DRINKING WATER SUPPLY AND SANITATION TO SUIT POST CYCLONE SITUATION IN THE COASTAL REGION OF BANGLADESH

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A THESIS BY

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ABSTRACT

Natural disasters such as cyclones and storm surges occur very frequently in Bangladesh specially in the coastal region of the country. Instant damages by cyclones and storm surge disasters are usually massive. Human lives along with their livestock and shelters are swept away. Damages to the sectors of agriculture, forestries, fisheries, industries and physical infrastructures are enormous.

The disaster surviving population face serious scarcity of safe drinking water during the post disaster period. This problem poses threat to their existence. Tremendous cyclones and tidal surges normally cause serious damage to the existing water supply and sanitation facilities in the coastal region. Hand tubewells are either broken or partially damaged and become unusable due to submergence by polluted or saline sea water. Limited sanitation facilities in the affected areas no longer exist. Ponds and other open water bodies are all contaminated by the onrush of saline water thereby leading to a serious crisis of drinking water and consequently post disaster outbreak of water borne diseases. These again take away lives of thousands of the affected people.

While the death toll in the April, 1991 cyclone is of the order of 1,50,000 an order of about 1,00,000 people got diarrhoea in matter of weeks after the cyclone due to the deficiency of safe water and proper sanitation facilities.

In general, the coastal region of Bangladesh is identified as a saline problem area. Complexity in hydrogeological situation makes the water supply in that region relatively difficult compared to other parts of the country. This is reflected in the low service coverage with potable water in the area. Rural sanitation coverage in the coastal region is also extremely poor.

By adopting proper measures, the post disaster crisis of drinking water supply in the affected areas may be redressed to a large extent and thus minimized loss of human lives.

This particular thesis work has focused on the overall water supply and sanitation in the coastal region of Bangladesh. The major thrust of the thesis has been put to find out ways and means to tackle the post disaster crisis of safe water supply and sanitation.

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DECLARATION

This is to certify that neither this thesis nor any part of it has been submitted or is being concurrently submitted in candidature for any other degree at any other institutions.

This is to further certify that except where specific reference to other investigations is made, the work described in this thesis is the result of the investigation of the author.

(MD. KHODA BUX)

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ABBREVIATIONS

ADB	=	Asian Development Bank.
DANIDA	=	Danish International Development Agency
DHS	=	Directorate of Health Services
DOM	=	Dissolved Organic Matter.
DPHE	=	Department of Public Health Engineering.
DTW	=	Deep Tubewell
FOM	=	Floculated Orgaic Matter.
GBM	=	Ganges - Brahmaputra - Meghna.
GOB	=	Government of Bangladesh.
IRP	=	Iron Removal Plant.
Kucha	=	Low Quality.
MPO	=	Master Plan Organisation.
NGO	=	Non-Government Organisation.
POM	=	Particulate Organic Matter.
PSF	=	Pond Sand Filter.
SST	=	Shallow Shrouded Tubewell.
STW	=	Shallow Tubewell.
SAE	=	Sub-Assistant Engineer.
TTW	=	Tara Tubewell.
TNO	=	Thana Nirbahi Officer.
TW	=	Tubewell.
VSST	=	Very Shallow Shrouded Tubewell.
VS	=	Village Sanitation.
UNICEF	=	United Nations' Children's Fund.
UNDP	=	United Nations Development Programme.
UP	=	Union Parishad.
WASA	=	Water Supply and Sewerage Authority.
WHO	=	World Health Organisation.

CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND

Bangladesh is naturally a disaster prone country. Of the disasters, cyclone and storm surges are usually massive and heavily destructive. Human lives are swept away as well as livestock along with their shelters and food. Damages to agricultural sector specially to standing crops, forestries and fisheries, to industrial sector and physical infrastructures including houses, roads, bridges, culverts and other utility services are all enormous.

A major challenge faced by the surviving population immediately after cyclones and tidal surges is the scarcity of pure drinking water which poses threat to their existence. Cyclones normally cause serious damage to the existing water supply and sanitation facilities in the coastal region. The existing technologies for water supply such as tubewells are either broken or partially damaged and become unusable due to submergence. Limited sanitation facilities in the affected area no longer exist. Ponds and other water bodies are all contaminated by the onrush of saline water thereby leading to serious crisis of drinking water. As a result outbreak of water borne diseases such as cholera and diarrhoea becomes evident in the affected area again causing death to numerous human lives.

Where the death toll in the April, 1991 devastating cyclone is of the order of around 1,50,000 Ref (Ministry of Relief and Rehabilitation,1991), an order of about 1,00,000 people got diarrhoea in matter of weeks after the cyclone due to the deficiency of safe water and proper sanitation facilities.

In general, the coastal region of Bangladesh is identified as saline area. Complexity in hydrogeological situation makes the water supply in that region relatively difficult compared to other parts of the country. This is reflected in the service coverage with potable water in the area which represents at present one operating tubewell for every 216 persons against a national average of 97 persons per operating tubewell (as of 1993 June). Sanitation situation in the area is also extremely poor with an insignificant number of people having access to sanitary latrines.

Where there is no recognised good water bearing formation in the coastal belt of the country including the offshore islands, some sporadic lenses of fresh water may be available at a very shallow depth. These are recharged pockets of fresh water either by rainwater or by fresh surface water ponds. Alternative technologies such as shallow shrouded tubewells, very shallow shrouded tubewells, and pond sand filters are being installed in addition to the conventional deep and shallow tubewell technologies to tap safe water from these fresh water pockets. In the sanitation sector pourflash water sealed latrines are considered appropriate as are being used in other parts of the country. Rainwater harvesting, underground communal septic tanks are newer technological options having potentials to meet emergency need during post cyclone periods. However question of sustainability of these technologies under situations of cyclone and storm surge disasters still remains unanswered.

This particular research project is an attempt to focus on the overall water supply and sanitation situation in the coastal region of Bangladesh. The major thrust of the project is given to assess various technologies in respect of their sustainability during and after cyclone and storm surge disaster.

1.2 OBJECTIVES OF THE STUDY

The overall objective of this study is to find out a reliable and sustainable post cyclone water supply and sanitation system in the coastal region of Bangladesh. The specific objectives are as follows :-

1. Assessment of pre-cyclone and post cyclone needs for water supply and sanitation services in the coastal region of Bangladesh including offshore islands.
2. Assessment of performance of existing water supply and sanitation technologies during normal periods as well as during post cyclone and tidal surge disasters.
3. Identification of appropriate alternative technologies for coastal region of Bangladesh.
4. Cost effective analysis of various alternative technologies.

1.3 METHODOLOGY OF THE STUDY

This special study is based on extensive literature search on various water supply and sanitation technologies. In addition to this, the following activities have been envisaged.

a) Data collection from various relevant organisations.

b) Visits to selected cyclone prone areas and conducting field survey for need assessment.

c) Analysis of collected and survey data.

d) Performance analysis of various technologies.

Data/information regarding present status of water supply and sanitation in the coastal belt have been collected from DPHE, UNICEF, and other organisations. Information has also been collected from different available literatures.

Field visits are an important part of this study. Visits have been made at the coastal areas such as Barisal, Patuakhali, and Cox's Bazar districts. Two thanas in the Cox's Bazar district named Moheskhali and Chakoria were selected for survey and house to house survey was carried out with previously designed questionnaire.

1.4 OUTLINES OF THE STUDY REPORT

This report consists of total six chapters including this introductory one.

Chapter two outlines the general profile of the coastal region of Bangladesh with special emphasis on the coastal environment. This also illustrates the effects of cyclone and tidal surges on the coastal region with special reference to the effect on the existing water supply and sanitation facilities.

Chapter three describes the existing situation as to water supply and sanitation in the coastal belt with a brief description of the technologies currently used for water supply and sanitation. This chapter also points out the suitability of existing technologies in the coastal belt.

Chapter four deals with the field survey and analysis of the findings. This also depicts the idea of the local people regarding possible measures to combat the situation arising out of cyclones and storm surges.

Chapter five is an attempt to outline the measures to be taken to mitigate permanently the crisis of water supply and sanitation in the coastal belt in the backdrop of cyclones and tidal surges.

The last and chapter six illustrates conclusion and recommendations on the topic of the study.

CHAPTER TWO

LITERATURE REVIEW

2.1 INTRODUCTION

The southern part of Bangladesh exists on the coast of the Bay of Bengal and is identified as the coastal zone. This is about 20 percent of the total country area of 1,44,000 square kilometers. According to 1991 census (BBS, 1993), this area is inhabited by about 25 million people who constitute about 25% of the total country population. The entire coastal belt is criss-crossed by many rivers and their tributaries which are under active tidal influence. Although plenty of surface water as well as ground water is available in the area there is serious scarcity of potable water. The problem is mainly due to unacceptable quality of water (i.e. excessive salinity in both surface and ground water).

This coastal area comprises of the complex delta of the Ganges-Brahmaputra-Meghna river system. It includes the districts of Khulna, Bagerhat, Satkhira, Noakhali, Laxmipur, Feni, Patuakhali, Borguna, Barisal, Jalakati, Perojpur, Bhola, Chittagong and Cox's Bazar as shown in Figure 2.1. The area under coastal region is estimated at 36,078 square kilometers. The density of population ranges from 379 per sq. kilometer in Bagherhat district to 1254 per sq. kilometer in Feni district (Ref. BBS, 1993).

2.2 CHARACTERISTICS OF THE COASTAL REGION

2.2.1 Topography

The topography of the project area is flat with a mild gradient towards the south. In fact, with the exception of some hilly regions on the old districts of Sylhet and Chittagong Hill Tracts, the rest of Bangladesh is primarily flat. Morgan and

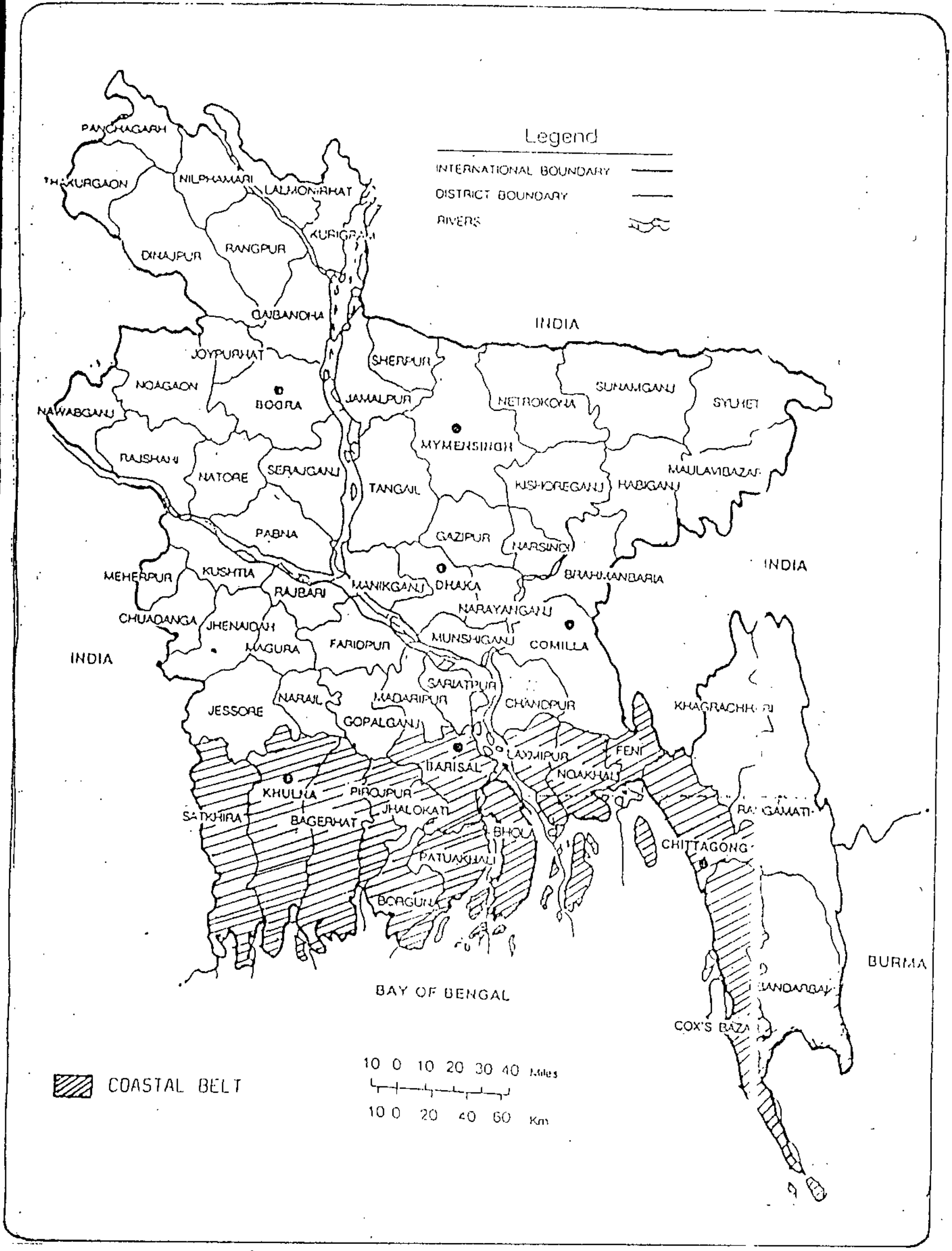


Figure 2.1 Bangladesh Map Showing The Study Area

Melntire (1959) identified the south-western part of Bangladesh as a recent deltaic plain with a southerly slope of approximately 6 cm per kilometer. Greater Khulna, Barisal and Patuakhali regions within the project area belong to this deltaic plain of extremely mild slope (UN - ESCAP, 1987).

2.2.2 General Hydrogeology

The Coastal region in general is a saline wedge which is very shallow near the coast and gradually declining towards inland (Figure. 2.2).

The body of fresh ground water is considered as floating on sea-water within the aquifer because of its lower specific gravity. The boundary between fresh ground water and saline water is known as interface. Along this interface the pressures due to the head of fresh water and comparatively dense saline water must balance.

The fresh water table or piezometric level, as one moves inland, must be higher than the sea level to maintain the occurrence of a fresh water mass in a saline subsoil. If for any reason, the piezometric level drops, the shape and position of the interface will be disturbed and will gradually be changed to reach equilibrium.

The position of the interface can be estimated (Shamsuddin, S.A.J, 1986) by the following relation. (Ghyben - Herzberg principle).

$$Z = -\frac{P_f}{P_s - P_f} \times h \quad \text{...................... Eq. 2.1}$$

Where, Z = Elevation (from m.s.l.) of the position where interface occurs.

P_f = Mass per unit volume of fresh water,

P_s = Mass per unit volume of sea water,

h = Elevation of the ground water table above mean sea level.

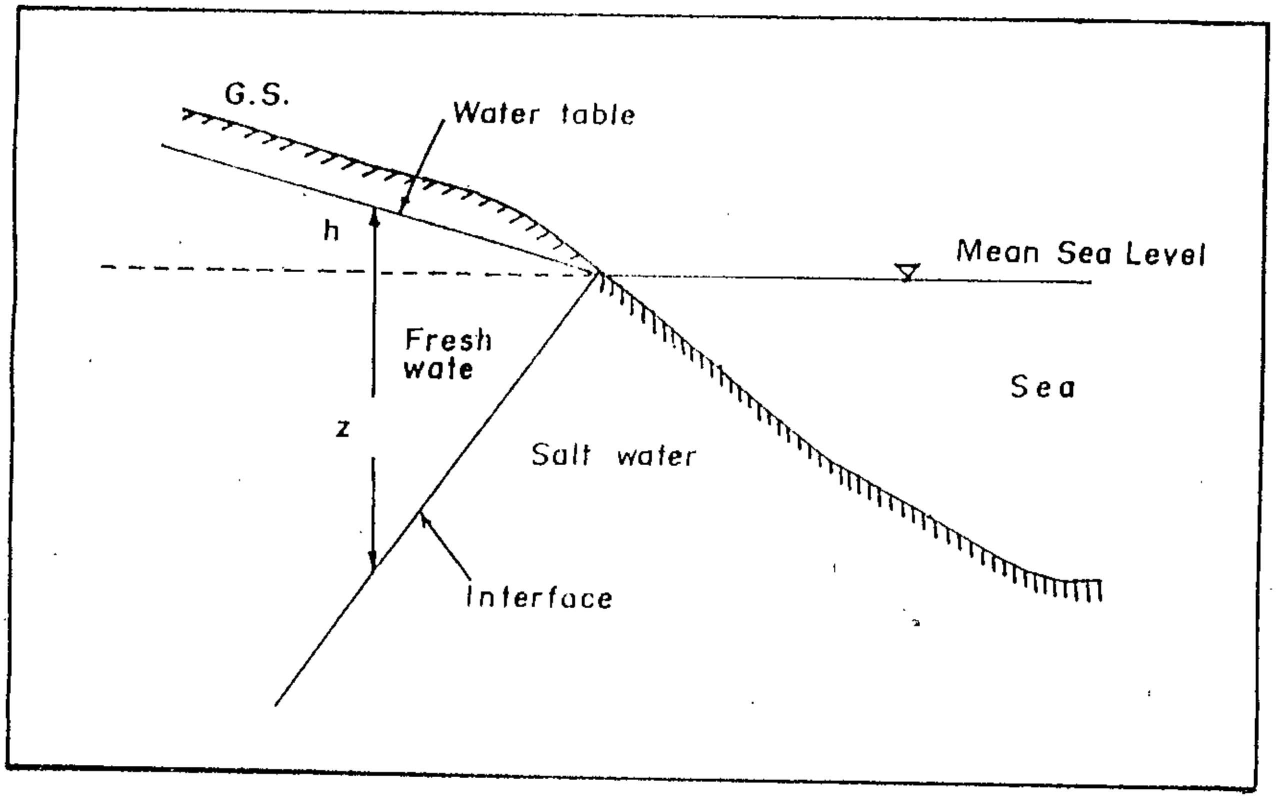


Figure 2.2 Figure Showing Fresh Water Salt Water Interface
In The Coastal Belt.

Assuming the densities of fresh water and saline water to be 1.00 and 1.025 t/m^3 respectively the above equation takes the form.

$$Z = -40h \quad \text{.................. Eq . 2.2}$$

This implies that fresh water extends to a depth 40 times the height that the water table is found above m.s.l. even though the response may be greatly delayed.

According to a study (DPHE-UNICEF, 1994), the coastal sediments can be divided into upper and lower aquifer sequences. The upper aquifer sequence is composed of a heterogeneous assemblage of sands, silts and clays all essentially in hydraulic continuity to a depth in excess of 152 metres. The spatial distributions of thickness of the upper aquifer from a UNDTCD (1979) study indicates that a clay and silt sequence ranging from 3 metres to 15 metres overlines the alluvial basin. In some places thin layers of very fine to fine sand occurs within the upper clay and silt unit. These sands yield small amount of water to shallow wells with varying water quality (fresh/brackish/saline), from place to place.

Below the upper shallow aquifer, alternating sand and clay layers containing brackish/saline water are encountered. The thickness of the saline zone varies but is normally within 90 - 210 meters (DPHE - UNICEF, 1993).

Below the upper aquifer sequence is the deeper water-bearing unit, referred usually as deep aquifer where fresh water is normally encountered. Available data of the area indicate that the deep aquifer extends beyond 300 meters. (DPHE - UNICEF, 1993). Previous study done by DPHE - UNICEF in the coastal area indicated that the deep aquifer does not occur in some areas south of Khulna town. This investigation also observed that the deep aquifers are non-existent in some areas of Shymnagar and Mongla Thanas within the drilled depth of 335 meters. The shallow ground water level and the deep piezometric surface are generally within 3 metres in the area. The deeper aquifers are recharged further inland from where the fresh water flows towards the coast in gently sloping hydraulic gradient. Pressure differences and/or clay layers prevent mixing of saline and fresh water (DHPE - UNICEF - DANIDA, 1994). Some typical boring logs have been shown in Appendices A1 though A5.

2.2.3 Climate

Although Bangladesh has six seasons in a year only three viz. winter,summer and monsoon are prominent. The sharp tropical monsoon climate is however, the most important aspect of the climatic features of the country. Coastal Bangladesh is typified by the general tropical climate of the country with the predominance of the monsoon during June to September, cooler-rainless periods during October to February and a hot and humid summer during March to June. The mean annual rainfall varies from 1500 mm in the West in the Khulna region to over 3800 mm in south of Cox's Bazar. The extent of rainfall in the coastal belt is higher than that in the rest of the country. The mean annual rainfall for last six years i.e., from 1985 to 1990 in some of the coastal districts is shown in Table 2.1.

Table 2.1 Mean annual rainfall from 1985 to 1990 in mm in some coastal districts.

District	Year					
	1985	1986	1987	1988	1989	1990
Khulna	1312	2416	1922	1780	1418	1921
Patauakhali	1701	2590	2446	2089	1769	2676
Bhola	1801	2597	2310	2337	1955	2254
Noakhali	2709	2980	3727	2686	2521	3454
Chittagong	3111	2784	3310	3126	2584	2985
Cox's Bazar	3517	2855	4684	3995	3050	4086
Feni	3137	4204	3898	2925	3110	3851
Barisal	1458	2110	1650	2364	1990	2378

Source : Statistical year book of Bangladesh, 1992

Cyclonic storms are an important feature of the coastal climate and occur during both the monsoon and premonsoon periods, the premonsoon types being the most destructive. Some examples of these are the April, 1991 Cyclone, May 1985 Urir-Char Cyclone, the November,1970 Cyclone, the great cyclone of 1919, the Bakergonj cyclone of 1876 and the Barisal cyclone of 1584.

Storm winds move at speeds of upto 240 km per hour and cause widespread damages. The most devastating elements are the storm surges, 3 to 6 meters high occasionally exceeding beyond this.

2.3 THE COASTAL ENVIRONMENT SCENARIO

As mentioned earlier, the coastal region of the country is formed by the complex delta of the Ganges - Brahmaputra - Meghna (GBM) river system. This area is rich in terms of its resources that have great potential for development. The river system flowing through Bangladesh on its way to the Bay of Bengal carries an estimated annual sediment load of about 2.4 billion tons (Al-Hussainy, 1989). These sediments are subject to coastal dynamic processes generated mainly by river flow, tide and wind actions leading to accretion and erosion in the coastal area of Bangladesh.

The coastal morphology of Bangladesh is characterized (UN - ESCAP 1987) by:

a) a vast network of rivers, and their tributaries;

b) an enormous discharge of river water heavily laden with sediments, both suspended and bed load;

c) a large number of islands in between the channels;

d) the swatch of no ground (a submarine canyon) running NE-SW partially across the continental self about 24 km south of the Bangladesh coast;

e) a funnel - shaped and shallow northern Bay of Bengal, to the north of which the coastal area of Bangladesh is located;

f) strong tidal and wind actions;

g) tropical cyclones and their associated storm surges.

These factors acting in complicated ways bring about geomorphological changes in the Bangladesh coast. The entire coast is about 710 km long (UN - ESCAP, 1987) and can be divided into three distinct geomorphological regions - the eastern, central and western regions.

The soils of the coast as stated earlier, are generally sediment deposits of the GBM and other rivers. Such soil are fertile, but salinity intrusion, both normal and that during cyclones, offsets part of the fertility. One-third of the arable land can be classified as saline in the coastal zone, with Khulna and Patuakhali being the most affected regions (UN-ESCAP, 1987).

West of the GBM delta lies the most important mangrove forest, the Sundarbans. This is the largest mangrove forest in the world in one patch (UN-ESCAP, 1987) and covers a total area of 5,71,508 ha of which about 1,70,000 ha consists of rivers, channels and other water courses. Out of a land area of 401,600 ha, 3,95,500 ha is occupied by forest and the remaining 6,100 ha is scrub jungle, grassland or bare ground.

The sundarbans receive large volumes of fresh water from inland rivers flowing from the north and saline water from tidal incursions from the sea. The fresh water is charged with alluvium which contains plant nutrients and this together with the salinity of the tidal water, is a major factor affecting the forest ecosystem (UN - ESCAP, 1987). The numerous rivers and streams which dissect the Sundarbans in a north-south direction are or were distributories of the Ganges. These rivers partially combine to form the five main estuaries which provide the major points of ingress for saline-water intrusion. The crucial problem in the present day Sundarbans is that only two of them, the Baleshwar and Passur systems have direct connections to the Ganges and thus to an uninterrupted source of fresh water.

2.4 SALINITY

Intrusion of saline water specially in the dry season constitutes a big problem in respect of fresh water supply, navigation, fish culture, agriculture and industrial activity in the coastal zone. Saline water from the Bay of Bengal is transported upland by tidal flows and how far inland the saline intrusion travels and what would be its extent and concentration depend on the quantum of fresh water discharging from upstream. Concentration of salts in water at different times of the year has important bearing on the ecology, agricultural product, industrial activities, navigation, fish and other aquatic life.

After construction of the Farakka Barrage on the Ganges designed to divert about 1130 m^3/sec of the Ganges water to the river Hoogly in India, and its commissioning in April, 1975 monthly low flow discharge of the Ganges in dry months within Bangladesh approximately dropped by 50% from the pre Farakka time (Al-Hussainy, 1989). This reduced flow not only severely affected the dry season availability of irrigation water but also accentuated sharply the salinity, navigational and fisheries problem. Conductivity of water at river Bhairab above Khulna was noted to have increased to 13,600 micromhos per sq. cm. in April 1976 and the penetration distance of salinity upstream more than doubled whole the area under salinity had increased by approximately 50% in 1976 from the pre diversion time (Al-Husainey, 1989). In April 1983 salinity observed at Khulna crossed all past records reaching 17,100 micromhos (Nishat, 1992).

2.5 OCCURRENCE OF CYCLONES AND TIDAL SURGES

Bangladesh is naturally a disaster-prone country. Among natural disasters, cyclones and floods are very prominent and frequent. They hit different parts of the country almost every year, and damages caused by them are severe. Both life and property fall under the grip of their devastation.

The Bay of Bengal is a natural place for formation of cyclone depressions. Innumerable such depressions of varying intensities form throughout the year but the mean annual storms generated from them is only 3.5 (Al-Husainey, 1989). Many of them do not pass over Bangladesh or weaken sufficiently before hitting the coast.

The combined effect of high water, storm surges, wind and rain conspires to harm the coastal communities and structures in Bangladesh. The Indian Ocean storm surges sweep out of the Bay of Bengal on the low lying coastal area with water height of about 9 meters (Rahman et al, 1992). Due to geographical set up of Bangladesh, location and the funnel shape of the estuary, the cyclonic storms take the shape of tidal bores and storm surges. Cyclonic depressions take place during the pre-monsoon periods (May) and post monsoon (Sept.-Oct.) time. For not very well known reasons most damaging cyclones accompanied by vicious tidal surges have taken place in November and December, with exception of the devastating April, 29 cyclone of 1991.

Available statistical record (UN - ESCAP, 1987) shows that since 1795 about 201 cyclonic storms lashed Bangladesh of which 43 storms were severe; of these, 20 occurred in pre-monsoon and 23 in post-monsoon time. During the monsoon period depressions generally transform into storms. As a result these usually cause heavy rainfall leading to floods in the coastal zone. Generally when a cyclone approaches the coast, because of the shallow water in the shelf region storm surges grow to the height ranging from 6 to 11 meters. A monthwise distribution of the severe cyclones in the Bay of Bengal from 1891 to 1991 is shown in Table 2.2.

Table 2.2 Monthwise number of severe cyclones in the Bay of Bengal (1891 - 1991).

Jan.	Feb.	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.	TOTAL
1	1	2	8	27	4	7	7	9	25	32	15	138

Source : Rahman et al, 1992

Loss of life and property as well as crops during severe cyclones may be quite heavy and there is little protection against them particularly in the coastal belts and the offshore islands. There were many killer cyclones recorded in the history during the last 1000 years. The storm of November 12-13 in 1970 was the worst-ever which blew with the speed of 221 km and killed 3,00,000 human and destroyed 65% of the fishing capability of the coastal region. In addition 2,80,000 cattle heads drowned, 4,00,000 houses were damaged or destroyed, 99,000 fishing boats were lost. (Rahman et al 1992).

The Cyclone of April 29, 1991.

The most severe cyclone of the recent time occurred on the night of April 29, 1991 which devastated a large part of the coastal area of the country (Figure. 2.3).

The loss of life and property caused by this cyclone were colossal. About 1,39,000 people lost their lives and over 10 million people in 19 districts of the coastal belt were affected (Rahman et al, 1992). More than one million cattle heads and poultry, fishes and birds were perished. Nearly about 70,000 acres of forest land were damaged fully and 8 lac acres of cropland, 85,000 acres of forest land damaged partly. Only crops damage was estimated to be about 1050 million US dollar. It is thought that due to early warning many people could take shelter in safer places and hence casualties were less compared to the magnitude of the cyclone.

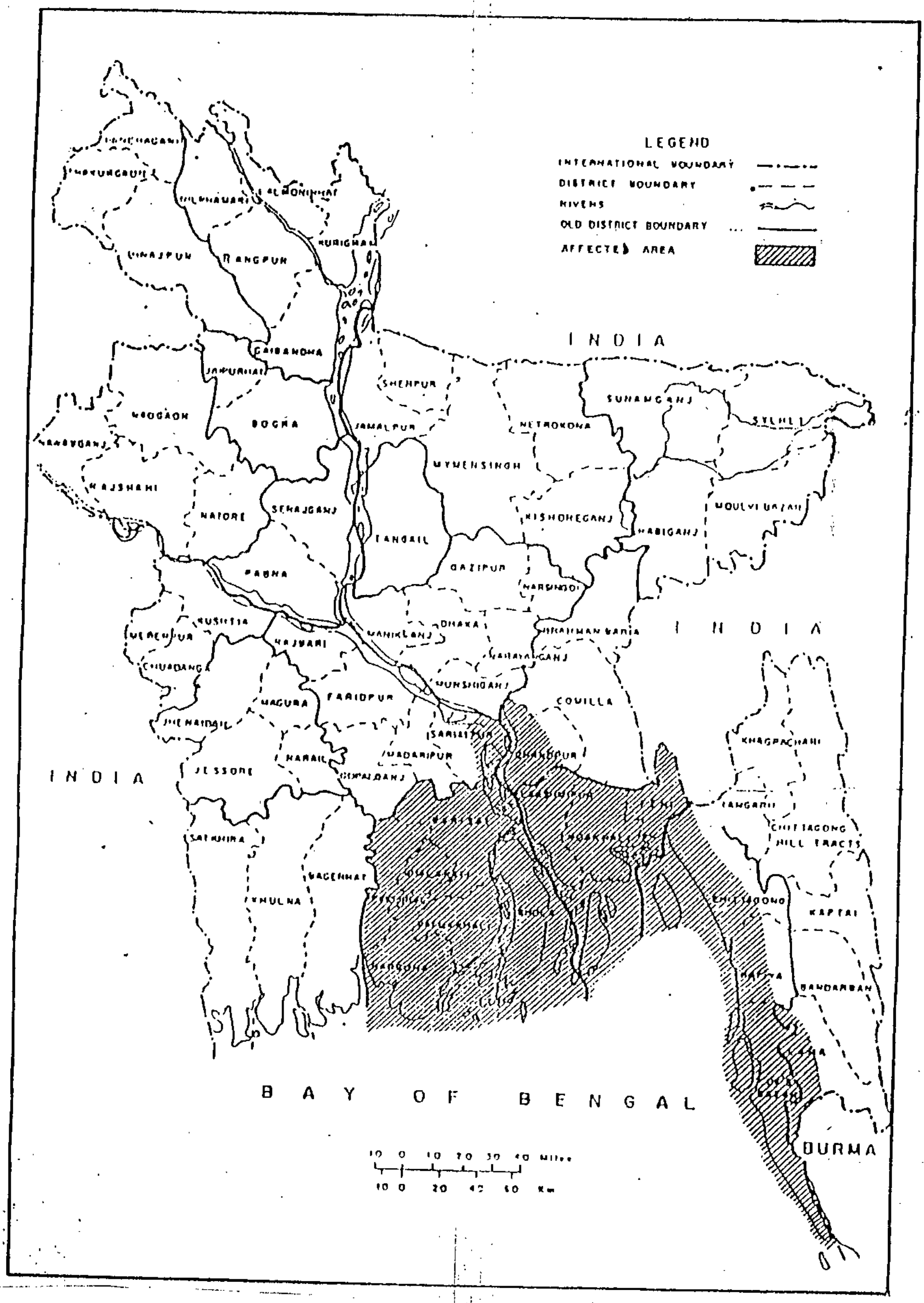


Figure 2.3 The Worst Affected Areas Of 1991 April Cyclone

The water supply and sanitation systems were also heavily damaged by April, 1991 cyclone. About 12000 hand tubewells (DPHE, 1991) were affected causing serious crisis of drinking water supply during the post cyclone period. The minimum sanitation system got damaged eliminating safe defecation system. A lot of money and a long span of time were required to restore the damaged water supply and sanitation facilities.

The devastated areas included Bashkhali; Anwara, Sandwip, Sitakunda and Patia, thanas under Chittagong district, Kutubdia, Moheskhali, Chokoria and Cox's Bazar sadar thanas under Cox's Bazar district and also Hatia Island.

2.6 CYCLONE AND DRINKING WATER SUPPLY AND SANITATION

Cyclone associated with tidal surges destroys among all other properties, water supply and sanitation facilities. Hand tubewells get inundated by polluted surge water ceasing supply of fresh water. Tubewells also become inoperative due to damages caused to its spare-parts such as handle, leather seat valve and buckets. The urban water supply systems too go out of order because of damage caused by serve tidal surges. The minimum sanitary facilities are destroyed by cyclone and tidal surges. As a result serious crisis of water supply and sanitation facilities prevails during the post-cyclone period.

The damage caused to rural water supply system in the affected districts by the devastating cyclone of April 29, 1991 is shown in Table 2.3.

The cyclones after causing the above devastations pose serious problem to water supply and sanitation. Safe drinking water becomes the first need of the cyclone affected people. The overall post cyclone situation turns so serious that it becomes very difficult to restore normal water supply for the first few days after occurrence of cyclones.

Because of the lack of necessary logistic support and due to disruption of communication water supply system can not be restored immediately. It takes time, money, materials and manpower to repair the affected tubewells and piped water supply systems. As a result the cyclone-torn people fall prey to untold sufferings from scarcity of drinking water. This results in the outbreak of diarrhoea, cholera, dysentery and other water-borne diseases in the cyclone affected area and they again take the lives of thousands of people.

Table 2.3 : Damage caused to rural water supply in the affected districts by cyclone of April 29, 1991.

Sl. No.	Affected Districts	Nos. of hand tubewell (running) as on the date of cyclone	Nos. of tubewell affected /damaged.
1	Khulna	10312	1519
2	Bagerhat	11063	813
3	Satkhira	10998	342
4	Noakhali	14941	1519
5	Laxmipur	9649	662
6	Feni	7753	673
7	Patuakhali	4607	2177
8	Borguna	2720	192
9	Barisal	18263	576
10	Jhalakati	4790	512
11	Perojpur	7815	420
12	Bhola	5248	138
13	Chittagong	25582	2134
14	Cox's Bazar	7635	692
	Total	141376	11697

(Source : Task Force report on the water supply in the cyclone effected area, 1991).

CHAPTER THREE

WATER SUPPLY AND SANITATION IN THE COASTAL REGION

(During pre and post disaster periods)

3.1 INTRODUCTION

The provision of safe water, improved sanitation and hygiene are basic elements of primary health care. These are also essential preconditions for child survival and development. In Bangladesh there are about 99 million episodes of diarrhoeal diseases every year and about 2,50,000 children under 5 years of age, accounting for one-third of all child deaths, die of diarrhoea (DHS, 1991). Another 1,00,000 children are affected by disability. Prevalence of parasitic infections in children under 5 years is frequently over 85 percent. Figure 3.1 shows causes of child mortality in Bangladesh.

3.2 THE STATUS OF WATER SUPPLY AND SANITATION IN THE COUNTRY INCLUDING COASTAL BELT

Bangladesh has made, on the other hand, enormous progress in respect of rural water supply. Now access to tubewell water is very encouraging. About 95% of the rural people now drink tubewell water. Around 85% of the rural households are within 150 meters from a source of safe water. In urban slums 98% households lie within 150 meters of safe water source (DPHE - UNICEF, 1992). But in the hilly areas and the coastal belt over 20% of people have to walk more than 200 meters to fetch clean water. Figure 3.2 shows the distance travelled to bring tubewell water in rural areas. Figure 3.3 illustrates time needed for one trip to get water in rural areas. But one disappointing aspect of rural water supply is that only 16% of the rural households use tubewell water for all purposes, (washing and drinking). This is mainly because of lack of health awareness, distance from the source of safe water and absence of privacy at the tubewell site. Poor quality of water also accounts for low level use of tubewell water. But people having private tubewells at their own houses consume much more water than

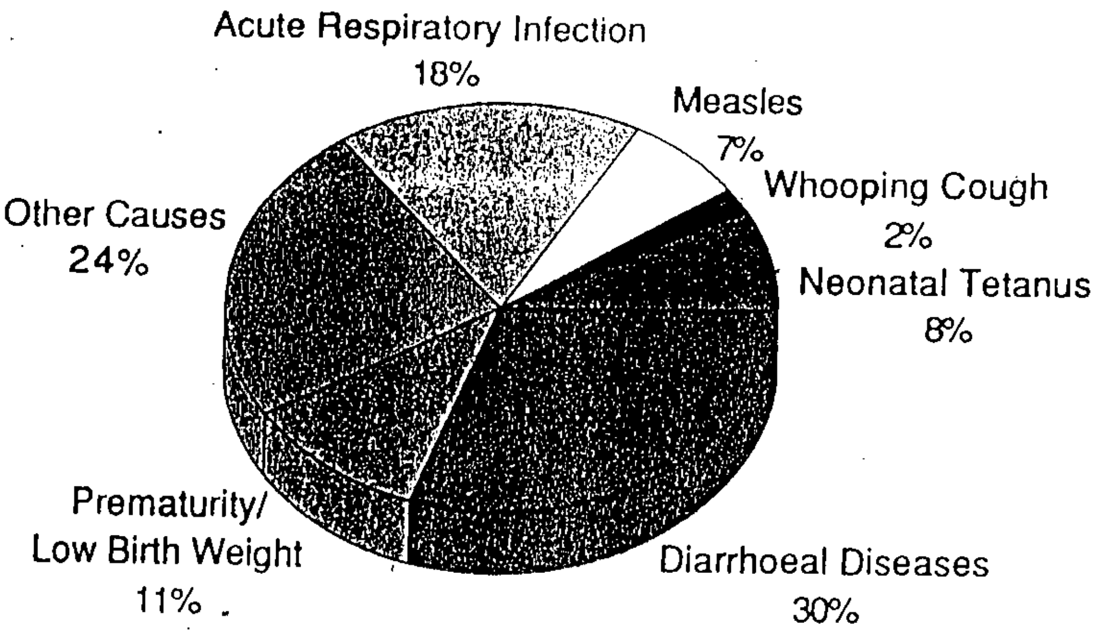


Figure 3.1 Causes Of Child Mortality In Bangladesh

Source : Towards Better Health : The Rural Water Supply and Sanitation Programme in Bangladesh DPHE - UNICEF Dec'92.

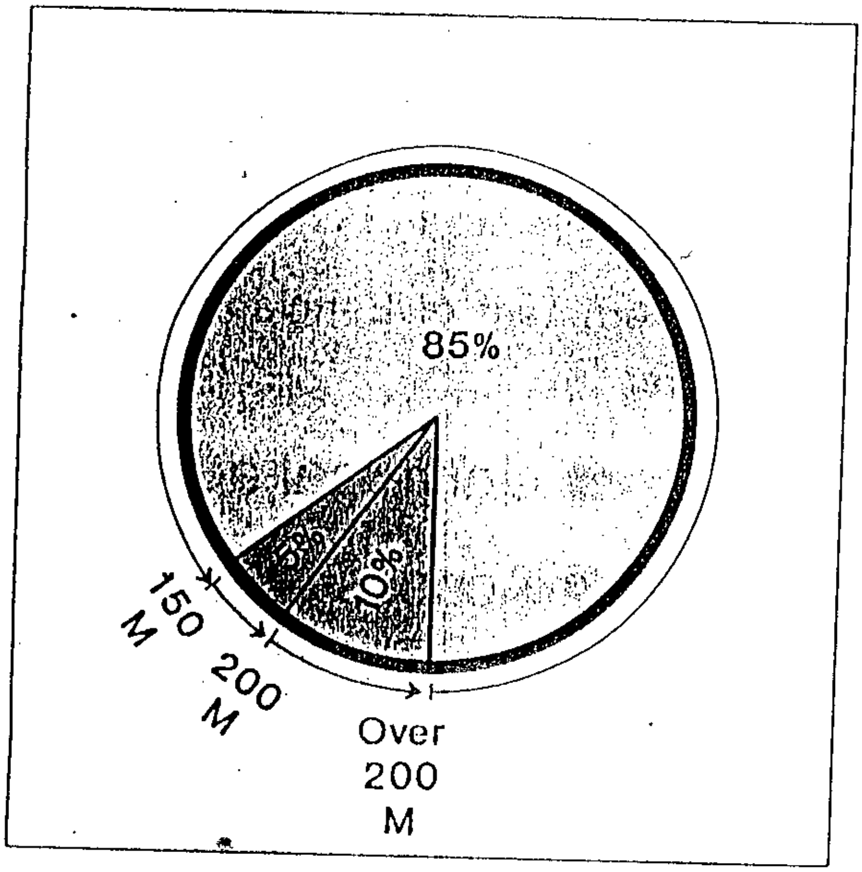


Figure 3.2 Distances Travelled To Fetch Tubewell Water In Rural Areas

Source : The status of Rural Water Supply and Sanitation UNICEF -DPHE,1993.

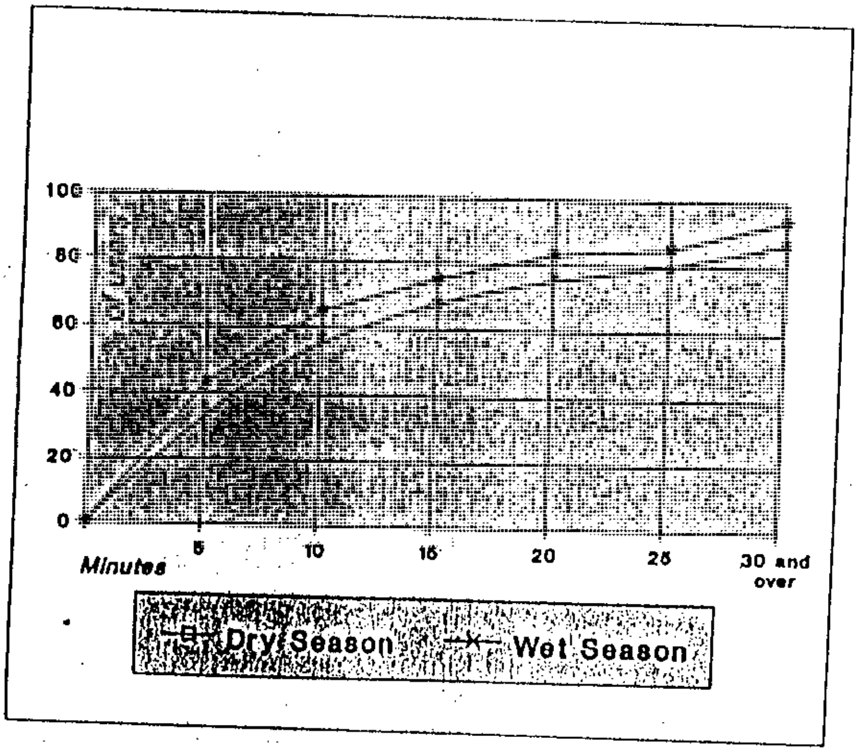


Figure 3.3 Time Needed To Bring Tubewell Water

Source : The status of Rural Water Supply and sanitation UNICEF-DPHE,1993 those who share govt. tubewells. The reasons for not using TW water for all domestic purposes are illustrated in Figure 3.4.

In the coastal belt and the hilly regions people need much more time to bring water because of more distance of the households from the source of safe water.

As of June, 1993, the Department of Public Health Engineering (DPHE), the national agency for water supply and sanitation has installed about 9,00,000 hand tubewells in rural Bangladesh (DPHE, 1993). The present service coverage in terms of population per tubewell stands to 97 and population per operating tubewell is about 92. The practice of sanitary excreta disposal has improved. According to UNICEF Report 1993, 33 percent of the rural population use a sanitary latrine (40% by water sealed latrines + 60% by home made latrines) as shown in Figure 3.5.

While the improvement of rural water supply facilities is impressive it has not been evenly spread throughout the country. Coverage rates vary sharply by hydrogeological area, from an average 79 persons per operating tubewell in the shallow water table area to 205 persons per operating tubewell in the coastal belt and 316 persons per operating tubewell in the low water table area specially the northern part of Bangladesh (DPHE - UNICEF, 1992). Figure 3.6 shows rural area wise coverage and population per public tubewell.

Because of the paucity of drinking water in the coastal belt diarrhoeal diseases break out several times every year in epidemic form causing death to hundreds of people. Incidence of diarrhoeal diseases has always been more than that in other parts of the country (DHS, 1991). The poor coverage in the coastal belt is largely due to ground water salinity down to depths varying from 30 to 250 meters in certain areas. As of today about 60,000 deep tubewells have been sunk in the saline coastal belt to draw fresh water from 30 to 250 meters underneath the saline layers (DHPE - UNICEF, 1993). The deep tubewells are approximately ten times as expensive as the more common shallow tubewells suitable for most part of the country.

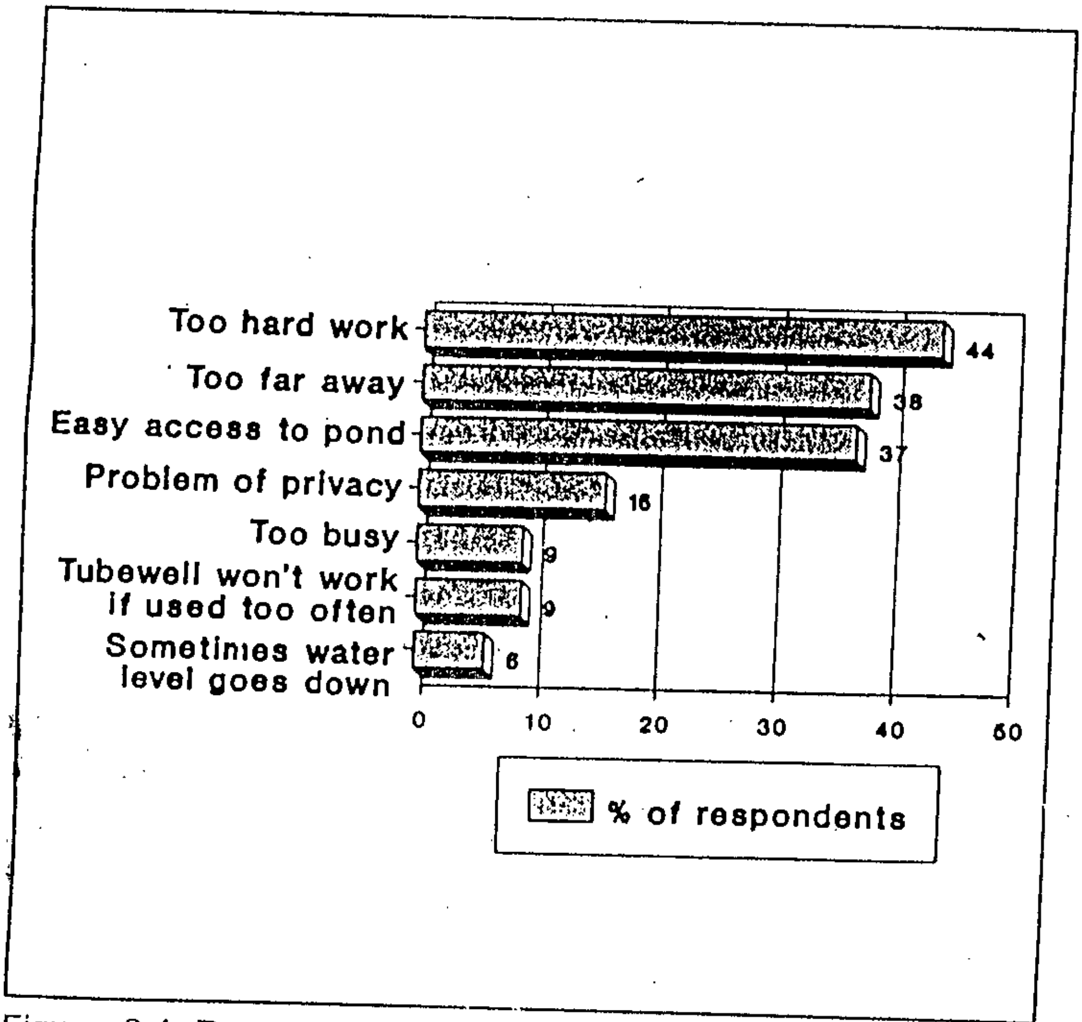


Figure 3.4 Reasons For Not Using Tubewell Water For Domestic Purposes.

Source : The status of Rural Water Supply and Sanitation UNICEF-DPHE,1993.

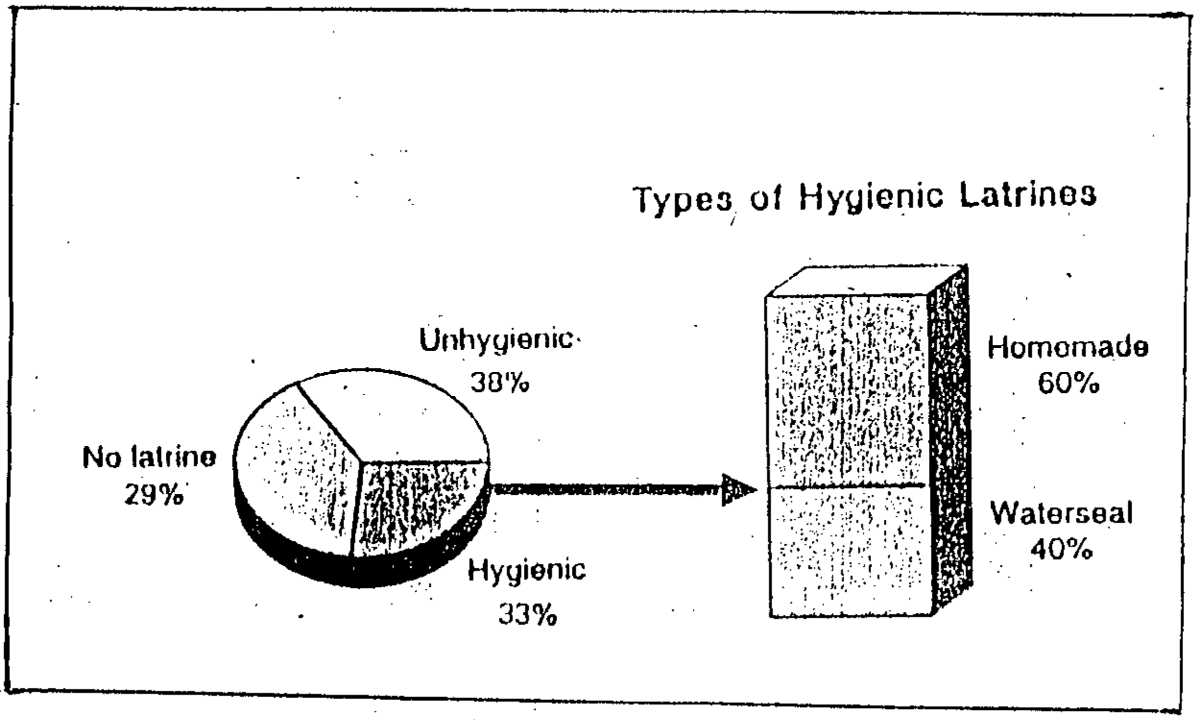
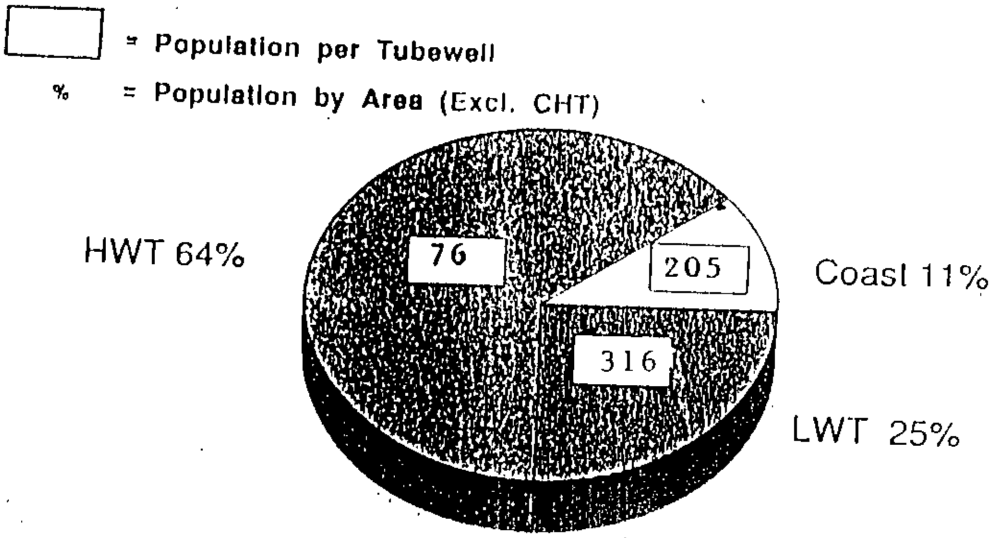


Figure 3.5 Coverages Of Rural Sanitation By Types Of Latrines In Bangladesh



Average Population served per Operating Tubewell = 97

Figure 3.6 Rural Areawise Coverage Of Water Supply And Population Per Public Tubewell

3.3 WATER AVAILABILITY IN THE COASTAL REGION

3.3.1 Surface Water

The coastal region, of Bangladesh is characterized by plenty of surface water. The total coastal area in respect of water availability is divided into two regions (MPO, 1986). These are discussed below :

South-east Region :

In this region mean monthly available streamflow varies from 400m^3/sec in March to 4,630 m^3/sec in July (GOB-Dutch, 1986). About 87 percent of the stream flow during the driest month (March) is the augmented flow in the Karnafully river by the Kaptai reservoir. Other significant sources of streamflow for the month of March are the Gumti River (4%), Feni River (4%), Sangu River (2%) and Matamuhuri River (2%). The streamflow is about nine percent of the total area of the region (coastal area) has a salinity greater than 2,000 micro-mhos. Instream storage potential is about 55 million cubic meter (GOB-DUTCH, 1986).

South-west Region :

In this region of the coastal belt, monthly available streamflow varies from 2820 m^3/sec in March to 44,000 m^3/sec in August. Over 70 percent of the available streamflows for the dry season enter the region through the Lower Meghna River. Other significant sources of streamflow during the driest month (March) are the Gorai River (4%) and the Arial Khan River (2%) which receive streamflow from the Ganges and the Padma rivers. Available static water and instream storage potential are both about 70 million cubic meter.

It should be noted that the stream flow in southern portion of the region covering about 35 percent of the total area of the region has a salinity level greater than a threshold level of 2000 micro mhos (GOB and Dutch, 1986).

3.3.2 Ground Water

Bangladesh is almost entirely underlain by water bearing layers in which ground water occurs at shallow depths. The average annual rainfall in the coastal region is about 2500 to 3000 mm. So it is expected that natural recharge of ground water in this region is high. Besides, direct precipitation, rivers, canals and numerous ponds in this area contribute to the ground water reserve. Of course the mechanism of recharge of fresh water in the case of deep aquifers is not yet clear since these aquifers are overlain by aquicludes and saline shallow aquifers. However it is assumed that the coastal area except some parts of Chittagong, Khulna, Satkhira and Bagerhat districts is rich in ground water which is the only reliable source of drinking water. And the water table is always at the suction limit of hand tubewells. So there is no problem of extraction of ground water by this technology.

3.4 QUALITY ASPECT OF POTENTIAL WATER SOURCES AT COASTAL AREAS

3.4.1 Surface Water

The Chemical properties of the surface water in Bangladesh are in general not restrictive for its use as a source for domestic water supply except in the coastal belt. At the coastal belt the water is brackish to saline and so can not be used for drinking purpose. During the monsoon period, most of the surface water has a high turbidity which requires expensive treatment.

Salinity in the surface water at Khulna zone has increased in dry season because of low flow discharge of the Ganges due to construction of the Faraka Barrage in India. In the dry season in 1989 salinity observed at Khulna crossed all past records reaching 28,000 micro-mhos. In 1993, in the dry season the level of salinity in the same place crossed 27,000 micro-mhos. The intrusion of saline water affects not only economy but also health. The health effect is produced through outbreak of diarrhoea in the coastal belt (GOB-Dutch, 1986).

The level of observed highest salinity at selected stations in the coastal belt of Bangladesh is shown in Table-3.1.

Table 3.1 : Level of observed highest salinity at selected areas of Bangladesh.

Station	Electric conductivity in micro-months								
	1982	1983	1984	1985	1986	1987	1988	1989	1990
Khulna	14300	17100	6300	8000	16000	12600	16240	28000	12200
Chalna	20000	25970	16000	35000	22000	21000	26000	32000	20000
Mongla	22000	24380	21000	21700	24000	18000	20000	28000	19500
Nalianala	-	-	24000	40000	40000	24000	28000	40000	32000
Patharghata	7000	7500	8000	6600	6500	7680	6000	11000	6250
Barisal	-	480	700	460	260	340	280	365	305

Source : Bangladesh Water Development Board, 1991.

3.4.2 Ground Water

With respect to ground water quality there is a severe constraint for its use for drinking purposes in the coastal region because of its high salinity content. Generally ground water at upper aquifers is highly saline. The maximum chloride content in drinking water as per WHO standards is 200 mg/litre. But chloride content in ground water at upper aquifers (upto 300 meters from G.L) exceeds maximum allowable limit. Figure 3.7 shows chloride content of ground water in the coastal region. This reveals the problem of use of ground water for domestic purposes. But it may be mentioned here that ground water at deep artesian aquifers (beyond 300 meters from G.L) contains chloride which is acceptable for drinking and other domestic purposes. In most of the coastal areas hand operated deep tubewells are used for extraction of fresh ground water.

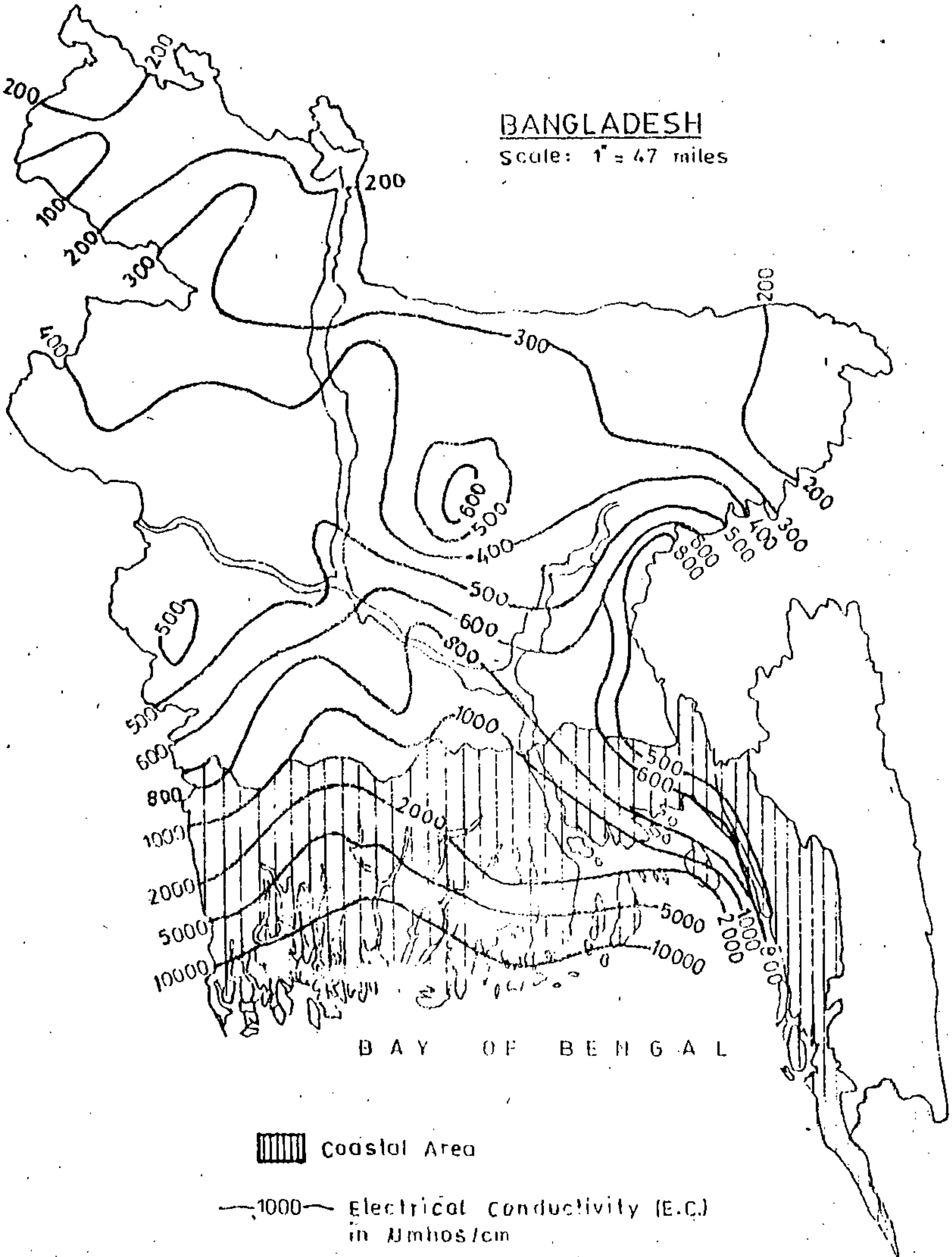


Figure 3.7 Chloride Content of Ground Water in The Country Including Coastal Area

Dissolved iron concentrations are high all over the country including the coastal region. In most places these are more than 2 ppm and at some places it exceeds 10 ppm (GOB-Dutch, 1986). This does not constraint on the use of ground water for drinking purposes. The local population may prefer bacteriologically unsafe water from surface sources over safe ground water containing iron Figure 3.8 shows iron content pattern of ground water all over Bangladesh including the study area.

3.5 WATER USE PATTERN IN THE COASTAL REGION

It is undenying that use of safe water for all domestic purposes can harvest desired health benefits. But although hand tubewells are within the range of acceptable distance from households people are accustomed to use a larger part of their daily water need from polluted surface sources such as ponds, rivers and canals which are naturally abundant in the coastal region. The reasons behind this trend have already been cited in Figure 3.4. Figure 3.9 shows the actual position of water use pattern from different sources in the coastal belt. It is evident that lack of awareness among the rural people is the main reason for not using safe tubewell water for all domestic purposes.

3.6 WATER SUPPLY TECHNOLOGIES

The present technologies used for supply of drinking water in rural Bangladesh including the coastal region include :-

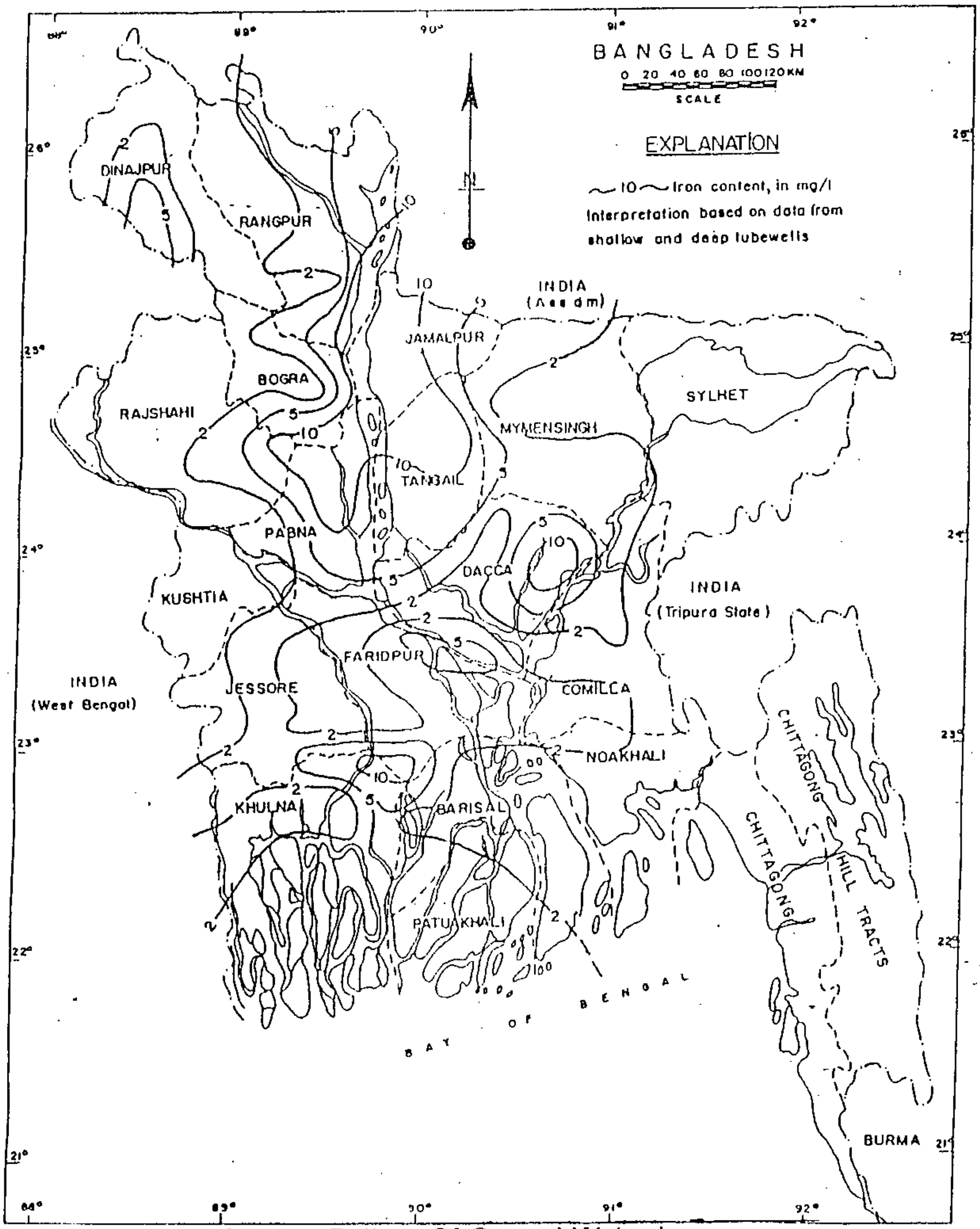
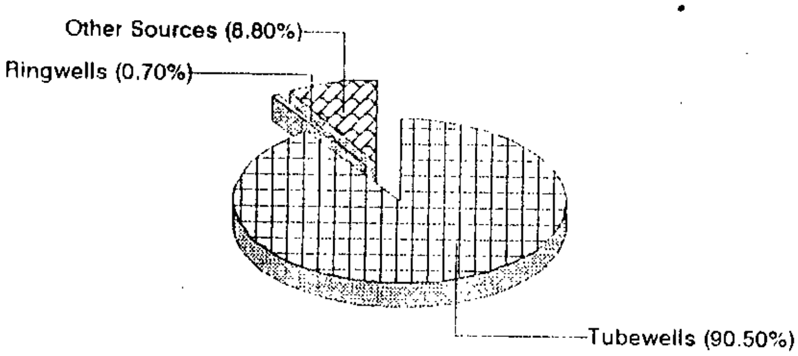
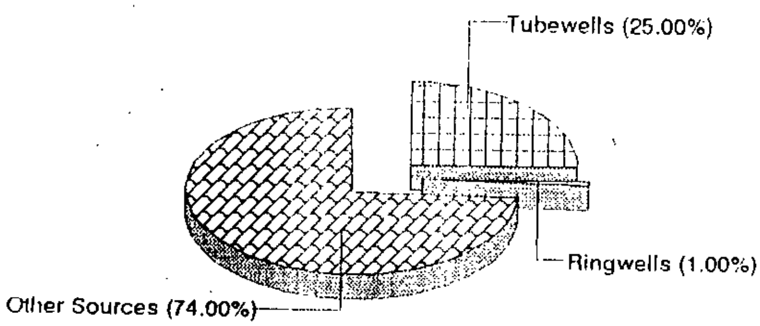


Figure 3.8 Iron Content Pattern Of Ground Water In Bangladesh

Source : The Hydrogeologic conditions of Bangladesh Groundwater Survey, UNDP 1982.



Sources of Drinking Water



Sources of Water for Other Household Work

Fig. 3.9 : Water use pattern in the coastal region of Bangladesh
(source :GOB - UNICEF, 1995)

1) Shallow Tubewell (STW)
2) Deep Tubewell (DTW)
3) Shallow Shrouded Tubewell (SST)
4) Very Shallow Shrouded Tubewell (VSST)
5) Pond Sand Filter (PSF)
6) Tara Tubewell.
7) Iron Removal Plant (IRP)
8) Rain Water Harvesting.

For rural water supply the country is divided into three major hydrogeological zones namely the high water table area (suitable for STW), Low water table area (suitable for Tara tubewell) and the coastal belt (suitable for DTW). Figure 3.10 shows these three major areas in the country map. The following sections provide description of the currently used technologies for rural water supply in the country.

3.6.1 Sallow Tubewell (STW)

This is also known as No. 6 Hand Pump tubewell (Figure 3.11). This is the simplest and the cheapest type of technology to extract underground water when and where the underground water table remains within 7 to 8 meters below the ground level. As the water level goes beyond this depth (suction limit) shallow tubewells get inoperative. The depth of a shallow tubewell varies from 20 to 75 meters according to the availability of aquifers of good quality water. A shallow tubewell upto a depth of about 100 meters can be sunk cheaply by simple sludger technique (Figure 3.12) which is a traditional hand drilling method generally carried out by ordinary tools. At present mostly

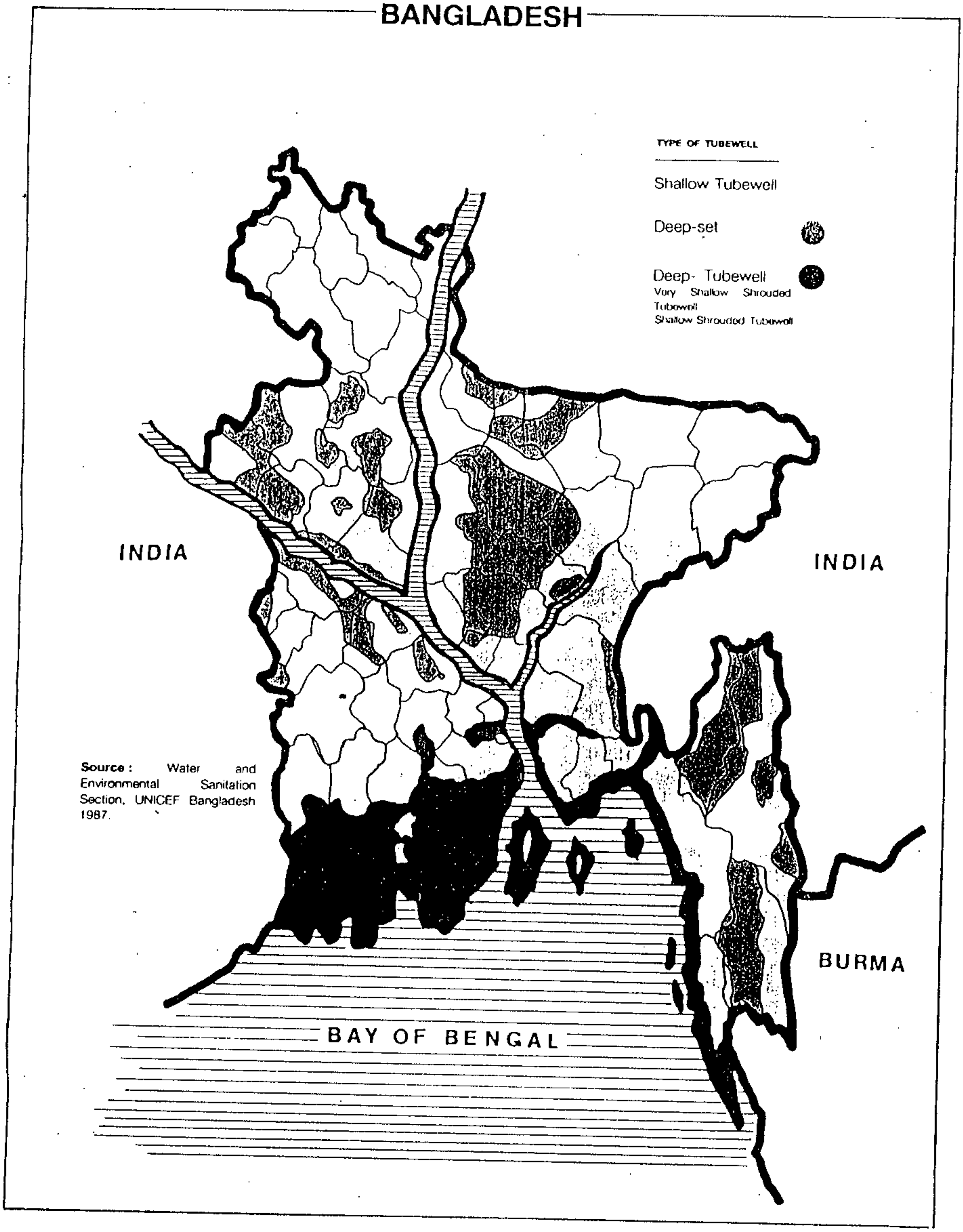


Figure 3.10 Technologywise Areas For Rural Water Supply In Bangladesh

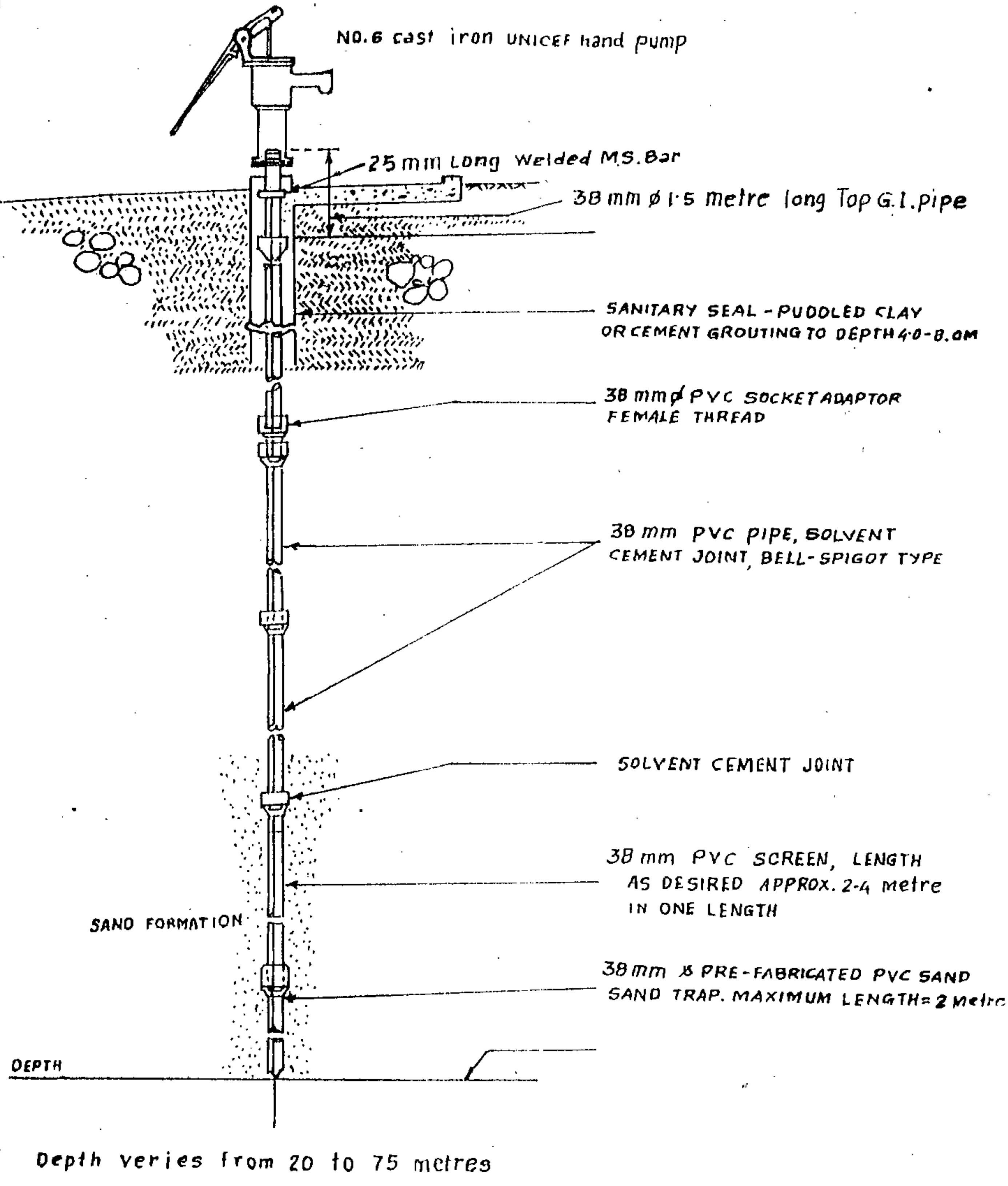


Figure 3.11Typical Diagram Of a Shallow Hand Tubewell

Figure 3.12 Boring Of Shallow Tubewell By Sludger Method

38 mm dia PVC pipe is used in sinking shallow tubewells with 1.50 meters long top GI pipe. Such a tubewell may also be installed by solely GI pipes.

Performance Of a Shallow Tubewell

The shallow hand pump tubewell is used extensively in rural Bangladesh as well as fringe areas of urban centres for domestic water supply. A properly developed STW can yield as much as 25 to 50 litres of water per minute. Its operation and maintenance are very simple, easy and cheap. A shallow hand tubewell can serve about 100 persons or 20 families. If properly installed and maintained it lasts for about 15 to 20 years. It can easily be resunk when it gets choked up by damage of its strainer or casing pipe.

But it has some limitations also. During dry seasons and drought the ground water level declines beyond suction limit(8m). Because of the lowering of ground water level in the dry season and during drought a good number of STW goes out of operation in some parts of the country (specially northern part) until water level rises due to recharge by rainfall during monsoon. It has been surveyed (DPHE - UNICEF, 1993) that about 20-25% of the shallow tubewells fitted with no. 6 hand pumps in the northern districts become in operative at the peak of the dry season. A recent hydrogeological study (DPHE - UNICEF, 1993) indicates that by the year 2000 about 50% of the shallow tubewells will lose their effectiveness during dry season due to decling of water table. In some places in the coastal belt STWs are suitable where ground water at upper aquifers are of acceptable qualities.

Economic Viability Of STW

Shallow tubewell has been being used in Bangladesh for a long time for water supply in the rural areas as well as urban slum and fringe areas. This technology is economically very much viable. Before introduction of the use of PVC pipe in tubewell sinking in our country only galvanized Iron (G.I.) pipe was used for this purpose. GI pipe is comparatively expensive. On the other hand PVC pipe is cheap. PVC pipe is now locally produced and available every where in the country. The pump of the tubewell made of cast iron is also produced locally. The cost of a shallow tubewell with pvc pipe varies from Tk. 2000/- to 4000/- (Tk. 40 = 1 US$) according to the variations in depth. The solvent families of the country can afford to buy such a shallow tubewell. A group of poor families also procure such a tubewell from their contributory fund.

Present Status Of STW

By implementing several rural water supply projects the Department of Public Health Engineering (DPHE) has so far installed nearly 8,00,000 shallow tubewells all over the country. About 59 million rural people are dependent on water supply through shallow tubewells. The present service coverage in average represents 79 persons per operating tubewell.

As of June, 1993 the total number of shallow tubewells in the coastal districts stands to 1,46,535. Shallow tubewells are not successful everywhere in the coastal zone. The places where this is not successful face acute problem of drinking water supply. DWTs, SSTs, VSSTs, PSFs etc. find solution to this constraint.

3.6.2 Deep Tubewell (DTW)

According to the practice in the Department of Public Health Engineering a deep hand tubewell (Figure 3.13) having a diameter of 38 mm is a well with well shaft of more than 75 meters depth but which uses the suction type No.6 handpump because the ground water level is less than 7 meters below ground level. In the coastal region of Bangladesh the depth of deep tubewells varies from 75 meters to 350 meters to find fresh water aquifers. Deep tubewells are expensive and take much longer time to install than shallow tubewells.

A deep tubewell of depth upto 75 meters can be sunk by manual labor using sludger method of boring. A team of about 6/7 borers can accomplish sinking of such a tubewell within 30 hours in soft sandy or clayey soil. Deep tubewells of depth greater than 75 meters are sunk by water jet method of boring using a manually operated dunkey machine or power operated pump. This is a labor intensive process requiring 10 to 12 borers for about 7 to 10 days under the same hydrogeological conditions.

Performance Of DTW

A hand operated deep tubewell can also yield about 5 to 10 gallons of water per minute. Mostly PVC pipe is used as casing pipe with 1.25 meters long top GI pipe for fitting pump. A cement concrete platform of size 1.5 m x 2.15m is constructed after sinking the tubewell. The Govt. tubewells are sunk outside the households of the caretakers so that other families of the locality can have free access to the well.

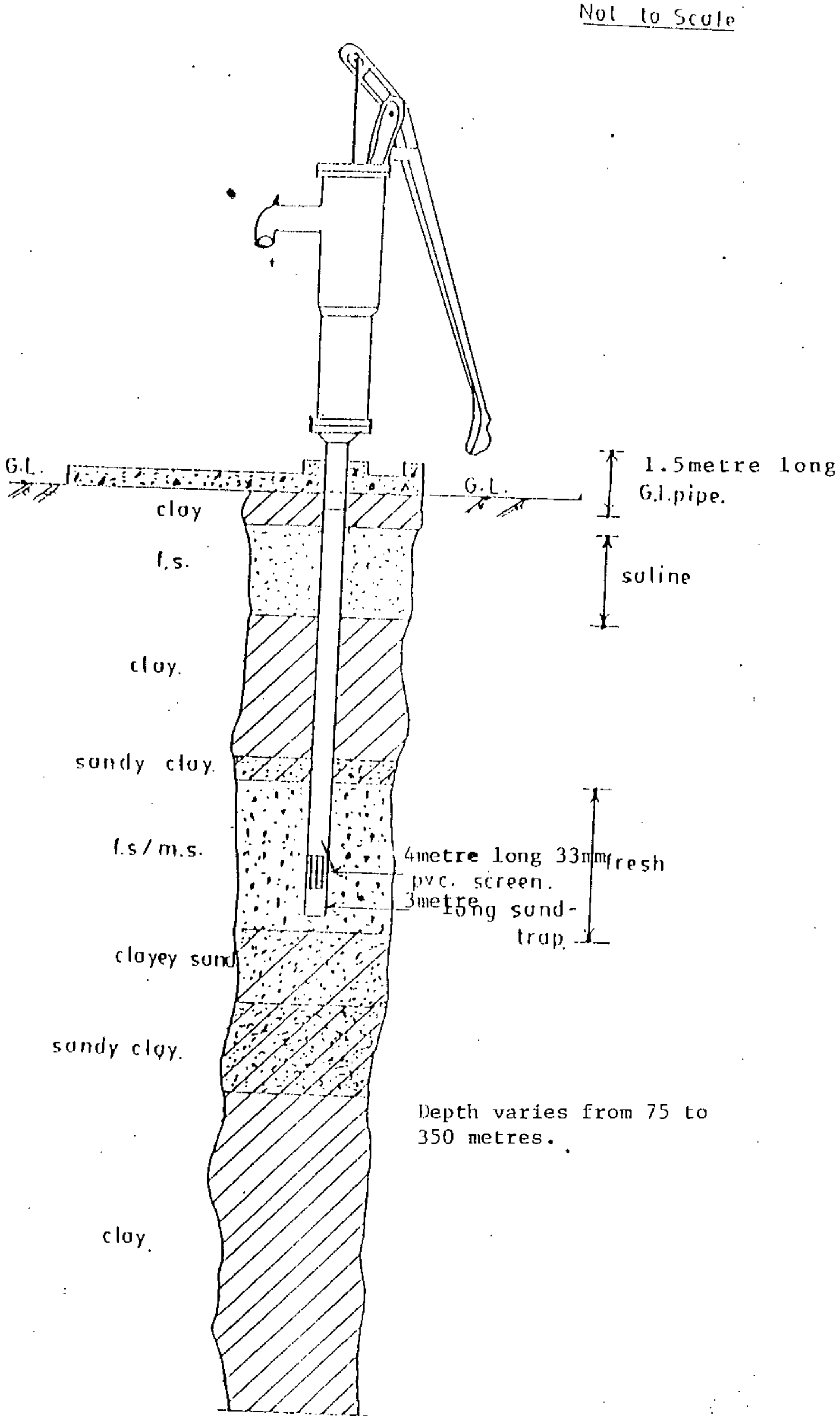


Figure 3.13 Typical Diagram Of a Deep Tubewell

The installation of Deep Tubewell needs special care because of its longer depth and high cost. The main problem with a deep tubewell is that when it gets chokedup, it is very difficult to withdraw the well for replacement with the same materials. In most of the cases it becomes impossible to withdraw the PVC casing pipe. Because of higher depth the casing pipe torns out and only a little of the same may be salvaged.

Economic Viability Of DTW

Because of its higher depth and special type of boring process a deep tubewell is expensive. The cost of such a tubewell with pvc pipe is around Tk.30,000/= to Tk.50,000/= according the variation in depths. It is difficult for a single family to install such a private tubewell from its own fund. So most of the people in the coastal zone where deep tubewell is appropriate depend on Govt. tubewell. Govt. on the other hand has to provide high subsidy in sinking public tubewells. According to the existing rule a group of people has to pay Tk. 2000/= for having a Govt. tubewell.

It is not economically viable to withdraw a choked up tubewell; only the pump and a small part of the withdrawn pipe can be reused.

Present Status Of Deep Tubewell

DPHE has so far install about 60,000 deep tubewell in the coastal belt of which nearly 41,000 are in the project districts. Every 205 persons have got a DWT. in the coastal area. This coverage is much lower than the standard coverage of one tubewell for every 75 person.

3.6.3 Shallow Shrouded Tubewell (SST)

A shallow shrouded tubewell is an ordinary hand pump tubewell having a depth of about 15 to 20 meters. This tubewell is sunk in fresh water aquifer with fine sand. In order to prevent yielding of sand with water and to create an artificial layer of sand the strainer zone of the tubewell is shrouded with coarse sand immediately after lowering the pipes. The performance of such a tubewell is similar to that of a shallow or a deep tubewell. The installation of a shallow shrouded tubewell is comparatively cheap. The cost for such a tubewell varies from Tk. 2000 to 2500. Such tubewells are being fielded in some places of the coastal districts of Khulna, Bagerhat, Satkhira and Noakhali where shallow or deep tubewells are not successful because of difficult hydrogeological characteristics. Figure 3.14 shows a typical shallow shrouded tubewell.

A SST can serve about 100 persons. If the shallow shrouded tubewell is installed at the proper aquifer, its performance and longevity are almost the same as a normal shallow or a deep tubewell. But if the strainer is not placed at the proper aquifer, the SST yields inadequate water because of lack of sufficient ground water storage. This is why special care needs to be taken during installation of the same. From the point of cost factor SST is a very cheap technology for rural water supply.

3.6.4 Very Shallow Shrouded Tubewell (VSST) :

It is also a very shallow hand operated well which is appropriate to certain areas in the saline belt. It is very inexpensive and is perhaps, a better solution to domestic water supply in the coastal rural areas than deep

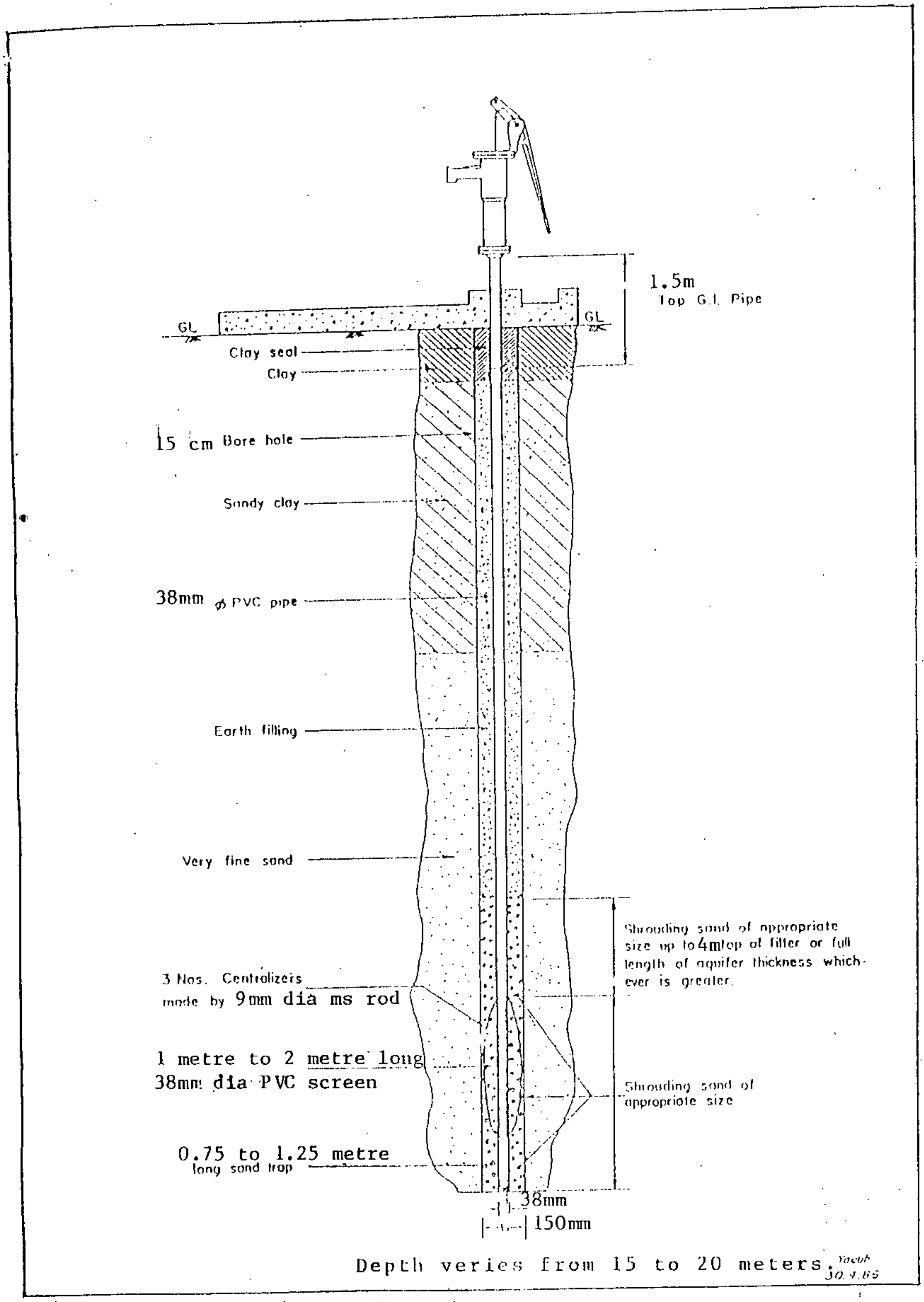


Figure 3.14 Typical Diagram Of a Shallow Shrouded Tubewell

tubewells. The depth of a VSST is around 6 to 15 meters. However it relies on two very specific conditions for its success; it can only operate where a small pocket of fresh water exists and where an aquifer (sand layer) exists within this fresh water zone. These two conditions do not apply throughout the saline belt of the coastal zone.

But it has been shown that fresh water famine appears in areas of the coastal belt where surface water disappears completely in the dry season. These areas are in general favorable for VSST areas due to high infiltration rate. In these areas, where the human settlements are also small and scattered, the VSST sinking programme is getting priority. Unfavorable ground water zones are often indicated by a limited fall in water level of the ponds. Therefore, for these areas surface water treatment of fresh pond water is being undertaken at this moment.

Very shallow shrouded tubewells can be placed in large numbers very quickly and at comparatively very low costs. It is estimated that such a tubewell cost only around Tk. 1500 - Tk. 2000. which is only 6 to 7% of the cost of a deep tubewell.

One VSST serves about 75 to 100 people. The performance of a VSST is same as that of a SST if it is installed at the proper water bearing aquifer. If there is no hindrance to recharge of the aquifer by rainwater or other surface water there its yield and longevity are same as those of a shallow tubewell. But it has been found that sometimes a VSST yields little water because of depletion or ground water storage during the dry season. This situation arises due to lack of recharge of water to the aquifer where the strainer of the well is placed.

3.6.5 Pond Sand Filter (PSF) :

This is useful at some parts of the coastal region. As the permanent presence of surface water is a pre-requisite they constitute a possible alternative for areas (ponds) with unfavorable infiltration condition.

A pond sand filter is constructed at the bank of a pond which contains water all the year round. Water from the pond is pumped by a hand pump into a raw water reservoir underlain by a sandbed. From the sandbed water pours out freely via a clean water reservoir and can be collected from a tap (Figure 3.15). The reservoir is constructed of bricks, brick chips, sand, cement etc. A PSF can serve about 100 persons.

A major problem with the pond sand filter is that if the pond water is rich in algae then the filter becomes clogged rapidly and it becomes difficult to clean the filter materials. The village people are not interested to clean the same very frequently. Sometimes pond sand filters have been found inoperative because of poor maintenance and non-cleaning of filter materials.

The cost for construction of a pond sand filter varies from Tk. 10,000/- to 16,000/- depending on the size, availability and price of construction materials.

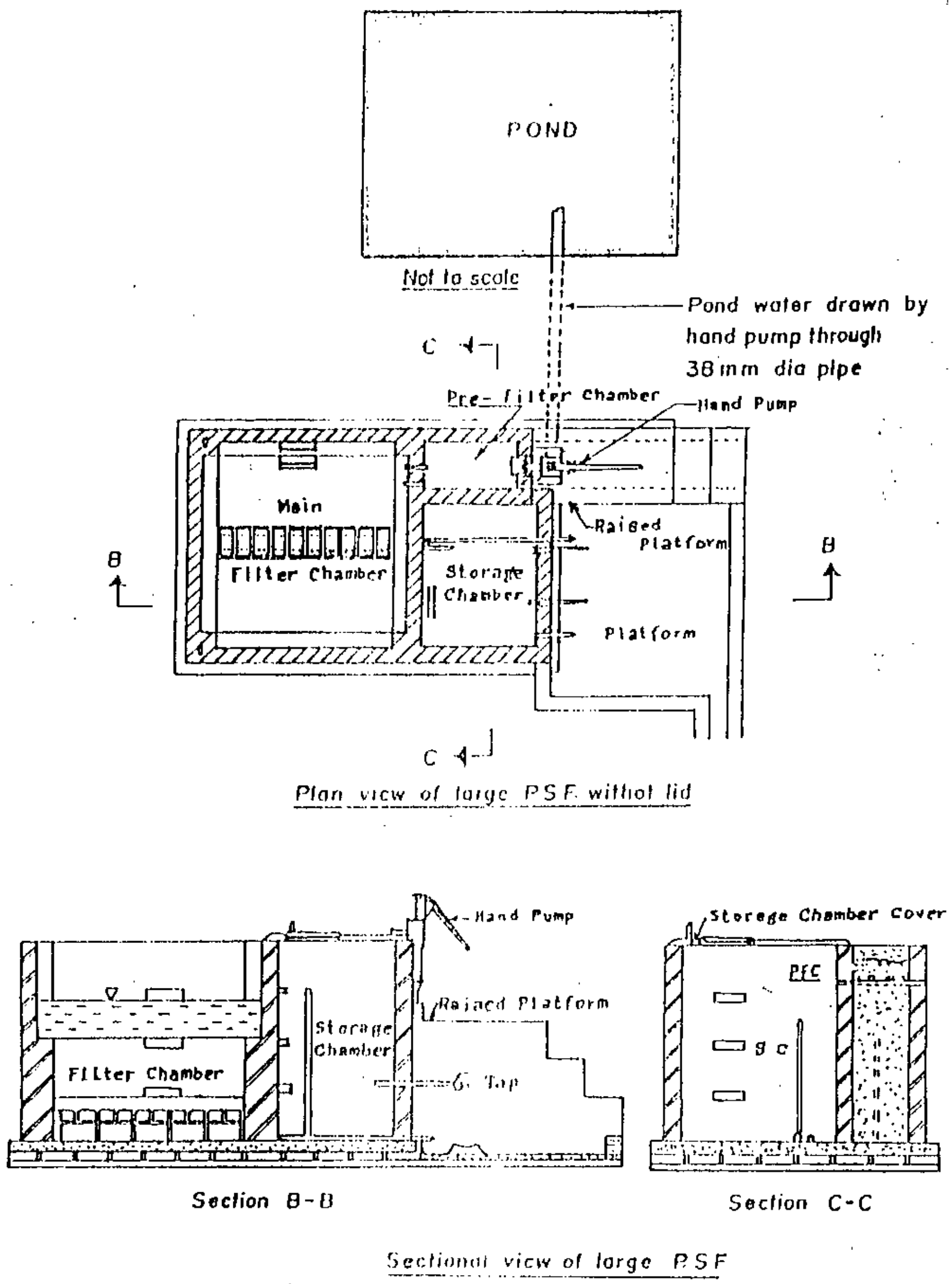


Figure 3.15 Typical Diagram Of a Pond Sand Filter

3.6.6 Tara Tubewell

In some parts of at least two coastal district viz. Bagerhat and Cox's Bazar, Tara tubewell is best suited for drawing underground water. A Tara or deep set tubewell is a special type of technology (Figure 3.16) by which ground water can be drawn even when ground water table declines beyond 7 to 8 meters during dry seasons or drought. But this tubewell is more expensive than a shallow tubewell.

At present Tara pump is being fielded mainly in the northern parts of the country where water table goes beyond suction limit and shallow tubewells go out of operation. The present version of Tara tubewell can draw water even when water tables goes below 15 to 20 meters from ground surface. The main performance of the Tara pump lies in its capacity to draw ground water when ground water table declines beyond the suction limit. In such case ordinary shallow tubewell ceases to operate. During the dry season and drought a large number of shallow tubewells in the northern districts of the country and also in the greater Dhaka and Mymensingh district go out of operation. This results in serious crisis of drinking water in these areas. To redress this problem Tara pump is an useful technology. But the quantity of water it draws during per unit time pumping is less than that of a shallow or a deep tubewell. Its mode of pumping is also different from that of a shallow tubewell and is a little bit difficult. The woman folk of the country do not like such type of pumping arrangement. To overcome this problems R&D work is going on to use lever type of handle as used in shallow tubewell or deep tubewell.

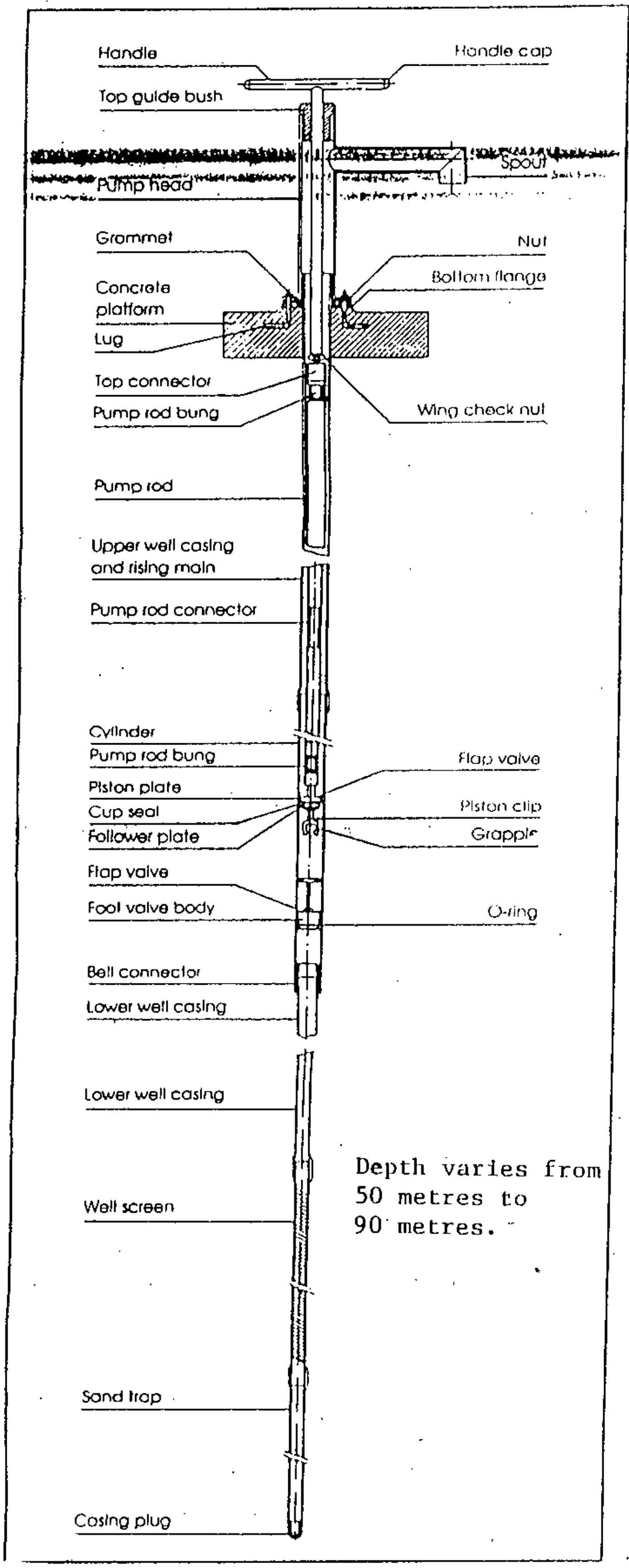


Figure 3.16 Typical Diagram Of a Tara Tubewell

3.6.7 Iron Removal Plant (IRP)

In some areas in Bangladesh the ground water contains dissolved iron in excess of normal drinking water standard (0.25 ppm). Dissolved iron content more than 5ppm (even upto 10 ppm) is found in tubewells in some places including Khulna, Bagerhat and Satkhira districts in the coastal zone. Some other plain districts have also high iron content in ground water. The rural people in Bangladesh do not object to use of water upto 5ppm dissolved iron content. But tubewell water with more than 5ppm is not preferred for domestic purposes. To reduce iron content DPHE with UNICEF assistance has developed a mini type iron treatment plant at tubewell site. This is made of locally available materials such as brick, brick chips, cement, sand etc. The cost of such an IRP (Figure 3.17) is about Tk. 1500 - Tk. 2000. It can serve about 100 to 150 persons.

Water passes from the handpump into a ferrocement channel. This is made at site from a mould and has a ferrocement cover at the handpump end. The water drops through the perforated base of the channel into the sedimentation tank and is aerated as it does so. The aeration causes soluble iron to precipitate out of solution and form a flocs of ferric oxide.

Some iron flocs are removed as the water flows across the sedimentation tank, either by sedimentation or, more commonly by adhesion to the walls and the mosquito nets suspended across the tank. The water then passes over a dividing wall and down through the filter where the rest of the iron flocs are removed.

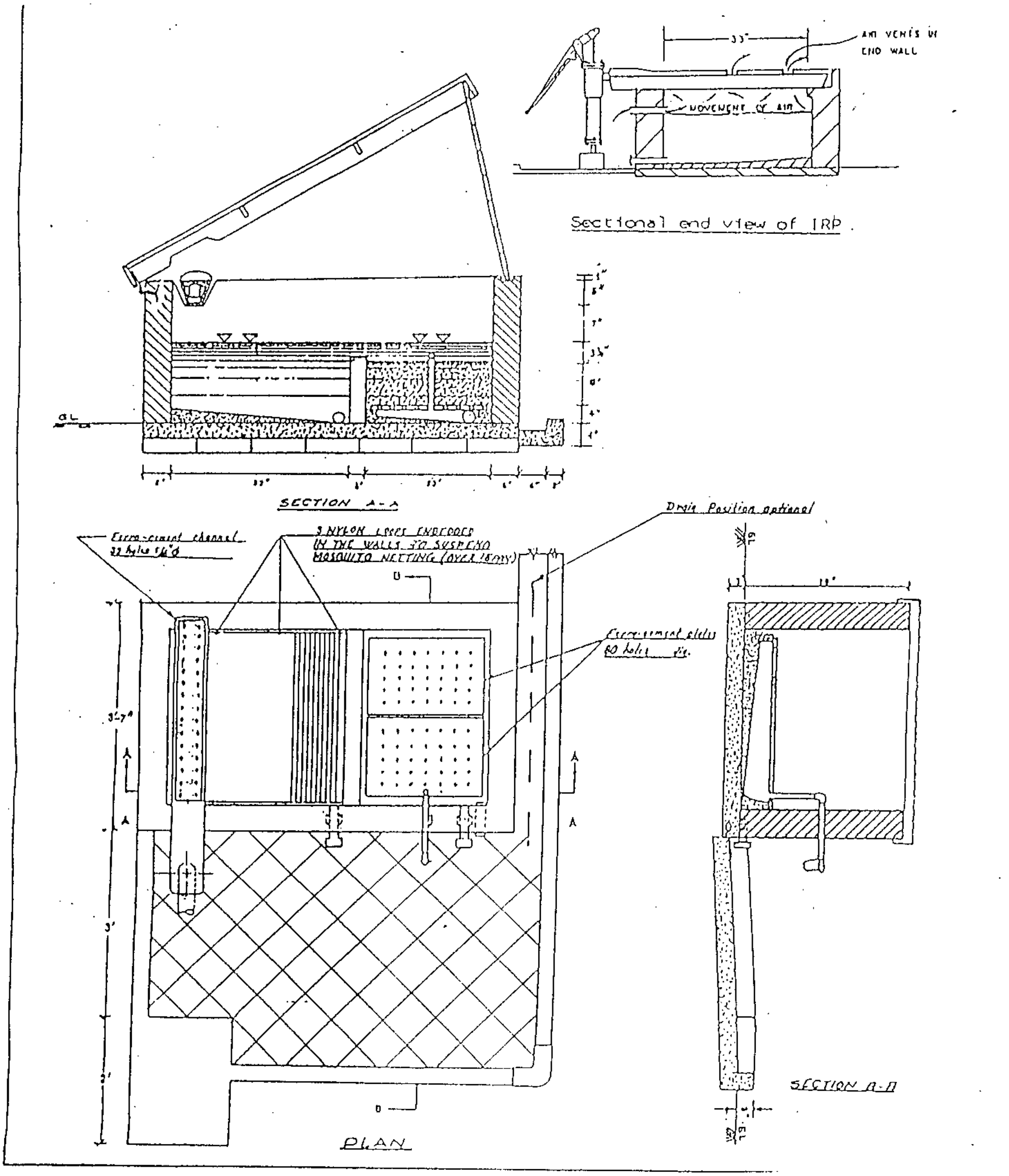


Figure 3.17 Typical Diagram Of An Iron Removal Plant.

The filter is 20 cm deep by 60 cm wide and 84 cm long. The brick chips are sieved to a size 3 mm to 15 mm". The same grade is used throughout for simplicity and maximum use of the filter volume. The brick chips can be removed and replaced without worrying about grading. The filter media rests upon perforated ferro-cement plates supported over a sump to ensure that the entire filter area is used and to make drainage and cleaning easier.

After passing through the filter the treated water is delivered through a 12 mm diameter GI pipe. This is fitted with a tapered wooden bung and the inside of the pipe is machined to a smooth taper to reduce wear and prevent leaks.

Ordinary plastic or brass taps are of no use as the head of water available is too small for adequate flow. A gate valve works well but soon becomes worn out due to being turned on and off may be 100 times a day.

A 25 mm diameter plastic overflow pipe is provided at a height that ensures that the water level does not become so high that inadequate aeration occurs. Because it is of large diameter, it ensures good air circulation through the tank.

A large platform is provided and all outlets (including overflow and drain) of the tank discharge onto it, which prevents the surrounding earth becoming muddy. The platform is big enough to contain all the brick chips when these need to be removed for cleaning by fresh water. The beneficiaries themselves can do this work when trained by DPHE personnel.

3.6.8 Harvesting Of Rain-Water

Though rainwater harvesting is not a common practice in Bangladesh, it can be practiced in rainy season in some parts of the coastal region specially Bagherhat and Satkhira districts. Because these two districts lack surface and subsurface water sources. The technological details of rain water harvesting are prescribed below.

Bangladesh is a tropical country and heavy rainfall due to north easterly wind pours in during the rainy season between June to October. The average annual rainfall in the coastal districts has been shown in section 2.2.3. in chap. 2. From the histogram of rainfall intensity it has been seeh that the minimum rainfall was recorded in January - February and November - December. This indicates that rainfall in Bangladesh is not uniform over the year. As such harvesting of rainwater in the rainy season and using the same in the dry season is both inconvenient and unnecessary in normal situation in Bangladesh particularly where tubewells are normally successful.

But the coastal belt of Bangladesh has good potential for harvesting rainwater. In the coastal belt there is a predominance of clay and clayey formations at ground level. As a result surface tanks serve as a rain water catchment reservoir which the coastal people can use round the year for drinking and other domestic purposes with or without any treatment (as per prevailing water quality).

In the recent years a series of exploratory boring has been carried out by DPHE and it has been confirmed that in some parts (Bagerhat and Satkhira districts) of the coastal belt the prospect of the availability of potable ground water is either non-existent or bleak. Herein the only solution will be the rain-water harvesting in the surface water ponds. These ponds have natural clay lining and will serve as rain water reservoirs. Pond Sand Filter can be constructed at the banks of the reservoirs for treatment of pond water. Rain-water harvesting is practiced in a very limited scale mainly on offshore islands. But the tragedy is that

all the surface ponds get inundated by saline water if the cyclone is associated with strong surge vanishing the prospect of rainwater use at that time.

Still harvesting of rain-water in special case through house roofs as catchment floor will be a cheap technology for safe water during the post cyclone period. It has been experienced that often heavy rainfall occurs for a few days after the cyclone. During this time rain water can be harvested and used for all domestic purposes specially where there is no alternative source of water supply.

Rain-Water Harvesting For Individual Families

For collection of rainwater for individual households, the corrugated iron sheet roofs provide good catchment area. Rain water running off the roof is led through a gutter and down spouts to a rain collection tank situated on the ground or below as shown in Figure 3.18.

Design/Development of a house-hold rain water collection tank should meet certain specifications including the following:

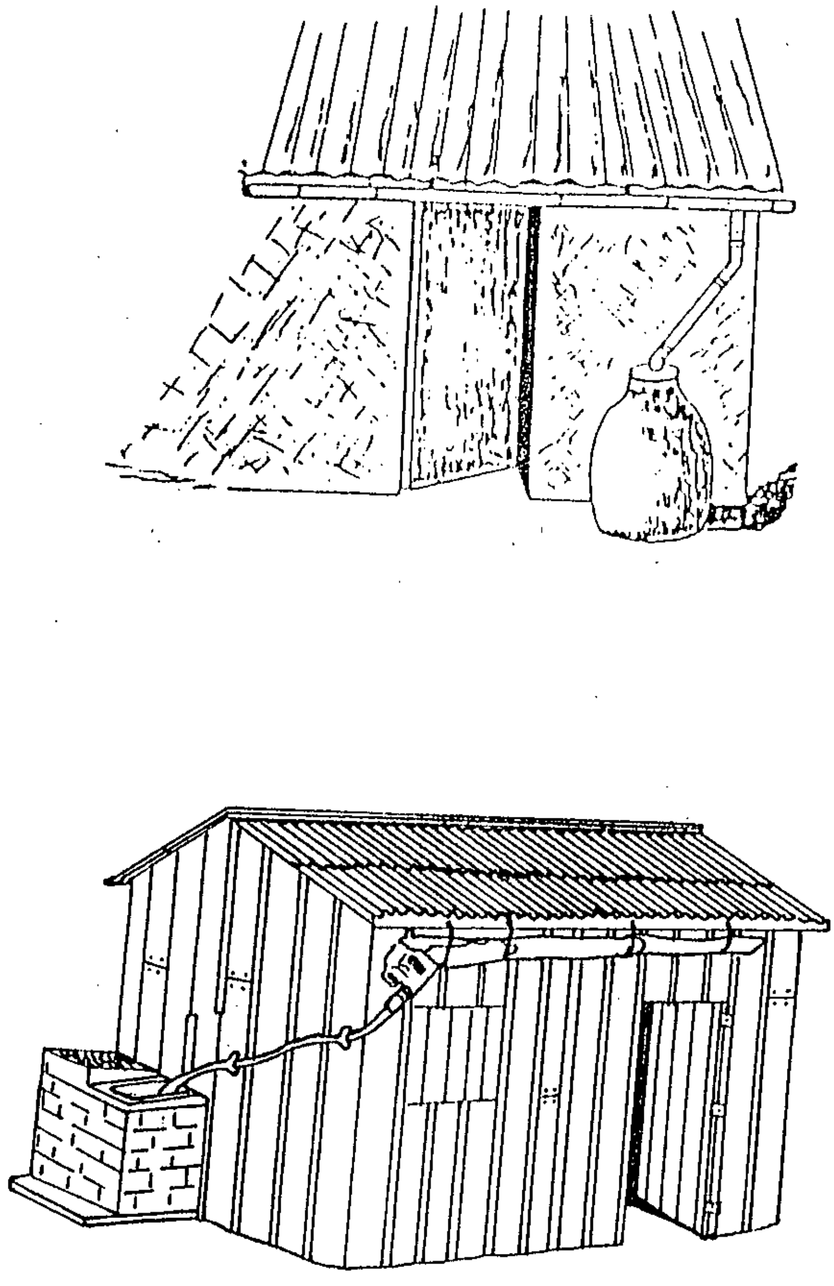


Figure 3.18 Typical Diagram Of Rainwater Harvesting For Individual Families.

1) The tank must be water-tight to prevent surface contamination from polluting the supply. Reinforced concrete or ferrocement would be the best to suit this requirement because it is strong, has a long life and it can be made watertight. Properly constructed earthen container may also be used as cistern which from the economic point of view will be most viable for local conditions.

2) A manhole of size 0.6 m x 0.6 m must be provided so that the tank can be cleaned and through which chlorine can be added for disinfection when necessary. The manhole entrance must be at least 5 cm above the tank surface and the cover should overlap by 2.5 cm from each side.

3) A flush water tank or a cut-off switch or deflector in the downspout must be provided to divert the first flush of rain water from entering the tank. This arrangement will permit clean water to enter the storage tank.

4) A screen vent is needed if there is no overflow, to allow displaced air to leave the tank. Normally a G.I. pipe of 100 or 150 mm in diameter with the outlet properly covered with a copper/aluminium window screen is employed for this purpose.

5) The tank should preferably be located in a shaded area to keep water cool.

6) A drain pipe of size ranging from 50 - 100 mm must be provided at the lowest part of bottom of the tank with a gate value. The size of the pipe may increase with the size of the tank.

7) In the event of the rain collection being constructed partly underground, the top surface of the tank must be at least 20 cm above the flooding level at times of heavy rainfall. In such cases the slope of the bottom of the tank must be dished to a pump, so that water can be bailed or pumped out when the tank needs cleaning.

8) If a hand pump is to be installed the pump must be securely mounted on bolts cast into the concrete tank cover. The flanged base of the pump should be solid with no hole for contamination to enter and sealed to the pump cover or the drop pipe must be sealed in with concrete and asphalt sealing compound.

9) The roof of the house used for collecting rain water should be a smooth, water tight material, like a galvanized sheet metal roof. A wooden or thatched roof may affect the quality of rain water as these materials tend to retain dust, dirt and leaves; water collected from these roofs contain more organic matter and bacteria than water from smooth surfaces.

10) A screened inlet of 20 mesh wire screen and down spout (usually of a 100 or 150 mm diameter) should be provided. The down spout should be proportioned to the catchment area to be drained.

11) A newly built or repaired rain collection tank should always be disinfected with 50 mg/l chlorine solution. The tank walls and bottom should be thoroughly washed with this strong solution and held for 24 hours.

12) Despite the fact that rain water is clean and safe in its nature when properly collected and stored, it is advisable however that a coarse sand filter be always employed when-ever possible. The sand filter has the advance of removing dust and debris which may give rise to tastes, or odours and other changes in the attractiveness and palatability of the collected rain water. Suggested filtration rate of the filter is 5.5 $m^3/m^2/mm$.

(Source : Rainwater Harvesting Bulletin, Vol-8, March, 1993).

Big Rain Water Collection System

For cyclone shelters (Figure 3.19) big rain water collection system can be made. For such shelters fully surface or partly underground rain water storage tank (water tight) can be built, since the roof of these buildings are generally well maintained and the areas are large enough to serve as catchment area for big rain water collection. Figure 3.20 shows a simple diagram (with surface tank) for rain water harvesting in the case of cyclone shelters. A (ground reservoir) tank of capacity 65 m^3 can serve a population of about 150 considering an ultimate supply of 5 lpcd. This type of rain water collector is found economically effective if the roof surface is more than $200m^2$. Figure 3.21 shows such a big rain water collection (ground) reservoir (65 m^3 capacity). In both the cases of surface and underground reservoirs arrangements should be made to make those water tight to protect against pollution either by surface water or by other possible ways.

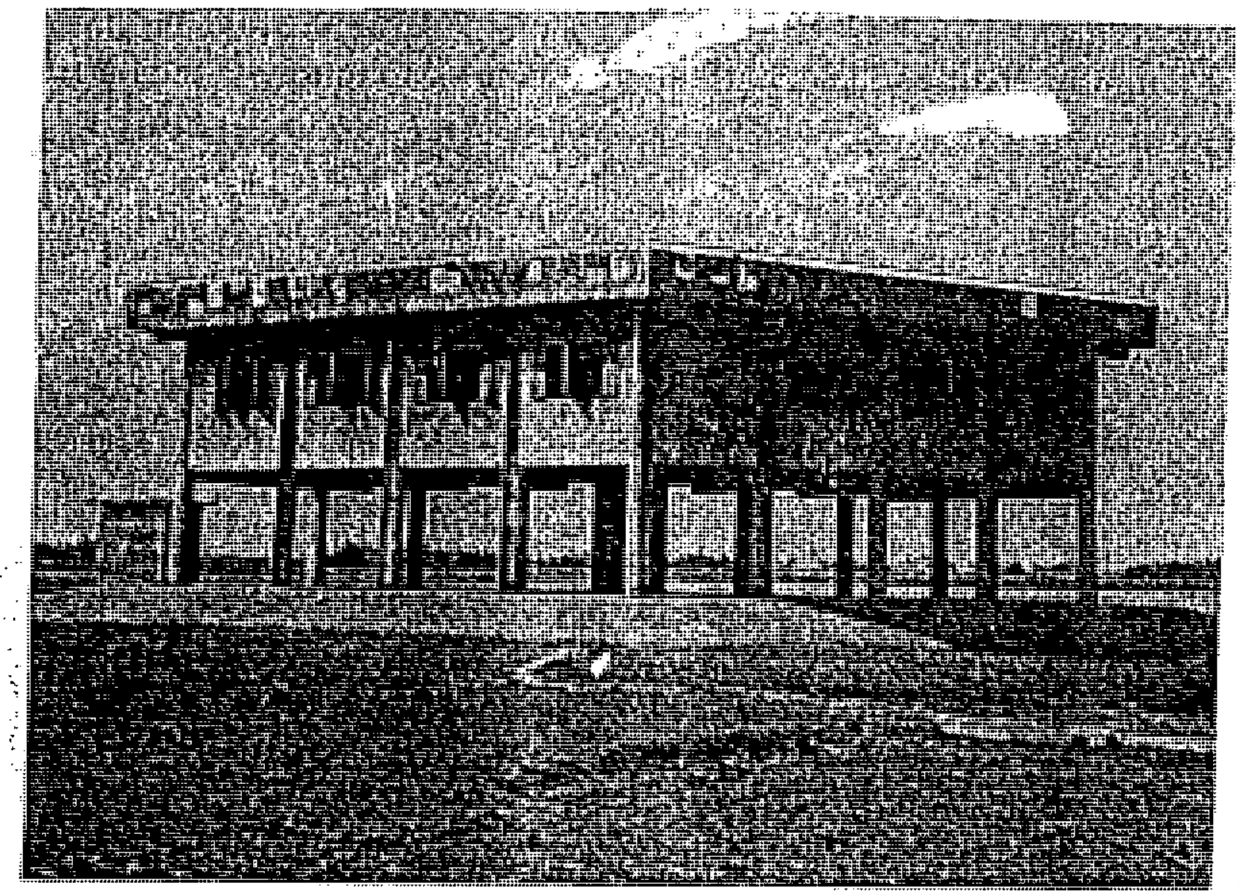


Figure 3.19 Photograph Of a Typical Cyclone Shelter

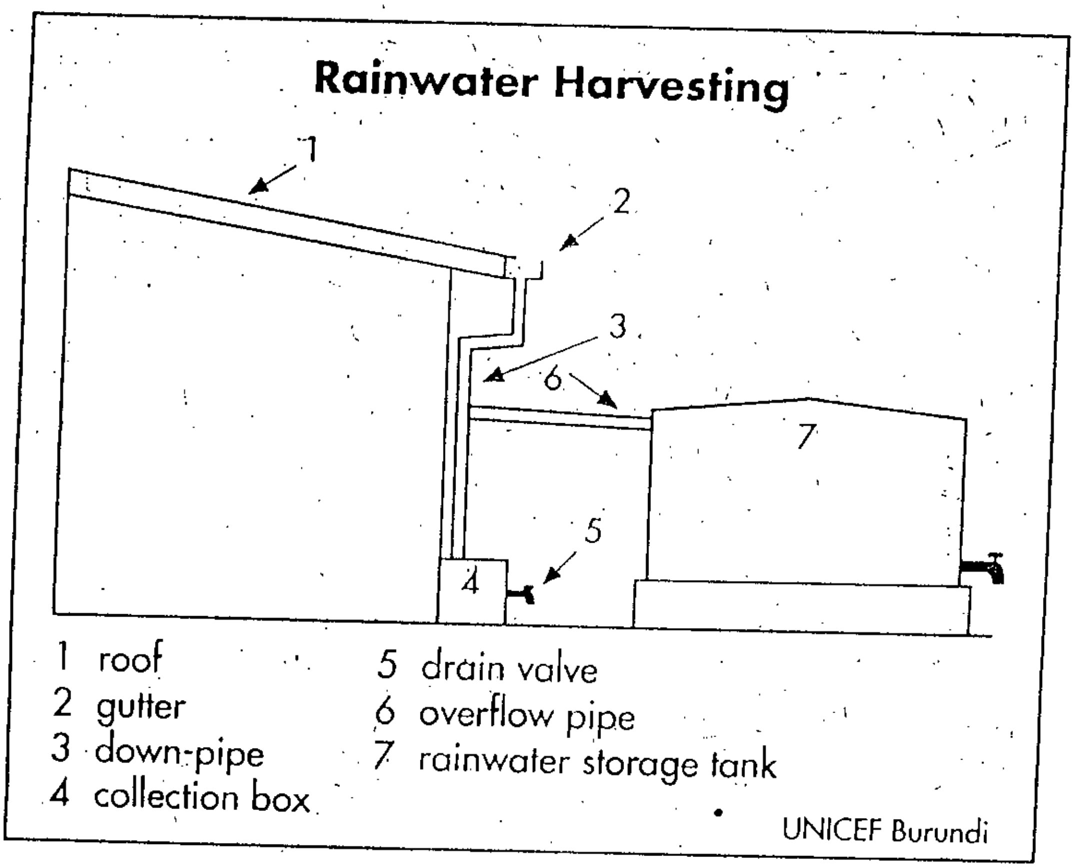


Figure 3.20 Typical Diagram Showing Rainwater Harvesting In The Case Of Cyclone Shelter

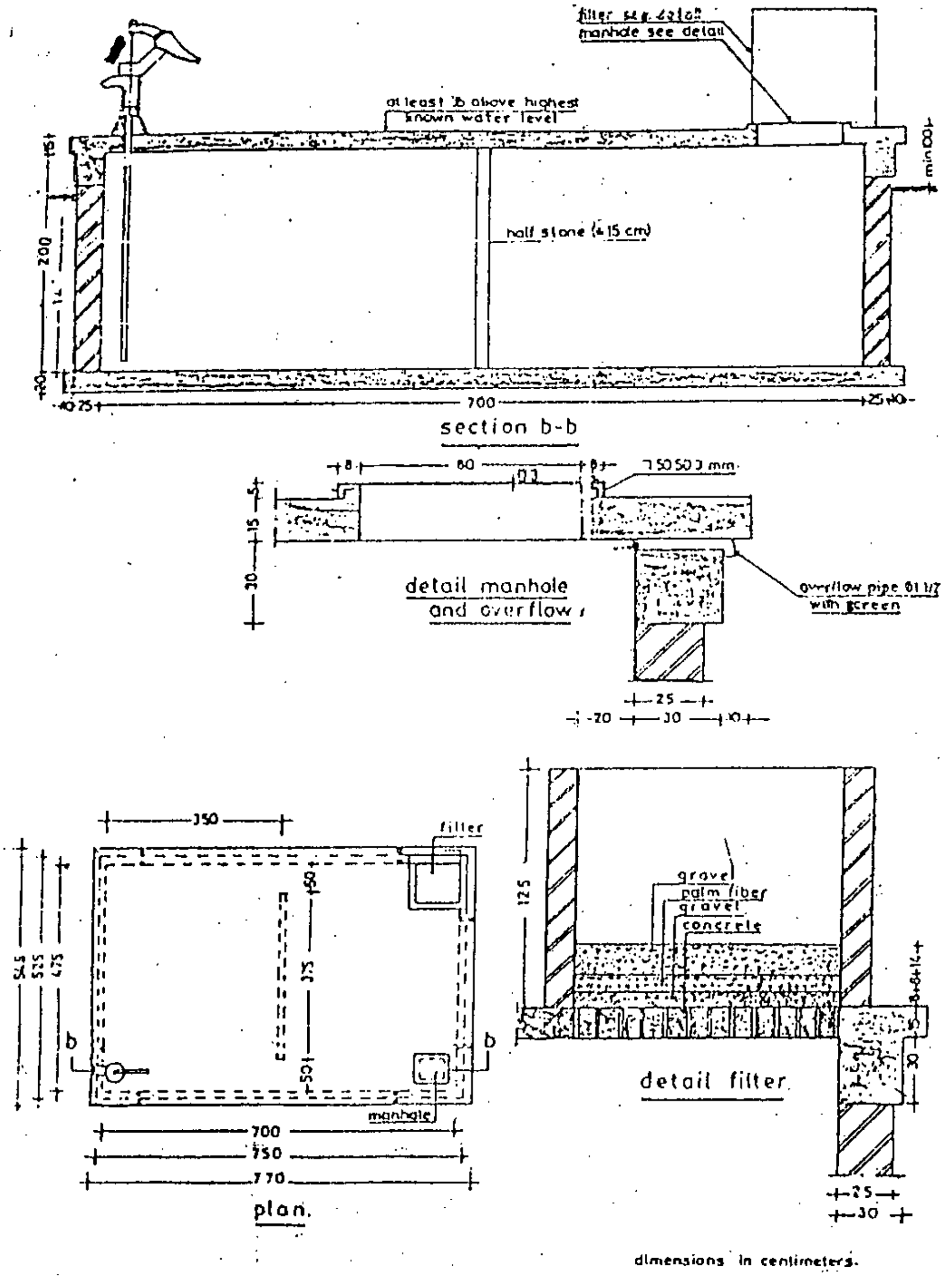


Figure 3.21 Typical Diagram Of a Big Rainwater Collection Reservoir

The water withdrawal from the tank can be done most practically by installing a hand pump. This will be the best means of preventing contamination and wastage of water. The most of the criteria described in the case of household rain water collection tank also apply to the big rain water collection system. The principle in general remains the same. However the following suggestion may be added.

1) Special emphasis should be placed on the structural design components of the tank to prevent leakage and uplift of the tank at times when the ground water level is high.

2) Construction work, should be closely supervised by technically competent personnel so that sound engineering construction techniques are applied.

3) The overflow pipe should be so located as to prevent the entrance of surface water at times of heavy rainfall.

4) Manhole covers and gates should be kept closed.

5) For safety against contamination by flood water such reservoirs may be constructed above ground level.

The coastal areas have a large number of cyclone shelters (about 850) some of which have not access to either tubewell water or surface water. Since all cyclonic storms are generally accompanied with high intensity rainfall those shelters may incorporate rain water harvesting facilities to meet the emergency water demand during cyclone and post cyclone periods. A part or the entire roof of the shelter will be used as catchment area. A permanent rain water cistern in each cyclone shelter may serve as a potential supplementary water supply system for the shelters. The strategies for dependable water supplies for cyclone shelters will be as follows :-

i) The areas where deep and shallow tubewell are successful due to availability of low-saline water bearing aquifers, the water supply system for shelters in these areas will be developed through installation of manually operated deep and shallow tubewells. These areas have already been identified through analysis of available hydrogeological and water quality data and survey data collected through the multipurpose cyclone shelter programme and DPHE's coastal study. In few shelter locations community type Iron Removal Plant (IRP) attached to tubewells will be required to reduce iron content of tubewell water in these locations to acceptable level.

ii) The areas where ground water of salinity lower than the acceptable level is not available, Slow Sand Filter (SSF) units will be installed to treat available low-saline surface water to produce water of acceptable quality for water supply.

A pond receiving rain water drainage from shelter and adjacent areas may serve as a source of low saline water round the year. An adjacent river discharging fresh water during monsoon may also be used as a source of low-saline water for 7 to 9 months. The facilities thus developed may serve as a community water supply for the households around the shelter.

iii) Since all the cyclonic storms are generally accompanied with high intensity rainfall, the shelters may incorporate rainwater harvesting facilities to meet the emergency water demand during cyclone and post-cyclonic periods. A part of the roof of the shelter building may be used for the collection of rainwater in a suitably located reservoir. A permanent rainwater cistern in each cyclone shelter may serve as a potential supplementary water supply system for the shelter.

iv) The water reservoir installed in the each shelter will be utilized for the storage of potable water for use during cyclone. The caretaker/ management committee of the shelter must ensure that adequate potable water has been stored in the reservoir of the shelter when there is warning for cyclonic storm.

3.7 EXISTING PHYSICAL FACILITIES

3.7.1 Water Supply

At present most of the rural people in Bangladesh have access to safe tubewell water. There have been tubewells within short accessable distance from the rural house-holds. But still there is regional disparity in rural water supply system. The coastal zone has low coverage as a result of this disparity. The main reason for comparatively poor coverage in the coastal belt is excess salinity in the upper aquifers of underground water resulting in failure of sinking the cheap technology i.e shallow tubewells every where.

The underground water from aquifers at depth 30 to 200 meters from the ground surface contains excessive salinity beyond human consumption. Moreover, almost all the surface sources are grossly polluted. So deep tubewells are installed to extract water beyond depth of 200 meters. As a result, the technology (deep tubewell) has been highly expensive and so sufficient numbers of deep tubewell could not be installed as yet. In addition to this, there are areas where even deep tubewells are not feasible and successful because of unavailability of fresh water aquifers. Table 3.2 shows the numbers of different technologies in the coastal districts as of June 1993.

TABLE 3.2 Existing number of tubewells in Coastal Districts of Bangladesh along with service coverage (As of June'93).

Sl. No.	Name of District	Population as at 1991	Nos. & Type of Tubewells			Total T.W	Total Running T.W.	Person per Tubewell	
			Shallow	Tara T.W	Deep T.W.			gross tubewell	Running tubewell
1	Khulna	2131638	11518	-	1769	13287	12310	116	126
2	Bagerhat	1476190	13339	-	104	13443	12814	111	116
3	Satkhira	1652807	13706	376	218	14300	13830	105	109
4	Noakhali	2345713	16565	-	2733	19298	17760	110	120
5	Laxmipur	1382677	12149	-	639	13029	12393	102	107
6	Feni	1156069	9634	-	982	10552	9695	111	121
7	Patuakhali	1298152	-	-	7294	7294	7085	194	200
8	Borguna	792534	114(PSF)	-	4490	4604	4476	183	188
9	Barisal	2202160	16931	-	4997	21928	21317	106	109
10	Jhalakati	697108	5261	-	1677	6938	65950	102	107
11	Perojpur	1102985	10040	-	1119	11159	10664	105	110
12	Bhola	1489415	-	-	7221	7221	7038	210	215
13	Chittagong	5729740	28048	-	5616	33664	30967	125	136
14	Cox's Bazar	1465022	9233	136	1968	11337	10699	107	114
	Total	24922210	146538	512	40827	2e+05	177643	128	134

Source : DPHE, 1993 (* PSF : Pond sand filter)

Besides, there are some non-conventional technologies such as shallow shrouded tubewell, very shallow shrouded tubewell and pond sand filter. The district wise status of these technologies is shown in the Table-3.3.

Table-3.3 District-wise status of SST. VSST and PSF in the coastal zone.

Sl. No.	Name & District	SST	VSST	PSF	Total
1	Khulna	42	146	91	279
2	Bagerhat	100	-	-	100
3	Satkhira	68	680	149	897
4	Noakhali	13	728	-	741
5	Laxmipur	-	245	-	245
	Total	223	1799	240	2262

3.7.2 Sanitation Facilities

Although 90 percent of the rural people in Bangladesh have access to safe drinking water the state of sanitation is alarmingly poor. The poor sanitation situation contributes to poor health status.

The greatest environmental threat to the country is the large quantity of deposit of about 25 thousand metric tons of human excreta everyday in the public domain. This is worsened by the high population density and the humid climate. At present only about 33% (40% by water sealed latrine plus 60% by home made latrine) percent of the rural families use sanitary latrines. The rest practice unsanitary defecation.

The coastal zone is not different from the overall sanitation status of the country as stated above. In the coastal areas the traditional latrines are constructed over ponds, canals and rivers as shown in the Figure 3.22. These latrines termed as hanging latrines allow the excreta to fall on the water bodies thus polluting the water. The use of these waters contributes to frequent occurrence of diarrhoeal diseases in epidemic forms almost every year terminating lives of thousands of people. Table 3.8 shows the number of low cost water sealed latrine in different coastal districts.

The Department of Public Health Engineering started rural sanitation programme in 1950 with WHO collaboration. Later on UNICEF came forward to help DPHE to improve rural sanitation situation and several projects were implemented in rural areas of the country. Now a big rural sanitation project named Rural Sanitation Project, Phase III is being implemented with UNICEF assistance. The target of this project is to produce and distribute about 200,000 sets of latrine to rural families. At present each thana has got a production centre (Figure 3.23) only with one sub-centre at the union level. The coastal belt also enjoys the same status. Besides govt. centres, there is a large number of private production centres in the country.

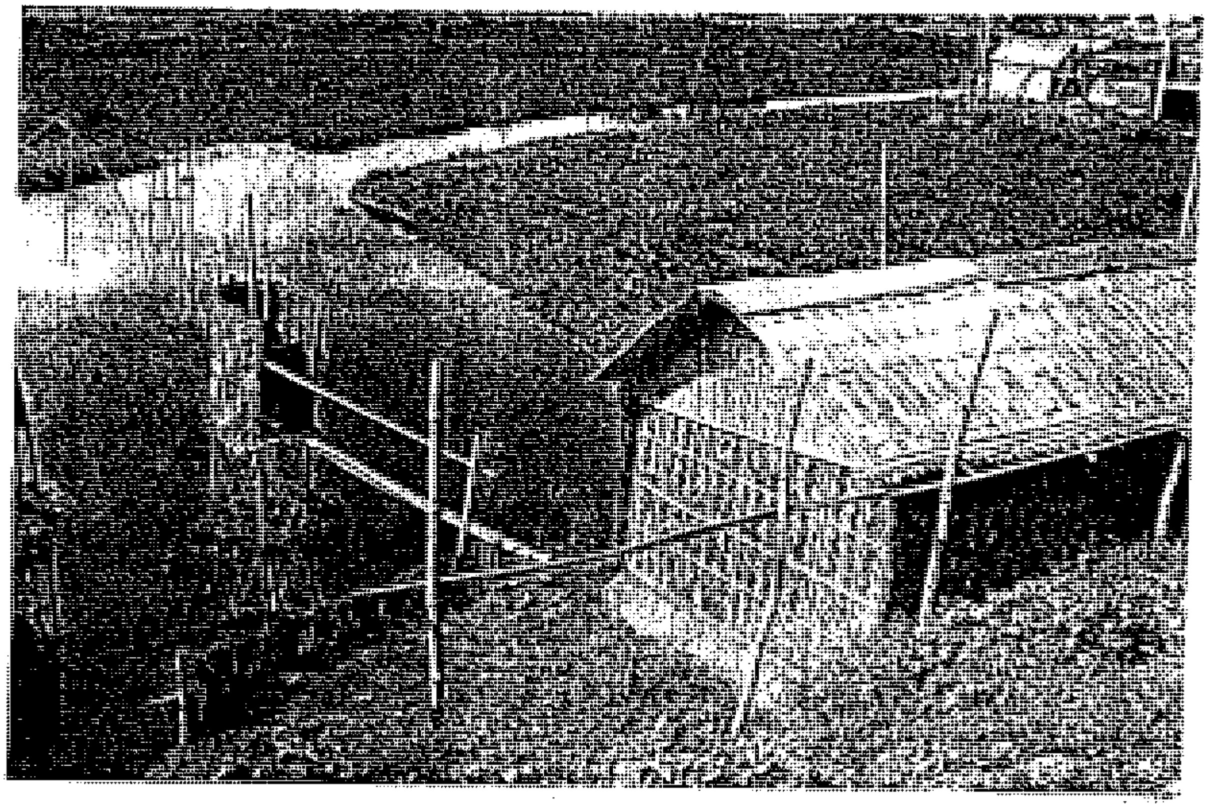


Figure 3.22 Hanging Latrine At The Coastal Belt

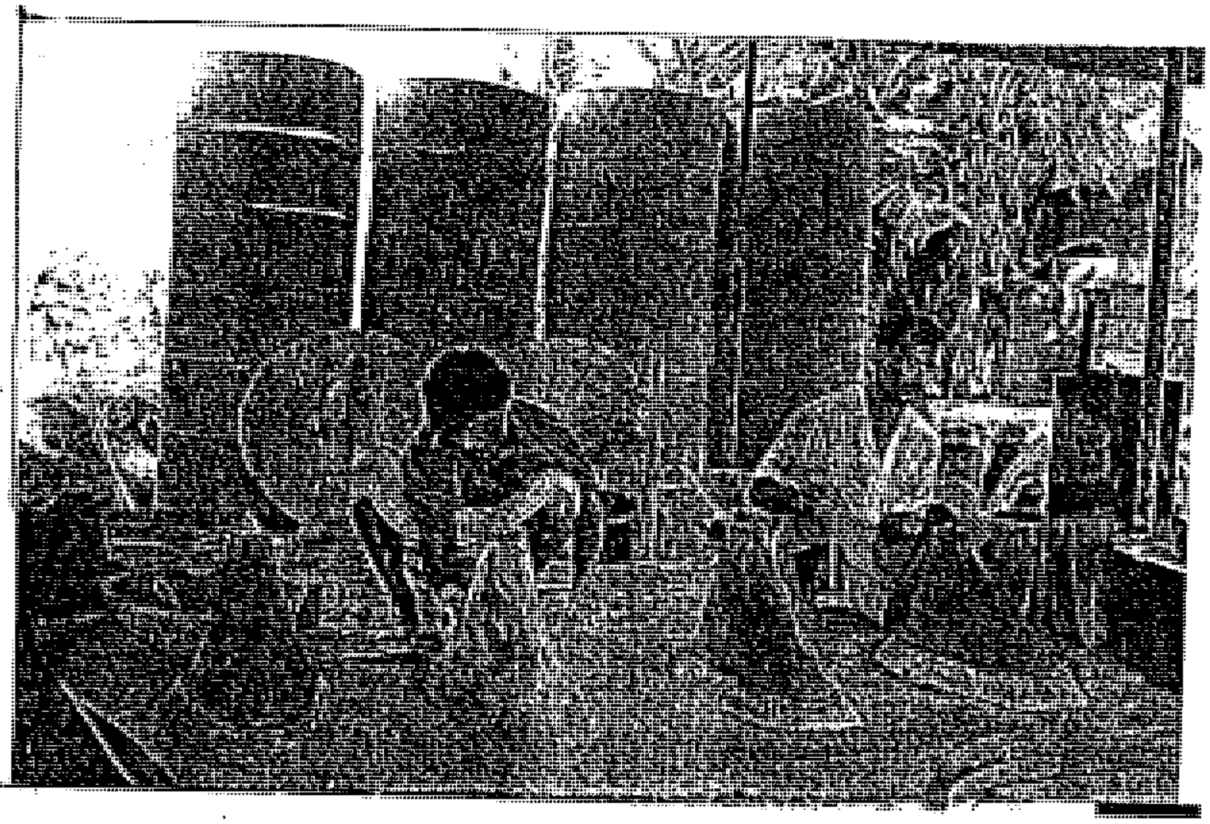


Figure 3.23 DPHE Village Sanitation Production Centre

Table-3.4 District-wise sanitary latrines in the coastal areas (as of June'1992).

Sl. No.	Name of Districts	Number of Sanitary Latrines	% Population Coverage
1	Khulna	40869	12
2	Bagerhat	29491	13
3	Satkhira	38778	15
4	Noakhali	23712	7
5	Laxmipur	11494	5
6	Feni	19659	7
7	Patuakhali	25165	13
8	Borguna	20148	17
9	Barisal	25093	7
10	Jhalakati	14276	13
11	Perojpur	21015	12
12	Bhola	18301	8
13	Chittagong	53812	6
14	Cox's Bazar	21416	10

Source : (DPHE, 1992)

3.8 POST DISASTER WATER SUPPLY AND SANITATION SITUATION

Severe cyclones occur at the coastal belt leaving remnants of devastation everywhere. The survivors face serious scarcity of basic needs such as housing, food, clothing, medicine and above all drinking water supply. Scarcity of drinking water appears as the immediate crisis to cause suffering of the cyclone-torn people although they are surrounded by plenty of water. But this water is highly polluted and saline and is fully unfit for drinking purposes. The devastating cyclone when associated with strong tidal surges affects along with all other infrastructures most of the drinking water sources. What happens to water supply and sanitation in the face of disaster is enumerated below :

1. The hand tubewells get inundated by storm surge of highly saline water. Saline water enters the well pipe. As a result the tubewells cease supplying sweet water unless they are brought to service by continuous pumping out the saline water.

2. Hand tubewells are also affected due to breakage of handles and damage to leather seat valves and buckets.

3. Pumps are detached from some tubewells and swept away by strong storm surges thus leaving the tubewells out of service.

4. The pond sand filters and iron removal plants are damaged and inundated.

5. All the natural sources such as ponds and canals are inundated by saline water and they cease supplying fresh water.

6. The piped water supply systems in municipalities also undergo serious damages due to storm surges. The pump houses, street hydrants and treatment plants get affected by tidal surge devastation causing hindrance to urban water supply.

7. The cyclonic storm with tidal surges also demolishes rural as well urban

sanitation facilities such as latrines and latrine production centres.

8. Office buildings and godowns of the water supply agency are also damaged by cyclones causing management problem of water supply and sanitation.

9. The overall water environment is deteriorated because of high level of pollution.

The damage caused to rural water supply system in the affected districts by the devastating cyclone of April 29, 1991 have already been shown in section 2.6. Almost every cyclone associated with tidal surges causes heavy damages to water supply and sanitation systems.

Because of the lack of necessary logistic support and due to disruption of communication water supply system can not be restored immediately. It takes time, money, materials and manpower to repair the affected tubewells and piped water supply systems. But for the authority it becomes very difficult to mobilize these requirements overnight. As a result the cyclone-torn people fall prey to untold sufferings from scarcity of drinking water. This results in the outbreak of diarrhoea, cholera, dysentery and other water-borne diseases in the cyclone affected area and they again take the lives of thousands of people.

Under such situation the people are forced to use highly polluted water for drinking, cooking, washing and other domestic purposes. On the other hand due to damage to latrines they defecate here and there seriously polluting the environment.

The situation of water supply and sanitation during the post disaster period is summarized as below (Table 3.5).

Table 3.5. Effects of cyclone and tidal surge on water supply and sanitation.

Sl. No.	Environmental parameters	Immediate effects during disaster	Post disaster effects
1	Water and Sanitation	1. Tubewells, ring wells, infiltration gallery, pond sand filter and iron treatment plants and sanitation systems are damaged. 2. Surface water bodies are inundated and polluted by saline surge water.	2. Scarcity of drinking water. 2. Outbreak of water borne diseases. 3. loss of lives by epidemics. 4. other health hazards. 5. Financial loss.

Therefore it is concluded that both water supply and sanitation systems are heavily damaged by cyclone and tidal surges causing scarcity of drinking water supply and sanitation facilities. This situation leads to occurrence of many water borne diseases which cause loss of human lives.

CHAPTER FOUR

FIELD STUDY

4.1 INTRODUCTION

An extensive field investigation program was undertaken during the course of this study. The program included :-

a) field visits to several coastal districts;

b) a questionnaire survey in two cyclone affected Thanas; and

c) a followup visit to a place where the survey was conducted.

The specific objectives of this program were :

(i) to obtain an overall idea of the real life situation of the people who face the devastation of cyclones and tidal surges in the coastal area.

(ii) to assess the situation with respect to drinking water supply and sanitation in the cyclone affected areas during post disaster period and,

(iii) to exchange views and ideas with the concerned people with regards to possible measures that could be taken to mitigate or minimize water and sanitation challenges during and after cyclones and tidal surges.

4.2 FIELD VISITS

Visits were made to Barisal, Bhola, Perojpur and Patuakhali districts of the coastal region of the country in order to appreciate the actual situation regarding water supply and sanitation during post cyclone period. The district level officers and the field engineers and technicians of DPHE were consulted during the visits on matters related to the status of water supply and sanitation in the coastal region. It was derived from consultations that the post cyclone situation of water supply and sanitation turns serious atleast for the first few days because of tremendous damages caused to the existing water and sanitation facilities. It was also revealed that lack of facilities coupled with lack of mass awareness of the linkage between water, sanitation personal hygiene and health results in the out break of diarrhoeal and other water borne diseases during post cyclone periods.

The field workers further informed that the cyclone affected people do not feel the urge of having a sanitary facility at that time when they desperately search for food and shelter for survival.

4.3 FIELD QUESTIONNAIRE SURVEY

The questionnaire survey was conducted in the coastal district of Cox's Bazar which was seriously affected by the 1991 cyclone. Two thanas under this district namely Chokoria and Moheskhali were selected for the field survey. A total of 68 households in these two areas were surveyed with a preset questionnaire prepared in Bengali to make it easily understandable by the respondents. The questionnaire translated in English is included in Annex-B. A filled in questionnaire translated in English and another in the original form are shown in Annexures C and D respectively. The field survey was conducted with assistance from two Sub-Assistant Engineers and four tubewell mechanics of DPHE posted at the respective thanas.

A total of 13 questions related to problems of drinking water supply and sanitation during and immediately after the devastation of cyclones and tidal surges were included in the questionnaire.

It may be mentioned here that only 68 households out of several house holds in two thanas may not be sufficient to have a fully representative picture of the situation. However from this limited survey effort an idea about the over all situation can be drawn.

100% of households surveyed responded and explained their dreadful experiences of the 1991 cyclone and the tidal surges. An analysis of the survey results revealed the following information.

i) 26 percent of the families replied that they had taken refuge at the cyclone shelters and Govt. offices before they survived the cyclone and the tidal surge; 25% families took shelter at the nearest pucca houses 12% families on their own lands by constructing tents or temporary sheds, 18% families on the nearest highland, 6% families on the trees, 13% families on the roofs of the existing houses and the mosques as shown Figure 4.1.

(ii) As shown in Figure 4.2, 82% of the households had access to a tubewell either within premises or nearby location and 18% had no access to tubewell within reasonable distance.

(iii) 100% of the tubewells were affected in any away during the cyclone (Figure 4.3) and the damages included-

a) detachment of the pumps from the tubewells (14%);

b) breakage of handles of pumps and damaged to leather seat valves and damage to leather seat valves (12%).

c) ingression of saline water and muds into the pump head and tubewell (100%).

(iv) 71% families replied that they used tubewell water for drinking and cooking purposes. But some of them had to travel even upto one and a half kilometers to bring tubewell water. Out of these families, 12% replied that for the first one or two days they had to use rain water for drinking and

In %	Types of Shelter
26	Cyclone Shelter
25	Nearest Pucca Houses
12	Tents on Own High Lands
18	Nearest High Lands
6	Trees
13	Roofs of Mosques/Houses
100	Total

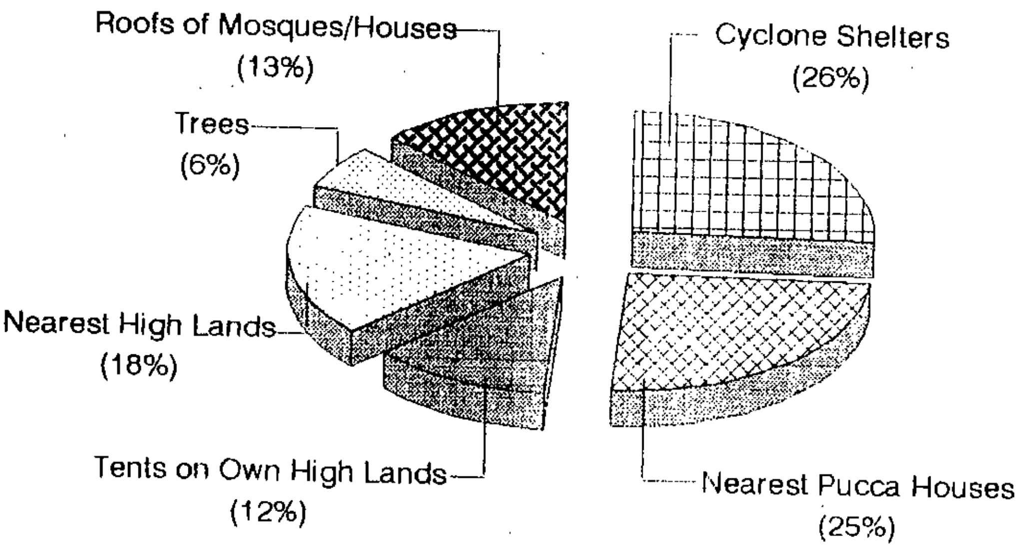


Fig. 4.1 : Types of Shelters Taken by People before Occurrence of April 1991 Cyclone and Tidal Surge

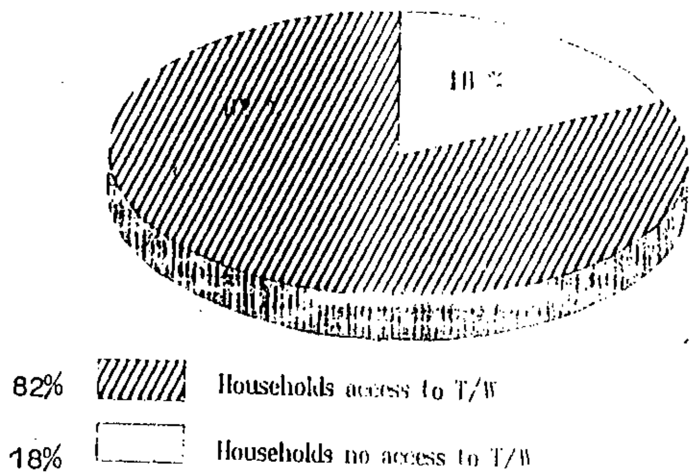


FIG. 4.2 ACCESS OF T/W TO HOUSEHOLDS SURVEYED

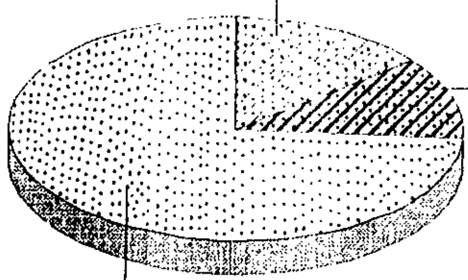


Fig. 4.3 : Types of damages to hand tubewells by cyclone with tidal surge, April 1991

cooking. Then they used tubewell water after repairing of the same. 29% families replied that they used water from dugs made on the ground for drinking and cooking purposes (Figure 4.4).

(v) 91% families replied that they faced problems in getting drinking water after disaster. The problems include long distance to travel to bring tubewell water, damage to the existing tubewells and entrance of polluted water into the tubewells.

(vi) 74% families replied that they had faced problem of safe water for the first one to four days after the cyclone.

(vii) All most all the families replied that they collected water from the nearest tubewells after disaster. A few families collected rain-water also.

(viii) All most all the families replied that after cyclone drinking water could be provided through tubewells. Some families indicated that a short galvanized iron pipe of the same diameter as the well pipe may be kept to the caretakers of the existing wells to raise the pump to protect the wells against submersion by tidal surge.

(ix) Most of the families replied that after the cyclone they practiced defecation on the open yard, in the dug made on the ground and on the hanging latrines. Some families climbed on the trees to defecate when the houses were flooded. Sometimes they used polythene bags to hold excreta and disposed those on the nearby ground.

(x) Another finding was that some of the families faced problems of long distance of tubewells from their households. They also stated that they could not use pond water because of excessive salinity.

(xi) All the families replied that surge water stood on the yard for about one to five days (one day is very common). The depth of that water varied from one to five meters.

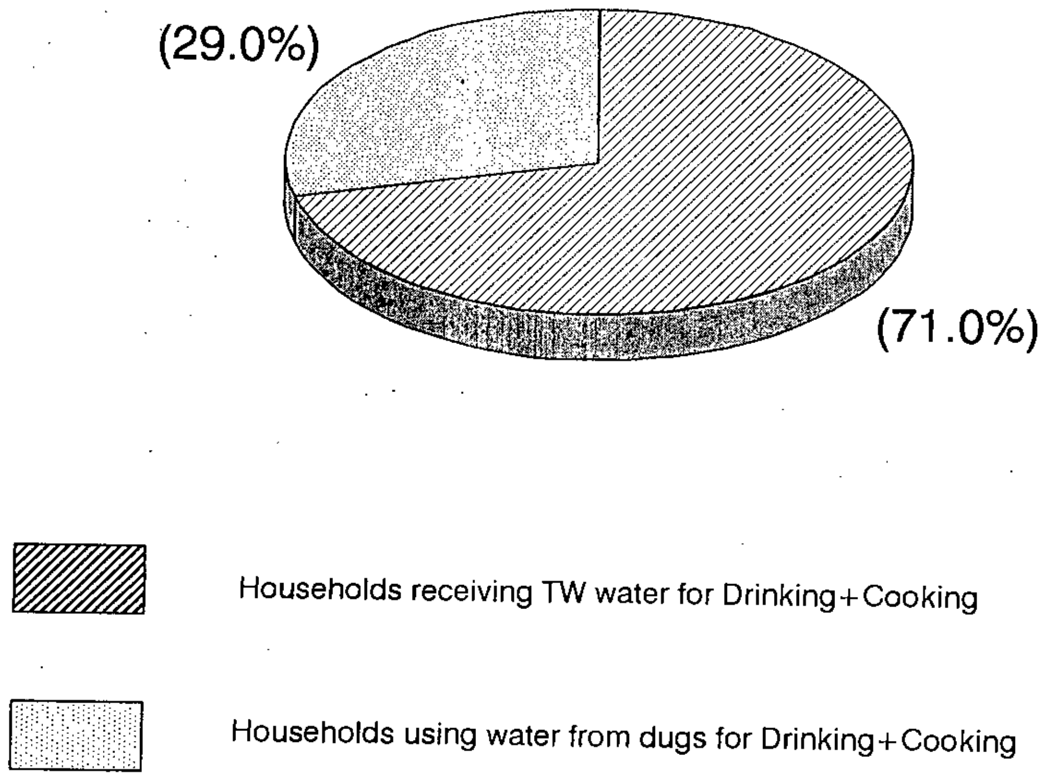


Figure 4.4 Sources of Water Used By Cyclone Affected People After 1991 Cyclone

(xii) Cyclone disrupted communication, damaged crops, households, livestock and other properties. Saline water inundated ponds, rivers and canals. The tubewells got inoperative. As a result different water borne-diseases broke out in epidemic form causing loss of lives after the cyclone. They suggested sinking of deep tube-wells to mitigate the problem of drinking water supply.

4.4 FOLLOW-UP VISIT

A follow-up visit to Moheskhali Thana of the Cox's Bazar district was made after the questionnaire survey was over and the data analysis was completed. The intention had been to confirm the findings of the field survey and discuss mitigatory measures that could be taken in respect of water and sanitation problems particularly during post cyclone periods.

Discussion were held with high Thana level officials the Thana Nirbahi Officer (TNO) who is the executive officer of the Thana Parishad, two Professors of Moheskhali College, the Sub-Assistant Engineer of DPHE, the Chairman of the Thana Central Cooperatives Association and local political leaders besides many local residents.

It was revealed that many tubewells have been sunk in that area and during the normal period the problem of water supply is not acute. But sanitation coverage is alarmingly low. The tidal surge during the cyclone engulfed the entire thana when a large number of houses, roads, culverts, tubewells and other infrastructures were damaged. All the surface water sources such as ponds and canals got inundated by tidal surge ceasing supply of sweet water.

An important information was received while discussing with them about post cyclone water supply and sanitation situation. They told that most of the VSSTs and SSTs yielded highly saline water for a few days after occurrence of tidal surge. This is because of infiltration of saline surge water into the shallow aquifers. The possible solution to this problem is to sink some shallow tubewells with higher depth or deep tubewells whichever is suitable. Because SSTs or

VSSTs are sunk at shallow depths say upto 10 meters in very shallow aquifers. This aquifers are not protected by any clay layer or aquiclude. As a result saline surge water rapidly infiltrates into the sweet water aquifers where SSTs or VSSTs are sunk. So they yield saline water. On the other hand deep tubewells are sunk at deeper aquifers protected by upper clay layers which prevent infiltration of saline surge water. Under such situation these wells would supply sweet water immediately after occurrence of tidal surge.

It is worth mentioning here that the local people are in the opinion that for permanent solution to the problem of cyclone and tidal surge, Beribandh (Cross Dam) should be constructed along the coast of the island. This will lessen to a large extent the intensity and damage of the devastation.

4.5 SUMMARY OF FINDINGS

From the analysis of the findings of the survey and field visit it is concluded that:

1) Most of the families suffered from scarcity of safe water supply for the first few days after the cyclone (1 day to 1 week).

2) All the surface water sources such as ponds, canals and rivers were polluted by high salinity and washed-in pollutants.

3) Most of the families have access to tubewells either at, near or away from the households of the coastal people.

4) Most of the tubewells were affected by the cyclone ceasing safe water supply for some-times after the cyclone.

5) The affected tubewells were repaired subsequently. Then the affected people collected water from the nearby tubewells.

6) The people who have no tubewells near their houses bring water from distant tubewells.

7) After the cyclone the people took shelter in cyclone shelters, nearby pucca houses, on high lands, on temporary tents and even on the trees.

8) In some cases surge water stood on the house-holds for a few days after the cyclone and then it receded down.

9) As the Kucha latrines were demolished by cyclone the affected people defecated here and there seriously polluting the environment.

CHAPTER FIVE

POST DISASTER SITUATION ANALYSIS AND SUGGESTED MEASURES

5.1 INTRODUCTION

The coastal region of Bangladesh with a large population encounters, as discussed in previous chapters some special problems relating to drinking water supply. Frequent occurrence of disasters like cyclone and tidal surge makes water supply and sanitation situation difficult. This results in outbreak of many water-borne diseases during the normal and the post disaster period. So far efforts have been made to mitigate the problem of drinking water supply by adopting some measures as pointed out in chapter three. Several non-conventional technologies have been found suitable in many areas of the coastal region for water supply during normal as well as the post disaster periods.

5.2 SITUATION ANALYSIS

It has already been pointed out in chapter two that the coastal region is a problematic area in respect of water supply. This is because of difficult hydrogeological conditions prevailing in the area. As it is adjacent to the Bay of Bengal, most of the surface water sources are highly saline which can not be used for drinking. The underground water at upper aquifers in the close vicinity of the coastline are also saline. So shallow tubewells and deep tubewells at depth upto 330 metres in these areas are not successful. The only reliable source for drinking water are hand operated deep tubewells which are again very expensive. As a result required number of deep tubewells could not be sunk as yet in the coastal belt. For these reasons the service coverage of water supply is still low compared to high water table area of the country.

Cyclone accompanied by strong tidal surges seriously damages lives and properties along with water supply and sanitation systems as mentioned in chapter two. Due to lack of awareness people do not adopt any precautionary measure to protect their water sources (tubewells) against damages caused by cyclone and tidal surges. The local people are not even acquainted to the appropriate technology for protecting their tubewells. As a result, tubewells are heavily damaged by cyclone and tidal surges.

The surface water sources such as rivers, canals, ponds etc. are also inundated by saline surge water ceasing supply of fresh water. This situation gives rise to serious crisis of drinking water supply during post disaster period. The environmental condition is further aggravated by unsanitary defection here and there because cyclone and tidal surges damage sanitation facilities too.

Safe water supply indeed becomes the primary need of the disaster surviving people. But immediate restoration of water supply becomes really difficult for many reasons. Cyclone and tidal surge damages not only water supply systems but also other infrastructures such as communication network. After the occurrence of disasters the government unusually attempts immediate restoration of water supply system. As the communications are disrupted severely by cyclone and tidal surges, immediate restoration of water supply becomes difficult. Rehabilitation work again needs man, money and materials which can not be arranged overnight under the prevailing conditions. Those who survive the disasters find little importance on restoration of water supply. They remain busy with procuring food and shelter. They hardly care for restoration of water supply and sanitation systems from their own end. The ultimate result is the serious scarcity of drinking water followed by occurrence of many waterborne diseases during post disaster period. This results in further losses human lives as mentioned in chapter one.

The existing tubewells in the coastal belt are the sources of safe water to the people during normal time. By this time a large number of tubewells have been installed here by DPHE. Efforts are also being made to raise the survice coverage by sinking more tubewells. These tubewells can serve the people during post disaster period provided these are protected against damage caused by cyclones and tidal surges. If tubewells can not be protected, mere sinking of tubewells will not do any good. So this chapter makes an endeavor to find out possible measures against the post disaster crisis of water supply and sanitation.

The present field study indicates the types of damages to existing tubewells during cyclones and tidal surges. The damages include detachment of pumps, damage to spares and ingression of saline surge water into the wells. The field survey data reveals that ingression of saline water into well casing pipes is of the highest order. The former two types of damages stand at 14% and 12% respectively. But ingression of saline water occurs in hundred percent of the tubewells. This is a determining factor in respect of saving the tubewells against damage by tidal surges. The field survey also indicates that an order of about 15% of the tubewells become inoperative due to detachment of pumps and damage to spares which appears not to be a major factor. The 85% of the tubewells remain intact but yield saline water during post disaster period because of ingression of surge water. Saline surge water enters the casing pipe and pollutes the underground aquifers. The surge water is highly saline. So, water drawn from the inundated wells during post disaster period can not be used for domestic purpose including drinking. It therefore, appears that if the existing tubewells could be protect against ingression of saline water, the magnitude of the crisis of water supply would be reduced significantly. In such cases restoration of water supply system would be very easy and instantaneous. Attempts are made here to outline several measures possible in the light of the following discussion.

5.3 SUGGESTED MEASURES

Safe drinking water becomes the most important need of the cyclone torn people particularly for the first few days after occurrence of the disaster. The measures to be adopted should satisfy the following criteria :

i. These should be acceptable to the local people as well as compatible to their choice and culture.

ii. The cost of the technologies such as hand operated SST, VSST, STW, DTW should be within the reach of the people.

iii. These should be installed easily within the shortest possible time.

iv. As far as possible locally available materials should be used. PVC pipes are most suitable and cheapest for sinking hand operated tubewells.

v. Operation and maintenance should be easy and simple. Community involvement in the task would ease the situation .

vi. Use of local labour to minimise the cost.

The following measures may be taken to appease the problem of water supply :

1) Installation of the commonly used technologies such as STW, DTW, SST, VSST, PSF etc in sufficient numbers according to their suitability from the hydrogeological point of view. That is present service coverage of water supply should be increased with special attention to the unserved and the underserved areas.

2) Sealing of tubewells before occurrence of cyclones and tidal surges.

3) Repairing of damaged water supply facilities immediately after the disaster.

4) Harvesting of rain water where feasible. This option may also be tried during normal periods where subsurface water sources are scanty.

5) Use of surface water through treatment where TW water is not available.

5.3.1 Sinking Of Hand Tubewells

The hydrogeological characteristics of the coastal region are different from other parts of the country. Mainly deep tubewell has been found to be the appropriate technology for extracting ground water for drinking and other domestic purposes. Besides, Other technologies such as STW, SST, VSST and PSF are also suited in some places. Accordingly all these types of technologies are being fielded for safe water supply. But the numbers of the existing tubewells are not adequate compared to the actual necessity. To ensure water supply as per need it is necessary to install more tubewells to raise service coverage.

Upto June, 1995, the Department of Public Health Engineering has fielded about 60,000 deep tubewells in the coastal districts of Bangladesh (DPHE, 1994). Excessively high salinity in both surface and underground water in the coastal region creates a big problem in respect of water supply. Most of the surface sources are highly polluted and saline. The underground water of upper aquifers contains salinity beyond human consumption. Tubewells having depths of about 250 meters to 330 meters draw fresh water from deep aquifers. Although deep tubewell is comparatively expensive, no cheaper, reliable and suitable alternative technologies have yet been found acceptable in all respect. So deep tubewells are being fielded in most of the areas of the coastal belt as appropriate technology.

But the service coverage of deep tubewells in the coastal zone is still poor. The present coverage stands to 216 persons (DPHE, 1994) per operating tubewell compared to average country coverage of 97 persons per operating tubewell. Therefore the coastal zone still remains under-served. Moreover there are localities where the people have no access to tubewells. These areas still remain unserved. The people of these areas depend on polluted surface water for domestic purposes. The main reasons behind this low coverage are hydrogeological factors and unavailability of cheaper technologies other than expensive deep tubewells (DPHE, 1992). However, STW, SST, and VSST have also been successful in some areas. From the statistics of the existing number of technologies it has been found that STW is also a commonly used in this area.

The Government of Bangladesh has set target to supply safe water by providing one operating tubewell for every 75 persons by the end of this century (DPHE, 1990). Considering the yearly population increase of 2.1%, to provide one operating tubewell for every 75 persons there is the necessity of sinking more 1,42,157 tubewells in 14 coastal districts. Based on existing scenario (DPHE, 1994), about 77% of the newly required tubewells will be shallow tubewells, 21% deep tubewells, 1% shallow shrouded and very shallow shrouded tubewell and 1% pond sand filters. To achieve 100% coverage in water supply in the coastal districts according to the above breakdown, the proposed physical facilities and cost of installation of those are shown in Table.5.1.

Table 5.1 : Proposed physical facilities and cost of installing the same in the coastal region (14 Districts)

Sl.. No.	Name of Technologies	Total number	Unit cost in Taka. (1991 Price)	Total cost in Taka.
1	Shallow Tubewell	1,09,461 Nos.	4000	4,37,8044,000
2	Deep Tubewell	29,853 Nos.	50,000	14,92,650,000
3	SST+ VSST	1,422 Nos.	2,500	3,555,000
4	Pond Sand Filter	1,421 Nos.	10,000	7,100,000
	Total			19,41,149,000

By raising the coverage of water supply through sinking additional tubewells in the coastal belt the paucity of drinking water supply in general can be minimized. Sinking more tubewells in the coastal belt means reducing the distance of households from tubewells thus ensuring easy access to safe water. This will encourage people to collect tubewell water for all purposes.

These tubewells may be sunk by the year 2000 at the rate of approximately 30,000 per year. The present programmes of sinking deep tubewells in the coastal belt is financially supported by Govt. of Bangladesh, UNICEF and the Saudi Government. Another programme has already been chalked out by DPHE for sinking deep tubewells in the coastal zone with financial assistance from the Islamic Development Bank (DPHE, 1994). The probable cost of the project is 10 million US dollar. Under this project, provision has been made to sink about 6000 deep tubewells, 1000 very shallow shrouded tubewells, 600 shallow shrouded tubewells and 120 pond sand filters. The rest of the required tubewells may be provided under other similar projects. Programmes for water supply and sanitation for the next Five Year Plan (1996-2000) are now being prepared (DPHE, 1994).

All the above technologies for rural water supply have been found to be very cost effective. The costs for each of the technologies, as shown in Table 5.1 are reasonable. One STW, DTW, SST or VSST can serve atleast 150 people for about 15 to 20 years with minimum maintenance cost. The average cost of a DTW per year considering 15 years, life stands to about Tk. 3,333.00. With the annual maintenance cost this amounts to Tk. 3500/-. Suppose such a DTW serves about 150 persons. Considering per capita per day consumption of water from the tubewell to be 20 litres, the total water drawn annually stands to 10,95,000 litres. Thus the unit cost per thousand litres comes to only Tk. 3 only. Against this cost, the cost of production of water in urban centers per thousands litres comes to atleast Tk. 10 to Tk. 25. The other technologies such as STW, SST or VSST are even more cost effective than DTWs. The production cost for the same quantity of water through a STW is only one-tenth of that of a DTW. So it is concluded that cost of water drawn by hand operated tubewells is very nominal. It has been stated earlier that there are some pocket areas in the coastal zone which are still underserved or unserved for hydrogeological and other reasons. Special attention should be given to cover such areas with appropriate technologies.

5.3.2 Sealing Of Tubewells Before Occurrence Of Cyclone

The most important and easy measure that may be adopted to mitigate the problem of drinking water supply after disaster is sealing of tubewells before occurrence of tidal surge. During cyclone and tidal surge many tubewells are damaged by detachment of their pumps under heavy thrust exerted by tremendous storm surge. On the other-hand, during cyclone if the area is inundated by surge water, saline and polluted water enters almost all the tubewells, ceasing supply of safe drinking water until those are restored by pumping out polluted water. This is an expensive and time consuming matter and can not be carried out easily by the disaster affected people as they remain busy in searching other necessities of life.

The damage to a tubewell of the above nature can be prevented by dismantling the pumps from it and sealing the upper end of the well pipe by a seal cap. This is to be done just before the cyclone starts. Screwed GI or PVC seal cap of the same diameter as the tubewell pipe is available in the market and in all stores of the Department of Public Health Engineering. Figures 5.1, 5.2 and 5.3 show such a seal cap, dismantling the pump from the tubewell and the process of sealing the well pipe by a seal cap respectively.

Each caretaker family of the coastal tubewells can be provided with a seal-cap. Simple training may also be provided to the caretaker families as to how the pump is dislodged from the tubewell and seal the same with the cap. This is a very simple operation which can be carried out by any adult member of the family. It involves no extra cost other than the cost of the seal cap. The cost of a GI seal cap is also reasonably low to the tune of only Tk. 40.00 (1 US dollar) only. A PVC seal cap costs only Tk. 10 to 15. The dislodged pump can be preserved safely at the house of the caretaker (may be fastened to tree or buried under ground to save against loss) or may be taken to the shelter where

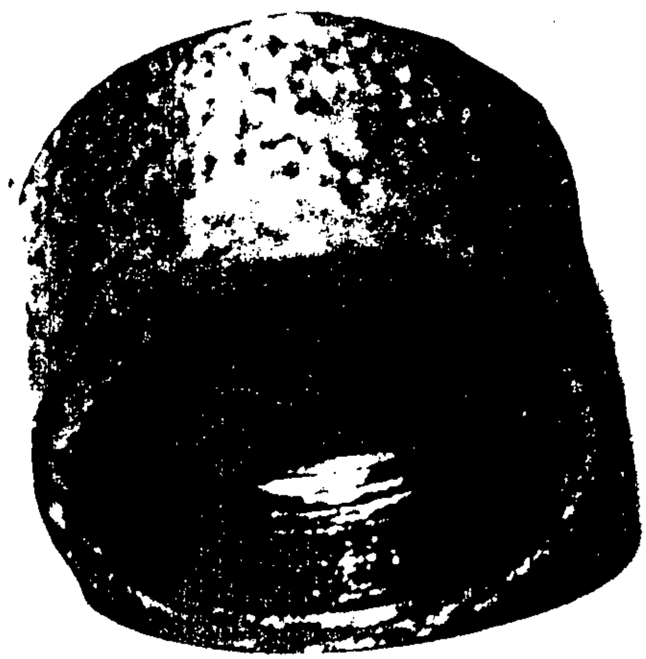


Figure 5.1 Photograph Of a Seal Cap For Sealing Tubewell

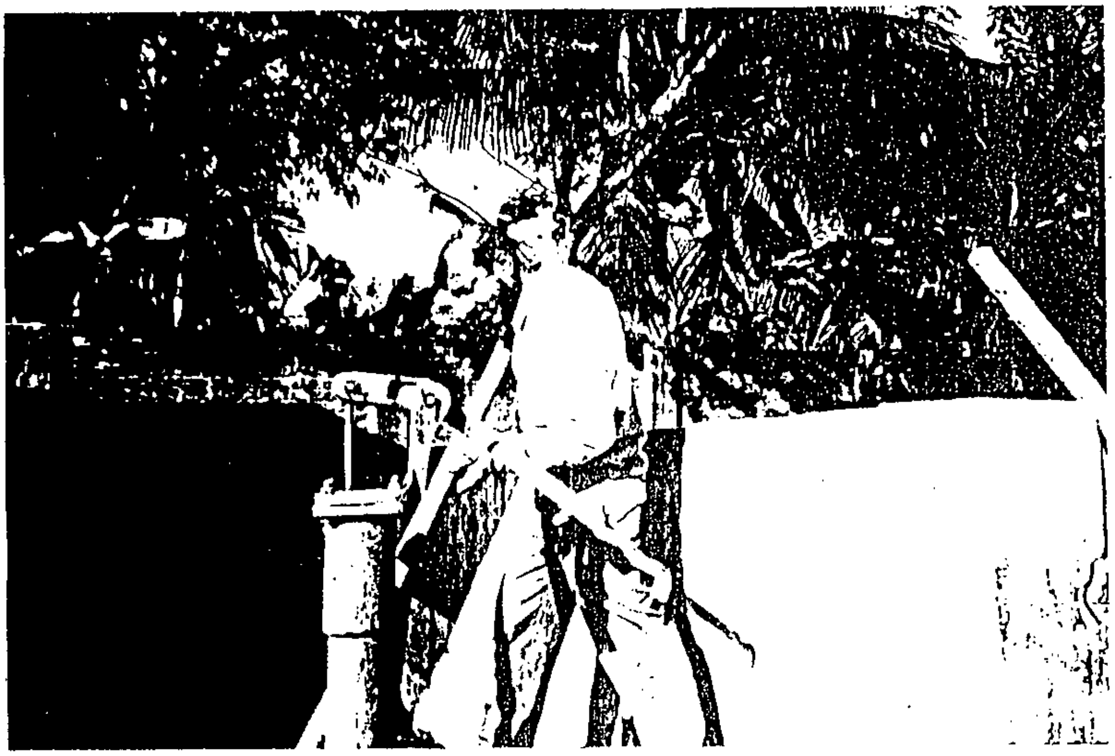


Figure 5.2 Photograph Showing Dismantling a Pump From Tubewell.

Figure 5.3 Photograph Showing Sealing Of Tubewell By a Seal Cap

the family members assemble for survival. There are many tubewells in the coastal belt now. As the tubewell is the only reliable source of safe water, simple sealing of the tubewells is undoubtedly the simplest, the cheapest and the most practicable method of protecting tubewells from devastation of storm surge. Moreover restoration of tubewells after cyclone by this method takes little time. This method is also applicable in the case of protection of tubewells from inundation by flood water.

Sealing tubewell before occurrence of the disaster is the most cost-effective method of restoring water supply during post disaster period. It requires no repair of tubewells as these are not damaged by cyclone or tidal surge. Not all the coastal tubewells are generally inundated by tidal surge. Only the tubewells in the disaster torn areas get inundated provided the cyclone is accompanied by high tidal surge. However assuming that all the existing tubewell are subject to inundation by tidal surge the total quantity of seal cap required figures to around 2,00,000 Nos. (rounded). Assuming cost of a PVC cap to be Tk. 10 the total cost for those quantity of seal caps stands to Tk.20,00,000/-. But actually seal caps should be provided to the caretakers of the nearest coast only because this area is prone to tidal surge. They may be only around 15 to 20% of the total coastal tubewells. Then cost will be only one-fifth of Tk. 20,00,000/- (i.e. Tk. 5 lac only). As there is a lot of tubewells in the coastal belt these may be used to supply safe drinking water after occurrence of disaster.

Tubewells can be sealed even by a piece of a branch of a tree having diameter a little larger than the well pipe. One end of this piece of the branch should be pointed and inserted into the pipe tightly so that the pipe end becomes water-tight (Figure 5.4). This measure will cost nothing but save the tubewell fully and ensure water supply immediately after disaster.

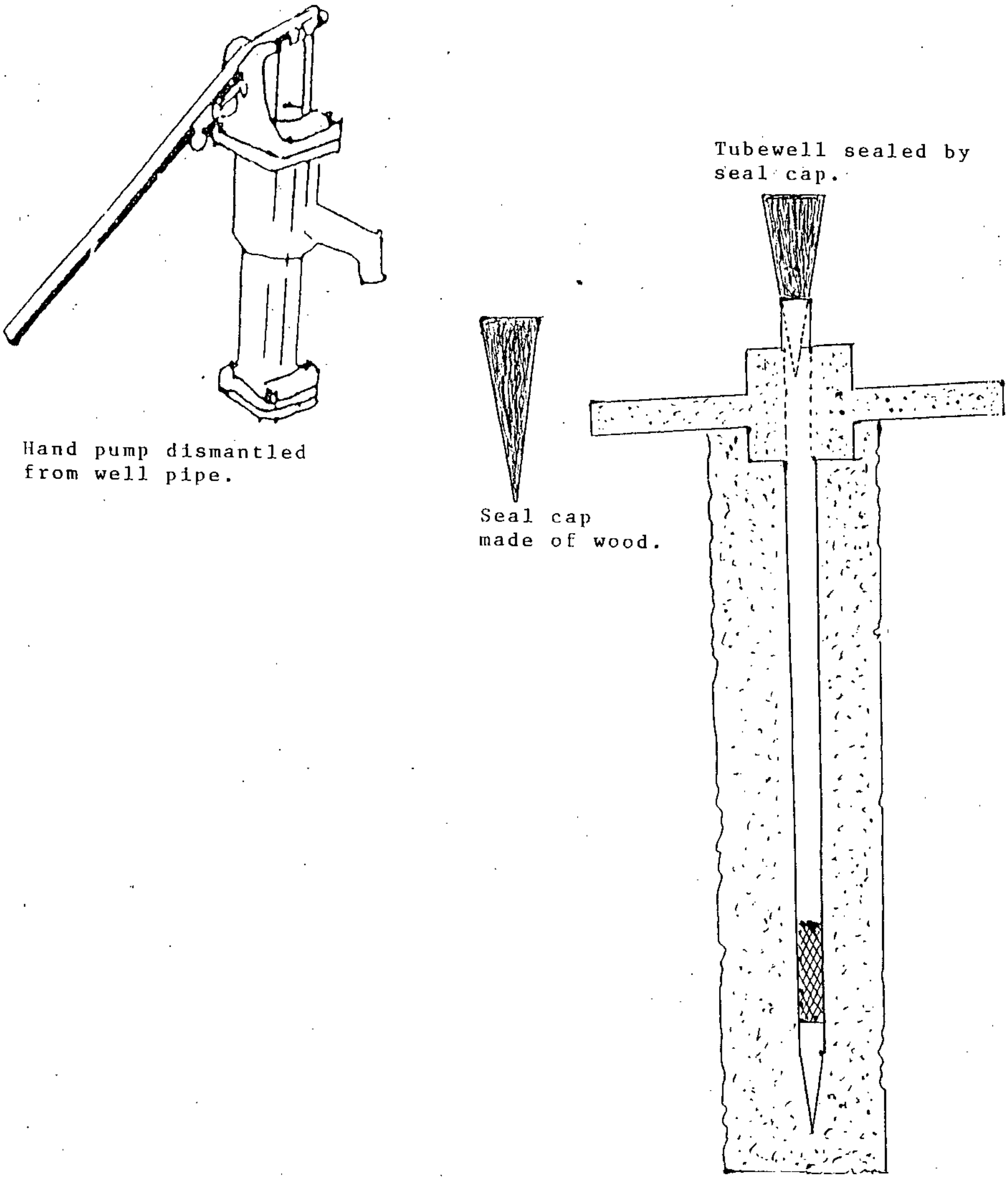


Figure 5.4 Diagram Showing Sealing a Tubewell By a Piece Of Stem Of Tree.

5.3.3 Repairing Of Damaged Tubewells

As discussed in chapter three, a large number of wells undergo damages caused by severe cyclones associated with strong surges. The damages include blowing of pumps, damage to spares such as handle, bucket and seatvalve, besides entrance of saline water into tubewells. The damaged tubewells may be brought to restoration by simple maintenance operation as follows:

i) In case the pump is detached from the tubewell and found nearby it may be reinstalled in the tubewell. In most of such cases the upper end of the top GI pipe below the pump is found broken. Then it will be necessitated to make new threads on the GI pipe and the previously threaded portion of the pipe stuck to pump should be removed. Any tubewell mechanic can make new threads on the GI pipe by a simple hand operated thread cutter. After new threads are made the pump is fitted with the tubewell and then it will be ready for service.

In case the pump is untraceable then a new pump is to be fitted. The cost of a new pump according to the present market rate is about Tk. 750/-.

(ii) For immediate repair of the tubewells undergoing such damages, necessary materials such as extra pumps, thread cutters and other tools like chaintong, hacksaw blade etc. should be kept reserved in local DPHE stores.

iii) When seat valves and buckets (made of either pvc or leather) are damaged they should be replaced by new ones. Other spares such as handle, piston rod, plunger and nut-bolts may also be necessary for repairing the damaged pumps and these should be kept reserved in local DPHE stores.

iv) When the saline or polluted water enters tubewells they may be restored by pumping out the saline water. This is a simple operation to be carried by a tubewell mechanic or any able member of the caretaker family. Continuous pumping for about 20 to 30 minutes will deplete the polluted water from the well pipe. After this operation has been finished, the tubewell needs to be disinfected against bacterial contamination.

v) For immediate repair of the damaged tubewells the most important factor is mobilizing manpower for the tasks. Either DPHE tubewell mechanics should be sent to the sites immediately after the disaster or arrangement should be made to repair to the tubewells by locally available manpower (NGOs, or Voluntary organizations such as Ansars,VDP, etc.).

5.3.4 Rain Water Harvesting

As discussed in chapter three, heavy rainfall occurs for some days after occurrence of cyclone and tidal surges in the costal belt. Where there is no tubewells and other reliable source of drinking water harvesting of rain water may be adopted for drinking and other domestic purposes during the post disaster period. The technological details of rain water harvesting have been enumerated in chapter three.

5.3.5 Disinfection Of Submerged Tubewells

Tubewells which are not sealed (by cap) and inundated by saline water need disinfection. Because polluted surface water enters tubewells when pathogenic bacteria find their lodge in them. Disinfection of the inundated tubewells can be accomplished by the simple method of chlorination as follows:

i) Add about 100 to 150 grams of bleaching powder to a bucketful of water (25 to 40 litres).

ii) Thoroughly mix the bleaching powder with the water.

iii) Allow the mix to stand for about half an hour.

iv) By this time pump the tubewell to drive out polluted water for about 10 to 15 minutes.

v) Filter the solution of chlorine in another bucket.

vi) Dismantle the pump from the well and keep it on a clean site or on the platform.

vii) Pour the chlorine solution into the well pipe and allow to stand for about half an hour. By this time the pathogenic bacteria will be killed.

viii) Then refit the pump tightly with the well.

ix) Finally pump out the chlorinated water in the well again for 10 to 15 minutes. Now the tubewell will be ready for use.

5.3.6 Treatment Of Surface Water By disinfecting Agents

Bleaching powder or water purifying tablets can be distributed to the families immediately after or preferably prior to cyclone. A stock of such materials may be kept reserved with the local stores of the Department of Public Health Engineering and the Directorate of Health Services. About the effectiveness of bleaching powder and WPT to purify water care should be taken. A study undertaken by a team from the International Centre for Diarrhoeal Disease Research, Bangladesh during post cyclone period (1991) reveals dismal information regarding effectiveness of WPTs. The team conducted the study 2-3 weeks after the cyclone of 1991. The study team found the quality of distributed water purifying tablets to have lost potency. The volume of water to be purified by a particular number of different types of tablets also confused local people regarding use of those tablets as the report reveals.

Therefore, quality of WPTs and bleaching powder supplied should be ensured and people should be trained in time in easy way as to use of water purifying agents. Limitation of this process is that when surface water is polluted by highly saline surge water then this process will not be useful because salinity can not be removed in this way.

5.3.7 Preserving Water Underground

For immediate and temporary relief from the crisis of safe drinking water for the first few days after cyclone, tubewell water can be stored in earthen or metallic pitchers put under earth. For this purpose, the containers of safe water should be tightly closed by polythene papers at mouths and then kept under ground at a depth of about 0.50 to 1 meter from the ground surface. Every family of the cyclone prone area having no tubewells may preserve drinking water in at least 3 to 4 pitchers immediately before occurrence of the disaster. This is an easy and simple technology to get pure drinking water at least for a few days during the post disaster period. The people may be advised to adopt this method when they are warned about occurrence of cyclone through different media.

5.4 MEASURES FOR SANITATION

As cited in section 3.2 compared to water supply situation in Bangladesh the sanitation front is bleak. The overall rural sanitation coverage in the country is about 33% including (40% by water sealed latrines and 60% by home made latrines) made latrine (DPHE-UNICEF, 1994). The coastal zone is not in any way different from this picture. The present technologies of sanitation include open defecation, overhung latrine and to a limited extent water sealed latrine. But during cyclone, overhung and water sealed latrines get damaged leaving the scope of only open defecation that deteriorates the environment seriously.

Along with water supply facilities there should also be sanitation facilities compatible with choice, culture and affordability of the local people. There are different technological options available for rural and urban sanitation.

Some the appropriate sanitation technologies for community and individual house holds are discussed here.

5.4.1 Pour Flash Water Sealed Pit Latrine

This is the type of latrine being fielded in Bangladesh since 1963 when the design was imported from Chiang Mai. Primarily a pilot project of supplying 10,000 latrines was initiated with UNICEF assistance. The project was completed in 1984. After a year of testing the design (specially of trap) was modified and the same is being used until now. Figures 5.5 and 5.6 show rectangular and circular type of water sealed latrine slab. In most cases the slab is placed above a pit constructed by R.C.C. rings (usually 5 rings for an individual household). The latrine is provided with a superstructure made of bamboo, CI, sheet or wood. Figure 5.7 shows such a low cost water sealed latrine with superstructure now being installed in rural Bangladesh.

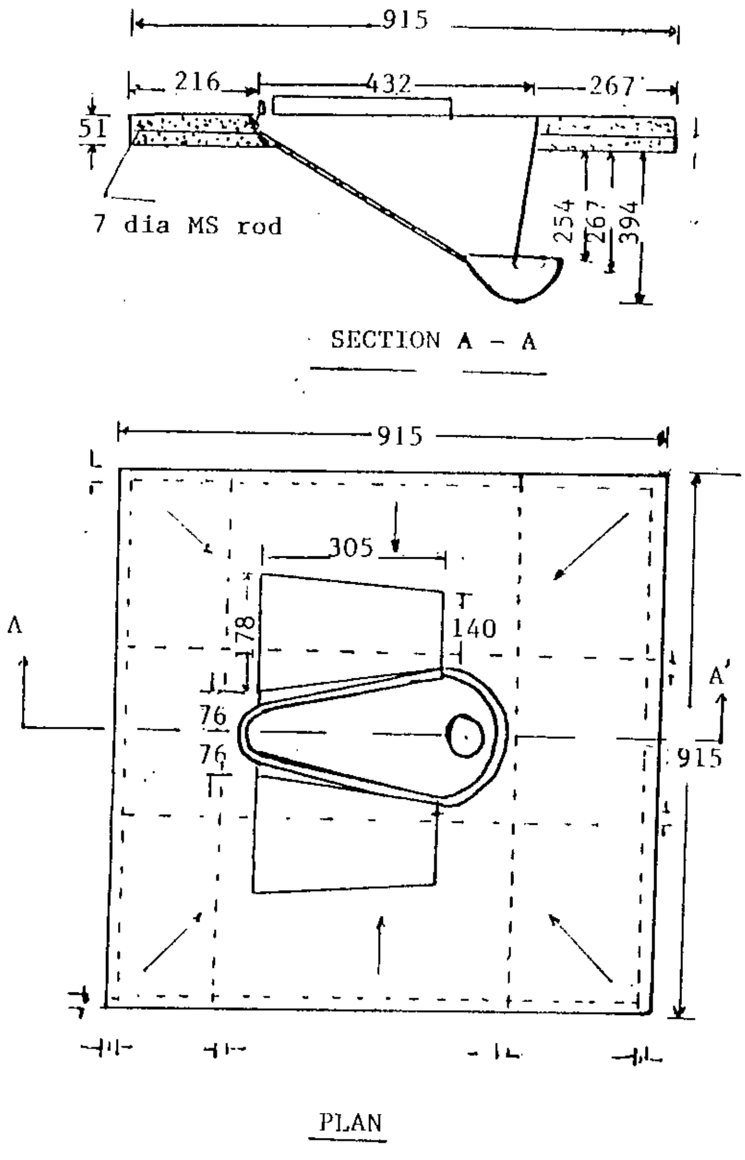
The advantages of water sealed latrine are as follows :

1) It fulfills all most all the aesthetic and health criteria of excreta disposal system.

2) It is cheap to construct and use

3) It can be constructed of locally available materials.

4) It is durable and its maintenance is easy and simple.



All figures are in mm

Figure 5.5 Rectangular Type Of Water Sealed Latrine

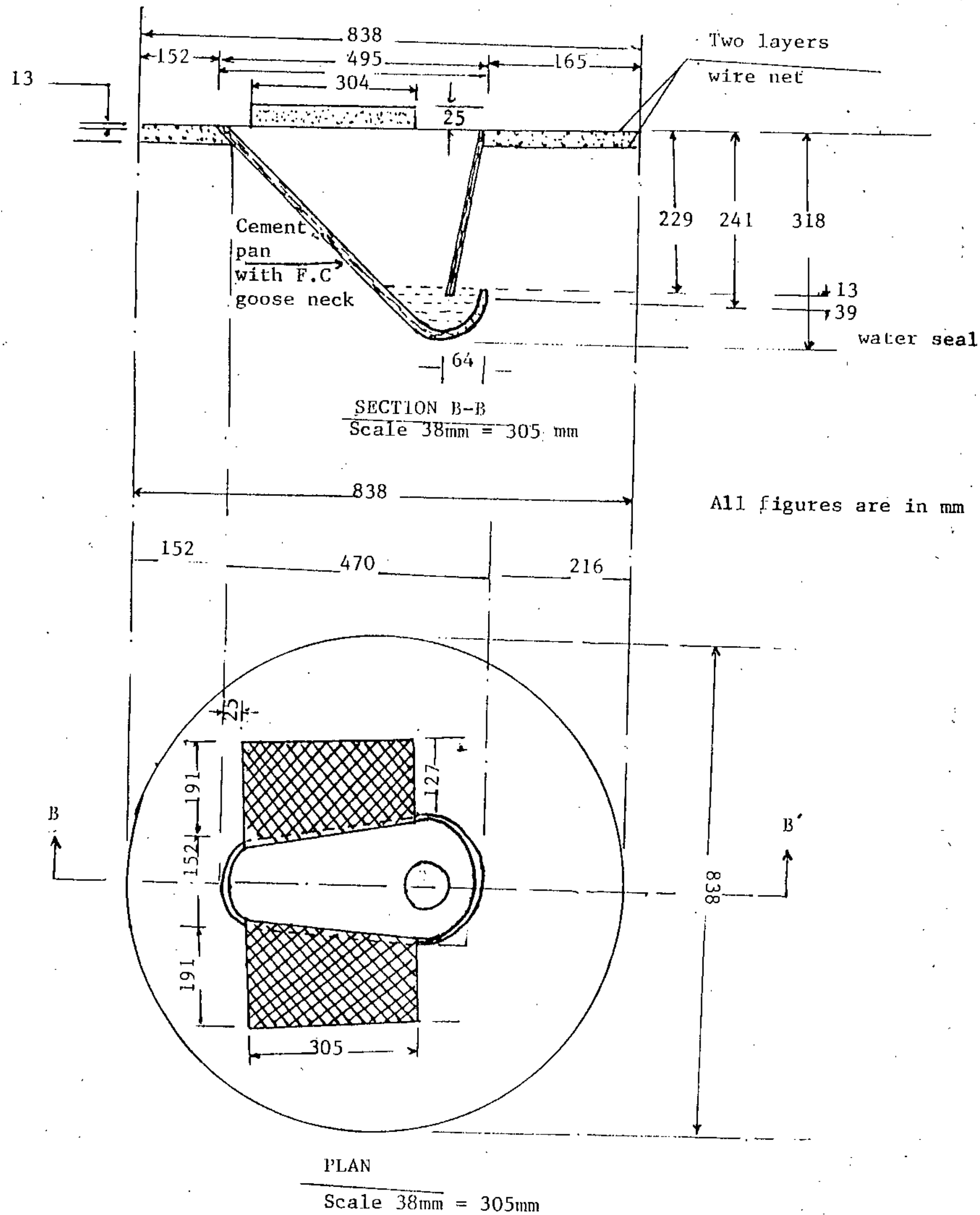


Figure 5.6 Circular Type Of Water Sealed Latrine

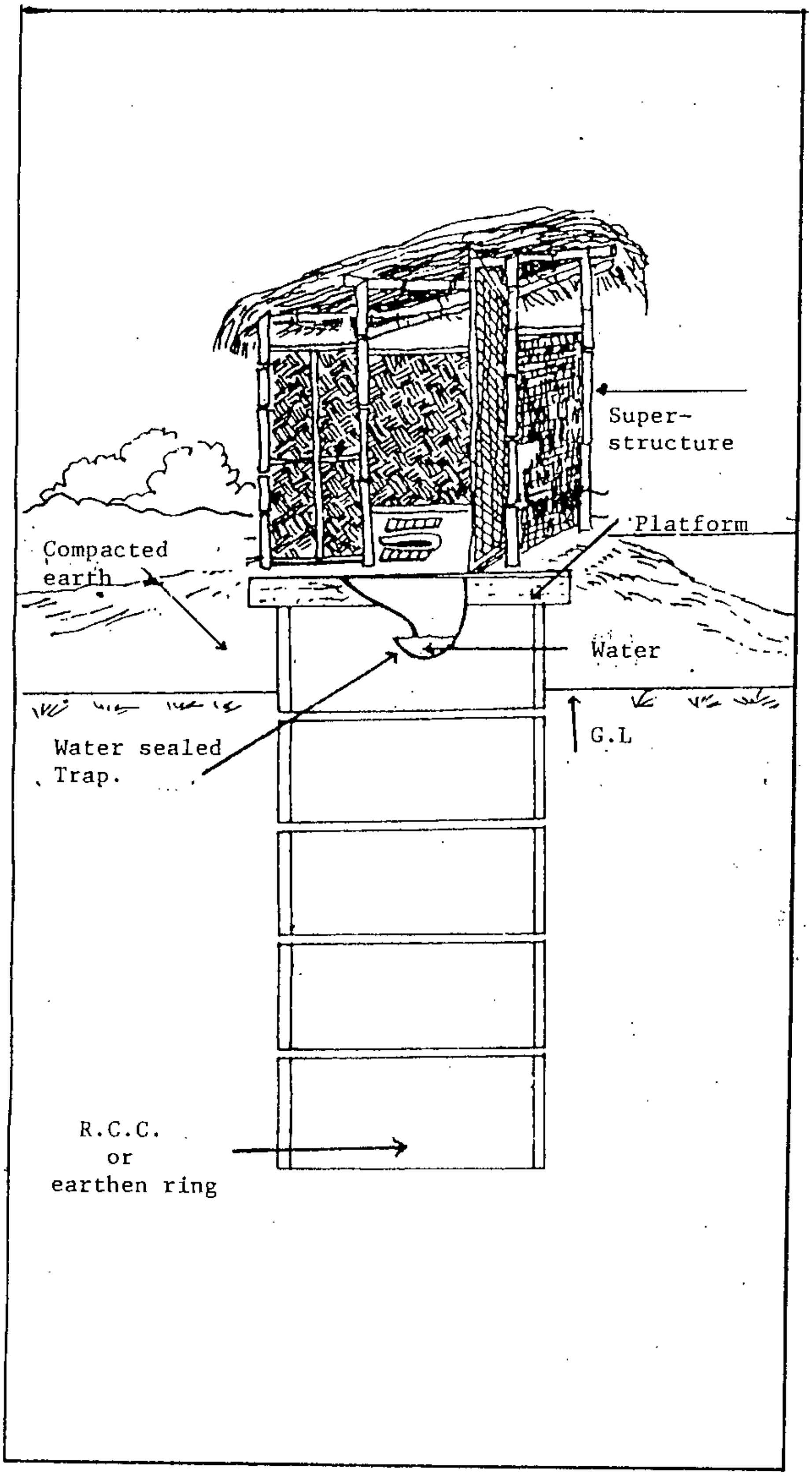


Figure 5.7 A Water Sealed Latrine With The Superstructure.

5) It can be constructed within or adjacent to the house.

6) It needs only a little quantity of water for flushing.

7) Its superstructure can be constructed by locally available materials.

8) It can be constructed by unskilled local labourers.

9) It can be constructed within the shortest possible time and is most suitable for construction to meet emergency such as cyclone or flood shelters.

The success of the pilot project encouraged DPHE to take up more ambitious project for rural sanitation. The first phase of the rural sanitation programme was taken in 1975 and completed in 1982. Under this project about 1,36,000 sets of water sealed latrine were distributed to families of rural areas. The second phase of the programme started in July, 1982 and the target of this programme was to distribute 2,25,000 sets of latrine with UNICEF assistance. This project was completed in June, 1985. At the end of this programme 2,26,163 sets of latrine were produced and sold to rural families (DPHE, 1985).

The ongoing programme of rural sanitation styled as Rural Sanitation Project, Phase III started in July, 1985. This programme is aimed at producing and distributing about 20,10,000 sets of latrine to the families of rural areas and urban slums. The programme will continue upto June'1996. It is also a UNICEF assisted project. At present the cost of one set of latrine consisting of one slab and 5 rings is Tk. 405/-. A complete latrine with superstructure of locally available materials now costs about Tk. 700 to Tk. 1000 only. Since inception, DPHE has supplied about 12,00,000 sets (DPHE, 1994) of latrine all over Bangladesh so far.

Water sealed latrine as an appropriate and cheap technology should extensively be installed at households of the coastal belt to provide a better sanitation condition as a prerequisite for good health. Improving the sanitation status by raising the service coverage will not only improve the health of the community but also provide a healthy environment during the post cyclone period. The superstructure made of cheap materials such as bamboo, wood, leaves (locally available Golpata) or CI sheet may be demolished or swept away by storm or tidal surges but the sub-structure i.e. the pit with the slab is supposed to remain intact. The superstructure can be reconstructed with locally available materials within a short time and used as before.

The low-cost water sealed latrines get damaged by cyclone and tidal surges. The superstructure of most of the latrines are washed away by surge water. The RCC slabs may also be washed away by strong tidal surge. But protection measure may be taken to keep the slabs in position. To do that the pan area of the slab should be covered by sack or polythene paper and the entire slab area should be covered by a thick earth layer. Besides about four bamboo or wooden poles or sticks can be inserted tightly at the middle of the four sides of the slab. This arrangement will prevent the slab from washing away by tidal surge.

Water sealed latrines may also be constructed at temporary and permanent cyclone shelters having no other alternatives for sanitary disposal of human excreta.

The present problems relating to low coverage of rural sanitation are identified as follows :

1) General poverty.

2) Lack of awareness and motivation.

3) Absence of production facilities (production centres are not within reasonable distance).

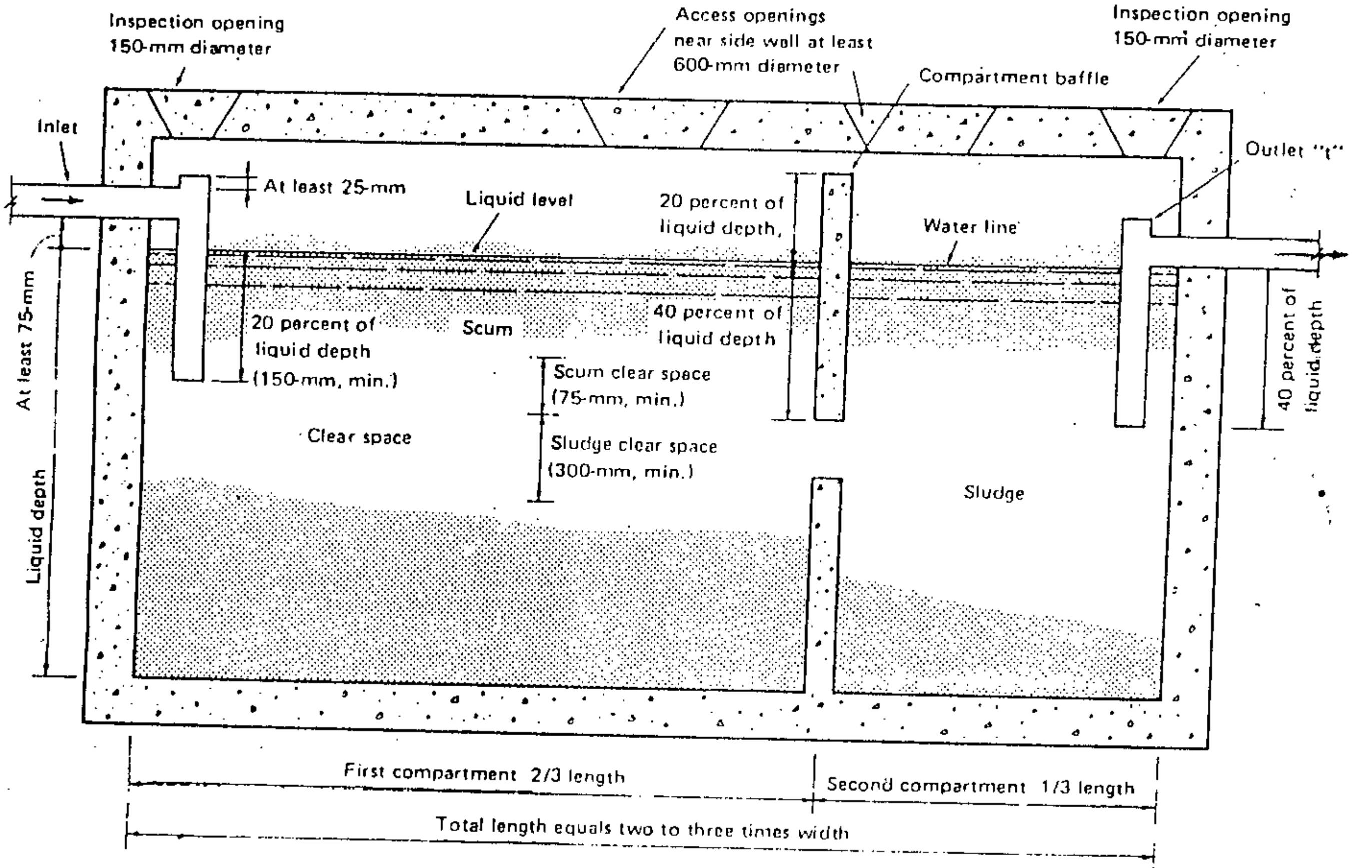
4) Enhancement of the price of the latrine material by withdrawing subsidy.

5) Problem of transportation of latrines from production and selling centres to the users families).

Elimination of the above constraints is a precondition to raising the standard of sanitation. This can be achieved by escalating the financial capacity of the community, raising awareness and motivating the people. Production of latrine sets should be made available to the people within reasonable distance for easy transportation. The price of latrine sets should also be reduced to bring it within the affordability of the rural people.

5.4.2 Septic Tank For Community Use

Septic tank (Figure 5.8) will be an appropriate technology for excreta disposal in the cyclone shelters. Unhygenic conditions rapidly develop in these places where a large number of people of different age groups are



Note: If vent is not placed as shown on figures 13–2, 3, and 4, septic tank must be provided with a vent.

Figure 5.8 A Typical Septic Tank For Eexcreta Disposal At Cyclone Shelters accommodated in small area. The existing shelters do not have any toilet facility within the building. Sanitation facilities like open pit type on the ground available to some 39% of the existing shelters could not be used during previous cyclones rather they contributed to the pollution of surge water along with the fecal matter left for natural degradation. Field survey indicated that only about 3% of the existing shelters could maintain a reasonable good sanitary condition during the 1991 cyclone (UNDP-GOB, 1992). The provision for an acceptable sanitation system for new cyclone shelters suitable for meeting the emergency situation during and post cyclone periods will undoubtedly prevent fast deterioration of environmental quality in and around the cyclone shelters.

Water supply together with sanitation facilities need to be provided within or attached to shelter buildings above surge level for uninterrupted use during cyclone periods. But the existing situation does not permit in most cases to provide the above facilities within the building with affecting the present uses of the same. On the otherhand, installation of water supply and sanitation by constructing an additional bay will be very costly. However to meet the requirements of uninterrupted water supply and sanitation facilities during the post cyclonic periods provision for limited facilities may be made in PWD type shelters taking 1.75 m inside space from the teachers common rooms situated in the first floor. A toilet in front and a water tank-cum rain water reservoir in the back may be constructed at minimum cost utilizing only a small functional area of the shelter. These facilities will be used only when the water supply and sanitation facilities provided on ground will be out of operation.

For shelters having no provision for excreta disposal facilities and having no scope for accommodating the same on the first floor, excreta disposal system with septic tank may be provided on the ground near the shelters. This of course will involve high cost.

Another economic option for excreta disposal system in cyclone shelters will be construction of a number of sanitary latrines in parallel with septic tank with double or triple pits (Figure 5.9). This system will be advantageous for a using the latrines by a group of people at a time.

5.4.3 Temporary Latrine With Earthen Jar As Pit

Cyclone with storm surge demolishes most of the Kucha latrines leaving no scope for sanitary defecation. This situation compels the disaster stricken people to defecate here and there on the open place adjacent to their houses. This seriously pollutes the environment and causes water-borne diseases.

Construction of new latrines or reconstruction of the damaged ones may not be possible on the part of the affected people. Because during the post cyclone period the people generally remain busy in reconstruction of their houses and looking for food, clothes and other necessities of life. They are not supposed to be serious about making a new latrine that will involve much money and time. Because under the prevailing condition this will be regarded as unimportant to them. But keeping a hygienic environment during the post disaster period is most important from health point of view. So an easy and cheap technology is the only solution to the problem. Here an idea of such a technology is contemplated.

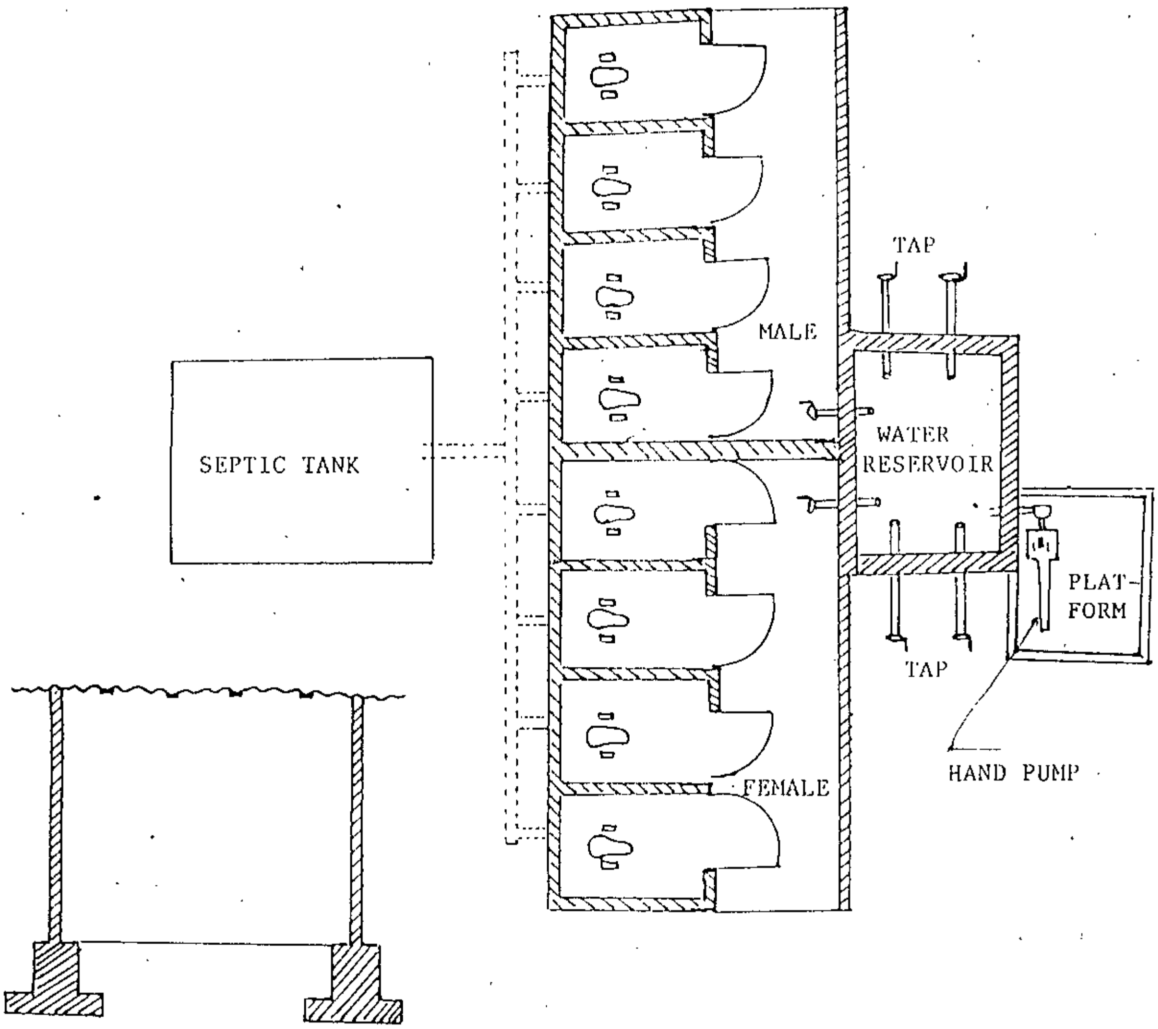


Figure 5.9 Diagram Of The Proposed Sanitary Latrines For Cyclone Shelters.

Fixed place defection with the condition of confining the excreta underground is the main theme of rural sanitation in Bangladesh. Under the conditions prevailing immediately after cyclone and tidal surge, safe practice of defecation can be done in the yard of the household by inserting a big earthen Jar into the ground with its open mouth a little (about 8 cm) above the ground level.

Figure 5.10 shows such a temporary latrine with supper structure made of very cheap locally available materials such as golpata, bamboo, Jute stick or other cheap materials.

This idea came to us while going to Moheskhali by a speed boat through the Bay where a big country boat was carrying many big earthen jars. On query the boatman told that these Jars are used for preservation of bettlenut in that area.

The capacity of such a Jar is about 40 gallons. These Jars are structurally sound also. The thickness of the surface of a jar is about 1.5 cm. The mouth has a circumference of about 1 meter. It has been known that in Greater Barisal areas many families are using such type of latrines.

This earthen Jar can be manufactured locally by the local artisans. For the purpose of using this as latrine pit the size of the same may be bigger with necessary thickness of the surface. For removing liquid part of the sewage (urine and water used for washing) the Jar should be provided with some holes at the bottom. Through these holes liquid (effluent) will percolate into the ground. Its limitation is that it will work only in the dry season when the ground water table remains atleast 2 meters below the surface level.

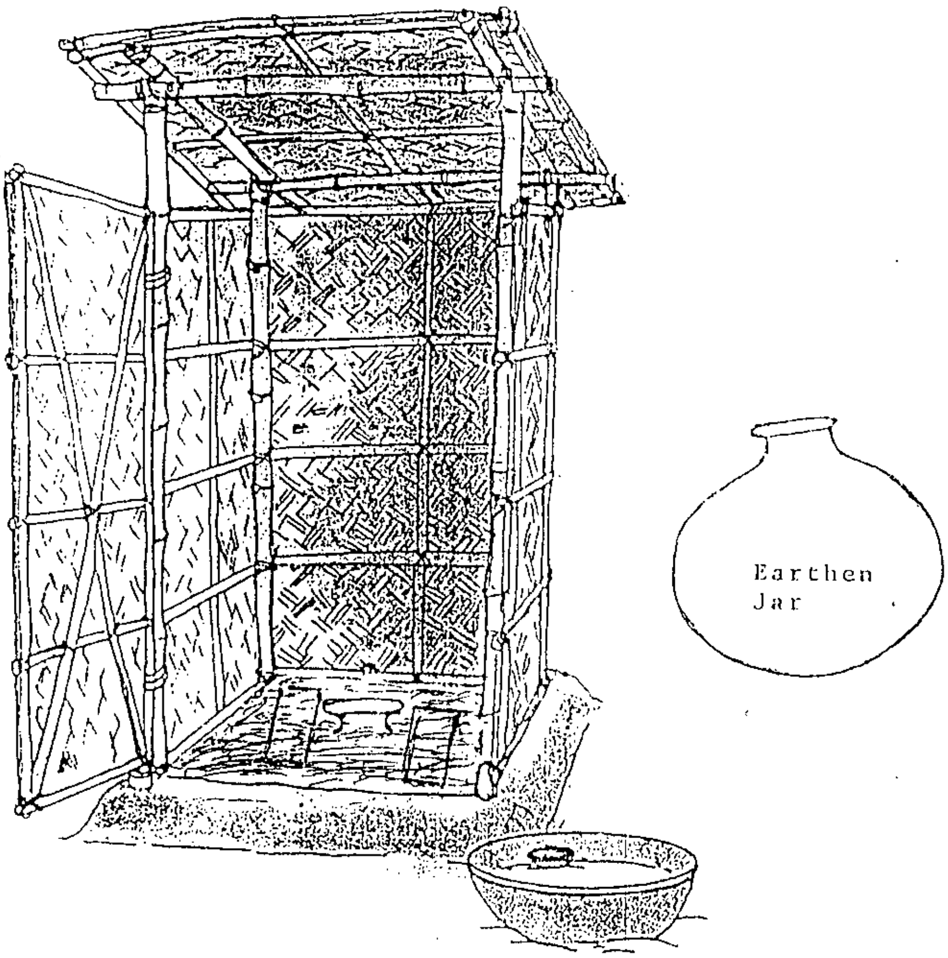


Figure 5.10 A Temporary Latrine With Earthen Jar As Pit

It has been assumed that a pit of about 150 - 200 literes capacity will last at least about one month.

When filled it may again be brought into service by emptying the sludge. A cover made of earth (with holes) may be used for keeping the pit closed when not used. For emergency use this will be an appropriate and the cheapest type of sanitation technology during the post disaster period.

5.4.4 Health Education

This is an important aspect of sanitation. The ordinary people in rural areas in our country are habituated to practice open defecation here and there. This is mainly because of lack of awareness. Poverty is not a major factor here. Behavioral change is most important in achieving sanitation. It is very difficult to change behavior in respect of defecation. So health education should be provided to the people to change their behavior. It has been found that even when the people use sanitary latrine, they do not wash their hands with soap or any detergent after defecation. The women folk who are maintaining the house hold work have little knowledge about personal hygiene. The sense of washing hands before handling food and after anal cleaning of their babies are quite absent in them. They are not habituated to use safe water for all domestic purposes although safe water sources are within their reach. They are habituated to stick to the usual unhygienic practices. But massive health education can bring about dramatic changes in behaviour.

About four years back DPHE with UNICEF and other Govt. and Non-Govt. agencies launched a drive in Agailjhara and Banaripara thanas of Barisal district to eliminate unsanitary defecation system and introduce sanitary ones. All the social forces were mobilized in this respect. Now those two thanas have achieved 100 coverage in sanitation. The people of those two thanas destroyed spontaneously their hanging latrines and constructed water sealed latrines at their house holds. They are also following hygiene education. This is a success story in Bangladesh in the field of rural sanitation. Similar success has also been achieved in some unions at Dhamrai thana under Dhaka district.

Health Education can be provided in mass scale. There are many Government and Non-Government agencies working at the root level of the country. There are other social forces such as political leaders, religious leaders, social workers who may take effective lead in this task. They may provide proper health education to the people. Mass media such as Radio, Television and Newspapers may play an important role in this respect.

5.5 NEED FOR PROPER INSTITUTIONAL SET-UP

Safe water supply together with sanitation is an important requisite for good health and development. To provide water supply and sanitation facilities to a vast population is indeed a gigantic task. As such, to ensure a sustainable water supply and sanitation system both during pre and post cyclone situation warrants necessity of pragmatic policy, workable strategy and proper institutional arrangement.

Any policy/strategy for the sector should be based on the principle of an integrated approach of water supply and sanitation drainage and personal hygiene practice. Such an integrated effort needs actions from the national and the local bodies to deal with these aspects.

To provide water supply and sanitation facilities to a large number of populations a gigantic task. Disaster like cyclone, tidal surge and flood complicate the existing situation by causing heavy damage to water supply and sanitation infrastructures. So to tackle the situation there should be a strong institutional setup from top to bottom. The present setup of DPHE (ANNEX-E) needs to be strengthened to overcome the crisis of water supply and sanitation drinking normal and post disaster periods.

5.6 CONCLUDING REMARKS

There are several possible ways by which the post disaster crisis of water supply can be tackled successfully some of those measures are expensive and time consuming. Some are very simple and easy. As for example simple sealing of tubewells before occurrence of cyclone and tidal surges is the most easy, cheap and simple method for protecting tubewells against damages cost by disaster. The coastal people should be introduced of this method through mass media such as newspapers, TV, Radio etc.

After all, full restoration of water supply and sanitation facilities in the cyclone affected areas needs prompt coordinated efforts from the related agencies. The Department of Public Health Engineering as a national agency in the sector may accomplish the task of co-ordination in this respect. Governments patronization in this matter will help achieve the desired goal.

CHAPTER SIX

CONCLUDING REMARKS AND RECOMMENDATIONS

6.1 INTRODUCTION

Drinking water supply and sanitation facilities are important aspects for sustaining life during pre and post disaster periods. The absence of adequate water supply and sanitation facilities during the post cyclone period is largely responsible for outbreak of epidemics such as diarrhoea, cholera and other waterborne diseases which cause loss of lives of thousands of people. This damage can significantly be minimized by certain measures with respect to water supply and sanitation facilities during post disaster period. Keeping this in view the following conclusions and recommendations are made.

6.2 CONCLUSIONS

(i) The service coverage of water supply and sanitation in the coastal region is low primarily due to complex hydrogeological conditions. The quality of both ground water as well as surface water are unacceptable because of excessive salinity.

ii) The water supply and sanitation facilities along with other properties undergo heavy damages caused by severe cyclones associated with tidal surges. Due to such damages of water supply and sanitation facilities serious crisis of water supply and sanitation occurs during the post disaster period.

iii) Due to scarcity of safe drinking water supply during post disaster period the coastal people are forced to use polluted surface water which leads to the outbreak of waterborne diseases including cholera and diarrhoea.

iv) Precautions are not taken to save the water supply and sanitation facilities before the occurrence of disaster due to lack of awareness of the people and absence of necessary logistic support.

v) The present practice of tackling the post disaster situation in respect of water supply and sanitation is inadequate, time consuming and expensive.

vi) Almost all the water supply facilities specially hand tubewells can be protected against the damages by a simple measure of sealing the tubewells before occurrence of cyclones and tidal surges.

vii) Among the types of dames to tubewells caused by cyclones with tidal surges, the most prominent is ingression saline water into the aquifers through casing pipes of tubewells. Tidal surges thus affected all most all the existing tubewells ceasing supply of fresh water.

viii) Although the existing water supply facilities are not yet adequate still these can meet the minimum demand of the coastal people during normal and the post disaster periods if protected from damage caused by disaster.

ix) Post disaster sanitation situation can also be improved through increasing sanitation coverage in the coastal area. The most important aspect of sanitation improvement is to bring about behavioral changes among the people of their defecation practice.

6.3 RECOMMENDATIONS

The following recommendations are made in respect of tackling the post disaster crisis of water supply and sanitation in the coastal region.

6.3.1 Water Supply And Sanitation During Pre Disaster Period

i) Compared to other parts of the country the coastal region has got low coverage due to high cost of deep tubewells which are suited in the coastal region. This problem can be minimized by adopting some non-conventional technologies such as SSTs, VSSTs, PSFs etc. which are cheap and appropriate in many cases.

ii) Installation of rainwater harvesting facilities should be attempted where there are no other sources of safe water supply.

iii) The cyclone shelters, should be provided with adequate water supply and sanitation facilities. Sufficient number of hand tubewells can be sunk at these cyclone shelters. These shelters may also be provided with rain water harvesting system as pointed out earlier.

iv) The areas which are normally served by SSTs or VSSTs should also be provided with some STWs with greater depth or deep tubewells for fresh water supply. This is necessary because the aquifers of SSTs or VSSTs often get saline due to inundation by saline water during the tidal surge. As a result SSTs and VSSTs yield highly saline water which is unfit for human consumption. But shallow or deep tubewells sunk in these areas may supply fresh water even during the post disaster period if protected properly.

v) Storage of sufficient spare parts and maintenance tools in local DPHE stores to urgently restore water supply through maintenance of damaged tubewells.

vi) Supply of at least one seal cap to each caretaker family to seal the tubewell prior to occurrence of cyclone and tidal surge. This will keep the tubewell free from intrusion of saline water into the casing pipe. The caretakers should also be trained in this regard.

vii) In urban centres of the coastal belt adequate measures should be taken to protect the existing piped water supply system prior to the occurrence of disasters.

viii) Low cost sanitary latrines at the rural households of the coastal zone should be installed in order to improve sanitation coverage.

ix) Installation of appropriate excreta disposal system for cyclone shelters should be ensured.

x) The people should be motivated through mass media towards health education. This will bring about behavioral changes in the people.

xi) Planting coconut trees in large numbers at all the households and public places for use of green coconut water for drinking during post cyclone period when fresh water from other sources is not available. This can help meet immediate demand of drinking water.

xii) Coastal embankments and associated afforestation can help reduce losses and damages by weakening the thrust of cyclones and tidal surges. Proper attention may be given to the feasibility of such measures against tidal surges.

6.3.2 Water Supply And Sanitation During Post Disaster Period

i) Removing the seal caps from the tubewell pipes and reattachment of the pumps which were detached from tubewells before the occurrence of disasters.

ii) Immediate repair of the damaged tubewells by govt. tubewell mechanics, voluntary organizations and NGOs.

iii) Disinfecting the tubewells which get submerged during cyclone and tidal surges by disinfecting agents.

iv) Sinking temporary tubewells on emergency basis where there is no tubewells.

v) Distribution of water purifying tablets (WPT) and other disinfecting agents to the families who use surface water in absence of tubewell water.

vi) Harvesting of rain water when available as an alternative source in individual houses and cyclone shelters.

vii) Supply of canned or bottled fresh water to places where no other sources of pure water are available for the first few days after disaster.

viii) Repair of damaged latrines immediately after cyclone and tidal surge.

ix) Installation of new low cost latrines where damaged latrines are not repairable.

x) Installation of temporary latrines with big earthen jar as underground excreta container. This will ensure fixed place defecation where excreta will not pollute the environment.

6.3.3 Software Aspects Of Water Supply And Sanitation

Framing definite and pragmatic policies in the matters of fighting disasters at national level is a precondition for successfully combating the post disaster water supply and sanitation situation in the coastal belt of the country. The following specific aspects should be taken into consideration.

i) To educate people through mass media towards measures to be taken before and after disasters in respect of water supply and sanitation.

ii) To motivate people through mass media regarding use of safe water and practicing sanitary defecation during pre and post disaster periods.

iii) Involving NGOs/Voluntary Organizations in the process of restoring water supply and sanitation system.

iv) Motivate people towards raising awareness to follow personal hygiene which is necessary for maintaining good health.

v) Strengthening DPHE's capacity (manpower) for tackling the emergency situation in respect of water supply and sanitation during the post disaster period.

vi) Making effective planning to address the crisis of water supply and sanitation from the central and the local levels.

vii) Adopting a comprehensive and co-ordinated programmes from the national level to mitigate the crisis of water supply and sanitation in the coastal belt.

ix) Firm political commitment from the central administration to redress the crisis of water supply and sanitation both during pre and post disaster periods is an important requisite.

Water together with sanitation is a basic need of human lives. Ensuring supply of safe water and sanitation facilities is a gigantic task that can not be handled solely by the government. Participation from all levels to effectively fight the problem is a precondition in this regard. Therefore, the community as a whole should be involved in the process.

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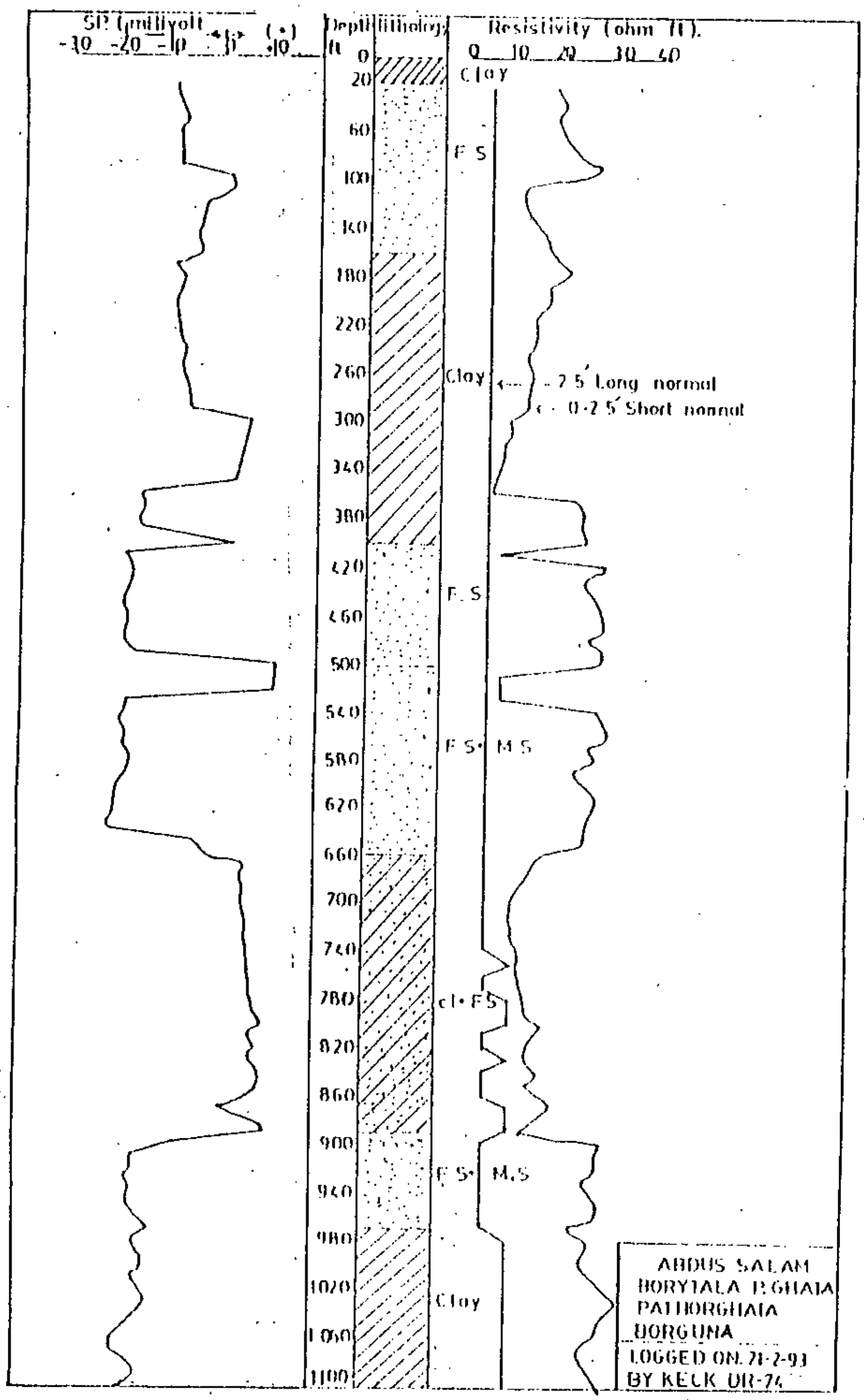
Appendix-A$_1$

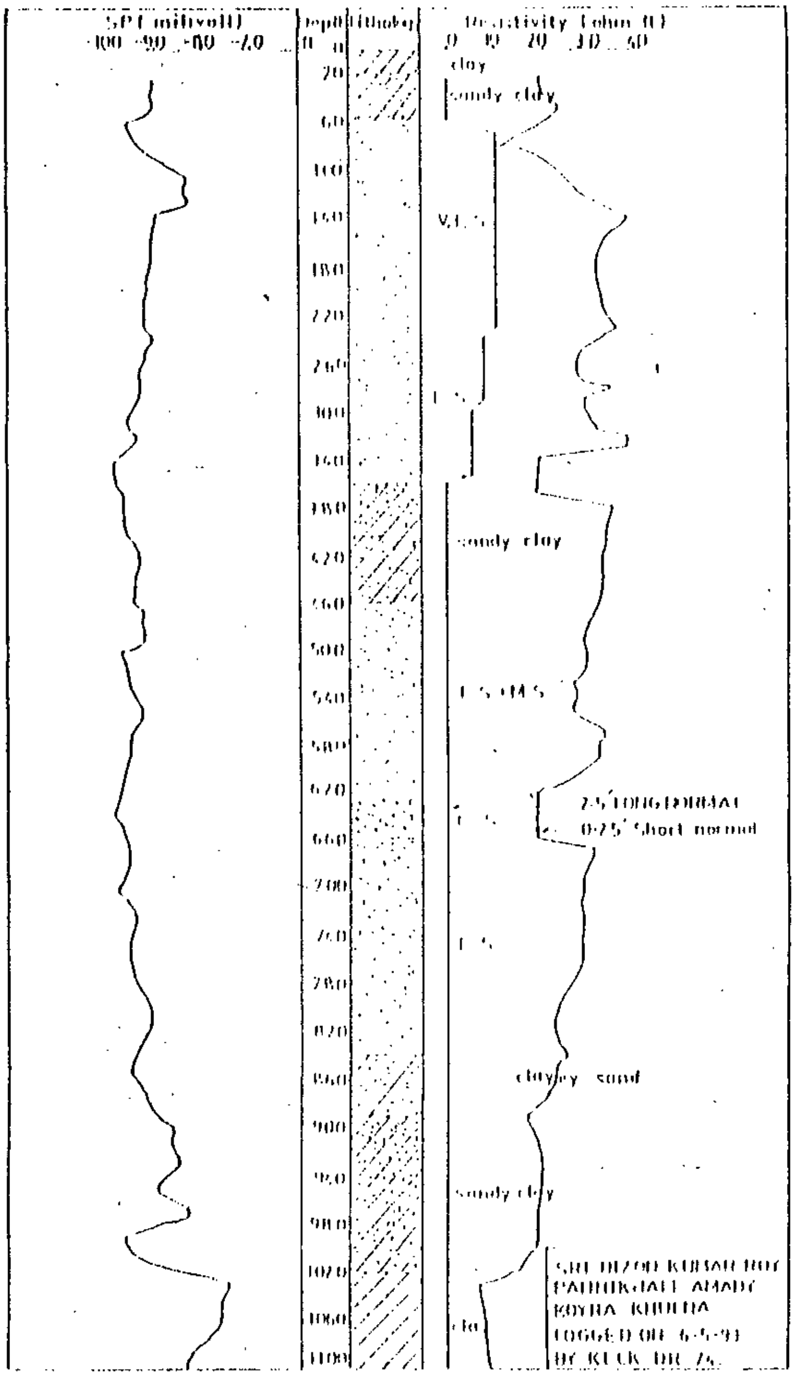
Under joint DPHE- UNICEF hydrogeological study in 1992-93 in the coastal area, borings were carried out in about 30 places in different coastal districts. Appendices A_1 to A_5 show such boring logs at five districts.

A boring log in Borgana District.



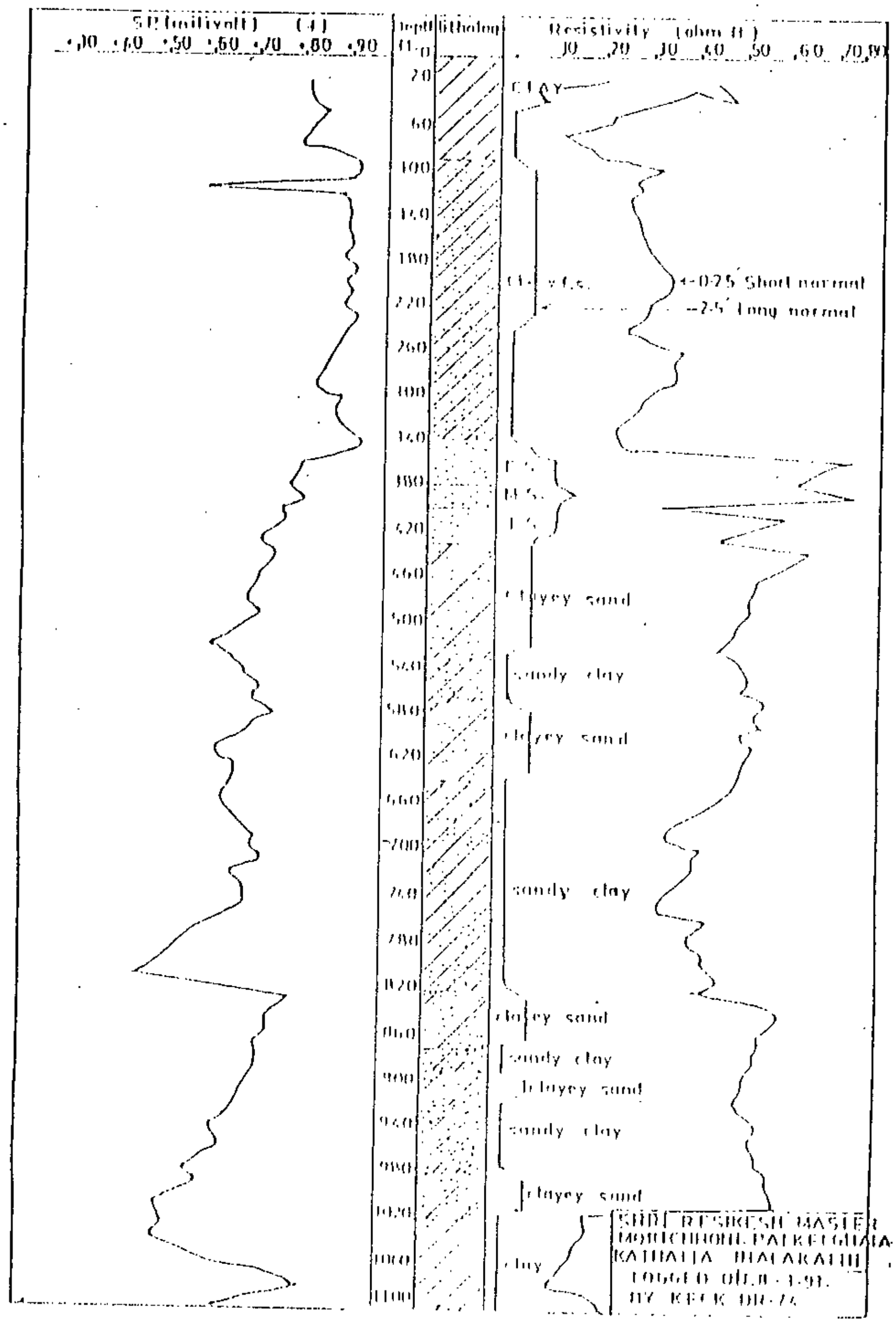
Appendix- A_2

A boring log in Khulna District.

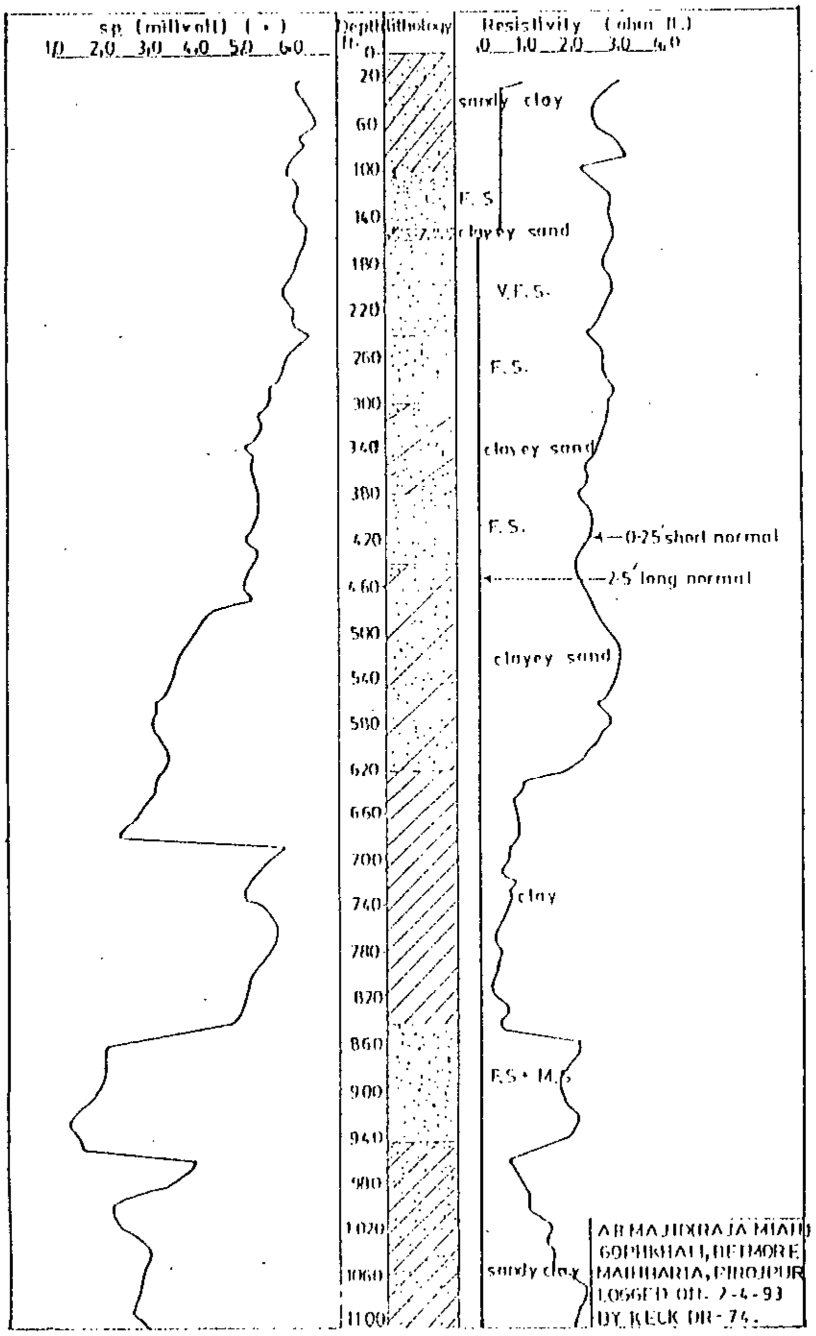


Appendix-A_3

A boring long in Jhalakati District.

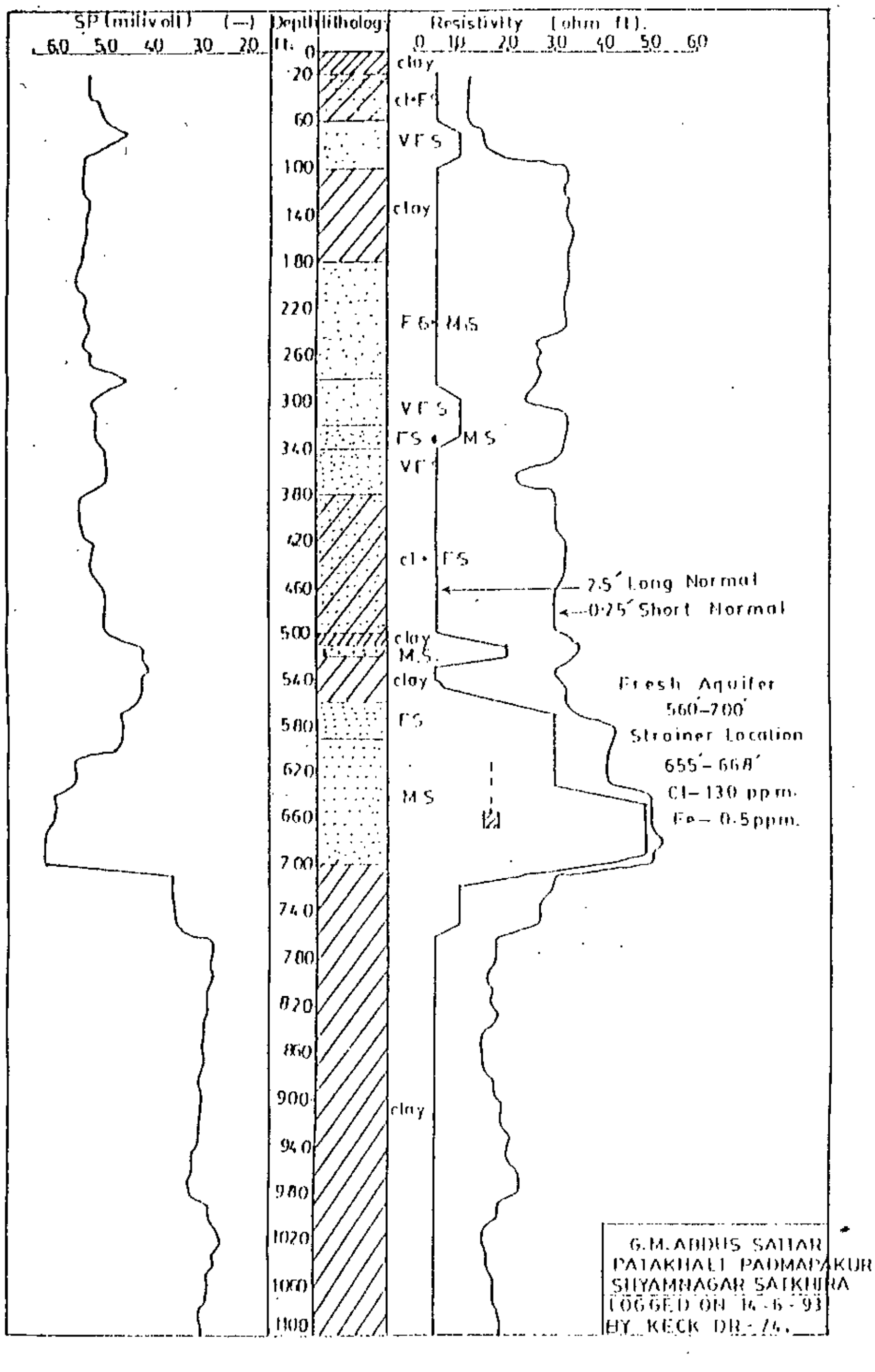


A boring log in Pirojpur District.



Appendix- A_5

A boring log in Satkhira District.



Specimen Field Questionnaire Form

A. Name of District ________________ B. Name of Thana ________________

C. Name of Union________________ D. Name of Village________________

E. Name of the head of the house hold ______________________________

Questions:

1. Did you fall in the grip of the cyclone of April, 1991 ?

2. Where did you take shelter after the cyclone ?

3. Is there any tubewell at your home/nearby locality ?

4. Was the tubewell in question No. 3 affected by the cyclone? What type of damage did it undergo ?

5. From where did you get water for drinking and cooking after the cyclone ?

6. Did you face any problem in getting drinking water and what was that ?

7. How long did you not get safe water after the cyclone ?

Contd.

8. Afterwards where did you get drinking water from ?

9. How drinking water can be provided after cyclone as you deem fit ?

10. Where did you defecate after the cyclone ?

11. Have you any other problem relating to drinking water other than post cyclone period ?

12. Did surge water stand on your house hold? If so, at which depth and for how long ?

13. Do you have any other information regarding the cyclone ?

Specimen Questionnaire Form with response translated in English

A. Name of District - Cox's Bazar B. Name of Thana- Moheskhali

C. Name of Union- Matarbari D. Name of Village- Sikderpara

E. Name of the head of the house hold- Moulavi Zafar Ahmed Sikder

Questions:

1. Did you fall in the grip of the cyclone of April, 1991 ?

   Yes

2. Where did you take shelter after the cyclone ?

   In the nearest cyclone shelter.

3. Is there any tubewell at your home/nearly locality ?

   Yes (Deep Tubewell)

4. Was the tubewell in question No. 3 affected by the cyclone? What type of damage did it undergo ?

   Pump was damaged. Saline and muddy water entered the well pipe.

5. From where did you get water for drinking and cooking after the cyclone ?

   From tubewell after repair of the same by Govt. mechanic.

6. Did you face any problem in getting drinking water and what was that ?

   We had no safe water for the first few days after the cyclone when the tubewell was out of order.

7. How long did you not get safe water after the cyclone ?

   One day

Contd.

8. Afterwards where did you get drinking water from ?

From Tubewell.

9. How drinking water can be provided after cyclone as you deem fit ?

By providing tubewells at every locality. There is no other reliable source.

10. Where did you defecate after the cyclone ?

Through hanging latrine.

11. Have you any other problem relating to drinking water other than post cyclone period ?

Sometimes pump of the well gets inoperative because of damaging of spareparts. During this time we face water supply problem (until it is repaired)

12. Did surge water stand on your house hold? If so, at which depth and for how long ?

Yes. 3 to 4 days.

13. Do you have any other information regarding the cyclone ?

Tubewell is the reliable source of drinking water in this area.

Sd\- Zafar Ahmed Sikder, Caretaker 19-9-93	Sd\ Kamal uddin Chowdhury Tubewell Mechanic. 19-9-93	Sd\ Md. Nur Hossain SAE/PHE Moheskhali. 19-9-93.

Appendix-D

Original Questionnaire form with
response in Bengali.

১। জেলার নাম: [illegible]　　　২। থানার নাম: চকরিয়া।

৩। ইউনিয়নের নাম: [illegible] বড় ভেওলা।　　　৪। গ্রামের নাম: নোয়াপাড়া

৫। বাড়ীর মালিকের নাম: [illegible]।

৬। আপনি / পরিবার সহ ১৯৯১ সালের ঘূর্ণিঝড়ে পতিত হইয়াছিলেন কিনা? হ্যাঁ।

৭। ঘূর্ণিঝড়ের পর কোথায় আশ্রয় লইয়াছিলেন? [illegible] আত্মীয় বাড়ীতে।

৮। আপনার বাড়ীতে/ পাড়ায় কোন নলকূপ আছে কিনা? হ্যাঁ।

৯। থাকিলে ঘূর্ণিঝড়ে উহার ক্ষতি হইয়াছিল কিনা? হইলে কিরূপ ক্ষতি হইয়াছিল? [illegible]
[illegible]

১০। ঘূর্ণিঝড়ের পর পানের জন্য কোন্ পানি ব্যবহার করিতেন? [illegible]

রান্নার জন্য কোন পানি ব্যবহার করিতেন? [illegible]

১১। পানীয় জল পাইবার ব্যাপারে কোন অসুবিধা ছিল কিনা? হ্যাঁ।
থাকিলে তাহা কিরূপ? [illegible]।

১২। কতদিন বিশুদ্ধ পানীয় জল পান নাই? প্রায় ৩ দিন।

১৩। পরে কোথা হইতে পানীয় জল সরবরাহ পান এবং কি ভাবে? [illegible]।

১৪। আপনার মতে ঘূর্ণিঝড়ের পর কোথা হইতে/ কি ভাবে পানীয় জলের ব্যবস্থা করা যায়? [illegible]

১৫। ঘূর্ণিঝড়ের পর কোথায় মলমূত্র ত্যাগ করিতেন? [illegible]

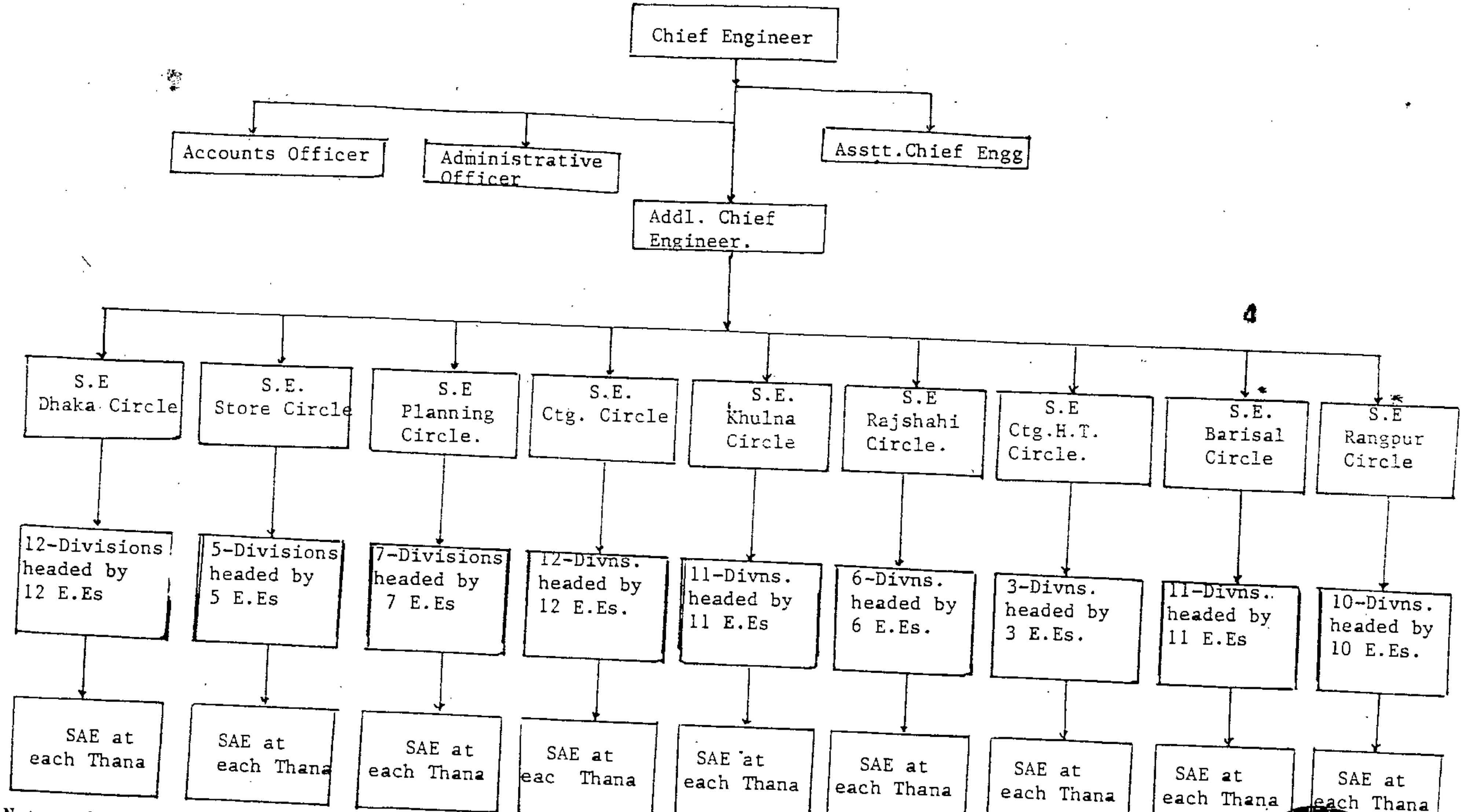
১৬। ঘূর্ণিঝড় ছাড়া অন্যান্য সময়ে পানীয় জলের কি অসুবিধা আছে? [illegible]।

১৭। সাইক্লোনের পরে বাড়ীতে পানি জমেছিল কিনা থাকিলে কত গভীরতায় ছিল এবং কতদিন ছিল?
৪'-৫' পানি ছিল। প্রায় ৩-৪ দিন।

১৮। অন্যান্য তথ্য

Appendix E

EXISTING ORGANOGRAM OF DPHE



Note :*1. Development Circle
2. There are another 5 Nos.Project Director/Superintending on development budget.
3. There is one post of Sub-divisional Engineer at each of the old District HQs.

S.E. = Superintending Engineer
E.E. = Executive Engineer
SDE = Sub-Divisional Engineer