Step by Step

IMPLEMENTATION GUIDELINES *for* RWHSs

D R A F T

Different Models of RWHSs:

- Cement/ Mortar Jar
- Ferro - Cement Tank
- RCC Ring Tank
- Do-it-yourself model (Motka)
- Underground RWHS

RURAL

November 2006

WaterAid – water for life
Dedicated exclusively to the provision of safe domestic water, sanitation and hygiene education

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Abbreviations

ASEH	: Advancing Sustainable Environmental Health
CAP	: Community Action Plan
CBO	: Community Based Organization
CSA	: Community Situation Analysis
DHTW	: Deep Hand Tubewell
DPHE	: Department of Public Health Engineering
DSHTW	: Deep Set Hand Tubewell
F	: Functional
HH	: Household
HTW	: Hand Tubewell
LGI	: Local Government Institutions
NF	: Non-functional
NGOs	: Non-government Organizations
O&M	: Operation and Maintenance
PF	: Partially Functional
POs	: Partner Organizations
Rehab	: Rehabilitation
SHTW	: Shallow Hand Tubewell
WAB	: WaterAid Bangladesh
WatSan	: Water and Sanitation
WS	: Water Supply
WSS	: Water Supply & Sanitation
WSTFC	: Ward Sanitation Task Force Committee

Glossary

1. Rainwater Harvesting (RWH)

Rainwater Harvesting (RWH) is a technique of water collection, which has been used since ancient times. A simple affordable, technically feasible and socially acceptable safe drinking water supply system in difficult geo-hydrological areas is very much in demand. RWH can be considered as a probable solution of drinking water crisis in arsenic affected areas, saline zone in the coastal areas, areas prone to declining watertable and having rocky/ stony layer in soil formation etc. The rainwater is free from arsenic contamination. The physical, chemical and bacteriological characteristics of harvested rainwater usually represent a suitable and acceptable standard of potable water.

2. Rainwater Harvesting Systems (RWHSs)

Rainwater Harvesting System (RWHS) is an option, which has been adopted in many areas of the world where conventional water supply systems are not available or adequately meets requirement of the people. To provide safe drinking water to rural communities; some organizations implemented several pilot programs and developed range of technological options of RWHSs considering affordability of the general mass. These models of RWHS are from indigenous do-it-yourself models to high cost profile Ferro-cement models.

2.1 Cement/ Mortar Jar (Household RWHS)

It is one of the proven models of RWHS in Bangladesh and also used in many countries (e.g. Thailand, Sri Lanka, Tanzania etc). The Cement/ Mortar Jar can be constructed in different size/ capacities such as 1,000 litres, 2,000 litres, 2,500 litres and 3,000 litres. This is one of the cheapest model of RWHS. *Construction procedures are described in* ***Annex: Design and cost information for RWHSs***.

2.2 Ferro – Cement Tank (Household RWHS)

It is also one of the proven models of RWHS which is used in Bangladesh and abroad. The Ferro–Cement Tank can be constructed in different capacities such as 2,500 litres, 3,200 litres, 3,800 litres and 4,600 litres. It is comparatively cheap model of RWHS. *Construction procedures are described in* ***Annex: Design and cost information for RWHSs***.

2.3 RCC Ring Tank (Household RWHS)

RCC is another proven model of RWHS in Bangladesh and developed locally. The RCC Ring Tank can be constructed in different capacities such as 1,000 litres, 2,000 litres and 2,500 litres. The RCC Rings are locally available and are used for different purposes. The rings could be used for construction of RWHS tank. RCC is comparatively cheaper model of RWHS. *Construction procedures are described in* ***Annex: Design and cost information for RWHSs***.

2.4 Do-it-yourself model (Motka)

This is an indigenous process of RWHS, which has been practicing in different parts of Bangladesh from the ancient. For example the people in coastal areas collect rainwater in a bigger earthen pot (called Motka). It is not need to have a sophisticated system for harvesting rainwater but the issue is that collection method should be scientific and hygienic. During rainy days, rainwater could be collected in a clean pot (which is available in house) using a piece of clean polythene hanging over with four sticks. Or a piece of split bamboo/ wooden channel can be hanged along the ridge of clean roof and clean rainwater can be harvested into pitcher. This could serve the crisis of water during rainy season (about six-months).

This type of RWHS may be of different capacities such as 100 litres, 250 litres, 300 litres, 500 litres and 1,000 litres. It is very cheapest model of RWHS. *Construction procedures are described in* ***Annex: Design and cost information for RWHSs***.

2.5 Underground RWHS (Community Based)

The construction of large capacity community based RWHS had been practiced from the ancient. This type of RWHS is suitable where a group of families live in a congested area and face scarcity of safe drinking water. The Community based underground RWHS can be constructed in different capacities such as 10,000

litres, 15,000 litres, 20,000 litres, 25,000 litres, 30,000 litres, 35,000 litres, 40,000 litres and 50,000 litres. *Construction procedures are described in* ***Annex: Design and cost information for RWHSs***.

3. Functional

RWHS which meets the following criteria -

- **a.** Could able to store adequate quantity of water having acceptable quality for certain period of time.
- **b.** All necessary parts are in place.
- **c.** Good, clean and effective catchment, gutter, down pipes, first flush system, platform, tank with lid are available.
- **d.** Effective waste water disposal system is available.
- **e.** Sanitary condition of RWHS and surrounding is satisfactory.

4. Partially Functional

RWHS which meets partially of the criteria mentioned in **3a**.

5. Non-Functional

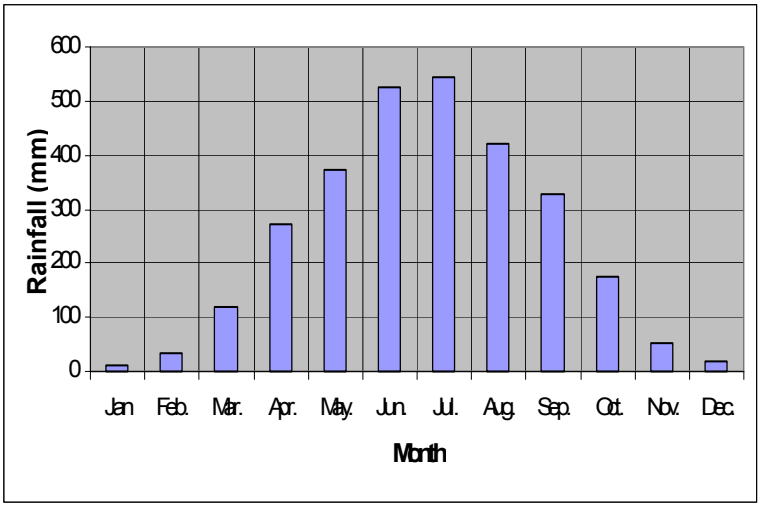
RWHS which is completely out of order.

1. Introduction

WaterAid is an international non government organization dedicated exclusively to the provision of safe domestic water, sanitation and hygiene education to the world's poorest people. WaterAid has been working in Bangladesh since 1986 to improve hygiene behavior and access to water and sanitation services for poor communities giving emphasis on demonstration of innovative approaches, participatory methods, gender and vulnerable groups and sustainability.

'Advancing Sustainable Environmental Health' (ASEH) is a DFID supported project of WaterAid Bangladesh (WAB) for hygiene promotion, environmental sanitation and water supply among for urban and rural poor. The project started in July 2003 and will be end up in March 2009 and is being implemented in partnerships with local rural and urban NGO partners. ASEH is promoting sustainable, community managed safe water supply and sanitation facilities among the target population in rural areas and urban slums. ASEH promotes financial and program management transparency and accountability of partner organizations to communities through empowering and strengthening LGIs to plan, monitor and implement WSS services.

WAB has been offering a range of water supply technology options to address the needs of communities at different geo-physical context under ASEH project. WAB implements different types of Rainwater Harvesting Systems (RWHSs) especially for rural communities along with other options.



The annual monsoon rainfall in Bangladesh could be utilized as a seasonal supply for safe drinking water means of reducing water-crisis at the household level in areas having scarcity of drinking water.

The heavy monsoon rain makes rainwater harvesting a viable option among the other technologies. In Bangladesh, an average of 2,500 mm rainfall occurs annually. The amount of rainfall in the Northeast region is highest (about 5,500 mm/year) and gradually decreases towards Southwest direction. Less annual rainfall is around 1,200 mm/year, which occurs in the Southwest region of Bangladesh. The annual rainfall pattern is not uniform over the year, about 75% rainfall occurs from April to October.

This Guideline is particularly dealing with the following RWHSs especially in **Rural** areas. The RWHSs can be divided into following broad categories. Such as –

1. Above ground RWHS (Household):
   - Cement/ Mortar Jar
   - Ferro - Cement Tank
   - RCC Ring Tank
2. Do-it-yourself model (Motka)- (Household)
3. Underground RWHS (Community based)

Description of these RWHSs is given in the glossary.

Detail design, drawing and cost information are given in - *ANNEX: Design and cost information for RWHSs*.

2. Advantage & disadvantages of RWHS

RWHS has many advantages and disadvantages. Some advantages and disadvantages of RWHS are as follows:

Advantages

- Safe source of drinking water and naturally free from bacteria and harmful chemicals.
- Installation cost is comparatively low.
- The operation and maintenance procedure of RWHS is very simple. Even locally trained village woman can easily operate & maintain the system.
- It offers convenience in reducing time and energy for collection of drinking and cooking.
- RWHS can be constructed with locally available construction materials and local mason can built it.
- The system is independent and therefore suitable for scattered settlements.

Disadvantages

- The initial cost may prevent a family from installing a RWHS.
- Mineral free rainwater has a flat taste, which may not be liked by many. It may also cause nutrient deficiencies of trace minerals among users.
- Since the distribution of rainfall is not equal throughout the year, large capacity tank is needed to store requisite amount of water to serve during dry period.
- Unavailability of suitable catchment of adequate capacity for harvesting rainwater.
- Drought or natural calamity (flood, cyclone etc.) may disrupt the RWHS.
- Due to lack of proper maintenance bacterial contamination may be occurred.

3. Purpose and Use of this Guideline

This Guidelines has been prepared based on the available Guidelines of WAB and reviewing available documents of other organizations (like IDE, NGO-F, DPHE-Danida, Unicef etc.) to meet the following purposes:

- This Guideline has been prepared as a tool to keep standard procedures for construction of different types of RWHSs under the programme of WaterAid Bangladesh uniformly by all Partner Organizations.
- It was attempted to reflect the National Policies as well as WaterAid's policies through the Guidelines in an operational manner and mainstream the policies.
- This Guideline will be used as a Handbook for the frontline staff as well as professionals.
- Ensure involvement of community, and other concerned stakeholders as relevant.
- This Guideline will guide the Partner Organizations to implement the installation with a certain level of flexibility allowing addressing local context in consultation and approval from WAB, if essential.

4. Implementation of RWHSs

- Type of RWHS will be selected based on hydro-geological situation of the area concerned as well as communities' preference and ability to pay etc.
- Implementation of RWHS will take place at hh level, schools, institutions, public places of rural areas.

Step 1: Need Identification

In order to identify the need of this specific water supply facilities for a particular community and proceed for installation of a suitable RWH option (different types of RWHSs), the following activities have to be undertaken.

- **Community Situation Analysis (CSA):** CSA must be conducted at cluster/ community with facilitation by the respective frontline staff of Partner Organization following the CSA guidelines (pls. see the Guidelines on Community Situation Analyses).

- The status of existing water supply facilities, besides other relevant information of the particular cluster/ community may be documented during CSA using the format **WAB-2006/Prog-001.** The cluster/ community identification will be marked by writing a number or note on top right corner of the same format).

- The summary information of the water supply situation in the community obtained from the overall situation analysis may be presented similar to the format **WAB-2006/Prog-003.**

- **CBO formation:** During the analyses of WatSan status for a particular community, frontline staff of Partner Organization ignites the people towards promoting access to safe water, safe sanitation and improve hygiene practices. Then the community people feel to take initiatives collectively for overcoming the adverse WatSan situation and the CBO is formed.

- **Community Action Plan (CAP)**: Once the situation is analyzed and orientation is conducted to CBO on how to develop action plan, the CBO will sit together with community people to prepare a **Community Action Plan (CAP)** with assistance from the frontline staff. During preparation of CAP, the below summary matrix should be analyzed carefully to assess the need new/ rehabilitation of water supply facilities for the community. Accordingly, the CAP should be prepared including required number of new or rehabilitation water supply options mentioning their types, budget, number of users, timeframe for installation, responsibilities, budget etc. and later on documented by the frontline staff as the matrix titled **CAP: Installation of Water Supply Options** given below.

- During determining present situation, average number of hhs per water supply facility having access to safe water needed to be calculated.

CAP: Installation of Water Supply Options

Preferred Option	No. of WS options		No. of HHs to be covered*		Time frame	Responsibility	Budget	Remarks
	New	Rehab	New	Rehab				
Cement/ Mortar Jar								
Ferro - Cement Tank								
RCC Ring Tank								
Do-it-yourself model (Motka)								
Underground RWHS (Community based)								
Others								
Total:								

** As per WAB's present practice the beneficiary hhs for different RWHS are: Cement/ Mortar Jar 2-3 hhs; Ferro - Cement Tank 2-3 hhs; RCC Ring Tank 2-3 hhs; Do-it-yourself model (Motka) 2 hhs; Underground RWHS (Community based) 30-100 hhs. For detail please see Part II RWHS Manual.*

- The frontline staff will assist the communities to prepare the above CAP and ensure that policies of Govt. of Bangladesh as well as WAB are reflected. Preference must be given to poor hhs and hhs of undeserved and un-served pockets.

- The CAP including proposed RWH options has to be carefully reviewed by respective frontline staff of Partner Organizations considering ASEH policy principles and endorsed by the CBO preferably in a CBO meeting.

Step 2: Application for a RWHS

- Based on the priority determined in CAP, respective frontline staff along with CBO members will have meeting(s) with the users to determine list of applicant households for each proposed RWHS along with number of users and preferred option.

- The respective frontline staff must explain the conditions of applying for a particular RWHS (e.g., estimated total cost, users' contribution, cost-recovery mechanism, caretakers' selection process, caretakers' roles & responsibilities, use and O&M of the facilities etc.) to the applicants in details.

- Upon discussion, each applicant or groups will fill-in an Application Form (**Annex-1**) for a particular type of RWHS.

- The respective frontline staff will assist the applicants to select the site for installation of proposed RWHS properly considering the **site selection criteria**.

- The frontline staff must ensure that signatures are obtained in the Application Form from both male and female member(s) of the applicant household(s).

Site selection criteria:
Proper selection of site for installation RWHS is an important factor for its sustainability. The site selection criteria for RWHSs are:

- RWHS must be constructed in the problematic geo-hydrological area likes excessive arsenic is found in underground water, salinity in coastal areas, hilly areas etc. to facilitate access to safe water for the unprivileged poor people.
- The selected site should about 500 ft way from any existing safe water sources (AIRP, DHTW, SHTW, PSF, DW/ RW etc. which is providing water round the year) installed by WAB, government or non-government organization. This condition will not affect the sources of safe water installed in any institutions or public places.
- The selected site (house) should have adequate size of catchment area (considering the capacity of tank). The selected catchment may be CGI or concrete or tiles roof and be free from overhanging trees, lead-pointing/painting etc.
- The height of edge of roof should be more than (about 1 feet) total height of the RWHS tank.
- The selected site should have adequate space for the construction of underground or above ground storage tank. It should be at least 5 meters away from nearby septic tank/ ditch/ pond etc.
- To avoid contamination of water sources, construction site of RWHS should be relatively high and at a corner of the house.
- The site of the proposed RWHS has to be selected in such a place from where women can collect and use water for necessary purposes with security and privacy.

- The representative from the applicant households will submit the filled-in Application Form to Partner Organization on their behalf through respective frontline staff.

Step 3: Site Verification for proposed RWHS

- The frontline staff will forward the Application Form to respective Partner Organization's office to be visited by the supervisory staff and/or Engineer preferably with LGI representative/ member of Ward Sanitation Task Force Committee (WSTFC).

- During site verification by the Supervisory staff/ Engineer, the following aspects to be critically observed.

    - Reliability of information as mentioned in the Application Form
    - Social, technical and legal feasibility of the proposed site for the particular RWHS.

- Recommendation should be made by the Supervisory staff/ Engineer if all the conditions are full-filled.

Step 4: Approval for a particular RWHS

- Once the site is qualified and design is selected/ approved, the recommended Application Form will be forwarded to Union Sanitation Taskforce/ Union WatSan Committee / respective PO office for review and approval.

- The competent approving authority (as decided by respective Partner Organization) will review and approve/ not approve the Application preferably in a formal meeting.

- In case of approved application, a simple approval letter (**Annex-2**) should be issued by the approving authority to the applicant households to acknowledge their demand and proceed for next step.

- If the Application is rejected, the applicant households will be informed with reasons for not being accepted by the authority (say, due to not meeting the criteria).

Step 5: Calculation of Cost Sharing

- The concerned front line staff as per the **Cost Sharing Strategy** (Please see Cost Sharing Strategy) will perform 'ability to pay analyses' of the applicant(s) hhs and determine the amount of upfront contribution and/or number of installments applicable for each hh for the rest.

- The applicant households will be informed about the upfront contribution and/or amount and number of installments by the respective Partner Organization's staff.

Step 6: Construction of RWHS

6.1 Procurement of materials:

6.1.1 Local Procurement

Procurement will be made by a Purchase Committee to be formed with two representatives nominated by the applicant group and one from Partner Organization, preferably Engineer.

The Purchase Committee will purchase the required materials as per the approved design, specification and estimate.

The respective Engineer of Partner Organization will be responsible for ensuring the quality of materials procured.

6.1.2 Central Procurement

In case of Central procurement, the Central Procurement/ Purchase Committee of the Partner Organization will procure the materials as per **Financial Guidelines for Partner Organizations**.

6.2 Mason selection and training

The quality of any construction depends upon skill and experience of the construction workers. RWH technology is a new type of installation and not very familiar technology in Bangladesh, so it is required to encourage private entrepreneurs to train and transfer the knowledge and skill.

The selection criteria of mason are:

- The skilled mason and/ or private producer should be selected from locality for construction of RWHS. The CBO can contribute in the selection process.
- The mason and/ or private entrepreneur should be willing to receive training on construction of RWHS and be engaged in the construction work as and when needed and requested by the community.
- It is required to train local masons on construction of new technologies and local potters to develop large capacity of Motka for low income group people.
- The main objective of the training is to develop skills to the masons to construct different models of RWHS, operate & maintain and underground rainwater as alternative source of safe drinking water.
- Training for the masons will be conducted in the community level by Partner Organizations.

The Purchase Committee/ Partner Organization will identify locally available mason groups and select one group on the basis of experience and skills for construction of RWHS. Partner Organization should

follow the mason selection critera in a transparent manner. A **Contract Agreement** (similar to **Annex-3**) between mason group and Purchase Committee/ Partner Organization will be signed.

The selected mason group will be given orientation on construction of RWHS by the engineer, Partner Organization. S/he will extend necessary on-job support to the mesons during construction of RWHS.

6.3 Construction of RWHS

The RWHS will be constructed by the assigned mason group as per the **Contract Agreement**, **'Manual for the construction of RWHS'** of WAB.

During construction, quality assurance will be made by the Partner Organization's staff, preferably by Engineer and the following issues to be taken into considerations:

- Construction is done at the site approved earlier.
- The materials purchased are properly stored and used.
- Construction follows the approved design and specification.

A drainage system will be constructed for the safe disposal of waste water.

The following aspects should be looked into during construction of drainage

- Upon completion of construction, ASEH marking (sample in annex -4) should be introduced on the constructed RWHS.
- Outlet of drain is maintained with proper slope and length.
- Soak-pit may be used for management of waste water.
- Utilization of waste water can be made for homestead gardening.

6.4 Water Quality (WQ) Test

6.4.1 Monitoring testing

Monitoring testing applies to all WAB programme funded and Non-WAB programme funded RWHS. Sample testing of all RWHSs should be undertaken to cover at least 10% of the partner's RWHS in each 6 months' period. Sample testing should include representative samples from each union covered and should be carried out on a rotational basis to eventually cover all RWHS. (For detail please see **Water Quality Standard &Testing Policy of WAB**).

6.4.2 Record keeping

Partner Organizations must keep records of all WQ tests. A standard sheet should be completed in the field and kept for each constructed RWHS. Information of WQ test during monitoring tests for that RWHS for each constructed RWHS should include its unique identification number and geo-reference in a systematic manner.

Step 7: Completion Report

A '**Completion Report**' containing detail information including RWHS identification, Contract information, date of start and completion of installation, size of the system, test results of water quality parameters at the time of commissioning and other technical information of the RWHS as attached **(Annex-5)** should be filled-in by Partner Organization's staff and to be acknowledged by the Representative of applicant households.

The '**Completion Report**' must be kept at Partner Organization's Office as a proof of completion of task and acceptance by respective users.

Step 8: Caretakers' Training and Tools Distribution

A total of two (one male and one female) caretakers from each of the constructed RWHS as proposed in the application form will be selected & trained.

The Engineer will be responsible to train the caretakers at site preferably within one week of construction of system. During training, the caretakers will be given a set of tools for repair and maintenance.

The set of tools shall contain the following instruments in a box:

- Slide wrench 12"- (1 piece)
- Screw driver - (1 piece)
- Pliers - (1 piece)

It should be noted that the toolbox should be given at the disposal of the female caretaker.

The role of caretaker is vital for proper operation and maintenance. The selection criteria of caretakers are:

- One female and one male will be selected for each water point and preferably from the same family.
- They should be willing to provide voluntary services to collect rainwater and operate & maintain the system properly.
- Caretakers should have easy access to the user group and capable to lead the user group.
- They will be willing to harvest rainwater as per the guideline as and when rainfall occurs (day or night).
- The caretaker should agree and willing to monitor the system and help CBO for providing necessary information about system.

Step 9: Handing Over

A '**Handing Over Note'** along with users' acknowledgement similar to the Completion Report should also be prepared and signed by all parties mentioned with **Annex-6.**

At the end of caretakers' training, a simple formal **Handing Over Ceremony** will be organized in the presence of applicant households, when the water supply facility will be formally handed over to the users.

During handing over, the photocopy of 'Hanging Over Note' must be handed over to the **Representative of applicant group** while the original copy will be kept at Partner Organization's Office as a record for handing over the facility to the respective users.

Step 10: Cost Recovery

As soon as the water supply facility is handed over and subsequently formally taken over by the users, cost recovery will be started in cases where the total contribution money has not been deposited by users as upfront.

The concerned front line staff already fixed up the amount and number of installments applicable for each applicant household as per the **Cost Sharing Strategy** (Please see 'Cost Sharing Strategy').

A register should be introduced mentioning names and amount of cost recovery for each of the applicant households. This should be updated at every month.

The following aspects should be taken into consideration during cost recovery exercise.

- The frequency of installment may be monthly and with a maximum of 12 months except for the last year installations.
- The Caretakers will be responsible to collect the cost recovery money from applicant households and deposit the same regularly. Proper documentation should be kept at register to ensure transparency of this process.
- The respective frontline staff will deposit the cost recovery money to Partner Organization's office within maximum of one week time from collection by Caretakers.

Step 11: Monitoring & Follow-up

After construction of RWHS, respective Partner Organization's staff will monitor the water quality as per **'Water Quality Standard & Testing Policy'**.

Other than water quality monitoring, respective Partner Organization will also monitor functionality, use and maintenance status of the water supply facilities for at least six months after handing over of the facility.

The following aspects should be considered during monitoring by Partner Organization's staff.

- functionality of the RWHS;

- functionality of the drains;
- cleanliness of roof, gutter etc, surroundings and drains;
- water use pattern during rainy season as well as lean period by the user groups;
- status of repair and maintenance;
- caretakers role and responsibilities;
- availability and condition of tools and tool box; and
- other matters related to use and maintenance

Annex-1

Partner Organization: _____

Advancing Sustainable Environmental Health Project

Application Form for
Rainwater Harvesting System

1. Application Sl. No: ……. …… 2. RWHS Code No: …… ……... (After construction)

3. Date of Application: ……

4. Union: ……. 5. Upazila: …… 6. District: ……..

7. Proposed site for RWHS:

Village:	
Ward No:	Cluster/Community ID (if any):
Distance from nearest safe water option:	(meter)
Distance from nearest latrine:	(meter)
No. of Applicant Households:	

8. Information of Applicant Households:

Sl. No	Name of Household Head		Occupation		Wellbeing Ranking	No. Of HH member*				Signature	
	Female	Male	Female	Male		F	M	C	T	Female	Male
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											

*M= Male; F=Female; C=Children; T=Total Note: Age below 10 years will be considered as children

Proposed Care Takers*:

1. Care Taker's Name: ……. ……... Father / Spouse : ……..

2. Care Taker's Name: ……. ……... Father / Spouse:……

Name of the Representative,
Applicant Household(s)

Name of Frontline Staff

Signature

Date: ----------

Signature

Date: ----------

9. Main Condition for Applying:

- Applicant household(s) must not have any Arsenic free HTW within 50 m distance;
- For construction of any RWHS, number of applicants household must be at least 2-3 households for households system. But the number may vary according to different type of RWHS; However, the present ranges are: Cement/ Mortar Jar 2-3 hhs; Ferro - Cement Tank 2-3 hhs; RCC Ring Tank 2-3 hhs; Do-it-yourself model (Motka) 2 hhs; Underground RWHS (Community based) 30-100 hhs.
- Upon approval of application, the household(s) must share the contribution money as per ability to pay analysis;
- The applicant household(s) must select one male and one female from the applicant household(s) as caretakers for RWHS.
- A common/ agreed/ convenient place within the proximity of applicant households will be chosen for the construction of community based system.

For Official Use Only

Union level Supervisory Staff and/or Engineer of Partner Organization will fill-up the following box after visiting the site and verifying the information in the Application Form:

Comments by Supervisory Staff and/or Engineer:	
Name & Designation:	**Name & Designation:**
Site Recommended: **Yes** ☐ **No** ☐	
Signature & Date:	**Signature & Date:**

Site Approval:

Approved: ☐ **Not Approved:** ☐

Name: …….....
Competent Approving Authority*

…….....
Signature & Date

**Union Sanitation Taskforce/ Union WatSan Committee / respective PO official will review and give approval.*

Annex-2

Partner Organization: _____

Advancing Sustainable Environmental Health Project

Approval Letter for Rainwater Harvesting System

Date: ----------

To: _____

Spouse/Father's name: _____

Village _____

Ward no. _____

Union: _____

Upazila: _____

District: _____

The Union Sanitation Taskforce/ Union WatSan Committee / Partner Organization …… is hereby pleased to inform you that the application for a …… submitted by you/ and/ the other applicants has been approved.

You are requested to deposit an amount of Taka _____ from the applicant household(s) as upfront contribution money to the Partner Organization's office within …….. days from issuing this approval letter.

And/ or,

A total amount of …… Tk at ……. monthly/…….. installment in ……...month(s)/year(s) as the rest amount of contribution money according to the ability to pay analysis.

The site mentioned in the application form can not be changed without prior approval from the concerned approving authority.

Prepared by Signature

_____ _____

(Staff of Partner Organization) Competent Approving Authority*

Date:_____ Date:_____

**Union Sanitation Taskforce/ Union WatSan Committee / respective PO official as decided to give approval.*

Annex-3A

Advancing Sustainable Environmental Health

Contract Agreement with Local Meson Group

Date: ----------

The agreement is made on …… between:

1. Mr./Ms. …… , son of/ spouse of ……, village:……..……, ward:……., union:……, upazila: ……, district: ……..……

And,

2. Rainwater Implementation Committee (RWIC)/ Partner Organization ……., village:……..……, ward:……., union:……, upazila: ……, district: ……..……

Both the parties are hereby agreed to the following terms and conditions for Construction of a RWHS at …….

Terms & conditions:

- RWIC/ PO will procure all the materials for construction of RWHS as per design, specification and estimate.
- RWIC/ PO ensure safe custody of the materials procured.
- The meson leader will be responsible for engaging required number of labors.
- The mason will construct of RWHS according to the given design & drawing.
- The mason will start working within _____ days upon signing contract with RWIC/ PO and RWIC/ PO will ensure availability of required materials.
- The construction must be completed within _____ days from signing contract including mobilization at site.
- No advance will be paid.
- Mason will be paid as below:
    - Total Contact amount _____ tk for the entire construction.
    - Nature of payment will be _____ _____ _____, etc.
- Any payment will be paid upon certification from RWIC/ Partner Organization's Engineer.

Des.	Rate	Qty.	Man-days	Total
1. Mason leader	?00	X	XX	XXX
2. Skilled labor	?00	X	XX	XXX
3. Unskilled labor	?00	X	XX	XXX
4. Shuttering	???	X	XX	XXX
5. Others	???	X	XX	XXX
Total =				XXXX

Agreed by

Signature

_____

(Name of mason leader……)

Date:_____

Agreed by

Signature

_____

(Name: Representative of RWIC/ PO)

Date:_____

Annex-3B

Partner Organization: _____

Advancing Sustainable Environmental Health

Contract Agreement with Contractor

Date: ----------

To: Ms/Mr. _____

Detail address: _____

_____

_____

The Partner Organization _____ is hereby pleased to inform you that you have been awarded for the construction of Public Toilet on the basis of your quotation……..

You are, therefore, requested to come and visit_____ office of Partner Organization _____ in order to receive the work order for the same after signing this contract.

This is to mention here that you are obliged to follow the terms & condition stated below –

1. All materials/ components must be supplied according to the given design and specification.
2. Construction of mentioned RWHS must be done according to the given design & drawing.
3. The construction must be completed within _____ days from issuing work order.
4. The work order will be valid for one month period of time from the date of issuing the same.
5. No advance will be paid along with work order.
6. Partial advance may be given upon satisfactory progress of work.
7. Payment will be made through "A/C payee check".
8. VAT and Tax will be deducted at source (Partner Organization's office) according to the GoB rules, if applicable.
9. The price quotation will not be changed for this period (if applicable).
10. All payments will be paid upon certification from Applicant Committee and/or Partner Organization on satisfactory construction of facility.
11. The Contractor will be refunded with the security deposit (5-10% earnest money of unit cost) after certification from Applicant Committee and/or Partner Organization.
12. In case of **unsatisfactory*** performance, the Contractor will be obliged to do the rectifications as required in consultation with Partner Organization's Engineer.

Agreed by

Signature
_____

(Name: ……)

Date:_____

Signature
_____

(Manager/Coordinator of Partner Organization)

Date:_____

Annex-4

Partner Organization: _____

Advancing Sustainable Environmental Health

ওয়াটারএইড বাংলাদেশ–এ্যাসে প্রকল্পের আওতাধীন নিরাপদ পানির ব্যবস্থাপনা এবং স্যানিটেশন অবকাঠামো সনাক্তকরণ

ওয়াটারএইড বাংলাদেশ স্থানীয় স্বেচ্ছাসেবী সংস্থার সঙ্গে অংশীদারীত্বের মাধ্যমে প্রধান প্রধান শহরগুলির বস্তি এলাকা এবং গ্রামাঞ্চলের মানুষের জন্য নিরাপদ পানি, পয়ঃনিষ্কাশন ব্যবস্থাসহ সুন্দর পরিবেশ ও স্বাস্থ্যসম্মত জীবনমান উন্নয়নের লক্ষ্যে Advancing Sustainable Environmental Health (ASEH) প্রকল্পের বাস্তবায়ন করছে। ইতোমধ্যে বেশ কয়েকটি সহযোগী সংস্থা তাদের কর্ম এলাকার বিভিন্ন স্থানে নিরাপদ পানির ব্যবস্থাপনা ও স্যানিটেশন অবকাঠামো তৈরী করছে। ASEH প্রকল্পের আওতায় নির্মাণকৃত অবকাঠামোগুলোর সঠিক হিসাবের জন্য সনাক্তকরণ প্রয়োজন। এই লক্ষ্যে নিম্নে কিছু উদাহরণ দেয়া হলোঃ

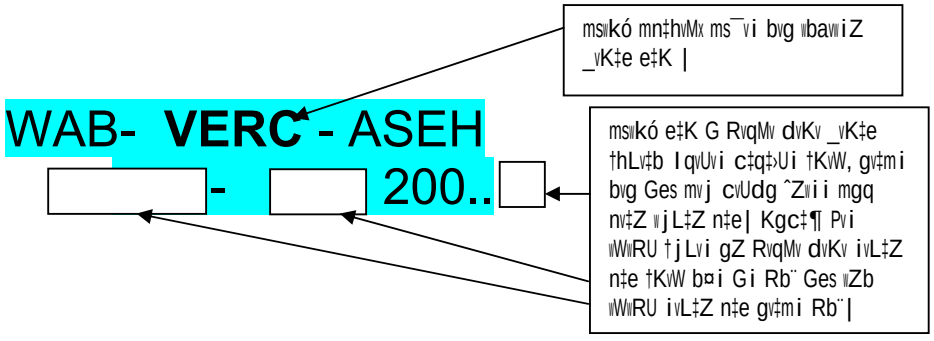
নমুনা টিনের বা এ্যালুমিনিয়ামের শীটের তৈরী হলে ভাল হয়। ব্লকে যা থাকবে:

WAB-Name of PNGOs-ASEH
#Water Point Code-Completion month-Year

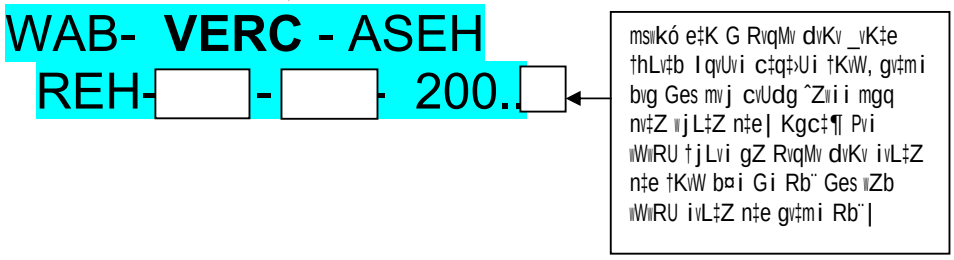
উদাহরণ:

WAB-VERC/DSK-ASEH
#00-124-Apr -2006

ব্লকের নমুনা:



যদি ওয়াটার পয়েন্ট পুনঃ নির্মাণ হয় তাহলে ব্লক হবে নিম্নরূপ



Annex-5

Partner Organization: _____

Advancing Sustainable Environmental Health

Rainwater Harvesting System Completion Report

RWHS Completion Report

(Original copy to be kept at PO's office)

A. RWH System Identification :

1. RWHS Identification Code:

2. RWHS Type: Cement/ Mortar Jar; Ferro - Cement Tank; RCC Ring Tank; underground RWHS (Community based); do-it-yourself model (Motka)

3. Representative's Name: 4. Spouse/ Father's Name:

5. Village: 6. Ward No.

7. Union: 8. Upazila:

9. District:

B. Contract Identification:

1. Name & address of Mason group leader/ Contractor:

2. a) Work Order No: 2. b) Work Order Date:

C. RWHS Completion Detail:

1. Construction start date: 2. Construction completion date:

3. Capacity 4. Curing done: Yes No

5. Disinfection Done: Yes No

6. Water Quality: a) pH: b) ----------: c) ----------:

Comments about construction:

I certify that above statements are true. Acknowledged by:

_____ _____

Name: Staff / Engineer
Partner Organization
Signature & date

Name: Chairperson, Applicant Committee
Signature & date

Annex-6

Partner Organization: _____

Advancing Sustainable Environmental Health

Handing Over Note (page-1)

Handing Over Date:

(Original copy to be kept at PO's Office while photocopy to be handed over to users)

A. RWHS Identification:

1. RWHS Identification Code:
2. Representative's Name:
3. Spouse/ Father's Name:
4. Village:
5. Ward No.
6. Union/ Ward:
7. Upazila:
8. District:

---

2. RWHS construction Detail:

1. RWHS Type: Cement/ Mortar Jar; Ferro - Cement Tank; RCC Ring Tank; underground RWHS (Community based); do-it-yourself model (Motka)
2. Construction start date:
3. Construction completion date:
4. Capacity
5. Gutter length:
6. Down pipe dia & length:
7. Water Quality: a) pH: b) ----------: c) ----------:

---

3. Other Information:

1. Name and address of Mason group leader / Contractor:
2. Engineer of Partner Organization:
3. Frontline staff:

Handed over by:

……..

Manager/ Coordinator of Partner Organization

Date:……

Partner Organization: _____

Advancing Sustainable Environmental Health

Handing Over Note (page-2)

For Partner's Official Use Only

Users Acknowledgement

(In case of Acceptable Rainwater Harvesting System)

We, the user(s) of the RWHS, hereby acknowledge that the construction of ……. RWHS as well as water quality in our opinion are satisfactory.

We shall use and be responsible for operation and maintenance of the RWHS regularly.

Witness (One of the users)	On behalf of the users
……	……..
Signature	Signature
Name:……..	Name:……..
	Representative, Applicant Group
Date:……..…	Date:……

Handed over by:

……..
Manager/ Coordinator of Partner Organization

Date:……

ANNEX: DESIGN and COST INFORMATION

for RWHSs

D R A F T

RURAL

November 2006

WaterAid Bangladesh

House 97/B, Road 25, Banani
Dhaka, 1213, Bangladesh
Tel. ++880 (0)2 881 5757, 881 8521 Fax: ++880 (0)2 881 8521
Email: info@wateraidbd.org
Web: www.wateraid.org

WaterAid – water for life
Dedicated exclusively to the provision of safe domestic water, sanitation and hygiene education

Table of Content

Abbreviations

ASEH	: Advancing Sustainable Environmental Health
CAP	: Community Action Plan
CBO	: Community Based Organization
CSA	: Community Situation Analysis
DHTW	: Deep Hand Tubewell
DPHE	: Department of Public Health Engineering
DSHTW	: Deep Set Hand Tubewell
F	: Functional
HH	: Household
HTW	: Hand Tubewell
LGI	: Local Government Institutions
NF	: Non-functional
NGOs	: Non-government Organizations
O&M	: Operation and Maintenance
PF	: Partially Functional
POs	: Partner Organizations
Rehab	: Rehabilitation
SHTW	: Shallow Hand Tubewell
WAB	: WaterAid Bangladesh
WatSan	: Water and Sanitation
WS	: Water Supply
WSS	: Water Supply & Sanitation
WSTFC	: Ward Sanitation Task Force Committee

1. Design aspect of Rainwater Harvesting System

The essence of appropriate technology is that equipment and techniques should be relevant to local resources and needs and to the local environment. The design of rainwater system for a specific area requires a thorough analysis. Rainfall, existing water sources, availability of materials, housing and roof types and the people's means of livelihood are the criteria to be analyzed prior to the design of tanks. The design consideration often compromised by site conditions, or negated by the purposes for which people actually use rainwater. For example, one might make a precise technical calculation about the optimum size of tank only to find that different size is built in order to cut costs.

The development of an appropriate technology for rainwater collection cannot be achieved by the simple process of collecting information and using it to formulate an optimum design. It is necessary to think in terms of an 'innovative dialogue' in which information, opinion and innovation come from users of the system as well as designers.

The design and construction of storage tanks is technically the most interesting and difficult aspect of Rainwater Harvesting System (RWHS). Consequently different issues should be critically considered during designing a Rainwater Harvesting System. Moreover, the hazardous aspects such as contamination of water, mosquito breeding, and ease of O&M should be considered in designing other components of Rain Water Harvesting System.

2. Components of RWHS and its Functions

The major components of a RWHS are:

2.1 Catchments

For Rainwater Harvesting System (RWHS) normally clean rooftop is being used as catchments. Catchments are an important component of RWHS. It is used for holding rainwater. CGI sheet roof, tile roof, concrete roof etc. may be used as catchments. Other hand as low cost option clean cloths or plastic sheet may be used as catchments instead roof. It should be free from any toxic material such as lead pointing, over hanging tree etc.

2.2 Gutter

Gutter is the water conveyance system from catchments to storage reservoir. Gutter may be made with different type of materials such as GI sheet, PVC pipe, split bamboo etc. It is also an important component of RWHS. Gutter normally did not use for the catchments with clean cloth or polythene.

2.3 Flushing System

Flushing system is also an important component of RWHS. It is applied to discharge first foul rainwater outside the tank easily. To maintain the quality of harvested water easy flushing system is very essential. It may be made with PVC pipe, GI pipe or bamboo.

2.4 Storage Tank

The main component of RWHS is the storage tank. In the storage tank collected rainwater is stored for subsequent use. It is the most expensive component of the system. It may be made with concrete, Ferro-cement, brick, plastic sheet, fiberglass, earthen Motka etc.

2.5 Water Collection Point

It is also an essential component of RWHS. For ensuring the hygienic use of stored water and to reduce the accidental losses a small chamber is constructed with the tank as water collect point. It may be made with brick, concrete, burnt clay pot etc.

3. Design criteria of Rainwater Harvesting System

Rainwater Harvesting offers a good arsenic free alternative drinking water source. A set of criteria may be considered for the selection of appropriate design of Rainwater Harvesting System that can provide a suitable, safe, socially acceptable, affordable and sustainable alternative source of water for drinking and cooking. The main design criteria are as follows:

3.1 Rainfall Quantities and Pattern

Rainfall quantity and pattern are two important factors for designing RWHS, as this influence in the capacity of storage reservoir. The total amount of water available to the consumer is a product of the total available rainfall and the collection surface area. The climatic conditions vary widely throughout the country. The average annual rainfall amount and pattern shows, the amount of rainfall that could be harvested is mainly occurred from April to October in all over the Bangladesh.

3.2 Daily Consumption Rate

Consumption per family varies with the number of family members and also their water use pattern. For design purpose, average daily water requirement (for drinking & cooking) for a nuclear family may be taken 30 L per day (2 litres for drinking & 3 litres for cooking). The design calculation can also be made with different daily requirement per family.

3.3 Number of Consumer

The system may design for a nuclear family consisting of 5.4 members or the as per the actual number of the family member of the house.

3.4 Storage Capacity (Litre)

Major cost involvement in RWHS is the storage/reservoir. It depends on the number of family members and the daily consumption pattern.

3.5 Construction Material

Locally available materials such as brick, concrete ring, Ferro-cement, earthen Motka etc. may be used for construction of rainwater storage tank.

3.6 Catchments

Catchments are an important component of RWHS. Suitable catchments also reduce the cost of construction. CI rooftop, tiles roof and thatched roof covered with polyethylene may be selected as catchments. CI sheet made shade or plastic sheet or clean cloths may also be considered in case of the unavailability of suitable rooftop.

3.7 Guttering

Locally available material, durable, cost, ease of installation and available skilled mason etc. may be considered during selecting material as gutter. The following materials may be used for gutter: GI sheet (Motka), PVC pipe and Split bamboo.

3.8 Flushing System

The design of flushing system is very significant to divert the first foul rainwater entering into the storage reservoir. The main considerations are to use of local materials and ease of installation, easy operation, maintenance and durability etc.

3.9 Water Collection Point

The main considerations are maximum use of stored water, ease of collection, cost, and reducing risk of accidental losses, hygiene purposes and drainage of water.

3.10 Cost

The aim is to develop low cost and affordable reservoirs.

3.11 Stage Construction

Required sizes of tank may consider for nuclear family and combined family may also use those. Additional tanks may be built when money is available to ensure high-level service.

3.12 Operation and Maintenance

The sustainability of a technology depends upon proper O&M. So ease of operation & users friendliness should be taken into consideration during design.

3.13 Social Aspects

Social acceptability of the user can be considered i.e.

- Use and management of stored water
- Women involvement.
- Security (in wet and dry season), in comparison to other sources

3.14 Economic Aspects

In the economic aspects the following issues can be considered

- Investment cost, O & M cost.
- Minimum investment cost to start getting a rainwater collection benefit
- Tank size versus cost & affordability & rainfall pattern and quantity.

4. Designing different Components of RWHS

Rainwater Harvesting is used in many ways. Some parts of the world it is used merely to capture enough water during a storm to save a trip or to the main water source. In this case, only small storage capacity is required, may be just a few small pots to store enough water for a day or half a day. At other end of the spectrum we see, in arid areas of the world, systems which have sufficient collection surface area and storage capacity to provide enough water to meet the full needs of the user. Between these to extremes exists a wide variety of different users patterns or regimes. There are many variables that mentioned earlier to determine different components of Rainwater Harvesting systems. The design of major components of a

RWHS is briefly described below:

- Storage Tank
- Catchments
- Gutter
- Flushing System
- Water Collection Point

4.1 Design of Storage Tank

Usually, the main calculation for designing a Rainwater Harvesting System will be to define the size of the water tank correctly to give adequate storage capacity. The storage requirement may be determined by a number of interrelated factors. They include:

- Local rainfall data and weather pattern
- Roof (or other) collection area
- Runoff coefficient (this varies between 0.5 and 0.9 depending on roof material and slope)
- User numbers and consumption rate

There are a number of methods for calculating the size of the tank of a Rainwater Harvesting System. These methods vary in complexity and sophistication.

4.1.1 Demand Side Approach:

A very simple method is used to calculate the largest storage requirement based on the consumption rates and occupancy of the building. This simple method assumes sufficient rainfall and catchments area which is adequate, and is therefore only applicable in areas here this is the situation. It is a method for acquiring rough estimates of tank size. A simple calculation has been shown to quantify the size of the tank on the basis of set considerations such as consumption per capita per day, number of people per household and longest average dry period etc.

Assumption:

- Consumption per capita per day (C) = 5 litres
- Number of people per household (n) = 6
- Longest average dry period (T) = 5 months or 150 days

Annual consumption, $Q = C \times n \times 365$

$= 10{,}950$ litres

Storage requirement, $q = \frac{10{,}950 \times 150}{365} = 4{,}500$ litres

(It is a method for acquiring rough estimates of tank size)

4.1.2 Supply Side Approach:

In low rainfall areas or areas where the rainfall is of uneven distribution, more care has to be taken to size the storage properly. During some months of the year there may be an excess of water, while at other times there will be a deficit. If there is sufficient water throughout the year to meet the demand, then sufficient storage will be required to bridge the periods of scarcity. As storage is expensive, this should be done carefully to avoid unnecessary expense.

Assumption:

- Consumption per capita per day (C) = 5 litres
- Number of people per household (n) = 6
- Longest average dry period (T) = 5 months or 150 days

Demand of water per month for a nuclear family = 30 x 30 = 900 litres

Reconsideration:

- Roof area : 10 m^2
- Runoff coefficient (for corrugated GI roof) : 0.8
- Average monthly rainfall (April to October) : 125 mm/month

Monthly available water which can be collected from the mentioned roof = 10 x 125x 0.8
= 1000 litres

So, if we want to supply water all the year to meet the needs of a nuclear family, the demand cannot exceed 1000 litres per month. The available harvested water cannot meet the expected demand. Careful water management will, therefore, be required.

Following table shows the comparison of water harvested and the amount of water required for a nuclear family.

Month	Rainfall (mm)	Catchment Area (Sq. M)	Runoff Coefficient	Supply of Water (Litre)	Cumulative Supply (Litre)	Monthly Demand (Litre)	Cumulative Demand (Litre)	Surplus/Deficit (Litre)
Apr	86	10	0.8	344	344	900	900	-556
May	482	10	0.8	1928	2272	900	1800	472
Jun	597	10	0.8	2388	4660	900	2700	1960
Jul	566	10	0.8	2264	6924	900	3600	3324
Aug	539	10	0.8	2156	9080	900	4500	4580
Sep	255	10	0.8	1020	10100	900	5400	4700
Oct	177	10	0.8	708	10808	900	6300	4508
Nov	18	10	0.8	72	10880	900	7200	3680
Dec	28	10	0.8	112	10992	900	8100	2892
Jan	25	10	0.8	100	11092	900	9000	2092
Feb	39	10	0.8	156	11248	900	9900	1348
Mar	52	10	0.8	208	11456	900	10800	656

Above table shows the calculation for fixing the size of storage tank. While calculating the greatest excess of water over and above consumption, the accumulated inflow (supply of water) and out flow from the tank and the capacity of the tank are taken under consideration. This occurs in October with a storage requirement of 4508 litres. All this water will have to be stored to cover the shortfall during the dry period.

4.2 Design of Catchments

A sufficient catchments area can provide the maximum storage of rainwater. Catchments may be of different materials that are CI sheet, Tiles, concrete, Polyethylene sheet over thatched roof, polythene sheet, clean clothes etc. In the rural area a good number of roofs are made with CI sheet. So main design may be made considering this type of roof. Beside this other available roofs may also be considered, such as tiles, thatched, fibreglass, concrete etc. The roof runoff coefficient (f) varies significantly on the basis of roof material, slope of the roof etc. This parameter varies in the range of 0.75 - 0.85. For calculating the required area of catchments made with CI sheet, the value of 'f' assumes 0.80

Assumption:

- Consumption per capita per day per nuclear family	(C)	= 5 L/capita/day
- Number of member per household	(n)	= 6
- Run-off coefficient	(f)	= 0.80
- Average monthly rainfall	(R)	= 238 mm
- Catchments area	(A)	= ?

Demand of water per month for a family = 5 x 6 x 30
= 900 liters.

Total Demand = R x A x f

$$A = \frac{900}{0.80 \times 238}$$

$A = 4.74\ m^2$

Say, $A = 5.0\ m^2$

Rainwater Harvesting System is mainly provided with the roof of the dwellers as a common surface for collection of rainwater. In domestic Rainwater Harvesting System the size of reservoir is restricted to a certain volume. The Rooftop catchments systems that are used are also restricted by the size of the roof of the dwellers. Sometimes other surfaces are used to supplement the rooftop catchments area.

4.3 Guttering

Gutter is used to transport rainwater from the roof to the storage reservoir. Gutter comes in a wide variety of shapes and forms, ranging from the factory made PVC type to home made gutter using bamboo or folding metal sheet. Gutter is usually fixed to the house just below the edge of roof, so that water falling from the roof into channel. Factory made gutters are usually expensive and beyond the reach of the poor.

'V' shaped gutters from galvanised steel sheet can be simply made by cutting and folding flat galvanised steel sheet. Such sheet is readily available in most of the local market. Fitting a down pipe to V-shaped gutter is very easy. The gutter can easily be hung along the edge of the roof with hanger. The hanger can be made easily with MS rod of 6mm diameter or MS flat bar (199mmx3mm).

The roof area and slope determine the size of gutter. An appropriate gutter width is corresponding to the roof areas. The cross sectional area (width and depth) of a guttering system can be calculated using the following formula and assumptions:

Assumptions:

- Highest rainfall intensity (r) = 10 mm/min
- Slope of the roof (S_1) = 25^0 - 30^0
- Slope of the Gutter (S_2) = 400:1

Considering a strip of one meter width of the catchments and length is 2.50 meters

Therefore, area of the strip, $A = 1x2.50 = 2.50\ m^2$
$r = 10mm/min$

$Q = A \times r$
$= 2.50x10$
$= 25$ litre/min
$= 0.00042\ m^3/sec$

We know, $V = 10.8(R)^{2/3} S^{1/3}$

Here, R = Mean hydraulic radius of gutter, 3 inch
S = 1/400

$V = 10.8\ (3)^{2/3} (1/400)^{1/3}$
$= 0.26$ m/s

$$\text{Area required, } A_q = \frac{0.00042}{0.26}$$
$= 0.017\ ft^2$

Actual area provided, $A_c = 0.195\ ft^2 >> 0.017\ ft^2$

Note that the actual cross sectional area of the gutter should be twice than the calculated area and the depth of the gutter is one half of the gutter width.

4.4 First Flush Device

Debris, dirt and dust would be collected on the roof of a house or other collection roof. When the first rain arrives, this unwanted matter would be washed into the tank. This will cause contamination of the water and consequently the quality will be reduced. Therefore, it is necessary to incorporate a system for diverting this 'first flush' water so that it doesn't enter the tank. The first flush device should be designed considering the availability of local materials, ease of operation and maintenance & costs.

The diameter of the outlet drain is proportional to the roof area i.e. the volume of rainwater collected in the gutter and also proportional to the width of the gutter. The rainwater would overflow if the outlet drain were too small. The calculation for determining the size of the gutter is shown below:

Assumption:

Diameter of the down pipe, d = 1½ inch
Inflow, $Q = 0.00042\ m^3/sec$
Velocity of flow at inlet v = 0.26 m/s

Cross sectional Area of the down pipe, $A = 0.0045\ m^2$

Volume of Water could flow through the pipe = A x V
$= 0.0045 \times 0.26$
$= 0.0012\ m^3/sec >> 0.00042\ m^3/sec$

Appropriate Width of Gutter and Diameter of Down Pipe (Outlet Drain) and Various Roof Areas have shown in the following Table

Roof Area, sq. m	Gutter Width, mm	Down pipe (Outlet Drain), mm
5	50	38
10	60	38
15	70	38
20	80	38
25	90	50
30	100	50

35	110	50
40	115	50
45	120	50
50	120	65
60	130	65
70	140	65
80	150	75
90	160	75
100	170	75

4.5 Water Collection Point

Different types of water collection device may be constructed. These are brick made small chamber with lid, burnt clay pot with cover etc. The tap has been designed considering the optimum use of water, ease of collection, hygienic purpose, cost and reducing risks of accidental water loss etc.

5. Construction of RWHS

The construction process of RWHS has been described below:

5.1 Construction of above ground RWHS (Household)

During literature survey different proven model of household RWHS has been identified which are being practised by different organization in Bangladesh and also in the abroad countries. Construction material of these types of RWHSs is locally available and trained up local mason & private producer can easily construct the system. The selected model will be constructed under the ASEH project through partners. The models are as follows:

- Cement/Mortar Jar
- Ferro - Cement Tank
- R.C.C Ring Tank

5.1.1 Cement/ Mortar Jar (Household RWHS)

It is one of the proven models of Rainwater Harvesting System in Bangladesh and also used in abroad (Thailand, Sri Lanka, Tanzania etc.). The Cement/ Mortar Jar may be of different size/capacities such as 1000 litres, 2000 litres, 2500 litres and 3000 litres. It also one of the cheapest model of RWHS. The construction requirements of different capacity of RWHS is described below:

Storage capacity (Litres)	Size of the reservoirs	Minimum Catchment area (Sq. m)	Type of Catchment	Nos. of family members (No.)	Number of reservoir per system	Average total Construction Cost (Tk.)
1000	Height: 1.10m Bottom dia: 1.15m Maximum dia: 1.27m Top dia: 0.56m 35-38mm wall thick	4.0 – 5.0	CI sheet, Concrete, Tiles, Polythene	3 – 4	1	2050
2000	Height: 1.38 m Bottom dia: 1.20 m Maximum dia: 1.38 m Top dia: 0.65 m 38-40 mm wall thick	4.50 – 5.50	CI sheet, Concrete, Tiles, Polythene	4 – 5	1	3700
2500	Height: 1.53 m Bottom dia: 1.30 m Maximum dia: 1.65 m Top dia: 0.70 m	5.50 – 6.50	CI sheet, Concrete, Tiles, Polythene	6 – 7	1	4500

Storage capacity (Litres)	Size of the reservoirs	Minimum Catchment area (Sq. m)	Type of Catchment	Nos. of family members (No.)	Number of reservoir per system	Average total Construction Cost (Tk.)
	38-40 mm wall thick					
3000	Height: 1.8 m Bottom dia: 1.35 m Maximum dia: 1.75m Top dia: 0.84m 40 – 45 mm wall thick	7.0 – 8.50	CI sheet, Concrete, Tiles, Polythene	7 – 8	1	5,500

Note: Cost need to be updated

Detail Cost Analysis of 2000 litre Capacity Tank

A. Construction material:

Item No.	Description of the material	Quantity	Rate (Tk.)	Amount (Tk.)
1.	**Cement:** Normal Portland cement, 50 kg per bag, initial setting time 40-50 minutes and final setting time 8-12 hours	3.5bag	250/bag	875.00
2.	**Sand:** Good quality local coarse sand. Free from, clay, silt, organic matter and shells	20 cft	6.5/cft	130.00
3.	**Brick:** First class Brick free from any defects. Cracking strength 5000-8000 psi.	30nos.	2.25no.	68.00
4.	**Khoa:** Broken Brick of 1 st class or picked, size from ¾ inch to ¼ inch of angular shape	1cft	27/cft	27.00
5.	**Water level Indicator:** ½ inch dia transparent PVC pipe, good quality.	4ft	9/ft	36.00
6.	**18 no. GI wire:** 18 no. GI wire, good quality	1 kg	50/kg	50.00
7.	**Polythene:** Polythene with good quality.	3 gauge	6.5/ gauge	20.00
8.	**Wire Mesh (Net):** Made of 18 gauge MS wire of high temper, ½ inh spacing in both direction, 0.91 m high.	20 rft	10/rft	200.00
9.	**Gutter:** Made of Good quality plane sheet of 1/2mm thick, length 6ft.	2 nos	40/no.	80.00
10.	**Inlet gutter:** Made of good quality plane sheet. 2ft length, 6inch wide and 4inch height. A nipple of 1.5-inch dia is joined below the hole, which is made 4 inch apart from one end of the inlet gutter, 2-inch height.	1 no.	90/no.	90.00
11.	**Delivery pipe:** ½ inch dia good quality GI pipe of 1 ft 10 inch long with ½ inch GI socket one end and ½ inch GI elbow another end of the pipe. Wall thickness 2.5-3.00 mm. Both end of the pipe will be threaded and 6-inch long clamp (6mm dia Ms rod) must be welded at 6-inch distance from that end of the pipe, which is entered into the tank Base. 2 inch long another GI pipe threaded one end and connected with ½ inch GI elbow whose unthreaded end raised 1 inch from bottom of the Tank Base.	1no.	L.S.	80.00
12.	**Tap:** 1/2inch x 1/2inch good quality Ball valve made of brass connected with delivery pipe through a ½ inch	1no.	45/no.	45.00

Item No.	Description of the material	Quantity	Rate (Tk.)	Amount (Tk.)
	GI socket.			
13.	**Drainage pipe:** ¾ inch dia good quality GI pipes 1 ft long with ¾ inch GI Tee and end cap with uniform thickness. One end of the pipe will be threaded and 6-inch long clamp (6mm dia Ms rod) must be welded at 5-inch distance from the unthreaded end of the pipe.	1 no.	L.S.	80.00
14.	**PVC pipe:** 1.5 inch dia PVC pipe, wall thickness 2.5 –3.0 mm.	10 ft	8.50	85.00
15.	**PVC elbow:** 1.5 inch dia PVC elbow, wall thickness 3.0-3.5 mm.	3no.s	14	42.00
16.	**PVC Tee:** 1.5 inch dia good quality PVC Tee, wall thickness 3.0-3.5 mm.	1 no.	15	15.00
17.	**Over flow pipe:** ¾ inch dia good quality GI pipe of 8 inch long with ¾ inch GI Tee and ½" dia GI nipple and 1-inch dia PVC elbow, with uniform thickness. One end of the pipe will be threaded.	1 no.	L.S.	70.00
18.	**GI elbow and cap:** 1.5 inch dia good qualities GI elbow and cap in flushing system for water control.	1 no.	L.S.	50.00
19.	**Hanger for gutter:** Made of 6mm dia MS rod for gutter and used along the corner of the catchment. Average length of each 3 ft.	5 nos	L.S.	50.00
20.	**Mosquito Net:** Made of nylon with 2.5' long and 8" wide, good quality.	As required	L.S.	20.00
21.	**Solvent cement:** Good quality solvent cement (50 gm)	½ no.	35/no.	18.00
22.	**Cover:** GI sheet made cover of 2' dia	1 no.	75/no.	75.00
23.	**Others:** 26gauge GI wire, Newspaper, thread tape, etc.	As required	L.S.	94.00
Total				**2300.00**

Note: Cost need to be updated

B. Labour and Mould charges:

Item	Day	Charge/day	Total Amount (Tk.)
Mason	7 days	120	840.00
Helper	7 days	80	560.00
Total			**1400.00**
Grand Total: (A+B)			**3700.00**

Note: Cost need to be updated

Construction Process (Cement Jar – 2000 litre Capacity)

The step-by-step construction process of the RWH System (Cement Jar) has been described in the following section:

Step –1: Preparing and Construction of Base

- Select a suitable site at one side of the house for jar construction. The site should be relatively high and hard. Draw a circle of 5'- 1" dia and compact soil. Build Brick wall at 5-inch wide and 9-inch high.

- After one day when the brick wall will become hard, fill home-sand (local sand) inner side the wall in such a way that 3 inch remain empty from the top surface of the Brick wall. Ram each layers of sand carefully and damp with water.

- Bind 3mm (No. 10) dia MS wire @ 5" c/c in both direction. Mix cement concrete (Cement: Sand: Khoa = 1:2:4) and pour out mixed cement concrete on polyethylene sheet at 3 inch thick. Install drainage pipe and delivery pipe.

Step – 2: Setting of Jar Mould

- After setting the concrete, draw a circle on the base with respect to it's centre of dia 4 ft 4 inch. Assemble mould segments on line of the circle and bind each segment joint with jute rope at least at 5 locations. Keep vertical gap of 1inch wide in one joint of the segment from top to bottom. Packing the gap with newspaper and tight with rope at least at 5 locations.

Step – 3: Plastering on Upper Surface of Mould

- Mix mud with water like paste (stone and other dust free). Lay clay paste lightly on outer surface of Jute cloth (chot) of mould. Clean the mud from the base and pour out water cement. Set jar mould (inner) of the opening at the upper part of jar segment.

- Mix cements sand (1:3), when the mud paste dry gently then give a layer of cement sand mixture of ½ inch thick. Keep one to two hours for setting cement sand mixture. Cut and wrap No. 18 GI wire on cement sand mixture. Place another layer of cement-sand mixture on wire of ½ inch thick. Place another layer of cement sand mixture on this layer at … inch thick and give finishing very well.

- Place outer dice of the collar of jar cover in such a way so that equal gap remained in all sides. Place cement sand mixture into the gap. After one hour first remove inner mould then outer mould and give finishing.

- Cut the plaster in to places for placing inlet pipe and over flow pipe.

Step – 4: Construction of Cover

- Level the surface of the soil around 2'- 6" dia besides the suitable place of jar. Place the outer dice of jar cover on the level ground.

- Make a frame of 3mm dia MS wire and bind @ 4" c/c in both direction according to measurement of dice.

- Place a layer of cement sand mixture (1:3) with ½ inch thickness, then place the wire and wire mesh frame on it. Cover the wire & wire mesh frame with a layer of cement sand mixture of ½ inch thick and give finishing.

Step – 5: Mould Separation from Inner Side of Jar

- Enter into the jar at least after two days of plastering cement sand mixture. Cut tie of mould joint of paper packing at first and remove the paper packing. Then cut all bindings of all joints and bring out all parts of mould one another.

Step –6: Setting of Inlet and Overflow Pipe

- Place inlet and overflow pipe (1½" PVC pipe) with the Jar. Clean mud from inner wall of jar and wash with water.

Step – 7: Plastering Inner Side of the Tank

- Spray grouting of cement water on the surface of the inside wall. Mix Cement-sand (1:3). Give a layer of plaster of ½" thick with net cement finishing on the wall and floor of the tank. And a gentle slope should be provided toward the drainage pipe, hence whole water could be drained out during the washing of the tank.

Step – 8: Cover Placing of the Tank

- Place the pre-cast cover on Tank, which was constructed. Place cover after proper curing.

Step – 9: Plastering of Jar Base

- Mix cement sand (1:4). Plaster the base of the jar at ½ inch thick.

Step – 10: Construction of Water Collection Point

- Draw a circle on the earth surface at the location of the tap of dia 2'- 0" taking the tap position as centre. Excavate the soil of marked circle to a depth of around 10".
- Place three layers of 3" thick brick wall as per lay out. Plaster inside and outside of the wall.
- Place 1" thick brick chips at the bottom of the chamber. Size of the Brick chips is ¼" - ¾".
- Place a cover of GI sheet over the collection point.

5.1.2 Ferro – Cement Tank (Household RWHS)

It is also one of the proven model of Rain water Harvesting System which is used in Bangladesh and also abroad. The Ferro – Cement Tank may be different capacities such as 2500 litres, 3200 litres, 3800 litres and 4600 litres. It comparatively cheap model of RWHS. The construction requirements of different capacity of this model RWHS is described below:

Storage capacity (Litres)	Size of the reservoirs	Minimum Catchment area (Sq. m)	Type of Catchment	Nos. of family members (No.)	Number of reservoir per system	Average total Construction Cost (Tk.)
2500	Height: 1.27 m Dia: 1.60 m 32 - 38 mm wall thick	5.50 – 6.50	CI sheet, Concrete, Tiles	6 - 7	1	4800
3200	Height: 1.60 m Dia: 1.60 m	8.00 – 9.50	CI sheet, Concrete,	9 - 10	1	6500

Storage capacity (Litres)	Size of the reservoirs	Minimum Catchment area (Sq. m)	Type of Catchment	Nos. of family members (No.)	Number of reservoir per system	Average total Construction Cost (Tk.)
	38 – 40 mm wall thick		Tiles			
3800	Height: 1.60 m Dia: 1.76 m 32 – 38 mm wall thick	9.50 – 11.50	CI sheet, Concrete, Tiles	11 - 12	1	7800
4600	Height: 1.60 m Dia: 1.92 m 40 – 45 mm wall thick	11.50 – 13.50	CI sheet, Concrete, Tiles	13 - 14	1	9300

Note: Cost need to be updated

Detail Cost Analysis of 3200 litre Capacity Ferro – Cement Tank

A. Construction materials:

Item no.	Description of the material	Quantity	Rate (Tk.)	Amount (Tk.)
1.	**Cement:** Normal Portland cement, 50 kg per bag, initial setting time 40-50 minutes and final setting time 8-12 hours	6.5 bag	250/bag	1625.00
2.	**Sand:** Good quality local coarse sand. Free from, clay, silt, organic matter and shells	40 cft	6.50/cft	260.00
3.	**Brick:** First class Brick free from any defects. Cracking strength 5000-8000 psi.	130 nos	2.25 no.	292.00
4.	**Khoa:** Broken Brick of 1st class or picked, size from ¾ inch to ¼ inch of angular shape.	7cft	27/cft	189.00
5.	**MS Wire:** No. 10 (3mm dia), good quality.	3 kg	32/kg	96.00
6.	**18 no. GI wire:** Good quality	2.5 kg	50/kg	125.00
7.	**Polythene:** Good quality.	6 yard	6.5/ yd	39.00
8.	**Wire Mesh (Net):** Made of 18 gauge MS wire of high temper, ½ inch spacing in both directions, 0.91 m high.	35 rft.	10/ rft.	350.00
9.	**Gutter:** Made of Good quality plane sheet of 1/2mm thick, length 6ft.	3 nos	40/no.	120.00
10.	**Inlet gutter:** Made of good quality plane sheet. 2ft length, 6inch wide and 4inch height. A nipple of 1.5-inch dia is joined below the hole, which is made 4 inch apart from one end of the inlet gutter, 2-inch height.	1 no.	90/no.	90.00
11.	**Delivery pipe:** ½ inch dia good quality GI pipe of 1 ft 10 inch long with ½ inch GI socket one end and ½ inch GI elbow another end of the pipe. Wall thickness 2.5-3.00 mm. Both end of the pipe will be threaded and 6-inch long clamp (6mm dia Ms rod) must be welded at 6-inch distance from that end of the pipe, which is entered into the tank Base. 2 inch long another piece of GI pipe threaded one end and connected with ½ inch GI elbow whose unthreaded end raised 1 inch from bottom of the Tank Base.	1 no.	L.S.	80.00

Item no.	Description of the material	Quantity	Rate (Tk.)	Amount (Tk.)
12.	**Tap:** 1/2inch x 1/2inch good quality Ball valve made of brass connected with delivery pipe through a ½ inch GI socket.	1 no.	45/no.	45.00
13.	**Drainage pipe:** ¾ inch dia good quality GI pipe of 1 ft long with ¾ inch GI socket and end cap with uniform thickness. One end of the pipe will be threaded and 6-inch long clamp (6mm dia Ms rod) must be welded at 5-inch distance from the unthreaded end of the pipe.	1 no.	L.S.	80.00
14.	**PVC pipe:** 1.5 inch dia PVC pipe, wall thickness 2.5 –3.0 mm.	15 ft	8.50/ft	127.00
15.	**PVC elbow:** 1.5 inch dia PVC elbow with wall thickness 3.0-3.5 mm.	4 nos.	14/ No.	56.00
16.	**PVC Tee:** 1.5 inch dia good quality PVC Tee, wall thickness 3.0-3.5 mm.	1 no.	15/ No.	15.00
17.	**Solvent cement:** Good quality (50 gm).	½ no.	35/ no	18.00
18.	**Water level Indicator:** ½ inch dia transparent PVC pipe, good quality.	4ft	9/ft	36.00
19.	**Over flow pipe:** ¾ inch dia good quality GI pipe of 8" long with ¾ inch dia GI Tee and ½"dia GI nipple and 1-inch dia PVC elbow with uniform thickness. One end of the pipe will be threaded.	1 no.	L.S.	70.00
20.	**GI elbow and cap:** 1.5 inch dia good quality GI elbow and cap in flushing system for water control.	1 no.	L.S.	50.00
21.	**Hanger for gutter:** Made of 6mm dia MS rod for gutter and used along the corner of the catchment. Average length of each 3 ft.	7 no.s	L.S.	38.00
22.	**Mosquito Net:** Made of nylon with 2.5ft long and 8" wide, good quality.	As required	L.S.	20.00
23.	**Others:** 26gauge GI wire, Newspaper, thread tape etc.	As required	L.S.	79.00
Total				**3900.00**

Note: Cost need to be updated

B. Labour and mould charges:

Item	Day	Charge/day	Total (Tk.)
Mason	8 days	120	960.00
Helper	8 days	80	640.00
Total			**1600.00**
Grand Total (A+B)			**5500.00**

Note: Cost need to be updated

Construction Process of Ferro – Cement Tank

Step – 1: Construction of Cement Segment

- Pile damp sand at approximately 2-ft width and 4 inch height then smooth the pile of damp sand with pre-cast frame of cement segment and prepare bed into curve shape like the dice.
- Mix cement with sand (cement: sand = 1:3). Prepare paste and add suitable amount of water with

mixed cement sand. Cover newspaper sheet on pile of damp sand then lay pre-cast frame (closely) on the newspaper sheet. Then splash water thoroughly on the laid frame and pour mixed cement sand (1:3) within the dice

- Smooth the surface mixed cement sand with wooden Trowel, remove pre-cast frame carefully so as not to crack segments. The removed pre-cast frames are used for other segments after cleaning with water. Leave them for 3-5 minutes. Then make 8 holes at specified points with 10 no. MS wire.

- Remove cements segments carefully from the bed after 12 hours and remove attached newspaper sheet from the segment body. Leave 10 – 12 segments in touch with the hard post and wall at least 12 hours covered with jute sacks, always sprinkle water. In this way, make 80 cement segments.

Step – 2: Preparing and Construction of Base

- Layout the plant at specified place and ram soil in the layout and compact. For base preparation, place one layer 5 inch Brick so as to keep the circle of dia 3 ft 2 inch in middle. During the placing of Brick, it should be kept in mind that the Bricks are in the same plane. If necessary, cut soil and place the bricks by levelling.

- Assemble 12 sheets of segments in line of the circle and hold two sheets together tight with wire no. 18. Such-like bind segments in 6 pairs. Place 6 pair segments or 12 segments on the Brick plastering along the circumference of the circle and tight each pair with another with No. 18 wire. Tight at least three places with No. 18 wire at the outer side of the joined cement segment.

- Filling inner side of the segment with home-sand and hit each layers carefully during sand filling and damp with water. In such a way that 5.5 inch site empty from the top surface of the cement segment.

- Brick flat soling on the top surface of the sand filling. Binding 3mm (No. 10) dia MS wire @ 5" c/c in both direction. Mix cement concrete (cement: sand: khoa = 1:2:4) and pour out mixed cement concrete on brick flat soling at 3 inch thick.

- Draw a circle with respect to the centre of Base of dia 5 ft 4 inch. Hold two segments together tight with GI wire of No. 18 and place along the line of circle. Bind each the other segment with tightly with No. 18 wire.

- Mix cements sand (1:2) and seal both side of the segment carefully. Later on stall drainage pipe and delivery pipe accordingly.

Step – 3: Construction of Outer Cover

- Penetrate a 9 mm dia MS rod into the soil of roughly plane and hard soil surface as if 375 mm remains the top of the soil. Mark at the height of 225 mm of the rod above the soil surface.

- Draw a circle of radius 813 mm with respect to the centre. Place lower dice of the outer cover along the line of circle. Pile sand inside the dice up to the mark of the rod.

- Place inner dice of the outer cover with respect to the rod and plane sand from the bottom of dice to the rod mark.

- Remove sand from the inside of outer dice about 1.5 inch width along the circumference and maintain sand sloping up to the bottom of inner dice according to figure.

- Compact sand carefully. Cut & bind 3mm dia MS wire and make frame. Cut wire mesh and bind on frame. During binding MS wire and wire mesh it should be kept in mind that MS wire and Net fall equally on the prepared sloping pile sand.

- Mount wires mesh and MS wire and again level sand. Lay newspaper sheets on sand and again check the placement of two dices with respect to the centre.

- Mix cement sand (1:3) and laid one layer of ½ inch thick on newspaper. Place the frame of MS wire and wire mesh on laid cement sand layer. Place MS wire and wire mesh on one layer of ½ inch thick

mixed cement sand. And 1 set another layer of cement sand mixture.

- Place the middle dice to make collar of manhole in such a way that equal distance remained within the inner dice. Pour cement sand mixture between the two dices. After ½ an hour leave inner dice at first, then the middle dice. Finish the top surface with net cement finishing.

- After 2 days mount the cover and remove paper from the bottom of cover. Curing should be done regularly after 12 hours of casting.

Step – 4: Construction of Tank Top Cover

- Fill the rest part of the central rod like a cone. The cone must start from the outer rim of the collar of lower cover. Cut and bind 3mm dia MS wire and make a cone. A layer of wire mesh should be cut and bind with GI wire on the cone. It should be kept in mind that the cone should fall equally on the prepared conical pile sand.

- Mount the Frame and level the piled sand. Cover the sand with wet papers. Before laying newspaper, cut and bind bark of banana tree or ½ inch thick newspaper sheet. Place the outer dice of upper cover in such a way that equal distance maintained in all sides from the collar of lower cover manhole. Lay cement sand (1:3) mixture on newspaper at ½ inch thick.

- Place MS wire and wires mesh conical frame on cement sand layer and place another layer of cement sand at ½ inch thick. Force cement sand mixture into the frame with Trowel very carefully. Put another layer of cement sand mixture at ½ inch thick and then complete finishing and net cement finishing.

- After 2 days mount lower and upper cover, remove newspaper and clean thoroughly. After 12 hours of moulding, arrange curing with fine.

Step – 5: Joining of Cement Segments

- Further assemble 5 layers of cement segment on one layer of installed cement segments during preparing base. During assembling each layer, it should be kept in mind that segments should be vertical on one another and dia should not be more / less than 5 ft 2 inch.

- Bind the segments with No. 18 MS wire. After binding the segments with GI wire, seal the joints of segments with cement sand mixture (1:2).

Step –6: Warping Wire Mesh

- Cut two pieces of wire mesh according to the outer circumference of the Tank. Warp the wire mesh round outer surface of the Tank and tie with No. 18 wire around the Tank.

Step – 7: Plastering Outer Side of Tank

- If there is any dust/mud on the surface of the tank or net, it should be cleaned enough. Cover wire mesh with a layer of cement sand mixture (1:3) and force in cement sand mixture into the net through shaking with trowel.

- Place Inlet and Overflow pipe with tank accordingly.

- Again, use ½" thick plaster and do finishing.

Step – 8: Plastering Inner side of the tank

- Mix Cement-sand (1:3). Plaster inner surface of the tank and floor with ½ inch thick mortar and smoothen, it accordingly.

- The plaster at the bottom should be slopped towards the drainage pipe, hence whole inside water could be drained out during the washing of the tank. Put net cement finishing inner side of the tank.

Step – 9: Cover Placing of the Tank

- Place the pre-cast outer cover on Tank, which was constructed earlier and seal the joint between cover and tank from both sides

Step-10: Construction of Water Collection Point

- Construct water collection point with 75 mm thick brick wall. The inner dia of the collection point should be at least 1'-6", so that users easily collect water. 2" thick brick chips must be placed at the bottom of the point and cover with GI/ Ferro cement lid.

5.1.3 R.C.C Ring Tank (Household RWHS)

It is also one of the proven model of Rain Water Harvesting System in Bangladesh and has developed by NGO Forum through it's R&D activities. The R.C.C Ring Tank may be different capacities such as 1000 litres, 2000 litres and 2500 litres. The RCC Ring is locally available, it is used for different purposes and could be used for the construction of RWHS tank. It is comparatively cheaper model of RWHS. The construction requirements of different capacity of this model RWHS is described below:

Storage capacity (Litres)	Size of the reservoirs	Minimum Catchment area (Sq. m)	Type of Catchment	Nos. of family members	Number of reservoir per system	Average total Construction Cost (Tk.)
1000	Height: 1.52 m Dia: 0.92 m 60 – 62 mm wall thick	4.0 – 5.0	CI sheet, Concrete, Tiles, Polythene	3-4	1	2700
2000	Height: 1.75 m Dia: 1.22 m 60 – 62 mm wall thick	4.50 – 5.50	CI sheet, Concrete, Tiles, Polythene	4 - 5	1	4000
2500	Height: 1.75 m Dia: 1.37 m 60 – 62 mm wall thick	5.50 – 6.50	CI sheet, Concrete, Tiles, Polythene	6-7	1	4800

Note: Cost need to be updated

Detail Cost Analysis of 2500 litre Capacity Tank

A. Construction materials:

Item no.	Description of the material	Quantity	Rate (Tk.)	Amount (Tk.)
1.	**Cement:** Normal Portland cement, 50 kg per bag, initial setting time 40-50 minutes and final setting time 8-12 hours	5 bags	250/bag	1250.00
2.	**Sand:** Good quality local coarse sand. Free from clay, silt, organic matter and shells	25 cft	6.5/cft	162.50
3.	**Brick:** First class Brick free from any defects. Cracking strength 5000-8000 psi.	75 nos.	2.25/no.	168.75
4.	**Khoa:** Broken Brick of 1st class or picked, size from ¾ inch to ¼ inch of angular shape	3 cft	27/cft	81.00
5.	**Indicator:** ½ inch dia transparent PVC pipe, good quality.	5 ft.	8.5/ft	43.00
6	**R.C.C. Ring:**	6 nos.	180/no.	1080.00

Item no.	Description of the material	Quantity	Rate (Tk.)	Amount (Tk.)
	3 ft inner dia, 1 ft height, 1.5 inch thick good quality R.C.C. Ring.			
7.	**MS Wire:** No. 10 (3mm dia) MS wire, good quality.	2 kg	32/kg	64.00
8.	**18 no. GI wire:** 18 no. GI wire, good quality	1 kg	50/kg	50.00
9.	**Polythene:** Polythene with good quality.	6 yard	6.5/ yard	39.00
10.	**Gutter:** Made of Good quality plane sheet of ½ mm thick, length 6ft.	3 nos.	40/no.	120.00
11.	**Inlet gutter:** Made of good quality plane sheet. 2ft length, 6inch wide and 4inch height. A nipple of 1.5-inch dia is joined below the hole, which is made 4 inch apart from one end of the inlet gutter, 2-inch height.	1 no.	90/no.	90.00
12.	**Delivery pipe:** ½ inch dia good quality GI pipe of 1 ft 10 inch long with ½ inch GI socket one end and ½ inch GI elbow another end of the pipe. Wall thickness 2.5-3.00 mm. Both end of the pipe will be threaded and 6-inch long clamp (6mm dia Ms rod) must be welded at 6-inch distance from that end of the pipe, which is entered into the tank Base. 2 inch long another piece of GI pipe threaded one end and connected with ½ inch GI elbow whose unthreaded end raised 1 inch from bottom of the Tank Base.	1no.	L.S.	80.00
13.	**Tap:** 1/2inch x 1/2inch good quality Ball valve made of brass connected with delivery pipe through a ½ inch GI socket.	1no.	45/no.	45.00
14.	**Drainage pipe:** ¾ inch dia good quality GI pipe of 1 ft long with ¾ inch dia GI Tee, ½ inch dia nipple and end cap with uniform thickness. One end of the pipe will be threaded and 6-inch long clamp (6mm dia Ms rod) must be welded at 5-inch distance from the unthreaded end of the pipe.	1 no.	L.S.	80.00
15.	**PVC pipe:** 1.5 inch dia PVC pipe, wall thickness 2.5 –3.0 mm.	15 ft	8.50/ft	127.00
16.	**PVC elbow:** 1.5 inch dia PVC elbow, wall thickness 3.0-3.5 mm.	3no.s	14/no.	42.00
17.	**PVC Tee:** 1.5 inch dia good quality PVC Tee, wall thickness 3.0-3.5 mm.	1 no.	15/no.	15.00
18.	**Over flow pipe:** ¾ inch dia good quality GI pipe of 8 inch long with ¾ inch dia GI Tee, ½ inch dia GI nipple and 1-inch dia PVC elbow with uniform thickness. One end of the pipe will be threaded.	1 no.	L.S.	70.00
19.	**GI elbow and cap:** 1.5 inch dia good qualities GI elbow and cap in flushing system for water control.	1 no.	L.S.	50.00
20.	**Hanger for gutter:** Made of 6mm dia MS rod for gutter and used along the corner of the catchment. Average length of each 3 ft.	5 nos	L.S.	50.00
21.	**Mosquito Net:** Made of nylon with 2.5-ft long and 8 inch wide, good quality.	As required	L.S.	20.00
22.	**Solvent cement:**	½ no.	35/no.	18.00

Item no.	Description of the material	Quantity	Rate (Tk.)	Amount (Tk.)
	Good quality solvent cement (50 gm)			
23.	**Others:** 26gauge GI wire, Newspaper, thread tape etc.	As required	L.S.	54.75
Total				**3800.00**

Note: Cost need to be updated

B. Labour charges:

Labour	Day	Charge/day	Total (Tk.)
Mason	5days	120	600.00
Helper	5days	80	400.00
Total			**1000.00**
Grand Total (A+B)			**4800.00**

Note: Cost need to be updated

Construction Process of R.C.C Ring

Step –1: Preparing and construction of base

- Select a suitable place for the construction of R.C.C. Ring tank at one side of the house. The place should be relatively high and hard. Draw a circle with the dia of the tank base at the selected place and compact soil.
- Construct brick wall of 5" wide and 9" height. When the brick wall will become hard, fill home-sand (local) inner side of the wall in such a way that 5.5" remains empty from the top surface of the Brick wall. Ram layers to layer carefully during sand filling and damp with water.
- Level the upper surfaces of sand filling and lay flat brick soling. Mix cement concrete (Cement: Sand: Khoa = 1:2:4) and cast mixed cement concrete on Brick flat soling at 3 inch thick. Compact the concrete before setting with hammering by wooden patent.
- Install drainage and delivery pipe accordingly.

Step – 2: Construction of main body of tank

- Draw a circle with respect to the centre of base measuring the dia of the tank after setting concrete. Place cement mortar (1:2) along the line and place pre-cast or locally purchased R.C.C. Ring. Set 5 to 6 nos of khoa ½ " size on first Ring before placing second Ring on it according to figure.
- Seal the joints with cement sand mortar (1:2). In this way place the required number of Rings.

Step – 3: Plastering the surface of tank

- Mix cement sand (1:4) and plaster the outer surface of the tank at ½ inch thick. Then Plaster the inner side (including the bottom) of the tank at ½ inch thick. Finish the surface of the plaster and net cement finishing.

Step – 4: Construction of outer cover

- Penetrate a 9 mm dia MS rod into the soil of roughly plane and hard soil surface as if 375 mm remains the top of the soil. Mark at the height of 225 mm of the rod above the soil surface. Draw a circle of as per the measured dia with respect to the centre. Place lower dice of the outer cover along the line of circle. Pile sand inside the dice up to the mark of the rod.

- Place inner dice of the outer cover with respect to the rod and plane sand from the bottom of dice to the rod mark.

- Remove sand from the inside of outer dice about 1.5 inch width along the circumference and maintain sand sloping up to the bottom of inner dice according to figure.

- Compact sand carefully. Cutting & binding 3mm dia MS wire and make frame. Cut wire mesh and bind on frame. During binding MS wire and wire mesh it should be kept in mind that MS wire and Net fall equally on the prepared sloping pile sand.

- Mount wires mesh and MS wire and again level sand. Lay newspaper sheets on sand and again check the placement of two dices with respect to the centre.

- Mix cements sand (1:3) and laid one layer of ½ inch thick on newspaper. Place the frame of MS wire and wire mesh on laid cement sand layer. Place MS wire and wire mesh on one layer of ½ inch thick mixed cement sand. And lay another layer of cement sand mixture.

- Place the middle dice to make collar of manhole in such a way so that equal distance remain within the inner dice. Pour cement sand mixture between the two dices. After ½ an hour leave inner dice at first, then the middle dice. Finishing the top surface with net cement finishing.

- After 2 days mount the cover and remove paper from the bottom of cover. Curing should be done regularly after 12 hours of casting.

Step – 5: Construction of top cover tank cover

- Fill the rest part of the central rod with sand of like a cone. The cone must start from the outer rim of the collar of lower cover. Cut and bind 3mm dia MS wire and make a cone. A layer of wire mesh should be cut and bind with GI wire on the cone. It should be kept in mind that the cone should fall equally on the prepared conical pile sand.

- Mount the Frame and level the piled sand. Cover the sand with wet papers. Before laying newspaper, cut and bind bark of banana tree or ½ inch thick newspaper sheet. Place the outer dice of upper cover in such a way that equal distance maintained in all sides from the collar of lower cover manhole. Lay cement sand (1:3) mixture on newspaper at ½ inch thick.

- Place MS wire and wires mesh conical frame on cement sand layer and place another layer of cement sand at ½ inch thick. Force in mixed cement sand into the frame with Trowel very carefully. Put another layer of cement sand mixture at ½ inches thick and then use finishing and net cement finishing.

- After 2 days mount lower and upper cover, remove newspaper and clean thoroughly. After 12 hours of moulding, arrange curing with fine.

Step –6: Setting of inlet and overflow pipe

- Place inlet and overflow pipe with 1½" dia at same level and one inch below the top of the main tank.

Step – 7: Cover placing of the tank

- Place the pre-cast cover on Tank, which was constructed elsewhere and seal the joint between cover and tank with cement mixture (1:2) well from both side.

- Place the cover after a day of plastering of both side of the tank.

Step – 9: Plastering of tank Base

- Clean gently of Brick wall of tank Base. Mix cement sand (1:4). Place a layer of cement sand mixture (1:4) with ½ inch thick and give net cement finishing.

Step – 10: Placing water collection point

- Construct water collection point with 75 mm thick brick wall. The inner dia of the collection point should be at least 1'-6", so that users easily collect water. 2" thick brick chips must be placed at the bottom of the point and cover with GI/ Ferro cement lid.

5.2 Construction of Underground RWHS (Community Based)

The concept of the construction of large capacity community based Rain Water Harvesting System had developed and practised from the ancient. The world largest community based RWH System constructed in Istambul. This type of RWHS is suitable where a grouped of family live in a compacted area and faced the scarcity of safe drinking water. This types of RWHS may be constructed that circumstances. The Community based underground RWHS may be different capacities such as 10000 litres, 15000 litres, 20000 litres, 25000 litres, 30000 litres, 35000 litres, 40000 litres and 50000 litres. It also one of the cheapest model of RWHS. The construction requirements of different capacity of community RWHS is described below:

Storage capacity (Litres)	Size of the reservoirs	Minimum Catchment area (Sq. m)	Type of Catchment	Nos. of family members (No.)	Number of reservoir per system	Average total Construction Cost (Tk.)
10000	Height: 1.83 m Dia: 2.67 m 150 mm wall thick	25 - 28	CI sheet, Concrete, Tiles	30 -35	1	20,000
15000	Height: 2.13 m Dia: 3.05 m 150 mm wall thick	35 - 38	CI sheet, Concrete, Tiles	35 - 40	1	25,000
20000	Height: 2.13 m Dia: 3.50 m 150 mm wall thick	46 - 48	CI sheet, Concrete, Tiles	45 - 50	1	31,200
25000	Height: 2.44 m Dia: 3.66 m 150 mm wall thick	55 - 57	CI sheet, Concrete, Tiles	55 - 60	1	41,400
30000	Height: 2.44 m Dia: 3.81 m 150 mm wall thick	64 - 66	CI sheet, Concrete, Tiles	65 - 70	1	49,500
35000	Height: 1.83 m Dia: 2.67 m 150 mm wall thick	72 - 75	CI sheet, Concrete, Tiles	75 - 80	1	53,200
40000	Height: 2.74 m Dia: 4.27 m 150 mm wall thick	82 - 85	CI sheet, Concrete, Tiles	85 - 90	1	62,000
50000	Height: 3.05 m Dia: 4.57 m 150 mm wall thick	92 - 95	CI sheet, Concrete, Tiles	95 - 100	1	72,500

Note: Cost need to be updated

Detail Cost Analysis of 25,000 litres Capacity Tank

Sl. No.	Item and Specification	Rate (TK)	Quantity	Present Amount (Tk.)
A.	**Reservoir**			
1.	**Brick:** 1st class brick, cracking strength 5000 - 8000 psi, free from any defects.	3.00/No.	2300 Nos.	6,900.00
2.	**Sand (for construction):** Coarse sand. Good in quality & free from any impurities.	8/Cft	180 Cft	1,440.00
3.	**Sand (for filling):** Local sand.	4/Cft	100 Cft	400.00
4.	**Cement:** Normal Portland cements, 50kg/bag, initial setting time 40-45 minutes, final setting time 8-12 hours. Free from any impurities.	250/Bag	38 Bags	9,500.00
5.	**Khoa:** Made from 1st class picked brick, size 19mm to 6mm.	32/Cft	90 Cft	2,880.00
6.	**MS rod:** Deformed MS rod dia 9mm of 40 grades.	22/Kg	240Kgs	5,280.00
7.	**Wire mesh (Net):** Made of 18 gauge MS wire of high temper, ½" spacing in both direction, 0.91m height.	4.5/Sft	320 Sft.	1,440.00
8.	**Manhole cover:** CI manhole cover of 24" diameter.(Lucky or equivalent)	700/No.	1 No.	700.00
9.	**Others:**	-	LS	460.00
	Sub-total			**29,000.00**
B.	**Gutter System**			
1.	**Gutter:** Made from 28 gauge plain sheet as per specification.	20/Rft	85 Rft.	1,700.00
2.	**Hanger:** Use No.3 plain MS flat bar in preparing hanger as per supplied design.	10/No.	30 Nos.	300.00
	Sub-total			**2,000.00**
C.	**Flushing System**			
1.	**PVC pipe:** 75mm dia PVC, water grade class-D (BS-3505), wall thickness 3.0mm-3.2 mm, bell socketed at one end, pipe must be straight and uniform thickness, free from any defects such as cracks, rupture, leak, etc.	25/Rft	40 Rft	1000.00
2.	**Washout chamber:** Concrete wash out chamber as per design.	400/No.	1 No.	400.00
3.	**Flushing device:** Made of PVC pipe as per supplied design.	175/No.	1 No.	175.00
4.	Fittings such as Elbow, Tee etc.	-	5 nos.	425.00
	Sub-total			**2,000.00**
D.	**Pump with water dispenser**			
1.	**Pump:** No. 6 Hand pump	1000/No.	1 No.	1,000.00
2.	**PVC pipe:** 50mm dia PVC, water grade class-D (BS-3505), wall thickness 3.4 mm-4.0mm, bell socket at one end, pipe must be straight and uniform thickness, free from any defects such as cracks, rupture, leak, etc.	20/Rft	20 Rft.	400.00
	Sub-total			**1,400.00**
E.	**Labour:**			
1.	Labour for Earth work	100/day	12 man days	9,60.00
2.	Mason for the construction of reservoir, gutter, flushing & hand pump fitting	250/day	21 days	5,250.00
3.	Labour for earth filling at outside of the reservoir	100/day	2 days	200.00
4.	Local carrying & contingency	LS		590.00
	Sub-Total			**7,000.00**
	Total			**41,400.00**

Note: Cost need to be updated

Construction Process of Underground RWHS

Step –1: Preparing and construction of base

- Select a suitable place for the construction of subsurface Brick tank at one side of the house. The place should be relatively high and hard soil. Draw a circle with the outer dia of the tank on the soil and excavate soil in a depth so that about 1 – 6” of the tank remain above the ground.

- The bottom of the excavation should be like a inverted dome as per the mentioned dimension in the drawing.

- After digging level the bottom of the pit and compact the soil. Give a layer of brick flat soiling. Cutting and binding MS rod as per specification. Mix cement concrete (Cement: Sand: Khoa = 1:2:4) and pour mixed cement concrete on brick flat soling at 4 inch thick. Compact the cast of R.C.C before setting with hammering by wooden patent.

Step – 2: Construction of main body of tank

- Draw a circle with respect to the centre of Base considering the diameter of the tank least 12 hours after casting RCC at base.

- Construct a circular tank with 5" thick brick wall. The thickness of mortar should not be more than ½ inch thick and the joints of the brick wall should be filled mortar properly. The wall should be constructed up to the mentioned height of the tank.

- Provide 5”x6” lintel at the middle height of the tank.

- Keep steps inside the brick wall.

Step – 3: Plastering

- Warping wire meshes around the inner side of the tank wall and fixes the wire mesh with the brick wall.

- Plaster inner side of the tank (wall and bottom) with cement sand mortar (1:3) and the thickness of the plaster will be about 1 inch. Net cement finishing in the inner side of the wall.

- Rough plaster will be provided on the outer side of the tank.

Step – 4: Construction of cover slab

- Provide necessary and adequate shuttering for the construction of slab. Lay polythene sheets and seal the opening of the shutter. Cut and bind 9mm dia MS Rod @ 5" c/c in both direction. Keep a hole of 1'- 10" dia at the corner of the cover frame for placing manhole cover.

- Mix cement concrete (1:2:4). Before casting identify the location for placing pump, water level indicator, air vent pipe etc. Then pour cement concrete (1:2:4) with 5 inch thick keeping the frame of MS Rod at least 1” clear cover of cement concrete layer.

- To make a collar of outer ridge of the slab so that rainwater could drain out through one location of the slab.

Step – 5: Setting of manhole cover

- Place the manhole cover at the proposed local (hole) on the slab. Mix cement concrete (1:2:4), set the cover and cast a layer of cement concrete mixture 2" thick.

- Finish the cement concrete with mortar (1:4).

Step – 6: Setting of inlet and overflow pipe

- Place inlet and overflow pipe, the inlet pipe should be one inch below the bottom of the slab. The over pipe should be at least one inch below the inlet pipe.
- The joint between wall and pipe should be properly sealed and finish with cement mortar.

Step – 7: Setting of flushing system

- According to figure flushing system to be set with PVC pipe 75mm-dia elbow and "T".
- Flushing system would be joined with the nipple to inlet gutter and with inlet pipe.
- As per drawing a flushing box will be constructed with brick masonry work.

Step – 8: Tube Well setting

- A simple hand Tube well would be set on the slab as per the drawing. The legs of the pump should be properly fixed with slab with cement concrete.
- The pipe of the Tube well inside the tank would be tied with mortar so that it can not move easily.

Step – 9: Construction of stair

- As per drawing construct stair for easily go on the roof the tank.
- Stair will be constructed with brick masonry work.

5.3 Construction of do-it-yourself model (Motka)

It is an indigenous process of Rain Water Harvesting System, which has been practising in different part of Bangladesh from the ancient. For example in the coastal areas people collect rainwater in a bigger earth wire pot (called Motka). It is no need to have a sophisticated system for harvesting rainwater but the issue is that the collection method should be scientific and hygienic. During rainy days rainwater could be collected in clean pot (which is available in his house) just hanging a piece of clean polythene with four stick. Or a piece of split bamboo/wooden channel/ can be hanged along the ridge of clean roof and clean rainwater can be harvested into pitcher. This could serve the crisis of water for the rainy season (about six-months).

This type of RWHS may be different capacities such as 100 litres, 250 litres, 300 litres, 500 litres and 100 litres. It is very cheapest model of RWHS. Even no need to spend money. The construction requirements of different capacity of RWHS is described below:

Storage capacity (Litres)	Size of the reservoirs	Minimum Catchment area (Sq. m)	Type of Catchment	Nos. of family members (No.)	Number of reservoir per system	Average total Construction Cost (Tk.)
100	Depend upon the local condition and availability of the pot	1.0 – 1.5	CI sheet, Concrete, Tiles, Polythene, cloth, etc.	not defined	one or multiple	100
200	Depend upon the local condition and availability of the pot	1.5 – 2.0	CI sheet, Concrete, Tiles, Polythene, cloth, etc.	not defined	one or multiple	150
250	Depend upon the local condition and availability of the pot	2.0 – 2.5	CI sheet, Concrete, Tiles, Polythene, cloth, etc.	not defined	one or multiple	200
300	Depend upon the local condition and availability of the pot	2.5 – 3.0	CI sheet, Concrete, Tiles, Polythene, cloth, etc.	not defined	one or multiple	250
500	Depend upon the local condition and availability of the pot	3.0 – 4.0	CI sheet, Concrete, Tiles, Polythene, cloth, etc.	not defined	one or multiple	350
1000	Depend upon the local condition and availability of the pot	4.0 – 5.0	CI sheet, Concrete, Tiles, Polythene, cloth, etc.	not defined	one or multiple	600

Note: Cost need to be updated

Detail Cost Analysis Motka (Capacity 500 litre)

Construction materials:

Item no.	Description of the material	Quantity	Rate (Tk.)	Amount (Tk.)
1.	**Cement:** Normal Portland cement, 50 kg per bag, initial setting time 40-50 minutes and final setting time 8-12 hours	5 Kg	5/Kg	25.00
2.	**Sand:** Good quality local coarse sand. Free from, clay, silt, organic matter and shells	1 cft	6.5/cft	6.50
3.	**Brick:** First class Brick free from any defects. Cracking strength 5000-8000 psi.	8 nos.	2.25/no.	18.00
4.	**Motka:** Good quality burnt clay pot. Capacity 500 litre.	1 no.	200/No.	200.00
5.	**Gutter:** Made of Good quality plane sheet of ½ mm thick, length 6ft.	2 nos	30/no.	30.00
6.	**Hanger for gutter:** Made of 6mm dia MS rod for gutter and used along the corner of the catchment. Average length of each 3 ft.	5 nos	L.S.	30.00

Item no.	Description of the material	Quantity	Rate (Tk.)	Amount (Tk.)
7.	**Mosquito Net:** Made of nylon with 2.5-ft long and 8 inch wide, good quality.	As required	L.S.	11.00
Total				**350.00**

Note: Cost need to be updated

Installation Process of Motka

Step –1: Preparing and construction of base

- Select a suitable site for Earth made (Motka) tank installation at one side of the house/Veranda (Inside or outside). If it is out side the room, the soil of the site of Earthen Motka installation should be relatively high and hard. Draw two circles together with 3ft dia each and compact soil. Build three brick stand.

- Plaster the brick stand using cement sand mixture.

Step – 2: Placing of Motka

- Set two burnt earthen Motka over the brick stand gently. To protect tilting of the Motka on the stand place packing with cement sand mixture.

6. Gutter Setting:

Step - 1: Hanger setting

- Gutter is generally made of CI sheet and 2-4 pieces of gutter is needed for each system. In each of the joint and middle of the gutter a hanger need to be hanged.

- Hanger is made with 6mm dia MS rod. It is bent like a V shape as per drawing and tie with rafter/button. Inner arm of the hanger's "V" gradually increases towards the plant in order to provide gentle gradient.

Step – 2: Setting of inlet gutter

- Generally inlet gutter is made of plane C.I. sheet at 2ft length, 6-inch width and 4-inch depth with a hole which is made of 1.5-inch dia at middle. If guttering system come from both direction of catchments or at 2 inch away from the closed end of inlet gutter, if the guttering system coming towards the tank from one direction of catchments. Only one-piece inlet gutter is needed for each system. A nipple is attached with the hole of inlet gutter at 1.5-inch dia and connected with the down pipe, which is made of 1.5-inch dia P.V.C pipe.

7. Setting of Flushing System:

- According to the figure flushing system need to be constructed with PVC pipe of 38mm dia, elbow and "T". One side of the Flushing system would have to be joined with the nipple of inlet gutter and another side with inlet pipe of the tank.

8. Setting of Indicator:

- To measure the quantity of stored water outside the tank, indicator is used with the tank and denoted scale on PVC pipe.

- Indicator is made of ½ inch dia transparent PVC pipe and length is as per the tank height. One end of the indicator pipe with be connected with drainage pipe and another end with the overflow pipe.

9. Curing:

Proper curing is very important for proper hydration of cement concrete mix. In the Ferro cement or cement mortar high proportion of cement sand mix is used.

- At least 7 days curing should be allowed for Tank and other concrete made parts. It is better, if one could do the curing by wrapping the tank and other parts with wet jute cloth (*chot*). The quality of water for curing should be the drinking water quality and must be free from salinity.

- After 7 days the one third of the tank should be filled up with rainwater or water from other suitable sources. Then after another 7 days two third of the tank should be filled up similarly. Rest of the tank should be filled up with water after another 7 days.

- Water should be kept at least 7 days after filled up the entire tank. The end of the curing water should be drained out and cleaned properly.

Tank construction period

- Spray some water on the mould before plastering to make it damp.

- Trowel a first layer of mortar onto the mould to a thickness about 0.5cm

- Plaster the second layer of 0.5cm in the same manner and check the mortar layer thickness by pushing in a nail or toothpick etc.
- Remove the molds after 24 hours the tank has been made.

10. Quality control during construction

- Quality of the construction works is very important for the sustainability of the plant. It should be ensured properly. Concerned personnel should follow up the quality of all the materials. He should also follow up the construction steps of the different components of the plant like; construction of main tank/reservoir, construction of cover, joining of wall, placing of wire mesh, plastering, fitting fixing drainage & delivery pipes, setting of gutter and flushing pipes, fixing the net in place etc.

- After the completion of the construction works of the plant concerned personnel should inspect the total works, he will take necessary corrective measure if there is any deviation with design and drawing and finally a completion report will be prepared and sent through a prescribed reporting format.

11. Operation & Maintenance

11.1 Regular Operation & Maintenance

- Clean the flushing system, gate valve at least once in a week. Oiling the nut bolt and movable parts.

- Clean the catchments and gutter of the system at least once in a week. If find any visible dirt (bird drop) on the catchments or gutter, clean it instantly.

- Caretaker/users should properly flush the first foul water for 6 – 15 minutes depending on the intensity of rain. Because debris, dirt and dust normally stick on the roof of a building or other collection roof. When the first rain arrives, this unwanted matter will be washed into the tank. This will cause contamination of the water and quality will be reduced. To address this problem flushing system in incorporated which divert this ‘first flush’ water so that it couldn’t enter the tank.

- Always keep open the cap of gate valve of flushing system. So that during absence of caretakers/users or at night dirty water could not entire into the tank.

- The tank cover should be kept closed, other wise flies & mosquitoes could enter into the tank and breed larvae thus pollute it. Sun light should be protected fully from entering the tank, as this would cause algae to grow inside the tank.

- The user keeps clean the surrounding of the tank every day.

- Users/ caretakers should always follow up the RWHS so that children do not waste the stored water or

damaged the parts of RWHS.

- Repairs the minor problems.

11.2 Periodical Operation & Maintenance

- Before storing water or starting rainy season in each year, it needs to clean the entire system with clean water and brush and disinfect the inner side of storage reservoir by bleaching powder mixed water. (Mix 4 teaspoon full of bleaching powder with 20 litres of clean water, then spread in the inner side of the tank and leave for 30-60 minutes. Drain out all water from the tank and wash with clean cloth. Close the cover of the tank.)

- Change and fix the fly guard net at the mouth of the down pipe at the beginning of rainy season in each year. It can sieve the debris, which comes with water.

- Clean the body (foot, legs etc) of the person before entire in the tank for cleaning.

- High the plinth level of surrounding area of Rain Water Harvesting Plant by soil for reduce water logging and damaging the base of the Tank.

12. Water Quality Monitoring

The relationship between water quality and health effects has been studied for many water quality characteristics. An examination of water quality is basically a determination of the organism, the mineral and organic compounds contained in water. The water quality should satisfy the drinking water standard set by WHO or the country has set standard. Rainwater is naturally occurred pure source of water. It is free organism, mineral and organic compounds. The quality of Rainwater mostly controlled by the collection and storage system. It is observed in the field that there is no bacteria with rainwater if it is properly collected (as prescribed) and stored in a clean reservoir even after 6 months after the collection of water.

- The quality of rainwater should be tested as per "water quality testing" guideline/ policy developed and approved by WaterAid.

- Rainwater is free from mineral and organism compounds, but susceptible for the bacteriological contamination. So total coliform (TC) and Focal coliform should be tested at least twice in a year (Rainy season and dry season).

- pH level of stored water should be monitored, tested and recorded in regular basis.

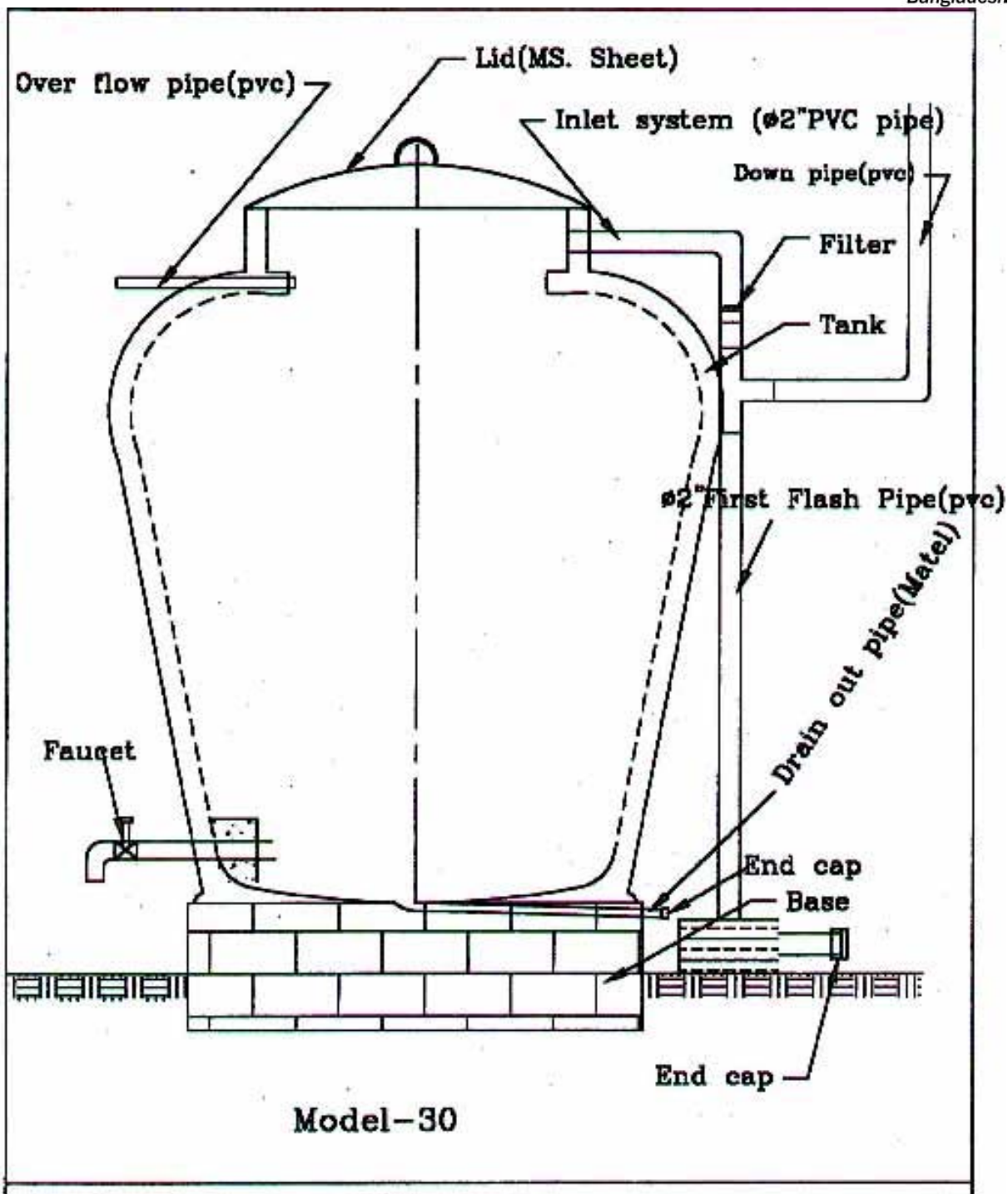
- Measures to protect the quality of the stored water include the exclusion of light from the stored water, cool storage conditions and regular cleaning.

- If bacteriological contamination is found with the stored water in rain season, then the whole water may be drained out and wash the storage reservoir properly and again collect rainwater. In the dray season water may be disinfected with chlorine solution. The amount of chlorine solution will be added into water that will depend upon the quality of stored water into Tank. The chlorine dose should be more than 2mg/L.

13. Management of Stored Water

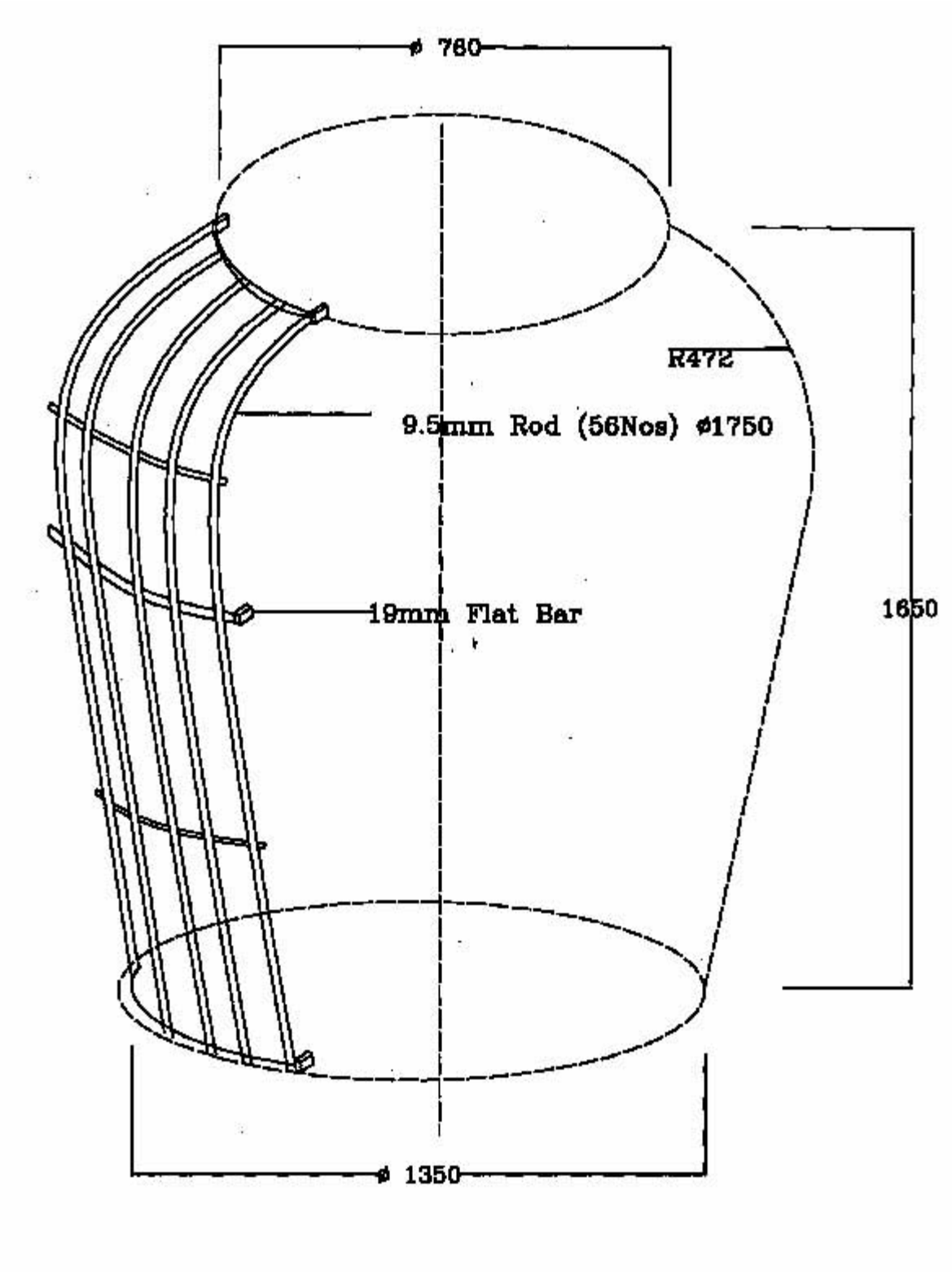
Proper management of stored water is very important to satisfy the requirement for the purpose it has been constructed. Because rainwater has a limitation and it can only be collected in the rainy days when it rains. So O&M and management of rainwater is high lighted and should be trained the user groups. This issue should be discussed during organize and conduction of software activities.

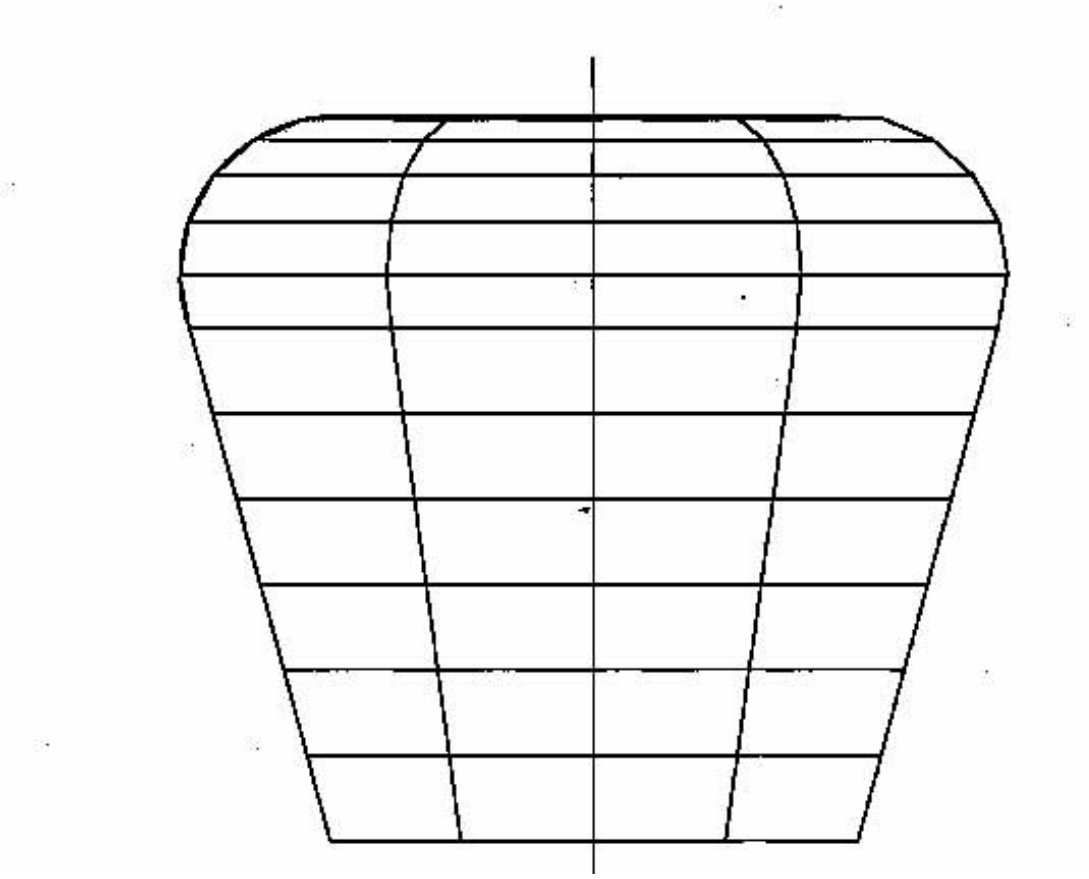
It is observed that RWH Provides water security at household level as it renders the control of water supply into the hands of the individual households. O&M and management of RWHs, are less complex than most other technologies. It offers immense convenience equal to Piped Water Supply during rainy season. Users should be learnt to limit the water consumption in the dry season. This way, they will have an adequate supply of water for essential needs for a longer period.

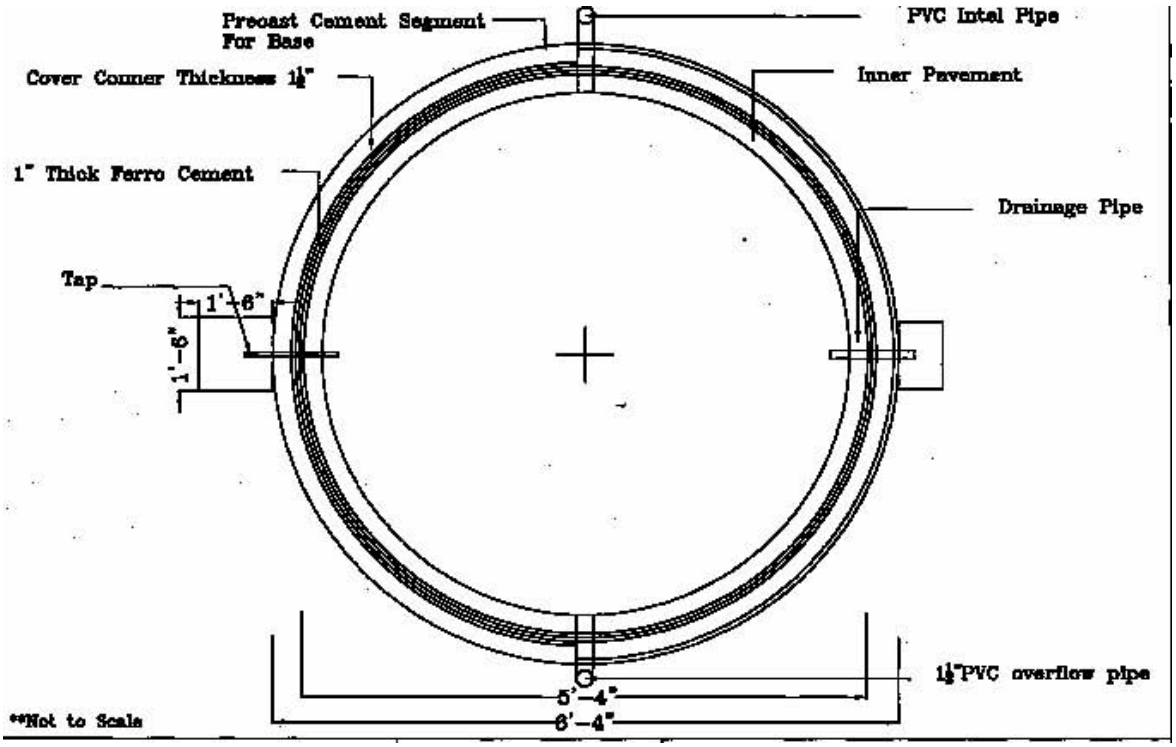


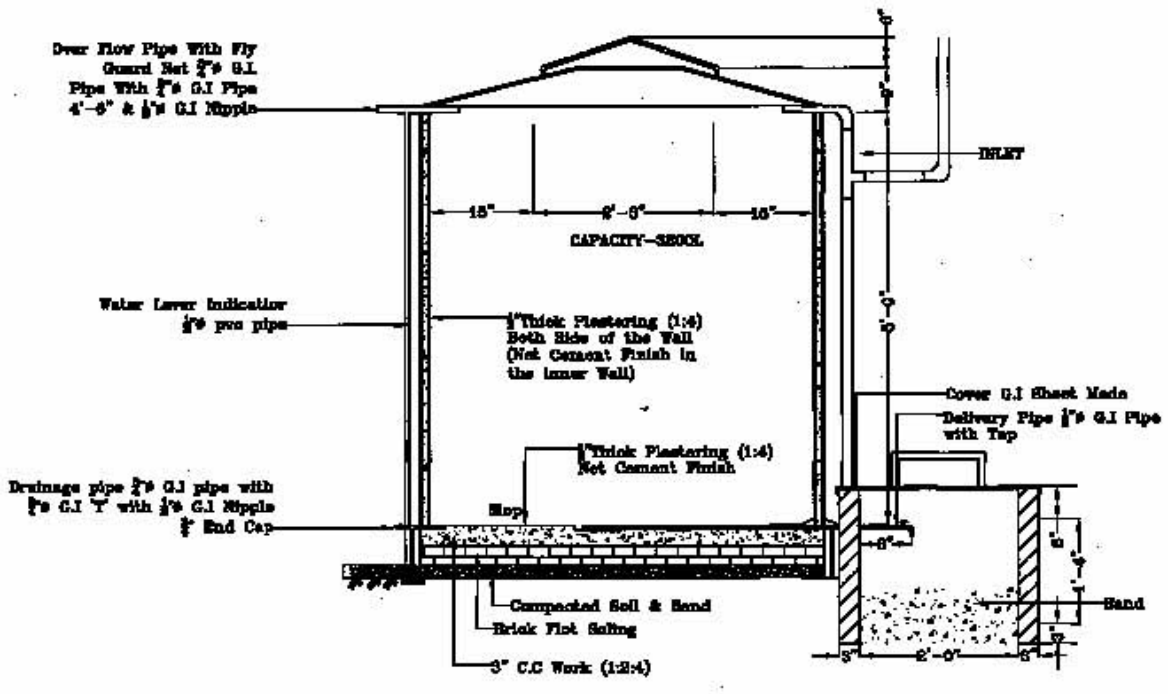
Model–30

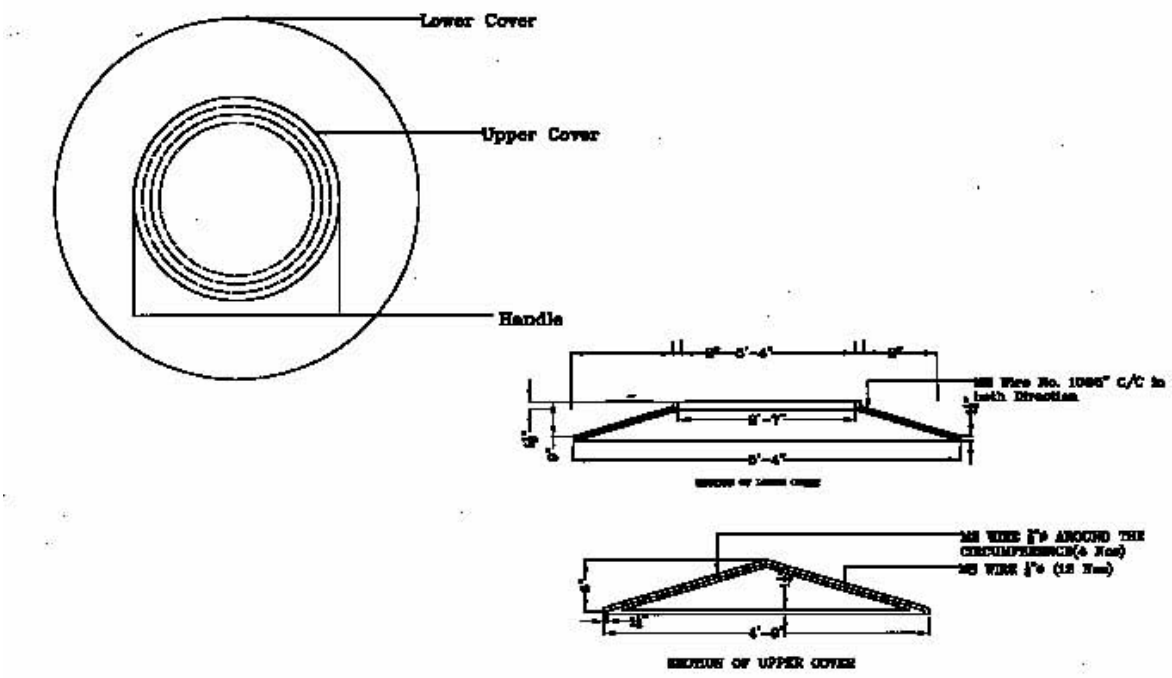
I. D. E. BANGLADESH.			
DRAWN BY	M. BAQUE	CHECKED BY	
MATERIAL			
SCALE		PARTS NAME	DRG. NO.
CUT OFF SIZE		AssayModel–30	
DATE	6/2000		

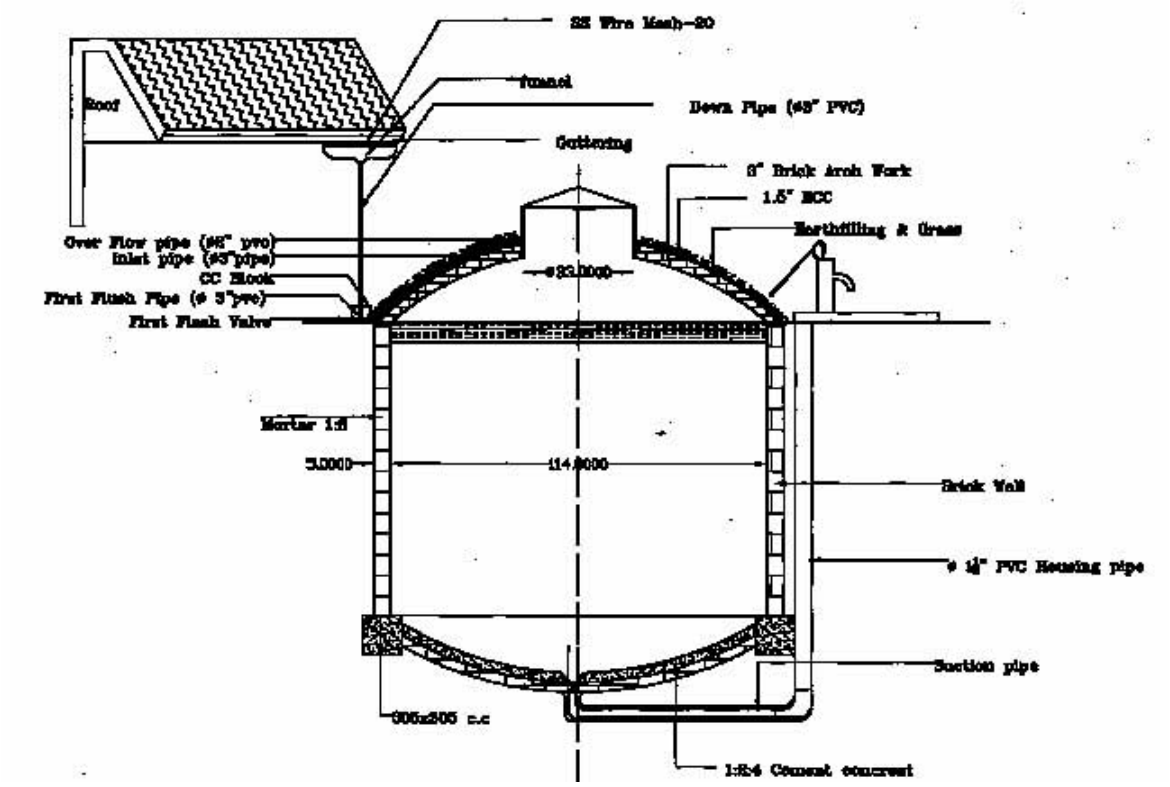

ø 780
R472
9.5mm Rod (56Nos) ø1750
19mm Flat Bar
1650
ø 1350

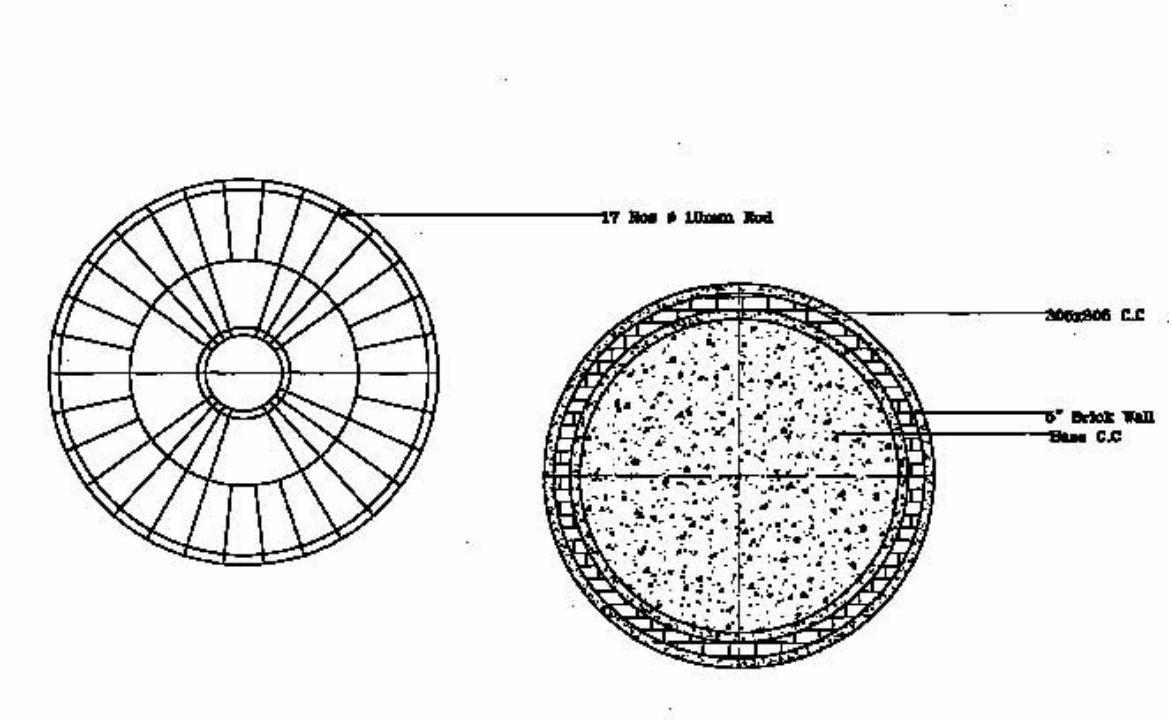


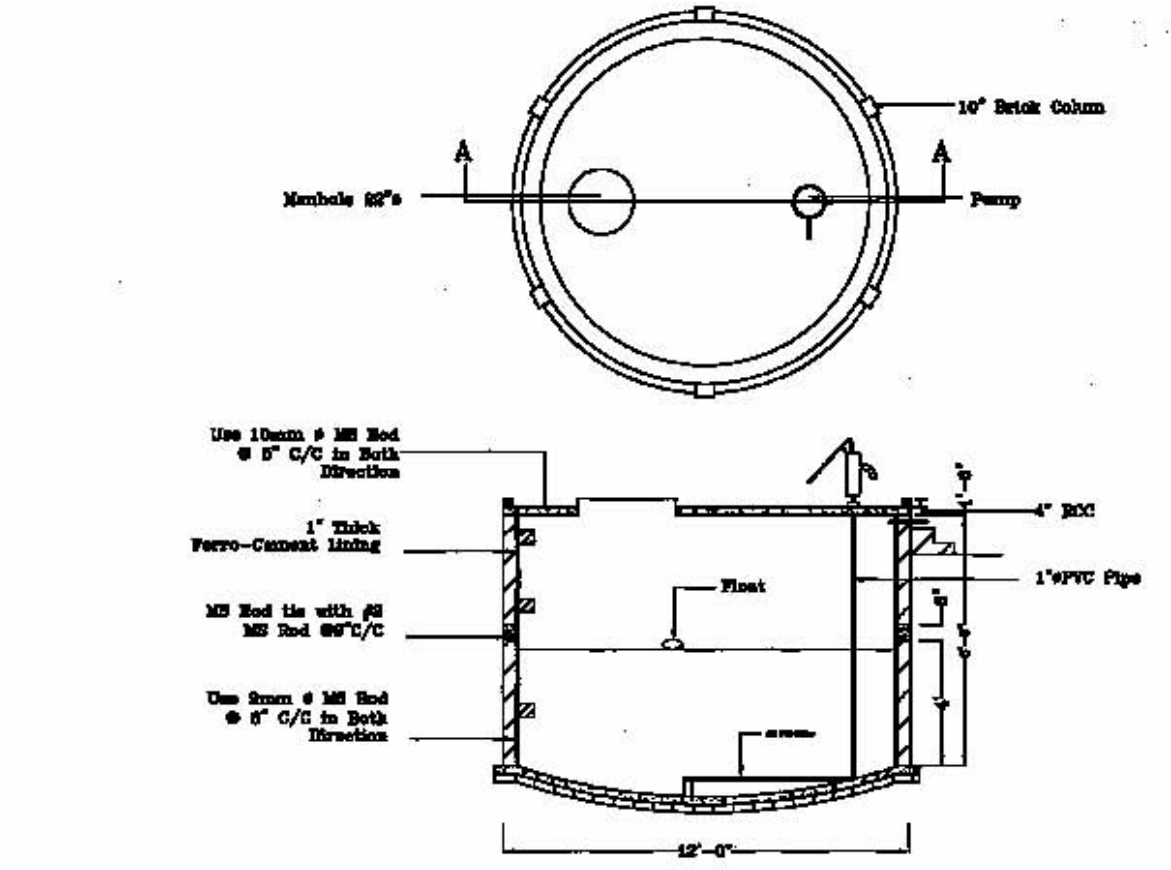

Precast Cement Segment For Base
PVC Intel Pipe
Cover Conner Thickness 1½"
Inner Pavement
1" Thick Ferro Cement
Drainage Pipe
Tap
1'-6"
1'-6"
1½"PVC overflow pipe
5'-4"
6'-4"
**Not to Scale

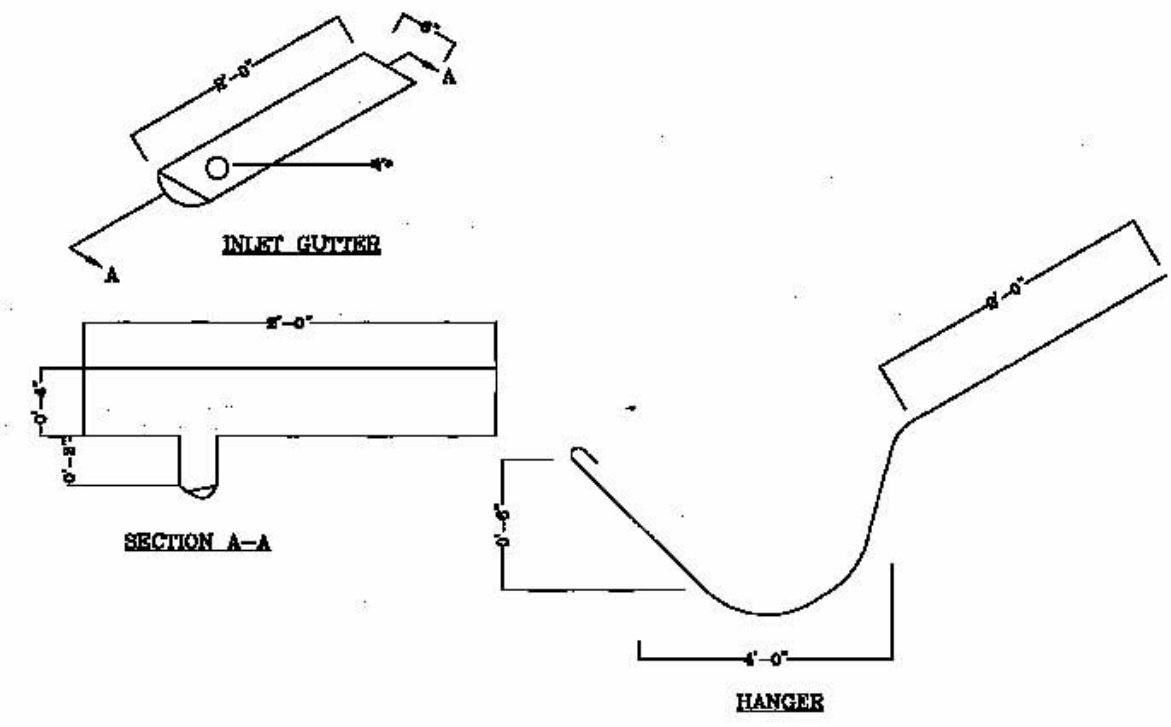

Over Flow Pipe With Fly Guard Net ¾" G.I. Pipe With ¾" G.I Pipe 4'-6" & ¾" G.I Nipple
INLET
15"
6'-0"
15"
CAPACITY-3200L
Water Lever Indicator ¾" pvc pipe
½"Thick Plastering (1:4) Both Side of the Wall (Net Cement Finish in the inner Wall)
Cover G.I Sheet Made
Delivery Pipe ¾" G.I Pipe with Tap
½"Thick Plastering (1:4) Net Cement Finish
Drainage pipe ¾" G.I pipe with ¾" G.I 'T' with ¾" G.I Nipple ¾" End Cap
Slope
Compacted Soil & Sand
Brick Flat Soling
3" C.C Work (1:2:4)
Sand
2'-0"

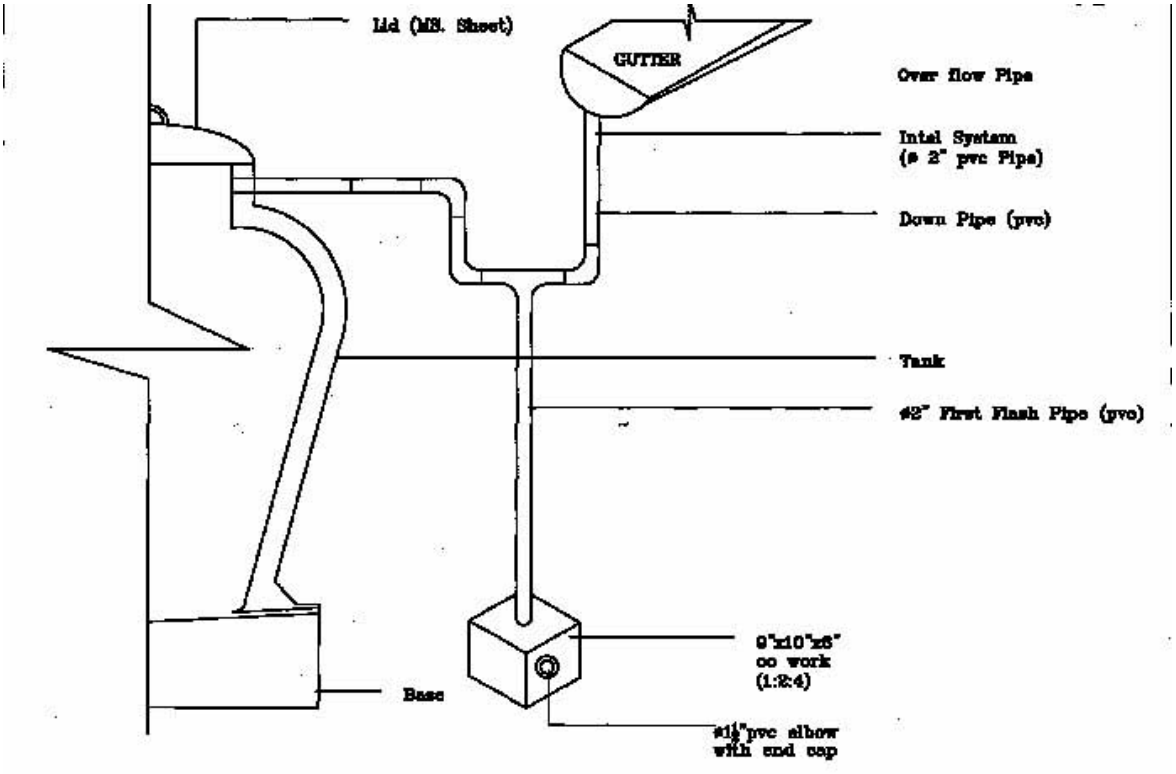

Lower Cover
Upper Cover
Handle

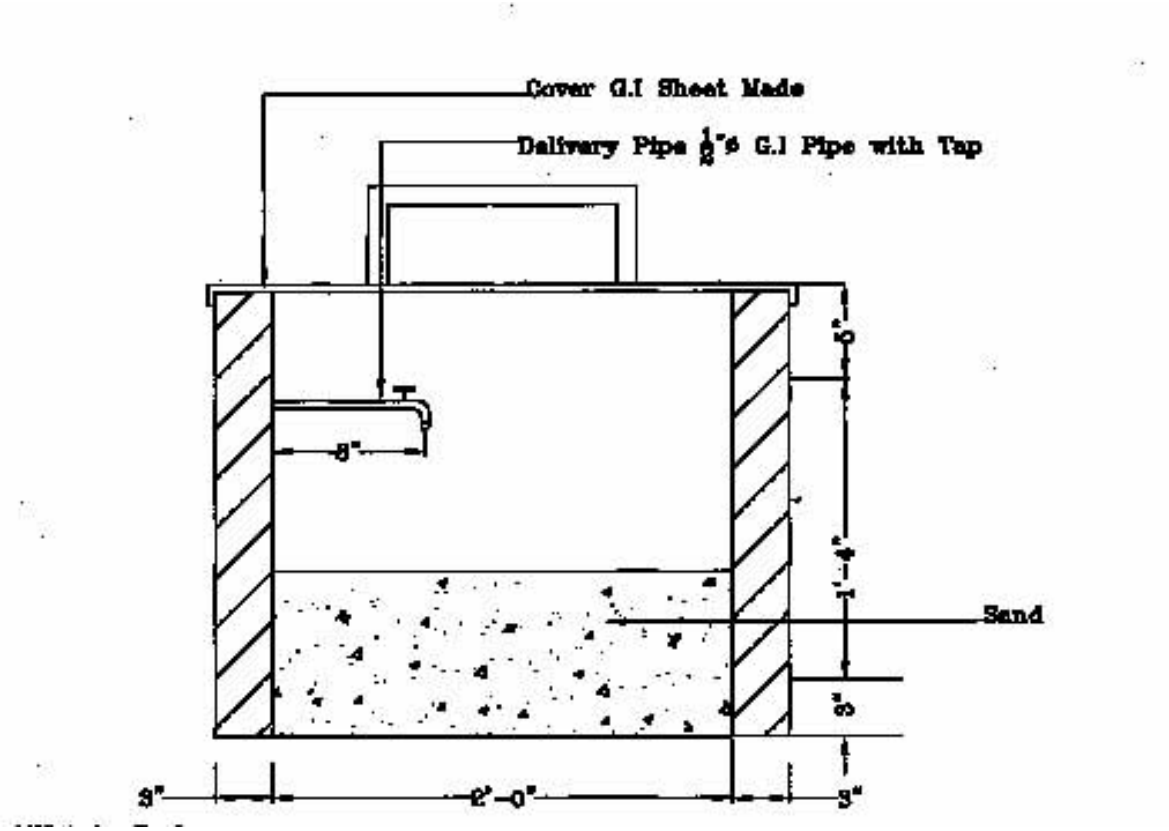

22 Wire Mesh-20
Funnel
Down Pipe (#3" PVC)
Roof
Guttering
6" Brick Arch Work
1.5" RCC
Earthfilling & Grass
Over Flow pipe (#2" pvc)
Inlet pipe (#3"pipe)
CC Block
First Flush Pipe (# 3"pvc)
First Flush Valve
Mortar 1:3
Brick Wall
4" PVC Housing pipe
Suction pipe
1:2:4 Cement concrete

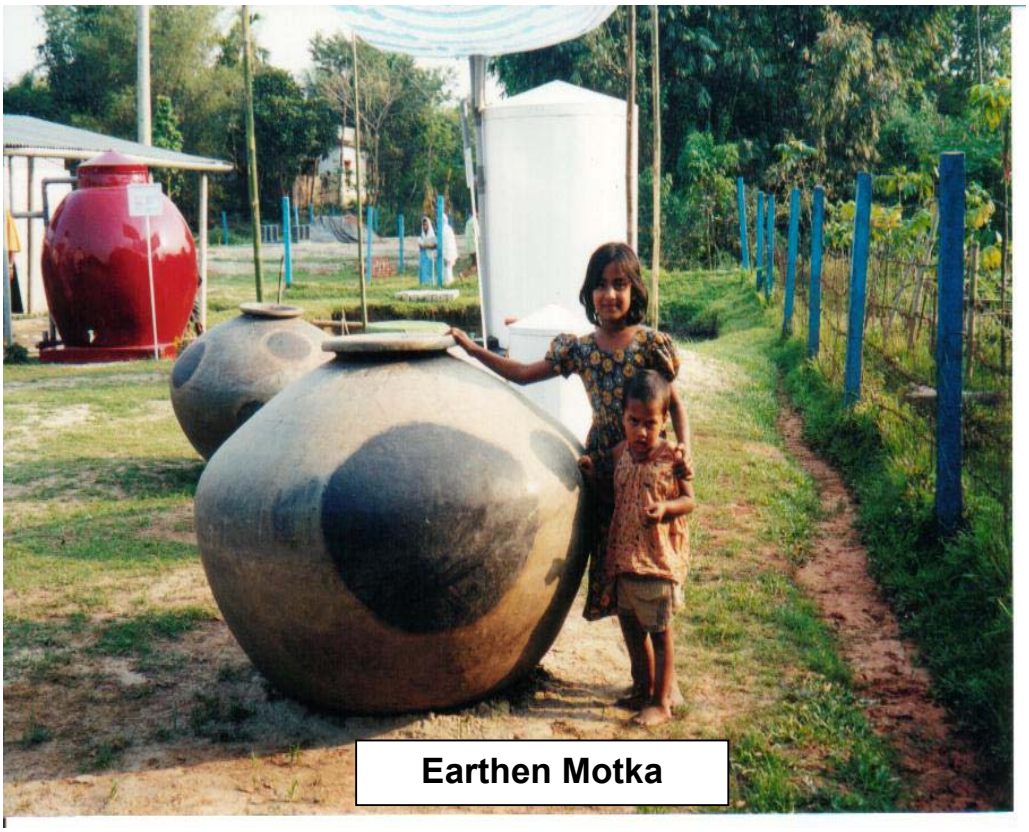

17 Nos ϕ 10mm Rod
6" Brick Wall
Base C.C


10" Brick Column
A
A
Manhole @2"s
Pump
Use 10mm ϕ MS Rod
@ 5" C/C in Both
Direction
1" Thick
Ferro-Cement lining
MS Rod tie with ϕ8
MS Rod @9"C/C
Use 9mm ϕ MS Rod
@ 6" C/C in Both
Direction
4" PVC
1"ϕPVC Pipe
Float
12'-0"


INLET GUTTER
SECTION A–A
HANGER


Lid (MS. Sheet)
GUTTER
Over flow Pipe
Intel System
(ø 2" pvc Pipe)
Down Pipe (pvc)
Tank
ø2" First Flash Pipe (pvc)
9"x10"x6"
co work
(1:2:4)
Base
ø½"pvc elbow
with end cap


Cover G.I Sheet Made
Delivery Pipe ½"ø G.I Pipe with Tap
5"
1'-4"
Sand
3"
3"
2'-0"
3"



Earthen Motka