No. 1

BASIC DESIGN STUDY REPORT ON THE PROJECT FOR KATHMANDU WATER SUPPLY FACILITY IMPROVEMENT IN THE KINGDOM OF NEPAL

JULY, 1991

JICA

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ON
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FOR
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IN
THE KINGDOM OF NEPAL

JULY, 1991

JAPAN INTERNATIONAL COOPERATION AGENCY

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PREFACE

In response to a request from His Majesty's Government of the Kingdom of Nepal, the Government of Japan decided to conduct a basic design study on the Project for Kathmandu Water Supply Facility Improvement and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Nepal a study team headed by Mr. Yutaka Hosono, Managing Director, Grant Aid Study and Design Department of JICA, from February 13 to March 20, 1991.

The team held discussions with the officials concerned of the Government of Nepal, and conducted a field study at the study area. After the team returned to Japan, further studies were made. Then, a mission was sent to Nepal in order to discuss a draft report and the present report was 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.

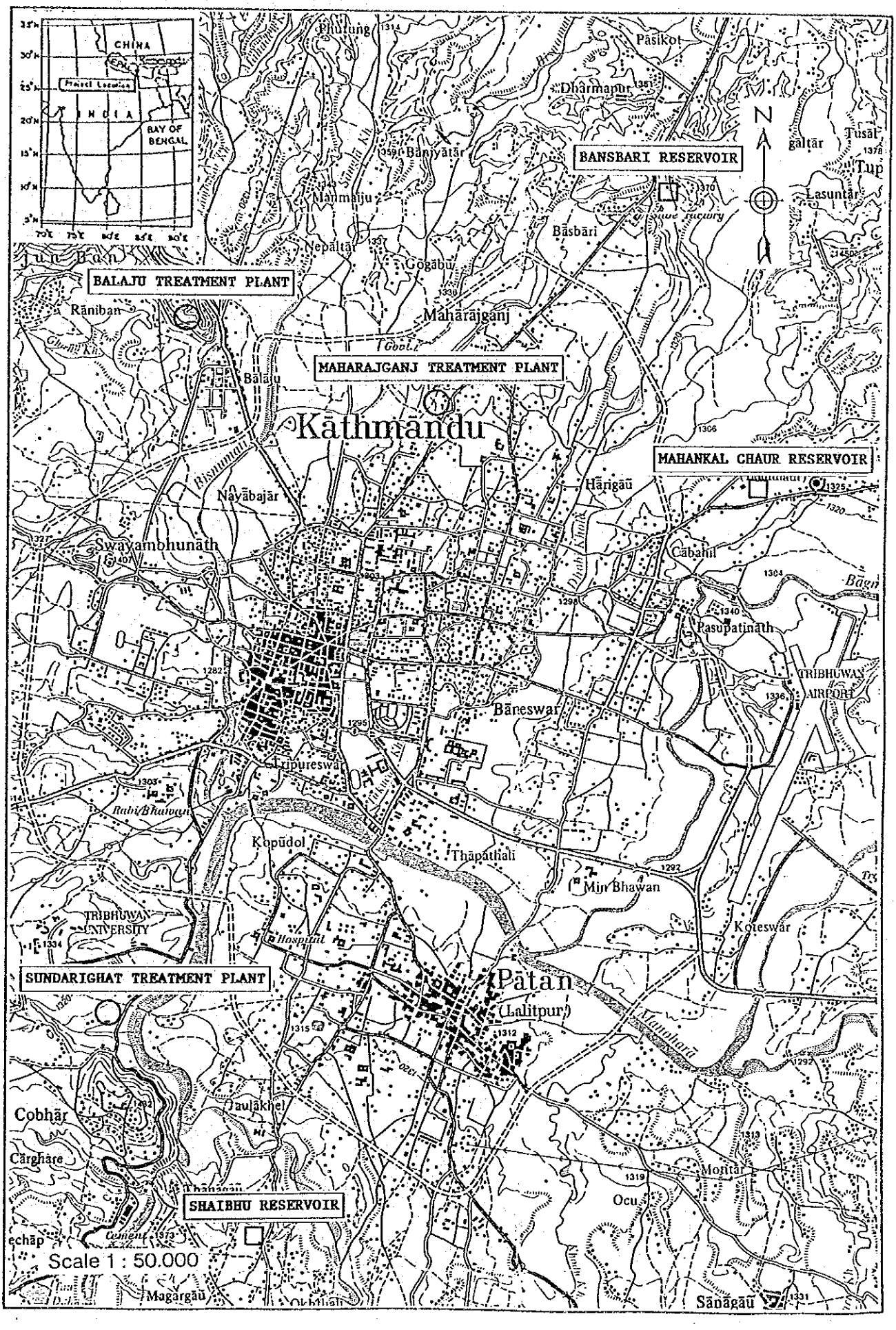
I wish to express my sincere appreciation to the officials concerned of His Majesty's Government of the Kingdom of Nepal for their close cooperation extended to the teams.

July 1991

Kensuke Yanagiya

Kensuke Yanagiya
President
Japan International Cooperation Agency

LOCATION MAP



SUMMARY

The waterworks of Greater Kathmandu, which consists of Kathmandu city, the Capital, and adjacent Lalitpur city, has a history of about 100 years, and its water sources and the distribution systems have been developed. The full-scale development of the water supply system commenced with the master plan established in 1973 in response to the rapid increase in water demand resulting from the concentration of the population to urban areas in the 1970's. This master plan provided for the following:

1) The water demand until 1996 should be coped with by the development of water sources in the Kathmandu valley, rehabilitation and construction of water supply facilities.

2) After 1997, development and expansion of the water supply facilities should be carried out using water source outside the valley.

With regard to 1) above, there are problems, such as a) as the groundwater developed in the 1980's contains iron, manganese, and ammonia nitrogen of high concentrations and have been supplied without treatment. This causes troubles of water quality ; b) as the recharge of groundwater source is small, the pumpage is restricted; c) the deterioration of the water supply facilities constructed before 1970 has been considerably reduced their function, causing the problems in terms of both water quality and quantity; and d) the rapid increase in the population has led to an unbalance between supply and demand.

With regard to Item 2) the Melamchi river was selected as a water source outside the valley by the UNDP in 1989. However, it is not prospected to utilize water from 2001, the target year, from the viewpoints of technical and financial problems as 27 km of water conveyance tunnel must be constructed in advance.

To cope with this situation, the Government of Nepal placed the water supply development of Greater Kathmandu as one of the issues to be solved most urgently in its national development plan, and has planned the 15YCDP. The UWSSRP, centering about a water distribution facility and service installations improvement plan, is now in the course of implementation with having aid from the IDA and UNDP. However, this UWSSRP has not take consideration into the countermeasure for the improvement of water quality and the water quantity problems, required to be solved urgently for the waterworks of Greater Kathmandu.

Under these circumstances, a master plan study was conducted by JICA from 1989 and 1990 for the development of water sources and water management within the valley to cope with the water demand until 2001, and as the result eight projects were proposed.

According to the results of this study, the Government of Nepal requested Grant Aid Assistance from the Government of Japan on five projects related to the improvement of groundwater quality and the expansion and renovation of existing treatment plants. In response to the request, the Government of Japan decided to execute a basic design study for the two projects that has been given the highest priority among the five projects, and JICA dispatched a basic design study team from February 13 to March 20, 1991.

This Study Team discussed with the Government of Nepal and the IDA, and conducted data collection on the water supply conditions, field survey and biological treatment experiments of groundwater. After return to Japan, the Study Team studied about the benefit of the Project, a water supply facility plan, a basic design of the water supply facilities and an operation, maintenance and management plan and estimated the Project's cost in consideration to the results of field survey and then prepared a draft final report.

JICA dispatched a study team for explanation of draft final report from July 11 to July 17, 1991. The team had a series of discussion with the authorities concerned of the Government of Nepal. The final report

was made taking consideration into comments subsequently made by the Nepalese side.

The basic concepts of the Project are set forth in the following:

1) Target year of the Project is 1995.

2) The planned water supply amount for Greater Kathmandu in 1995 is 85,700 m^3/d and per capita consumption is 101 lcd for Kathmandu city and 94 lcd for Lalitpur city.

3) The planned water supply amount in the Project is 26,500 m^3/d for the Mahankal Chaur project and 22,100 m^3/d for the Bansbari project.

4) The targets of the improvement of the water quality are the removal of iron and manganese, disinfection of coliform and other bacteria, securing of sterilizing effects in the distribution network, prevention of secondary problems in the distributing network due to iron and ammonia nitrogen, and prevention of the corrosion of the distribution pipes by improving the corrosive supplied water.

5) The water sources are to be the conjunctive use of the existing groundwater and existing surface water plus surface water to be developed. The annual pumpage from the existing groundwater source should not exceed 15,600 m^3/d to conserve it.

6) The treatment plants should be designed according to following principles:

   a) Groundwater, after ammonia nitrogen is removed by biological filtration treatment, should be treated by means of coagulo-sedimentation and manganese sand filtration.
   b) Surface water should be treated by means of coagulo-sedimentation and rapid sand filtration.

c) The method of coagulation should rely on granule PAC made in Japan, since it makes the feeding operation precise and easy, and has excellent performance.

7) Water tanks at the treatment plants should be made of reinforced concrete with high watertightness.

8) Pile foundations should be used of reinforced concrete square piles fabricated and driven on site.

9) Water conveyance pipes should be mainly used hard vinyl chloride pipes which has high anti-corrosion and workability.

The details of the basic design of the facilities worked out according to the above basic principles are given in the tables on the next pages:

Details of Basic Design of the Mahankal Chaur Project

Items	Contents of facility
1. Water intake facilities	
a) Surface water	Branch pipe ϕ450 mm (with pressure reducing valve), Intake pipe ϕ500 mm
b) Groundwater	Existing wells (Manohara, Gokarna, Dhobi Khola well fields)
2. Conveyance facilities	
a) Balancing reservoir	Capacity 4,600 m^3
b) Water conveyance pipe	ϕ500 mm x 9,130 m (VM pipe)
3. Treatment facilities	
a) Bio-filter	19,100 m^3/d, 10 basins x 15.9 m^2 (2.46 m x 6.46 m)
b) Receiving well and mixing basin	2 basins x 53 m^3 (2.5 m x 5.6 m x 3.8 m)
c) Flocculation basin	12 basins x 48 m^3 (1.0 m x 2.95 m x 8.1 m x 2 rows)
d) Sedimentation basin	2 basins x 815 m^3, and 3 basins x 534 m^3
e) Rapid sand filter and filter for iron removal	10 basins x 18.8 m^2
f) Clear water reservoir	2 basins x 560 m^3
g) Transmission facilities	Pump: 6.7 m^3/min x 7 m x 11 KW x 4 units
h) Coagulant dissolution and feeding equipment	(dissolving) 0.4 m^3 x 2 tanks, (storage) 1.0 m^3 x 2 tanks
i) Alkali agent dissolution and feeding equipment	(for biological filtration) 0.4 m^3 x 2 tanks and 2.0 m^3 x 2 tanks
j) Alkali agent dissolution and feeding equipment	(for surface water) 0.4 m^3 x 2 tanks and 1.3 m^3 x 2 tanks
k) Bleaching powder dissolution and feeding equipment	1 Set
l) Sodium hypochlorite generating and feeding equipment	1 Set (capacity: 130 kg-Cl_2/d)
m) Bleaching powder dissolution and feeding equipment (spare)	0.4 m^3 x 2 tanks and 0.65 m^3 x 2 tanks
n) Electrical installations	600 KVA incoming and transforming equipment Diesel generator: 300 KVA x 1 unit
o) Foundation piles	350 x 350 square (reinforced concrete piles)

Details of Basic Design of the Bansbari Project

Items	Contents of facility
1. Water intake facilities	
a) Surface water (expansion and improvement of existing intakes)	Shivapuri 14,000 m^3/d, Bisnumati 7,000 m^3/d
b) Groundwater	Existing wells (Bansbari well field)
2. Conveyance facilities	
a) Water conveyance pipe	ϕ250 mm x 2,019 m, ϕ200 mm x 1,433 m, ϕ350 mm x 3,826 m (VP pipe)
3. Treatment facilities	
a) Bio-filter	17,600 m^3/d, 10 basins x 14.7 m^2 (2.46 m x 5.98 m)
b) Receiving well, mixing basin	2 basins x 53 m^3
c) Flocculation basin	4 basins x 117 m^3 (1.15 m x 3.15 m x 8.1 m x 4 rows)
d) Sedimentation basin	4 basins x 660 m^3 (5.2 m x 3.0 m x 42.3 m)
e) Rapid sand filter and filter for iron removal	8 basins x 20.0 m^2
f) Clear water reservoir	2 basins x 465 m^3
g) Transmission facilities	Pump: 2.7 m^3/min x 7 m x 5.5 KW x 3 units
h) Coagulant dissolution and feeding equipment	(dissolving) 0.4 m^3 x 2 tanks, (storage) 1.0 m^3 x 2 tanks
i) Alkali agent dissolution and feeding equipment	(for biological filtration) 0.4 m^3 x 2 tanks and 1.5 m^3 x 2 tanks
j) Alkali agent dissolution and feeding equipment	(for surface water) 0.4 m^3 x 2 tanks and 1.0 m^3 x 2 tanks
k) Bleaching powder dissolution and feeding equipment	0.4 m^3 x 2 tanks and 1.0 m^3 x 2 tanks
l) Electrical equipment	500 KVA incoming and transforming equipment; Diesel generator: 300 KVA x 1 unit
m) Foundation piles	350 x 350 square (reinforced concrete piles)

The implementation agency of the Project is NWSC, and the Greater Kathmandu Water Supply Department, its subordinate organization, is in charge of the Project. It is considered that since they have rich experience of projects by the IDA and foreign assistance, their ability to carry out the tasks will be sufficient.

Although the operation and maintenance of the facilities developed under the Project will be the responsibility of the Greater Kathmandu Water Supply Department, but actually the work will be performed by new organizations consisting of personnel related to the operation and maintenance of intakes, treatment plants, and distribution facilities of which is to be built under this Project. The plant managers of both the projects are chiefs of these subordinate organizations.

The cost to be borne by the Government of Nepal in the Project will be 18.6 million NRs. The operation and maintenance cost will be 22.2 million NRs annually. Assuming the water charge to be 4.0 NRs/m^3 for house connection and 6.2 NRs/m^3 for standpost, the revenue from the water charge will be 31.4 million NRs, enough to meet the annual expense.

The Project will be implemented in two phases and the construction period will be 12 months for each phase, including the time for procurement and transportation of the materials and equipment. Including the period of detailed design and tender, the Project will take 22 months after the signing of the Exchange of Notes (E/N).

The rate of water-borne disease in the distribution areas where water has been supplied without treatment is extremely high, that is 100 to 340 persons per 10,000 population. After completion of the Project, it can supply good enough amount of safe and sanitary water. It is, therefore, highly expected to reduce the rate of water-borne disease, and also contribute to the improvement of inhabitant's life and public hygiene. The water supply amount of the Project is more than 57.4% of the total amount, and this effect will be brought to more than half of citizens.

It is also expected to remove inhabitant's dissatisfaction to the waterworks administration, and become easy to obtain an cooperation of inhabitants. This contributes to sound water supply management. Thus, it is judged that the Grant Aid Assistance by the Government of Japan for the Project is significant and reasonable.

It is very important that the facilities must have proper operation and management for the purpose of playing good enough effectiveness of the Project. Therefore, NWSC is required to arrange following points.

1) Administrate a guaranteed procurement route for chemicals needed for the treatment of water.
2) Establish a system of water charge collection.
3) Training of the personnel.
4) Enlightenment of citizen (try to give proper knowledge to the citizen).
5) Arrange Japanese experts for training of the personnel and its preparedness.

It is also necessary to carry out the UWSSRP promptly after adjusting of overlap in some parts of the development's targets between the UWSSRP and JICA Water Supply Development Plan, which is the basis of the Project.

Furthermore, it is necessary to adjust that the Melamchi project can be carried out, considering the facilities of JICA Water Supply Development Plan and the UWSSRP, and also avoiding overlapping investment.

BASIC DESIGN STUDY REPORT

ON

THE PROJECT

FOR

KATHMANDU WATER SUPPLY FACILITY IMPROVEMENT

IN

THE KINGDOM OF NEPAL

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ABBREVIATIONS

Organizations

ADB	: Asian Development Bank
DWSS	: Department of Water Supply and Sewerage
GTZ	: Deutsche Gesellschaft für Technische Zusammenarbeit
GWE	: German Water Engineering GmbH
IBRD	: International Bank of Reconstruction and Development
IDA	: International Development Association
JICA	: Japan International Cooperation Agency
MHPP	: Ministry of Housing and Physical Planning
MLD	: Ministry of Local Development
MPLD	: Ministry of Panchayat and Local Development
MOH	: Ministry of Health
NEA	: Nepal Electricity Authority
NWSC	: Nepal Water Supply Corporation
SMEC	: Snowy Mountains Engineering Corporation Ltd.
UNDP	: United Nations Development Programme
UNICEF	: United Nations Children's Fund
WHO	: World Health Organization
WSSC	: Water Supply and Sewerage Corporation

Unit and Others

CIF	: Cost Insurance and Freight
FOB	: Free on Board
DSR	: Debt Service Ratio
GDP	: Gross Domestic Production
GNP	: Gross National Production
NRs.	: Nepalese Rupees
lcd	: Litter per Capita per Day
Mld	: Million Litter per Day
MCM	: Million Cubic Mater
15YCDP	: Fifteen Year Comprehensive Development Program
UWSSRP	: Urban Water Supply and Sanitation Rehabilitation Project
RID	: Regional Integrated Development

CHAPTER 1 INTRODUCTION

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The Greater Kathmandu water supply system, which has a history of about 100 years, has been expanded and developed in three phases in accordance with a master plan drawn up with the cooperation of UNDP in 1973. With the completion of the plan in 1987, the system now satisfies the immediate demand for water quantitatively. A subsequent plan based on the master plan, now underway, aims at 1) the betterment and improvement of the existing water supply facilities, and 2) the expansion of the facilities by bringing in water from outside the Kathmandu valley to cope with the growth in demand since 1997. With regard to 2) above, however, the problems associated with the construction of a tunnel, 27 km long, and providing a reservoir for the backup still remain unresolved, thus precluding the prospects of using such water until at least the year 2001.

Under these circumstances, from 1989 to 1990 a master plan study was implemented by JICA concerning the possible expansion of water resources within the valley to cope with demand until 2001, leading to proposals for eight projects. Based on the results of the study, the Government of Nepal has requested the Japanese Government for grant aid assistance in implementing five of the projects.

In response, the Japanese Government has decided to implement a basic design study for two of the projects which were given the highest priority. The Japan International Cooperation Agency, in response to the decision, dispatched a basic design study team led by Mr. Yutaka Hosono, Managing Director, Grant Aid Study and Design Department of the Japan International Cooperation Agency, to Nepal from February 13 to March 20, 1991.

The study team held discussions with those concerned of the Nepalese Government and IDA, collected data on the water supply situation, and conducted a field survey as well as conducting biological filtration

experiments on groundwater. The basic matters of agreement reached in the discussions with the Government of Nepal have been compiled as minutes of the discussions.

In work performed after returning to Japan, the beneficial effects of the Project were examined on the basis of the field survey, and a water supply facility plan, the basic design, an estimate of the Project's cost, and a maintenance and management plan were drawn up as a draft report giving the optimum plan of implementing the Project.

The Japan International Cooperation Agency then dispatched a study team headed by Mr. Kenichi Shishido, Grant Aid Study and Design Department of JICA, to Nepal to give the explanation of the draft report from July 11 to July 17, 1991, where the explanation and discussions were held with those concerned of the Nepalese Government.

This report takes into consideration the discussions with the Government of Nepal and the comments subsequently received from them and forms a proposal for implementing the Project.

A list of Survey Team members, the survey schedule, a list of those concerned in Nepal, and the Minutes of Discussions are included as appendices.

CHAPTER 2 BACKGROUND OF THE PROJECT

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2.1 General Situations in Nepal

(1) Geography

The Kingdom of Nepal is a land-locked country adjoining India on the south, east, and west and China on the north. It lies between longitude 80°4' and 88°21' east and latitude 26°22' and 30°27' north. The average east-west extent is about 800 km and the country is about 160 km from north to south, giving it a territorial area of 147,181 km^2, or about twice as large as Hokkaido. As a result of the Himalaya Range along the country's northern border, its geographical features are extremely varied. The elevation, for example, ranges from 100 m to higher than 8,800 m above sea level and 83% of the territory is hilly or mountainous. Topographically, it can be classified into three distinct three regions.

The Northern Himalayan region is an area of high mountains reaching 5,000 to 8,800 m above sea level. This accounts for 41% of the total area.

The central hilly region consists of valleys and basins between lower mountains stretching east to west across the center of the country at the altitude of 600 to 5,000 m above sea level. The plains, including the Kathmandu valley, are gradually becoming urbanized and the lower mountains have been cleared almost to the summits for terraced fields. This region accounts for 42% of the total area.

The Southern Terai region has a relatively flat topography with the altitude of 100 to 600 m above sea level averaging 300 m. It ranges in width between 25 and 32 km along the border with India. This accounts for 17% of the total area, and 40% of it is farmland constituting the granary of Nepal.

(2) Climate

The varied topography of the country described above means that the climate varies greatly depending on the location. From the climate of mountains with glaciers, the conditions vary to a tropical monsoon climate of the area 100 m above sea level. Generally, however, the weather is continental, with a great deal of rainfall between June and September due to the monsoon and dry weather in winter. Rainfall from November to February accounts for less than 3.3% of the precipitation. The distribution of annual precipitation varies significantly according to the regions: from 250 mm in the lower southern region to 2,500 mm in the northern mountainous region.

(3) Population

According to a census taken in 1981, the total population of the Kingdom was 15,022,839. The increase in population since 1952, when the first modern census was taken, was 1.32% per year on the average between 1952 and 1961, 2.07% between 1961 and 1970, and 2.66% between 1971 and 1981, showing a tendency to increase.

Looking at the population by the regions and the population density, a remarkable concentration in the southern fertile region can be seen: 8.7% and 25.1 persons/km^2 in the northern mountainous region; 47.7% and 116.08 persons/km^2 and 43.6% and 192.70 persons/km^2 in the central and southern Terai regions, respectively. (Refer to Table 2.1.1)

The urban population in Nepal accounted for 3.6% of the total population (336,000) in 1961, but it increased to 4.0% (462,000) in 1971 and 6.38% (957,000) in 1981. (Refer to Table 2.1.2)

According to the latest survey (1985/86), the urban population of 1,360,000 accounted for 8.1% of the total, showing a rapid movement towards the cities.

Table 2.1.1 POPULATION AND POPULATION DENSITY BY TERRAIN (1981)

Terrain	Population (Person)	Population Density (Person/km^2)
Himali Region	1,302,896	25.10
Eastern	638,439	32.40
Central	413,143	65.80
Western	19,951	3.40
Mid-western	242,786	11.40
Far-western	-	-
Hilly Region	7,163,115	116.08
Eastern	1,250,042	116.90
Central	2,108,433	178.60
Western	2,150,939	117.50
Mid-western	1,042,365	76.00
Far-western	604,336	89.40
Terai Region	6,556,828	192.70
Eastern	2,113,442	290.70
Central	2,387,781	256.00
Western	957,969	182.00
Mid-western	670,760	91.70
Far-western	426,876	88.10
Total	15,022,839	102.20

Source: Statistics of population

Table 2.1.2 URBAN POPULATION IN NEPAL

City	Terrain	Population (Person)		Growth Rate (%)
		1971	1981	
1. Kathmandu	Hilly	150,402	235,160	4.60
2. Biratnagar	Terai	45,100	93,544	7.60
3. Lalitpur	Hilly	59,040	79,875	3.10
4. Bhaktapur	Hilly	40,112	48,472	1.90
5. Pokhara	Hilly	20,611	46,642	8.50
6. Mahendranagar	Terai	-	43,834	-
7. Birgunj	Terai	12,999	43,642	12.87
8. Dharan	Terai	20,603	42,146	7.40
9. Janakapur	Terai	14,294	34,840	9.30
10. Hetauda	Inner Terai	16,194	34,792	7.90
11. Nepalgunj	Terai	23,523	34,015	3.70
12. Siddharthanagar (Bhairawa)	Terai	17,272	31,119	6.10
13. Bharatpur	Terai	-	27,062	-
14. Dhangadhi	Terai	-	27,274	-
15. Butwal	Terai	12,815	22,583	5.80
16. Tribhuvannagar (Ghorahi)	Inner Terai	-	20,608	-
17. Rajbiraj	Terai	7,832	16,444	7.70
18. Birendranagar	Inner Terai	-	13,859	-
19. Dhankuta	Hilly	-	13,836	-
20. Lahan	Terai	-	13,775	-
21. Tansen	Hilly	6,434	13,125	7.40
22. Ilam	Hilly	7,299	9,773	3.00
23. Bhadrapur	Terai	7,499	9,761	2.70
Total		461,938	956,721	

(4) Race, language, and religion

The people are mainly Tibetan-Burmese-language tribes of the Mongolian origin in the central and higher mountainous regions while Indian-Aryan-language groups are abundant in the southern Terai region. The main races include Tamang, Newari, Magar, Rai, Gurung, Rimbu of the Tibetan-Burmese-language group and Buramin, Tetori, and others of the Indian-Aryan-language group. The composition is 54% held by highly assimilated Nepal family, 19% by Biharu family, 6% by Tamang family, 4% by Newari family, and 13% by others.

The languages spoken include Nepalese, which is the official language, and some 40 tribal language of 14 language groups including Bihari, Tamang and Newari.

About 90% of the total population believes in Hinduism, the state religion, and 5% in Buddhism, 3% in Islam, and some in Christianity. Although the Constitution dictates that Hinduism is the state religion, two or even three faiths are sometimes adopted because of a complete freedom of religion allowed in the country.

(5) Economy

The economy of the Kingdom of Nepal depends on agriculture and related industries. These account for about 60% of the GDP and more than 90% of employment. For this reason, the GDP growth naturally depends on the trends in agricultural production. However, since the agriculture depends on rainwater, the growth has been extremely unstable: 2.8% in 1984/85, 4.3% in 1985/86, dropping to 2.7% in the drought year of 1986/87, and improving to 9.8% in 1987/88 due to a sudden increase in agricultural output.

In view of this situation, the government has placed emphasis in its development administration on the infrastructure for agricultural production, which centers around irrigation systems. The infrastructure for industrial production, such as electric power development, is also a

focus of the sixth 5 year plan for the years 1980/81 to 1984/85 and of the seventh 5-year plan for the years 1985/86 to 1989/90. Every effort is being made to increase employment opportunities through stable expansion of agricultural production and a rapid expansion of industrial output. However, the country is confronting problems such as a shortage of equipment and materials for agricultural production because its industries are underdeveloped and dependence on the import of raw materials for industrial production and of construction equipment and materials. This situation makes it difficult to achieve high economic targets. Changes in major economic indices are shown in Table 2.1.3.

Table 2.1.3 PRINCIPAL ECONOMIC INDICES

		1985	1986	1987	1988
Population (Thousand person)		16,527	17,038	17,591	18,053
GDP	Total Amount (Million NRs)	50,428	57,828	67,835	74,575
	Agriculture (Million NRs)	26,819	30,582	35,648	41,608
	Non-agriculture (Million NRs)	23,609	27,246	32,187	32,967
GNP per Capita (US$)		160	160	160	170
Consumer Price Index		100.0	119.0	131.8	143.6
D S R (%)		5.3	7.7	8.4	9.1
The Balance of Foreign Debt (Million NRs)		10,244	14,829	20,065	25,361
Foreign Exchange Rage 1 NRs = US$		0.0548	0.0471	0.0458	0.0429
Classification (DAC/United Nations)		Low Income Country/LLDC, MSAC			
Area (Thousand km^2)		114			

(6) Trade balance

Nepal's trade structure is typical of a developing country, with exports of primary products and processed goods, such as carpets, beans, and jute and imports of industrial products, such as petrochemical products, machines, cars, and electrical appliances. Looking at trade volume in the years between 1980/81 and 1986/87, exports accounted for 10% of GDP per year on an average, while imports were about 26% on an average, showing a large excess of imports. The changes in imports and exports are shown in Table 2.1.4.

The main trading partner is India which accounts for 60% of the total exports and about 45% of imports. According to records for 1989, trade between Nepal and Japan was 71.77 million dollars in imports and 1.84 million dollars in exports, a deficit for Nepal by a large margin although the actual scale was small, about 2% of total imports and exports. Records of direct investment by Japan in Nepal between 1951 and 1989 show investments of 3.65 million dollars in 10 cases, which is quite small. A future issue will be how to reduce the deficit and how to expand trade through Japanese efforts in development and imports.

The international balance of payments for the Kingdom is just about balanced at present thanks to revenues in foreign currency from tourism and foreign assistance, and due to restraints on imports imposed due to the shortage of foreign currency. Nevertheless, it is expected that imports will increase rapidly as the number of development projects expands, and worsening of the trade balance seems inevitable.

Table 2.1.4 DIRECTION OF FOREIGN TRADE

(Unit: Million NRs)

		1983/84	1984/85	1985/86	1986/87	1987/88
Export (FOB)	Total	1,703.9	2,740.6	3,078.0	2,991.4	4,114.6
	To India	1,160.7	1,601.7	1,241.1	1,302.6	1,567.8
	To other countries	543.2	1,138.9	1,836.9	1,688.8	2,346.8
Import (CIF)	Total	6,514.3	7,742.1	9,341.2	10,905.2	13,869.6
	To India	3,058.0	3,895.8	3,970.9	4,262.0	4,593.8
	To other countries	3,456.3	3,846.3	5,370.3	6,643.2	9,273.8
Balance of Trade		-4,810.4	-5,001.5	-6,263.2	-7,913.8	-9,755.0

(7) Industry

1) Agricultural sector

The area of cultivated land in Nepal is about 2.9 million ha, which is only 20% of the total area of the country. Moreover, one third of the cultivated land is located among hills and mountains where natural conditions are difficult. The development of irrigation systems also lags and presently developed irrigation systems serve only about 0.14 million ha, or just 5% of all cultivated land. The main agricultural products are grains, such as rice, wheat, maize, and millet, and cash crops, such as sugar cane, oil seed, tobacco, jute, and potato.

Due to the small scale of operation, inadequate use of machines and materials in production, and soil erosion resulting from uncontrolled forest development, the agricultural productivity in Nepal is low and lacks international competitive power. Stable expansion of agriculture, Nepal's main industry, depends on achieving the targets of agriculture development plans and on the stability of prices, as is often emphasized by the Government of Nepal. Changes in the production of agricultural products are shown in Table 2.1.5.

2) Mining and manufacturing industry sector

Although manufacturing industry in Nepal centers around the processing of agricultural products, including jute processing, sugar manufacturing, tobacco manufacturing, rice polishing, and wheat milling, industries for which there is a domestic supply of raw materials, such as cotton weaving, cement manufacturing, furniture manufacturing, brick manufacturing, and agricultural tool manufacturing, and cottage industries, such as carpet weaving, handicrafts, ready-made clothes manufacturing, all of these industries are small in scale and output accounts for about 4% of GDP. In developing a large-scale industrial base and increasing industrial production rapidly, problems exist which make the situation very difficult for industrialization. These include the dependence on imports for production equipment and materials and the restricted domestic market. Changes in industrial production are shown in Table 2.1.6.

Because of a scarcity of available mineral resources other than limestone, the output of the mining industry is about 0.2% of GDP, contributing little to the total.

3) Tourism sector

The Kingdom of Nepal is blessed with fine tourist attractions, including unique traditional arts, spectacular mountain scenery, and an abundance of animal and plant life, and these bring in precious foreign currency by hosting tourists from abroad. Revenues from tourism in 1989 were as high as 2.74 billion Nepalese Rupees, which accounts for about 40% of GDP, a figure equivalent to 65% of the exported output of commercial goods. In the present era of international travel, with people eager to take advantage of their leisure, the number of tourists from abroad is expected to increase still further in the future. In response to this, the Government of Nepal has been making every effort to encourage tourism - developing new tours, adding new air routes, and increasing promotional activities, for example.

Table 2.1.5 PRINCIPAL AGRICULTURAL PRODUCTS

(Thousand Ton)

	1983/84	1984/85	1985/86	1986/87	1987/88
Food Crops					
Paddy	2,757	2,709	2,804	2,372	2,982
Maize	761	861	874	868	902
Wheat	634	534	598	701	745
Barley	22	24	23	25	24
Millet	115	124	138	138	150
Cash Crops					
Sugar cane	509	408	558	617	814
Oil seeds	73	84	79	83	94
Tobacco	7	6	5	5	4
Jute	25	33	61	23	15
Potato	383	420	357	395	567

Table 2.1.6 PRINCIPAL INDUSTRIAL PRODUCTS

Products		1983/84	1984/85	1985/86	1986/87	1987/88
Jute-goods	Ton	21,333	20,026	16,389	18,289	17,198
Sugar	Ton	17,496	11,039	15,190	24,565	30,040
Cigarettes	Lakh sticks	37,407	42,520	47,410	56,000	60,460
Matches	Th.Gross	1,121	1,239	1,144	1,314	1,215
Liquor	Th.liter	358	1,027	1,264	1,283	2,118
Soap	Ton	5,594	7,676	9,182	11,460	12,303
Shoes	Pairs	72,697	83,000	121,000	121,000	214,444
Leather	Th.pieces	2,770	2,247	2,001	2,877	1,014
Agricultural tools	Ton	481	340	391	363	297
Tea	Ton	827	989	1,052	1,112	1,290
Stainless steel utensils	Ton	439	580	425	421	389
Brick & tiles	Th.pieces	29,760	25,254	28,451	33,876	34,629
Beer	Th.liter	3,125	2,278	3,016	3,699	5,276
Cotton textiles	Th.meters	10,240	10,533	14,118	17,822	9,914
Cement	Ton	39,225	31,479	96,043	151,631	215,010
Biscuits	Ton	3,638	4,339	4,698	4,536	4,674
Plywood	Th.sq.ft.	4,116	2,627	2,038	2,488	1,314
Synthetic textiles	Th.meters	3,591	3,300	6,424	11,561	13,363

(8) State of social infrastructure

1) Electric power

The shortage of electric power in the Kingdom of Nepal was greatly relieved upon completion of the Kule Kani No.1 and No.2 Power Stations with the assistance of the Japanese Government, but still only residents in large cities, major provincial towns, and nearby villages can enjoy the

benefits of electrification, while most mountain villages have not yet received electricity. In recent years, power stations and transmission facilities have been added with assistance from other countries and the electrified areas have gradually expanded. Nevertheless, power still tends to be short, leading to frequent interruptions even in Kathmandu, and making the provision of backup diesel generators necessary for critical electric facilities.

2) Transportation

International air links include daily round-trip flights between Kathmandu and Bangkok and Kathmandu and New Delhi, in addition to regular flights to Colombo, Dhaka, Rangoon, Calcutta, etc. Major domestic cities are also connected with regular air routes.

With regard to domestic transportation, highways connecting the various cities in the southern Terai region, the north-south trunk roads that intersect them, and most roads in large towns and cities are paved, so vehicle transport is relatively good. Many roads connecting local towns through mountains have not yet been paved, though, and as regular maintenance is not sufficient, the roads often become unpassable due to landslides during the rainy season.

3) Communications

Although international mail to Japan takes about a week, air parcels from Japan occasionally take more than 20 days due to customs clearance and the fact that parcels have to be sent via India. The telegram service is slow, with even domestic communications taking time. However, international telephone services have recently been improved and direct overseas dialing has become possible in principle. On the other hand, the domestic telephone system is in poor condition; not only does it involve much waiting but connections are often lost.

2.2 General situations of Water Supply Sector

(1) Administration of water supply

The administration of the water supply in the Kingdom of Nepal is undertaken by two government agencies. The Nepal Water Supply Corporation (NWSC) has jurisdiction covering the districts around 14 large cities including Kathmandu, while the Department of Water Supply and Sewerage (DWSS) has jurisdiction over provincial cities and major villages. In addition, the Ministry of Local Development (MLD) has jurisdiction over the water supplies to villages, although small scale water supply in provincial districts were transferred to the DWSS in 1988.

NWSC, the implementing agency for this Project, was established in 1973 as the WSSB (B stand for Board) under the assistance of IBRD for the purpose of promoting water supply projects around 14 large cities including Kathmandu. In 1984, it became the WSSC and was again renamed, becoming the NWSC, in March 1990. Institutionally, the NWSC is an independent organization controlled by a management committee consisting of a chairman appointed by the Government, representatives from the Ministry of Housing and Physical Planning (MHPP), the Ministry of Finance, and the Ministry of Health, representatives of local autonomous bodies, and the General Manager of the NWSC. Although in principle the cost of implementing water supply is covered by water rates, the situation is that it is difficult to collect fair rates due to difficulties in the collection system, and with the limited resources of low-income beneficiaries, it is difficult to greatly increase water rates. Thus, water supply is operated with assistance from government subsidies.

The DWSS is a department of the MHPP, and it has the jurisdiction over water supplies in the districts around provincial cities and over small-scale water supply in towns and villages, outside the jurisdiction of the NWSC. Also, it is in charge of shallow wells with hand pumps in both the east and west development regions.

The MLD is in charge of water supply to remote villages. Of the local water supply conventionally covered by the MLD water supply involving piping work were transferred to the DWSS in 1988.

(2) The situation of water supply

As a part of effort to expand Basic Human Needs (BHN), the Government of Nepal has been encouraging the construction of water supply systems which supply clean water of sufficient quantity. Looking at the money provided for the development of water supply projects thus far, it has increased markedly since the Fifth Development Plan.

(Unit: Million NRs)

	4th Plan	5th Plan	6th Plan	7th Plan
Budget for development of water supply	93	389	1,011	989
Proportion to total development budget (%)	1.1	3.3	4.6	4.1

In terms of urban and provincial water supply, the present development situation is as follows:

1) Development of urban water supply

The development of urban water supply has progressed with the NWSC and DWSS having jurisdiction, respectively, over 14 major cities and 19 provincial cities. Full-scale urban water supply development was made under the master plan for water supply and sewerage in Greater Kathmandu, which was drawn up with the cooperation of the UNDP in 1973. The plan covered three cities in the Kathmandu valley and improvements of water facilities and the expansion of the sewerage-handling capacity were implemented as the First Project from 1974 to 1984. Subsequently, in the Second Project running from 1977, water supply in five cities, including the three above, was improved and a development plan was drawn up for water-supply facilities in another six cities.

In the Third Project, which was commenced in 1980, the water supply facilities were improved by expanding them to 12 cities and new water sources were developed (exploitation of groundwater) to cope with the rapidly increasing demand for water. This work was completed in 1987.

In the Fourth Project since 1983, a water supply development plan for most cities is being drawn up, and the improvements and expansion of water-supply facilities is being carried out in sequence starting with those for which financial backing have been obtained to undertake safe and sufficient water supply meeting its original mission as waterworks.

In 1990, to promote the efficient and timely development of water supply to large cities, the First 5-year plan (UWSSRP) out of the Fifteen-Year Comprehensive Development Programme for water supplies and sanitation (15YCDP), covering three cities in the Kathmandu valley and nine outside, was chosen for financing by the IDA and the execution design work is now in progress by a German consultant.

2) Development of local water supply facilities

The development of water supply to relatively large villages with a water-using population of 3,000 to 4,000 inhabitants is being implemented in sequence in accordance with the DWSS's yearly plan.

The development of water supply for relatively small villages with a water-using population of about 1,500 is being implemented. It was under the jurisdiction of the MLD until 1988 and is now under that of the DWSS with the cooperation of UNICEF.

Also, a development plan for water forms part of the Regional Integrated Development Plan (RID) jointly implemented by the MLD and the DWSS, and the development of deep wells with hand pumps for the southern Terai region, etc., has been promoted.

Besides these projects, the construction of shallow wells by non-governmental organizations, such as the Red Cross, and by labor service of beneficiary residents in scattered remote villages can also be

mentioned. The rate of dissemination of water supply facilities resulting from the above implementation projects as of 1990 is given below. Table 2.2.1 shows the development of water supply projects in the Kingdom of Nepal and the development plan for the years between 1990 and 2000 is shown in Table 2.2.2.

	Water Supply Population	Water Supply Ratio (%)	Total Population
Local water supply	5,753,000	33.6	17,129,000
Urban water supply	1,196,000	66.0	1,811,000
Average throughout country	6,949,000	36.7	18,940,000

Table 2.2.1 URBAN WATER SUPPLY PLAN IN NEPAL

	Objective City
1. First Project (1974 - 1984)	
a) Rehabilitation of Water Supply Facilities	Kathmandu, Lalitpur, Pokhara
b) Survey on Sewerage	Kathmandu, Lalitpur
2. Second Project (1977 - 1984)	
a) Rehabilitation of Water Supply Facilities	Kathmandu, Lalitpur, Pokhara, Birgunj, Biratnagar
b) Expansion of Sewerage	Kathmandu, Lalitpur
c) Preparation of Master Plan	Kathmandu, Lalitpur, Pokhara, Birgunj, Biratnagar
d) Preparation of Feasibility Study	Nepalgunj, Bhairahawa, Butwal, Hetauda, Janakpur, Dharan
3. Third Project (1980 - 1987)	
a) Rehabilitation of Water Supply Facilities	Kathmandu, Lalitpur, Bhaktapur, Pokhara, Birgunj, Biratnagar, Nepalgunj, Bhairahawa, Butwal, Hetauda, Janakpur, Dharan
b) Expansion of Sewerage	Kathmandu, Lalitpur
4. Fourth Project (1983 - Future)	
a) Feasibility Study on Urban Development Plan	31 Cities (Kathmandu, Lalitpur, Bhaktapur, Pokhara, Birgunj, Biratnagar, Mahendranagr, Dhangadhi, Birendranagar, Tribhuvannagar, Bharapur, Lahan, Rajbiral, Dhankuta, Ilam, Bhadrapur, Nepalgunj, Bhairahawa, Butwal, Hetauda, Janakpur, Dharan, etc.
b) Rehabilitation and Expansion of Water Supply Facilities (1983 - 1990)	Tansen, Lahan, Rajbinaj, Birendranagar, Tribhuvannagar, Damak, Dhamkuta

Table 2.2.2 IMPLEMENTATION SCHEDULE FOR WATER SUPPLY DEVELOPMENT PLAN (1990 to 2000)

Plan	Period
1. Completion of project following the 7th plan project	1991 - 1995
75 projects	1991
120 projects	1992
200 projects	1993
250 projects	1994
250 projects	1995
2. Implementation of UWSSRP for the first five-year plan based on 15YCDP	1991 - 1995
3. Rehabilitation and expansion of water supply facilities for 3 town councils	1992 - 1995
4. Rehabilitation of 300 water supply systems in rural and semi-urban areas	1992 - 1996
5. Implementation of the proposed rural water supply project in central region, 27 piped systems serving 147,000 people	1992 - 1995
6. Implementation of the proposed deep-set handpump tubwell programme for northern Terai belt of eastern and central regions to serve 1.52 million people	1991 - 1995
7. Implementation of on-going FINNIDA supported project for rural water supply and sanitation in western region	1991 - 1994
8. Implementation of on-going ADB supported rural water supply and sanitation project	1991 - 1995
9. Implementation of on-going UNICEF supported CWSS projects	1991 - 1995
10. Construction of new water supply facilities based on priority list of annual district sector development plan to meet the target set for the year 2000	1993 - 2000

(3) Operation and management of water supply facilities

The water supply facilities in Nepal are operated and managed by two organizations. The operation and management of large-city facilities is under the jurisdiction of the NWSC, and that of facilities in provincial local cities and villages is under the jurisdiction of the DWSS.

Water Supply in large cities are made in principle under a self-supporting accounting system with water rates collected by the NWSC. Since the facilities in large cities were extended without a plan to meet rapidly increasing water demand resulting in complicated distribution networks, the balance between the distribution system and demand distribution cannot be maintained. At the same time, water quality control is inadequate because the treatment facilities cannot deal with the worsening water quality. Thus, the facilities cannot achieve their original mission, and complaints from beneficiary residents are becoming intense. In addition since the installation of water meters in the houses is inadequate, and the system of collecting water rates from public water taps and public institutions is deficient, there is no fair and proper collection of water rates, so water projects are unprofitable and subsidies are needed from the Government.

According to a survey completed in 1990 (Management Information and Technical Support Project - MITS Project), all water supply systems in 14 large cities require some repair or improvement, and when the poor management system including technical staff, labor, and wages is considered too, the need for urgent improvement is clear.

In principle, the operation and management of water supply in provincial cities and villages after construction is to be transferred to the local authorities having jurisdiction. However, the maintenance and management of such facilities has been neglected due to a lack of technical staff and a shortage of funds in most such authorities, so many water supply systems are unable to function properly. The present situation is that the DWSS has taken over the duties in terms of both personnel and finance as a temporary measure. All the same, it is

difficult for the DWSS to fully cope with the situation using its own staff and budget because there are so many water supply systems throughout the country. As a result, the management system of many of the provincial water facilities is in trouble.

The MHPP, in conformity with the decentralization policy announced in 1982, has offered the following guidelines to the operators of local water supply facilities to help them with their sound management.

a) A water supply committee should be formed by beneficiary residents to operate and manage the facilities.
b) The Water Supply Committee should appoint a person to be in charge of operation and management and obtain consent to the payment of operation and management costs from beneficiary residents.
c) The beneficiary residents should provide labor and money for the construction and improvement of the facilities.

2.3 Related Development Plans and Programs

(1) National Development Plans

The Kingdom of Nepal drew up a series of seven national development plans over the years from 1956 with the aim of creating an economic infrastructure and improving people's living standards. The seventh 5-year plan, following the sixth 5-year plan (1985/86 - 1989/90), targets development in the following areas:

a) Acceleration of production expansion
b) Increasing productive employment opportunities
c) Repletion of minimum basic needs of the people

To achieve these targets, the seventh 5-year plan positioned the agricultural sector as the motive force behind national development and made agricultural development the most important point. Emphasis was also

placed on the development of a social infrastructure which forms the basis thereof. The following major policies deriving from the above were set out:

a) The agricultural sector is the most important development sector.
b) Forest resources must be protected and developed, and the soil preserved.
c) Energy must be concentrated on the development of water resources, industry, export, and tourism.
d) The rate of increase in population must be controlled.
e) The integration of the domestic economy should be improved and the infrastructure bolstered.
f) Decentralization of power should be advanced, aiming at activating the regions.
g) The social infrastructure must be expanded, including the areas of education, sanitation, and water supply.

The specific details of the Seventh 5-year Plan include a target rate of the GDP growth of 4.5% per annum, and to achieve this target it is considered necessary to achieve the growth of 3.5% in the agricultural sector and 5.7% in the non-agricultural sector. The amount to be disbursed for development is set at a total of 50.41 billion NRs on the basis of the prices in 1984/85, the breakdown of which is 27.0 billion NRs for the public sector, 2 billion NRs for the Panchayat sector, and 21.41 billion NRs for the private sector. The breakdown of the industrial sector is given below:

(Unit: Million NRs)

	Public Sector	Panchayat, Private Sector	Total
Agriculture, forestry, and irrigation	8,380 (31.0)	8,900 (38.0)	17,280 (34.3)
Mining, manufacturing, and electric power	7,040 (26.1)	3,800 (16.2)	10,840 (21.5)
Transportation and communications	5,130 (19.0)	2,130 (9.1)	7,260 (14.4)
Social services	6,450 (23.9)	8,580 (36.7)	15,030 (29,8)
Total	27,000 (100%)	23,410 (100%)	50,410 (100%)

The Government of Nepal made the development of waterworks a priority issue in the repletion of the basic needs of the people, and to implement this a development budget of 0.99 billion NRs was allotted for the period of the Seventh 5-Year Plan. This is equivalent to 4.1% of the total development budget.

(2) Regional Development Plans

In the Seventh 5-Year Plan, decentralization of power to local governments is highly valued, and along this line, a development plan should be drawn up for each region aiming at regional activation through the central and local government working together. The target of the regional development plans should, of course, include increasing employment opportunities by promoting the non-agricultural sector and developing the communication and transportation networks, but emphasis is also placed on disseminating and widening social services, such as education and job training, the improvement of the sanitation and water supply sector, and participation of the residents in social activities. For this purpose, for social service sector in addition to the budget allotted to development plans for this sector, a subsidy of 1 billion NRs has been allotted by Central Government. The regional development plans aim at developing the regions by combining the budget allotted to the

regional plans from Central Government and the subsidies as above-mentioned with the local funds of about equivalent amounts. The plan of disbursing the funds for regional development plans from the Central Government is as follows:

	Amount (million NRs)	Proportion (%)
Agriculture and forestry; and irrigation	1,608.3	25.3
Mining and manufacturing industry, and electric power	713.8	11.3
Transportation and communications	588.7	9.3
Social services	3,434.7	54.1
Total	6,345.5	100.0

2.4 Foreign Assistance

Assistance from other countries plays an improve in the development budget of the Kingdom of Nepal, and in the Seventh 5-Year Plan foreign assistance accounts for about 65% (2.5 billion NRs) of the development budget of 41.5 billion Nrs. Table 2.4.1 shows changes in the development budget and the amount of foreign assistance over the past 10 years, and Table 2.4.2 the major donating countries and organizations.

Foreign assistance in the water work development projects has also played a great role since 1980, the ratio of foreign assistance to the total budget being about 40% in both the Sixth 5-Year Plan and the Seventh 5-Year Plan. A breakdown of this amount is shown below.

(Unit: Thousand NRs)

	The Sixth 5-year Plan		The Seventh 5-year Plan	
	Annual Budget	Foreign Assistance	Annual Budget	Foreign Assistance
Provincial	661,012	139,658	1,665,158	540,276
Cities	389,023	295,534	570,122	340,789
Total	1,050,035 (100%)	435,192 (43.5%)	2,225,280 (100%)	811,065 (39.5%)

The countries and organization which contributed to water supply development are Japan, the U.K., the Netherlands, U.S.A., Germany, ADB, the World Bank (IDA), UNICEF, UNDP, WHO, and others. The total amount of assistance during the 10 year period from 1981 to 1991 was 1,417.61 million NRs. The breakdown of this is shown below.

(Unit: Thousand NRs)

Countries and organizations	Amount	Recipient
ADB	273,794	DWSS/MPLD
U.K.	124,068	DWSS
World Bank (IDA)	517,867	NWSC
Japan	50,000	DWSS
Netherlands	943	MPLD/IRD
UNICEF	292,209	DWSS/MPLD
UNDP	13,849	DWSS/NWSC
U.S.A.	8,694	MPLD
West Germany	40,090	DWSS/NWSC
WHO	87.096	MHPP/MLD/MOH
Total	1,417,610	

The major foreign assistance projects in progress at present include local water supply and sanitary facilities development project Phase 1 and Phase 2 (1986 to 1993) in the Central and Far West areas by ADB to the amount of 31 million dollars in loans, and the local cities development project by Japan, construction for which is now in progress.

Japan's assistance is for a project to improve and expand water supply facilities in eight local cities and a region, and construction work has begun dividing the project into four phases as part of a grant aid cooperation from the Japanese Government. The assistance which has already been given totaled 1,141 billion yen in 1989 and 1,241 billion yen in 1991.

Also, the IDA and UNDP have decided to provide a total loan of 66 million dollars for the Urban Water Supply and Sanitation Programme (UWSSRP) in the First 5-year Plan of 15YCDP, and the work is to be started in 1991.

Table 2.4.1 DEVELOPMENT EXPENDITURE AND FOREIGN AID IN NEPAL

(Unit: Million NRs)

Year	Development Expenditure	Grant	Loan
1981/82	3,726.90	999.30	694.20
1982/83	4,982.10	1,090.10	938.25
1983/84	5,163.80	876.60	1,615.40
1984/85	5,488.70	923.30	1,685.60
1985/86	6,213.10	1,172.90	2,340.60
1986/87	7,373.00	1,285.10	2,455.20
1987/88	9,428.00	2,076.80	3,518.30
1988/89	12,328.80	1,680.60	5,282.30
1989/90(1	12,411.50	1,783.00	5,471.20
1990/91(2	12,326.75	2,509.40	4,935.40

Note: (1 Provisional Net Figures
(2 Budgetary Figures

Table 2.4.2 MAJOR DONOR COUNTRIES AND ORGANIZATIONS IN NEPAL

(Unit: Million NRs)

	Grant	Loan	Total
Countries	778.67	299.67	1,078.34
1. Australia	10.88	-	10.88
2. Austria	0.60	-	0.60
3. Canada	23.09	-	23.09
4. China*	55.24	-	55.24
5. Denmark	50.00	-	50.00
6. Finland	42.48	-	42.48
7. France	0.09	0.16	0.25
8. Federal Republic of Germany	57.80	-	57.80
9. India*	105.11	-	105.11
10. Japan	152.50	230.27	382.77
11. Kuwait		31.79	31.79
12. Netherlands	2.25	-	2.25
13. Norway	4.11	-	37.45
14. Saudi Arabia*		37.45	37.62
15. Switzerland	42.62	-	42.62
16. U.K.	116.83	-	116.83
17. U.S.A.	115.07	-	115.07
Organizations	173.86	2,062.23	2,236.09
1. ADB	-	681.46	681.46
2. EEC	21.79	-	21.79
3. FAO	4.90	-	4.90
4. IDA	-	1,145.25	1,145.25
5. IFAD	-	142.34	142.34
6. ILO	16.74	-	16.74
7. IMF	5.91	-	5.91
8. OPEC	-	93.18	93.18
9. UMN	7.10	-	7.10
10. UNCDF	16.18	-	16.18
11. UNDP	7.71	-	7.71
12. UNFPA	23.06	-	23.06
13. UNICEF	57.46	-	57.46
14. WFP	7.61	-	7.61
15. Others	5.40	-	5.40
Total	952.53	2,361.90	3,314.43

Source: Ministry of Finance
* indicates the country that does not participates in the supporting countries group.

2.5 Outline of the Request

(1) Background of the Request

The water supply in Greater Kathmandu which includes the whole of the Capital and the adjoining city of Lalitpur, has a history of nearly a hundred years since water supply began in 1896. Until about 1930, a springs were exploited and distribution facilities to supply the water from the springs were built. In the 1960's, the Balaju and Maharajganj treatment plants were constructed to remove the turbidity of the spring water which was a problem during the monsoon season. Previously water had been supplied without any treatment. To meet the increasing demand, the Sundarijal treatment plant was constructed as a new system in which the tailrace from the Sundarijal power station was used as the source of water.

As the 1970's began, the concentration of the population towards the cities increased water demand so rapidly that water shortages began to be critical. The Nepalese Government, in 1973, worked out the Greater Kathmandu water supply and sewerage master plan with the cooperation of the UNDP. The plan consisted of two essential elements: (1) Until 1996, the water demand should be met by developing the water sources such as springs and groundwater within the Kathmandu Valley and by improvement and expansion of water supply facilities such as distribution reservoirs and pipelines. (2) After 1997, the water supply facilities should be expanded and improved by exploiting water resources outside the valley.

Based on this master plan, three projects were carried out with funds coming from the World Bank. Through these projects, the Pharping springs in the southern part of the valley, tube wells in the northern aquifer district, and reservoirs at Shaibhu, Bansbari, Mahankal Chaur and others, were developed or constructed, and water distribution piping was extended and improved. All this was completed in 1987 and has contributed to achieving (1) above. As for (2), meanwhile, the UNDP conducted a study in 1989 to locate the most suitable water source outside the valley, and selected the Melamchi river which flows north to the valley. A

feasibility study is now in progress under the World Bank, with the aim of starting water supply in 2001. However, the project involves some as yet unsolved problems, such as the construction of a 27 km water conveyance tunnel, securing a back-up reservoir, and the scale of various facilities. Thus making it impossible to have the prospect of realizing water-utilization from outside the valley at least until 2001. In addition to this problem, (1) which should meet water demand until 1996 after its completion in 1987 faces the following serious problems in quantity and quality in supplying water to the Greater Kathmandu:

1) Groundwater produced by the tube wells, which were constructed in the third project, contains iron, manganese, and ammonia nitrogen at such high concentration that it cannot be used as a source of water supply without treatment. Since this groundwater is actually supplied without any treatment, quality of supplied water is poor, with further deterioration due to the proliferation and extinction of various bacteria inside the distribution piping.

2) The existing treatment plants constructed in the 1960's have become deteriorated and suffering from reduced treatment capacity. Accordingly the amount of water supplied from these plants is greatly restricted and the quality of treated water is also insufficient.

3) The groundwater in the Kathmandu valley is limited since it is artisan water contained in lacustrine deposits with little recharge. The shortage of water is made worse by the defective well design, construction supervision, and the declining of groundwater level which further limits the quantity of pumped groundwater. The supply is far less than the design capacity.

4) The rapid increase in population and the activation of urban functions have brought about a great rise in water demand and made the shortage more acute.

5) In the water distribution area, the water pressure is not uniformed due to deterioration and the inconsistent expansion of pipes. Excessively high water pressure causes frequent leakage in areas near the reservoirs, while at the far end of pipes the pressure is so low that the supply fails at times.

Under these circumstances, the Government of Nepal has requested the Government of Japan to provide technical assistance to assess the potential of water resources within the valley and to make the water supply development plan by means of water-utilization thereof with the target year set at 2001.

In response to the request, JICA conducted a master plan study on Groundwater Management Project in the Kathmandu Valley (called the JICA Master Plan Study), from 1989 to 1990. As a result, the following recommendations were made: (1) The groundwater abstraction should be limited to an appropriate quantity. The future increasing water demand by the year 2001 should be met by conjunctive using the groundwater and exploitable surface water in the valley; (2) Groundwater should be treated to eliminate colored water caused by its iron and manganese, and ammonia nitrogen be removed to maintain residual chlorine in the pipes with a certain disinfection effect. The study also proposed therein a water supply development plan (called the JICA Water Supply Development Plan) consisting of eight projects to be implemented in the three following stages:

1) Stage 1

The plan is to improve the quality of existing groundwater source and to exploit surface water sources for use together with groundwater. The following are the most urgent projects in terms of both water quality and quantity.

- Mahankal Chaur project
- Bansbari project

2) Stage 2

This is to improve the existing water treatment plants and to carry out related water supply development plan.

- Balaju project
- Lambagar project
- Sundarijal project
- Shaibhu project.

3) Stage 3

This is to construct a new water supply system using newly developed surface water sources

- Manohara project
- Balkhu project

Based on the result of the JICA Master Plan Study, the Nepalese Government in August 1990, requested the Japanese Government for Grant Aid to help it with a total of five projects which were two projects in Stage 1 for raising groundwater quality and three projects in Stage 2 for improving water quality by improving the existing water treatment plants.

(2) Objective of the Request

The objective of the request is to solve some of the various problems facing Greater Kathmandu's water supply, particularly those requiring urgent improvement as pointed out in the JICA Master Plan Study. The tasks involved are to improve groundwater quality, renovate the existing treatment plants which have been so deteriorated that they do not fulfill their function, and to expand the water supply capability to meet the rapidly increasing water demand by using surface water source exploitable within the valley. It is also expected that the improvement of the water supply situation in Greater Kathmandu will promote public hygiene and upgrade living standards of inhabitant.

(3) Details of the Request

The five projects for which help has been requested by the Government of Nepal are the following:

1) Mahankal Chaur project

a) Construction of a new intake in the Dhobi Khola with capacity of 14,300 m^3/d.

b) Construction of a raw water conveyance system between from the Dhobi Khola intake and the new water treatment plant.

c) Construction of a new intake with a capacity of 14,300 m^3/d in the penstock of the Sundarijal power station.

d) Construction of a raw water conveyance system between the Sundarijal intake to the new water treatment plant.

e) Construction of a pre-treatment facility for groundwater with a treatment capacity of 18,600 m^3/d.

f) Construction of a new water treatment plant with a treatment capacity of 35,700 m^3/d at the existing Mahankal Chaur reservoir.

g) Installation of a booster pump for transmission of treated water.

h) Provision of equipment and instruments for monitoring water quality.

2) Bansbari project

a) Construction of a new intake in the Bisnumati Khola with a intake capacity of 14,300 m^3/d.

b) Construction of a raw water conveyance system between the existing intakes in Bisnumati and Shivapuri and the new water treatment plant.

c) Construction of a pre-treatment facility for groundwater with a treatment capacity of 17,700 m^3/d.

d) Construction of a new water treatment plant with a treatment capacity of 20,700 m^3/d at the existing Bansbari reservoir.

e) Installation of a booster pump for transmission of treated water.

f) Reconstruction of the existing Maharajganj reservoir.

3) Shaibhu project

a) Installation of disinfection equipment with a capacity of 24,500 m^3/d.

b) Construction of a distribution main with a diameter of 500 mm and a length of 3,500 m.

c) Addition of a new reservoir with a capacity of 4,500 m^3.

d) Provision of equipment and instruments for monitoring water quality.

4) Balaju project

a) Construction of a new water treatment plant with a treatment capacity of 9,300 m 3/d.

b) Rehabilitation of the existing reservoir

5) Sundarijal project

a) Replacement of the existing intake pumps

b) Construction of a new water treatment plant with a treatment capacity of 20,600 m^3/d.

c) Construction of three new reservoirs, two having a storage capacity of 1,850 m^3 and the another with 1,550 m^3.

CHAPTER 3 OUTLINE OF THE PROJECT AREA

CHAPTER 3 OUTLINE OF THE PROJECT AREA

3.1 Characteristics of the Project Area

(1) Location

The survey area of the Project is Greater Kathmandu including Kathmandu city, the capital of Nepal and adjoining Lalitpur city to the south. Greater Kathmandu, situated in the Kathmandu valley, belongs to Bagmati Zone in the hilly area of the central region. The valley is divided into three administrative districts: Kathmandu, Lalitpur and Bhaktapur. Each district has towns and villages which amount to 130 units in the valley as a whole.

(2) Topography

The Kathmandu valley located at the southern edge of the Mahabharat mountain range, is about circular in shape measuring 30 km respectively in the east to west and south to north directions, and is about 656 km^2 in area. The central floor of the valley, 1,300 m to 1,400 m above sea level, is surrounded by mountain range of 2,000 m or more in elevation. The highest place in the surrounding mountain range is Phulcoki which rises 2,762 m at the southern watershed of the valley. The floor of the valley is about 400 km^2 in area, and Greater Kathmandu, the surveyed area, is in the western central part of the valley.

The only river running through Kathmandu valley is the Bagmati river descending from the mountainous area at the north of the valley, and all the tributaries within the valley join around Greater Kathmandu, then flow through Cobhar in the southern part of the valley and finally out of the valley.

(3) Geology

The Kathmandu valley is composed of two series of geological successions. One succession, deposited in the Quaternary, overlies the basement rocks in the central part of the valley. Another, surrounding the valley, is bedrock of the Precambrian to the Devonian (Paleozoic Era). Many mountain ridges stretch down to the bottom of the valley from its environs, forming buried ridges. It has been confirmed that the depth from ground surface to the Precambrian bedrocks ranges from tens of meters to over five hundred meters. The thick deposits of the Quaternary in the central part of the valley consist of lacustrine and fluvial deposits. The lacustrine deposits are classified into three types: arenaceous sediments, argillaceous sediments and intermediate types between these two.

(4) Climate and hydrology

1) Climate

The climate of the Kathmandu valley is warm, classified into the subtropics, and is clearly divided into the wet and dry seasons. From June to September there comes the monsoon with winds from the Bay of Bengal, and it is during this season that most of the rainfall concentrates. From March to May, it is spring which brings about strong winds and occasional squalls. In the pre-monsoon period, thunderstorms occur with hail. From December to February, it is winter, when northwesterly trade winds brings about rainfall, though small in a total amount, in the mountainous areas surrounding the valley.

2) Precipitation

As the rainfall characteristics in the Kathmandu valley, the annual precipitation on the floor of the valley is around 1,300 mm, while that in the contiguous mountainous areas is around 3,000 mm; these figures are nearly equivalent to the elevation. In the wet season during the four months from June to September, approximately 80% of the annual rainfall is concentrated, with the largest amount of rainfall occurring in July and August.

In the JICA Master Plan Study, an isohyetal map (Refer to Fig. 3.1.1) was prepared based on the data obtained by rainfall observation stations at nine places in the valley. The isohyetal map indicates that the average annual rainfall of the whole valley is 1,912 mm. The average monthly rainfall of the Kathmandu valley is shown in the following table:

(unit: mm)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
19	21	32	71	125	309	509	491	252	68	7	8	1,912

3) Air temperature

The air temperature of the Kathmandu valley is considerably affected by trade winds blowing from southeast in the wet season and from northwest in the dry season. According to data from the Kathmandu Airport observation station located in the floor of the valley, the annual mean temperature is 18°C. During the warm season from March to November, the mean temperature is 23°C, with a maximum of around 30°C in June. In winter from December to February, the mean temperature is 11°C and in December and January, the coldest months, the minimum temperature can fall below 0°C, though it is rare. The monthly mean temperature (1968 to 1986) at the Kathmandu Airport is as follows:

(unit: °C)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
9.4	11.4	15.6	19.2	21.5	23.4	23.7	23.7	22.3	19.1	14.7	10.8	17.9

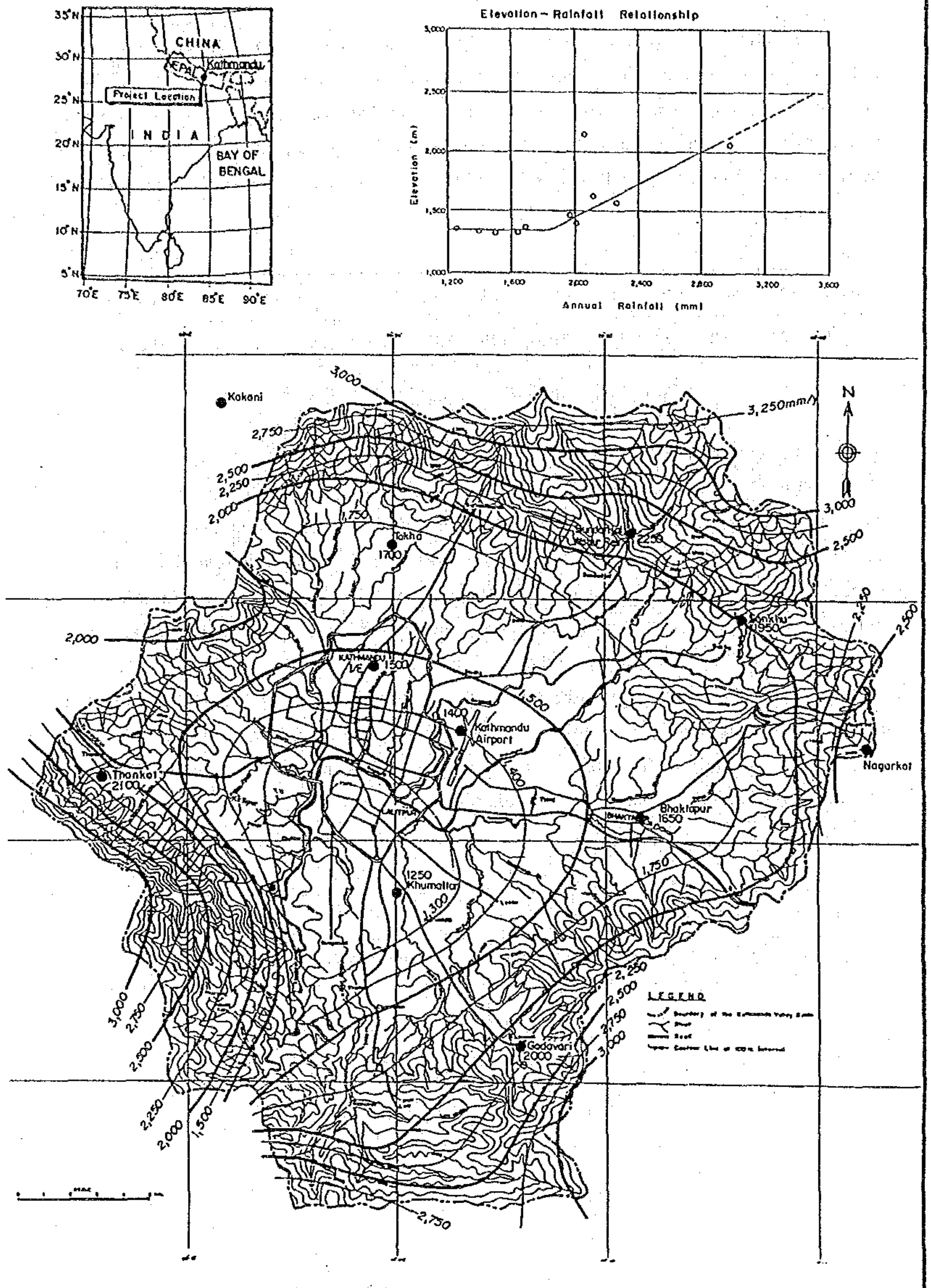


Fig. 3.1.1 ANNUAL ISOHYET OF KATHMANDU VALLEY

4) Relative humidity

The relative mean humidity observed at the Kathmandu Airport is 63% in the dry season, 84% in the wet season and an annual mean humidity of 77%. With the minimum humidity being recorded in April and the maximum between July and December, the humidity rises and falls throughout the year in proportion to the variations of rainfall. The monthly mean humidity (1976 to 1986) at the Kathmandu Airport is set forth in the following table:

(unit: %)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
81	75	63	63	67	74	83	82	83	82	84	84	77

5) Evaporation

The amount of evaporation usually varies according to daily air temperature, humidity and rainfall. The evaporation in the Kathmandu valley rises in the high temperature period from March to October, and falls in the lower temperature period from November to February. Shown below is the monthly pan-evaporation observed at the Kathmandu Airport.

(unit: mm/d)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
2.4	3.0	4.1	5.0	5.0	4.7	4.5	4.6	3.7	3.3	2.6	1.9	3.7

6) Runoff of rivers

Only the Bagmati river runs out of the Kathmandu valley. Its basin being formed of it and its tributaries. The Bagmati river has its origin in Sivapuri Lekh at the northern end the valley. The main tributaries are Nakhu Khola, Balkhu Khola, Bisnumati Khola, Dhobi Khola, Manohara river, Khodu Khola, Hanumante river, and Godawari Khola. The profiles and schematic diagram of these rivers are illustrated in Fig. 3.1.2.

Name	Drainage Area (km^2)
Bisnumati Khola	103.4
Dhobi Khola	28.9
Bagmati river	74.2
Manohara river	73.1
Hanumante river	91.2
Godawari Khola	45.1
Khodu Khola	34.6
Nakhu Khola	57.2
Balkhu Khola	43.0

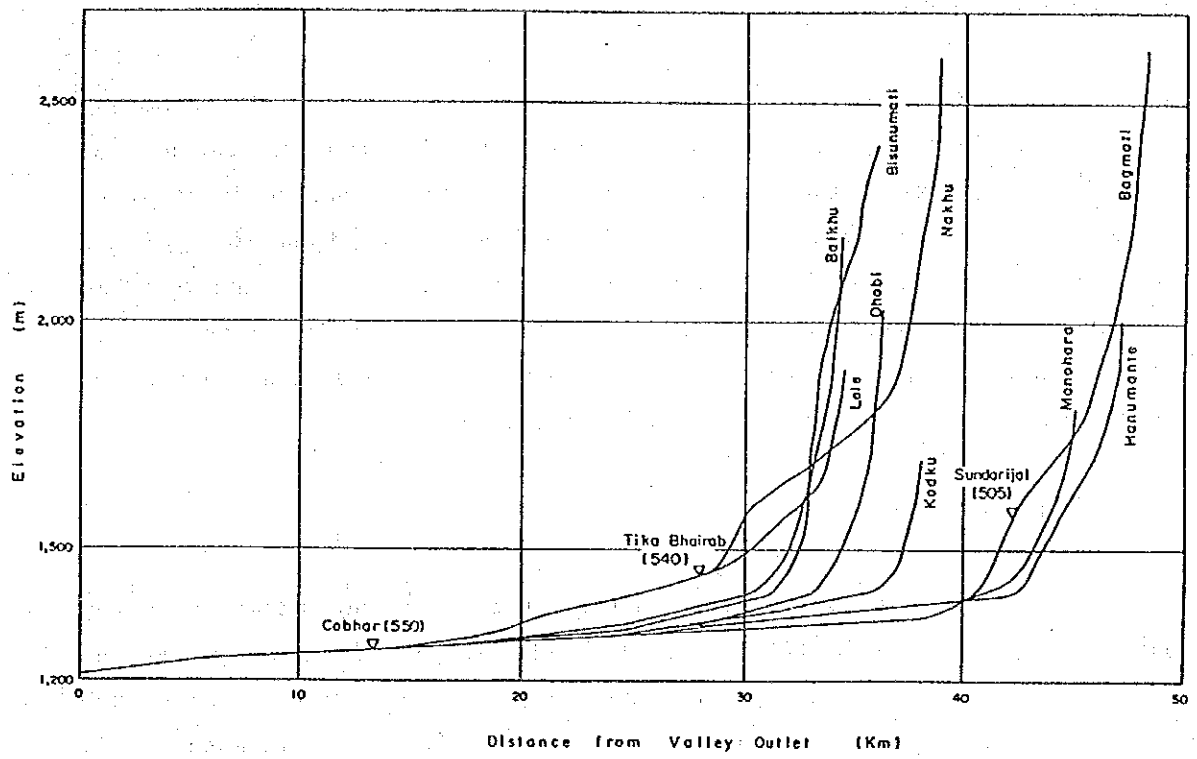
On the basis of data obtained at Sundarijal gauging station located in the upper reaches of the Bagmati river (drainage area: 16 km^2), as a part of the JICA Master Plan Study, the daily runoff data flow from 1941 to 1986 was verified using the tank model method and processed into daily discharge in 5-day units. The monthly mean runoff and specific discharge at the station are shown as follows:

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
Runoff (m^3/s)												
0.23	0.20	0.19	0.21	0.31	0.90	2.30	3.09	2.17	0.95	0.44	0.29	0.94
Specific discharge ($m^3/s/100\ km^2$)												
2.48	1.89	1.44	1.73	2.49	15.5	47.3	53.9	35.4	16.7	7.00	3.88	15.8

At Cobhar gauging station (drainage area: 585 km^2), located at almost outlet of the valley, the annual mean runoff is approximately 500 MCM, the runoff coefficient being 45%. The monthly mean runoff at the station is as follows:

(Unit: m^3/s)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
2.48	1.89	1.44	1.73	2.49	15.5	47.3	53.9	35.4	16.7	7.00	3.88	15.8



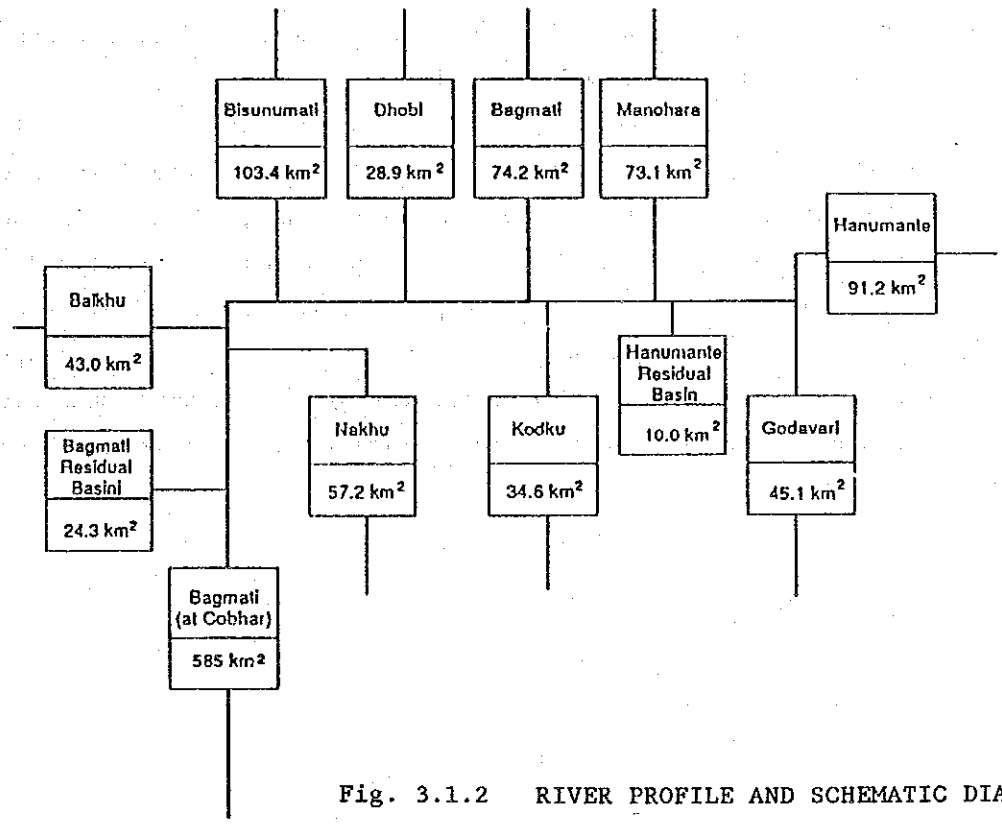


Fig. 3.1.2 RIVER PROFILE AND SCHEMATIC DIAGRAM

3.2 Socio-economic Situations

Since the capital was established in the 11th century, the Kathmandu valley has developed as the collecting and distribution center for commodities traded between Tibet and India. Principal administrative agencies and offices are located there, and most functions of Nepal are concentrated in this social and economic center. Also attracting artistic and cultural activities, this place plays a pivotal role in the future development of the country. The Kathmandu valley has such social and socio-economical situations as mentioned below:

(1) Population

According to a 1981 census, the population of the Kathmandu valley amounted to 766,345 in total, divided into 363,507 in urban areas and 402,838 in rural areas. During the 10 years from 1971 to 1981, the average annual growth rate in population was 3.76% in urban area, 0.87% in the rural area and 2.14% overall in the valley. The last figure is lower than the average rate for the country as a whole of 2.62%. This lower growth rate is considered to be attributable to out-migration from the valley and the effects of family planning.

On the other hand, the 1981 population of the three administrative districts of Kathmandu, Lalitpur, and Bhaktapur was 422,237, 184,341 and 48,472 respectively. The distribution rate of population to the urban and rural areas was 55:54, 43:57, and 30:70 respectively. The gravitation of population toward the urban area has intensified in recent years as shown in Table 3.2.1. In Kathmandu city particularly, the growth rate in population is high, with the average annual rate during the period from 1971 to 1987 reaching 4.47%.

Table 3.2.1 POPULATION AND POPULATION GROWTH RATE IN KATHMANDU VALLEY

Location	Population				Average Annual Growth Rate (%) *1		
	1952/1954	1961	1971	1981	1952/54-1961	1961-1971	1971-1981
Kathmandu Valley	410,995	459,990	618,911	766,345	1.41	2.97	2.14
Urban	178,699	202,609	249,563	363,507	1.57	2.08	3.76
Rural	232,296	257,381	369,348	402,838	1.28	3.61	0.87
Kathmandu District	193,782	224,867	353,756	422,237	1.86	4.53	1.77
Urban	105,247	121,019	150,402	235,160	1.75	2.17	4.47
Rural	88,535	103,848	203,354	187,077	1.99	6.72	-0.83
Lalitpur District	133,753	145,301	154,998	184,341	1.03	0.65	1.73
Urban	41,334	47,713	59,049	79,875	1.79	2.13	3.02
Rural	92,419	97,588	95,949	104,466	0.68	-0.17	0.85
Bhaktapur District	83,460	89,822	110,157	159,767	0.92	2.04	3.72
Urban	32,118	33,877	40,112	48,472	0.67	1.69	2.10
Rural	51,342	55,945	70,045	111,295	1.07	2.25	4.63

Note) Population Monograph of Nepal, Central Bureau of Statistics,1987
Urban area is defined as a community with population 5,000 or more.
*1: Exponential model

(2) Industry

1) Agriculture

The principal agricultural products of the Kathmandu valley are paddy, wheat, maize and potatoes, whose production in 1987/88 was 88,090 tons, 34,750 tons, and 16,700 tons respectively. However, any of this production in the valley accounts for 5% or less of national production. In addition, millet, barley, and oil-seed are produced, although their production amounts to 1% or less of national production. Accordingly most of the crops produced in the valley are consumed there.

Cultivated acreage in the valley, which was 40,990 ha in 1982/83, rapidly decreased to 37,650 ha in 1987/88, a decrease rate of about 8% annually. While the cultivated acreage of the country as a whole has tended to increase, the aforementioned decrease indicates that in the Kathmandu valley, the advance of urbanization has accelerated the turning of farm land into housing lots.

2) Mining and manufacturing industries

The Kathmandu valley's industrial sector has developed basically centered on agricultural product-related industries, such as jute processing, sugar and tobacco manufacturing, leather processing, and wheat milling. In addition, there are import-replacing industries including cotton fabrics, cement manufacturing, and drink bottling operations.

In the Kathmandu valley, the number of establishments of manufacturing industries with 10 or more employees was nearly 1,500 in 1986/87, with the total number of the employees amounting to 53,000. This indicates that the proportion is around 16% and 35% respectively of the establishments and employees in the country. In the Kathmandu district, there are 820 establishments (55% of the above number) with more than 30,000 employees (58%). In the Lalitpur district, meanwhile, the manufacturing industries have grown remarkably, and in 1986/87 the numbers of establishments and employees became 2.9 times and 4.5 times respectively as many as those of 1981/82. The 1986/87 total production of industrial products in the valley was 2.81 billion NRs, which is

equivalent to 21% of the country's gross out of the manufacturing industry.

3) Tourism

The Kathmandu valley is blessed with natural environment, historical and religious remains and other tourist attractions. Tribhuvan Airport, the only international airport in Nepal, is also located here and is used by 80% of visitors to the country. The valley thus plays an essential role as the hub of tourism.

The 1987 figures of hotel rooms and beds in the country were 23,194 and 45,395 respectively, 80% of them being in the valley. In the same year, about 225,000 people, 90% of the total foreign visitors, using hotels in the Kathmandu valley, staying 2.87 days on an average. Proportion of bed occupancy in 1987 was 46% in the valley.

(3) Social infrastructure

1) Electric power

In the Kathmandu valley, electricity supply is relatively stable, although trouble in substations, sometimes causes interruptions in local services and variations in voltage. Principal power stations supplying the valley are Derighat hydraulic power station (14 MW) located on the Trisuli river to the northeast of the valley, Sunkosi hydraulic power station on the Sunkosi river to the east of the valley, the 1st and 2nd Kule Khani power stations (60 MW and 14 MW) on the tributary of the Bagmati river running to the south of the valley, and Marsyangdi power station which started operation in 1989. There is also Sundarijal power station, though small in scale (0.64 MW), in the upper reaches of the Bagmati river.

2) Transportation

Most of the main roads in the valley are paved, allowing smooth passage in the wet season. However, they are not well maintained. Although a ring road of about 30 km in circumference, encircling Greater Kathmandu, was constructed under assistance from China to cope with the

recent increase in the amount of traffic, it suffers from chronic congestion in the morning and evening rush hours. As the principal means of traffic, buses and taxi are used. Trolley buses run in a part of the Kathmandu urban area and between Kathmandu city and Bhaktapur city. There is also regular services with long-distance buses connecting the valley with principal domestic cities.

It is about 133 km from the Kathmandu valley to Hetauda, a town on the east-west main road in Terai region. From Hetauda it is around 53 km to Birganj, and 324 km eastward to Biratnagar, along the east-west main road. These towns, located on the border with India, are the base points for transportation of traded materials. About three quarters of imported materials unloaded at Calcutta port are transported to Birganj. About three quarters of materials exported to countries other than India pass Biratnagar for transportation to Calcutta port.

Tribhuvan Airport, situated in the Kathmandu valley is used for international and domestic transportation. The airport is the only international airport in Nepal, from which there are regular international flights to Delhi, Bangkok, Dhaka, Colombo, and Karachi, and also it is the focal point of domestic air service with regular flights to principal cities.

3) Communication

The communication network of the country as a whole has not been well developed yet, although it is essential to the country's development. As far as the Kathmandu valley is concerned, however, telephone networks have been considerably upgraded and now offer long-distance service to principal domestic cities. International communication is available by using telex, facsimile and telephone lines by the satellite.

4) Health and hygiene

The statistical data on water-borne diseases in the Kathmandu valley is shown in Table 3.2.2. It indicates that the annual number of occurrences of the diseases ranged from about 4,000 to 7,000 in the period from 1980 to 1987. The principal diseases are gastroenteritis, enteric

fever, hepatitis, dysentery, meningitis, etc., attacking people mainly in the wet season from June to September. About 6,600 cases, 64% of the total number of water-borne diseases was gastroenteritis, although it is strongly possible that many of these cases are to Cholera since many of the afflicted people show indicated the symptoms similar to disease. The incidence rate of water-borne diseases in the valley is 760 cases per 100,000 population, a rate which is remarkably high even among developing countries.

Table 3.2.2 CASES OF WATER BORNE DISEASES IN KATHMANDU VALLEY

	1980		1981		1982		1983		1984		1985		1986		1987	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Gastro-Enteritis	2,954	69.5	3,011	69.2	2,646	57.3	3,497	50.6	3,371	48.4	2,430	38.1	2,260	37.4	4,274	64.3
Cholera	24	0.6	116	2.7	-	-	115	1.7	4	0.1	-	-	-	-	10	0.1
Enteric Fever	76	1.8	98	2.3	152	3.3	343	5.0	410	6.9	489	7.7	476	7.9	322	4.8
Diphtheria	2	0.0	9	0.2	10	0.2	-	-	-	-	-	-	-	-	-	-
Measles	261	6.2	225	5.2	157	3.4	322	4.7	196	2.8	74	1.2	249	4.1	45	0.7
Hepatitis	81	1.9	283	6.5	645	13.9	343	5.0	478	6.9	701	11.0	486	8.1	511	7.7
Dysentery	261	6.2	199	4.6	275	5.9	321	4.7	491	7.0	474	7.5	368	6.1	246	3.7
Tetanus	40	0.9	38	0.9	39	0.8	61	0.9	51	0.7	38	0.6	37	0.6	20	0.3
Meningitis	14	0.3	8	0.2	68	1.5	493	7.2	236	3.4	139	2.2	273	4.5	103	1.6
Others	534	12.6	358	8.2	633	13.7	1,392	20.1	1,729	24.8	2,014	31.7	1,886	31.3	1,113	16.8
Total	4,243	100	4,345	100	4,625	100	6,892	100	6,966	100	6,359	100	6,035	100	6,644	100

Source: Statistical Year Book of Nepal 1989, Central Bureau of Statistics

3.3 Hydrogeology

(1) Groundwater recharge and discharge

The availability of groundwater recharge in the Kathmandu valley is restricted by the widespread distribution of lacustrine deposits interbedding with impermeable black clay which prevents easy access to the aquifers. The upper part of the deposits in the northern area of the valley is formed of unconsolidated highly permeable micaceous quartz sand and gravel. The thickness of unconsolidated coarse-grained sediments is 60 m, and this stratum forms the principal water aquifers of the valley. The quality of this groundwater is characterized by electrical conductivity as low as 100 to 200 micro-simens/cm, and the transmissivities of the aquifers range from 83 to 1,963 $m^3/d/m$.

The upper part of the deposits in the central part of the valley consists of very thick (as much as 200 m) impermeable stiff black clay accompanied by some lignite. Unconsolidated coarse-grained sediments of medium or low permeability underlie this thick black clay. The groundwater has electrical conductivity as high as 1,000 micro-simens in some wells located near Tripureswar. The transmissivities of these aquifers range from 32 to 960 $m^3/d/m$. The water head in this area is generally high, all the gas wells in particular being self-flowing. According to the dating analysis made in the JICA Master Plan Study, water in the gas wells is estimated to be about 28,000 years old. This ensures that groundwater in the central part of the valley is stagnant with little recharge.

The southern part of the valley is characterized by a thick impermeable clay formation and low-permeable basal gravel. The aquifers have hardly developed and are only recognized along the Bagmati river between Cobhar and Pharphing. The aquifer in the Kathmandu valley, being isolated from other groundwater, contain artisan water pressured by lacustrine deposits. The movement of groundwater in the aquifer is immaterial, and the groundwater can almost be regarded as fossil water according to the dating measurement using tritium and carbon isotope. The

coefficients of the pressure layer is estimated to be 0.0003 m/d (12 cm/year).

(2) Groundwater district

The aquifers in the Kathmandu valley is divided into three parts: the northern, central and southern groundwater districts. The boundaries of these districts and the distribution of wells are illustrated in Fig. 3.3.1. The condition of the aquifers in the districts are as follows:

1) Northern groundwater district

The northern groundwater district, which includes the Bansbari, Dhobi Khola, Manohara and Gokarna and Bhaktapur well fields, is the principal water source supplying Greater Kathmandu.

In the northern part of Bansbari well field, with Dhobi Khola, Manohara and Gokarna well fields, the upper lying deposits are of unconsolidated, highly permeable quartz sand and gravel as much as 60 m thick, and yielded large quantities of water during the pumping tests that were conducted upon the completion of wells. However, these coarse sediments interbed with several impermeable clay sediments in an unfavorable recharge condition, causing the tendency of excessive pump discharge.

2) Central groundwater district

This district is located in the area around Greater Kathmandu in the central part of the valley and surrounding areas. The aquifers is covered with 200 m thick impermeable clay and the groundwater of these aquifers, having little recharge possibility, is stagnant artisan water.

3) Southern aquifer district

This district is situated between the mountainous area in the southern part of the valley and the geological structure line from Kirtipur to Godawari. It is composed of thick impermeable clay layers and low-permeable basal conglomerate. The aquifer is hardly developed and only recognized along the Bagmati river between Cobhar and Pharphing,

where the Pharping well field is and from which water is supplied to Lalitpur city by NWSC.

(3) Current use of groundwater

In the Kathmandu valley there are 38 NWSC wells for water supply, 4 NWSC wells for observation, 37 private wells and 8 gas wells, in total 87 deep wells.

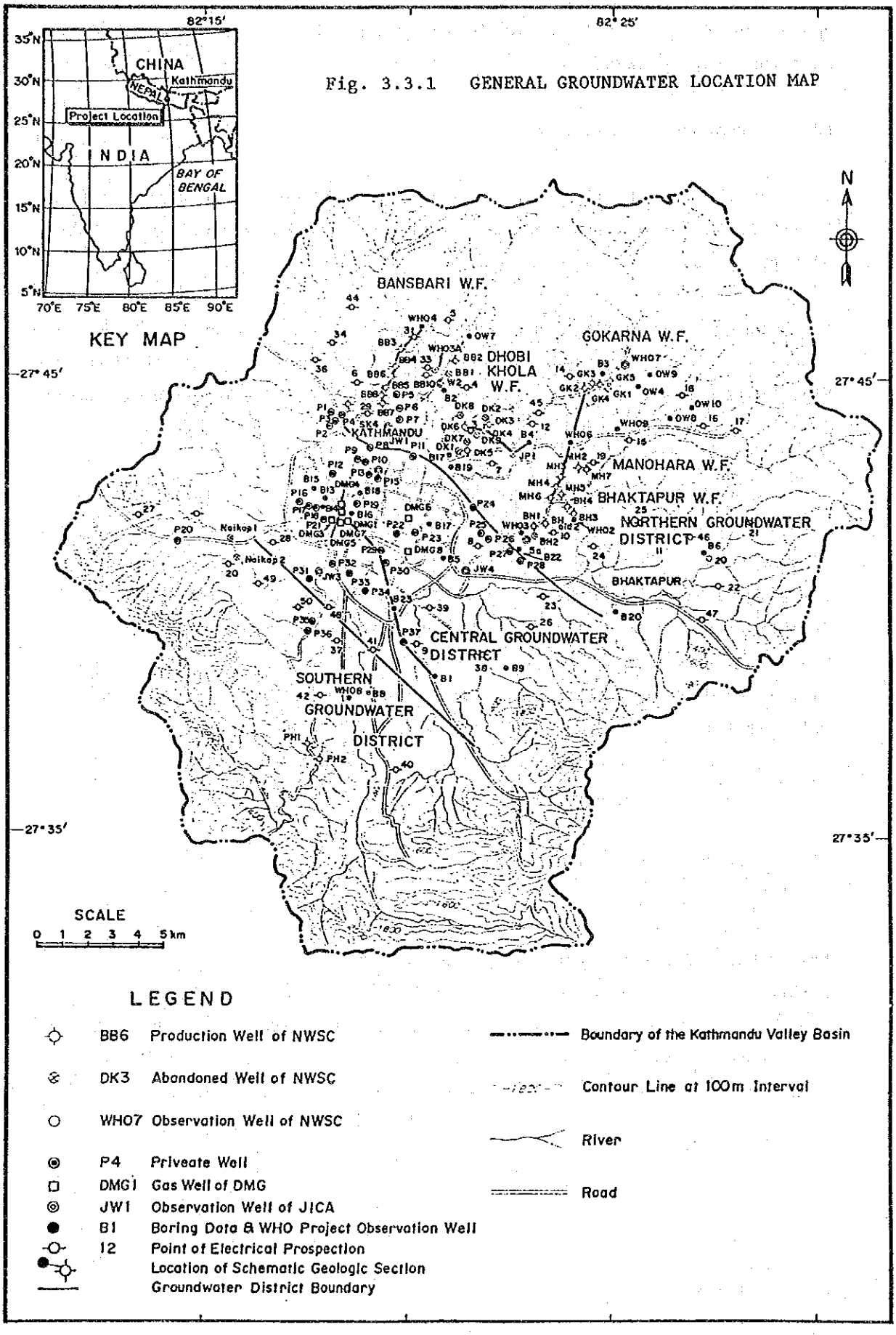
Among these wells, about 60 were operating at the end of 1989, the annual pump discharge being estimated at approximately 14 million m^3. Fig. 3.3.2 shows the 1972 to 1989 variation in groundwater pump discharge in the Kathmandu valley.

Groundwater pump discharge increased greatly after most NWSC wells were well prepared for operation in 1988. Among the 60 wells operating, 28 are possessed by NWSC, providing more than 80% of the total pump discharge in the Kathmandu valley. The pump discharge of NWSC's wells is estimated to have reached 0.66 to 1.24 million m^3/month in 1989. Meanwhile, the Bansbari well field yields 40% or more of the total pump discharge of well fields. The pump discharge of private wells and gas wells is far smaller than that of NWSC's wells. While NWSC's wells have increased production, the pump discharge of private and gas wells has mostly remained constant these past several years.

(4) Trend of groundwater levels

Since the construction of deep wells, executed in the third project by the World Bank, the decline in the static groundwater level has become marked. In the Manohara well field, the water levels have dropped progressively about 10 m during these past four years. As pump discharge has increased year by year, the decline of the groundwater levels has become serious enough to halt the operation of some of the wells.

Fig. 3.3.1 GENERAL GROUNDWATER LOCATION MAP



LEGEND

BB6	Production Well of NWSC	Boundary of the Kathmandu Valley Basin
DK3	Abandoned Well of NWSC	Contour Line at 100m Interval
WHO7	Observation Well of NWSC	River
P4	Priveate Well	
DMG1	Gas Well of DMG	Road
JW1	Observation Well of JICA	
B1	Boring Data & WHO Project Observation Well	
12	Point of Electrical Prospection	
	Location of Schematic Geologic Section	
	Groundwater District Boundary	

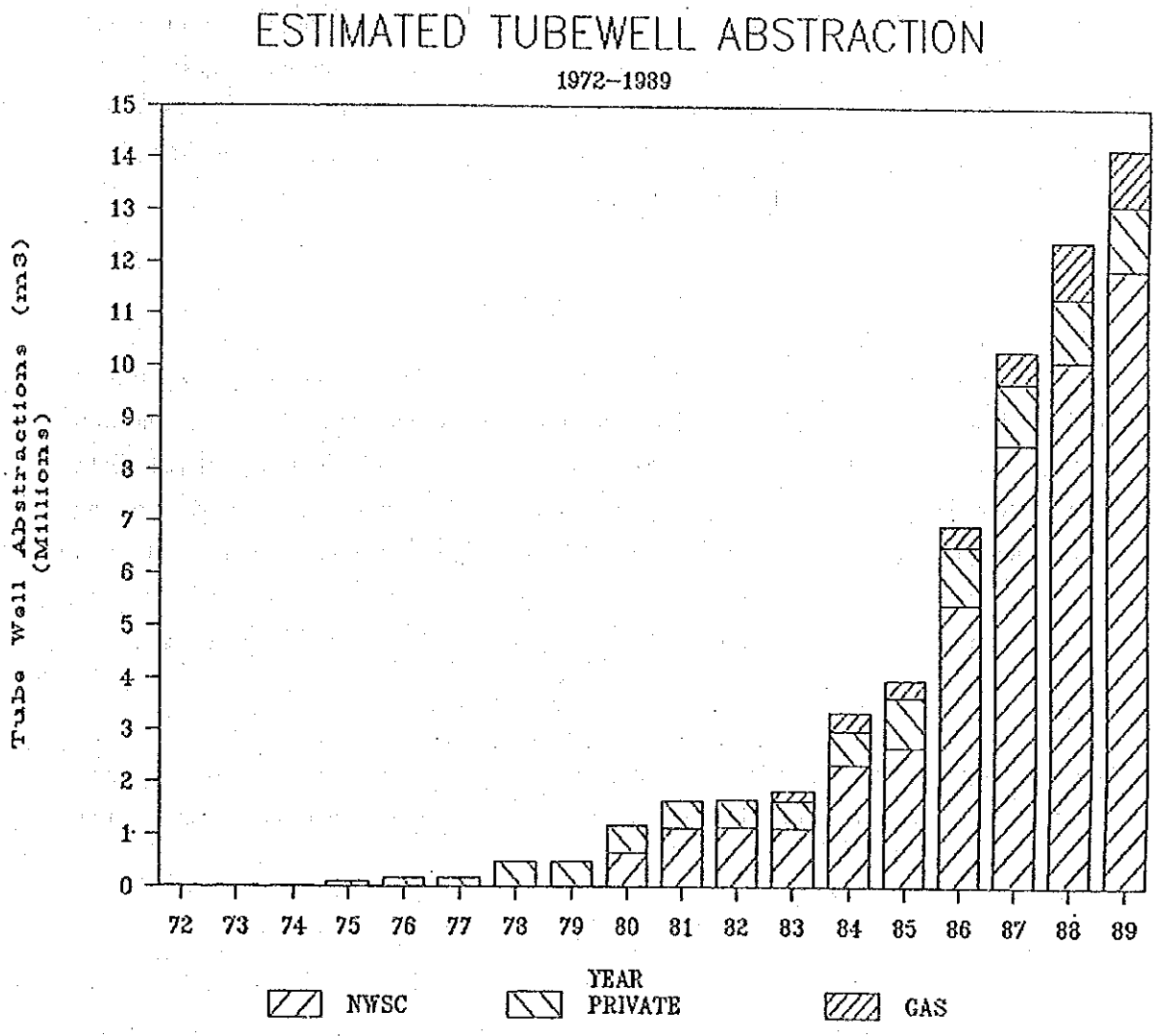


Fig. 3.3.2 GROUNDWATER ABSTRACTIONS FROM TUBE WELLS IN KATHMANDU VALLEY

3.4 Present Water Supply

3.4.1 Water supply systems

At present there are five water supply systems in Greater Kathmandu under the management of NWSC, Balaju, Bansbari, Maharajganj, Mahankal Chaur, and Shaibhu. The areas surrounding Greater Kathmandu and rural villages are supplied with water from the four water supply systems in Sundarighat, Chapagaon, Dood Pokari and Lokhat. An outline of the water supply systems is described in the following. Service areas of these systems are illustrated in Fig. 3.4.1.

(1) Balaju system

The system has various water sources including five springs in the basin of Bisnumati Khola running in the northwestern part of the Kathmandu valley, the river of Lambagar Khola and some wells in the Bansbari well field. Raw water obtained from these sources is conveyed to and treated by the Balaju treatment plant. Treated water is temporarily stored in a reservoir situated in the treatment plant and then supplied to the northwestern part of Kathmandu city in the morning and evening, twice a day.

Villages located along conveyance lines from the springs to the treatment plant are supplied with untreated water from the conveyance lines.

(2) Bansbari system

This system, which was constructed in the third project by the World Bank, relies for groundwater only on the Bansbari well field. The ground water obtained from the wells of the well field is stored in the Bansbari reservoir without being treated and supplied to the southwestern part of Kathmandu city. Since the Bansbari reservoir is too small in capacity (2,000 m^3) to meet the production of the groundwater, overflowing occurs at times outside of water supply hours in the morning and evening. This

overflowing water is transmitted to the Maharajganj reservoir by its distribution line.

(3) Maharajganj system

This system obtains water from the sources of the two springs of Shivapuri and Bisnumati in the northern part of the Kathmandu valley and some of the wells in the Bansbari well field. Part of the raw water coming from these sources is supplied without treatment to villages located along conveyance lines and then conveyed to the Maharajganj treatment plant. Water treated by the plant is stored in its reservoir and supplied to the northern part of Kathmandu city. Groundwater overflowing from the Bansbari reservoir during non-supply time flows into that reservoir.

(4) Mahankal Chaur system

This is the largest water supply system for Greater Kathmandu. At first the system consisted of the Sundarijal treatment plant which treated water (river water from the Bagmati river) discharged by the Sundarijal hydraulic power station in the northwestern part of the valley, and Mahankal Chaur reservoir which supplied the treated water. Later, the third project by the World Bank made available groundwater from the Gokarna, Manohara and Dhobi Khola well fields as additional water sources. Water treated by the Sundarijal treatment plant and the groundwater from the well fields is partially supplied to villages located along the transmission lines and then transmitted to the Mahankal Chaur reservoir. In the reservoir, treated water (surface water) from Sundarijal and untreated groundwater are mixed and stored. The system supplies water to the eastern and central parts of Kathmandu city.

(5) Shaibhu system

This system has its water sources in three springs, which were developed in the southern part of the valley under in the first project, and wells in the Pharphing well field, constructed later under in the

third project. From two of the three springs, namely Sat Mul and Sesh Narajan, water flows into the Shaibhu reservoir by gravity. Water from another spring, Kutori Mul and groundwater are conveyed to a pumping station and pumped into the Shaibhu reservoir. The reservoir has a simple-type sand filter, with which water conveyed from the sources is treated before storage. Shaibhu system supplies water to the whole city of Lalitpur.

(6) Sundarighat system

The system, located in the lower reaches of the Bagmati river, obtained at first river-bed water from the river itself. Recently however, the system stopped operation as more and more city sewage has flowed into the river and its raw water has become too much polluted. Last year, operation resumed with the opening of a new intake facility, constructed in the downstream of Nakhu Khola. Water received from the Nakhu Khola is conveyed to and treated by the Sundarighat treatment plant before being stored in its reservoir. The system supplies water to the areas outside of the ring road in the southwestern part of Kathmandu city.

(7) Chapagaon system

This system supplies water to villages in the southern part of Lalitpur city, with Muldore spring in the southern part of the valley as its water source. To meet increasing water demand, an intake facility was constructed in the upstream of the Nakhu Khola last year. River water flows naturally down for the Nakhu Khola, while spring water is conveyed to a reservoir by pumps. From the reservoir, water is supplied to villages located along distribution line by gravity, and also transmitted to Tahakhel reservoir, which was constructed downstream of the system, for supply to areas contiguous to Lalitpur city and outside of the ring road.

Without a treatment facility for treating the river water of Nakhu Khola, the system has some problems such as not being able to intake highly turbid water during the wet season.

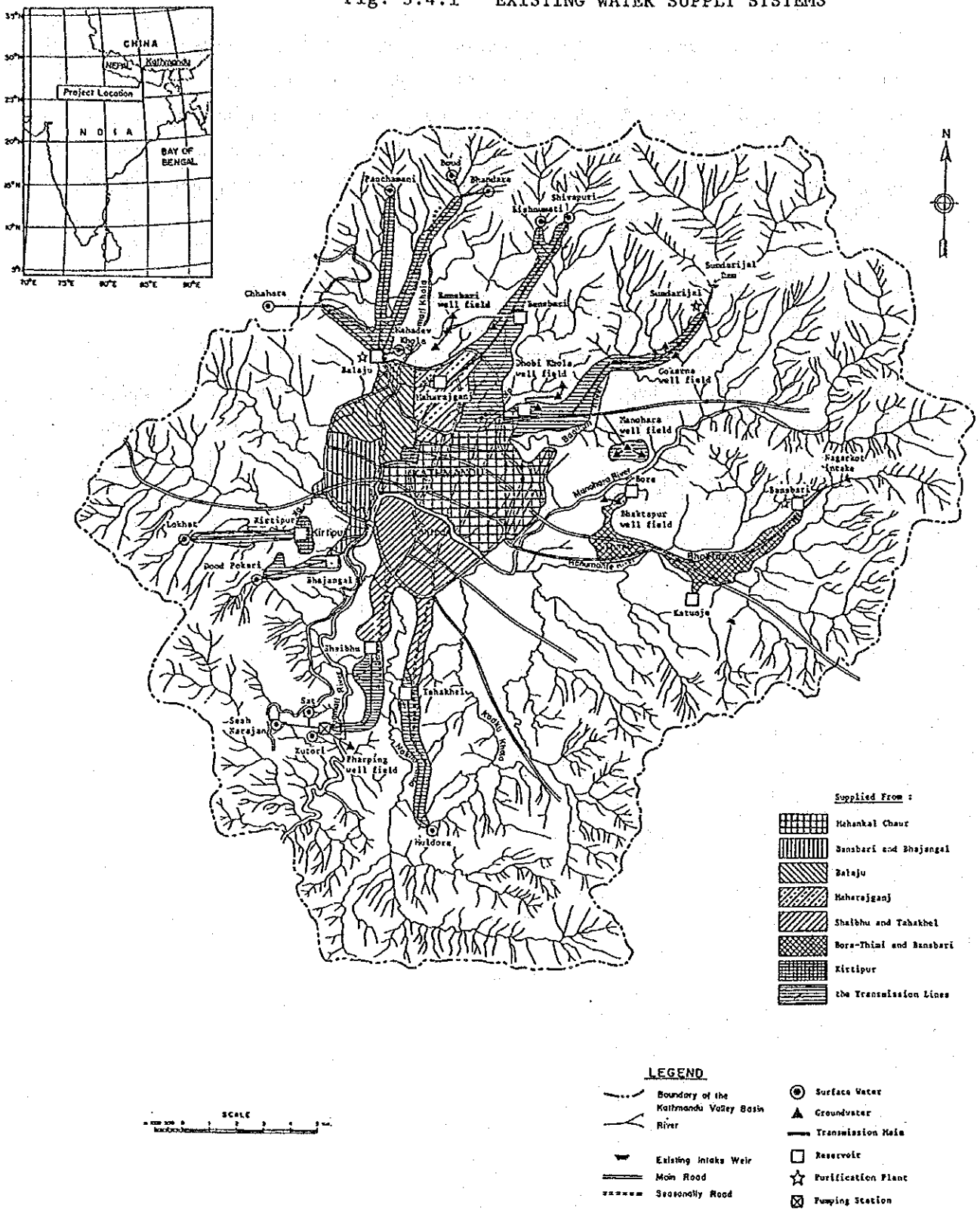
(8) Dood Pokari system

The water source of this system is Dood Pokari spring in the southwestern part of the valley. Water obtained from the source is partially supplied to villages near the to conveyance line and stored in Bhajangal reservoir. From the reservoir water is distributed by means of pumps to the surrounding areas of high elevation and the areas outside of the ring road in the southern part of Kathmandu city.

(9) Lokhat system

This system uses Lokhat spring in the western part of the valley as its water source. Water obtained from the source is partially supplied to villages near the conveyance line and stored in Kirtipur reservoir. The system is mainly intended to supply water to Kirtipur in the southwestern part of Kathmandu to city.

Fig. 3.4.1 EXISTING WATER SUPPLY SYSTEMS



3.4.2 Sources of water supply

(1) Capacity of water supply sources

In Greater Kathmandu and its neighboring villages, river water, spring and groundwater obtained from deep wells is used for the water supply systems. Its total production capacity (design capacity) is 57,270 m^3/d of surface water (including spring water), and 45,860 m^3/d of groundwater, a total of 103,580 m^3/d. In fact, however, the production the of groundwater is below the above-mentioned capacity because of the repairs of the wells and power interruptions, a decline from the capacity caused by the blinding of the filters, and a lower groundwater levels preventing some wells from operation. Available production capacity of the water supply systems is as follows:

(Unit:m^3/d)

System	Surface water	Groundwater	Total
Balaju	8,230	3,810	12,040
Bansbari	-	14,430	14,430
Maharajganj	3,120	2,920	6,040
Mahankal Chaur	20,000	21,610	41,610
Shaibhu	19,770	3,090	22,860
Sundarighat	1,500	-	1,500
Chapagaon	1,700	-	1,700
Dood Pokari	2,900	-	2,900
Lokhat	500	-	500
Total	57,720	45,860	103,580

(2) Quality of water supply sources

Springs, a source of surface water, provide stable and favorable water quality in both the dry and wet seasons. River water can be used as a water source if properly treated although its turbidity and the concentration of iron contained therein rise immediately after a rainfall in the wet season.

On the other hand, groundwater, excepting that of the Pharphing well field in the southern part of the valley contains such a high contents of iron, manganese and ammonia nitrogen that it cannot be used for water supply unless treated.

Now such groundwater is being supplied untreated, problems in colored water and blockage of water pipes both caused by iron and manganese, as well as an abnormal proliferation of bacteria related to iron and ammonia nitrogen inside water pipes, all lead the to a reduction in the quality of the water supply. Furthermore, the low pH value of the groundwater causes corrosion of water pipes. In a water analysis made as a part of the JICA Master Plan Study, the following results were obtained.

(Unit: mg/l)

Well fields	pH	Iron	Manganese	Ammonia nitrogen
Gokarna	6.9 6.7	2.6 0.81	0.18 0.02	1.0 0.3
Manohara	6.7 6.5	7.4 2.2	0.26 0.08	2.6 0.7
Dhobi Khola	6.1 6.0	5.5 2.2	0.35 0.22	6.0 0.8
Bansbari	6.8 6.2	3.0 1.2	0.27 0.03	3.2 0.4
Pharping	7.7 7.3	0.13 0.12	0.22 0.06	0.1 0.1

Note: Upper figures in each section indicate maximum values obtained from the analysis, and the lower show minimum values.

3.4.3 Water supply amount

Surface water and groundwater conveyed from the sources of water supply systems are stored in reservoirs, whether untreated or treated by water treatment plants attached to the systems, and distributed generally by intermittent supply twice a day for 4 hours each in the morning and evening. Now in Greater Kathmandu, there are a total of five reservoirs,

including the four reservoirs of Balaju, Bansbari, Maharajganj and Mahankal Chaur, which supply water to Kathmandu city and Shaibhu reservoir which supplies water to Lalitpur city. Additionally, water supply systems in surrounding villages supply water to Greater Kathmandu, though in small amounts.

At the time of making the JICA Master Plan Study, the amounts of inflow into and supply from these reservoirs were analyzed, on the basis of the records of water levels and operation including the terms of opening and closing valves, as well as the operation records of the wells from which water is supplied to the reservoirs. The analysis result shows that the amount of supplied water was 62,755 m^3/d in the summer of 1989 (August). Shown below are amounts flowing into the reservoirs and the amounts supplied to Greater Kathmandu.

(Unit: m^3/d)

System	Inflow amount			Storage vari-ation	Amount supplied
	Surface water	Ground-water	Total		
Balaju	7,387	3,163	10,550	-33	10,583
Bansbari	-	8,344	8,344	-87	8,431 (-1,588)*1
Maharajganj	1,992	956	2,948	-21	2,969 (+1,558)*1
Mahankal Chaur	12,222	9,427	21,649	-44	21,693
Shaibhu	17,479	-	17,479	0	17,479 (6,961)*2
Sub-total	39,080	21,890	60,970	-185	61,155
Others					1,600*3
Total					62,755

Note) *1: The amount of overflows from Bansbari reservoir. The water flows into Maharajganj reservoir.

*2: The amount of overflows from Shaibhu reservoir. The water is supplied to Lalitpur city.

*3: The inflow amount from water supply systems located surrounding villages.

In this site survey too, a similar analysis was conducted for Mahankal Chaur and Bansbari reservoirs, after collecting records on water levels and other factors. As a result, it was found that the amount of supply from Bansbari reservoir was 7,692 m^3/d, and that from Mahankal Chaur reservoir was 23,394 m^3/d in total, formed of 11,930 m^3/d of surface water and 11,464 m^3/d of groundwater.

3.4.4 Water demand

In the JICA Master Plan Study, for the purpose of learning the current state of water use in Greater Kathmandu, information was collected from the NWSC about the number of connections and the likes, and a questionnaire of the consumers was made at revenue offices of NWSC. The questionnaire covered such items as the level of water consumption, use, installation and current operation of water meters and the number of consumers per connection. The number of samples collected by this questionnaire was about 24,700, that is, 46% of the number of connections maintained by NWSC.

On the basis of this analysis, water demand in Greater Kathmandu is described below.

(1) Number of connections

In 1989 the number of connections in Greater Kathmandu was 53,255 in total, broken down into 41,707 in Kathmandu city and 11,548 in Lalitpur city. The number of them is shown below, classified by the existence and current operations of water meters. It shows that metered connections that were functioning account for about 70% of all.

Category of connection	Kathmandu	Lalitpur	Total
Metered (Functioning)	28,147	9,015	37,162
Metered (Non-functioning)	8,025	1,050	9,075
Non-metered	5,087	1,317	6,404
Standpost	448	166	614
Total	41,707	11,548	53,255

On the other hand, the number of connections classified by uses is as follows. The number of connections for domestic use accounts for approximately 93% of the total number.

Use	Kathmandu	Lalitpur	Total
Domestic	38,779	10,861	49,640
Commercial	1,808	390	2,198
Industrial	296	53	349
Institutional	376	78	454
Standpost	448	166	614
Total	41,707	11,548	53,255

(2) Original unit of consumption

According to the aforementioned questionnaire, the monthly level of water consumption for per connection in the classified uses is as follows: the number of consumers per domestic connection is 7.65 in Kathmandu city and 6.55 in Lalitpur city, while per capita consumption is 87.6 lcd in Kathmandu city and 81.6 lcd in Lalitpur city. In Greater Kathmandu on the whole, the number of consumers per connection is 7.32, the daily level of consumption per person being 86.0 lcd.

(Unit: m^3/month)

Use	Kathmandu	Lalitpur	Total
Domestic	20.8 (87.6 led)	16.6 (81.6 led)	19.5 (86.0 led)
Commercial	66.3	62.9	65.4
Industrial	87.0	52.2	79.8
Institutional	139.8	47.9	102.6
Standpost	34.7	34.7	34.7

The above level of consumption per connection concerns the connection with functioning meters, out of the samples obtained from the questionnaire. In the case of connections with non-functioning meters and connections with no meters, more wastage of water is found than in the case of connections with meters. GTZ's study report "Leak Detection and Repair-Kathmandu/Patan Water Supply System - 1988" indicates that the level of water consumption from connections with non-functioning meters is 1.10 times larger than those with meters and that from connections with meters is 1.77 times higher than that for connections with meters.

Since the questionnaire was carried out in July and August when water demand peaks, these original units of consumption are regarded as maximum yearly values.

(3) Water demand

On the basis of the above number of connections and the original units of consumption, water demand in 1989 in Greater Kathmandu was 44,510 m^3/d. Water consumption broken down classified by the uses was as follows:

(Unit: m^3/d)

Use	Kathmandu	Lalitpur	Total
Domestic	28,903	6,378	32,281
Commercial	4,375	850	5,225
Industrial	889	99	988
Institutional	2,189	139	2,328
Standpost	502	186	688
Total	36,858	7,652	44,510

Additionally, on the basis of the above total level of consumption (44,510 m^3/d) and the supplied amount (62,755 m^3/d) given in 3.4.3, the rate of water leakage is estimated to be approximately 30%.

3.4.5 Treatment facilities

Among the systems of water supply in Greater Kathmandu, Balaju, Maharajganj and Sundarijal systems are equipped with treatment plants. The outline of the facilities and current conditions of the operation and maintenance of the treatment plants are as follows:

(1) Balaju treatment plant

This plant was constructed in 1961. Its water sources are springs in the basin of Bisnumati Khola, the river of Lambagar Khola, and part of groundwater from the Bansbari well field. Although its design capacity is 10,900 m^3/d, the deterioration of the facilities and defective operation and maintenance have reduced the actual capacity to 7,390 m^3/d, more or less, and also impaired the quality of treated water. Chlorination is performed by adding bleaching powder. However, since the bad quality of water for treatment and the inadequacy of the injection facilities prevent proper injection of bleaching powder, residual chlorine is hardly detected in the distribution reservoir.

(2) Maharajganj treatment plant

This plant was constructed in 1960. Its design capacity is 2,400 m^3/d. Its water sources are the two springs in Bisnumati and Shivapuri, as well as part of groundwater from the Bansbari well field. In its facilities, the operation of the sedimentation basin has been suspended because of water leakage. Since the rapid sand filter basin has deteriorated and been defectively operated and maintained it does not function. Chlorination is incomplete as the case of the Balaju treatment plant, and it is unable to fulfill its duty of providing safe and sanitary water supply.

(3) Sundarijal treatment plant

This system, constructed in 1966, uses water from the Sundarijal power station (surface water of the Bagmati river) after its use at the station. Its design capacity is 19,600 m^3/d. The facilities have deteriorated the coagulant feeding equipment, flocculator, sedimentation basin and sterilization equipment are partially out of order, and the current operation and maintenance are improper. Therefore, the amount of treated water has decreased and the quality of treated water is unsatisfactory. A coagulant is added only when the turbidity of water is extremely high during the wet season. The bad quality of treated water and insufficient control of the addition hinder the purpose of water supply.

3.4.6 Distribution facilities

In Greater Kathmandu there are five reservoirs in total, formed of four reservoirs which supply water to Kathmandu city, Balaju, Maharajganj, Bansbari and Mahankal Chaur, and Shaibhu reservoir which supplies water to Lalitpur city. The reservoirs provide intermittent supply twice a day to areas throughout Greater Kathmandu. The storage capacity, distribution area and supply hours of the reservoirs are as follows:

Reservoir	Capacity (m^3)	Distribution area	Supply hours
Balaju	3,700	Northwestern part of Kathmandu city	4:00 - 8:00 15:00 - 20:00
Maharajganj	3,800	Northern part of Kathmandu city	5:00 - 9:30 14:00 - 19:00
Bansbari	2,000	Southwestern part of Kathmandu city	4:00 - 10:00 15:00 - 21:00
Mahankal Chaur	9,000	Eastern and central part of Kathmandu city	1:30 - 8:00 14:00 - 19:30
Shaibhu	2,700	Lalitpur city	4:30 - 8:30 16:00 - 20:30
Total	24,500		

In Greater Kathmandu, the network of distribution pipes is extremely complicated because it has been expanded without a plan to meet increasing water demand and the expansion of distribution areas. The network is not provided in proportion to the distribution of demand. Under the circumstances, water supply depends upon elaborate operation of valves. In the distribution areas uniform water pressure is not obtained; water pressure lowers in the terminal ends of water pipes, while rising so excessively in the upstream parts of pipes as to cause water leakage. In the case of a decline of water pressure in the terminal ends of pipes, unlawful acts such as pumping and sucking water directly from water pipes using pumps cause pollutants coming from outside water pipes.

3.4.7 Quality of supplied water

Kathmandu city uses as water supply sources spring water, river water and groundwater produced in the deep wells which were constructed in the third the project. Groundwater, containing high concentration of iron, manganese and ammonia nitrogen, is supplied without treatment, while spring water and river water are treated by the treatment plants. However, these treatment plants, which were constructed nearly 30 years

ago, have deteriorated so much and malfunction so frequently that they are incapable of satisfactory treatment. The decline in treatment functions, though not significant in the dry season when raw water quality is relatively stable, aggravates the quality of treated water in the wet season when raw water quality is bad. Moreover, groundwater supplied without treatment suffers from colored water caused by iron and manganese, together with the lowering of water pressure caused by blockage of water pipes and other direct problems, as well as secondary trouble caused by iron and ammonia nitrogen. As a result, these contents consume a considerable amount of chlorine for disinfection, and consequently prevent residual chlorine with a certain effect of disinfection from being retained.

Meanwhile, Lalitpur city uses spring water from the southern part of the valley for water supply, and this water is stable in quality in both the dry and wet seasons; the city enjoys good quality water and has few problems in water quality unlike those found in Kathmandu city.

In the JICA Master Plan Study, water quality was analyzed with regard to connections in Kathmandu city and Lalitpur city. As a result in the connections in Kathmandu city, no residual chlorine was detected both in the dry and the wet season. In connections in Lalitpur city, approximately 0.1 to 0.2 mg/l residual chlorine was detected.

Under such circumstances, it can be concluded that the quality of water supplied to Kathmandu city in particular is defective and the original purpose of supplying clean and safe water has not been accomplished.

According to the report presented by the Ministry of Health (MOH), the number of occurrences of water-borne diseases in the Kathmandu valley (meaning only the number of patients who received medical treatment in hospitals) was 8,128 from June to September, 1990, (the wet season when the occurrence of water-borne diseases peak). In Greater Kathmandu, the number of occurrences was 4,972 in total, divided into 3,883 in Kathmandu city and 1,089 in Lalitpur city.

Occurrences per 1,000 people were 7.7 persons in Kathmandu city and 4.7 persons in Lalitpur city, indicating the occurrences rate in Kathmandu city being more than 1.6 times larger than that in Lalitpur city. Particularly in Kathmandu city, the occurrences were confirmed in all of its 33 wards.

Out of the 33 wards in Kathmandu city, the cases of 15 ones ranking higher in this occurrences rate of water-borne diseases are described below, as well as systems of water supply for the wards.

Ward No.	Number of occurrences	Occurrences rate (per 1,000 people)	Water supply system
6	302	34.3	Mahankal Chaur
32	212	27.3	Mahankal Chaur
15	266	22.7	Bansbari
7	189	15.9	Mahankal Chaur
31	85	12.4	Mahankal Chaur
13	126	10.1	Bansbari
12	63	10.0	Mahankal Chaur
10	232	9.7	Mahankal Chaur
9	101	9.3	Mahankal Chaur
17	86	8.0	Balaju
2	39	7.3	Maharajganj
11	54	6.8	Mahankal Chaur
3	63	5.9	Maharajganj
4	51	5.2	Maharajganj
29	58	4.7	Maharajganj

The above table indicates that the areas suffering high occurrence rates of water-borne diseases correspond to the water supply areas depending on groundwater for water sources.

CHAPTER 4 OUTLINE OF THE PROJECT

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4.1 Objectives of the Project

Greater Kathmandu has been developing springs in the southern part of the valley and groundwater in the northern groundwater district and seeking suitable water sources to cope with expected water demand until the year 1996 on the basis of the 1973 Master Plan. However, the available groundwater pumpage is very limited and, in quality, the groundwater is causing contamination and colored water, as well as flowing-out of bacteria from connections as mentioned in the previous section 2.5. The water then has no protection against pathogenic bacteria.

Table 4.1.1 shows the changes in quantity of groundwater abstracted. In 1984 the groundwater began to be supplied without treatment and the proportion of groundwater produced from wells in the northern part of the valley reached 36% of the yearly mean water supply in 1989. With regard to surface water, treatment plants constructed in the 1960's have deteriorated, and their treatment function is paralyzed. Consequently, the water supply capacity is severely limited and even the treated water is extremely poor quality. Thus, the situation is similar to that of the groundwater supply. Under these circumstances, NWSC now faces with the need to pursue the following tasks:

1) Improvement of groundwater quality.
2) Improvement of existing treatment plants.
3) Improvement of existing water sources (surface water and groundwater).
4) Improvement of distribution pipes and prevention of water leakage.
5) Improvement of house connections (including installation of water meters).
6) Reconstruction of the water distribution system.
7) Development of surface water sources in the valley.

To implement these tasks, the NWSC is now executing the 15 year Comprehensive Development Programme (15YCDP) for water supply and sewerage with the cooperation of the IDA/UNDP and the JICA Water Supply Development Plan.

Items 3), 4), 5), and 6) are already being in implementation stage by the Urban Water Supply and Sanitation Rehabilitation Project (UWSSRP) under the first 5-year plan (1991 to 1995) of the 15YCDP (details of the 15YCDP and the UWSSRP are given in Para. 4.2.2). With regard to items 1), 2), and 7), the Government of Nepal has requested Grant Aid Association from the Japanese Government based on the JICA Water Supply Development Plan.

The objectives of the Project are to improve the groundwater quality and to secure sufficient water by developing surface water source within the valley for the conjunctive use with the groundwater, which is considered the most urgent in the JICA Water Supply Development Plan.

Table 4.1.1 GROUNDWATER ABSTRACTION FROM NWSC PRODUCTION WELLS

(Unit: m^3/d)

System	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Balaju										
Balaju	28	336	336	336	336	336	336	336	336	347
BB7	0	0	0	0	0	0	1,006	1,508	1,508	1,189
Sub-total	28	336	336	336	336	336	1,342	1,844	1,844	1,536
Bansbari										
BB3	0	0	0	0	0	168	2,018	2,018	2,018	1,834
BB4	0	0	0	0	0	0	46	553	553	436
BB5	0	0	0	0	0	0	0	0	0	1,114
BB6	0	0	0	0	0	0	332	1,994	1,994	2,020
BB8	0	0	0	0	0	0	1,069	1,283	1,283	1,125
Sub-total	0	0	0	0	0	168	3,465	5,848	5,848	6,529
Maharajganj										
BBold	336	504	504	504	504	504	504	504	504	502
BB2	0	0	0	0	988	988	988	988	988	964
Sub-total	336	504	504	504	1,492	1,492	1,492	1,492	1,492	1,466
Mahankal Chaur										
DK1	0	0	0	0	173	173	173	173	158	0
DK2	0	0	0	0	113	225	225	225	207	0
DK3	0	0	0	0	46	273	273	273	273	283
DK4	0	0	0	0	0	0	426	639	639	654
DK5	0	0	0	0	882	882	882	882	882	874
DK6	0	0	0	0	148	254	254	254	254	242
GK1	0	0	0	0	0	0	0	0	0	706
GK2	0	0	0	0	0	0	0	273	410	233
GK3	0	0	0	0	0	0	0	290	387	631
GK4	0	0	0	0	0	0	0	228	341	177
MH2	0	0	0	0	0	0	0	147	1,764	1,696
MH3	0	0	0	0	0	0	0	0	1,108	1,674
MH4	0	0	0	0	0	0	0	0	0	953
MH5	0	0	0	0	0	0	0	0	0	1,030
MH7	0	0	0	0	0	0	307	1,229	1,229	877
Sub-total	0	0	0	0	1,362	1,807	2,540	4,613	7,652	10,030
Pharping										
PH1	0	0	41	0	0	0	0	0	0	41
PH2	0	241	241	241	241	241	241	241	241	241
Sub-total	0	241	282	241	241	241	241	241	241	282
TOTAL	364	1 ,081	1,122	1,081	3,431	4,044	9,080	14,038	17,077	19,843