ROOF TOP RAIN WATER HARVESTING

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CHAPTER 1

1.1 INTRODUCTION

Rainwater harvesting is a technology used to collect, convey and store rain for later use from relatively clean surfaces such as a roof, land surface or rock catchment. The water is generally stored in a rainwater tank or directed to recharge groundwater. Rainwater infiltration is another aspect of rainwater harvesting playing an important role in storm water management and in the replenishment of the groundwater levels. Rainwater harvesting has been practiced for over 4,000 years throughout the world, traditionally in arid and semi-arid areas, and has provided drinking water, domestic water and water for livestock and small irrigation. Today, rainwater harvesting has gained much on significance as a modern, water-saving and simple technology.

The practice of collecting rainwater from rainfall events can be classified into two broad categories: land-based and roof-based. Land-based rainwater harvesting occurs when runoff from land surfaces is collected in furrow dikes, ponds, tanks and reservoirs. Roof-based rainwater harvesting refers to collecting rainwater runoff from roof surfaces which usually provides a much cleaner source of water that can be also used for drinking.

1.1.1 APPLICATION AREAS

Rainwater harvesting systems can be installed in both new and existing buildings and harvested rainwater used for different applications that do not require drinking water quality such as toilet flushing, garden watering, irrigation, cleaning and laundry washing. Harvested rainwater is also used in many parts of the world as a drinking water source. As rainwater is very soft there is also less consumption of washing and cleaning powder. With rainwater harvesting, the savings in potable water could amount up to 50% of the total household consumption.

1.1.2 CRITERIA FOR SELECTION OF RAINWATER HARVESTING TECHNOLOGIES

Several factors should be considered when selecting rainwater harvesting systems for domestic use:

- Type and size of catchment area
- Local rainfall data and weather patterns
- Length of the drought period
- Alternative water sources
- Cost of the rainwater harvesting system.

- When rainwater harvesting is mainly considered for irrigation, several factors should be taken into consideration. These include:
- Rainfall amounts, intensities, and evapo-transpiration rates .
- Soil infiltration rate, water holding capacity, fertility and depth of soil .
- Crop characteristics such as water requirement and length of growing period .
- Hydrogeology of the site .

1.2 OBJECTIVES

- To meet the increasing demand of water.
- To Control Wastage of Rain Water.
- To avoid the flooding of roads.
- To make the Unit Independent for Water Consumption.

1.3 BENEFITS OF RAINWATER HARVESTING

- Rainwater is a relatively clean and free source of water .
- Rainwater harvesting provides a source of water at the point where it is needed .
- It is socially acceptable and environmentally responsible .
- It promotes self-sufficiency and conserves water resources .
- Rainwater is friendly to landscape plants and gardens .
- It reduces storm water runoff and non-point source pollution .
- It uses simple, flexible technologies that are easy to maintain .
- Offers potential cost savings especially with rising water costs .
- Provides safe water for human consumption after proper treatment .
- Low running costs.

1.4 COMPONENTS OF ROOFTOP SYSTEM

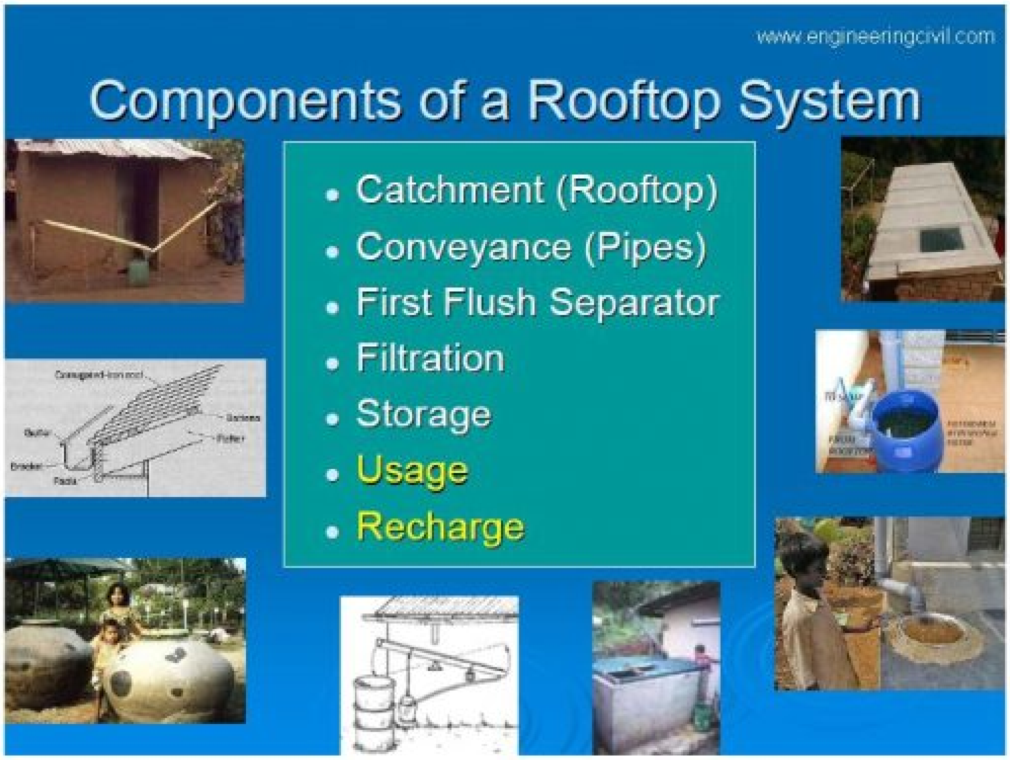


Figure 1.1 -COMPONENTS OF ROOFTOP SYSTEM

1.4.1 CATCHMENT

The surface that receives rainfall directly is the catchment of rainwater harvesting system. It may be terrace, courtyard, or paved or unpaved open ground. The terrace may be flat RCC/stone roof or sloping roof. Therefore the catchment is the area, which actually contributes rainwater to the harvesting system.

1.4.2 CONVEYANCE (PIPE)

Rainwater from rooftop should be carried through down take water pipes or drains to storage/harvesting system. Water pipes should be UV resistant (ISI HDPE/PVC pipes) of required capacity. Water from sloping roofs could be caught through gutters and down take pipe. At terraces, mouth of the each drain should have wire mesh to restrict floating material

1.4.3 FIRST FLUSH

First flush is a device used to flush off the water received in first shower. The first shower of rains needs to be flushed-off to avoid contaminating storable/rechargeable water by the probable contaminants of the atmosphere and the catchment roof. It will also help in cleaning of silt and other material deposited on roof during dry seasons Provisions of first rain separator should be made at outlet of each drainpipe.

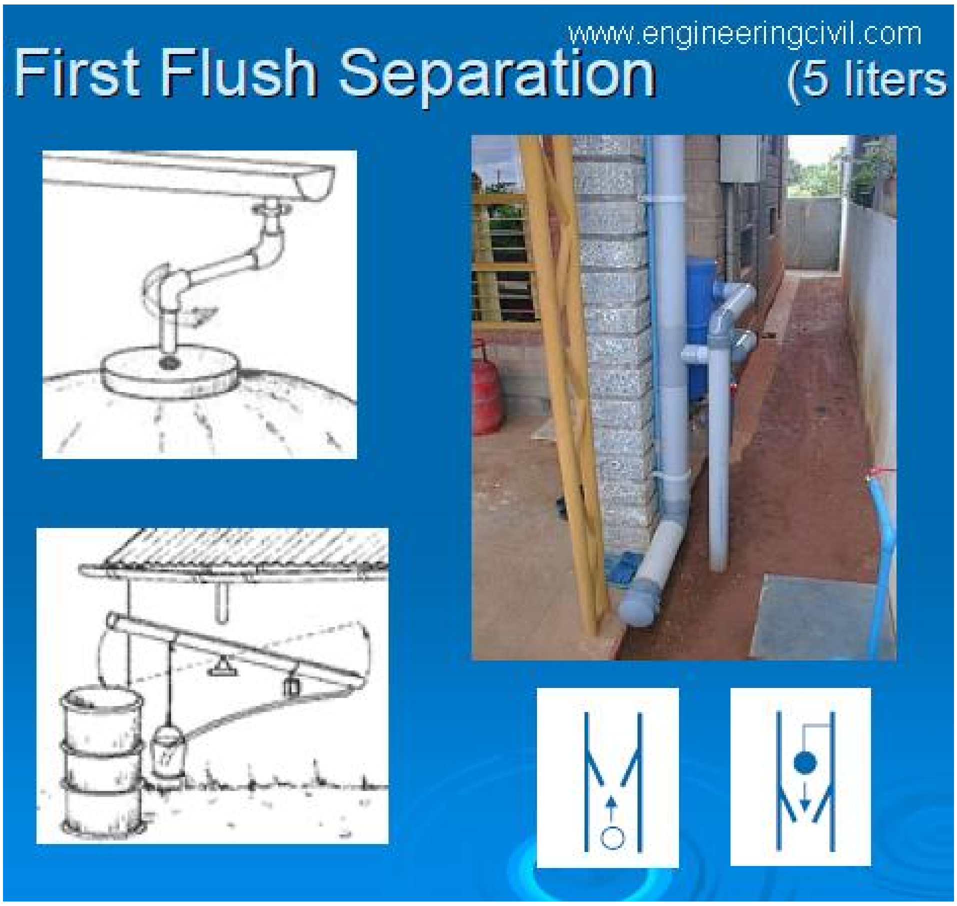


Figure 1.2-First Flush

1.4.4 FILTER

Filters are used for treatment of water to effectively remove turbidity, colour and microorganisms. After first flushing of rainfall, water should pass through filters or directly stored in tank and filter before use. A gravel, sand and 'netlon' mesh , Pressure filter is designed and placed on top of the storage tank or near the tank depending upon the use.

Pressure Sand Filter

Pressure sand filter consists of a pressure vessel-this could be either vertical or horizontal-fitted with a set of frontal pipe work and valves, graded silica quartz sand supported by layers of graded under bed consisting of pebbles and gravels, a top distributor to distribute the incoming water uniformly throughout the cross section of the filter, and an under drain system to collect filtered water.

Raw water flows down wards through the filter bed and as the suspended matter- which has usually been treated by addition of a coagulant like alum- is retained on the sand surface and between the sand grains immediately below the surface. There is steady rise in the loss of head as the filter process continues and the flow reduces once the pressure drop across the filter is excessive.

- Technology:Mechanical filtration
- Material:Stainless steel

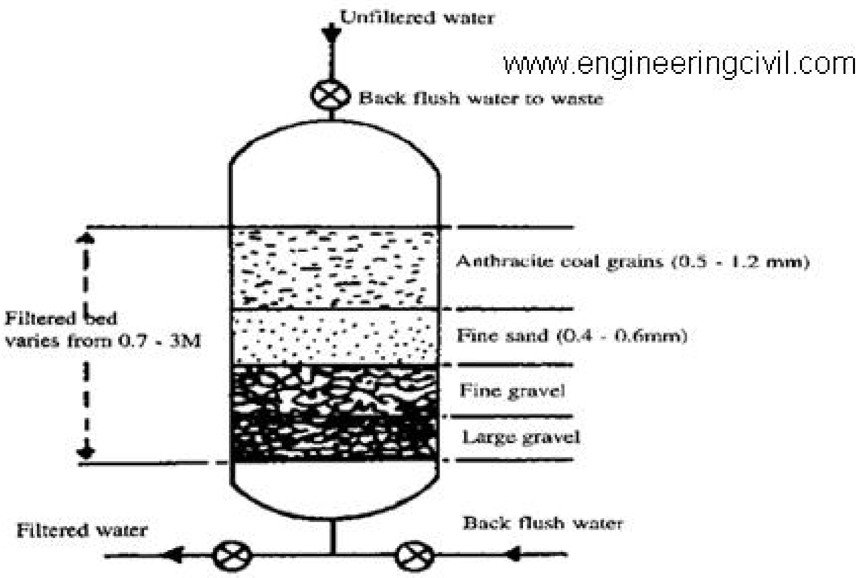


Figure 1.3- PRESSURE SAND FILTER

1.4.5 STORAGE

It is used to store the water that is collected from the roof through filter. For small scale water storage plastic buckets, jerry cans, clay or cement jars, ceramic jars, drums may be used. For larger quantities of water, the system will require a bigger tank with cylindrical or rectangular or square in shape constructed with Ferro cement or cement rings or plain cement concrete or reinforced cement concrete or brick or stone etc. The storage tank is provided with a cover on the top to avoid the contamination of water from external sources. The storage tank is provided with pipe fixtures at appropriate places to draw the water to clean the tank & to dispose of extra water.

Figure1.4- STORAGE TANK

1.5 RAINWATER USE

- Intermittent – in situations with one long rainy season when all water demands are met by rainwater. During the dry season, water is collected from other sources.
- Occasional – water is stored for only a few days in a small container. This is suitable when there is a uniform rainfall pattern with very few days without rain and when a reliable alternative water source is available.

- Partial – rainwater is used throughout the year but the ‘harvest’ is not sufficient for all domestic demands. For example, rainwater is used for drinking and cooking, while for other domestic uses (e.g. bathing and laundry) water from other sources is used.
- Full – for the whole year, all water for all domestic purposes comes from rainwater. In such cases, there is usually no alternative water source other than rainwater, and the available water should be well managed, with enough storage to bridge the dry period.

1.6 SUSTAINABILITY

Rainwater harvesting is one of the most promising alternatives for supplying water in the face of increasing water scarcity and escalating demand. The pressure on water supplies, increased environmental impact from large projects and deteriorating water quality, constrain the ability to meet the demand for freshwater from traditional sources. Rainwater harvesting presents an opportunity for the augmentation of water supplies allowing t the same time for self-reliance and sustainability.

1.7 ECONOMIC EFFICIENCY

Valid data on the economic efficiency of rainwater harvesting systems is not possible. Dependent on the regional conditions (water and wastewater prices, available subsidies), the amortization period may vary between 10 and 20 years. However, it shouldbe taken into consideration that for the major investment (storage and pipe work) a period of use of several decades is expected.

1.8 COSTS

The associated costs of a rainwater harvesting system are for installation, operation and maintenance. Of the costs for installation, the storage tank represents the largest investment which can vary between 30 and 45% of the total cost of the system dependent on system size. A pump, a pressure controller and fittings in addition to plumber’s labor represent other major costs of the investment.

1.9 WATER TREATMENT AND SAFE STORAGE

- Boiling, thermal microbial deactivation.
- Solar Water Disinfection (SODIS), UV radiation microbial deactivation.
- Safe Water System, sodium hypochlorite disinfection combined with safe water storage
- NaDCC (sodium dichloroisocyanurate) dosing, chlorine disinfection.
- Ceramic filters, filter usually impregnated with silver for its bactericide and viricide properties.
- Biosandfilters, mechanical and biological filtration through a sand bed.
- Flocculation and disinfection systems, particle removal through flocculation Combined with disinfection.

CHAPTER 2
LITERATURE REVIEW

2.1 REVIEW
Name of journal: International Journal of Research in Engineering and Technology

Name of author: Utsav R. Patel , Vikrant A. Patel et.al

Volume:(2013), Vol. 02, Issue 01, pp.14-18

Title: Rooftop rainwater harvesting (rrwh) at spsv campus, visnagar: gujarat – a case study

Methodology: Methodology include
1. First of all rainwater is captured on rooftop of campus building
2. Determination of use of captured water
3. Determination of collection surface from which the rainwater is collected which is to be used for rainwater harvesting

Conclusion:
Hence it was finally concluded that implementation of RAINWATER HARVESTING PROJECT to the campus of S.P.S.V. will be the best approach to fight with present scenario of water scarcity in all aspects, whether it is from financial point of view or from optimum utilization of land surface. By implementation in water harvesting project in S.P.S.V. campus we can make little noble cause for rain water conservation which will be beneficial to the students of campus. It may also helpful to the campus.

2.2 REVIEW

Name of journal: African Journal of Agricultural Research

Name of author: Pawar C. B, Patil S. S.et.al

Volume: Vol. 9,19 June 2014

Title:A case study of rooftop rainwater harvesting of Renavi village in Sangli District in Maharashtra:

Methodology:A general village survey was carried out to assess the rooftop area of houses; number of houses were collected through personal discussion with beneficiaries and Gram panchayat records. The information related to the geographical location of Sangli district and monsoon collected from socio- economic review of Sangli District respectively. For the sake of reliability, the quantitative data was collected from a focus group discussion.

Summary:
1. Rooftop rainwater harvesting is one of the optimistic and economically viable methods of rainwater harvesting. Rooftop rainwater is allowed to percolate in the ground and become helpful to increase ground water recharging groundwater aquifers.
2. Rainfall data was collected from the Jalja Report. The Renavi village is situated in the Khanapur block in the eastern part of Sangli District, whose annual rainfall is 558 mm (Jalja, 2005). For the present research, the annual rainfall of the year 2005 which was 527

mm have been considered for carrying out potential assessment.
3. The village survey revealed that the Renavi village has 231 houses and total population is 1300.In this 70 Houses are selected for rainwater harvesting purpose

Processes that are carried out in this research:
1. In this study coefficient of runoff and potential of rainwater is calculated
2. Roof top area is measured using the tape used for surveying
3. After that estimated rainwater harvested in liters is calculated using the roof top area

Conclusion:
Roof top rain water harvesting measures need to be given priority in the drought prone areas and should be incorporated in the watershed development programs. As illustrated by this case, roof top rain water harvesting measures helps in fulfilling the domestic water need as well improving the ground water level by few meters.

2.3 REVIEW

Name of journal: Journal of Research in Humanities and Social Science

Name of author:V.S. Pawar-Patil and Sagar P. Mali

Volume: Volume1 ~ Issue 4 (2013)

Title: Potential Roof Rain Water Harvesting In Pirwadi Village Of Kolhapur District, Maharashtra (India) – A Geospatial Approach

Methodology: This research paper include comparison between conventional procedure for adopting the rainwater harvesting method and using geospatial technique.

Conclusion:

In Pirwadi village, the water deficiency situation in hot season can be change in to water adequate situation by adopting the roof rainwater harvesting techniques. The total potential of roof rainwater harvesting is more than enough to satisfy the total annual drinking and cooking requirement of the people in this village. The aforesaid discussion emphasizes that the rainwater harvesting techniques are proficiently useful to tackle down the water scarcity problem in rural areas.

2.4 REVIEW

Title: Potential of rainwater harvesting in urban Zambia

Name of author: LubingaHandia, James MadalitsoTemboet.al

Volume: Nov. 2013. Vol. 4, No. 5

Aim: The study was aimed to evaluate the applicability of rainwater harvesting in Zambia

Methodology: Pilot stations (five) were selected in Lusaka based mainly on catchment/collecting area material (roof), number of users, alternative water sources and affluence or density of residential area. The RWH system that was used in the research for the pilot system was the roof harvesting system.His comprised a collection surface (roof), guttering, storage tanks and first flush. The gutters were designed using the Rational and Mannings formulas. Design of the storage tanks was based on the mass curve analysis.

Conclusion:
Author have made conclusion that the water which would be harvested from the pilot stations could be used for drinking purposes.

2.5 REVIEW

Name of journal : International Journal of Scientific & Engineering Research

Name of author :J.R.Julius, Dr.R.AngelinePrabhavathet.al

Volume: Volume 4, Issue 8, August-2013

Title :RAINWATER HARVESTING (RWH) – A REVIEW

Methodology :
1) Rainwater stored for direct use in above ground or underground sumps / overhead tanks and used directly for flushing, gardening, washing etc. (Rainwater Harvesting)
2) Recharged to ground through recharge pits, dug wells, bore wells, soak pits, recharge trenches, etc. (Ground water recharge)

Conclusion:
It is no denying that sustaining and recharging the groundwater along with judicious use of the limited fresh water resources is the need of the hour. If sufficient measures are not taken up immediately, we will face a crisis which will be detrimental to the very survival of mankind. Efficient management of water resources and education about judicious utilization of water resources along with measures of harnessing, recharging and maintaining the quality of water and water bodies has to be taken up on war footing.

2.6 REVIEW

Name of journal : Hindawi Publishing Corporation Scientific World Journal

Name of author : SadiaRahman,M. T. R. Khan,et.al

Volume: Volume 2014, Article ID 721357,

Title : Sustainability of Rainwater Harvesting System in terms of Water Quality

Methodology : Water samples were collected from the selected residential building where a rainwater harvesting system was planned using laboratory prepared plastic bottles to collect samples. Samples were bottled carefully, so that no air bubble is entrained in the bottle. All parameters were measured in the environment laboratory of Bangladesh University of Engineering Technology (BUET).

maximum amount of rainwater that could be encountered from a roof top is

$$V = A \times R \times C, (1)$$

where V is the amount of harvestable water, A is catchment area, R is total amount of rainfall, and C is the runoff coefficient.

Equation (1) was used to calculate the amount of harvested water from a residential building located at Dhaka, Bangladesh.

Conclusion:
Paper tried to focus on the sustainability and effectiveness of a rainwater harvesting system in terms of quality.

2.7 REVIEW

Name of journal : Engineering journal Volume : 5 | Issue : 1 | Jan 2015 |

Name of author : Ramya R andRudrappaShetahalli

Volume: Volume 5 | Issue : 1 | Jan 2015 |

Title : Design of Rooftop Rainwater Harvesting System for The Administrative Block of V.v.c.e., Mysore

Methodology : Primarily the current consumption of water in the administrative block of VVCE was studied. This was achieved by taking into account the count of individuals residing in the study area alongside with the per capita consumption.

The assessment of the rainfall receptive area was next undertaken.

Further, the quality of rainwater collected on the roof top area of the administrative block was analyzed for physico-chemical and biological parameters, by referring to ‘Standard Methods’.

Then by applying empirical relationships in the field of rainfall analysis and hydrology. This was then subjected to ascertain cost estimation and eventually the cost benefit was analyzed for the rooftop rainwater harvesting system.

Conclusion: The harvested rainwater can be used for non-potable purposes after employing filtration from the designed composite rainwater harvesting unit. When the quality aspects of main source of drinking water is looked into, rainwater harvesting is an economical option to overcome dependency on water supply. Also the rainwater quality assessment indicates it’s relatively pollution free, indicating considerably economical treatment. The cost benefit ratio of 1.53 indicates the research as a favourable and viable proposition.

2.8 REVIEW

Name of journal : International Research Journal of Engineering Science, Technology and Innovation (IRJESTI)

Name of author : Shittu O.I, Okareh O. T et.al

Volume: Vol. 4(1) pp. 032-037, January 2015

Title: Development of rainwater harvesting technology for securing domestic water supply in Ibadan, Nigeria

Methodology : The first stage of the research consisted of planning a research approach in order to develop an idea of rainwater harvesting systems and the methods being adopted in the collection, storage, and usage.

Primary and secondary data were collected from relevant sources.

Rainfall data for a period of ten (10) year between the periods 1995 – 2004 was obtained from the Agroclimatology, Department of the International Institute of Tropical Agriculture IITA Ibadan.

Conclusion:
Rainwater harvest system has proven to be an effective intervention for the perennial water shortage at household level in Ibadan city.

2.9 REVIEW

Name of journal: Applied Water Science Journal

Name of author:HayssamTraboulsiand MarwaTraboulsi

Title: Rooftop level rainwater harvesting system

Volume: Vol. 4(1) pp. 032-037, January 2013

Aim: This paper introduces a new technique to rainwater harvesting which can be easily used in both rural and urban areas: it collects and stores rainwater directly in tanks already installed on building roofs and not necessarily in special ground or underground ones.

Methodology:
1) First of all potential of rainwater is calculated by using the formula of potential harvesting water HW= R x A x K

Where,

R is the average rainfall

A is the total roof area

K is the runoff coefficient

2) Then the rain water harvesting is designed. While designing the rainwater harvesting catchment area should be calculated from the footprint created by the roof .

The conveyance an ordinary water pipe to pump the accumulated rainwater into the water storage tank through a water filter .

Conclusion :
It is far cheaper than the ordinary rainwater harvesting systems as it eliminates the need for a special ground or underground storage tank, submersible pump, first flush diverter and other less expensive materials. It could harvest as much as 196 m3 a year if installed on a rooftop of 400 m2 and receives an average yearly rainfall of 765 mm like the city of Beirut in Lebanon.

2.10 REVIEW

Name of journal : Science Direct

Name of author:ChiemekaOnyekaOkoye, OguzSolyalet.al

Title: Optimal sizing of storage tanks in domestic rainwater harvesting systems: A linear programming approach

Volume:104(2015) 131-140

Aim: This paper proposes an optimization model to determine the optimal tank size of a single residential housing unit for rainwater harvesting and storage.

Summery:

1) First of all mathematical model based on linear programming has been proposed and it is used in the optimal sizing of rainwater storage tank for domestic rainwater harvesting and storage
2) Then this optimization model can be used to determine the rainwater tank
3) this model was applied to the case study from Northern Cyprus
4) then the experiment of sensitivity analysis was taken. The sensitivity analysis is used to determine the optimum size of tank which is required the drinking purpose. The sensitivity analysis reveals that the optimal tank size increases with the roof area, but decreases with an increase in the discount rate and the unit cost of building the tank

Conclusion:
As shown by the case study application, the proposed optimization model is an effective tool that can be used by public authorities or individuals to make feasibility analysis of RWH systems at residential housing units.

2.11 REVIEW

Name of Journal: International Journal

Name of author: Junling Wang, Wan Sun et.al ()

Title: Case study: rainwater utilization and water saving design of village

Aim: The paper presents case study on the village called as maquanying located in china in which the rainwater harvesting planned and water from the rainwater harvesting can be utilize for the water consumption.

Methodology: A dimensionless methodology based on the water balance simulations atdaily temporal scale was applied to rainfall series inmaquanying (china) taking into account historical and future scenarios characterised by climate change in rainfall patterns. The obtained results show high water saving benefits also for relatively small storage tanks with reduced marginal benefits as the tank size increases.Also, the use of the storage tank can provide a significant reduction of water volume discharged to the storm water sewer system. An almost identical performance of the system was obtained with the different rainfall scenarios, confirming the efficiency of the system also under climate changing conditions.

1) Agricultural water is used for the majority of entire water consumption in Maquanying village, and most of them is derived from ground water wells. Therefore, excessive extract causes the problem of imbalance of water cycle and bad local ecological environment.
2) With reducing the extraction from groundwater, moreover, this strategy maintains the stability of geological ecology and benefits village's socio-economic sustainable development
3) Rainwater is used for the drinking purpose for that the rainwater harvesting is design.

Conclusion :
The rainwater amounts used from Cunbei wood area of Maquanying village approach 6249m3/a, and 23221m3/a by using rainwater transmitted from neighbouring village Hegezhuang. Furthermore, rooftop rainwater collected reach 1770m3/a by application of 10 single-family houses renovation to reduce potable water use in yard greening, sprinkling etc. As a result, the potable water saving amount of Maquanying is up to 146434m3/a.

2.12 REVIEW

Name of Journal: International journal

Name of author: Jillian Zankowski, Yixin Sunet.al

Volume: Volume 4 Jan 2014

Title: Gutter Design and Selection for Roof Rainwater Catchment This paper investigates the impact of gutter cross-section on the performance and efficiency of rain water harvesting from roof catchments.

Methodology: Experiments were conducted on a rainwater simulator that was modeled after the simulator described by Miller and Fennessey.

The simulator was used to test conveyance, conductance and interception characteristics of the four different gutter designs.The Duration of each experiment was 2 minutes.

During this time rainfall intensity was captured in the cylinder.

It may be noted that rainfall intensity was determined by total amount captured in the cylinder divided by the duration of experiment.A corrugated metal sheet areuse for roof catchment.

Once raw data were collected for each gutter then multiplied by their weighted rate then best gutter for each rainfall intensity is determined.

Conclusion:
This area is suitable for designing the gutter and water can be used for rainwater harvesting process.

2.13 REVIEW

Name of journal: Physics and Chemistry of the Earth

Name of author: Kudakwashe E. Motsi, Edward Chumaet.al

Volume : v(2004) 1069–1073

Title:A Rainwater harvesting for sustainable agriculture in communal lands of Zimbabwe.

Methodology:

The study was carried out at farmers fields with their full participation in the selection of the treatments that were to be tried on their fields. The fields where trials were carried out have sandy loams to sandy soils derived from the granite parent material.. The areas surrounding the fields used to have savanna woodlands but now are almost bare. Rich and poor farmers participated in the research trials. Farmers volunteered into the project during stakeholder workshops that were held to introduce the project to the communities. After explaining what the project was all about participants were asked to volunteer into the project In Chivi all selected farmers participated in the research but six and four farmers in Mudzi and Gutu respectively finally took part in the research in the first year. Farmers who participated in the research were assisted in carrying out field operations especially the construction of water harvesting structures.

Conclusion:
Generally the soils in the areas under study had poor water holding capacities.. Water harvesting techniques had statistically significant better residual moisture retention capacities than the conventional tillage treatment.. Tied-ridges were observed to be the best in terms of moisture retention. The yields under tied ridges, infiltration pits, fanyajuus were significantly higher compared to yields under conventional tillage. Tied ridges had the highest yields per unit area followed by fanyajuusintensi

2.14 REVIEW

Name of journal: Universal Journal of Environmental Research and Technology

Name of author: Rohitashw Kumar, Thaman S., AgrawalGet.al

Volume: Volume 1, Issue 4: 539-544

Title: Rain Water Harvesting and Ground Water Recharging in North Western Himalayan Region for Sustainable Agricultural Productivity

Methodology:A general survey was carried out to assess the rooftop area of houses; number of houses were collected through personal discussion with beneficiaries and records. The information related to the geographical location of study area and monsoon collected from socio- economic review of Himalayan Region respectively. For the sake of reliability, the quantitative data was collected from a focus group discussion.

Conclusion:
Use of rainwater harvesting will increase the crop yield by 25-35% during rabi season and additional water for population use by 55 % in the area.

2.15 REVIEW

Name of journal: African Journal of Agricultural Research

Name of author: Mohd. Saleem ,Muqeem Ahmed ,et.al

Volume: Vol. 2, Issue. 5, Sep.-Oct. 2012

Title: Analysis of Groundwater Quality Improvement Using Rainwater Harvesting: A Case Study of Jamia Millia Islamia

Aim: The study was aimed to evaluate the ground water quality technique using the rainwater harvesting which is located in new delhi

Methodology: To achieve the main objectives of the study,

Following methodology have been adopted
1. Groundwater Quality Test Results of February 2011 are arranged and analyzed.
2. Groundwater Samples were collected in the month of November, 2011 (Post-Monsoon period) and analyzed.
3. Groundwater Samples were collected in the month of April 2012, in order to know the changes in the groundwater quality since the rainwater recharge.
4. All the three groundwater quality test results of the JMI was compiled and comparative study was done to reveal the overall impact of rainwater harvesting on groundwater quality of the JMI campus.
5. Analysis of rainwater sample and groundwater sample of the JMI Campus in order to check the impact of rainwater harvesting.
6. Study of the impact of rainwater harvesting on groundwater quality potential of the JMI

Summary:
1. The groundwater quality analysis data at pre-installation period of the rainwater harvesting structures at the JMI is collected.
2. Groundwater samples in the PostMonsoon period covering the entire JMI campus area is collected in order to analyses the impact of rainwater harvesting on groundwater quality.

3. Groundwater samples after few months isknow to know the changes in the groundwater quality since the post-monsoon times.
4. Comparative Study is done of quality of all the threegroundwater quality test results in order to ascertain the overall impact of Rainwater Harvesting on groundwater quality of the campus area.

Conclusion:

It can be concluded that the rainwater recharge improves the quality of groundwater and its quality depends upon the amount of rainwater recharged and the environment of rainwater collection and recharging

CHAPTER 3
METHODOLOGY
3.1 STUDY AREA
The campus area of WAGH GURUJI SCHOOL is selected. The existing maps of campus were studied and the dead boundaries for the area in which work is to be executed were fixed.Total area is 16136m^2.The visual study of total area was done.

Figure 3.1 – Location Map of Study Area

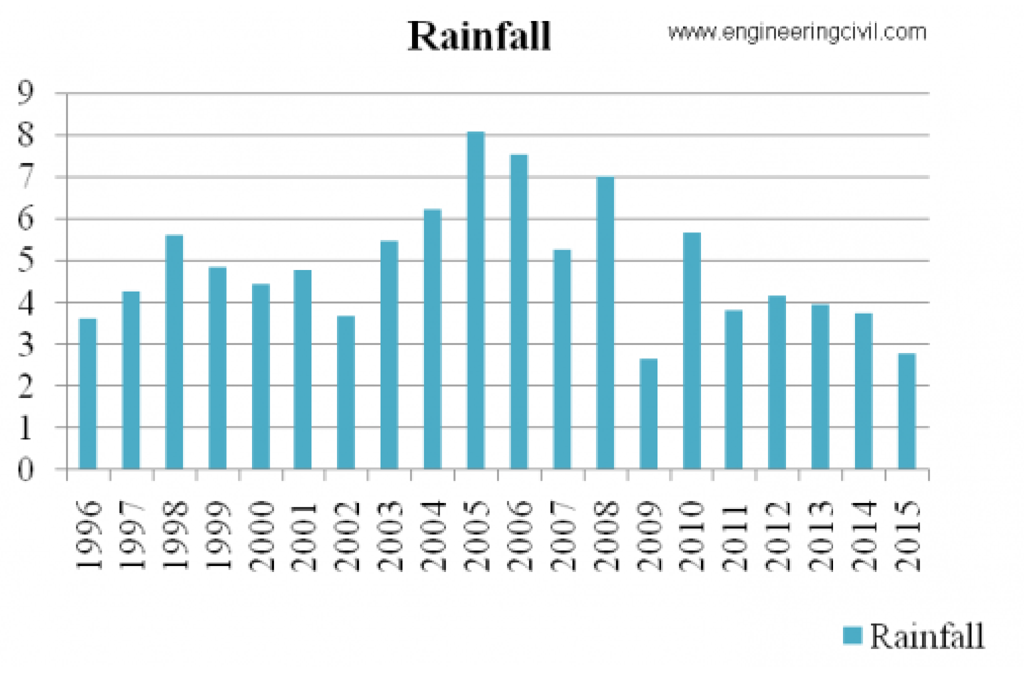
The study area has geological position ,
(20^0 00′ 50″N – latitude and 73^0 45′ 56″E – longitude)

3.2.RAINFALL DATA ACQUISITION
The rainfall data for Nashik District was collected fron “Jalvidnyanbhavan MERI Nashik”.For the purpose of calculation of total rainfall intensity and total discharge we can use this data. The rainfall data which we are collected is on yearly basis.

Table 3.1-YEARLY RAINFALL DATA

Year	Rainfall (mm)	Temperature (^{0}C)	Evaporation (mm)

1996	359	30.46	3.52
1997	427	28.98	2.90
1998	560	27.04	2.50
1999	485	28.97	2.92
2000	444	29.35	4.61
2001	479	29.55	3.26
2002	367	30.15	5.75
2003	546	30.09	3.39
2004	621	29.26	3.32
2005	808	29.70	3.45
2006	754	29.41	3.18
2007	525	29.65	3.28
2008	700	30.15	3.26
2009	265	30.52	3.52
2010	568	28.54	2.85
2011	382	29.04	3.30
2012	415	29.65	3.25
2013	396	28.23	3.10
2014	373	29.38	3.19
2015	310	30.18	4.78



GRAPH 3.1-YEARLY RAINFALL DATA

3.3.AREA CALCULATION

This is the second stage of the project in which we had calculated the area of selected region and differentiated it in various categories.

The selected categories are as follows

- Roof cover
- Open ground
- Bituminous road

Dividing the work area for surveying in the categories viz;

Table 3.2-Area calculation

WAGH G. SCHOOL		**AREA(m²)**
TOTAL AREA		16134.82
	PAVEMENT	1613.48
	TOTAL ROOF	2041.62
	TOTAL OPEN G.	12479.71

The measurement of the area is done with the help of measuring tape. The measuring tape we used for the measurement was linen or cloth tape.

Table 3.3 -Average & maximum parameters

PARAMETER	**AVERAGE**	**MAXIMUM**

RAINFALL (mm)	5.121378	113.2
TEMPERATURE (^{0}C)	29.66287	42.5
EVAPORATION (mm)	3.716021	12.1

These are the parameters which we consider during our project work like rainfall , temperature and evaporation . The average values and maximum values of the annual rainfall, temperature and evaporation is given in above table.

Table 3.4-Water requirement and bill of School

Name of Area	No. of Head (User)	Water Capacity (lit.)	Water Bill (Yearly) (Rs.)
WaghGuruji School	1845	30000	15000

The water capacity of the school, number of users and the total annual water bill is collected from the school .which we can utilise for the further use in project work for calculations of water requirements, total expenditure on the water bill.

3.4 ESTIMATION AND DESIGN

3.4.1 ESTIMATING RUNOFF

Calculations of surfaces runoff by rational method of surface runoff estimation. There are different runoff for different surfaces, each surface has specific runoff coefficient, by relating it to the rainfall intensity one can judge the amount of runoff from that surface.

Also the different types of losses are considered accounting the water collection, the losses are of various kinds such as evaporation, infiltration, transpiration, etc

Table 5-Design Parameters for Average Data

RAINFALL(mm/day)	
AVERAGE	5.121378
MAXIMUM	113.2
TEMPERATURE(°C)	
AVERAGE	29.66287
MAXIMUM	42.5
EVAPORTAION(mm/day)	
AVERAGE	3.716021
MAXIMUM	12.1

Following are the areas of the campus and respective runoff coefficients:

TYPE OF SURFACE	AREA(m^2) (A)	RUNOFF COEFF. (C)	A*C	“C” OVERALL
ROOF COVER	2043.53	0.95	2337	
OPEN GROUND	12062	0.3	3618.6	
CONC. BLOCK PAVMENT	1614	0.7	1129.8	
TOTAL	16136	1.95	6813.7	0.65

The runoff coefficients we mentioned above are taken from the book of S.K.Garg , Irrigation and water supply engineering

3.5 REQUIREMENT OF WATER QUANTITY

At wagh Guruji School :

1) Total roof area (A)=2043m^2

Rainfall intensity (i)=6mm/day

Q=C x i x A

Q=0.95x(i/1000)x2043.63

Q=11.64m^3/day

Total discharge=11.64m^3/day

Quantity of water collected in rainy season.

Q=11.64x30x3

Q=1047.6m^3

1047.6m^3or10,47,600litres of water is collected from roof of waghguruji school.

Demand of water for drinking purpose :

= No. of users x requirement of water per head x270 days

= 1845 x3 x270

=14,94,450 litre.

2) Total Area of open ground =12062 m^2

runoff coefficient=0.3

Rain fall intensity=6mm /day

$Q=C \times i \times A$

$Q=0.3 \times (6/1000) \times 12062$

Q= 21.71 m^3/day

Total Discharge = 21.71 m^3/day

Total water collected in one rainy season $Q=21.71\times30 \times 3$

Q=1954.04 m^3

Water is collected From open ground of WaghGuruji School is 1954 m^3.

3)Total Area of Pavement =1614 m^2

runoff coefficient=0.7

Rain fall intensity=6 mm /day

Q=CiA

$Q=0.7 \times (6/1000) \times 1614$

Q= 6.77 m^3/day

Total Discharge = 6.77 m^3/day

Total water collected in one rainy season

$Q= 6.77\times30 \times 3$

Q=609.8 m^3

Water is collected From Pavement area of WaghGuruji School is 610 m^3.

3.6 DESIGN

3.6.1 REQUIRED CAPACITY OF WATERTANK

Roof water flow is collected in water tank. Roof water collected from north area of campus i.e. the campus of WaghGuruji school .According to survey we have observed that the bore wells and the open wells in this area are dry. Because of this reason there is no bore well provided for the proposed building.

Hence,

Runoff calculation:

We can provide a water tank for the North area of campus.

1) Total Area of open ground = 12479.71m^2
2) Total Area of pavement = 1613.48m^2
3) Total Area of Roof Top = 2041.63 m^2

Now, runoff coefficient

C=0.9
A = 2041.63m²
Q =C x i x A
= 0.9 x (6/1000) x 2041.63
Q = 11.29 m³/day

Total water collected in one rainy year;

Q =11.29 x 30 x 3
Q = 1016.19 m³

The amount of water collected in one rainy year = 1017 m

3.6.2 DESIGN OF TANK
Q = 1017 m³

Assuming additional 10 % losses,
Q = 1017 – 0.1 x 1017
Q= 915.3 m³
Total depth = 4 m
Hence,

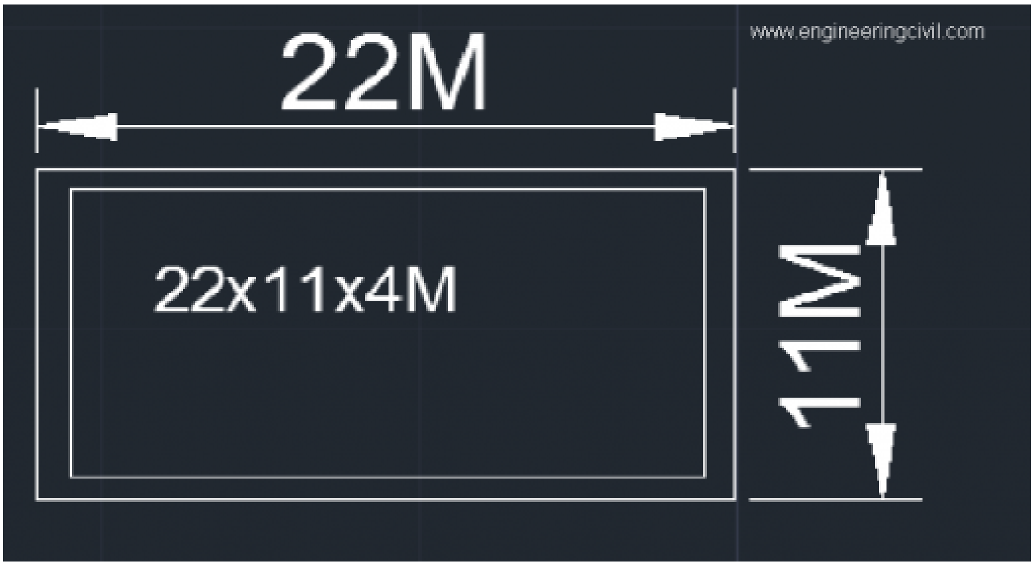
A = 915.3/4 = 228.8 m²
A = B x W

To provide rectangular storage tank
B = 2 W
Therefore,
B = √114.4 = 10.69 m
B=11m

Hence, size of tank = (4 x 11 x 22) m

Which is Economical

As the Size of the tank is (4 x 11 x 22) m



3.6.3 FILTER

- **Pressure Filter :**

Material For the Filter tank is Mild Steel Fabricated Tank,

Discharge per Day = 11.64 m^3/day

Assuming Working Hours = 16 hrs

Discharge per hour = 11.64/16

=0.72 m^3/hr

Considering Rate of Filtration as 10 m/hr

By Using Manual on Water Supply andTreatement CPHEEO.

Now,

Area = Discharge/Velocity

=11.64/10

Area=1.16 m^2

Diameter of the Filter

Area = $(\pi/4) \times D^2$

$1.16 = (\pi/4) \times D^2$

D = 1.21 m

Considering height (H) = 1.5 m

Media Details :

1) Media depth (Sand) = 0.7 m

2) Gravel Depth = 0.3 m

3) Free board for

expansion =0.35 m

4) Under drain system = 0.3 m

Total Height =1.65 m

Providing Height = 1.7 m

3.6.4 DESIGN OF PIPES

As the pipes used for collection of water should have proper size so that during the storm period they should carry the excess amount of water though them without causing any disturbance (breaking of pipes , leakage) in the work.

Q = A x V

But Q = 11.64 m^3/day

Q = 1.34 x 10^{-4} $m^{3/}$sec

Now, Assume velocity of flow = 0.6 m/sec

A = Q/V

= (1.34 x 10^{-4})/0.6

Butas ,

Area = (π/4) x D^2

((π/4) x D^2 = (1.34 x 10^{-4})/0.6

D = 16.35 mm

As per the design calculations the pipe diameter is very small and not available in market.

As per the CPHEEO manual the minimum pipe diameter should not be less than 150 mm.

Hence we are proposing pipe size as **150 mm**.

Pump for lifting water from the tank to the filter is of 3HP, which gives flow rate as 1m^3/hr.

3.6.5 COST ANALYSIS:

Cost of Storage Tank :

Excel Sheet constructed by Using Maharashtra JeevanPradhikaran DSR.

SL NO	DESCRIPTION	UNIT	NO	L (m)	W (m)	D/H (m)	QTY	Rate	Amount
	SEWAGE TREATMENT PLANT							**MJP DSR 2015-16**	
A	**Preliminary Work**		**1**	**22.00**	**11.00**	**4.00**			
1	Excavation								
a	Up to 1.5 m	Cu.m	1	22.90	11.90	0.50	136.26	139	18939.45
2	Plain Cement concrete with 12-20 mm	Cu.m	1	22.90	11.90	0.10	27.25	3454	94124.95
3	Reinforced cement concrete (M-30) including formwork								
a	Bottom Slab	Cu.m	1	22.40	11.40	0.20	51.07		
b	Vertical Walls	Cu.m	2	22.40	0.20	4.00	35.84		
c	Vertical Walls	Cu.m.	2	11.40	0.20	4.00	18.24		
						Total	**105.15**	5313	558672.58
4	Corrossion Resistance Steel (CRS) reinforcement for RCC work	MT					**9.46**	48524	459215.61
					Cost of Civil Works				**1130952.58**

Total Cost of the RCC Storage tank = **Rs. 11,30,953/-**

Cost of filtration Unit :

SL NO	Description	QTY	Cost/m3	Cost
A	**Pressure Sand Filter**			
	Vessel cost	22800	Rs	

Area of Filter	1.15	m2	
Depth of Sand	0.70	m	
Volume of Sand	0.80	m3	
Cost of media	4.00	Rs/kg	
Density of Sand	1780.00	kg/m3	
Weight of Sand	1432.78	kg	
Total Cost of Sand	5732		
Cost of PSF	31386		
Total No of filters	1	nos	
Cost of PSF	31386	Rs	
Cost of PSF			**31386**
Consider piping and valves and fitting cost as 20%	6277.2		
Total cost of PSF	37663.2		**37664**

- Cost of filtration Unit,
- Pressure Filter = 37664
- Cost of Pump and fixtures =10,000
- Total Cost = Rs. 47664/-

- Cost of PVC pipes for rooftop collection :

1. Total length of PVC pipes = 280m.
2. Cost of 6” PVC pipe =Rs. 210/ m (market value)
3. Total cost of PVC pipes =Rs. 58,800/-
4. Cost for fitting and fixtures=Rs. 8,000/-

- **Total cost = Rs. 66,800/-**

Table 6-COST ANALYSIS

Sr.No	Description	Value (Rs.)
1	**Total cost of construction water tank**	1130952 /-
2	Pressure Filter	37664 /-
3	Total cost of PVC pipe	58,800/-
4	Cost for fitting and fixtures	8000/-
5	Cost of Pump and Fixing	10,000/-

6	**Total Cost**	**12,45,416**/-

Total Cost of the Rain Water Harvesting System is Rs.12,45,420/-

This is one time investment for construction of the this Unit.

The maintenance cost of the unit is very less as there only need maintenance for Pump, pipe line and filter units. So we can suggest only 3 – 4 % amount of the total Project will be sufficient to maintain the unit in operation.

CHAPTER 4

RESULT&DISCUSSION

RESULT

- FROM THE EXPERIMENTAL WORK CARRIED OUT FOLLOWING RESULTS ARE LISTED BELOW
- The total area under Project is calculated as 2042 m^2.
- The total cost of the rain water harvesting system is Rs.12,45416/- calculated and suggested.
- The water which will be collected by the rain water harvesting system is of Drinking Quality.
- So we are successfully achieving the Goal of the Project.

SR No.	**Description**	**Value**
1	Total area under Project	2042 m^2
2	Total discharge collected from roof	915.3 m^3/sec
3	Total annual water bill	Rs. 15000/-
4	One time cost of installation of rainwater harvesting System	Rs. 12,45,416/-

DISCUSSION

- From the experimental work carried out, if we provide the Rainwater Harvesting System at WaghGuruji School the total amount of the rain water to be saved is equal to **9,15,300**liters per year. The project saves plenty of Water as the water management is the need of generation.
- This is one time investment in the work of rainwater harvesting though its Costly but the requirement of the drinking purpose is fulfilled upto**66%** only through rain.
- Now a days cost of the water per liter is quite high compared to that the water collected in this system gives reliable quantity of water. In project area there are two bore wells are provided which operate for the sanitation and gardening purpose so in future we thought about collection of open surface water and recharge the wells .

- In future water collected from surface run off is harvested in bore wells which will serve the purpose of recharging aquifers and fulfill the increasing demand of water.
- The total Cost of the project is **12,45,416** though it is quite high but the rainwater harvesting is the need of this Era. This is one time investment but the achievements are too high.
- As the Rain water is free and clean source of water, the initial cost is zero ,we only need a structure which control the wastage of water in the form of rain water harvesting.
- Now a days water Cost is rapidly rising as the population increasing at enormous rate so rain water harvesting is beneficial to save the money.

CHAPTER 5
CONCLUSION

The contour maps obtained from contour survey shows that the slope of the ground is towards the NE of the WaghGuruji School, hence collection and storage tank can be provided in NE zone. The rooftop water collection can be used to fulfil the daily drinking demand. By installing given rain water harvesting system every year huge amount of water will be savedand huge expenditures on procurement of water will be reduced.

The huge amount of precipitation occurring on the ground can be harvested and utilized for different purposes, if proper collection system is provided. As so many parts of the world facing the problems of water crises, one must understand the importance of water, and should made optimum use of water and adopt efficient methods of collecting and saving the rainwater. The procedure adopted in this study is proven to be costly as per the cost analysis, very easy as per methodology and very efficient as per the discharge calculated**.**

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Figures and Tables

*We at engineeringcivil.com are thankful to **Er Shubham Sunil Malu** for submitting this very useful paper to us. We are sure this would be of great help to all engineers seeing more information on rain water harvesting.*

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