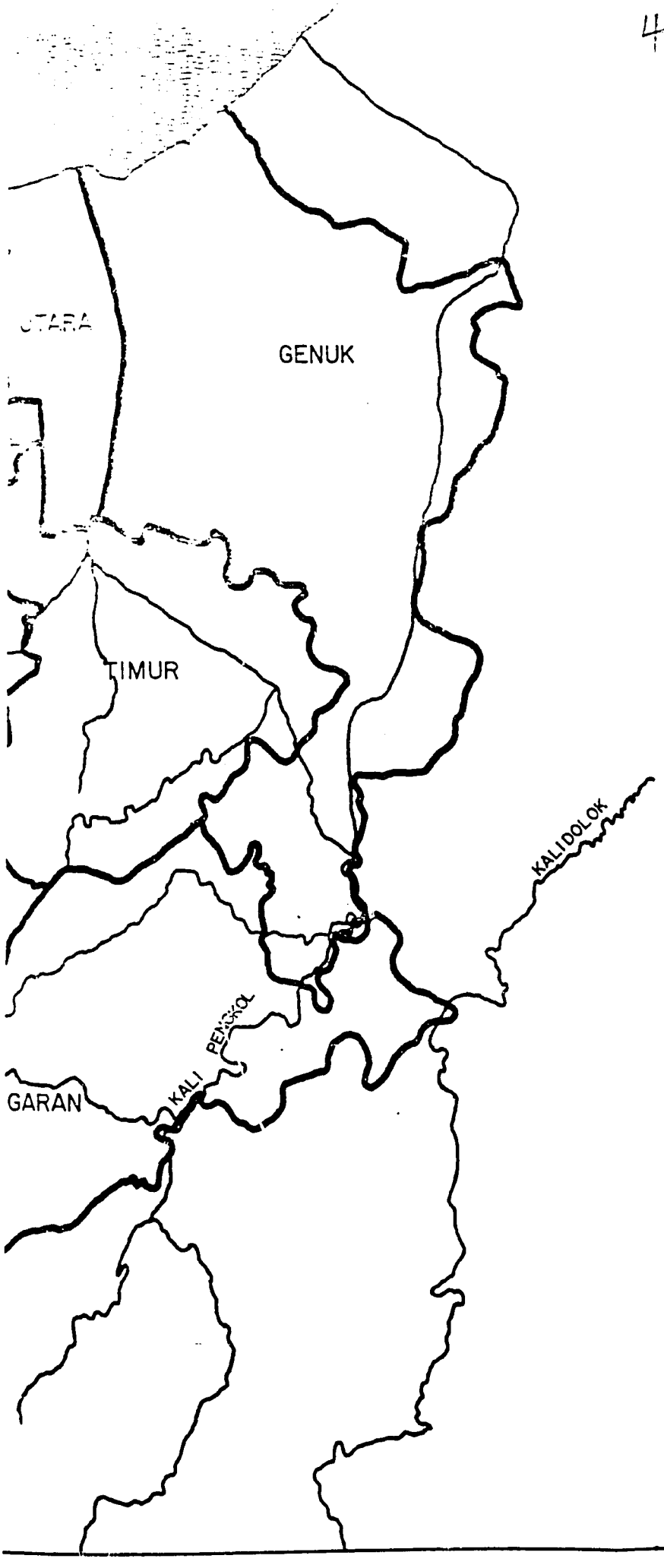
LEGEND
RAILROAD
HIGHWAY
SECONDARY ROAD
JRATUNSELUNA BASIN PROJECT BOUNDARY
RESERVOIRS :
EXISTING
UNDER STUDY
PROPOSED
IRRIGATION SERVICE AREAS
TUNTANG / JRAGUNG
OTHER
SERANG ESTIMATED NET IRRIGABLE AREAS ± 36,000 ha
JRAGUNG AND TUNTANG ESTIMATED TOTAL NET IRRIGABLE AREAS = 34,949 ha
WEDUNG
PELAYARAN
KUDUS
GEMENG
GROGOL-KARANG-ASEM
DEMAK
TUNTANG SERANG
JRAGUNG
SEMARANG
GLAPAN BARAT
TUNTANG
SERANG
PURWODADI
DAMSITE PENGGARON
DAMSITE DOLOK
DAMSITE GLAPAN
DAMSITE JRAGUNG
DAMSITE GUNUNGWULAN
DAMSITE BANDUNGHARJO
DAMSITE KEDUNGOMBO
DAMSITE NGLANJI
RAWA PENING
SALATIGA
Ambarawa
Tengaran
Kembang Ampel
Gubug
Grobogan
Purwodadi


JAVA SEA
N
REMBANG
LASEM
Sumberrawang
Kragan
Kalipang
Sarang
Karangmangu
Djuwono
Djakenan
Pasarbangi
Prayu
Sulang
Pragen
Gunem
Kadiwono
Karangasem
JAVA SEA
JRATUNSELUNA
WEST JAVA
CENTRAL JAVA
EAST JAVA
INDIAN OCEAN
GRENENG
TEMPURAN
DAMSITE BALONG
DAMSITE KEDUNGWARU
BLORA
Plantungan
Kadjar
Taunan
Bogoredjo
Batican
Ketringan
Singonegoro
Djepon
Tambakredjo
Damit
Dingin
Djatirogo
Sidoredjo
Djamprong
Kedjuren
Bogilan
DAMSITE BANJARREJO
Banjarredjo
Semanggi
Djagong
Kunduran
Ngaringan
Bondung
Djatisemen
DAMSITE TIRTO
Wirosari
Dumpil
Kuwu
Tuko
Sandjan
Kradenan
Gubus
NGLANGON
BUTAK
DAMSITE SAPEN
SURU (SIMO)
Plumpun
Doplang
Randublatung
Wulung
Bekutuk
Kalisari
Nglirun
Buloh
TJEPU
Padangan
Purwosari
Malo
Sumberredjo
Kasiman
Nglobo
Ngawenan
Kedinding
Sumber
Sidoredjo
Bantjer
Sukoredjo
Tambakredjo
Blimping gede
Ngandong
Kalangan
Papungan
NGAWI
Ngale
Paron
Walikukun
Kedunggalar
Mantingan
Sambungmatjan
Gondang
Ngrampal
Geneng
Kedung
Bedenden
Putjangan
Gentong 2
REPUBLIC OF INDONESIA
MINISTRY OF PUBLIC WORKS
DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT
JRATUNSELUNA BASIN DEVELOPMENT PROJECT
TUNTANG/JRAGUNG RIVERS
INTEGRATED DEVELOPMENT PLAN
LOCATION MAP
0
5
10
15 km.
SCALE


JAVA SEA
KALI MANGKANG
TUGUREJO
BARAT
TENGA
SELATAN
SEMARANG
jatingaleh
MIJEN
KALI KREYO
KALI KRIPIK
GUNUNG PATI
KALI GARANG



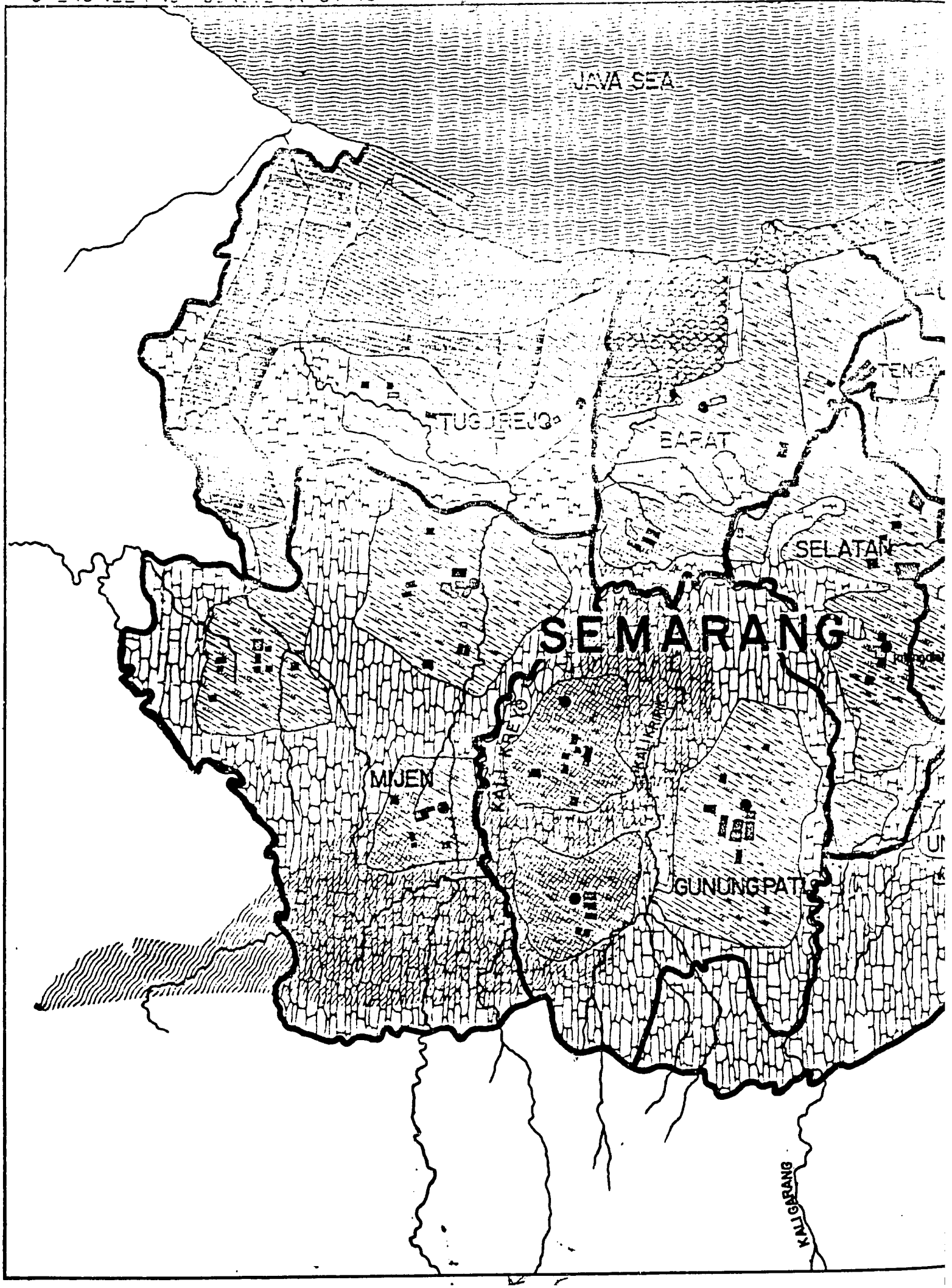
TUNTANG / JRAGUNG RIVERS

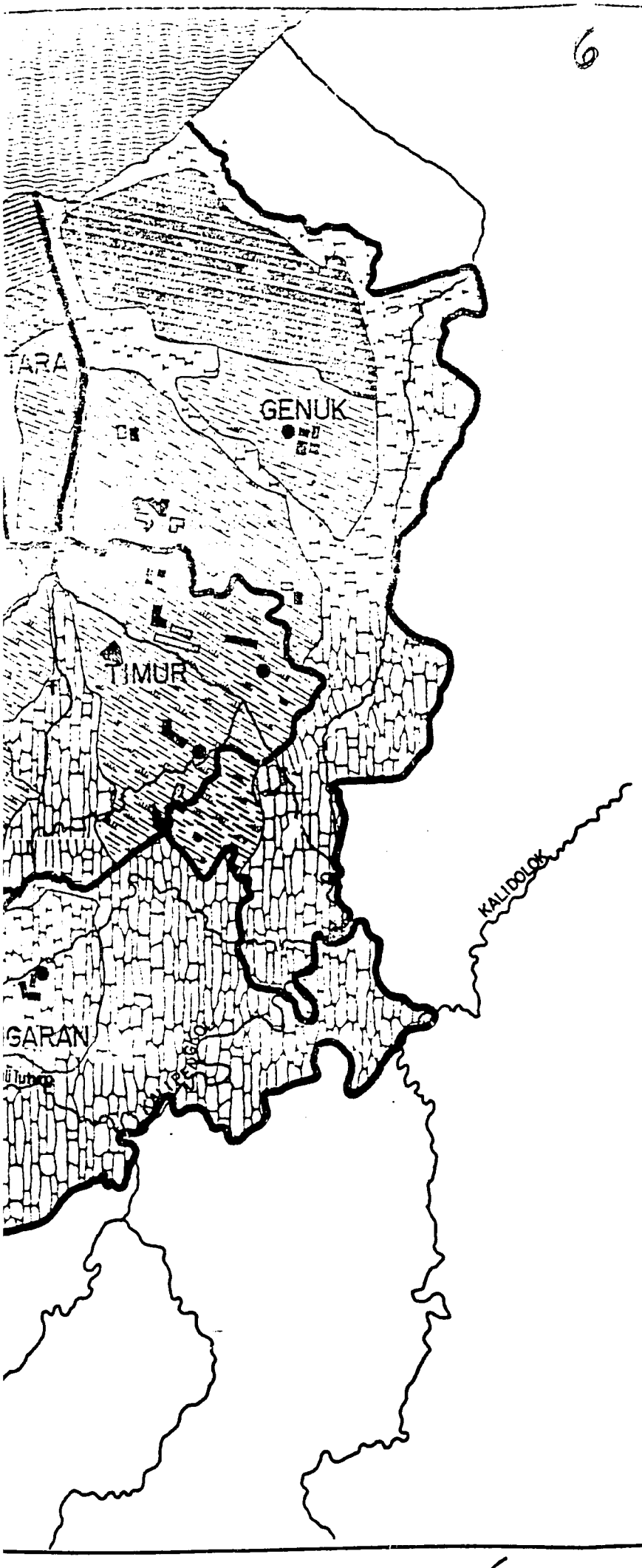
INTEGRATED DEVELOPMENT PLAN

CITY OF SEMARANG

BOUNDARY MAP

SCALE : 1 : 100,000


JAVA SEA
TUGUREJO
BARAT
SELATAN
SEMARANG
MIJEN
GUNUNGPATI
KALI KREO
KALI KRINGING
KALI GARANG



LEGEND

- BUSINESS CENTER
- INDUSTRY
- HARBOR
- HOUSING
- AGRICULTURE
- PARK
- PUBLICS& SCCIAL BUILDINGS
- MISCELLANEOUS COMMERCE
- WATER
- BUS TERMINAL
- DISTRICT BOUNDARY
- RIVERS

TUNTANG / JRAGUNG RIVERS
INTEGRATED DEVELOPMENT PLAN

CITY OF SEMARANG
LAND USE MAP

SCALE : 1 : 100,000