NEED ASSESSMENT OF POTABLE WATER SUPPLY IN RAJSHAHI CITY CORPORATION AREA

By

MOHAMMAD ABUL MANSUR CHOWDHURY

Department of Civil Engineering,
Bangladesh University of Engineering and Technology
Dhaka, Bangladesh.

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Mohammad Abul Mansur Chowdhury

Approved as to Style and content by:

12/10/04

Dr. Md. Mafizur Rahman : **Chairman**
Associate Professor (Supervisor)
Dept. Civil Engineering
BUET

Dr. Md. Habibur Rahman : **Member**
Professor
Dept. Civil Engineering
BUET

Dr. Md. Delwar Hossain : **Member**
Professor
Dept. Civil Engineering
BUET

12th October, 2004

Candidate's Declaration

It is here by declared that this project or any part of it has not been submitted else where for the award of any Degree or Diploma.

Signature of the Candidate

DEDICATED TO MY PARENTS

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ABSTRACT

For the purpose of making an assessment of water supply in Rajshahi city area, a questionnaire survey throughout the all 30 wards was conducted by the author. The bottled water samples were collected from the community users points of every ward for laboratory test. Tests were carried out for the determination of Arsenic (As), Iron (Fe), Total dissolved solid (TDS), Total Solid (TS), Total Suspended Solid (TSS), Total Coliforn (TC) and Faecal Coliforn (FC) present in the supply water. Some secondary data regarding the population, water connections, water quality, distribution system were collected from different organizations for the study. Presence of iron in the study area is excessively high. Besides, from the questionnaire survey it was learnt that the water pressure at the users end is very low and people at the periphery of the ward get insufficient amount of water which contain substantial amount of suspended solids every now and then. Appreciable leakage of water points were observed by the author in all the wards. Now the water supply sections of City Corporation and the DPHE are trying to improve the present situation of water supply system by treating the ground water and replacing the leaky mains and also increasing the number of pumps for desired pressure at the users end. From the questionnaire survey the view of the water users is distinct that peoples (73%) is agree to pay more to enjoy a better supply systems. Peoples of different professions, different age, different race irrespective of gender interviewed in the survey work.60% people said that the water is not good for drinking that's why they use pond water for drinking. 78.66% people is not satisfied with the present water supply. Moreover the water quality test result clears the present view of Rajshahi City water supply condition. The quality of supply water should be improved as it contains objectionable amount of FC.FC were found nearly 63% of the study area. So disinfection actions should be enhanced for a potable water supply. Out of 30 ward, ward no.5, ward no. 13, ward no.14, ward no.17, ward no. 22 & ward no.25 show the presence of TSS. The amount of TSS in these entire wards is higher than the allowable limit of 10 mg/l. More over among these 6 wards ward no. 14 shows 37 mg/l, which is higher by 27 mg/l from allowable limit. Test results shows that the supply water of RCC is not free from arsenic contamination. The maximum level of arsenic detected in ward no.16, which is 0.34 mg/l. From the questionnaire survey it is evident that people shows their view about the poor quality of water. Test results also ensure that the prescience of iron in ward no. 20 & 27. The values are 1.4 mg/l and 1.2 mg/l respectively. 76.66% people in the study area expressed their deep concern about the in sufficiency of water supply.

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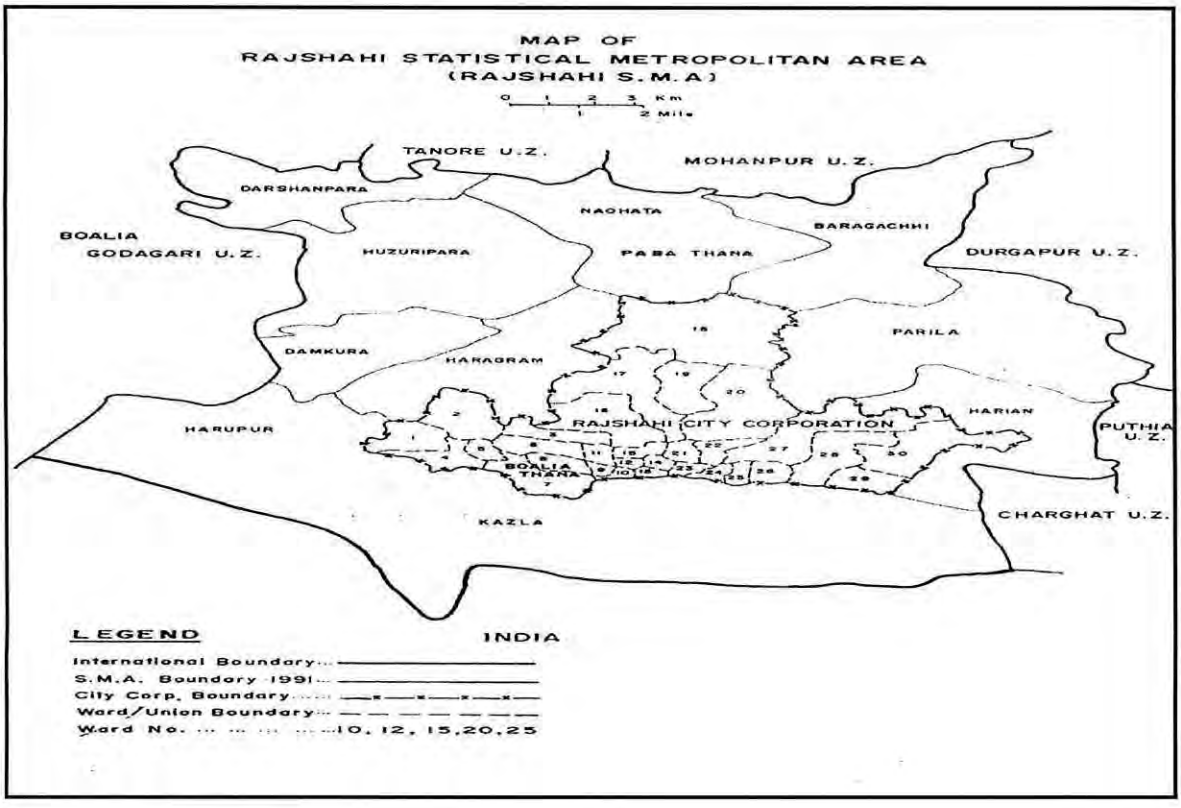
CHAPTER 1
INTRODUCTION

1.1 Background

Safe water is vital for sustenance of life on earth. On the other hand water is crucial for economic and social development including energy production, agriculture, domestic and industrial use. Therefore, every unit of water should be used effectively, equitably and appropriately. The economic value that water creates should be given due attention when apportioning scare water resource among competing uses, without infringing on the right to basic services for all the people. In 1994, Bangladesh Water Development Board made an observation on 1250 tube-wells all over the country. For the last 4 years, the ground water table has been declined by 3 feet to 4 feet on an average each year.(BETS, 1994)

Rajshahi, is located in the northwestern part of the country along the Padma River. Due to high investment and running cost, the possibility of using water from the Padma as a source of water was abandoned and extraction of ground water through deep tube-wells was considered a reliable alternative source for water supply in Rajshahi town. Ground water is available in and around Rajshahi city from the shallow and deep aquifers. Withdrawal of water by wells is the only sources of water for RCC water supply system. The Rajshahi water supply system was installed in 1935 by the water supply section of the Ministry of Works, Culcutta, India and commissioned in 1937 using ground water as a source. The system had more 100 nos. street water reservoirs known as *Dhopkhals* (See App. B)each with a capacity of 470 gallons(RCC,2002). These reservoirs were connected to a centrally built iron and hardness removal plant and an elevated service reservoir through reticulated distribution pipes. The treatment plant had a capacity of 700 m^3/day but was abandoned in 1965. The elevated service reservoir is not in use now. However, many of the street water reservoirs are still in use by RCC.



Source : BETS, 1994

Figure 1.1: Rajshahi Zilla

During the decades 1980 and 1990, DPHE with Dutch Government and Government of Bangladesh support, implemented Rajshahi Water Supply Master Plan in 1981. Simultaneously RCC also implemented phase construction and extension of water supply systems. At present from *45 deep tube wells* through reticulated pipe networks of 400 km (June, 2002) the system covers 46% of the present demand. This piped water supply coverage of 46% has recently increased by 13% from the previous coverage of 33% . With the completion of a project by DPHE before June , 2002 added 20 more deep tube wells and 121 km pipe networks to the existing system. This completed project also includes 3 nos. ground water treatment plants each with a capacity of 400 m^3/hr, designed to simple lime softening followed by aeration, flocculation, sedimentation and rapid sand filtration. Now DPHE is implementing the second phase (2002-2006) project on service extension through treated piped water supply. This second project is aimed to increase piped water supply coverage to more 35% population with the implementation of 2 nos. surface water treatment plants, 01

no. ground water treatment plant, 10 nos. production tube- wells and 105 km pipe networks. The project is targeted for completion by June 2010.

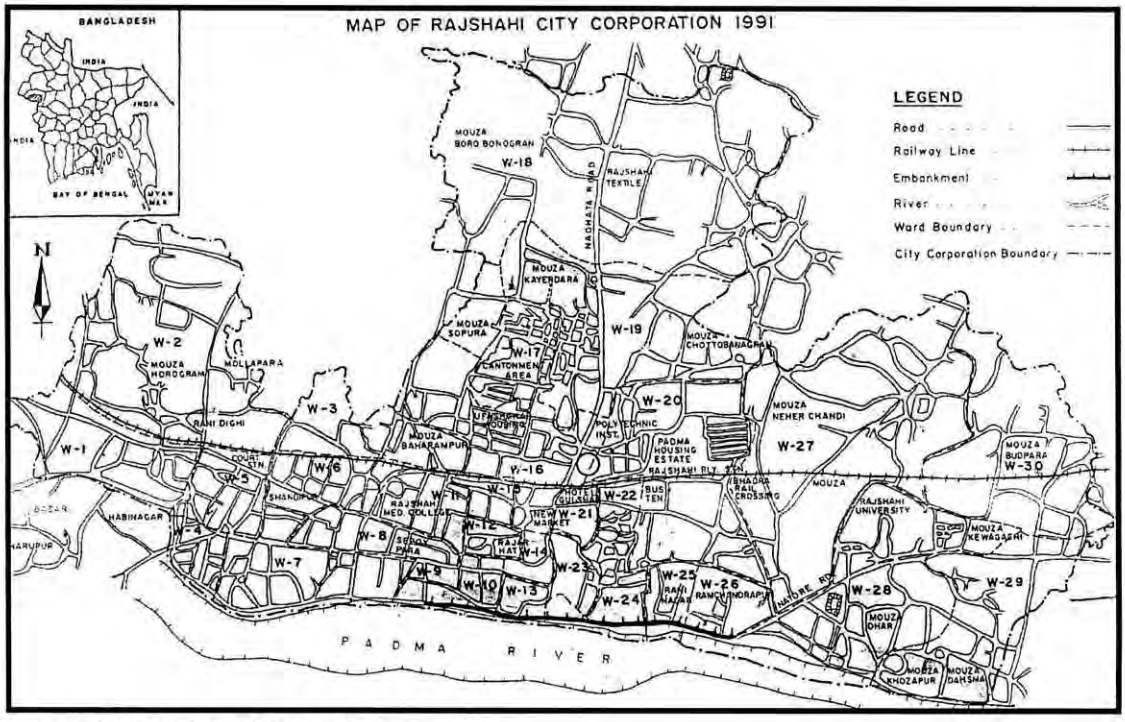


Figure 1.2: Rajshahi City Corporation

The Rajshahi City Corporation is maintaining the same tariff structure and charges since 1989. The revenue being realized is not adequate for basic operating cost. For this reason no surplus is available for maintenance or the expansion of the system. In some of the cases the supply system suffers a huge water loss from old pipes, poor system control and excessive consumer wastage. Sometime the consumers suffer from frustration because of inadequate storage capacity of the system and the intermittent supply.

1.2 Objectives of the study

To conduct the study the following objectives were set forth:

1. To identify the collection and distribution process of water supply system in Rajshahi City Corporation.
2. Comparison of the present water quality with previous ones.
3. Assessment of current and future demand of the potable water in the RCC area.

1.3 Methodology of the study

Considering the objectives of the study, a questionnaire was prepared for the users. An overview of total water supply system would come out from the questionnaire survey which would not only be helpful for assessing the demand but also for

detecting the problems of existing water supply system. Data collection involved two stages. These were primary data collection and secondary data collection. Data have been collected through questionnaire survey in all the 30 wards of the City Corporation. Each and every ward of the RCC was surveyed on random sampling basis. For the determination of the present water quality (Test data of As, Fe, TDS, TSS, TS, TC, FC) 30 Nos. bottled samples were collected one from each ward and the same were tested in the Environmental laboratory of BUET. To achieve the objective an extensive literature review was conducted for background information on water supply system in the RCC area. A number of data sources as RCC, RDA, DPHE, BBS were used in this study

1.4 Organization of the project

The project is divided into five chapters. Chapter 1 describes the background of the problem including the objectives, methodology of the work. Chapter 2 is a presentation of relevant literature providing importance, sources, quality investigation, standards, existing conditions, population studies and demand assessment. Chapter three describes the existing condition of the water supply system of Rajshahi City Corporation .Chapter 4 describes data collection (both primary and secondary) and discussion on existing supply conditions. Chapter 5 analyzes the collected data's with the aid of graphs, presents relevant discussions on those and finally reveals findings. Nevertheless, important conclusions and recommendations along with few limitations are made in chapter 6.

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction

Water is absolutely essential for man, animals and plants. Without water, life on earth would not exist. Man uses water not only for drinking and culinary purposes but also for bathing, laundering and other domestic purposes. It is difficult to imagine any clean and sanitary environment without water.

Health problems related to the inadequacy of water supplies are universal but generally of greater magnitude and significance in developing countries. Although population under water supply coverage improved significantly during the Water and Sanitation Decade and after the Decade, It has been estimated that about 25% of the population in developing countries still does not have access to safe water (Ahmed and Rahman 2003). As a result millions of people in developing countries each year suffer from water related diseases. The infant mortality rate is still very high in developing countries largely due to unsafe water supply.

2.2 Objectives of water supply

The broad objectives underlying any water supply system are to:

- Supply water in adequate quantity.
- Supply safe and wholesome water to the consumers.
- Make water easily available to users.

2.3 Sources of water supply

All fresh water on earth comes in the form of precipitation. It is evaporated from the oceans, condenses to form clouds and finally precipitates over land. When water hits the ground, a portion of its runs off across the surface of the ground and a portion of its percolate into the ground. Therefore, the sources of water supply are of two types:

1. **Surface water**
2. **Ground water**

2.3.1 Surface water sources:

The water running across the surface of the ground has been designated as surface water. Rajshahi municipality is bordered on the southern side by the river Padma, is the major source of water. Because of the effect of Farakka Barrage, the flow of the river reduces sharply during the dry season. Water velocity reduces to 1 ft/sec in dry season from 10 ft/sec in wet season. As a result the silt load in this river rises sharply

and reduces the river flow width. Though it is easily envisaged that the Padma river water cannot be a potential source of water supply for Rajshahi town, but the possibility of investigating river Padma as a source of water supply still lies particularly during the dry season. The existing channel near the embankment that is flowing for the last 25 years seems to be a potential source in terms of quantity and quality. With minor treatment like coagulation, sedimentation and chlorination the water may be supplied for water supply. Detail hydrological study will be carried out for the assurance of quality.

2.3.2 Ground water sources:

Ground water is the most important source of water supply in Bangladesh. Except for few hilly regions of Bangladesh is entirely under laid by water bearing formations at depth varying from zero to 20m below the ground surface.

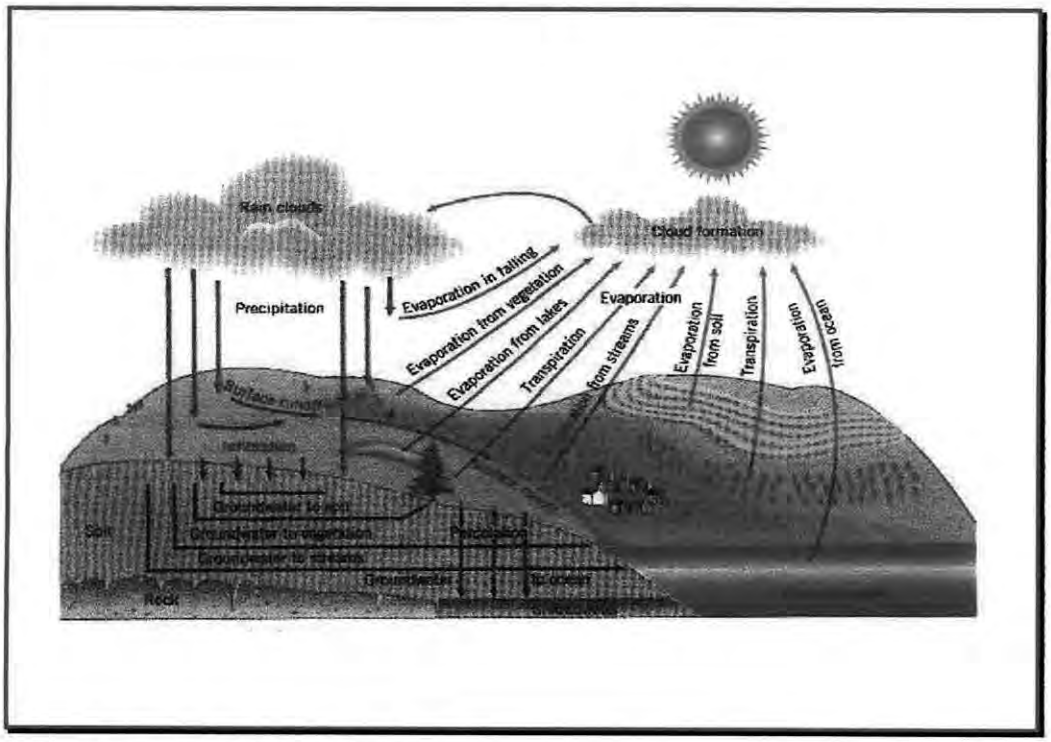


Figure 2.1: The Hydrological cycle

Ground water is recharged through slow infiltration from rainwater during the rainy season and from bills, pond and streams. Ground water level of the study area experiences fluctuation during the year due to the pronounced seasonal precipitation in the monsoon climate. The ground level is the highest during the monsoon in August and September and lowest in March and April. According to the record of water level at specified WDB wells in May

1982, the Maximum water level was 7.0m and the minimum 3.6m at Paba (Ref. Feasibility studies on Rajshahi water supply, sanitation and drainage project, 1994). Furthermore, the water level fluctuation in the study area is closely related to the fluctuations of the Ganges river water level. The Holocene alluvium is recharged from the Ganges River during the monsoon only. The tube-well water level rises during the rainy season, and falls during the dry-winter season when the water in the Ganges is at its lowest level. Thus human manipulation of the Ganges river water level affects local ground water conditions.

Presently, ground water constitutes the only source of water supply to the Rajshahi city corporation area. Ground water is being extracted from 45 wells. The total depth of the existing tube-wells varies from 187 feet to 262 feet. The average lengths of the wells screens are around 80 feet. The diameter of the screens varies between 6 and 8 inches stainless steel screens are used. The yields of the wells vary between 32000 and 38000 IGPH.

2.4 Water quality investigation

The availability of a water supply adequate in terms of both quantity and quality is essential to human existence. Early people recognized the importance of water from a quantity viewpoint and could judge water quality only through physical senses of sight, taste and smell. Most of the common diseases in our country are water borne. Physical, chemical and biological quality of domestic water need to be investigated to determine their effects on human health and well-being of the community.

The impurities in the natural water may be grouped into the following four categories:

- Impurities of mineral origin
- Impurities of organic origin
- Living impurities
- Radioactive impurities

These impurities may be present in suspension, solution or pseudo-solution. The effects of some of the impurities in water on human health are presented in table 2.1.

Table 2.1: Effect of impurities present in water

Impurities	Effect on water	Effect on health
Living impurities		
Bacteria	Turbidity at high concentrations	Diseases
Viruses	--	Diseases
Algae, protozoa, fungi	Turbidity, odour,colour	Diseases, toxicity
Impurities of mineral & organic origin		
Silt and clay	Turbidity	--
salt or calcium and magnesium	Hardness, alkalinity, taste, Corrosiveness and scale formation	--
Salt of sodium	Alkalinity,salinity,foaming,taste,scaling	--
Fluorides	--	Tooth decay
Nitrate	Algae growth	--
Iron and manganese	Taste,hardness,scaling	Toxicity, diseases
Arsenic, lead, heavy metals	--	Diseases
Vegetable dyes	Colour, acidity	--
Gases		
Oxygen	Corrosiveness, taste	--
Carbon dioxide	Acidity, corrosiveness	--
Hydrogen sulphide	Odour, corrosiveness, acidity	Toxicity
Radioactive impurities	--	Diseases

(Ahmed and Rahman 2003)

No available information on surface water quality was obtained. Some information (Table 2.2) about the existing deep tube well water quality of the RCC area. In all cases the information is limited to a few water quality parameters, where as the accuracy of the analysis is not known.

Water analysis report

Location of sample: Ramchandrapur Treatment Plant

Type of sample: Raw water

Date of collection: 14/05/2002

Date of experiment: 16/05/2002

Laboratory: Zonal laboratory, DPHE, Rajshahi

Table 2.2: Water analysis report

Sl. No.	Name of Parameters	Results	Units	Acceptable limit	Remarks
1	Temperature	26	(°C)	-	
2	P^H	7.5	-	6.5-9.2	
3	Turbidity	-	NTU	25	
4	Electro Conductivity (EC)	830	μScm^{-1}	50-1500	
5	Chloride	91	mg/l	600 Max^m 1000	In problem Area
6	Total hardness (as $CaCO_3$)	317	mg/l	250 Max^m 450	In problem Area
7	Calcium hardness (as $CaCO_3$)	277	mg/l	200	
8	Magnesium hardness (as $CaCO_3$)	40	mg/l	50	
9	Acidity (CO_2)	42	mg/l	50	
10	Alkalinity (HCO_3)	475	mg/l	600	
11	Total iron	2.74	mg/l	1.0	In problem Area
12	Total Manganese	0.98	mg/l	0.5	
13	Total Arsenic	0.11	mg/l	<0.05(Bang.)	<0.01(WHO)
14	F.C bacteria	Nil	Nos/100ml	0	

2.5 Water quality standard for drinking water

Many countries in the world have developed drinking water criteria and standards. Bangladesh developed the first water quality standards in 1976 based on the WHO 1971 International Drinking Water Standards. The Bangladesh Standard specification for Drinking Water (BDS 1240:1989) was prepared and published by the Bangladesh Standard Testing Institution (BSTI) for the control of drinking water quality. The Environmental Conservation Act (ECA,1997) with WHO for drinking water standards are presented in table 2.3.

Table 2.3: Drinking water standards

Water quality parameters	Unit	Bangladesh Standards	WHO guide line value,1993
1. Aluminium	mg/l	0.2	0.2
2. Ammonia(NH_3)	mg/l	0.5	1.5
3. Arsenic	mg/l	0.05	0.01
4. Barium	mg/l	0.01	0.7
5. Benzene	mg/l	0.01	0.01
6. BOD_5 20 ^0C	mg/l	0.2	-
7. Boron	mg/l	1	0.3
8. Cadmium	mg/l	0.005	0.003
9. Calcium	mg/l	75	-
10. Chloride	mg/l	150-600*	250
11. Chlorine (residual)	mg/l	0.2	0.6-1.0
12. Chloroform	mg/l	0.09	0.2
13. Chemical oxygen demand	mg/l	4	
14. Coliform (faecal)	N/100ml	0	0
15. Coliform (total)	N/100m	0	0
16. Colour	Hazen unit	15	15
17. Copper	mg/l	1	1
18. Detergents	mg/l	0.2	0.2
19. Dissolved oxygen	mg/l	6	
20. Fluoride	mg/l	1	1.5
21. Hardness (as $CaCO_3$)	mg/l	200-500	
22. Iron	mg/l	0.3-1.0	0.3
23. Lead	mg/l	0.05	0.01
24. Magnesium	mg/l	30-35	
25. Manganese	mg/l	0.1	0.1
26. Mercury	mg/l	0.001	0.001
27. Nickel	mg/l	0.1	0.2
28. Nitrate	mg/l	10	50
29. Nitrite	mg/l	<1	3
30. Odour	mg/l	Odourless	
31. Oil and Grease	mg/l	0.01	
32. P^H	-	6.5-8.5	
33. Phosphate	mg/l	6	
34. Phosphorous	mg/l	0	
35. Potassium	mg/l	12	
36. Sodium	mg/l	200	200
37. Suspended solids	mg/l	10	
38. Total dissolved solids	mg/l	1000	1000
39. Temperature	^0C	20-30	

(Ahmed and Rahman, 2003)

2.6 Demand assessment

2.6.1 Introduction

Future water demand for the projected population of an expanding urban area is the primary basis of a long-range development and investment plan for water supply. To estimate the total demand for the next 20 years, consideration would be given to determine the present population and growth rate trends, urban densities, existing and projected land use, water consumption parameters, water use pattern under different socio-economic conditions, commercial, industrial and public usage of water loss, wastage and other unaccounted water.

The total consumption is the sum of the domestic use, commercial and industrial usage, public use, loss and wastage expressed on a per capita basis. But this average daily per capita consumption also depends on a number of local factors and varies from day to day, month to month during the year. The maximum daily consumption is likely to be 180% of the annual average and may reach 200%. Total demand is calculated by multiplying the total average per capita consumption with the total population. The typical water requirements for domestic and other purposes are given in table 2.4.

Table 2.4: Water requirement for domestic purposes

Types of water supply	Water consumption Range, lpcd	Typical water consumption, lpcd
Village open/tube wells and stand post		
Distance, > 1000 m	5 – 10	7
Distance, 500- 1000 m	10 – 15	12
Distance, 250- 500 m	10 – 20	15
Distance, 50 – 250 m	15 - 40	25
Distance, < 50 m	20 - 50	35
Water supply source in yard		
Well in yard	20 – 60	40
Single tap in yard	30 – 80	50
House connection		
Single tap	30 – 60	50
Multiple tap	70 - 250	150

Source: (Ahmed & Rahman, 2003)

Table 2.5 : Water requirements for other purposes

Nature of consumption	Range of Consumption, lpcd	Average Consumption, lpcd
Commercial use	10 – 150	40
Industrial use	30 – 450	120
Public use	10 –100	25
Livestock	10 – 35	20
Loss & wastage	20 – 150	40

Source: (Ahmed & Rahman, 2003)

Table 2.6 : Water requirements in rural and urban areas in Bangladesh

Areas	Water consumption, lpcd
Rural areas	50
Upazila towns	100
Zila town	120
City corporation	180

Source: (Ahmed & Rahman, 2003)

2.6.2 Present population and population projection

From an old city of population of 40000 in 1951 covering an area of 8.57 sq. km, Rajshahi has grown to become one of the urban giants in Bangladesh over the last decades. Experiencing an average annual growth rate of about 3.569% during the past decades. Rajshahi has become a dominant city of the new millennium in our country, to accommodate 0.57 million population over an area of 93 sq. km. Ward wise population in Rajshasi is presented in table 2.7:

Table 2.7: Ward Wise Population

Word No.	Population	Word No.	Population
1	20420	16	23471
2	18329	17	15338
3	19406	18	20418
4	17375	19	25505
5	17378	20	20410
6	17578	21	21626
7	16366	22	15353
8	24685	23	20622
9	19404	24	18483
10	15498	25	14321
11	21427	26	16482
12	16348	27	20422
13	15342	28	20834
14	20423	29	17579
15	17365	30	21433

Source: (RCC, 2002)

2.6.3 Per capita water demand

Information of per capita water demand is required for finding out the total water requirement of a town. This is done by finding out water need for each head, which will reflect the gross water requirement. Water demand of different heads may be summed up, and the figure may be divided by the population of the concerned area, which shows present equivalent per capita water demand. Thus both the domestic and non-domestic needs are expressed with relation to population. At present, RCC pipe supply system serves about 46% of the total population through a combination of house connection, yard connections and street hydrants. Thus there still remains a substantial unmet demand at all levels in Rajshahi city corporation area. The short fall has been partly met through the use of private tube wells.

Per capita consumption of water is the total consumption of water divided by the population and the number of days in the years. It is generally expressed as liter per capita per capita per day (lpcd) or gallons per capita per day (gpcd).

2.6.4 Factor affecting per capita consumption of water

- Population distribution
- Climatic condition
- Quality of water
- Pressure of water
- Water rates metering
- Nature of supply
- Water source
- Availability of an alternative source
- Sanitation
- Efficiency of management

2.7 Quantity of supply

Presently water supply Department of RCC serves about 46% of the total population only. So it is found that almost half of the inhabitants are deprived of present water supply facilities in the city. The following figure 2.2 shows that the percentage of population served by water supply department of RCC.

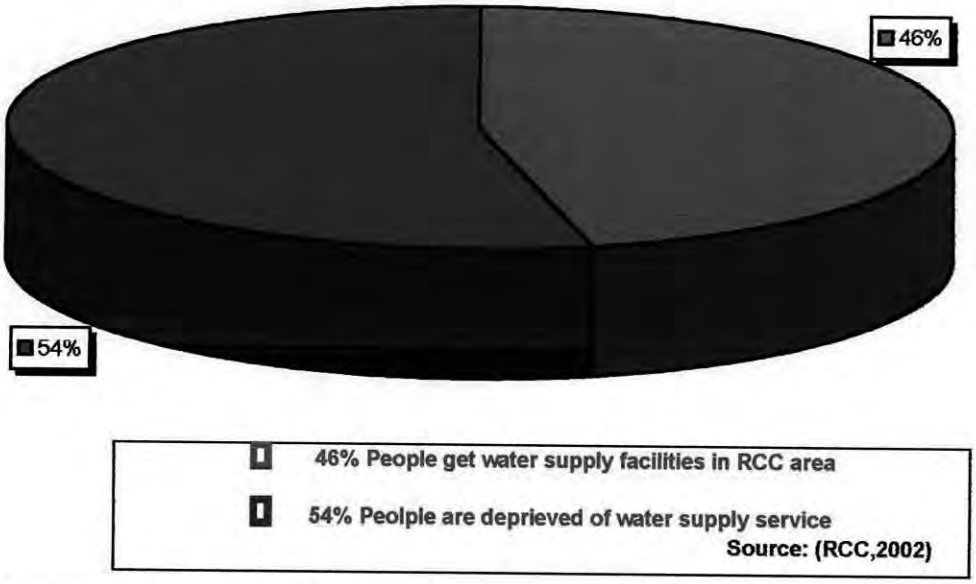


Figure 2.2 : Percentage of Population getting the water supply service by RCC

2.8 Demographic studies

The demand assessment for the present and future years with respect to water supply would be based on present and future population of the project area i.e. for Rajshahi city corporation the total quantity of water requirement by the community can be computed by equation 2.1

$$Q_f = P_f \times q \quad \text{..... (2.1)}$$

Where Q_f is the quantity of water requirement per day, P_f is the projected population estimated at the end of the design period and q is the rate of consumption per capita per day.

2.9 Population projection:

The present population of a community could be obtained from the recent census. The most widely used method is geometric progressive method, which is also known as empirical method suggested by Hardenberg. The future population can be estimated by this method using the equation 2.2

$$P_f = P_p\,(1+r)^n \text{.....(2.2)}$$

Where, P_f = future population; P_p= present population ; r = rate of yearly growth and n = numbers of year to be considered. The population growth rate (r) is available from the census report. The rate of population growth can also be estimated from population data of two "n" years interval in the recent part using the expression. (Equation 2.3)

$$r = \sqrt[n]{\frac{p_2}{p_1}} - 1 \quad \text{..... (2.3)}$$

where , P_1 and P_2 are population data of two dates of "n" number of years apart.

m^3/sec. in 1992. Water velocity reduces to 1 ft./sec. in dry season from 10 ft./sec. in wet season. As a result silt load in this river rises sharply and reduces the river flow width. Furthermore, large variation in surface water quality due to fluctuation of river flow makes surface water treatment provisions expensive. Though it was envisaged that the Padma river water cannot be a potential source of water supply for Rajshahi town but due to increasing demand of water and arsenic contamination in ground water compelled the authority to implement 2 nos. surface water treatment plant of capacity 2272 m^3/hr each by June, 2006.

Table 3.1: Proposed Development Plan of 2nd phase DPHE project (2002-2006)

Components	Quantity
Production tube wells	10 Nos.
Pipe Mains - New - Rehabilitation	 105 km 10 km
Water Treatment Plants - Surface water treatment plant - Ground water treatment plant	 2 Nos. (capacity 2272 m^3/hr each) 1 Nos. (capacity 400 m^3/hr each)
Daily piped water supply to be increased	55,440 m^3
Target population to be served	79%

Source: *RCC, 2002*

Table 3.2 : General information:

Sl. No.	Item	Description
1	Area	93.34 sq.km
2	Annual precipitation	1447.6 mm
3	Suitable water containing aquifer avg. depth	110 ft- 180ft
4	Total population	750000
5	Population growth rate	5.9%
6	Household no.	64000 nos.
7	Road (pucca & Semi pucca)	336 km
8	Existing man power	106 nos.
9	Total water demand(piped 100% demand)	100000 cumec/day*

*Avg. water consumption- 65.57 lpcd & Loss & Wastage – 46%. Source : *RCC, 2002*

Table 3.3 : Service Indicators:

Sl. No.	Item	Description
1	Pipe supply coverage: Area Population	63% 75%
2	Hand tube –well coverage	30%
3	Other coverage (Source: Pond, river etc)	7%
4	Existing piped water supply Qty.	46000 m^3/day
5	Production tube-well (running)	45 nos.
6	Water availability (Pumping hours)	10 hours
7	Avg. yield of existing P.T.W	100 m^3/hr i.e. 1000 m^3/day
8	Length of pipe (running)	400 km(up to June,2003)
9	Service connection (House connection)	11000 nos.
10	Stand post (Street hydrant)	750 nos.
11	Water reservoir	35 nos.
12	Overhead tank	5nos. (1 dismantled)
13	Hand tube-well no.	3750 nos.

Source : *RCC, 2002*

Table 3.4 : Water Sources Used by Households :

Sl. No.	Water Sources	% Of Total users
1	House connection	57.41
2	Stand post	8.44
3	Hand tube-well	11.15
4	Wells	4.66
5	Others	18.34

Source: *RCC, 2002*

Table 3.5 : Snapshot on statistics of water connections of varying diameter since inception:

Year	Water in connection size (in mm)						
	100	75	50	37.5	25	18.75	12.5
1939-86	3	1	1	14	72	1569	2527
1987	-	-	-	1	5	236	201
1988	-	-	-	2	2	183	93
1989	-	-	2	1	2	145	83
1990	-	-	-	1	4	148	87
1991	-	-	-	1	7	98	58
1992	-	-	-	1	2	121	81
1993	-	-	-	1	5	276	118
1994	-	-	-	5	4	245	84
1995	-	-	3	-	8	417	135
1996	-	-	1	1	8	295	107
1997	-	-	-	-	5	284	90
1998	-	-	-	-	1	318	87
1999	-	-	-	3	5	602	133
2000	-	-	-	1	2	443	100
2001	-	-	-	-	5	590	120
2002	-	-	-	1	13	767	143
2003(May, 03)	-	-	-	-	12	561	88
Total	**3**	**1**	**7**	**33**	**150**	**6737**	**4247**

Source: *RCC, 2002*

3.3 Storage facilities

There were five elevated water storage tanks with a capacity of 1.5 lakh IG each. But recently the storage tank located in Kadirgonj water works premises has been dismantled. The other tanks are located in DPHE campus, Ramchandrapur water works, Paba water works and Hatem khan water works premises respectively. All these storage tanks are know abandoned.

3.4 Operational Management of the water supply service

The planning and development of the water supply system is done by DPHE under the direct supervision of the Superintending Engineer of DPHE, Rajshahi circle. The responsibility of operation and maintenance is with the water supply section of RCC which is under direct control of the Chief Executive Officer who is responsible to Mayor. The overall operational management activities along with the phased

development of water supply service in the city are implementing by Water Supply Section under Engineering Department of RCC. Headed by an Assistant Engineer, the Water Supply Section is composed of 144 employees. Out of which 106 employees are working against the total sanctioned posts and the rest 38 are engaged on temporary basis. As a Divisional Town Rajshahi City water supply system should be more strengthen. It has only one first class officer where as in Dhaka WASA there are 175 first class officers with the total number of employee is 3135. (Ref. WASA, 2000).

The present tariff structure is designed on the basis of a bye-law titled as "Rajshshi Water Supply – water tax fixation and collection Bye-Law, 1989, "approved by the government.

3.5 Water demand

Water demand of RCC area has been assessed on the basis of predicted future population, per capita water consumption, non-residential water requirement and losses and wastages. Water demand up to the year 2015 is summarized below:

Table 3.6: Estimated Population and water demand

Parameter	Year				
	1995	2000	2005	2010	2015
Population	529539	596234	689454	789454	952723
Water demand (m^3/day)	78843	88857	116473	156528	232286

Source: BETS, 1994

From the above population and water demand statistics it is evident that the growth rate is in increasing trend and so the water consumption rate. As in 1995 the growth rate was 2.40% where as as in 2015 it will be 3.596%(assumed) and per capita water demand was 148 litre/day in 1995 and in 2015 it will be will be 243 litre/day(assumed).

3.6 Water quality

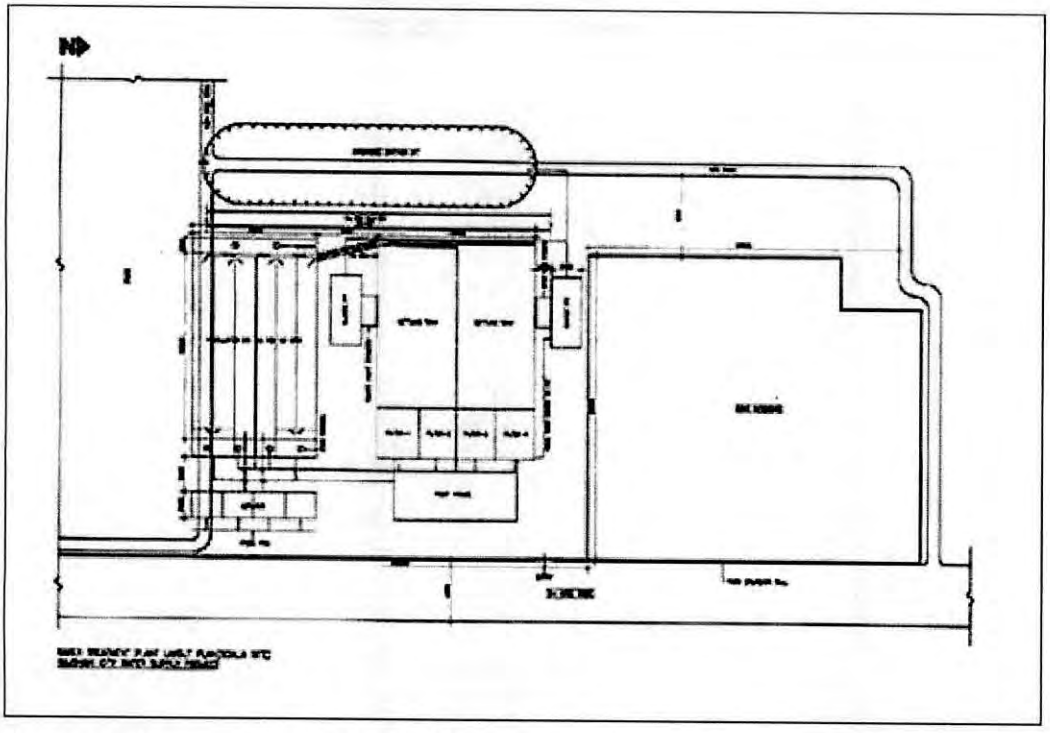
An ideal water works management should ensure that the water supplied for public distribution should be free from pathogenic organisms, undesirable taste and odor, should be clear, palatable, of reasonable temperature, neither corrosive nor scale forming in pipes and should be free from minerals which could produce undesirable

physiological effects. Therefore, when water is supplied to a town from a public water supply scheme, potable water should be supplied for drinking purposes. Potable does not mean pure water but free from harmful impurities, harmful salts and harmful bacteria.

The aim of laboratory tests were to ensure that potable water confirming to standard was supplied to consumers. The taste data have been given in Appendix-A. Tests were performed for the determination of water quality parameters AS, Fe, TDS, TSS, TS, TC and FC. From the test results it was observed that all the parameters except the value of TC and FC were within the acceptable range albeit few wards were exceptional. The value of FC was very high in few wards which indicates the real feature of the quality of water supply in this metropolitan city. The most important parameter of drinking water quality is the bacteriological quality i.e. presence of pathogenic organisms. Pathogenic bacteria cause typhoid, cholera, dysenteries etc. Though ground water is vulnerable to bacterial pollution unlike surface water, it can easily be affected by the same due to system leakage. This is the major reason of faecal pollution in Rajshahi city water supply system .Many leaky points in the water mains adjoining the public sewage drains were seen by the author during the field visits. As the system of supply is intermittent so during the non supply period such pollution is a common phenomena. People experiencing water borne diseases every now and then. Those who are boiling the drinking water they are safe but still some poor people who collect their water from street stand pipe have no sufficient means to boil the water as the fuel is costly. They are the victim of water borne diseases and some times embracing the cold death.

3.7 Water treatment

Manganese, iron and hardness are identified as the major water quality problem in ground water supply. So simple steps in the treatment process are Aeration, Sedimentation and rapid sand filtration. In addition arrangement of post-chlorination to reduce the risk of bacterial contamination. Every treatment plant is treating the water coming from 4 nos. of deep tube-wells. Figures show the location of treatment plant & layout of water treatment plant.



(Ref. Feasibility studies on Rajshahi water supply, sanitation and drainage project, 1994).

Figure 3.1: Ground water treatment plant at Ramchandrapur

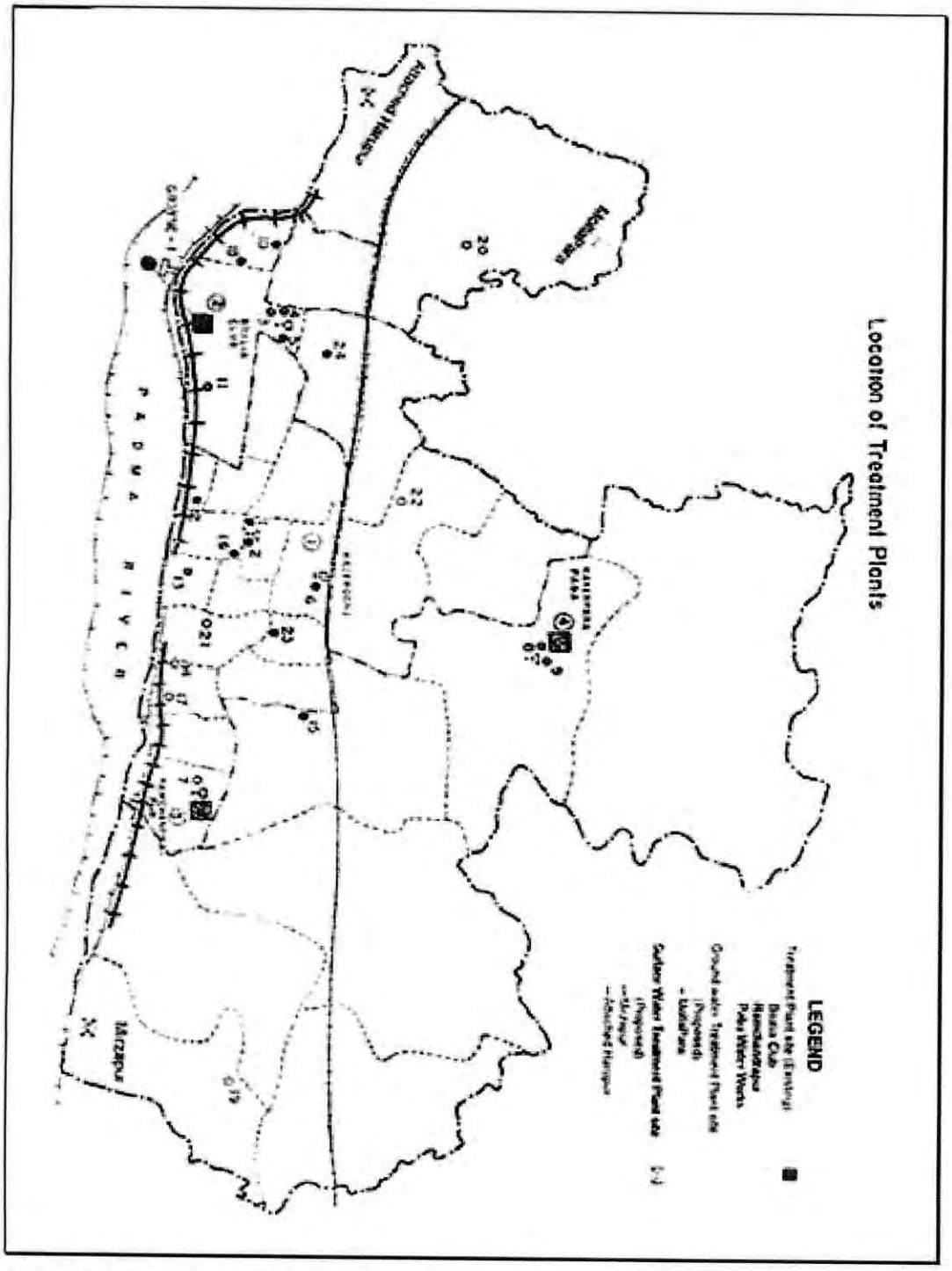


Figure 3.2: Location of Ground water treatment plant

3.8 Questionnaire survey

Questionnaire survey was conducted by the author in 150 nos. of house hold of all 30 wards to know the opinion of water users about the water supply system of RCC. The survey was done on a random basis, which does not necessarily represent the exact feature of RCC water system. But one can have an idea of the whole system. Survey result have been listed in appendix-F

CHAPTER 4

ANALYSIS AND DISCUSSION

Rajshahi water works started in 1937 with construction of public water hydrants known as Dhopkal (See Appendix-B). 85 are still in operation. It has been observed from the water tariff structure that from pipe diameter of 1½" to 4" are treated as commercial line and pipe diameter of ½" to 1" are treated as domestic line. Again from water connection summary it was observed that the commercial demand is only 0.37% where as domestic demand is 99.63%. So it is a burning issue to ensure a potable water supply system in Metropolitan area. The data on water quality that collected from RCC and DPHE were insufficient to make any comment. Their results showed that the iron and manganese contents were a bit higher than the acceptable limit (Table-2.2). Infact the concerned authority for looking after the water supply system is indifferent about maintaining the quality which is much more important than quantity. Because users need potable water supply which will satisfy all the criteria of ideal water.

Recently, three ground water treatment plants have been constructed by the DPHE at three different locations with a view to improving the quality of water. The plants were designed to remove Fe, Mn, and Hardness & Bacteria. Each plant can treat the water coming from 4(four) deep tube wells. It has been stated earlier that there 45 deep tube wells in the RCC area. Hence only the water of 26.67% deep tube wells is under the coverage of water treatment plants. The purified water coming out from the plants is directly mixing with the water coming from the other tube wells. As a result the consumer getting a mixture of treated (26.67%) and untreated (73.33%) water. Obviously the quality of raw water will dominate in the supply. As the plants are located in three different sites so the ultimate result would not be satisfactory. If the supply from the three plants were limited to a definite zone then the objectives would be achieved and the people would get pure drinking water. In this way total area may come under a potable water supply network. The out come of the primary data were based on a household survey of size of 150 nos. of household through out the entire 30 wards. In the questionnaire survey the water users' were interviewed with questions pertaining water supply system.

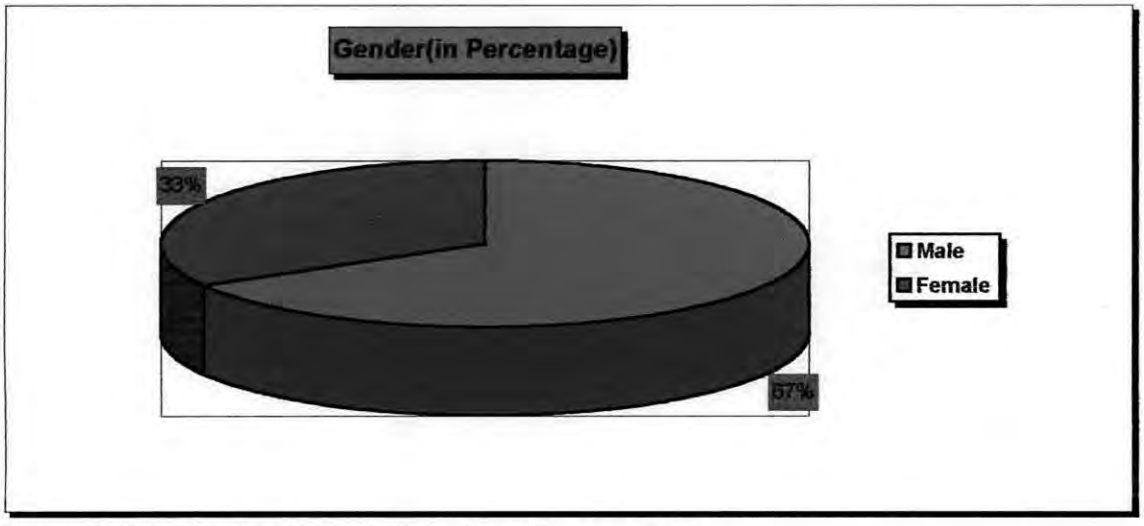


Figure 4.1: No. of male and female interviewee (in percentage)

Fig. no. 4.1 shows the percentage of male and female users who were interviewed. Numbers of female participants (33.33%) were nearly half of the male (66.66%). Infact females are more exposed to water use then male. So the nos. of female participant is a key point is the study.

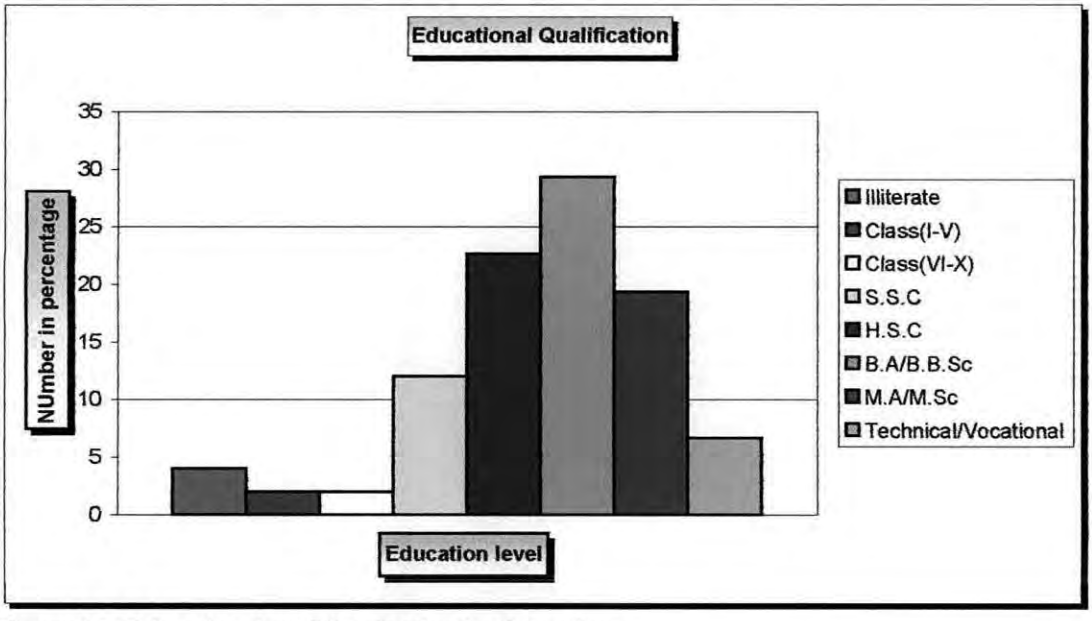


Figure 4.2: Educational qualification level of interviewee

Fig. no. 4.2 reveals the educational status of the interviewees where the percentage of graduate level was the highest (29.33%) among all other levels. Transparencies of the survey work mainly depend on the understanding power and consciousness of the users. In this regard the aim of the study is justified.

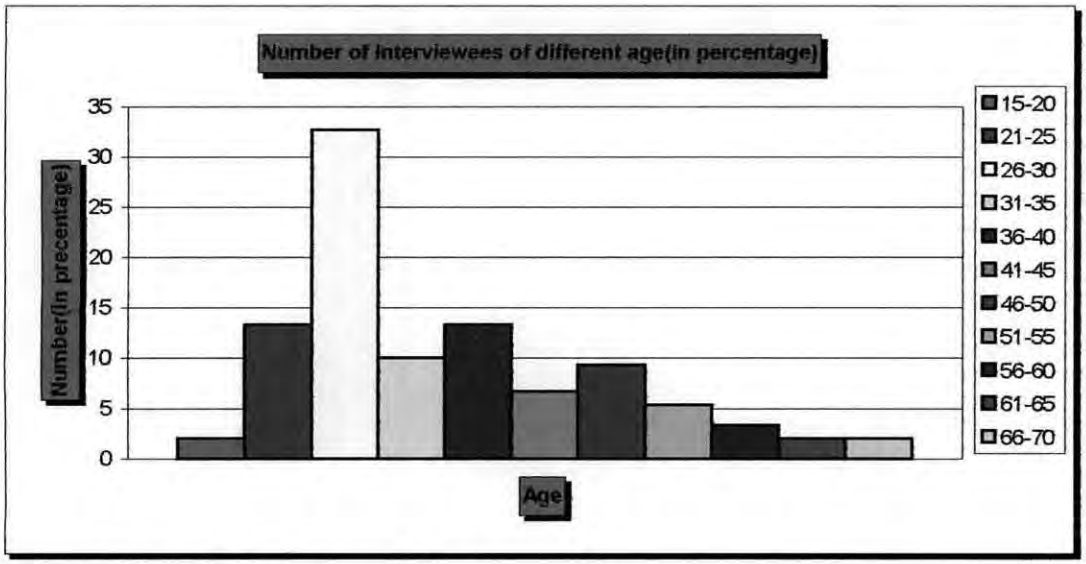


Figure 4.3: Number of Interviewees of different age (in percentage)

Fig. no. 4.3 describes the percentage of interviewees of different age where the users of the age level 26-30 attained the top position (32.66%) in the survey work. Next nearest age level were 21-25 (13.33%) and 36-40(13.33%). Hence there was a proper blending of people of different ages.

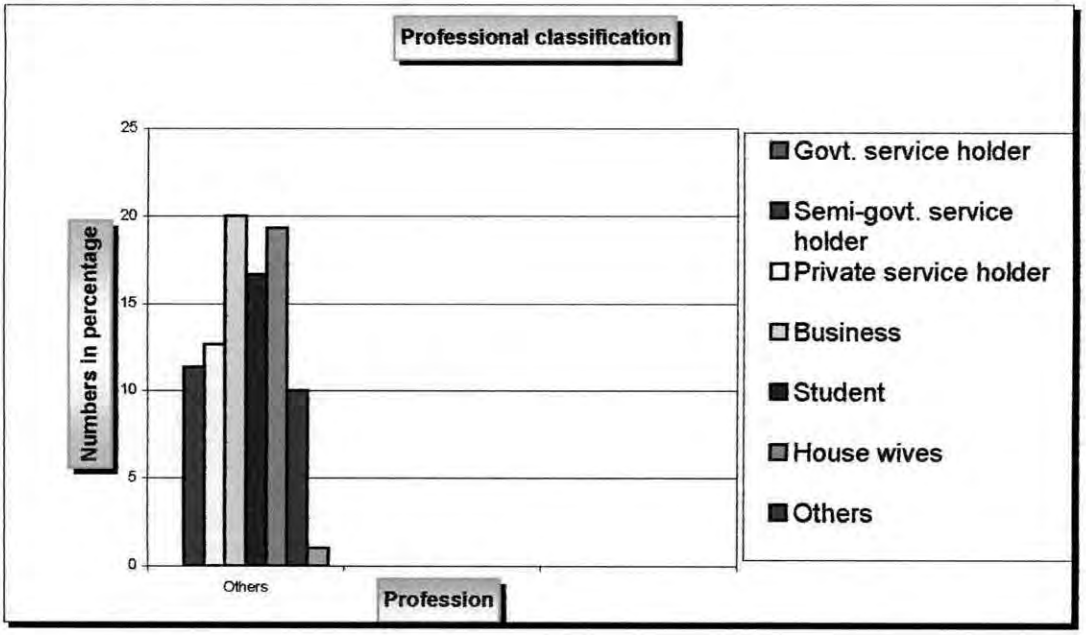


Figure 4.4: Professional classification

Fig. no. 4.4 makes a comparative figure of interviewees of various professions. Among the interviewees there were 20% businessman, 19.33% house wives, 16.66% students, 12.66% private service holders, 11.33% semi-govt. service holders, 10% government service holders and 10% of others category. Other category includes the

retired persons, strangers and unemployed persons. The results of the questions for the assessment of water quality were studied from the graphs prepared with the aid of data collected from the field. The survey work was dealt with only piped water supply in the RCC area. No user claimed any objection about the taste (saline or sweet) of water i.e. the taste of water is sweet.

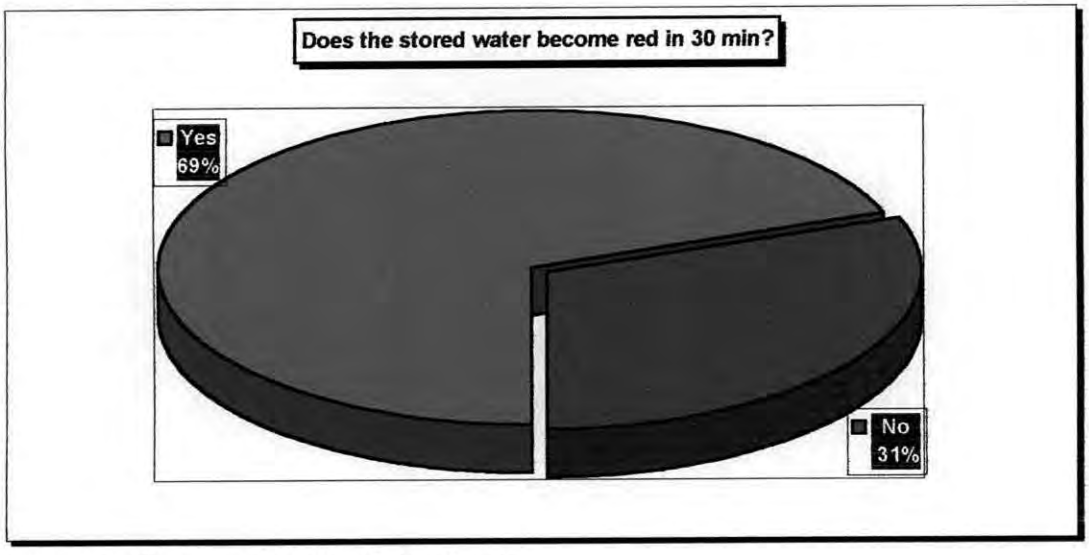


Figure 4.5: Change in the color of stored water

From the, Fig.-4.5, 69% users said the stored water became red within 30 minutes. Where as the rest 31% said no. Infact, some zone of RCC area are governed by the higher intensity of iron content.

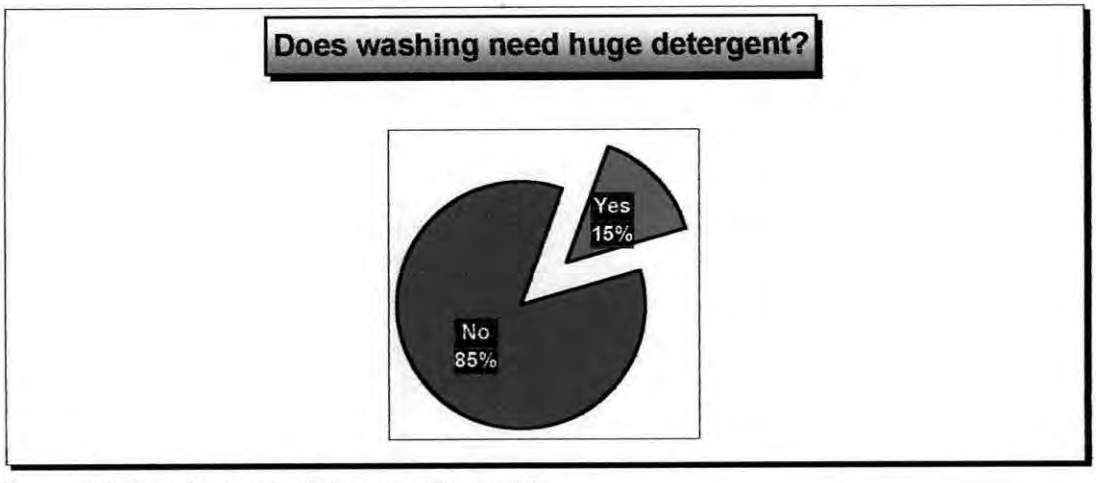


Figure 4.6: Requirements of detergent in washing

From the Fig.-4.6, only 15% users said that washing need huge detergents and the other said no. Consumption of detergent is mainly related with the hardness of water.

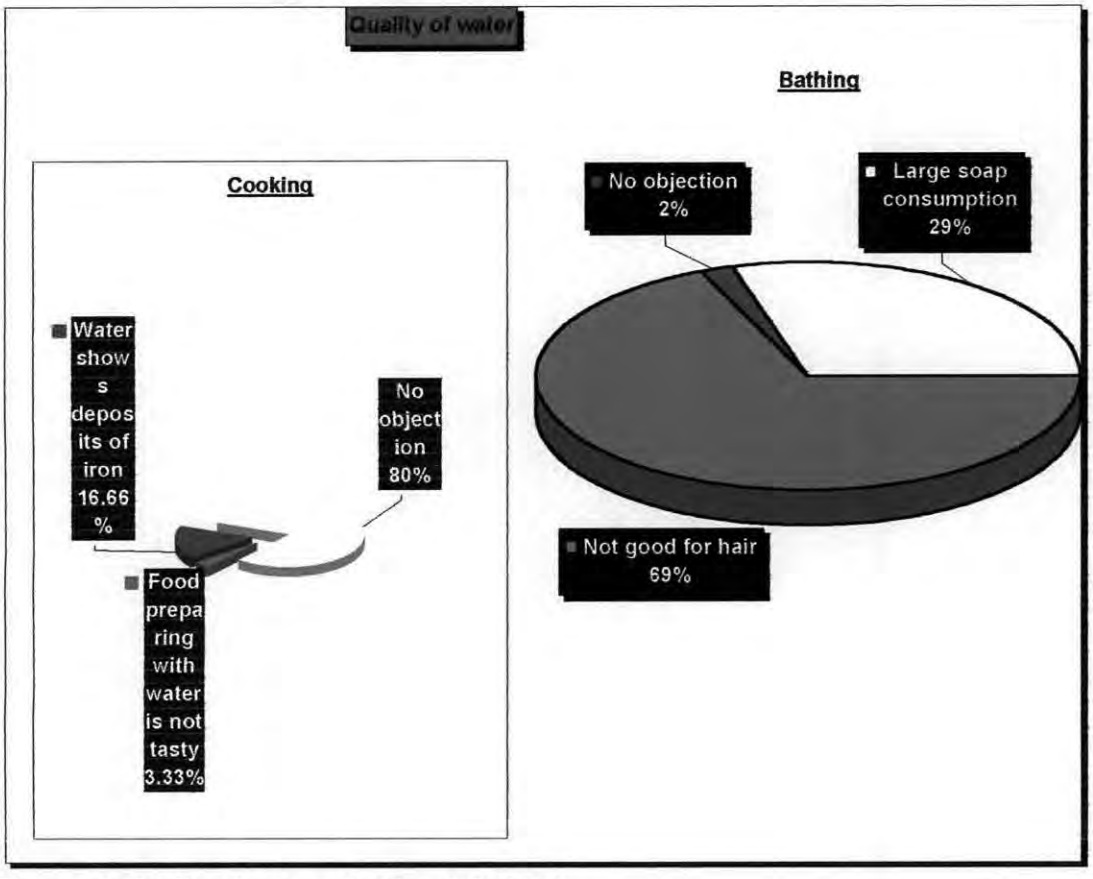


Figure 4.7: Quality of water (Cooking & Bathing)

For asking about the quality of water as bathing and cooking from the figure above , 68% users claimed that the water is not suitable for bathing as it is sticky. 29% claimed no objection and only 2% said water consumed much soap. From the Fig.-4.7, 80% users agreed to use the water for cooking without any objection. 16% said that water shows deposits of iron after cooking. 3.33% said food prepared with this water is not tasty so they use pond water for cooking. About the quality of water majority of the consumers raised no objection for cooking but in cage of bathing they uttered that the water is not suitable for maintaining good hair. So the water contains iron along with hardness.

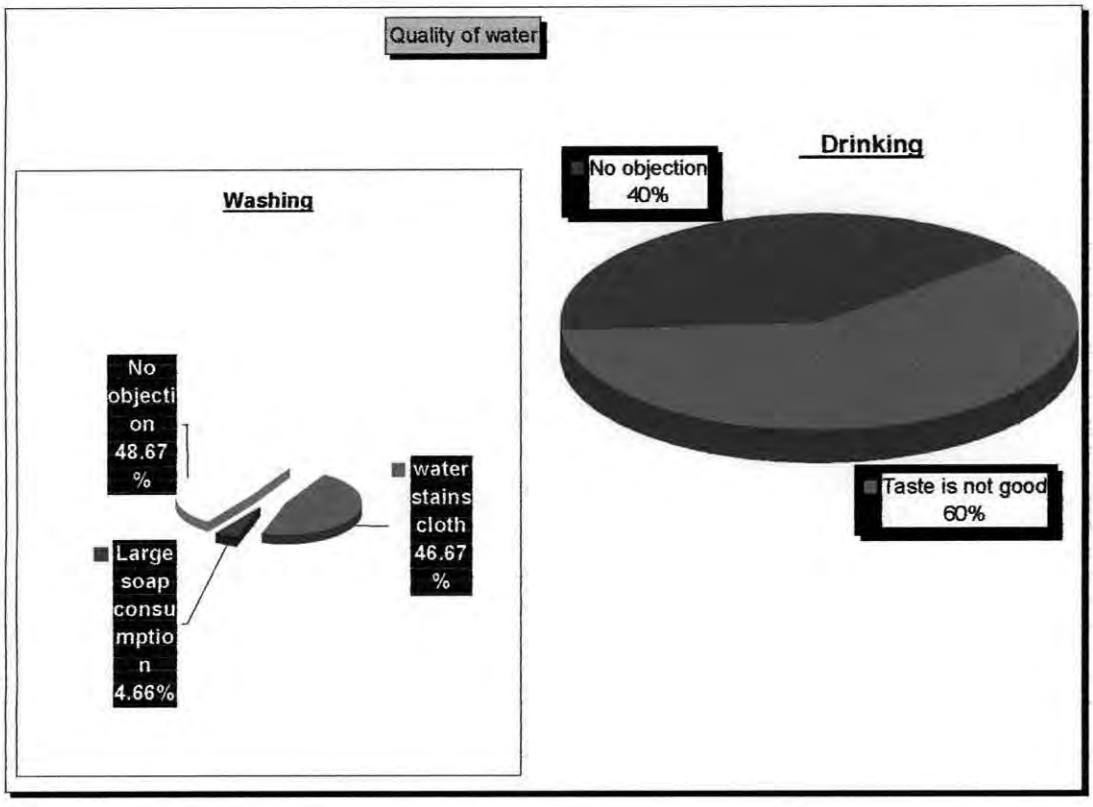


Figure 4.8: Quality of water (Washing & Drinking)

Fig.- 4.8, stands for drinking purpose.60% consumers do not use tap water as it is not reliable. They use shallow tube well water instead. It is noted that almost every house there is a shallow tube well. 40% people use tap water for drinking purpose. Fig.-4.8 , developed form the data collected on washing criterion.46% people said that water stains cloth so they pond water or shallow tube well water for washing. Where as 48% people did not show any disparity with the quality of water for washing. Only 4% people said that it consumes large soap for washing.

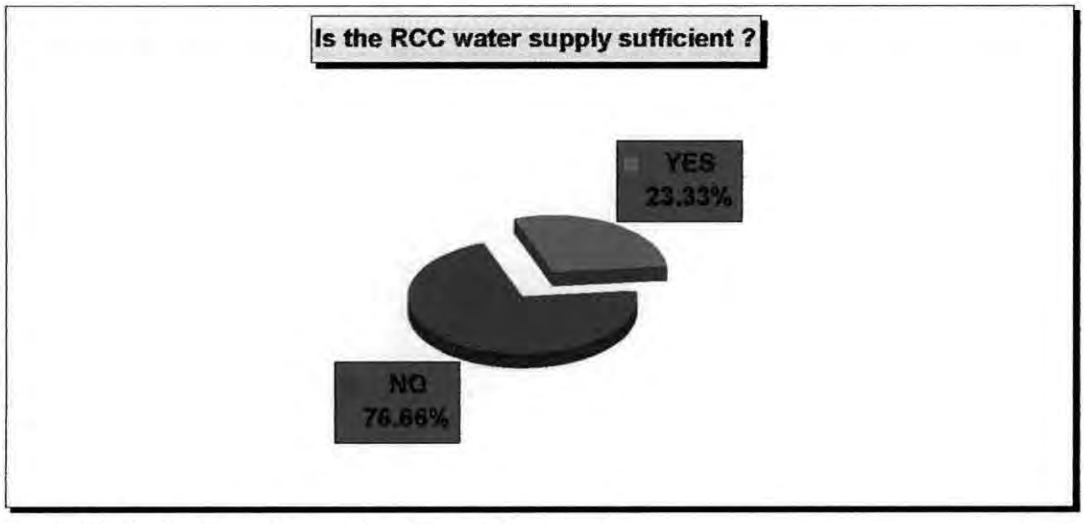


Figure 4.9: Sufficiency of present water supply system

In Fig.-4.9, it is clear about the sufficiency of water supply.76% users said that the supply is not sufficient to meet their demand and the rest said the supply is enough. Infact the supply is not sufficient as the water pressure is low at users end. Due to leakage at street stand pipes substantial amount of water is wasting.

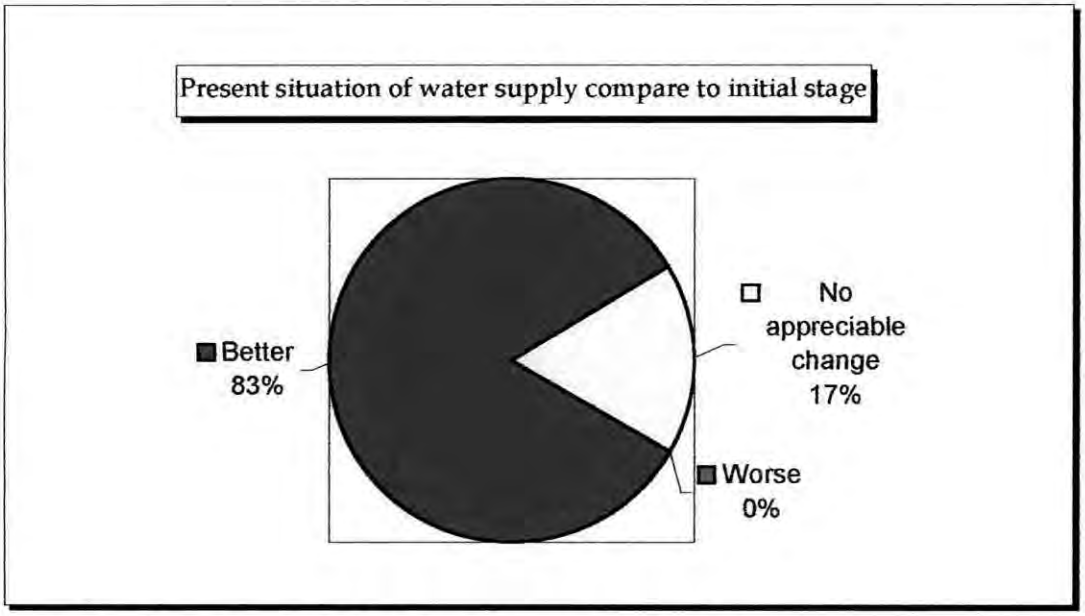


Figure 4.10: Present situation of water supply compare to initial stage

Fig.-4.10 shows the comparative feature of present water supply condition in view of the people with past system. 88% users said the present supply condition is better than the earlier and 18% said no appreciable change at all. Improvement in the supply system along with passage of time is consistent that's why people said the system is improving. Due to increasing demand the RCC and the DPHE jointly trying to cope with the demand.

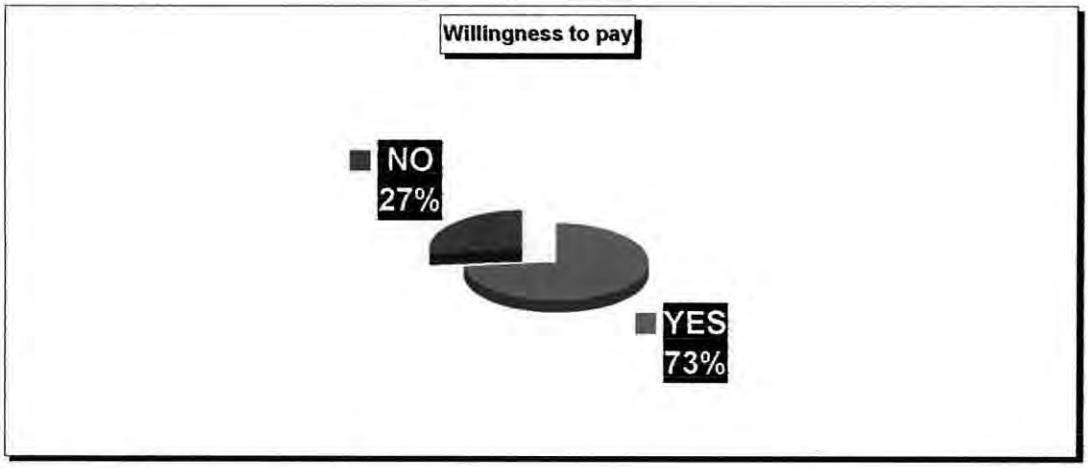


Figure 4.11: Willingness to pay

It was asked to the users about the willingness to pay more for better service i.e. high pressure all time, better quality, continuous supply etc. From Fig.-4.11, 73% people

were agreed to pay more and only 26% said that they would not pay more. For having a better supply system people of all works of life is ready to pay more. But those who have meager in come they are satisfied with the prevailing system with poor quality and insufficient quantity.

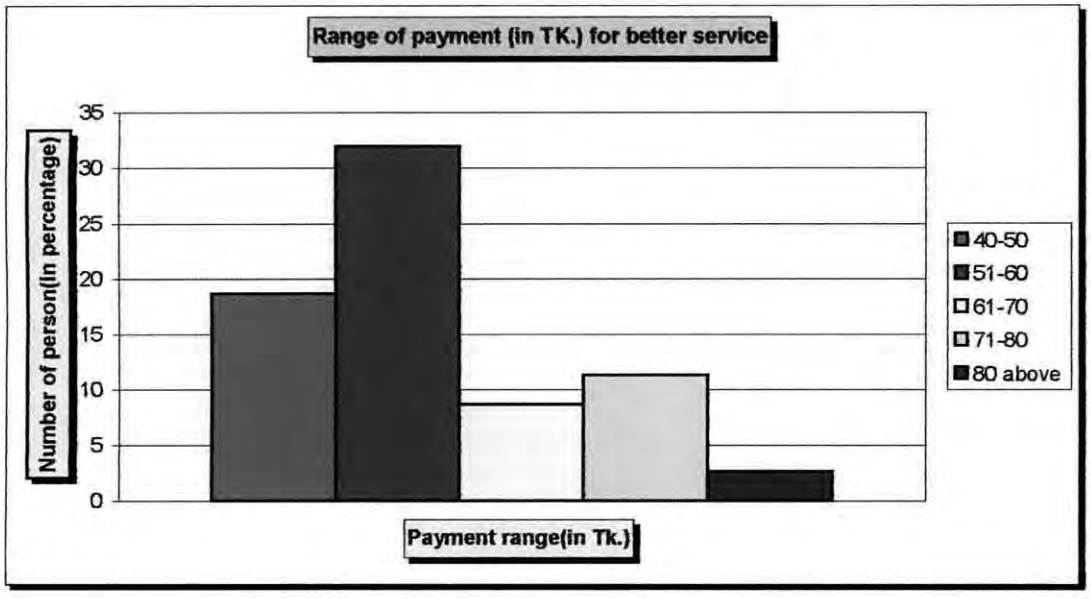


Figure 4.12: Range of payment (in TK.) for better service

A comparative payment range of willing to pay by the users has been figured in Fig.- 4.12. The range of payment is based on a fictitious scale prepared by the author. It only shows that the consumers willingness to pay more to have a sound water supply system.

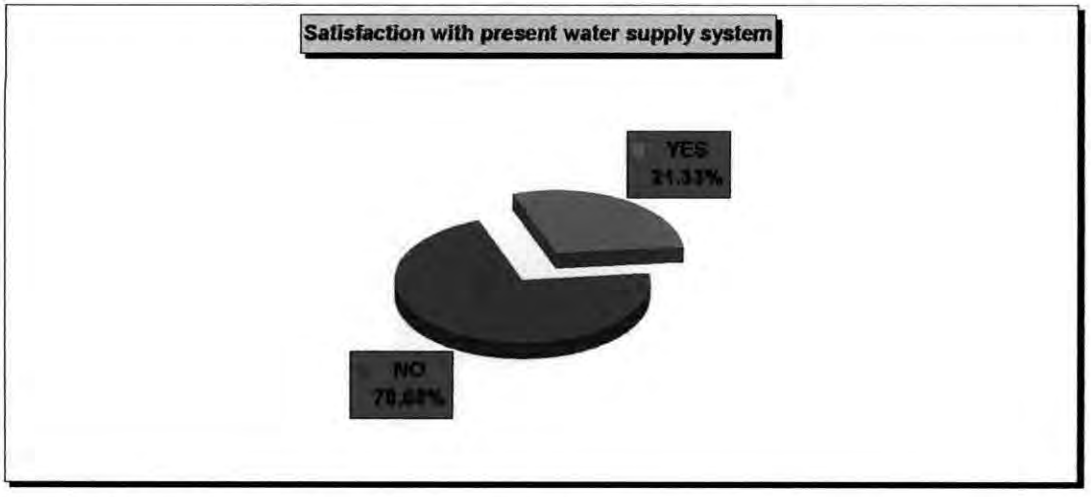


Figure 4.13: Satisfaction with present water supply system

Fig.-4.13, reflects the satisfaction of the consumers with the existing water supply system as a whole. 78% users were not satisfied with the supply where as 22% were satisfied with the supply. Actually satisfaction is directly related with the living standard, expectation, and consciousness. Hence more the consciousness, the higher

the expectation and then satisfaction is a function of an efficient water supply management.

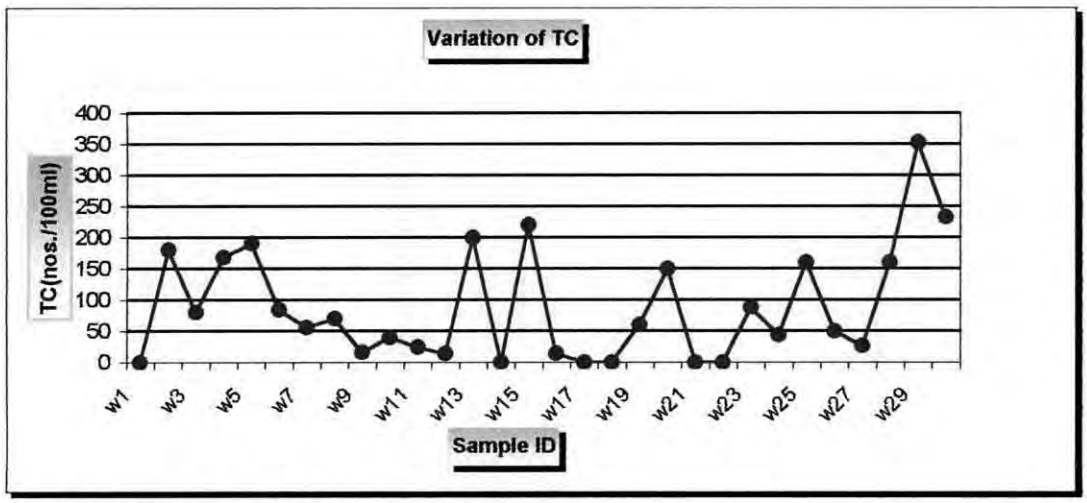


Figure 4.14: Variation of TC

For the presentation of water quality test results 6 nos. of graph have been prepared. Fig.- 4.14 , shows the variation of TC. A wide variation of TC has been noticed among the 30 wards. Out of 30 samples only 6 samples satisfied the Bangladesh guideline for drinking water. The sample from the rest 24 wards showed the value higher than the acceptable limit.

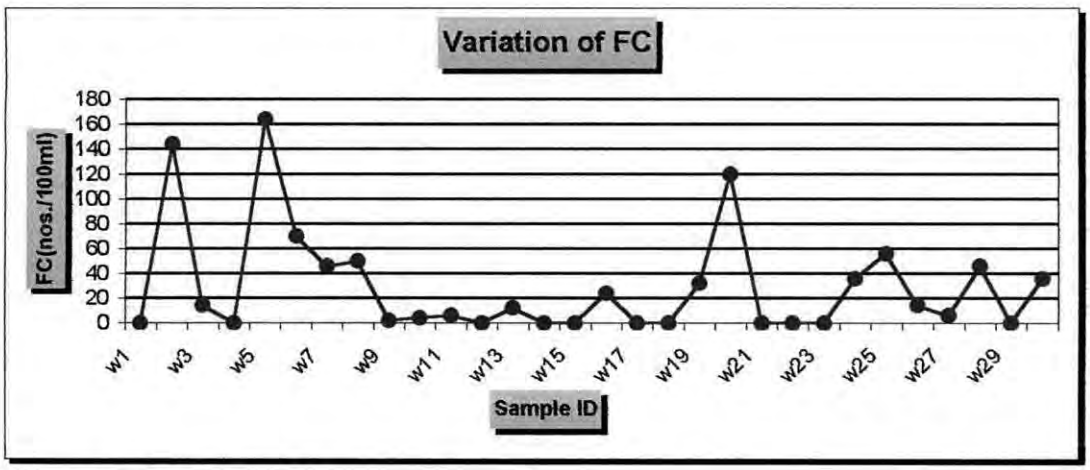


Figure 4.15: Variation of FC

From the Fig.-4.15, variation of FC showed the presence FC was very high in the water of ward no. 2,5 and 20. Only 11 samples satisfied the Bangladesh guideline for drinking water. It should be noted that the standard value for Bangladesh of TC and FC is zero. Presence of FC indicates that the water contains faecal material. This faceal material hold diseases producing faecal bacteria. For a potable water supply system presence of FC is unwanted.

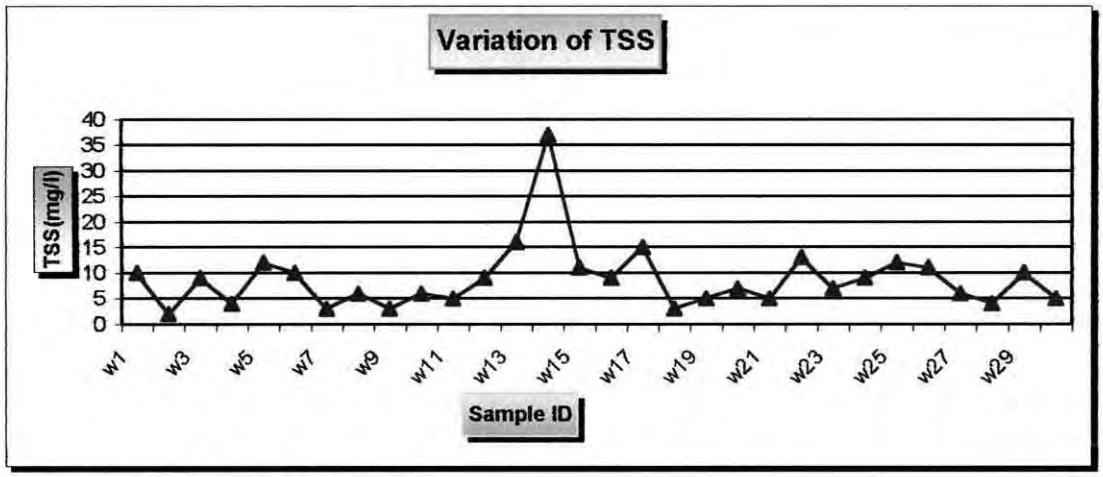


Figure 4.16: Variation of TSS

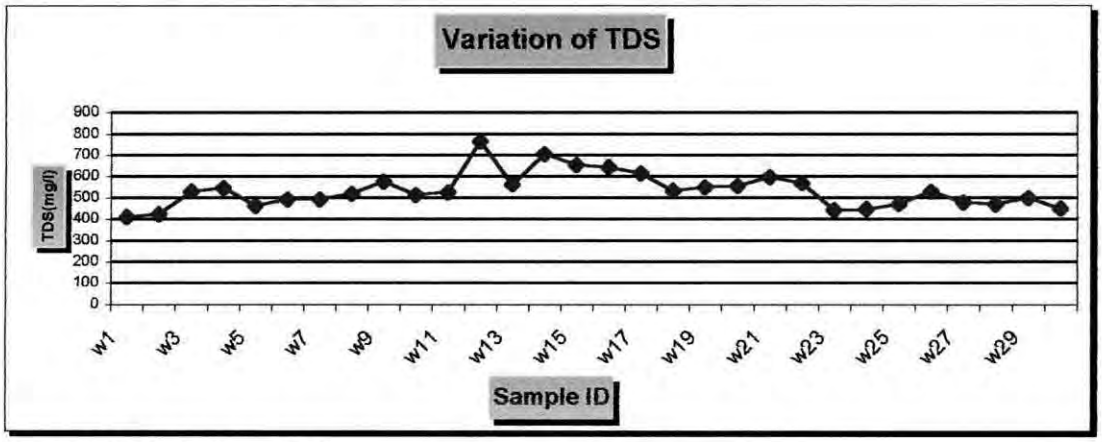


Figure 4.17: Variation of TDS

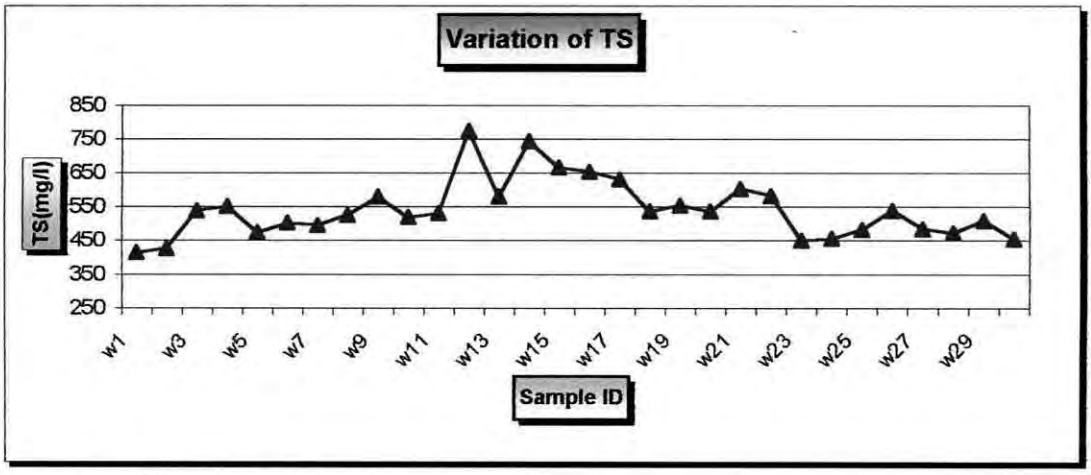


Figure 4.18 : Variation of TS

Fig.- 4.16, 4.17 and 4.18 , show the variation of TSS,TDS and TS. Fig.-4.16 shows that the TSS in few wards exceeded the permissible limit of 10 mg/l in Bangladesh. Though the values TDS and TS from the Fig.-4.17, and 4.18, are high in all the wards but below the value set for Bangladesh guideline for drinking water.

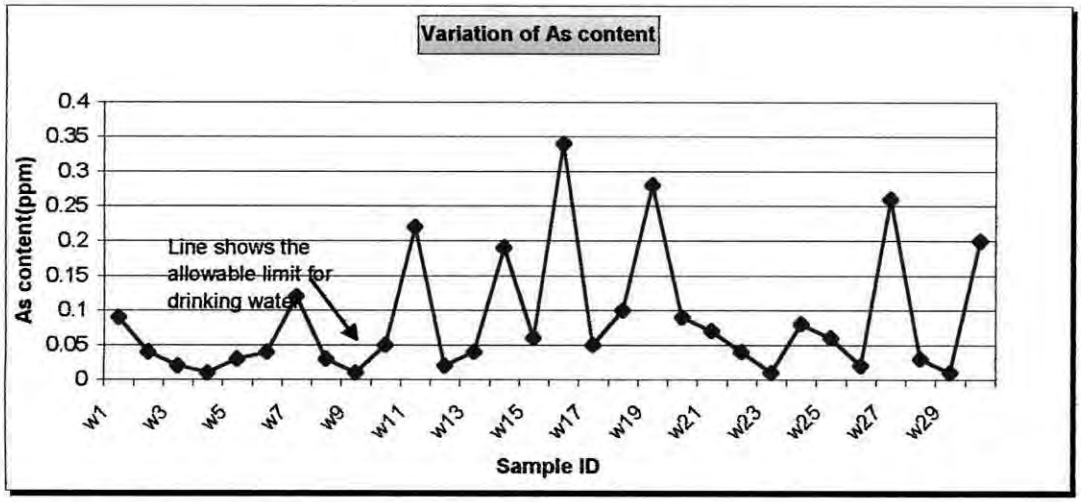


Figure 4.19: Variation of As content

Fig.- 4.19 , is made for indicating the variation of Arsenic content in all the 30 wards of RCC. Out of 30 Samples 12 exceeded the limit value 0.05 mg/l for Bangladesh. Hence the water supply authority should take initiative for arsenic removal from the supply water after a thorough water quality testing. Otherwise people will suffer form arsenocosis.

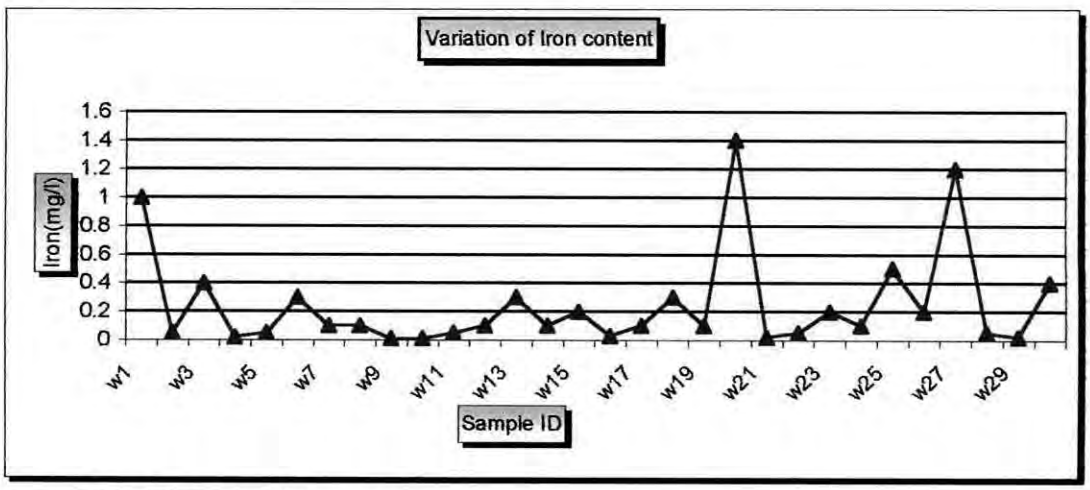


Figure 4.20 : Variation of Fe content

Fig.- 4.20, is plotted for the assessment of variation of iron content in all the 30 wards of RCC area. Iron content in ward 20 and 27 exceeded the standard value for Bangladesh (0.3-1.0 mg/l). Above all the amount of iron content is appreciable in almost all the wards. Presence of iron interfere with laundering operations, impart objectionable stains to plumbing fixture and cause difficulties in distribution system by supporting the growths of iron bacteria.

CHAPTER 5

Conclusions, Recommendations and Limitations

Conclusions :

The following conclusions have been drawned from the study by the author.

- The quality of supply water should be improved as it contains objectionable amount of FC.FC were found nearly 63% of the study area. So disinfection actions should be enhanced for a potable water supply.
- Out of 30 ward, ward no.5, ward no. 13, ward no.14, ward no.17, ward no. 22 & ward no.25 show the presence of TSS. The amount of TSS in all these ward is higher than the allowable limit of 10 mg/l. More over among these 6 wards ward no. 14 shows 37 mg/l, which is higher by 27 mg/l from allowable limit.
- Test results shows that the supply water of RCC is not free from arsenic contamination. The maximum level of arsenic detected in ward no.16, which is 0.34 mg/l
- From the questionnaire survey it is evident that people shows their view about the poor quality of water. Test results also ensure that the prescience of iron in ward no. 20 & 27. The value are 1.4 mg/l and 1.2 mg/l respectively.
- 76.66% people in the study area expressed their deep concern about the in sufficiency of water supply.

Recommendations :

5.1 Creation of a new water authority

This would involve a transfer of water supply from the joint efforts of RCC and DPHE to a Water Authority with transfer of development tasks of planning, design, construction, operation and maintenance. Consequently, the whole water supply system will be the control of a single simplified authority ensuring a better service for the city dwellers. Dhaka and Chittagong WASA organisational system can be incorporated in this regard.

5.2 Privatisation of water supply services

RCC water supply could completely privatised in the manner some banks and industrial enterprises have previously been privatised by the Government of Bangladesh. A major benefit would be that administrative and managerial efficiency would increase, resulting in improved service to the consumers.

5.3 Metering System should be incorporated

Introduction of a metered water supply system administered through the Water Supply Section as the most appropriate mechanism for Rajshahi City Corporation to upgrade their revenue generation over the long term. The major advantages of such a system include-

- Payments based on actual use will encourage better water management and conservation.
- Increased consumption through sharing of connections will be charged as per actual use.
- Pricing formulas can be developed which directly relate service costs to the level of use.
- All revenue will come through a single point, which can be controlled by the Water Supply Section.

Under the metering program existing consumers with service connections in areas that are awaiting rehabilitation will continue to pay according to the existing system, while new connections or reconnections in the areas will be metered. To encourage acceptance of the meters it is suggested that households that will no longer pay the water portion of the holding tax.

5.4 Ground water monitoring system should be developed

There should be a regular ground water monitoring and evaluation system for the deep municipal aquifer to forecast the consequence of over extraction as the demand for water supply increases with time .It is important that a ground water resource monitoring system should be implemented as early as possible.

5.5 Rehabilitation of existing distribution system

The existing water supply system is generally in poor condition due to aging, lack of proper quality control during construction and a lack of regular maintenance. Numerous leaks contribute to the high system losses and the existing system, as a

whole will require extensive repair and rehabilitation. Many of the sluice valves and chamber will require repair, most of the public hydrants are damaged and need to be re-built or replaced, many of the service connections need to be rehabilitated. Periodic cleaning of the distribution lines and supply mains should be ensured because the users claimed that they faced dirty supply water every now and then. There were five overhead reservoirs in the supply system, one of which has been dismantled recently, beside by RCC bhaban. The rest four are nearly abandoned.

The proposed rehabilitation programs of the abandoned overhead tanks includes the following:

1. As the supply system is electricity dependent, so currently no electricity means no supply. In this regard the overhead tanks may be the source of supply during period of load shedding.
2. May be a means of reduction of pressure variation at the users end.
3. Can be acted, as settling tank, so supply be will be of better quality.
4. Continuous supply will be assured.
5. Utilization of asset.
6. No need to construct extra deep tube well.
7. Facility of adding bleaching agents for killing the bacteria population in the water.
8. No interruption in the supply in case of any overhauling work of the pumping stations or of any sudden shutdown.

5.6 Expansion of distribution system

The expansion program will include all capital construction works necessary for expansion of the existing supply, distribution and storage capacity to provide a potable water supply system. This would include:

- Development of production wells to meet the additional supply requirements.
- Construction of distribution and conveyance system.
- Construction of overhead tanks or ground storage reservoirs and
- Installation of new service connections equipped with water meters.

5.7 Replacement of abandoned wells

There are nearly 5 production tube wells within the RCC inventory, which have been abandoned or are not running. These wells should be replaced to augment existing supply capacity.

Limitations :

During the process of the study the researcher faced some problems in the field at the time of data collection, map collection, and information collection. The main limitations of this study are stated as:

- There was not such information available from the secondary sources, which created huge discomfort to this study.
- Lack of sufficient relevant literatures also hindered the researcher to conduct the study.
- Different organizations were not helpful enough to provide information for conducting the study.
- The interviewees were not helpful to assist the survey work duly.

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APPENDIX- A

Water quality test result :

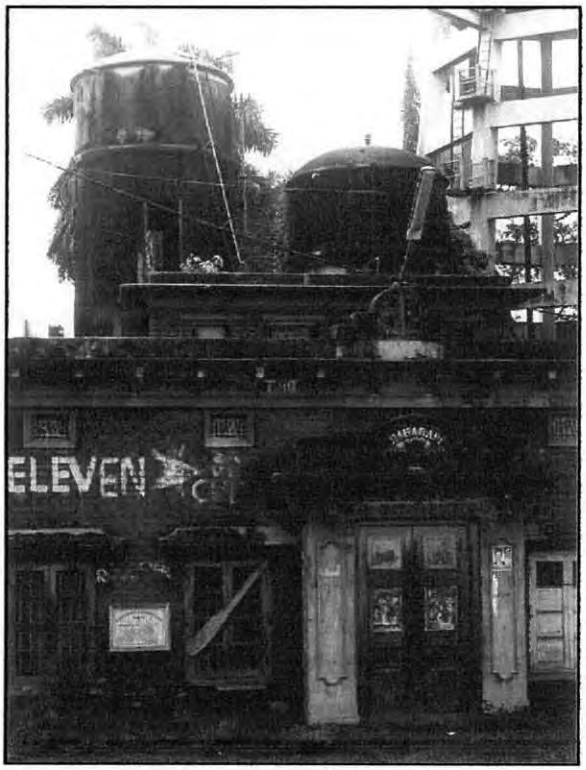
Sample Location	Sample ID	Laboratory Test Result						
		TC (Nos./100ml)	FC (Nos./100ml)	TS (mg/l)	TDS (mg/l)	TSS (mg/l)	As (ppm)	Fe (mg/l)
W1-Katalbari	W1	0	0	414	410	10	0.09	1
W2-Ranidighi	W2	180	144	426	424	2	0.04	0.05
W3-Bohorampur	W3	80	14	539	530	9	0.02	0.4
W4-Kesobpur	w4	168	0	551	547	4	0.01	0.02
W5-Botpara	w5	190	164	474	462	12	0.03	0.05
W6-Laskmipur	w6	84	70	502	492	10	0.04	0.3
W7-Chandipur	w7	56	46	495	492	3	0.12	0.1
W8-Kazihata	w8	70	50	526	520	6	0.03	0.1
W9-Sheikhpara	w9	16	2	579	576	3	0.01	0.01
W10-Hatemkhan	w10	40	4	519	513	6	0.05	0.01
W11-Sweepercolony	w11	24	6	530	525	5	0.22	0.05
W12-Sapura	w12	14	0	774	765	9	0.02	0.1
W13-RCC area	w13	200	12	579	563	16	0.04	0.3
W14-Uposahar	w14	0	0	743	706	37	0.19	0.1
W15-Bornalirmor	w15	220	0	666	655	11	0.06	0.2
W16-Zinnanagar	w16	14	24	653	644	9	0.34	0.03
W17-BSCIC area	w17	0	0	631	616	15	0.05	0.1
W18-Sapura salbagan	w18	0	0	536	533	3	0.10	0.3
W19-Chotobonogram	w19	60	32	554	549	5	0.28	0.1
W20-Ranibazar	w20	150	120	536	556	7	0.09	1.4
W21-Ghoramara	w21	0	0	603	598	5	0.07	0.02
W22-Sagarpara	w22	0	0	582	569	13	0.04	0.05
W23-Boshpara	w23	88	0	449	442	7	0.01	0.2
W24-Ramchandrapur	w24	44	36	455	446	9	0.08	0.1
W25-Talaimari	w25	160	56	482	470	12	0.06	0.5
W26-Meherchandi	w26	50	14	539	528	11	0.02	0.2
W27-Padmahousing	w27	26	6	484	478	6	0.26	1.2
W28-Kazla	w28	160	46	472	468	4	0.03	0.05
W29-Binodpur	w29	352	0	509	499	10	0.01	0.02
W30-Chowdopai	w30	232	36	454	449	5	0.20	0.4

Sample collection date(dd/mm/yy) : 13/07/03, 17/07/03, 24/07/03
Collector name : M.A.Mansur Chowdhury

Appendix –B

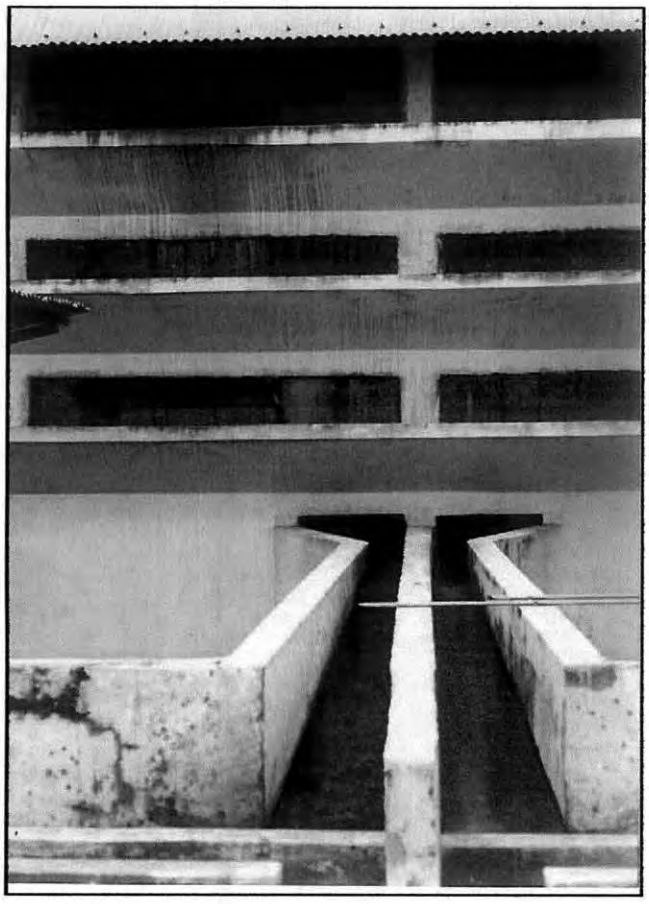
Photograph-01(Maharani Hemanta Kumari Water Works,Rarshahi 1937)

Photograph-02 Street water reservoir, local named as 'Dhopkhal' , are still in use.

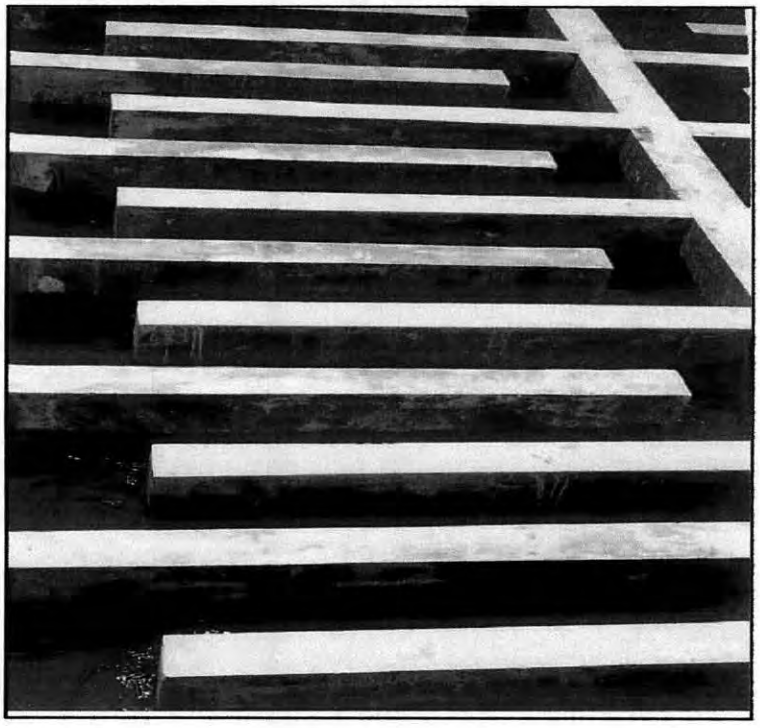


Photograph-03 Iron & hardness removal plant, installed in 1937, the first effort to safe water supply

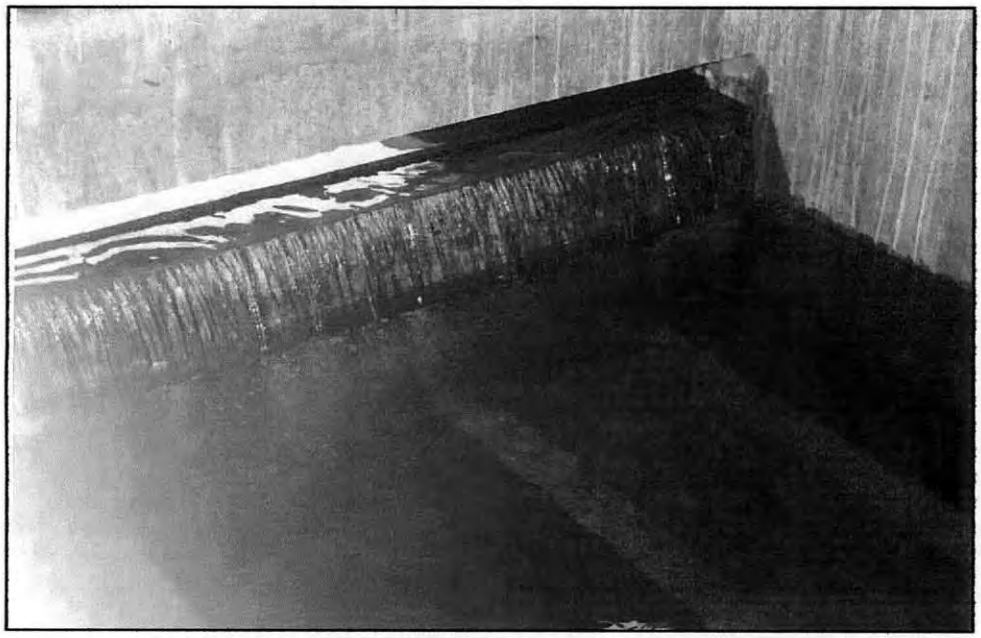
Photograph-04 Sedimentation tank of Water Treatment Plant near BDR camp



Photograph-05 Iron affected aeration chamber at Ramchandrapur Treatment Plant.



Photograph-06 Flocculation Chamber of Water Treatment Plant at Rajshahi Central Park

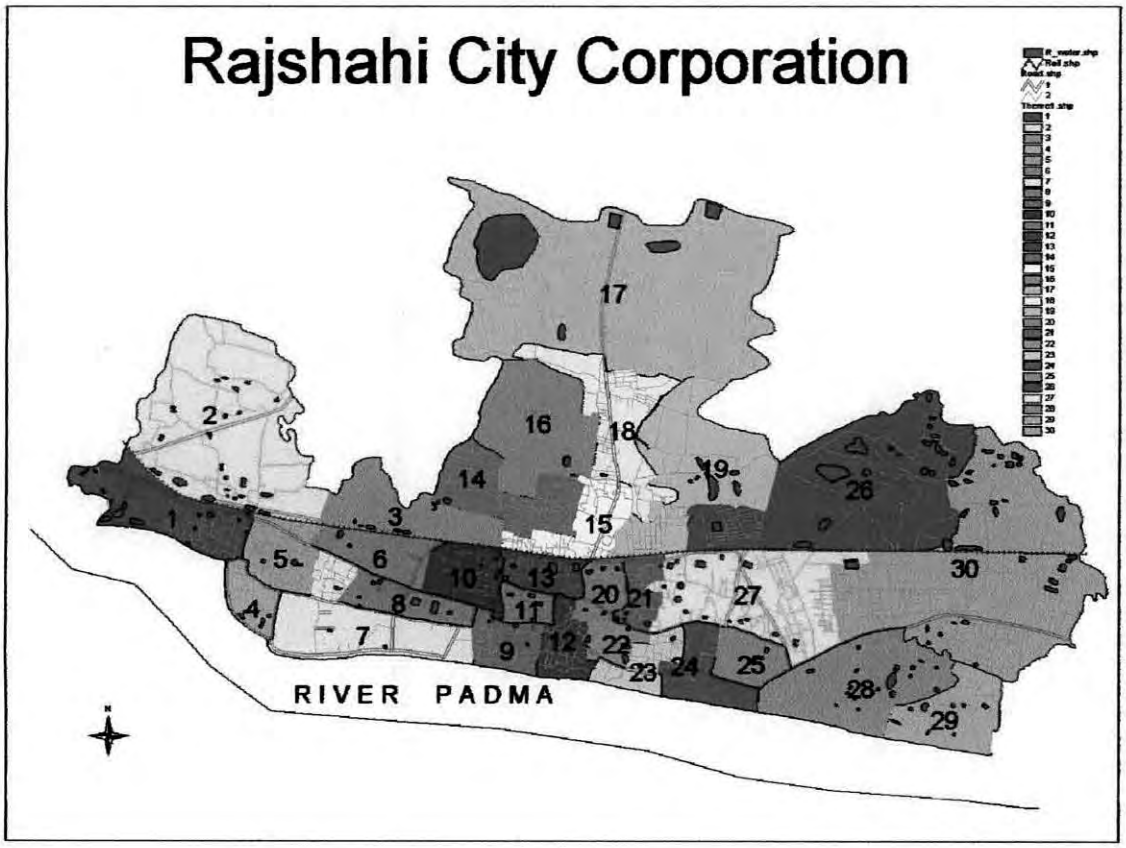


Photograph-08 Rapid sand filtration chamber of water at Rajshahi Central Park Water Treatment Plant.

Photograph-09 Pump House (Turbine) at PN Girls School.

Photograph-10 Pump House(Submersible) at Hatem Khan(Hemnati Kumari Water Works Compound)

Appendix-C


Rajshahi City Corporation
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RIVER PADMA

Appendix-D
Distribution Network of Piping System of RCC

APPENDIX-E

Department of Civil Engineering

Bangladesh University of Engineering & Technology, Dhaka

Questionnaire for the Research on
Need assessment for potable water supply in Rajshahi City

(N.B. All information will be used for research only)

SAMPLE NO.....
DATE.....

SURVEY QUESTIONNAIRE

ADDRESS: **QUESTIONNAIRE NO. :**

WARD NO. :
AREA :
HOLDING NO. :

NAME OF THE INTERVIEWEE :
NAME OF THE INTERVIEWER :
SIGNATURE OF THE INTERVIEWER :

1. Family information

Sl. No	Relation with Head	Age	Sex (male /female)	Education	Profession

Profession		Education	
Govt.	*01*	*Illiterate*	*0*
Semi-govt.	*02*	*Class(I – V)*	*1*
Private service	*03*	*Class(V-X)*	*2*
Business	*04*	*S.S.C*	*3*
Student	*05*	*H.S.C*	*4*
House wife	*06*	*B.A/B.Sc*	*5*
Others	*07*	*M.A/MSc*	*6*
		Technical/Vocational	*7*

02. What is the system for supplying water to your house?
- i) Pipe line □
- ii) Tube well □
- iii) Pond /River □
- iv) Rain water harvesting □

03. Does the stored water become red 30 minutes?
- i) Yes □
- ii) No □

04. Does washing need huge detergent ?
- i) Yes □
- ii) No □

05. Taste of water
- i) Sweet □
- ii) Saline □

06. Quality of water

1) Bathing
- Not good for the hair □
- Large soap consumption □
- Other (specify) □

2) Cooking
- Food prepared with the water is not tasty □
- Water shows deposit of iron □
- Other(specify) □

3) Drinking
   Taste is not good □
   Other(specify) □
4) Washing
   Water strains cloths □
   Large soap consumption □
   Other (specify) □

07. Is the RCC supply water sufficient?
   i) Yes □
   ii) No □

08. If the water is saline in that case how do you purify water for drinking?
(Applicable only for saline zone)
   i) Boiling □
   ii) Chemical □
   iii) Other process □

09. Existing condition in context of supply schedule
   i) Regular □
   ii) Irregular □
   iii) Intermittent □

10. Frequency and duration of water supply .
   i) Whole day □
   ii) Once daily □ Hours □
   iii) Twice daily □ Hours/ day □
   iv) More than twice a day □ Hours/ day □

11. When does the supply is available?
   i) Morning □
   ii) Evening □
   iii) Night □

12. Availability of piped water

i) Sufficient	□	
ii) Insufficient	Dry season	Wet season

13. Present condition of supply compared to initial stage
   i) Worse □
   ii) Better □
   iii) No appreciable change □

14. Monthly payment(Tk.) ---------- only.

15. Willingness to Pay for Water Supply

i) Are you willing to pay more taka per month for the house connection which you own at present. If a continuous and reliable supply of water will be guaranteed (high pressure all day long). However of the same quality as it present.

Yes How much Tk.---------- No

ii) Are you willing to pay more taka per month for the house(yard) connection you own at present in case the water will be of better quality(soft water) and with high pressure throughout the day.

Yes How much Tk.---------- No

iii) Are you prepared to apply for a house (yard) connection if the quality from this piped supply is better (soft + more reliable) than at present.

Yes No

If yes, connection Fee Tk. -------- Monthly water charge Tk. -------

16. Are you satisfied with the present water supply system of Rajshahi City Corporation?

i) Yes □

ii) No □

17. Any suggested opinion for improving water supply system in Rajshahi City

i)_____

ii)_____

Appendix –F

Water Users' information (From questionnaire survey)
(The Survey was conducted for 150 nos. of household)

Professional classification in percentage of total no. of household 150

Government service holder	10%
Semi-govt.	11.33%
service holder	12.66%
Private service holder	20%
Business	16.66%
Student	19.33%
Housewife	10%
Others	0.02%

Educational Qualification

Illiterate	4%
Class *(I-V)*	2%
Class *(V-X)*	2%
S.S.C	12%
H.S.C	22.66%
B.A/B.Sc	29.33%
M.A/M.Sc	19.33%
Technical/Vocational	6.66%

Gender

Male	66.66%
Female	33.33%

Age

15-20	2%
21-25	13.33%
26-30	32.66%
31-35	10%
36-40	13.33%
41-45	6.66%
46-50	9.33%
51-55	5.33%
56-60	3.33%
61-65	2%
66-70	2%

Does the stored water become red in 30 min?

Yes	69.33%
No	30.66%

Does washing need huge detergent?

Yes	15.33%
No	87.66%

Quality of water

Bathing

Not good for hair	68.66%
Large soap consumption	2%
No objection	29.33%

Cooking

Food preparing with water is not tasty	3.33%
Water shows deposits of iron	16.66%
No objection	80%

Drinking

Taste is not good (so not in use)	60%
No objection	40%

Washing

Water strains cloths	46.66%
Large soap consumption	4.66%
No objection	48.66%

Is the RCC water supply sufficient?

Yes	23.33%
No	76.66%

Present situation of water supply compare to initial stage

Worse	0%
Better	88%
No appreciable change	18%

Willingness to pay

Yes	73.33%
No	26.66%

Range of Payment (in Tk.)

40-50	18.66%
51-60	32%
61-70	8.66%
71-80	11.33%
80 above	2.66%

Satisfaction with the present water supply system.

Yes	32%
No	78.66%