

JAPAN INTERNATIONAL COOPERATION AGENCY

No. 7

NATIONAL CAPITAL DISTRICT COMMISSION
PAPUA NEW GUINEA

**THE STUDY
ON
THE PORT MORESBY
WATER SUPPLY DEVELOPMENT PLAN
IN
PAPUA NEW GUINEA**

FINAL REPORT

IMMEDIATE REMEDIAL MEASURES

MARCH 1994

**TOKYO ENGINEERING CONSULTANTS
IN ASSOCIATION WITH
PACIFIC CONSULTANTS INTERNATIONAL**

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PREFACE

In response to a request from the Government of Papua New Guinea, the Government of Japan decided to conduct a master plan and feasibility study on the Port Moresby Water Supply Development Plan and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Papua New Guinea a study team headed by Mr. Kazufumi Momose, Tokyo Engineering Consultants Co., Ltd., and composed of members from the said company and Pacific Consultants International, 4 times between September 1992 and March 1994.

The team held discussions with the officials concerned of the Government of Papua New Guinea, and conducted field surveys at the study area. After the team returned to Japan, further studies were made and the present reports were prepared.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of Papua New Guinea for their close cooperation extended to the team.

March 1994



Kensuke YANAGIYA

President

Japan International Cooperation Agency

THE STUDY
ON
THE PORT MORESBY WATER SUPPLY DEVELOPMENT PLAN
IN
PAPUA NEW GUINEA

MARCH, 1994

Mr. Kensuke YANAGIYA
President
Japan International Cooperation Agency

LETTER OF TRANSMITTAL

Dear Sir,


We are pleased to submit herewith the Final Report entitled "THE STUDY ON THE PORT MORESBY WATER SUPPLY DEVELOPMENT PLAN IN PAPUA NEW GUINEA".

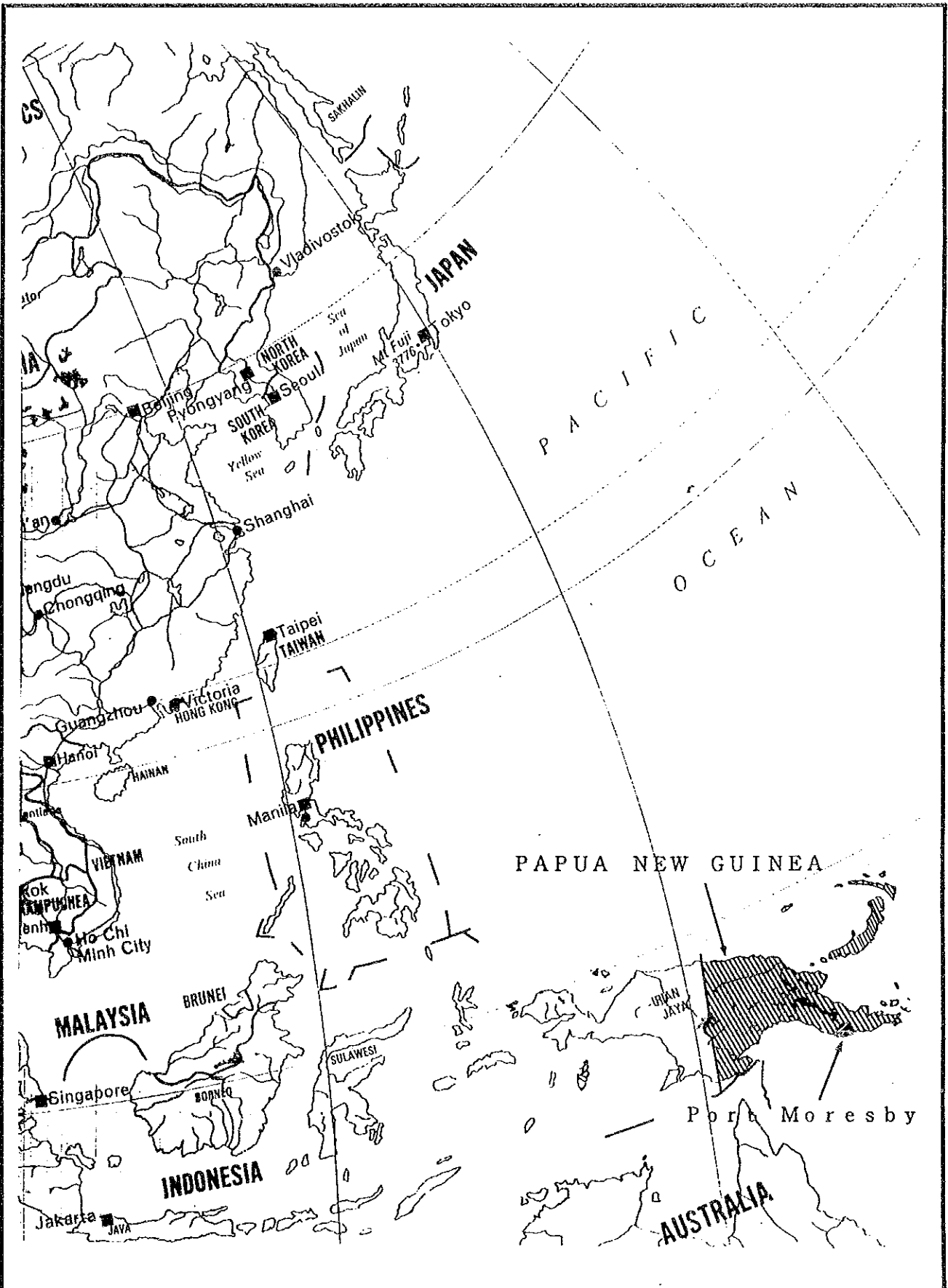
This report has been prepared by the Study Team in accordance with the contract signed on August 1993 and May 1994 between the Japan International Cooperation Agency and the Joint Venture of Tokyo Engineering Consultants and Pacific Consultants International.

The report consists of the Summary in English and Japanese, the Main Report in English, the Immediate Remedial Measures in English, and the Appendix in English. The Summary summarizes the result of all studies concisely and includes conclusions and recommendation. The Main Report contains results of survey, analysis and explains about Master Plan and Feasibility Study. The Immediate Remedial Measures Portion are published separately. The Appendix includes data, details of investigations and analysis.

All members of the Study Team wish to express grateful acknowledgment to the personnel of your Agency, Advisory Committee, Ministry of Foreign Affairs, Ministry of Health and Welfare, Embassy of Japan and JICA in Papua New Guinea, and also to the officials of the Government of Papua New Guinea for all assistance extended to the Study Team. The Study Team sincerely hopes that the results of the study will contribute to the improvement of health and sanitary conditions of people in Port Moresby.

Yours faithfully,


Kazuyuki MOMOSE
Team Leader

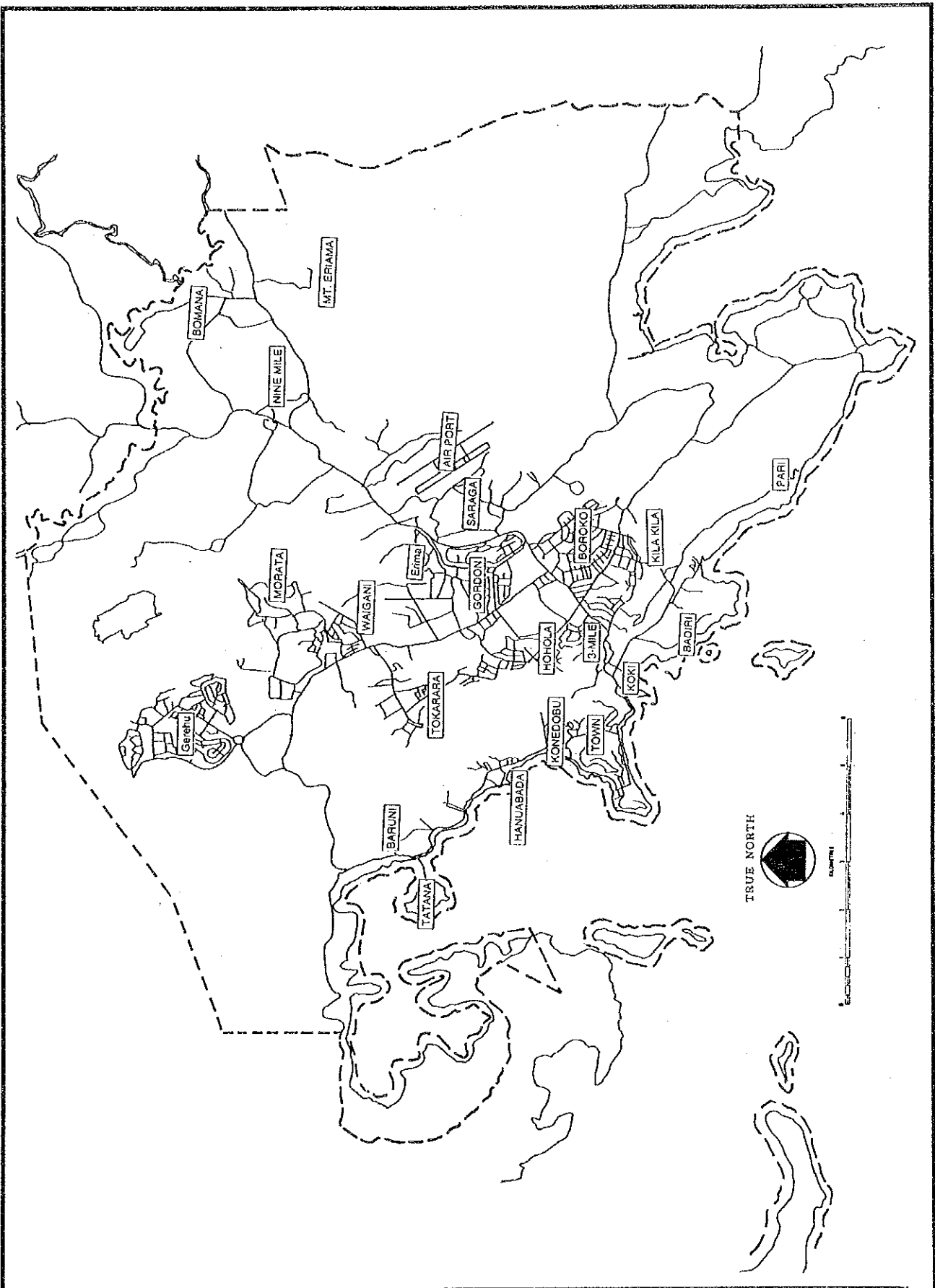


TITLE

LOCATION MAP

PORT MORESBY WATER SUPPLY DEVELOPMENT PLAN

TOKYO ENGINEERING CONSULTANTS in association with PACIFIC CONSULTANTS INTERNATIONAL.



TITLE

CITY OF NCD

PORT MORESBY WATER SUPPLY DEVELOPMENT PLAN

TOKYO ENGINEERING CONSULTANTS in association with PACIFIC CONSULTANTS INTERNATIONAL

SUMMARY

The total land area of Papua New Guinea is 462,840 km² and the population is a little less than 4 million (comprising of more than 500 tribes, speaking more than 700 different languages). PNG is the largest independent country in the South Pacific Ocean. The country is blessed with abundant natural resources, and development has been progressing in various fields such as agriculture, forestry, fisheries, mining, oil and tourism in recent years. About 80% of the population is self-sufficient or depends on farming for livelihood. The standard of living of the general population is said to be at the same level as the level of population in the post-developing countries.

Port Moresby, the capital of Papua New Guinea, has a population of about 190,000 (according to the 1990 census) and the city is growing rapidly. The water supply authority for this city (NCD: National Capital District) is the Water Supply Unit of the National Capital District Commission (NCDC).

The water supply facilities of this city are timeworn, and the influx of population into the city from the inland areas has further accelerated the insufficiency of the water supply quantity. The result is that since the second half of the eighties, daily suspension of water supply has continued and water supply provision has been ranked as the most important topic in the infrastructure of the National Capital District. Under these circumstances, the government of Papua New Guinea requested the Japanese government for grant aid and cooperation for the implementation of "Port Moresby Water Supply Development Plan" and for installation of special transmission pipelines from the 9-mile area to the town area.

On receiving this request, the Japanese government decided the implementation of the "Port Moresby Water Supply Development Plan," and the Japan International Cooperation Agency deputed a study team to the site from September to December 1992, and from May to August 1993. The study team analyzed the problems in the already existing water supply system, prepared a master plan with the year 2015 as the target, selected an urgent rehabilitation project and implemented a feasibility study for the first phase program with the year 2000 as the target.

The results of the survey showed that the biggest problem of the already existing water supply system (hardware aspects) is the inadequacy of supply quantity and inadequacy of performance of the transmission pipelines to the city. It was concluded that the supplied water was not distributed equally to various areas in the city. (The water pressure at the end of the pipelines is either higher than necessity, depending on the

area, or excessively low in low-lying areas.) This is because, the topography in Port Moresby has plenty of undulations made up of ridges and valleys running parallel to each other and the shore in the north-south direction. Therefore, the water supply system has a natural downflow. With such irregular topography, and imperfect conditions of the implementation and operational system (software aspects) of the Water Supply Unit, the technology to pump water using pumps for attaining equal distribution, is inappropriate from the aspects of maintenance and management costs under the present situation. The main prerequisites of design criteria for the overall supply system include the construction of a water treatment plant at a high altitude from the ground level, and natural downflow.

The measures for the existing water supply system from the hardware aspects include simultaneous improvements in both supply capacity and delivery capacity to satisfy the demand. Since the expansion of a part of the water treatment plant in 1977, however, no major investment has been made for the existing water supply system. Therefore, enormous construction costs and a long-term implementation period are necessary for carrying out radical reforms. Under this grant aid and cooperation program, the first priority will be given to laying of transmission pipelines (bore diameters 1,100 mm and 600 mm) which could deliver water at equal pressures throughout the city if supplied quantity is sufficient, and a proposal for the water supply rationing plan for distributing equally the relatively inadequate water supply quantity.

The outline of the planned transmission pipelines and the water supply rationing plan is shown below.

transmission pipeline route	Pipe diameter	Length
from the airport to Erima point	1,100 mm	2.59 km
from Erima point to 3-mile point	600 mm	7.19 km

The water supply rationing plan varies for the rainy season (from December to March) and the dry season (from April to November.)

	Rainy season	Dry season
water supply rationing time	1 day in 6 days	1 day in 3 days
Number of water supply blocks	6	3

Note: The demand quantity in the rainy season shall be reduced compared to the dry season.

The focus of this project will be the laying of approximately 10 km of transmission pipeline in a one-term plan rather than dividing the work in several terms. The water supply rationing plan has been judged feasible by the NCDC side and the details of the plan are described in this report.

The portion of this project by the Papua New Guinea and the expenses are estimated as given below.

Access road costs	300 (thousand Kina)
Water for water pressure tests	2
Total	302

By laying the special water transmission pipelines, the water pressure in inadequate water supply areas (locations at high altitudes at a considerable distance from the water treatment plant: particularly Town and Hanuabada areas) will be improved, resulting in a satisfactory water distribution system. The pipes of 1,100 mm diameter from the near airport to the Erima point will become a part of the transmission pipeline for the low zone in the near future (Feasibility Study target year 2000), thus eliminating unnecessary investments. (We are well aware of the urgency of increasing the overall supply quantity of the system as a radical measure.) Besides, the effects mentioned below may be anticipated by implementing the water supply rationing plan.

- 1) Water will be supplied to all areas of the entire city at the adequate pressure and in appropriate quantity, except on the water supply rationing day.
- 2) By fixing a water supply rationing day, the awareness for saving water will be firmly impressed in the minds of the people.
- 3) The inadequate water supply areas in the past will be eliminated, therefore, water charges can be recovered from the people in these areas.
- 4) The expenses incurred for measures in the inadequate water supply areas until now (water tank trucks, valve operations at local stations at night, etc.) will no longer be necessary.
- 5) By implementing the water supply rationing plan, the all-embracing experience of NCDC, which is the implementing organization, will accumulate, reinforcing the maintenance and management aspects.
- 6) By identifying the 1,100 mm pipeline from the airport to the Erima point as a part of the transmission pipeline for the future, and by implementing this plan, the basic solution and policy for the existing system in the near future can be defined clearly.
- 7) On-the-job training can be given to the junior employees of the NCDC Water Supply Unit by allowing them to participate in the pipeline works.

In this way, from the hardware aspects, this is a unique project for laying water transmission pipelines. The effects of this project have been described before, but we may mention again that the effects of this plan from the software aspects, when combined with the water supply rationing plan, are anticipated to be significant, particularly on the entire NCDC organization.

For the smooth implementation of this project, the reinforcement of NCDC in software aspects, and its cooperation are indispensable. Deputation of specialists for reinforcement of the software aspects must be considered also.

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CHAPTER 1 INTRODUCTION

The Japan International Cooperation Agency started the master plan and feasibility study of Port Moresby water supply development in August 1992. In the project study for the first year that ended in March 1993, JICA framed a master plan and an urgent rehabilitation project. From this study, it was concluded that daily suspension of water supply has continued from the second half of the eighties, because of the inadequacy in quantity of water supplied and the unsatisfactory performance of the transmission pipelines. As a solution to these problems, JICA framed a master plan with the year 2015 as the target and selected an urgent rehabilitation project. Furthermore, during the project study in the second year 1993, JICA carried out a feasibility study with the year 2000 as the target. The government of Papua New Guinea started investigations for implementing the work proposed in the feasibility study for resolving the water shortage, but enormous working expenses and a considerably long implementation period are necessary for the implementation. The water shortage is likely to worsen due to the increase in demand even during the implementation period.

The water supply rationing plan has been proposed for implementation until fundamental measures proposed in the feasibility study are adopted, so that the limited water is equitably distributed to the people for the time being. From the hardware aspects, the laying of transmission pipelines to the coastal areas, which is the biggest obstacle to the implementation of the plan, has been proposed.

The government of Papua New Guinea requested the Japanese government for grant aid and cooperation for the urgent rehabilitation project in June 1993. Based on this request, the Japanese government decided to carry out a basic design study. The basic design study was carried out in addition to the master plan and feasibility study of the water supply system. On-site study for collecting documents and materials was not performed because adequate information and data were collected in the master plan and feasibility study of the water supply system. During the explanation of the draft final report on the master plan and the feasibility study in December 1993, the scopes to be borne by Papua New Guinea were confirmed.

The JICA deputed a study team to Papua New Guinea from March 9 to 18, 1994 to explain the contents of this report - the project for the immediate remedial measures - to the government and related officials of Papua New Guinea, held discussions with them and has signed the results of the meetings as minutes of the agreement. A part of the facilities proposed in the urgent rehabilitation project has been changed in the basic

design study, and these changes have also been incorporated in the minutes of the agreement.

CHAPTER 2 Background of the project

2.1 Outline of Papua New Guinea

(Geography)

Papua New Guinea (hereafter abbreviated to PNG) is an island nation located about 5,000 km from Japan and directly north of Australia. The country belongs to Oceania and together with Fiji and New Caledonia, forms a South Pacific island group called Melanesia.

The area of PNG is 462,840 km² (approximately 1.25 times the area of Japan). The eastern part includes the main island of New Guinea that occupies the maximum area (the western part includes Irian Jaya, belonging to Indonesia), the New Britain island, New Ireland island, Bougainville island, Manus island and about 700 other large and small islands. The main island of New Guinea is the second largest island in the world after Greenland. Its area is more than three times the area of Honshu in Japan. High and rugged mountain ranges run through the central part of the island, and some of the highest peaks exceed 4,000 m. A large number of basins and plateaus are contained within these mountain ranges, which are blessed with cool climate. For this reason, more than 40% of the population inhabit the mountainous land. New Britain island and most of the other islands are the peaks of volcanoes of a mountain range under the sea, that have appeared above the sea level.

PNG is administratively divided into Port Moresby National Capital District (NCD) and 19 other provinces. The NCD and 14 provinces are located on the main island of New Guinea, while the remaining 5 provinces are a part of the island of New Britain.

(Climate and Vegetation)

Except the central highland area and a part of the southern coast of the main island of New Guinea, the whole of PNG has a tropical rain forest climate. From December to April, the monsoon winds blow from the west or northwest, while trade winds prevail from the south-east from May to October. In the coastal areas, the minimum temperature is in the range of 20 to 25 °C (average 21°C), the maximum temperature lies in the range of 30 to 35°C (average 32°C), with practically no change in these figures every year. In the delta region of the Papua Gulf, the annual rainfall exceeds 5,000 mm, with a part of the region having an annual rainfall that exceeds 7,000 mm,

indicating that is one of the locations with the heaviest rainfall in the world. The average for the entire island, however, is about 2,000 mm. The high-lying areas in the central part are called 'highlands.' These areas have an average temperature of 10 to 15°C, a maximum temperature in the range of 25 to 30°C, low humidity, the areas are suitable for raising crops and livestock, and have a comparatively high population density.

Except for a part of the land in PNG, the soil is generally infertile. Except for tropical agricultural products such as coffee, cocoa, tea, copra, and oil palms, there is very little land suitable for cultivating crops and agricultural products. If the whole of PNG is observed, the population density is very low. A large number of inhabitants dwell in the marshland, and in the delta part in the south that has a potential for farming. Also, there has been very little progress in agricultural developments. However, because of the tropical rain forest climate, the country is suited to cultivation of trees, and forests occupy about 85% the land area.

(Population, people and race)

The total population of PNG as of 1990 is estimated as 3,690,000. This figure when converted to the national average population density, works out to 8.1 persons per square kilometer. The average annual increase in population from 1971 to 1990 was 2.2%.

The majority of the inhabitants of Papua New Guinea belong to the Melanesian race but there is a small minority belonging to the Micronesian race (northern part of Manus island) and the Polynesian race.

The Melanesian inhabitants may be divided into Papuans belonging to the Melanesian race in the broad sense, and Melanesians belonging to the Melanesian race in a narrower sense. The Papuans are mostly distributed in the Papua region currently (south of the central part of New Guinea island). Papuans are generally of average height, but the inhabitants of the highlands are smaller in height, have a compact stature and well developed muscles. The Melanesians are mainly distributed in the New Guinea area currently (northern part of the New Guinea island, and the New Britain island), are generally taller than the Papuans, with skin of a light brown color.

As a result of the intermingling of these two peoples over many years, the differences in the appearance have almost disappeared now. More than the differences in the physical appearance, the differences in the manners, customs and languages of small

pockets in the country are remarkable, in spite of being inhabitants of the same country. As of now, more than 700 different languages are being used among the 500 or more tribes in the whole country. Just prior to the independence of the country, there were many tribes who had been leading the life of people in the Stone Age. This is attributed to the lack of contact between individual tribes who were isolated and lived independently. The phenomenon of area-wise fractionation is a unique characteristic of PNG that cannot be observed in other parts of the world.

Table 2-1 Population distribution

Name of province and NCD	Area (km ²)	Population			Population density (person/ km ²)
		1971	1980	1990	
Western	99,300	70,339	78,337	108,705	1
Gulf	34,500	58,273	63,843	68,060	2
Central	29,500	175,515	116,361	140,584	5
NCD	240	*	112,429	193,242	805
Milne Bay	14,000	108,528	127,725	157,288	11
Northern	22,800	65,918	77,097	96,762	4
Southern Highlands	23,800	192,047	235,390	302,724	13
Enga	12,800	131,816	164,270	238,357	19
Western Highlands	8,500	211,456	264,129	291,090	34
Chimbu	6,100	159,729	178,013	183,801	30
Eastern Highlands	11,200	236,752	274,608	299,619	27
Morobe	34,500	240,930	305,356	363,535	11
Madang	29,000	168,212	209,656	270,299	9
East Sepik	42,800	180,149	220,827	248,308	6
West Sepik	36,300	93,479	113,849	135,185	4
Manus	2,100	24,356	25,829	32,830	16
New Ireland	9,600	58,507	65,657	87,194	9
East New Britain	15,500	108,238	130,730	184,408	12
West New Britain	21,000	60,783	88,415	127,547	6
North Solomons	9,300	90,382	125,506	159,500	17
Total	462,840	2,435,409	2,978,057	3,689,038	8

Source: National Statistical Office

Note: * NCD (National Capital District) belonged to Central Province until 1978.

In the Papua area, Motu - a mixture of English and the Papuan language is commonly spoken. In the New Guinea area, pidgin English is widely spoken by mixing the Papuan, Melanesian, Polynesian and furthermore, German with English. The official language of PNG is English.

(History)

PNG was sighted the first time by an European when a Portuguese landed in the northern part of New Guinea in 1512. During the sixteenth century, many Portuguese and Spaniards landed in PNG but their stay was limited to a short period in local areas, therefore, details of PNG were not known. In this period, the whole territory came to be known as Papua New Guinea, the word "Papua (curly hair)" associated from the hair of the natives, and the word "New Guinea" from the similarity of the natives to the people living in the coastal districts of Guinea in Africa.

The area was explored by the Dutch in the seventeenth century. New Ireland island was discovered in 1642, and New Britain island in 1700. From the eighteenth century, British activities increased and there were frequent explorations to various areas of PNG. In 1872, a British Navy commander John Moresby visited the place known as Port Moresby now, and the entire picture of PNG became clear.

The main island of New Guinea was divided into two when the Germans annexed the northern half of the New Guinea main island in 1884, which became as "German-administered New Guinea" while the southern half of the main island became "British-administered New Guinea." Later, in 1899, the German-administered New Guinea was directly controlled by Germany, but with the outbreak of the First World War in 1914, Australian troops occupied this territory. After the war, the League of Nations entrusted the administration of this territory to Australia. Meanwhile, a territorial pact was signed between the British-administered New Guinea and the Dutch-administered New Guinea (now Irian Jaya, belonging to Indonesia) in 1895, but with the formation of the Australian federation in 1901, this territory came under the control of Australia in 1902. In 1906, PNG became a territory of Australia.

With the entry of the Japanese army in 1942, PNG was placed under the military administration of Japan. However, with the defeat of Japan in the war in 1945, PNG came under Australian control again. The United Nations placed PNG under Australian administration as a trust territory in 1946.

Papua New Guinea became a self governing country in 1973, with Australia retaining only the diplomatic and defense rights. In 1975, Papua New Guinea was entrusted with the diplomatic and defense rights and it became a fully independent country. In the same year, a new constitution was adopted, and the country's entry into the United Nations was recognized.

(Social system)

The units of social life of PNG, excepting cities, are rural communities consisting of 100 to 500 members. Food items include the catch from fishing and hunting, bananas, taro, yam, and breadfruit; grains are negligible.

For a while after the independence, there were frequent fights between rural communities. Fighting was the most important aspect of a man's work, together with hunting, and counting the number of dead in a fight assumed an extraordinarily serious aspect. Firearms were not used, but the bow and arrow, and the club, were the main weapons. In the past, head hunting and cannibalism were customary, as were religious practices, but with the diffusion of the moral laws of Christianity and the expansion of the authority of the police, these practices have almost totally disappeared now.

In recent years, there has been a tendency for the population to accumulate in cities, starting with Port Moresby, and the social lifestyle is rapidly changing and becoming centered around cities. Traditional social lifestyle and customs are disappearing rapidly. Amidst these circumstances, some old systems do remain, such as the land ownership system, which is a problem particularly in the urban areas of the National Capital District.

The status of land ownership among the natives is originally very complicated and territorial wars were waged frequently (wars occurred because of land ownership disputes before the independence). Modern land ownership rights have not been established yet, and specific usage rights, occupancy rights, entrance rights in areas and districts exist customarily. These rights are retained not by individuals but by rural communities. However, individual ownership rights existed during the former German occupation. This is because the land owned by the German New Guinea companies were acquired mainly by Australians, and most of these lands have become plantations. Besides these owned lands, lands purchased by the government from the inhabitants and now belonging to the country also exist. The traditional ownership practices mentioned above are recognized in the present constitution also, and the desire to convert to modern ownership practices, cannot be observed.

(Government)

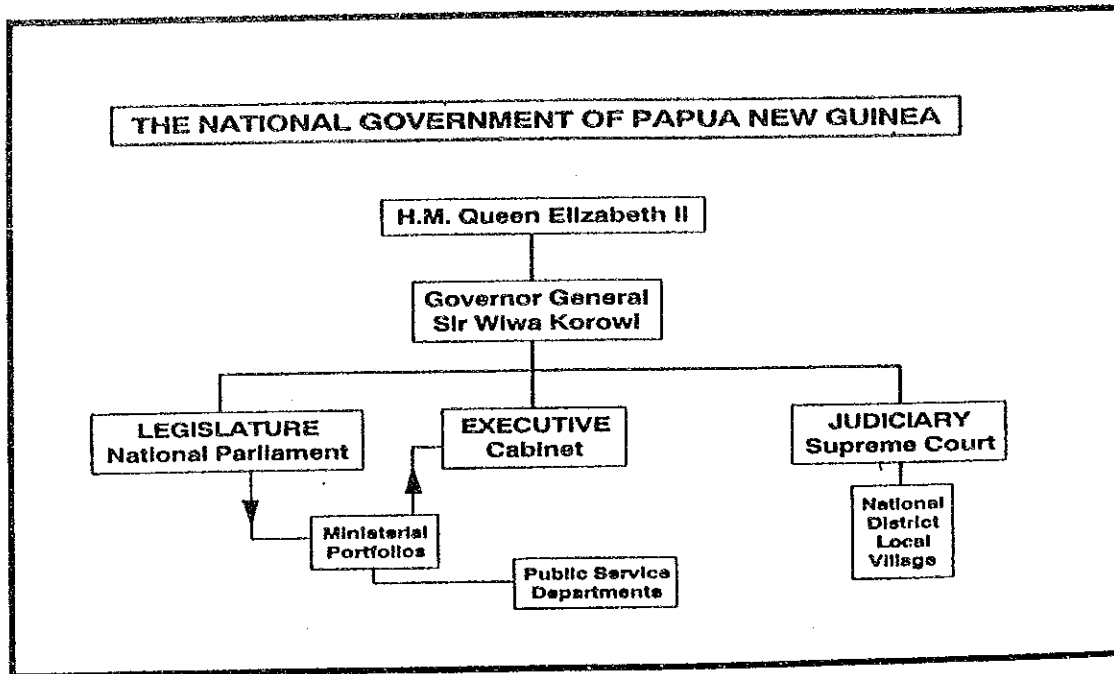
Papua New Guinea is a constitutional monarchy that looks up to the British monarch as the head of state, and is a parliamentary democracy with the respective independence of the legislature, the executive and the judicature. The powers of the head of state include the power to appoint and dismiss the Governor-General, the Prime Minister, and members of the cabinet, the power to appoint judges of the Supreme Court and High Court, and ratification of pacts. The Governor-General is appointed by the people of PNG, similar to other Commonwealth nations. He represents the British monarch and conducts himself in national affairs and duties.

The legislature is a unicameral national parliament, and members of the parliament are normally elected by the people (voting rights for persons above 18 years of age, eligibility for election for persons above 25 years of age). The total number of seats is 109, including 20 elected members from the provinces (National Capital District + 19 provinces) and 89 members elected from districts (total 89 districts in the whole country, with one district unit consisting of 25,000 to 30,000 persons). There is also a system for nominating members to the parliament but no member has been elected this way until now. The term for a legislator is 5 years. Currently there are 7 political parties with seats in the parliament, and the rivalry of local barons of the various parties has continued since the independence of the country. Administrative power has been maintained by a coalition of multi-parties. The coalition, however, is not permanent and depends on the results of the election from time to time.

The cabinet consists of ministers under the Prime Minister, and it assumes total responsibility for the administration of the country. The Prime Minister is appointed by the head of state, based on the name recommended by the parliament. Members of the cabinet other than the Prime Minister, are nominated by the head of state, based on the recommendation of the Prime Minister. The number of cabinet members is six, and is fixed as less than one-fourth the number of members of the parliament.

The judicature consists of the Supreme Court, the High Court, the District Court and other courts at the lower level. The Supreme Court is the ultimate judging authority. It has the powers to screen all judicial decisions taken by the high courts, and has jurisdiction over all matters related to interpretation of the Constitution. The Supreme Court usually consists of three or more judges. The High Court has jurisdiction over civil and criminal affairs.

THE NATIONAL GOVERNMENT OF PAPUA NEW GUINEA



The "provincial government" system investigated in the draft bill in the constituent assembly of 1975 was totally abolished due to various reasons. However, in 1976, voices were raised from the districts for an early installation of local governments and the Constitution came to be revised. The result was that fundamental laws related to provincial government were enacted, and the decentralization system was established. Currently, 19 provincial governments, excluding the National Capital District have been installed. The provincial government has independent legislative and administrative powers as a local self-governing body. Legislative powers with respect to public schools, sales of alcohol, public recreation, housing, culture centers, sports organizations, rural courts have been recognized. Taxation powers for consumable items other than alcohol, gasoline and beverages have been recognized also.

(Economy)

The GNP per capita of Papua New Guinea is 770 U.S. dollars (as of 1990), which is in the middle range of the GNP for developing countries. However, about 80% of the population depend on their livelihood totally or partially on agriculture, and the standard of living of the general population is the same as that of a post-developing country.

Due to the natural conditions of PNG, cities and communities are dispersed on a small scale, obstructing the foray of the monetary economy to the districts. Small scale

dispersion and the high cost of transportation of goods are the reasons for the underdeveloped domestic manufacturing industries. Also, the country depends on imports for a major part of the consumable goods, which increases the price of commodities and the capital cost. Besides, the dependence on foreign countries (particularly Australia) for technology and capital resources, and the traditional land ownership system (95% of the land is owned by various tribes) have become fetters to economic development.

The PNG economy may be broadly divided into self-sustaining economy and monetary economy. However, the majority of the people belong to a semi-self-sustaining economy that lies between the two economies mentioned above. The monetary economy depends largely on the mining industry (gold and copper), agriculture and forestry industry (coffee, cocoa, wood, etc.). The mining sector accounts for 65% of the exports, which is 15% of the GDP. The agriculture and forestry sector accounts for 35% and 40% of the exports respectively. Meanwhile, the agricultural sector employs 85% of the labor force of the country, whereas, the mining industry employs less than 1%. The employment figures for the mining industry is but a very small fraction of the total.

Mining work started in the Bougainville Mine from 1972, the OK Tedi Mine from 1984 and the Misima Gold Mine from 1989. Besides, developments on the Porgera Gold Mine, Lihir Gold Mine and other small mines, oil exploration of the Papua coast and southern highlands are in progress. There was a suspension of the mining operation in the Bougainville Mine, but in the long term, the mining industry is anticipated to develop significantly.

After May 1989, the Bougainville Mine suspended operation due to extremist troubles, and there is no sign of solution to the problem yet. Therefore, in January 1990, the Bougainville Mine drastically cut down the total number of employees and decided on a long-term closure. Due to the closure of the mine and drop in exports, international revenue and foreign capital reserves have deteriorated, public finances have deteriorated, and detrimental influences on the economy have surfaced.

On the other hand, in the agricultural sector, due to the long term depression in the status of the international agriculture markets, stagnation in agricultural exports (coffee, cocoa, palm oil, copra) has been continuing since 1980. Besides, the domestic agricultural industry is underdeveloped, and the country depends on imports for most of the required raw materials.

Since the independence in 1975, the PNG government's basic policy is development of the economy and equitable distribution of wealth. However, when the Wingti government came into power in 1985, a policy that gave first priority to economic growth was adopted. The budget restrictions of this government on education, welfare, public order, and sudden economic localization policies, however, led to increasing criticism, and the Namaliu government that came into power in 1988, reverted to a policy that focused on development, while maintaining a balance between economy and welfare.

However, the anticipated development of national economy and expansion in employment, together with the increase in population (2.2% per year), has not been achieved, and social instability that has occurred as a result of the deterioration of political stability, has been increasing. For this reason, the government has launched the structural adjustment policy that aims for regional development and focuses mainly on the promotion of small scale agricultural industries in the budget for 1990. Also, in January 1990, the government constructed a comprehensive economic policy that encompasses the curtailing of financial disbursements, tightening of financial expenditure, devaluation of currency and curbs on loans, as countermeasures against the deteriorating economic status.

(Water supply administrative organization)

The administration for water supply in PNG was under the jurisdiction of the Department of Commonwealth of Australia, when the country was under Australian rule before the independence. After the independence in 1975, the administration passed over to the Department of Works.

For the management, maintenance and control of the water supply facilities of the cities, the NCD (National Capital District), 18 provincial cities and other towns in the provinces, and district towns are divided into three stages, and there are independent administrative bodies for administering each of them.

For NCD, the water supply administration was transferred to the City Council of Port Moresby in 1976, and came under the jurisdiction of the Water Supply and Sewage Division. When the City Council of Port Moresby upgraded to the National Capital District Interim Commission (NCDIC) in 1981, the control of the Water Supply and Sewage Division was also transferred to NCDIC. NCDC was formally inaugurated in 1990. There was a long-term controversy on whether the NCDC or the Water Board (mentioned later) would control the water supply facilities of NCD after the independence. The Supreme Court passed a judgment in 1990, whereby NCDC was

given the responsibility for the administration of the water supply facilities, as in the past. The Water Supply and Sewage Division of the NCDC has been proposing an independent project for water supply.

The construction, management, maintenance and control of water supply and sewage facilities of the 18 provincial cities and other cities in the provinces, are being carried out by the Water Board established in 1986. The Water Board is a self-supporting organization that belongs to the Department of Works. This organization manages, maintains, and controls water supply facilities in 10 (Lae, Kundiya, Mt. Hagen, Wewak, Madang, Popon-detta, Alotau, Daru, Kimbe, Rabaul) of the 18 cities. Arawa city also falls under the jurisdiction of the Water Board but due to the trouble in Bougainville, it has stopped managing the water supply facilities of Arawa city since 1990. Out of the 10 cities mentioned above, only Lae has been yielding profits.

The water supply maintenance of cities other than NCD and the 18 cities mentioned above, is being carried out by the Department of Works and local self-governing bodies. The local self-governing body investigates and confirms the needs for water works, and the Department of Works carries out the maintenance and control of the facilities, manages and implements the works based on the investigations of the local self-governing body.

The Department of Health is responsible for the supply of drinking water and provision of sanitary facilities for rural communities other than the cities and towns mentioned above.

(Status of water supply)

Accurate data showing the status of water supply is not available but the population that is being supplied with water is estimated as about 14% of the district population and about 50% of the urban population. Due to the unstable supply of safe drinking water and unhygienic conditions, contagious diseases, typhoid, and skin diseases are known to occur widely.

(Basic policy for the provision of water supply facilities)

Out of the 24 items listed as development targets established under the national development plan, there are three items related to drinking water supply facilities, that are listed below. These three items form the basic concepts of the policy of water supply administration.

- Ensuring basic living standards

- Ensuring basic human needs in the districts and improving the quality of life
- Improving the health levels of the people and eliminating contagious and non-contagious diseases.

Supply of safe drinking water has been recognized as a basic need of the people. Observing the whole of PNG, however, large differences in the level of development are apparent, depending on the area. Therefore, modern water supply facilities may not necessarily suit all the areas in the countries. In the beginning of the eighties, the mid-term plan for provision of drinking water facilities and sanitary facilities prepared according to "The International Drinking Water Supply and Sanitation Decade" advocated by the United Nations, proposes the effective use of abundant rain water available in village communities and small towns. The policy is to provide water supply facilities with a complete distribution network, based on the premise of distribution of water to each household so that social conditions are satisfied. The policy also presupposes collection of a small amount of water charges to ensure independent profitability, or to supply water only to these areas that do not receive adequate rain water, or are not blessed with good natural conditions.

According to the mid-term development targets and policies appended to the national budget of 1994, drinking water supply is a basic need of the people and is classified in the same category as housing, communications and information. Until now, the provision of drinking water supply and sanitary facilities tended to be delayed because of the high cost of construction of these facilities on account of the geography, topography and low population density of the country. Under these conditions, the promotion of these works forms one of the most important targets of the development project, irrespective of whether the place is a city or a village.

The government is currently working out a long-term policy for the provision of drinking water supply facilities and sanitary facilities for the whole country. In view of the large number of public organizations that will participate in the provision of these facilities, the government is assigning the sequence of priority and defining clearly the responsibilities of organizations that will control these facilities, in order to eliminate duplication of work and waste of labor.

The first and second stages of work on water supply and sanitary facilities of cities have been implemented with the assistance of the Asian Development Bank, and the third stage of work is currently in progress. This work will be carried out by the Water Board, local governing bodies, and the Department of Works.

The third stage of work for village communities started in 1991, with a plan that focuses mainly on the supply of drinking water to areas that are not covered yet. This work is being implemented by the Department of Health.

The budget for city water supply works of the Water Board in 1994 amounts to 4.8 million Kina. Almost the entire amount is destined for the Rabaul and Madan city water supply projects.

(National development plan)

The seven development targets listed below, have been considered in the five-year plan for 1994 to 1998.

- 1) More effective development of non-governmental sectors
- 2) Expansion of employment opportunities
- 3) Further expansion of production activities in rural areas
- 4) Perfection of public services in districts
(Education, health, law, infrastructure, water works, expansion of agricultural industries, practical education, land utilization)
- 5) Shift to industrialization
- 6) Expansion of economic opportunities for Papua New Guineans (particularly in the rural areas)
- 7) Sound macro-economics

The 1994 budget has been decided on the framework of the economic and development plan for each of the 15 sectors given below.

- 1) Agriculture and livestock
- 2) Forestry
- 3) Fisheries and marine resources
- 4) Mining and petroleum related industries
- 5) Industrial development
- 6) Provision of infrastructure (roads, airports, harbors, electricity, communications)
- 7) Development of land administration and related matters
- 8) Environment and its maintenance
- 9) Health
- 10) Population
- 11) Education and training
- 12) Provision of social infrastructure (water supply and sewage, housing, radio broadcasts, information, communications)
- 13) Law and order
- 14) Welfare of women, children and families

15) Rehabilitation of farming village services and Bougainville

For water supply and sewage facilities, 4.8 million Kina has been allocated in the budget for the Water Board. Generalizing the items in this sector, the government, after recognizing the inadequate supply of safe drinking water and the unsanitary conditions, has been advocating safe and clean drinking water and public hygiene for the people, as the fundamental line of policy.

(Trends of aid for the project)

Table 2-2 shows the funds for the programs that are in effect as of 1992, and in the past from various donor nations and aid organizations. (Source: 1992 Report on Foreign Aid, Department of Finance and Planning)

Table 2-2 Foreign aid for PNG

Units: million Kina

Aid organization	Grants	Soft loans	Total	%
Bilateral Aid				
Japan	158.1	383.4	541.5	23.5
Australia	177.6	-	177.6	7.7
Germany	28.5	39.1	67.6	2.9
U.S.A.	51.5	-	51.5	2.2
China	1.3	18.2	19.5	0.8
New Zealand	14.4	-	14.4	0.6
South Korea	1.1	12.3	13.4	0.6
Kuwait	-	10.2	10.2	0.5
Sub-total	432.5	463.2	895.7	38.8
Multi-national aid				
Asian Development Bank	19.0	485.1	504.1	21.8
World Bank	1.7	451.4	453.1	19.6
EEC	126.0	302.2	428.2	18.6
UNDP	16.0	-	16.0	0.7
IFAD	-	10.3	10.3	0.5
CFTC	0.5	0.5	0.5	-
Sub-total	163.2	1,249.0	1,412.2	61.2
Grand total	595.7	1,712.2	2,307.9	100.0

The following are the trends of aid:

- * The overall trend shows that 38.2% of the aid is between two countries, while 61.2% is multi-national aid.
- * 595.7 million Kina is through grants, the remaining 1712.2 million Kina is made up of soft loans. 48.3% of the aid between two countries is by grants, while 11.6% of the multi-national aid is by grants.
- * Japan is the largest donor of aid between two countries (541.5 million Kina, out of which 29% is grant aid), followed by Australia (excluding budget support) and Germany (67.6 million Kina, 42% of which is by grants)
- * The Asian Development Bank is the largest multi-national aid organization (504.1 million Kina, out of which 3.8% is by grants), followed by the World Bank (453.1 million Kina, 0.4% grants), and EEC (428.2 million Kina, 29.4% by grants).

The necessity of setting up an aid receiving system for PNG had been pointed out in the past, and in 1989, OIDA was set up in the Department of Finance and Planning, to serve as the organization dealing with matters related to receiving foreign aid. Thus a system for receiving foreign aid and for using it effectively is being constructed. Furthermore, project cycle guidelines are being prepared, as a part of the rationalization and standardization of aid-receiving formalities.

The functions of OIDA are given below.

- * Formalities for proposals and requests from various donors for foreign aid, and from within PNG, and checking the same.
- * Negotiations for foreign aid
- * Implementation, monitoring and assessment of foreign aid
- * Financial control and audit of foreign aid
- * Advice related to foreign aid given to government and related organizations
- * Work related to communications and adjustments with all donors.

2.2 Outline of the Request

The PNG government considers the provision of infrastructure for Port Moresby, the capital, as the most important topic, and particularly considers giving top priority to the drinking water supply problem, because suspension of water supply is chronic. Due to the relative inadequacy of the quantity of water supply, because of the time-worn water supply facilities of the city and the influx of population into the city, suspension of water supply has been continuing since the second half of the eighties. This has resulted in detrimental effects on public facilities such as hospitals and schools,

governmental and economic activities, and has also affected fundamental needs, sometimes even survival.

To cope with the problem in this country, out of the adjustments by various countries, international organizations and banks, the Asian Development Bank had planned to finance the water supply sector but, until the second half of the nineties, there was a conflict between the Water Board and NCDC over the control of water supply administration of Port Moresby, therefore, the funds did not come. This conflict was resolved when the Supreme Court decided that NCDC would continue to control the water supply administration, as in the past.

Under these circumstances, the PNG government made a request to Japan in November 1991 to investigate the water supply development project for Port Moresby city and the surrounding areas. The outline of the request is given below.

Name of case: Port Moresby city water supply development project

Objectives: To prepare an urgent rehabilitation project and master plan related to improvement and expansion of the Port Moresby water supply system, and to implement a feasibility study taking the target year for the development as 20 years henceforth.

Upon receiving this request, the Japanese government decided to implement it. The Japan International Cooperation Agency deputed a study team to PNG from September to December 1992, and May to August 1993. The study team analyzed the problems in the existing water supply system, prepared a master plan taking the target year as 2015 and selected an urgent rehabilitation project and further implemented a feasibility study taking the target year as 2000,

The PNG government requested the Japanese Government for grant aid in June 1993 for the urgent rehabilitation project. The basic design study was implemented as a supplement to the water supply development project study. On-site study was not carried out because adequate data and materials were collected.

The contents of the request include the laying of special transmission pipelines from the 9-mile area to the Town area along the coast. The short term objectives include the easing of inadequate water supply, particularly by supplying water to low water pressure areas. The long term objectives include the creation of an efficient NCDC organization, as an independent working body, rationalization of maintenance and controls, and prevention of water leakages. This request also includes specialists

related to maintenance, control and management, and training of personnel. The organization responsible for implementing this project is NCDC.

2.3 Outline of project area

2.3.1 Natural conditions

(Geography and topography)

Port Moresby, the capital of PNG is located at latitude 9° 30' south, longitude 145° 09' east, in the southern coast of the Gulf of Papua on the main island of New Guinea.

The project area of Port Moresby, National Capital District, consists of a rocky belt along the coast and an inland plain that is demarcated by a precipitous ridge that drops straight down to the sea.

The inland plain is occupied by parallel ridges that run approximately in the north-south direction, and wide, flat and winding valleys, towered by the ridges. The height of the ridges reaches 200 m above sea level, and the valleys are roughly 50 m or less, above sea level. In the northern and eastern parts of Port Moresby, the ridges become smaller in height, and are absorbed by the flood plains of the Laloki river and the Waigani marshland. The project area has a complex topography with many ups and downs. Fig. 2-1 shows the configuration of the land in the project area.

(Soil and vegetation)

The soil in the project area is generally infertile. Red or brown colored rocky soil covers the ridges, with rocks and stones of various sizes on the slopes of the ridges. In the valleys, dark colored clay rising unevenly above the ground is a predominant feature, a vestige of the marshland that this land was in the past.

Vegetation is similar to that found in the Savannah regions, with trees, predominantly eucalyptus trees, mixed with grassy plains. The Savannah vegetation has been formed because of man-made deforestation and destruction of the forests by fire. The lowland forests that dotted this region in the past, are being dissipated and are receding deeper into the valley, with the elapse of time.

(Climate)

The climate in the project area receives the influence of two pressure systems. From May to October, the trade winds generated by the high pressure in the tropics located in the south, blow always from the south west direction. At the beginning of the season,

the wind speed is comparatively low, but at the end of this season, the wind speed usually reaches 20 to 30 knots. A complete dry season occurs in the project area during this period, and the demand for water becomes critical.

Between December to March, the influence in the shift of the tropical convergent zone, is received first from the south and then from the north. During this period, a wet north-westerly wind blows along with the flow of the upper atmospheric air mass above the project area, bringing rainfall practically every day.

April and November are transition periods between the two climates described above. The humidity increases and the wind becomes gentler, due to the influence of the two pressure systems.

The temperature throughout the year is high, and seasonal changes are few. The range of the maximum and minimum temperatures of a day exceeds the annual range of mean temperatures.

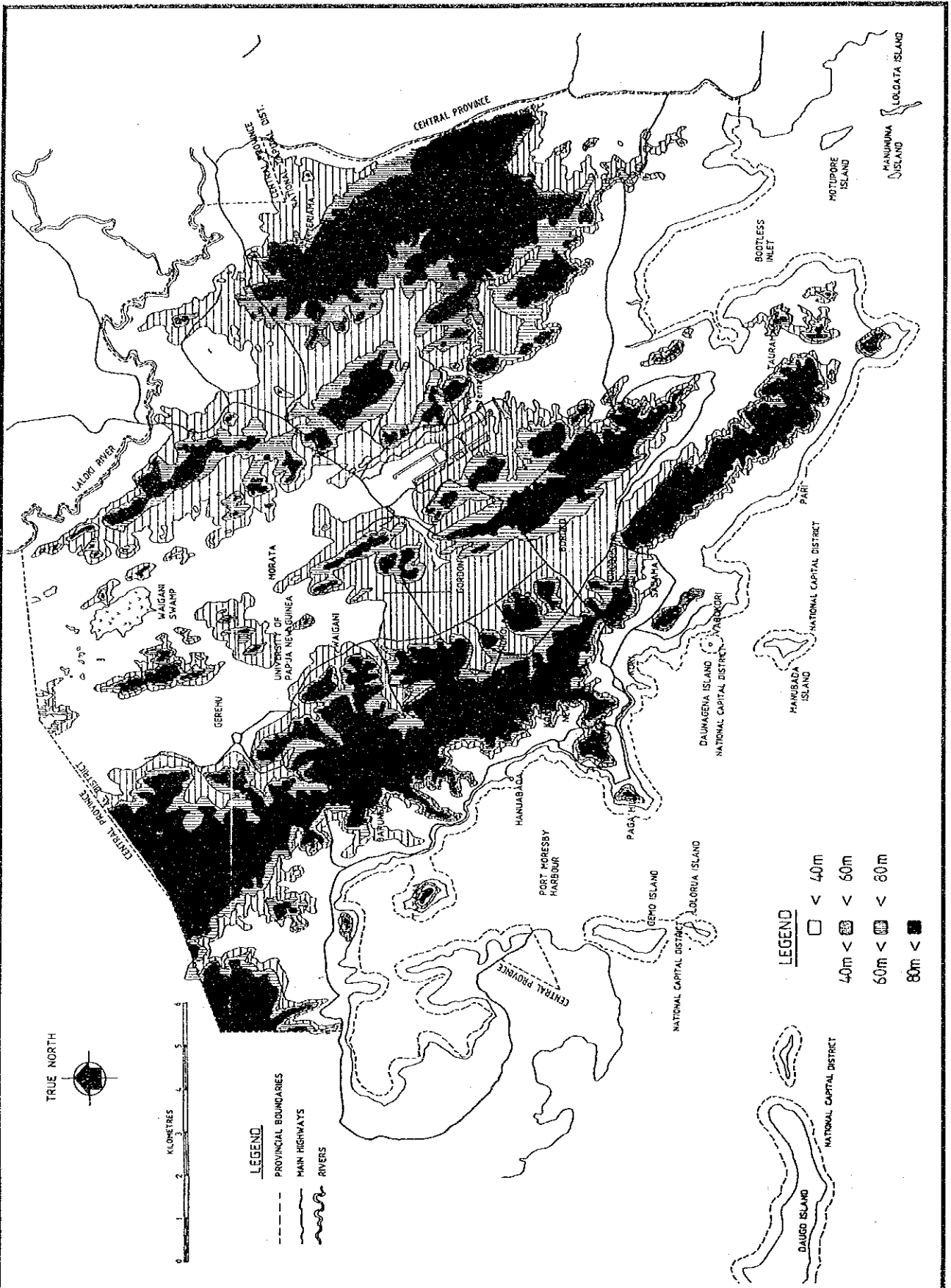
The mean annual rainfall in the project area is about 1,100 mm, which is a very low value compared to the other parts of Papua New Guinea. On the other hand, the annual evaporation amount exceeds 2,000 mm, which is more than the annual rainfall received. The temperature and amount of rainfall received in Port Moresby are given in Table 2-3, Table 2-4 and Fig. 2-2.

Table 2-3 Temperature in Port Moresby (1991, in degrees C)

Month	Max.	Max.	Mean	Min.	Min.
	(Month. mean)			(Month. mean)	
January	35.4	32.6	29.1	25.6	19.4
February	34.7	31.9	27.5	23.1	21.0
March	32.4	30.5	26.4	22.3	17.3
April	33.4	31.7	27.7	23.7	22.5
May	31.7	30.0	26.1	22.1	20.0
June	32.5	30.2	28.2	26.1	18.9
July	31.6	30.0	26.5	22.9	21.0
August	32.7	28.7	25.8	22.9	21.0
September	33.5	30.6	26.0	21.3	18.6
October	32.8	30.8	27.1	23.3	21.6
November	33.5	31.7	27.4	23.0	21.1
December	35.6	33.1	28.3	23.5	21.1
Annual	35.6	31.0	27.2	23.3	17.3

**Table 2-4 Rainfall (1980-91) and evaporation (1991)
for Port Moresby by month**

Month	Amount of rainfall			Evaporation amount
	Mean	Maximum	Minimum	
January	212.4	421.4	53.2	192.3
February	134.4	288.4	82.8	164.8
March	229.8	498.4	100.4	229.0
April	109.2	320.4	6.0	147.6
May	51.5	148.4	0.0	143.0
June	45.9	161.2	0.0	150.6
July	27.1	122.3	1.0	156.4
August	39.8	157.4	0.0	147.4
September	28.4	162.6	0.0	187.8
October	52.0	207.6	0.0	192.8
November	68.4	199.4	0.4	180.8
December	133.0	291.4	3.2	195.6
Annual	1,131.9	2,237.5	780.0	2,088.1



TITLE

CONFIGURATION OF LAND IN THE PROJECT AREA

Fig. No.

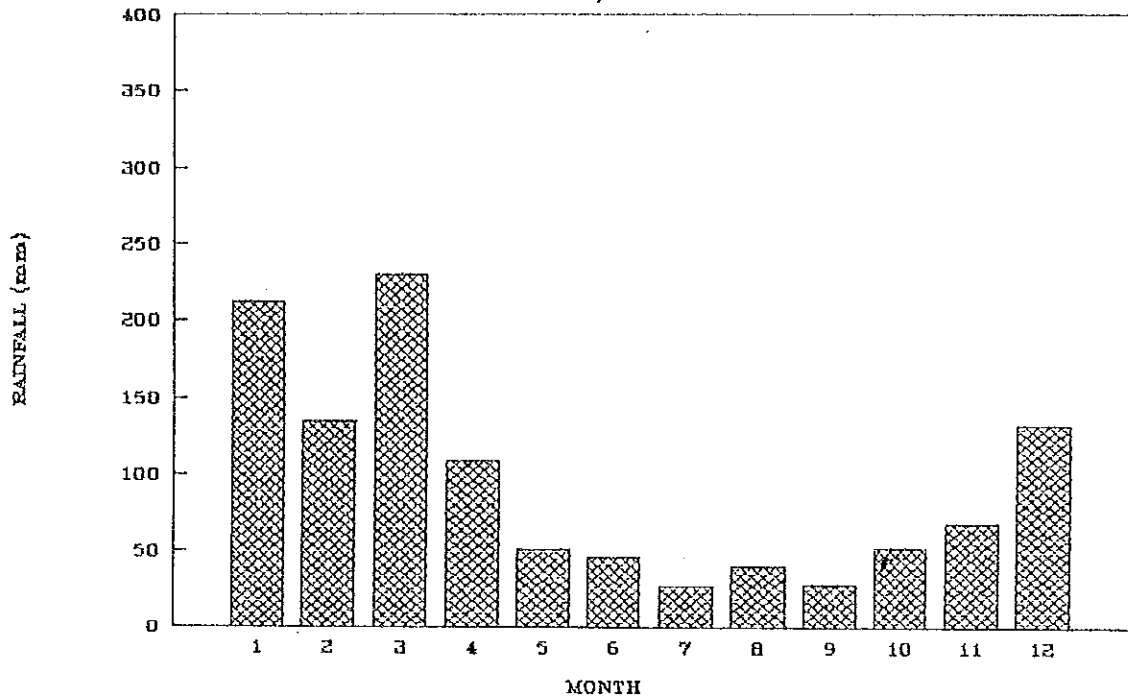
2.1

PORT MORESBY WATER SUPPLY DEVELOPMENT PLAN

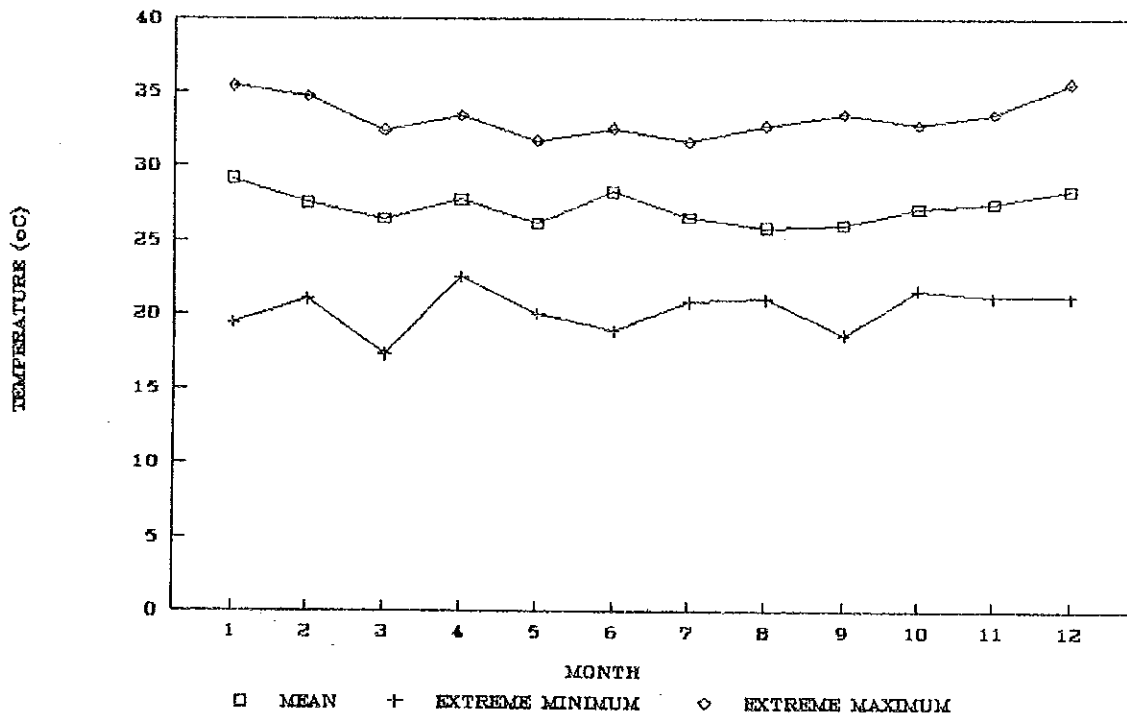
TOKYO ENGINEERING CONSULTANTS in association with PACIFIC CONSULTANTS INTERNATIONAL

RAINFALL IN PORT MORESBY (1980 - 1991)

Total 1,132 mm



TEMPERATURE IN PORT MORESBY (1991)



TITLE

TEMPERATURE AND RAINFALL

Fig. No.

2.2

PORT MORESBY WATER SUPPLY DEVELOPMENT PLAN

TOKYO ENGINEERING CONSULTANTS in association with PACIFIC CONSULTANTS INTERNATIONAL

2.3.2 Social and economic status

(Population and development status)

The population of Port Moresby was only 4,000 in 1945. The population reached 76,507 in 1971, and increased to 195,382 in 1990. The average increase in population during this period was 5%. The population now (as of 1992) is estimated to be more than 215,000. More than half the male population of the natives was under 30 years of age in 1990. This implies that young males migrated to the National Capital District in search of education and jobs. Foreigners in Port Moresby were estimated at 7,503 as of 1990.

The current land utilization status and development status of the project area are shown in Table 2-5, Fig. 2-3, and Fig. 2-4. In 1987, it was reported that 30% of the total population lived in village communities or villages, 30% lived in residences meant for the high-income level group, and the remaining lived in rented houses for the low-income level group. The housing status also reflects the status of water usage.

In the Port Moresby National Capital District, the harbor and the neighboring areas were first developed. Later, the area was developed as a commercial and administrative center. Currently, in the low-lying land of the city, a large number of high-rise buildings stand close together. A few high class residences have been developed, extending from the city toward the hill, and most of these high class residences coexist with houses of hired help. Several high-rise buildings for the high-income level group can also be observed.

A few commercial zones and light industry zones have been developed in the Koki District and Badili District. Within these zones, residential areas constructed by the low-income level group of people also coexist. Konedobu District and Kaebaga District consist of various types of residences, buildings belonging to public organizations, and light industrial zones.

Since there is a restriction on the land in the vicinity of the Town area and along the coast, development has progressed toward the interior areas such as Korobosea, Waigani, and Gerehu. Developments in the Korobosea District and Boroko District started from the fifties, and the areas mainly consist of high class residences and high-rise buildings together with the houses of hired help. Gordon District was developed in 1960, and has high class residences similar to the two districts mentioned above, coexisting with several houses belonging to the low-income level group of people. Four-Mile / Gordon District is mainly an industrial belt, and the Waigani District,

adjacent to it, consists of residential areas and buildings occupied by public organizations.

Tokalala District and Gerehu District are residential areas, consisting of houses mainly meant for the low-and-medium-income level groups, that were constructed by the National Housing Commission. Morata District has a large number of houses that have been constructed by the people themselves.

Table 2-5 Status of development districts of Port Moresby

Name of District	Typical development status					
	Res.A	Res.B	Res.C	Public	Comm	Indust.
Gerehu	A	B				
Morata		B	C			
Tokalala		B				
Hanuabada			C			
Konedobu/New Town	A	B	C	P	C	I
Town (Res.)	A					
Town (Ind.,Comm.)					C	I
Koki/Badili	A	B	C			
Kaugere/Kilakila			C			
Korobosea/Boroko	A					
Murray Barracks	A	B				
Hohola		B	C			I
Gordon	A					I
Waigani	A	B		P		
University	A			P		
Six-Mile, Saraga	A		C			I
Erima			C			
Taurama	A	B		P		
Pali, Tatana, Baruni, Gabutu, Babukori			C			
Idobada	A					
Bomana		B	C			

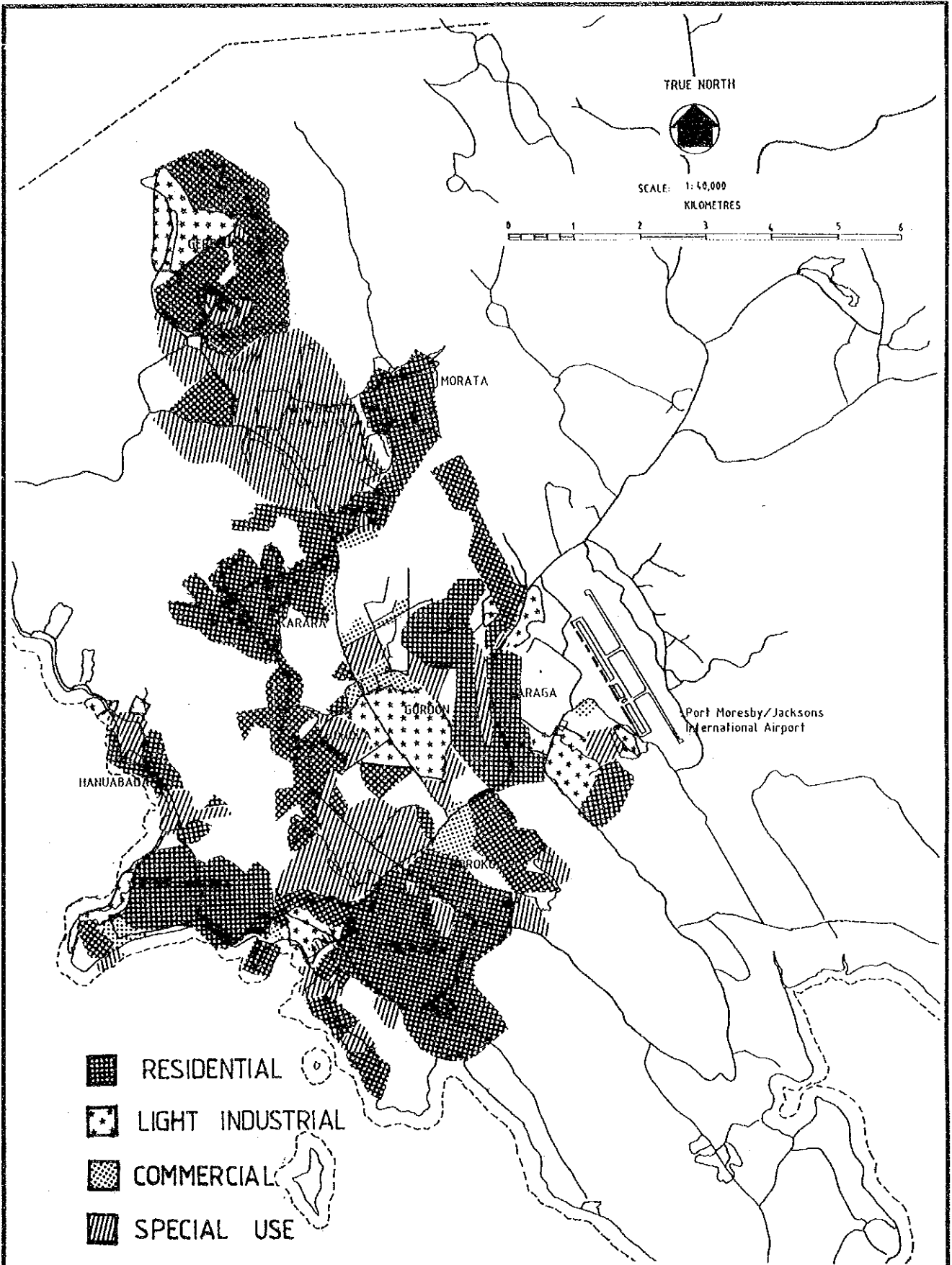
Note: Res.A: High income level

Res.B: Low income level

Res.C: Constructed by the people themselves

Together with the authorized developments mentioned above, several unauthorized developments can be observed in the surrounding areas also. These unauthorized developments are concentrated in the Bomana District along the Hubert-Murray highway in the north eastern part between the Six Mile and Nine Mile areas.

Almost all the residences in the authorized development areas are connected to the sewage system but the unauthorized development areas are not connected. Oxidation ponds have been constructed at one location in the Waigani marshland and several locations in the Gerehu District for processing the sewage from the interior parts. The sewage along the coast, including the Town area is mostly dumped directly into the sea through discharge pipes in the sea.



TITLE

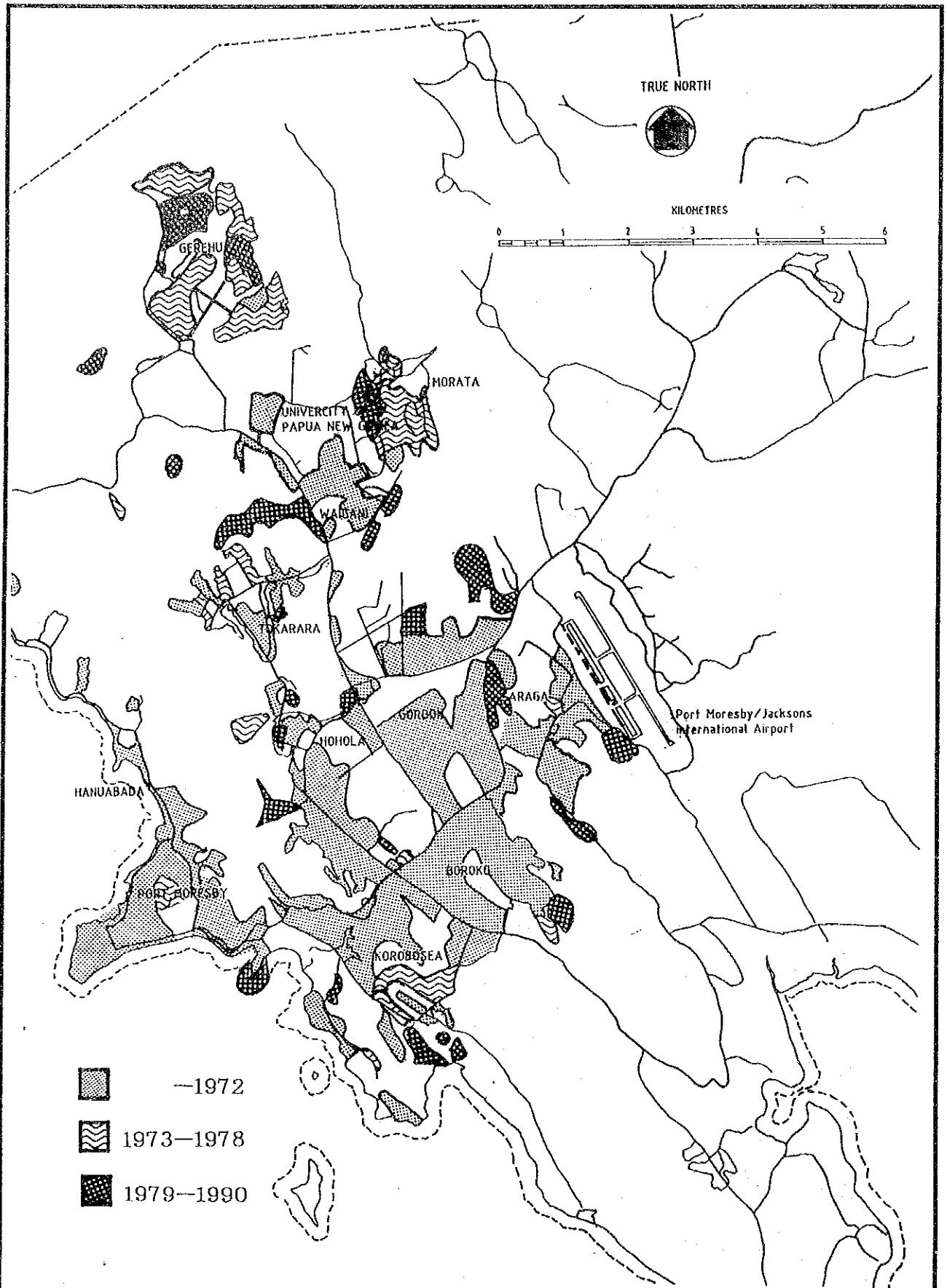
LAND UTILIZATION STATUS

Fig. No.

2.3

PORT MORESBY WATER SUPPLY DEVELOPMENT PLAN

TOKYO ENGINEERING CONSULTANTS in association with PACIFIC CONSULTANTS INTERNATIONAL



TITLE

DEVELOPMENT STATUS

Fig. No.

2.4

PORT MORESBY WATER SUPPLY DEVELOPMENT PLAN

TOKYO ENGINEERING CONSULTANTS in association with PACIFIC CONSULTANTS INTERNATIONAL

(Economic and employment status)

The economic status of the Port Moresby National Capital District is largely influenced by the economic trends of the whole country of Papua New Guinea. In contrast to the economy of the other areas of the country which are subject to rapid fluctuations, the economy of the National Capital District depends to a large extent on the disbursements of the government, and is, therefore, more stable.

The economy of the National Capital District has a close affinity with the economy of the country, and simultaneously has a close affinity with the economy of the central province surrounding the National Capital District. Port Moresby is the largest market for manufactured goods for the neighboring agricultural village belt, at the same time, it offers employment opportunities for the inhabitants.

Generating employment opportunities for the increasing labor force, is the most important topic confronted by the National Capital District. Although it is quite natural for the increase in employment in the official economic sector to be an important aspect in the policy, the importance of the informal economy must be recognized also. Informal economy refers to the small fishing businesses, unofficial sales of vegetables, beverages, craftwork objects, shells, household furniture, unofficial employment of housekeepers, and so on. The informal economy does not deal with huge amounts, but a large number of people depend on it for their income.

The employment by sector in the National Capital District as of 1991 in the descending order is - government-related jobs, transportation / communications, trading and retailing industry, construction, and small scale industry. This status is not expected to change for the time being. The permanent employment rate in the Port Moresby city is 70% in the above mentioned sectors. The situation in the National Capital District for the last few years has not been satisfactory. In 1986/87, 4,611 persons registered with the Labor Department seeking employment, but the number of persons who did find jobs amounted to only 559 (12%). The situation worsened in 1988/89, with 7,520 person registering their names and only 173 persons (2.3%) finding jobs. The deterioration in the employment status is expected to continue in the next few years.

The main industries in the city may be broadly classified as given below:

Printing, paper manufacture, beer brewing, soft drink manufacturing industries, household furniture and lumber industries, chemical industry, cement manufacture, gas, garment industries, canning industry, steel industry and bread-making industry.

(Social environment)

The status of basic infrastructure (roads, telephones, communications, electricity, gas, sewage) in the city and the living environment is described below.

The arrangement of the Port Moresby city took shape with the housing development during the period when the country was governed by Australia. Therefore, the road network is satisfactory. However, after independence, the housing developments could not keep pace with the population expansion, resulting in 'unplanned development' of the city. The roads in the areas where this expansion occurred remain backward.

Public buses which are called PMVs (Public Motor Vehicles) are the means for commuting within the city. The PMVs are operated by private enterprises, and about 600 to 700 buses operate over 23 routes in the city. The seating capacity of a bus is 25 persons, and the average fare for travel within the city is 0.4 Kina.

Telekom operates telephone and facsimile services for the whole of PNG. Telephones are used in all the government agencies, offices and residences of the high income level group. The latest digital switchboard is used and the telephone system in Port Moresby city is satisfactory. Direct dialing to all parts of PNG naturally is possible, besides the capability of direct dialing to 123 countries of the world. Public telephones have been installed in the important hotels, telephone offices, hospitals and airport. The fee for a telephone call within the city is 0.17 Kina. Long distance phone charges range between 0.25 Kina to 0.75 Kina per minute.

Elcom supplies power to the whole of PNG. However, the power supply to the city is supplied independently, separate from the power supplied to other areas in the country. Power generation equipment are of two types - hydro-electric power generation using the reservoir at the dam, which is also used for water supply, and diesel power generating equipment. In recent years, due to the shortage of water that has been continuing, the required hydro-electric power could not be generated, therefore, power failures have occurred sometimes, especially when switching over to the diesel generators. In the dry season in 1993, due to the fall in level of the dam reservoir, the quantity of power generated dropped, and planned power stoppages were implemented for each zone. Besides these energy sources, propane gas is also being used.

The sewage in the coastal region is collected by sewage pipes and discharged into the sea at several points on the coast. The sewage in the interior parts is collected in the Oxidation Pond to the north of the city, treated, and then discharged into the Laloki river.

Garbage is collected by NCDC and thrown at two garbage dumping sites in the city.

2.3.3 Outline of the relevant sector

(Water supply system)

Fig. 2-5 shows a sketch of the water supply system. The system configuration is given below.

(1) Water intake points at two locations

1) ROUNA 1/3 POND

Multi-purpose head pond for hydro-electric power generation by the Elcom

Height above ground level = 273 m

2) BOMANA in the Laloki river

Pumped to the Mt. Eriama water treatment plant using pumps

(2) Conduits: 2 nos.

1) From ROUNA 1/3 POND to water treatment plant

Length = 12.6 km, pipe diameter = 750 mm, transmitting capacity = 98 mld

2) From Bomana pumping station to water treatment plant

Length = 5.1 km, pipe diameter = 525 mm, pump head = 154 m, transmitting capacity = 21 mld

(The transmitted capacities are assumed values.)

(3) Water treatment plant at 1 location: Mt. Eriama water treatment plant

Designed capacity: 136 mld

Extension work: Extension work has being carried out three times in the past.

First stage: 27 mld in 1965

Second stage: 41 mld in 1968

Third stage: 68 mld in 1977

Height above ground level: 160 m

It cannot be said that maintenance and control are satisfactory.

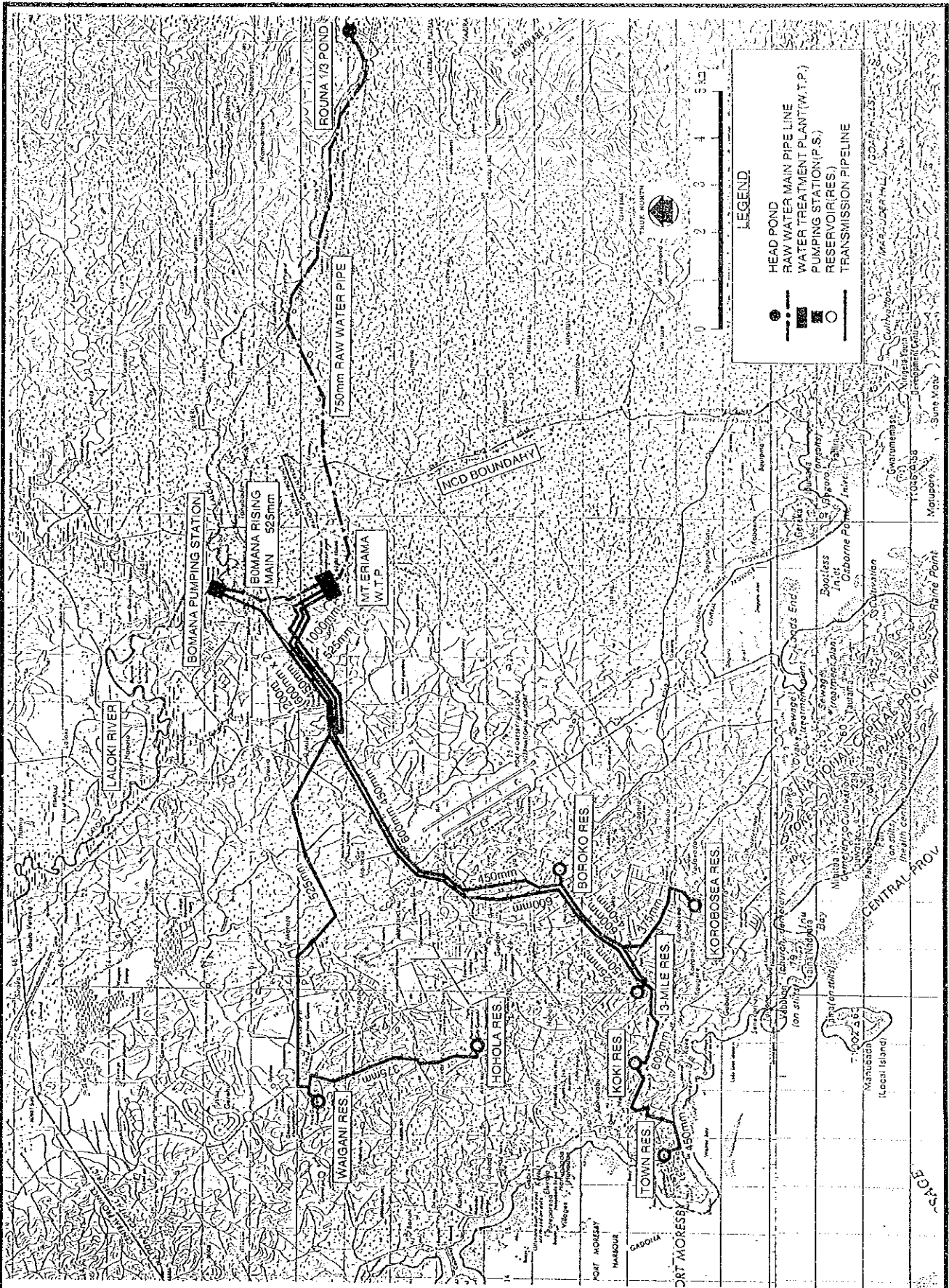
(4) Distribution reservoirs in city: At 7 locations

Delivery and distribution are by the natural downflow system, therefore, maintenance and control costs for the system are economical. The water pressure between 0 to 80 m in the city is quite different from the districts. This is because of the irregular and extreme rise in the terrain within the city.

Since 1977, there have been no radical investments for the existing system. Furthermore, with the influx of population from the rural areas into the city and the extremely high usage of water per person compared to neighboring countries, the result is a relative shortage of water.

Fig. 2-6 shows the low pressure water areas. The main characteristics are the areas with high elevation situated far from the water treatment plant. The Town District and Hanuabada District are locations in these areas with a comparatively high population.

Fig. 2-7 shows details of the trunk main system. In the dry season, when the demand for water is high, the water in the Town Reservoir never reaches the maximum level. Therefore, the valves have to be operated at night and water is supplied by using water carrying trucks.



TITLE

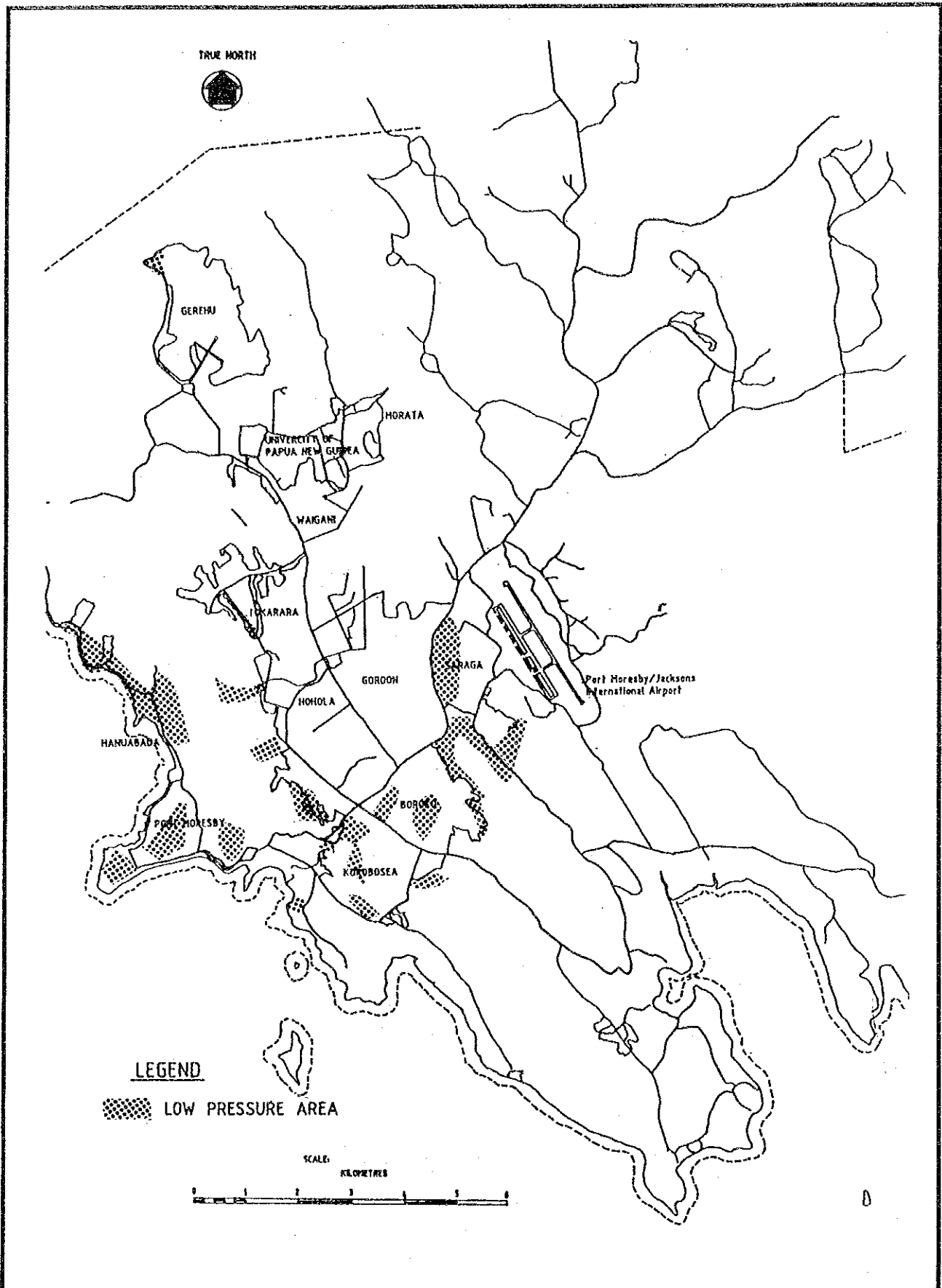
SKETCH OF THE EXISTING WATER SUPPLY SYSTEM

Fig. No.

2.5

PORT MORESBY WATER SUPPLY DEVELOPMENT PLAN

TOKYO ENGINEERING CONSULTANTS in association with PACIFIC CONSULTANTS INTERNATIONAL



TITLE

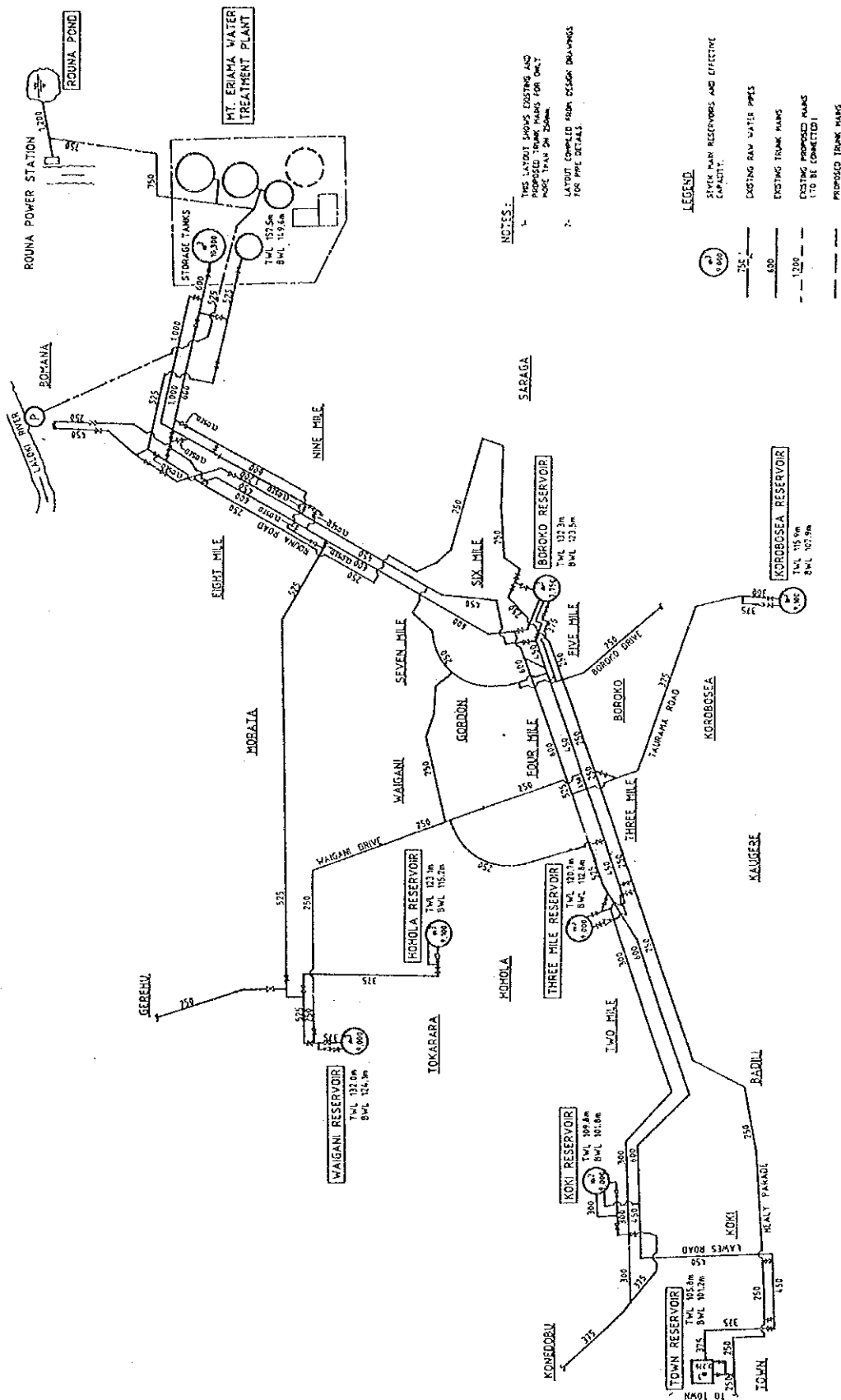
SKETCH OF LOW PRESSURE AREAS

Fig. No.

2.6

PORT MORESBY WATER SUPPLY DEVELOPMENT PLAN

TOKYO ENGINEERING CONSULTANTS in association with PACIFIC CONSULTANTS INTERNATIONAL



TITLE **SKETCH OF THE TRUNK MAIN SYSTEM** Fig. No. **2.7**

PORT MORESBY WATER SUPPLY DEVELOPMENT PLAN

TOKYO ENGINEERING CONSULTANTS in association with PACIFIC CONSULTANTS INTERNATIONAL.

(Organization and management)

NCDC reformed its organization on July 12, 1993. It formerly consisted of three departments, which have been expanded to five departments in the new organization. The names of the old and new departments are given below.

Old departments

- Dep. of Finance and Administration
- Dep. of Technical and Engineering
- Dep. of Community Services

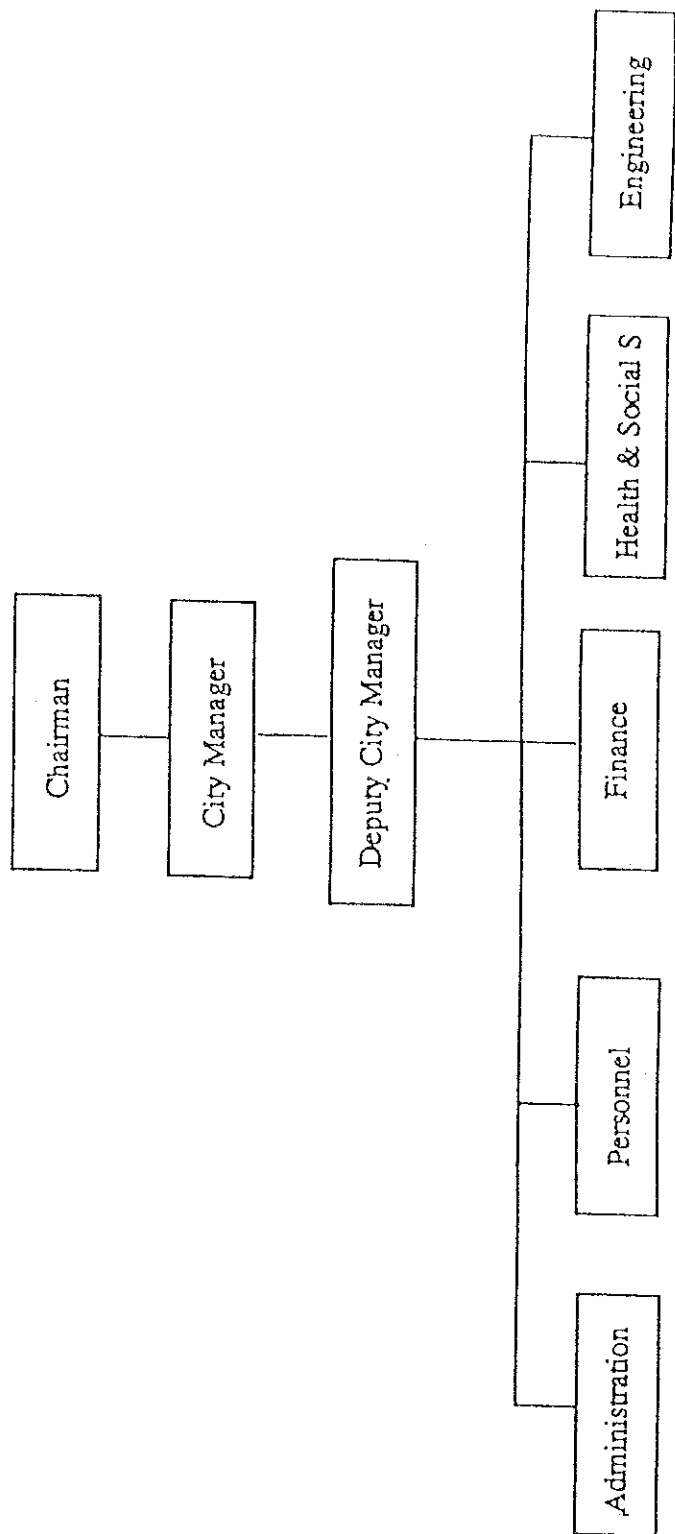
New departments

- Dep. of Administration
- Dep. of Personnel
- Dep. of Finance
- Dep. of Health / Social Services
- Dep. of Engineering

In the new organization, three departments (Administration, Personnel and Finance) have been created from the former Dep. of Finance and Administration which was overburdened, aiming for better efficiency. The new organization chart is shown in Fig. 2-8.

In the old organization, there was one department for sewage and water supply, whereas in the new organization this department has been split into two, with the objective of realizing a better system, capable of higher efficiency. However, the topics related to organization and management mentioned below, must be considered in future.

- * Efficiency in meter reading operations
- * Elimination of illegal connections
- * Reinforcement of management of assets
- * Improvement in the rate of recovery of tariffs (currently about 60%)
- * Provision of maintenance and control ledgers
- * Provision of ledgers for pipes
- * Establishment of employee training system



TITLE
NEW ORGANIZATION CHART

Fig. No.
2.8

PORT MORESBY WATER SUPPLY DEVELOPMENT PLAN

TOKYO ENGINEERING CONSULTANTS in association with PACIFIC CONSULTANTS INTERNATIONAL

CHAPTER 3 OUTLINE OF THE PROJECT

3.1 Objective

The water supply facilities of NCD were constructed over a period from the middle of the 1960's to the middle of the 1970s, by Australia the former suzerain. Later, with the independence of PNG in 1975, and after the third expansion work for Mt. Eriama water treatment plant was implemented, there has been no further large scale expansion or renovation work. Only small diameter distribution pipelines and service pipelines were singly added to the existing system until now, to meet the demand in small areas. In this way, since the last 20 years there has been no implementation of expansion or rehabilitation plans of the system. As a result, various locations in the city are suffering from a chronic shortage of water and low pressures. This has led to detrimental effects in the life of the people and economic activities in the city.

Coupled with the problem of the water supply system, the irregular and steep terrain makes unavoidable the inequitable distribution of water for the people. That is, there are areas with ample water supply throughout the year, and in contrast, there are also areas with practically no water supply or areas with lesser demand for water in the rainy season that get water only for a fixed period in the year. Such areas are concentrated at locations remote from the water treatment plant, or located at a high altitude above the sea level. However, in these areas, the high income group households are receiving a comparatively stable supply of water by installing individual pumps and tanks. The effects of the water shortage are felt more markedly by the low income group households in these areas.

To solve problems in the water supply system such as these, the JICA study team was deputed to PNG. A master plan for the water supply project and urgent rehabilitation project was prepared, and a feasibility study was carried out.

The works to be taken up under the urgent rehabilitation project are the reinforcement of delivery capacity to the low pressure areas in the city (particularly Town and Hanuabada areas), and the implementation of the water supply rationing plan after the installation of the transmission pipelines. The objective of this project is the equitable supply of water to the people by constructing transmission pipelines and implementing the water supply rationing plan after constructing the pipelines.

3.2 Study and examination on the request

The Papua New Guinea Government requested the Japanese Government to take up the work of reinforcing the delivery capacity of the water supply system to the city on an urgent basis, with the aim of equitable water supply, after selecting this item from the urgent rehabilitation project prepared by the JICA study team (reinforcement of financial capacity, curbing the demand quantity, and equitable water supply). In the master plan, three alternative proposals related to the transmission pipeline routes and pipe diameters were specified and examined from the viewpoint of conformity with the master plan, hydraulic performance and ease of construction etc. The result was that the JICA study team determined the new transmission pipeline plan given below, as the optimum solution.

(Urgent rehabilitation of transmission pipelines)

	Pipe dia.	Length	Type
Airport to Erima area	1100 mm	2596 m	Ductile iron pipe
Erima area to 3 Mile area	600 mm	7195 m	Ductile iron pipe

The appropriateness, necessity, and adequacy of the specifications of transmission pipelines for the project itself are examined in detail below, with respect to the construction plan of the transmission pipelines and the water supply rationing plan, using the transmission pipelines.

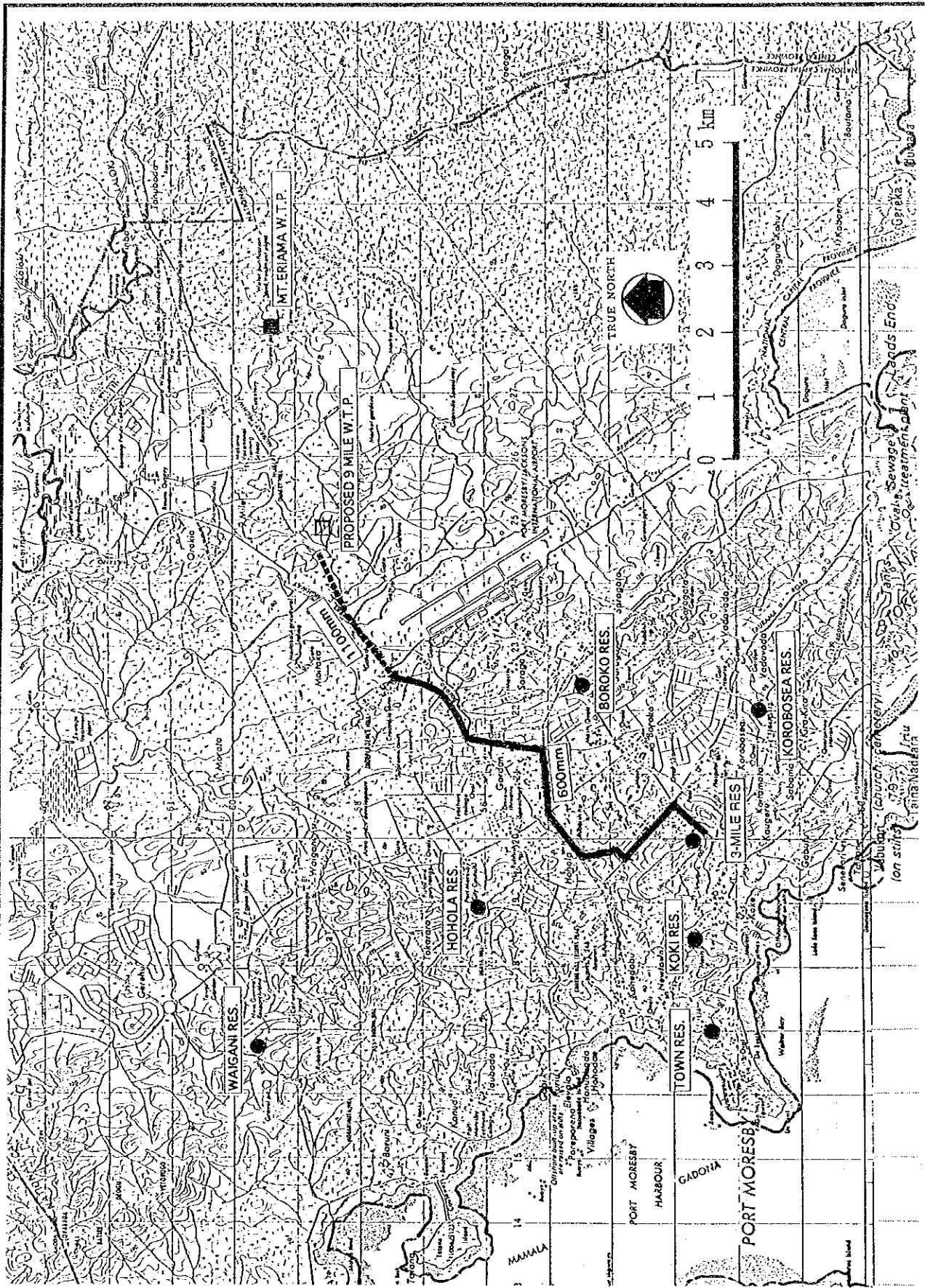
3.2.1 Appropriateness and necessity of the project

(1) Appropriateness and necessity of the transmission pipeline laying plan with the aim of equitable water supply

The low water pressures at various locations in the city may be attributed to the inadequate capacity of the entire water supply system.

The basic data for the water supply system in 1990 is as follows;

Population	195,382 persons (1990 census)
Demand Quantity	155,837 m ³ /day (daily maximum)
Supply Quantity	125,000 m ³ /day



TITLE

SPECIAL TRANSMISSION PIPELINE ROUTE

Fig. No.

3.1

PORT MORESBY WATER SUPPLY DEVELOPMENT PLAN

TOKYO ENGINEERING CONSULTANTS in association with PACIFIC CONSULTANTS INTERNATIONAL

It is clear from the above basic data that demand quantity exceeds the supply quantity, bringing in water shortage in the city. Further, water shortage will worsen year by year if no measures are taken because the population will keep increasing. In addition, the problem lies that the areas suffering from water shortage are rather fixed because terrain governs pressures of water distributed by natural flow.

The problems are summarized by the three points given below, which form the keynote of the water supply system.

- 1) Inadequate capacity of the intake water quantity and transmitted water
- 2) Inadequate supply of water from the water treatment plant
- 3) Inadequate capacity of the transmission pipelines supplying water from the water treatment plant to the consumers

In contrast, however, the distribution pipelines and service pipelines, are adequate for the purpose.

The rehabilitation and expansion of each facility separately, improvements and problems in preventing water leakages, and the countermeasures for problems, are shown in the following table.

By independently improving and expanding the facilities for intake water, transmitted water, treated water, and delivered water, the results will not be effective. To expand these facilities, all facilities from the intake water to the delivered water, must be simultaneously expanded. Tremendous construction costs and considerable execution period are necessary for simultaneous implementation of all these facilities. Therefore, urgent rehabilitation is considered to be unavoidable (Shortfall will reach to 70,000 m³/day in 1995.).

For expansion of the transmission facilities, however, if the necessary transmission pipelines are laid for the currently treated water, equitable water supply can be ensured to the citizens by rationing the water supply.

Measures for reducing the water demand by water leakage prevention work may also be considered. To implement this work, however, the expansion of the organization and simultaneous expansion of hardware, such as replacement materials and equipment will become necessary, which may lead to difficulties in promoting this project. Even if implementation becomes possible, the actual reduction in the water leakage and the period for the implementation cannot be predicted, and unknown factors will still

remain. Besides, there is no guarantee that the available water after reducing the leakage will be distributed on priority to low water pressure areas, and an increase in the demand quantity until the water reaches the low pressure areas may occur also.

Consequently, the urgent rehabilitation of water supply to the low water pressure areas, the reinforcement of transmission capacity on a priority basis, and the water supply rationing plan using the transmission pipelines, are considered to be appropriate because these works can be implemented in a comparatively short period, the effects will be visible at an early stage, and the benefits will be distributed equitably to the citizens.

The equitable distribution of water supply by the water supply rationing plan, however, is at best an urgent safety measure, and cannot be considered a solution to the basic problem. An early implementation of the work of expanding the entire water supply system considering the increase in population and development of industries, is anticipated.

Water supply belongs to BHN, and with this project, the low water pressure areas will be eliminated, which is in line with the main points of the grant aid program.

(2) Appropriateness and necessity of specifications of transmission pipelines (routes, pipe diameters)

The appropriateness and necessity of laying transmission pipelines were examined in the previous section. In this section, the appropriateness of the specifications, namely the routes and pipe diameters of the transmission pipelines are examined. (refer to Fig. 3-1.)

1) Appropriateness of the route

PNG mostly consists of lands that are held by tribes, called customary lands, and the ownership system of these lands usually prevents or delays the implementation of work. Therefore, it is important that the routes of the transmission pipelines in this project do not lead to conflicts with the existing land ownership system. The routes requested for the project are through roads, road reserves, or Elcom's reserves, or through military sites, and are not expected to pose problems related to land rights. Detailed investigations related to routes are described in the section on the current status of the project area.

The requested routes in conformity with the water supply master plan, can be also effectively utilized in future and the master plan has been given the status of a top

priority plan. Details are given below, and the routes are considered appropriate, considering adjustments with future projects.

Table 3-1 Consistency of transmission pipeline routes with future projects

Route	Diameter	Length	Future project
Airport area to Erima area	1100 mm	2,596 m	Used as transmission pipelines for low zone. Connected to transmission pipelines of Erima and Gerehu water service reservoirs.
Erima area to 3 Mile area	600 mm	7,195 m	Used as transmission pipelines for high zone. Transmission pipelines of 1350 mm for high zone laid from the 9 Mile area to the city, and connected to pipes at the point of entry to the city.

The transmission pipelines will serve as special pipelines to the low water pressure areas in the urgent rehabilitation project, but currently pipes with large head losses are transmission pipelines from the 9 Mile area to the 3 Mile service reservoir. Particularly, the head loss of the transmission pipelines from the 9 Mile area to the Erima area at the point of entry to the city, reaches as much as 10/1000, and by the time the pipeline reaches the entrance of the city, a head loss of more than 30 m is generated. The water delivery capacity for this part must be increased. The planned transmission pipeline route includes this part, avoids the existing transmission pipeline routes concentrated at the entrance of the city, and proposes the laying of pipelines up to the 3 Mile service reservoir after longitudinally traversing the Hohola District. This will not only enable water to be delivered to the coastal Town and Hanuabada areas where water shortage is most critical, but also to areas at a high altitude in the interior parts, such as Hohola and Tokalala. Therefore, this route proposal is consistent with future projects also, and is flexible in that water can be delivered to almost all the existing low water pressure areas, and is deemed to be a suitable plan.

2) Appropriateness of the pipe diameters

The pipe diameters were examined and decided in the master plan. Detailed hydraulic considerations were added to test the feasibility again. These are described below.

(Methods)

The current (1993) and future (1996; scheduled completion of transmission pipelines) water demands for each area were estimated, the transmission pipelines mentioned

above were added to the existing transmission pipeline system. By pipeline network analysis, the possibilities of delivering water to the low water pressure areas were analyzed.

(Water quantity conditions)

Water quantity; Daily maximum demand in 1996

Water savings; 10% (current level; estimated from the current water consumption quantity)

Water supply quantity; 115,000 to 120,000 m³ per day (same as the current water supply quantity)

(Water supply rationing plan)

The water demand quantity already exceeds the water supply quantity currently. Even when the transmission pipelines are completed, an increase in the water supply quantity is not anticipated. Therefore, a water supply rationing plan by restricting the use of water for particular areas at particular times has been prepared, and the possibilities of delivery of water has been examined by pipeline network calculations. In the water supply rationing plan, the demand quantity is planned out by the zoning of blocks set in the master plan. The project will be implemented in these block units. The plan for rationing of water includes cutting the demand quantity of a particular area and delivering this water on priority to another low water pressure area. One case obtained by calculations is given below. The distribution zoning is shown in Fig. 3-2. (The details are explained in Appendix L, master plan and feasibility study).

Water supply to Korobosea and Boroko distribution blocks are cut and water delivered to Koki and Town distribution blocks (distribution bases of Town and Hanuabada areas) where water shortage is critical. Water supply to Gerehu distribution blocks are cut and water delivered to Waigani distribution blocks (distribution bases of Hohola and Tokolala areas).

(Results of calculations)

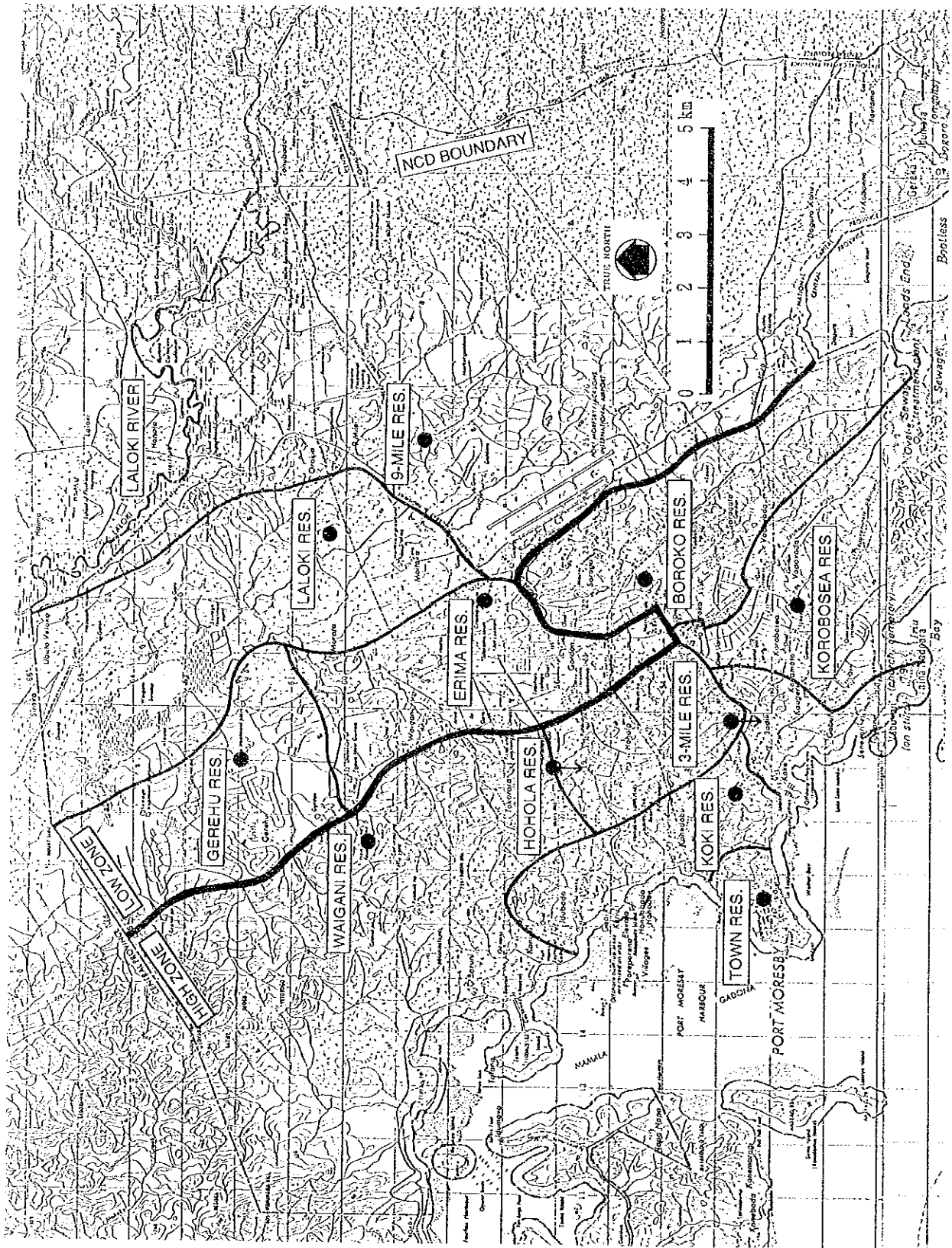
The calculation results are shown in Table 3-2, and the longitudinal cross section that includes the hydraulic gradient lines, is shown in Fig. 3-3.

Table 3-2 Comparison of heads

	Three Mile Ridge	Koki reservoir	Town reservoir	Waigani reservoir
Ground level	95	103	105	100 max.
High water level of reservoir	120.7	109.8	105.8	
Total water head	118.3	113.9	112.7	85.4
Residual head	(23.2)	(10.9)	(7.7)	(-14.6)

For this Case, the plan is to deliver water on a priority basis to the Town and Koki distribution blocks, therefore, as seen from the table above, water can be delivered without problems to the low water pressure areas. If water is supplied after 1996 by this method, it can be said that water can be delivered by this supply method until 2000, by predicting the increase in the demand quantity. There is a possibility that low water pressure areas may remain in a part of the Waigani and Tokolala distribution blocks, but if water is to be delivered on priority to the Waigani, Tokolala and Gerehu distribution blocks, the program in other case can be implemented.

Based on the hydraulic considerations described above, the diameters of the planned transmission pipelines are judged to be appropriate for the purpose.



TITLE

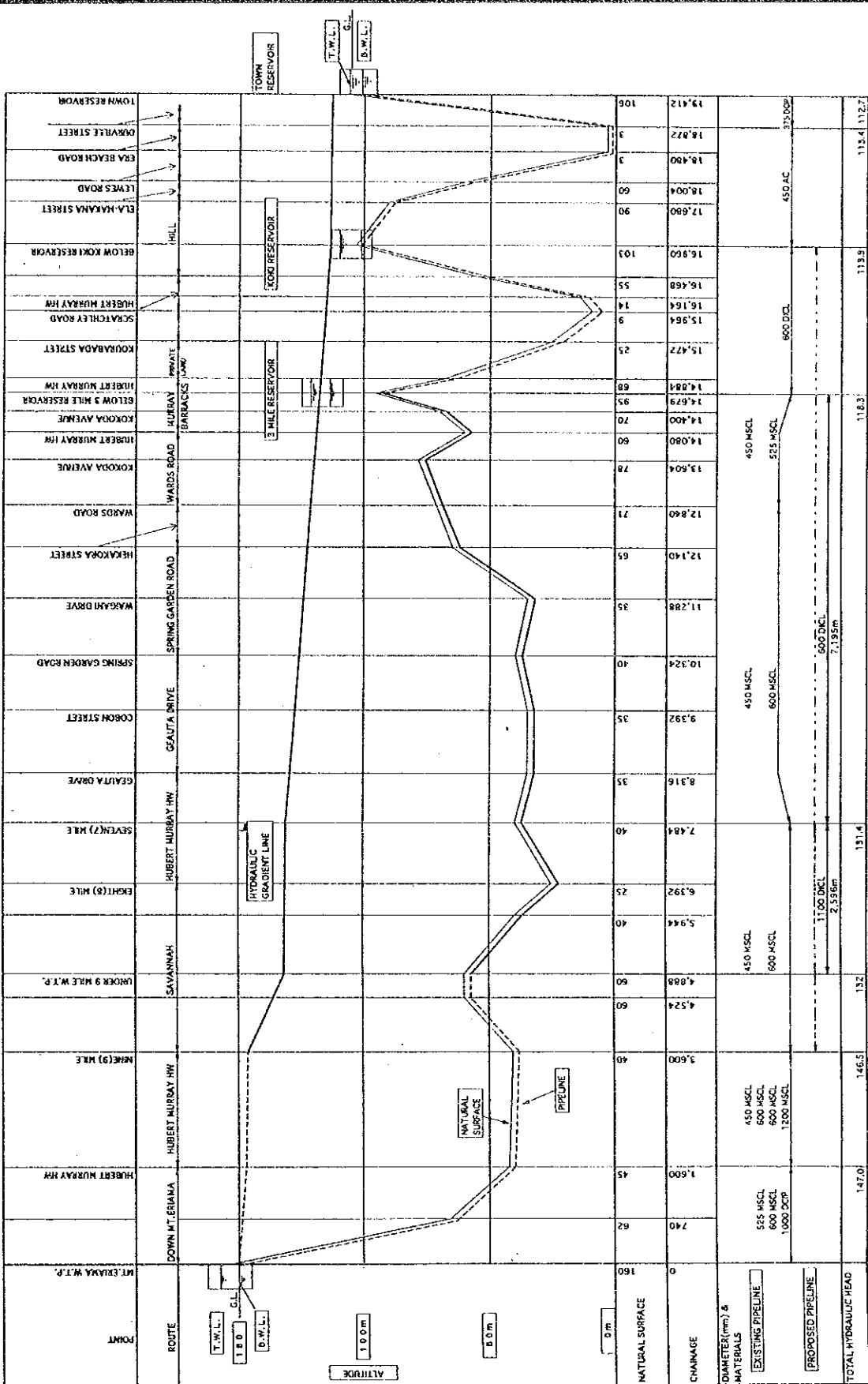
DISTRIBUTION BLOCKS (ZONING)

Fig. No.

3.2

PORT MORESBY WATER SUPPLY DEVELOPMENT PLAN

TOKYO ENGINEERING CONSULTANTS in association with PACIFIC CONSULTANTS INTERNATIONAL



TITLE **HYDRAULIC GRADIENT OF THE TRANSMISSION PIPELINE PLAN** Fig. No. **3.3**

PORT MORESBY WATER SUPPLY DEVELOPMENT PLAN

TOKYO ENGINEERING CONSULTANTS in association with PACIFIC CONSULTANTS INTERNATIONAL

3.2.2 Implementation and management of the project

The implementing organization for this project is the Department of Engineering, National Capital District Commission. This department consists of Planning, Design, Construction and Maintenance & Control Sections. The Water Supply Unit of the Maintenance & Control Section is in charge of the water supply work. For the project in question, the Water Supply Unit will be the main body for implementing the project.

In spite of the water supply received by the residents in the low water pressure areas currently, during the rainy season when the demand quantity decreases, there are cases where some of the residents do not pay the water charges, claiming low water pressures during the dry season. If this project is implemented, the water supply in the city will be distributed equitably, therefore, water charges can be collected correctly, even from consumers who are not paying them currently. We have verified that there is a large number of such consumers in the Town District, which is a high class residential area. The supply of water which is being received free of charge by illegal settlements currently, will be reduced and the quantity that is reduced will be distributed to the consumers in other areas who can pay the water charges, thereby resulting in increased recovery of water charges. From these aspects, the implementation of this project is anticipated to lead to a substantial increase in income.

There is no need to increase the staff for maintenance and control of the transmission pipelines that are to be laid in the project. The work can be done as a part of the routine work being done currently, and will not lead to increased disbursements. Therefore, the implementation of this project will contribute to the reinforcement of the financial base of NCDC, which is currently operating the water supply services with general accounting methods, and will also contribute significantly to the promotion of water supply expansion works.

The work allocated by the PNG government and the countermeasures for the same, for the construction of transmission pipelines are given in the table below.

Allocation of work	Countermeasures
Acquisition of sites for laying transmission pipelines	The sites planned for laying transmission pipelines are all roads, reserves, and sites belonging to public organizations, therefore, acquisition of rights for laying these pipelines is easy.
Construction of access roads for installing the pipelines in the easement near the airport	Paving work is not necessary, therefore, construction of access roads is simple.

As shown in the table above, we feel that there is no problem in the plan of operation of the PNG government during the construction of transmission pipelines. The scale of the staff and the budget necessary for actual implementation of the water supply rationing plan after construction of the transmission pipelines, are given below. We feel that there will be no problem from the organizational aspects on the PNG side.

(Staff)

During the on-site study in the second year, the JICA study team used the site staff and practically tried out the water supply rationing plan. The results showed that the work required for implementing the water supply rationing plan involved only the opening and closing of valves at several locations, which does not require a specially high level of technology, and the work can be completed easily and within a short period of time. Therefore, we have verified that the existing staff can easily cope with the work and no additional staff will be required.

The work itself can be implemented easily, but the preparation of the water supply rationing plan requires a slightly high level of technology. An outline of the water supply rationing plan has been prepared by the JICA study team. We feel that the plan can be implemented using this outline as reference, and if necessary, deputation of experts from Japan may be considered also.

(Budget)

This has been stated in the section on staff requirements. To implement the water supply rationing plan, there is no need for increasing the staff, and the work itself does not require new equipment and materials, therefore, additional expenses will not be incurred. The required budget is small, and can be compensated easily by the increased collection of water charges, mentioned before.

3.2.3 Examination of relation with or duplication by other similar projects and aid projects of international organizations

For the implementation of this project, adjustments with similar projects and related projects of other aid organizations must be checked and coordinated.

Similar projects in the water supply sector are as given below.

- * Port Moresby City Water Supply Master Plan (Port Moresby Plan) prepared in 1980
- * Port Moresby City Water Supply Interim Plan prepared in 1988 and entrusted to the Water Board
- * JICA Water Supply Master Plan ranked as a top level plan of this project

Thirteen years have elapsed since the preparation of the Port Moresby Plan. The per capita figures and population figures for the plan have changed significantly, and the plan cannot be used as the water supply master plan for the current situation. Also, the Interim Plan focused mainly on the study (1988) of the status of the per capita figures, population, and housing developments, and future projects were not contemplated. Therefore, the JICA Water Supply Master Plan, which is the latest of the plans and reflects the current situation, is the ideal solution for the NCDC Water Supply Project. There is consistency between this plan and the current project.

Similar projects other than water supply projects that are in progress currently, are listed below.

- * Drainage Project (Under preparation as of 1994)
- * City Planning (study and preparation started from 1994)

The former project has no direct relation with this project. Therefore, there is no need to make adjustments or consider the former project in relation to the current project. For the City Planning, adjustments have begun since the beginning of this year, and the framework of the City Plan considering population and housing developments is scheduled to be established. Items that may influence the water supply development project include the planning framework such as estimation of future population, and plans for new development areas (location, application). However, the JICA master plan, which is a top level plan for this project, is being formulated with rather detailed investigations and studies of future population, population distribution, and predictions of development areas in future which are necessary for the water supply project. Therefore, there is practically no deviation from the City Plan, which will be newly formulated. The JICA study team has also received confirmation for reflecting the

salient points of the JICA water supply master plan in the City Plan, which is to be newly formulated.

The master plan and the feasibility study prepared by JICA are planned as follows;

Master plan (1994 - 2015)

Phase 1 (1994 - 2000)

Phase 2 (2001 - 2007)

Phase 3 (2008 - 2015)

Feasibility study (1994 - 2000)

Stage 1 (1994 - 1996)

Stage 2 (1997 - 2000)

Fig. 3-4 shows the relationship of the daily maximum demand in each year with the supply quantity according to the implementation plan in the master plan and the feasibility study.

Currently, there are no other aid programs of countries or organizations that have a direct bearing on the water supply works or related sectors.

3.2.4 Examination of the constituents of the project

This project mainly focuses on the implementation of the plan for laying transmission pipelines (hardware aspects) and the water supply rationing plan (software aspects) using these transmission pipelines.

This project will enable a more efficient water supply rationing plan (software aspects) to be realized, and since the water transmission pipelines (hardware aspects) will be used for providing an equitable supply of water to the citizens, the constituents of this project are adequately interconnected.

3.2.5 Examination of requested facilities and equipment

As mentioned before, this project accounts for the laying of transmission pipelines in the areas mentioned below. With the construction of these pipelines, water will be supplied to low water pressure areas, therefore, the project is considered appropriate for satisfying the request of PNG.

Section	Dia.	Length	Type of pipe
Airport to Erima area	1100 mm	2,596 m	Ductile iron pipe
Erima to Airport area	600 mm	7,195 m	Ductile iron pipe

3.2.6 Examination of the necessity for technical assistance

The current project includes the water supply rationing plan, using the transmission pipelines that are to be constructed in the project. For this water supply rationing plan, a rather high level of knowledge and analyzing techniques for setting the distribution blocks and simulation procedures are necessary. This seems to indicate a necessity for technical assistance in this field, but the JICA study team has been preparing documents and materials necessary for the water supply rationing plan, which include detailed demand quantity estimation, water quantity allocation, distribution blocks and zoning, and also an outline of the water supply rationing plan for the future, in its water supply master plan report. Based on this report, and referring to it when necessary, the local staff should be able to prepare the rationing plan on their own. Therefore, technical assistance is not deemed to be necessary.

The PNG Government, however, has been seeking technical assistance related to overall management of the water supply, including water leakages, during the explanatory meeting of the draft final report of the water supply master plan, which is the top level plan in this project. If this request is submitted officially and experts are deputed, the implementation of the water supply rationing plan through technical assistance will satisfy the aspirations of the PNG Government.

3.2.7 Basic policy in grant aid

The effects, feasibility, and capacity of PNG to implement the project were investigated in detail as mentioned above. Since the outcome of the project matches the grant aid program, we have judged that the implementation of the project under Japanese grant is feasible and appropriate. Based on the premise of receiving grant aid from Japan, the outline of the project is investigated and the basic design implemented, as described in the subsequent sections.

3.3 Project description

The objective of the project is the improvement of low water pressure areas by the construction of transmission pipelines that will be used for the immediate and urgent implementation of the water supply rationing plan, ensuring equal benefits to the citizens.

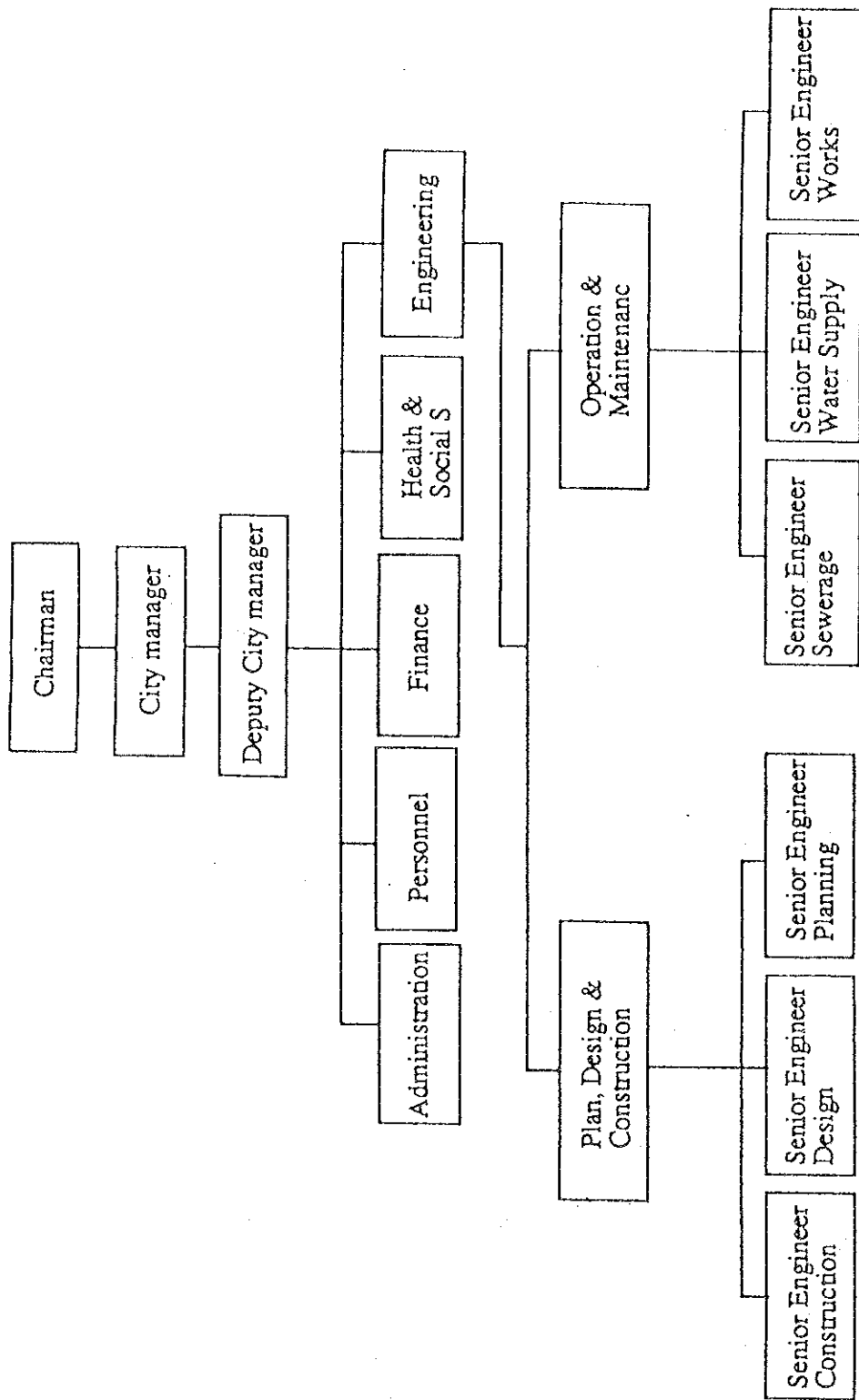
3.3.1 Executing agency and operational structure

Considering the present water supply maintenance and control system, the organization for implementing this plan (water supply rationing plan) is the Water Supply Unit, Maintenance and Control Section, Department of Engineering. The organization chart is shown in Fig. 3-4. As of 1993, the number of employees in the Water Supply Unit, Maintenance and Control Section is 184, out of which 24 persons belong to Mt. Eriama water treatment plant and are responsible for the maintenance and control of this water treatment plant. The remaining 160 persons are responsible for maintenance and control of the transmission and distribution pipelines and small scale pumping facilities. However, out of this work force, there are only 5 technical personnel, while the rest are workers and laborers for piping work.

Fig. 3-5 shows the organizational setup of personnel involved in the implementation of the trial water rationing experiment conducted by the JICA study team in July, 1993. For this trial implementation of the water rationing plan, a total of 35 persons were required and the breakdown is as follows:

Preparation of water rationing plan	- 1 person
Preparations for implementation	- 11 persons
Implementation	- 18 persons
Study of effects of implementation	- 4 persons.

Preparatory work and operations can be performed by the same person, therefore, a total of 23 persons can cater to the work. The water supply rationing plan is a tentative plan until the implementation of the expansion works, therefore, the number of personnel mentioned above need not be increased immediately. We feel that a reorganization of the duties of the personnel in the Water Supply Unit will be adequate for coping with the work.



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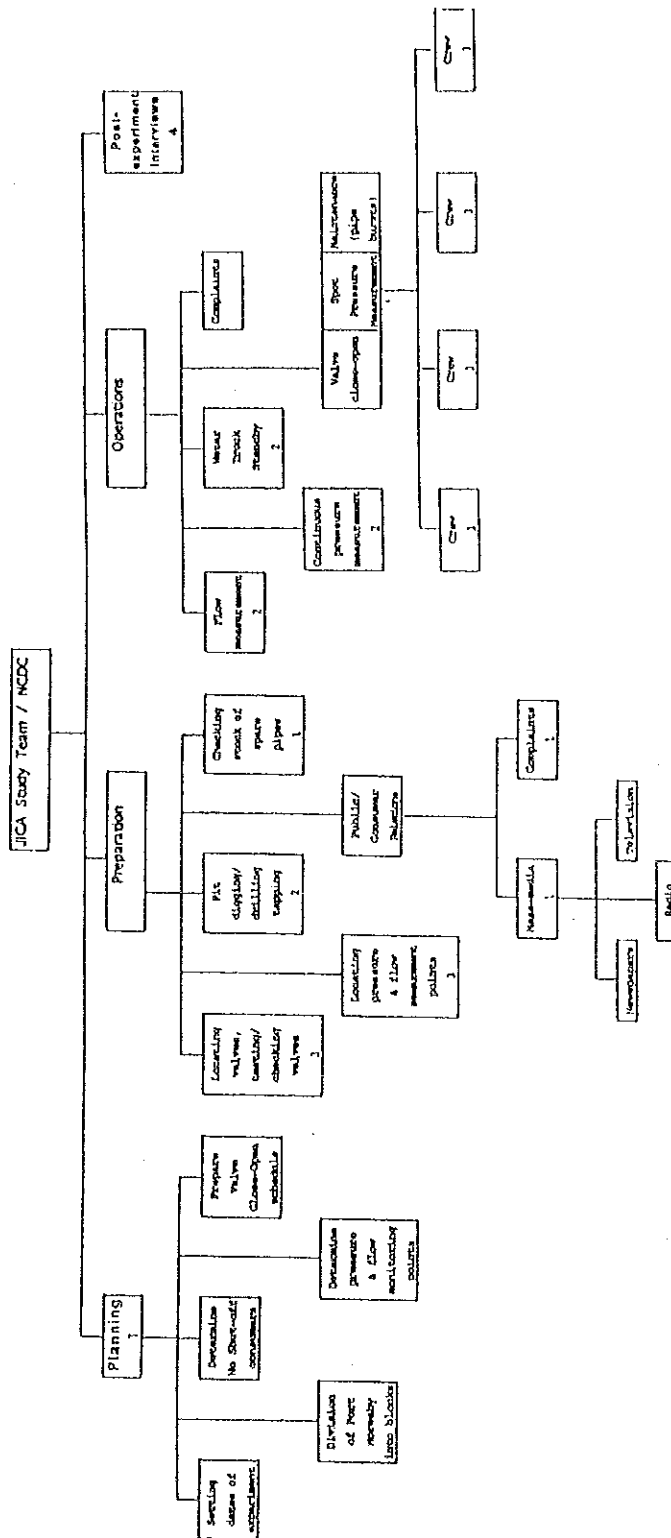
ORGANIZATION CHART OF MAINTENANCE & CONTROL SECTION

Fig. No.

3.4

PORT MORESBY WATER SUPPLY DEVELOPMENT PLAN

TOKYO ENGINEERING CONSULTANTS in association with PACIFIC CONSULTANTS INTERNATIONAL



TITLE ALLOCATION OF PERSONNEL FOR WATER RATIONING PLAN Fig. No. 3.5

PORT MORESBY WATER SUPPLY DEVELOPMENT PLAN

TOKYO ENGINEERING CONSULTANTS in association with PACIFIC CONSULTANTS INTERNATIONAL

3.3.2 Operational plan

This project is restricted to the construction of transmission pipelines and implementation of the water rationing plan using the transmission pipelines.

(Transmission pipeline design plan)

1. Transmission pipes

Route	Pipe dia.	Length
Airport to Erima area	1,100 mm	2,596 m
Erima to 3 Mile area	600 mm	7,195 m

2. Accessory equipment

Sluice valves at two locations (1 each for Hohola area and 3 Mile area) that enable area-wise water rationing and accessory equipment (air valves and blow-off valves fitted to aqueducts and siphon culverts)

(Water supply rationing plan)

The JICA study team prepared a simple water supply rationing plan during the on-site study in the first year - 1992. Later, the local staff implemented the water rationing plan on a trial basis. The results confirmed increased pressure in the transmission pipelines. Grievances were also few, leading us to believe that the local staff had succeeded in the implementation. During the on-site study in the second year - 1993, the personnel responsible for the water rationing plan were allocated as necessary, the water rationing plan was prepared and a trial was carried out again. The results of this trial are described in the water supply master plan. The implementation was smooth, and results proved to be successful. Consequently, it was confirmed that the rationing plan can be implemented without problems by the local staff only. The outline of the plan is described below.

To formulate the water supply rationing plan and to implement it, not only must the technical aspects be cleared but the operational and management aspects must be followed up also. The implementation procedure of the plan from the technical and operational aspects, is shown in Fig. 3-7.

Distribution blocks: The distribution blocks in the water supply master plan will be used (Please refer to Fig. 3-2).

(The blocks will be integrated or divided to obtain optimum blocks, based on the demand quantity and consumption quantity.)

Implementation procedure: The city will be divided into 3 (dry season) or 6 (wet season) distribution blocks. Water to the distribution block will be cut for one day in three days or six days, and this water will be distributed to other areas where there is a demand. To simplify the plan, the implementation cycle will be taken as one week.

Allocation of personnel: Please refer to Fig. 3-5.

Others: The demand quantity shows an increasing trend year after year, therefore, the plan needs to be reviewed once a year.

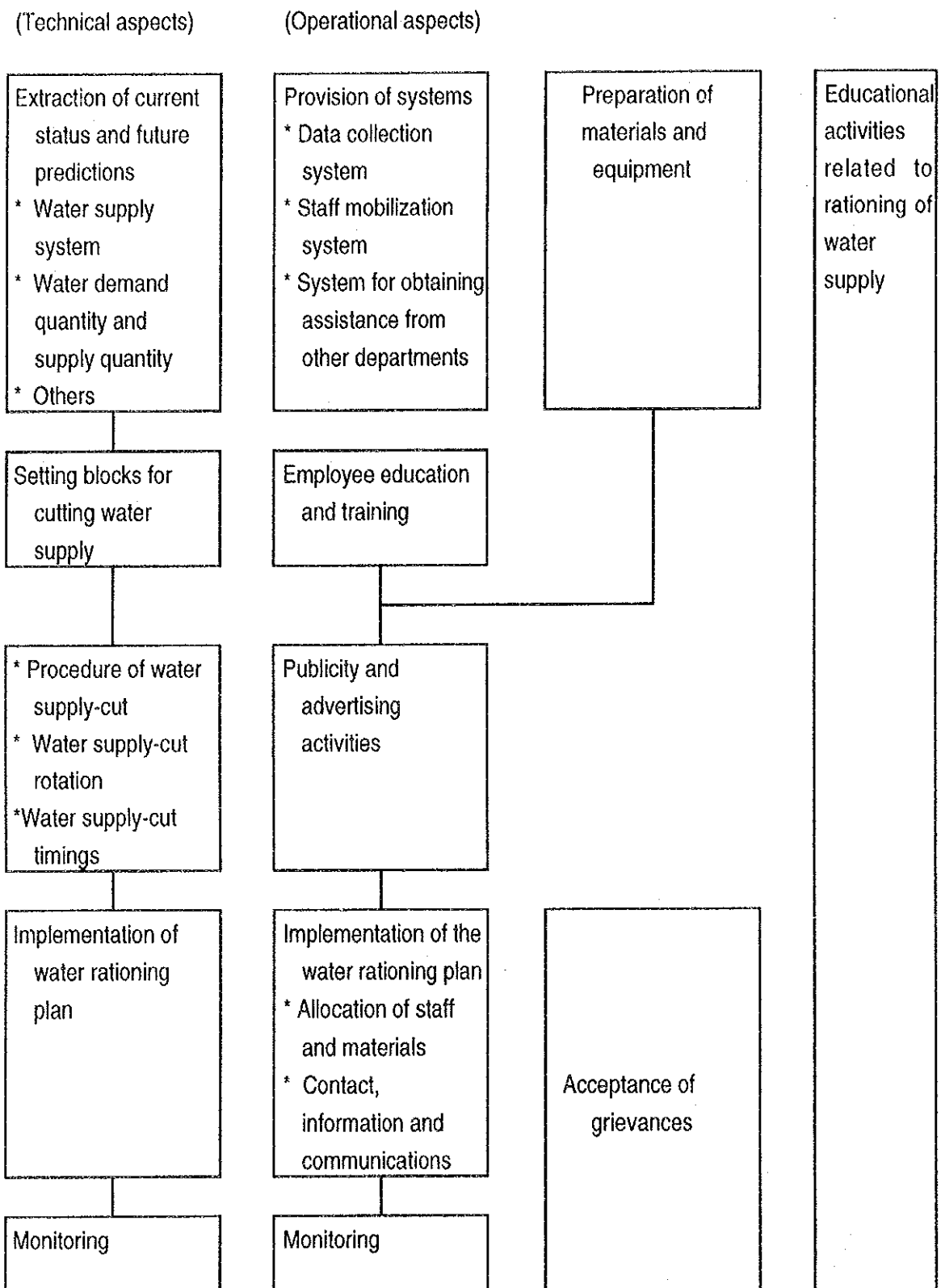


Fig. 3-7 Implementation procedure for water rationing plan

3.3.3 Position and status of the project area

The transmission pipeline to be laid in this project extend from the vicinity of the 9 Mile water treatment plant (airport) to the 3 Mile service reservoir, traversing through Erima and Hohola areas for a distance of about 10 km. (Please see Fig. 3.) The details of the installation position, status of the surroundings, and land owners for each space are given below. The land owners' map for the transmission pipeline route and the owners are given in the Appendix.

1. Transmission pipeline route

Planned 9 Mile water treatment plant vicinity (Airport) to Department of Civil Aviation (DCA)

Installation position: Reserve of the existing transmission pipeline, no roads for installation.

Status of surroundings: Savannah belt, no houses in the surroundings.

Owner: Government

Problems: None in particular

Land owned by Department of Civil Aviation

Installation position: Reserve of the existing transmission pipeline, no roads for installation.

Status of surroundings: Savannah belt, but a dormitory for the employees of DCA is being constructed.

Owner: Government (DCA)

Problems: After discussions with the DCA, reserve rights for 15 m at the center of the existing transmission pipelines (2 nos.) were acquired. New transmission pipelines can be installed within this width.

Department of Civil Aviation to Hubert Murray Highway

Installation position: Reserve of already existing transmission pipeline, no roads for installation.

Status of surroundings: Savannah belt, no inhabited houses in the surroundings.

Owner: Government

Problems: None in particular

Hubert Murray High to entrance of city (Erima area) - Along the road

Installation position: Road reserve

Status of surroundings :Savannah belt, no houses in the vicinity. Jackson International Airport to the south. Waigani marshland belt continues to the north.

Owner: Government
Problems: None in particular

Entrance of city to Spring Garden road --- along the road

Installation position: Road reserve
Status of surroundings: Entry to the city from this point. Almost all residential areas along the road.

Owner: Government
Problems: None in particular

Spring Garden Road to Ward Road ---- along the road

Installation position: Road reserve
Status of surroundings:Mostly industrial and commercial sites along the road. However, residential area exists near the Ward Road.

Owner: Government
Problems: A part of the road reserve width is narrow, therefore, digging under the road will be necessary.

Ward Road to Hubert Murray Highway ---- along the road

Installation position: Road reserve
Status of surroundings: Site for military barracks along the road. A part of the residences, school facilities and buildings of the power company are included.

Owner: Government
Problems: None in particular

Hubert Murray Highway to 3 Mile service reservoir --- Military site

Installation position: Military site along the Hubert Murray Highway. Pipelines to be installed parallel to existing pipeline.

Status of surroundings: Military site continues to the north. Site specially for housing complex to the south.

Owner: Government (army)
Problems: Since this is a military site, permission for laying the pipeline is necessary but this can be obtained.

2. Valves

Valves for water supply to Hohola area

Installation position: Along the Ward Road, in front of the power company. Positioned at a location where the planned transmission pipeline connects the existing dia. 250 mm pipeline.

Status of surroundings: Military site in the surroundings. However, a part of the residences, school facilities and buildings of the power company are also included.

Owner: Government

Problems: None in particular

Valves for water supply to Town and Koki areas

Installation position: At the point where the planned transmission pipeline connects the existing dia. 600 mm pipeline under the 3 Mile service reservoir. Altitude is approximately 90 m.

Status of surroundings: Military site to the north. Residential complex to the south. Rather steep slope in the surroundings, and the 3 Mile service reservoir is at an altitude of 112 m.

Owner: Government

Problems: The existing pipelines are interconnected in a complex manner. The position must be accurately identified.

3.3.4 Outline of facilities and equipment

The main facilities and equipment necessary for implementing this project are pipes and valve equipment, since transmission pipelines are to be installed. The details are given below.

Diameter (mm)	Length (m)	Remarks
Transmission pipeline 1,100 mm	2,596 m	Sluice valve chamber, blow-off equipment, air valve chamber, siphon culvert (1 location, 25 m)
Transmission pipeline 600 mm	7,195 m	Sluice valve chamber, blow-off equipment, air valve chamber, aqueduct (1 location, 12 m)

3.3.5 Maintenance and control plan

(Necessity of maintenance and control)

This project consists of the construction of transmission pipelines and implementation of the water supply rationing plan. Therefore, materials for routine maintenance and control normally required for construction items, machinery and electric equipment, are not necessary. For the transmission pipelines, similar to the existing buried pipes, practically no maintenance or control is necessary. However, for implementing the plan for equitable distribution of water, valve operation is necessary. Valves that have aged considerably may leak or may get damaged. Damage to pipes that are buried may also be considered. In view of these considerations, a permanent stock of valves and pipes must be maintained, and repairs must be carried out beforehand where necessary.

(Method of maintenance and control)

* Repair of valves and pipes

Materials required: Valves, pipes, packing, joints, etc.

Machinery required: Excavator

Personnel required: About 3 including 1 engineer

The staff in the Water Supply Unit currently are skilled in valve and pipe repairs and this has been verified during the on-site study. An ample quantity of permanent stock of pipes and valves has been verified also.

(Maintenance and control system)

The organization responsible for maintenance and control during and after the implementation of this project is the Water Supply Unit, Maintenance and Control Section of NCDC, but as mentioned above, no special maintenance and control work is necessary for this project, and the current setup of the Water Supply Unit can cope with the work adequately.

(Maintenance and control expenses)

As mentioned above, the current setup can cope with the project work adequately. Also, a permanent stock of materials necessary for repairs is available, therefore, practically no additional expenditure will be incurred for the implementation of this project. NCDC does not have to allocate additional budget for the implementation of this project. The project also has good prospects for securing increased income through recovery of water charges.

3.4 Technical Assistance

The necessity of technical assistance for the transmission pipeline construction plan and the water supply rationing plan using the transmission pipelines was examined in section 3.2.6. The results of the examination indicated that technical assistance for this project is not particularly necessary.

The PNG Government, however, has been seeking technical assistance related to overall management of the water supply, including water leakages. If this request is submitted officially and experts are deputed, the implementation of the water supply rationing plan through technical assistance will satisfy the aspirations of the PNG Government. The fields that may be considered for technical assistance are given below.

- * Management of the entire Water Supply Unit
- * Prevention of water leakage
- * Improvements in the system focusing on meter installation, meter reading and water charge collection
- * Guidance for framing the water supply rationing plan
- * Guidance for implementing the water supply rationing plan
- * Others

CHAPTER 4 BASIC DESIGN

4.1 Design policy

For resolving the problems of relative water shortage and inadequate capacity of the water supply which directly confront the existing water supply system, the basic design of the project thoroughly considers the natural conditions, social conditions, construction status, current status of fund procurement and current status of maintenance and control. The proposal suits the standards of NCDC. The main points in the design for equitable distribution of water supply are summarized below.

1) Policies with respect to natural condition

The rainy season is from December to April. A work schedule shall be proposed so that the peak of the work does not occur during this period.

2) Policies with respect to social condition

Night work will not be conducted taking into account of the public order. When night work cannot be avoided, guardsmen will be employed on construction sites.

3) Policies with respect to construction procedure

Japanese engineers will be deployed on this project which consists of laying transmission and installing aqueduct although experienced local contractors managed by Australian and New Zealander exist. The main fields cover architectural works but water works.

4) Effective utilization of local resources

Effective utilization of local resources restricts the project expenses to a minimum and also satisfies the economic results anticipated by the aid donor countries. Almost all resources for the construction are available in Port Moresby city.

5) Utilization of local construction machines

Construction machines are available, similar to 4) above. The main construction machines such as cranes, drag shovels, rollers, etc. are available locally and can be used.

6) Policies with respect to construction period

The main work in this project is the construction of special transmission pipelines extending for about 10 km. From the nature of the work, splitting the construction