A MINI PROJECT

ON

"RAINWATER HARVESTING AS A SUSTAINABLE SOLUTION: A STUDY AT ASSAM ENGINEERING COLLEGE, JALUKBARI"

Submitted in Partial Fulfillment for the Requirements for the award of Degree of

MASTERS OF TECHNOLOGY (CIVIL ENGINEERING)

UNDER

ASSAM SCIENCE AND TECHNOLOGY UNIVERSITY

(With Specialization in Water Resources Engineering)

SESSION: 2023-2025

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ACKNOWLEDGEMENT

We are highly honoured to express our sincere and heartfelt gratitude to **Dr. Jayanta Pathak**, Head of Department, Civil Engineering Department, for encouraging and allowing us to present the project on the topic at our department premises for the partial fulfillment of the requirements leading to the award of Bachelor of Technology in Civil Engineering.

We would like to express our heartfelt gratitude to our Project Supervisors, **Dr. Bipul Talukdar**, Professor, Department of Civil Engineering for his guidance, encouragement and for providing us necessary facilities, valuable suggestions and constructive criticism in carrying out the project work.

Last but not the least, we are thankful to the Faculty and Staff of the Civil Engineering Department of our college and other technical and non-technical staff who helped us to learn a lot of new things and we are extremely grateful to them.

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CANDIDATE DECLARATION

We hereby certify that the work presented in the project entitled **“Rainwater Harvesting as a Sustainable Solution: A Study at Assam Engineering College, Jalukbari”** is the authentic record of our own work carried out under the guidance of **Dr. Bipul Talukdar**, Professor, Department of Civil Engineering, Assam Engineering College, Jalukbari. The project is submitted in partial fulfillment of requirements for the award of the degree of **“Master of Technology in Civil Engineering**” under specialization on **Water Resources Engineerin**g to the Department of Civil Engineering, Assam Engineering College, Jalukbari , Guwahati-781013, Assam.

The matter embodied in this dissertation has not been submitted to any other institute for the award of any other degree. We have followed the guidelines provided by the Department of Civil Engineering, Assam Engineering College, Jalukbari, Guwahati-781013,Assam. Whenever materials from other sources are used, due acknowledgement is given to them by citing them in the text of this project and giving their details in the references.

This is to certify that the above statement made is correct to the best of my knowledge.

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CERTIFICATE FROM THE SUPERVISOR

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The content of this report has not been submitted to any other university for the award of any degree.

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It is to certify that the project report entitled **“Rainwater Harvesting as a Sustainable Solution: A Study at Assam Engineering College, Jalukbari”** is hereby accorded our approval as a study carried out and presented in a manner in their 3rd semester courses for acceptance in partial fulfillment for the award of **Master of Technology** in **Civil Engineering** under specialization on **Water Resources Engineering** degree for approval does not necessarily endorse or accept every statement made, opinion expressed or conclusion drawn as recorded in the report. It only signifies the acceptance of the project report for the purpose for which it is submitted.

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ABSTRACT

Water scarcity is a serious problem throughout the world both urban and rural communities. Urbanization industrial development and increase in agricultural field and production has resulted in over exploitation of groundwater and surface water resources and resultant in determination in water quality. The conventional water resource namely well, river and reservoirs etc. are inadequate to fulfill the water demand due to unbalance rainfall. Wilder rainwater harvesting in investigate a new water source.

The aim of the present study is to use rainwater and thus taking close to the concept of nature conservation. In this study, the rainwater harvesting (RWH) system is analyzed as an alternative source of water at the campus of Assam Engineering College, Jalukbari in the state of Assam. The expected outcome of the study is the development of rain water harvesting system for catchment area of the campus from parking academic building hostels up to the canteen. Result of the analyses shows that the present rainwater harvesting fulfills a decent amount of water needed in the campus. The development system satisfies the social requirement and can be implemented in rural areas by considering almost all the technical aspect.

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CHAPTER-1

INTRODUCTION

1.1 OVERVIEW

Water is essential for life on Earth, and without it, life would be unimaginable. However, freshwater resources are becoming increasingly scarce over time. According to reports from global organizations, including the United Nations, if the current situation does not improve and preventative measures are not implemented, the world may face a severe freshwater shortage by 2050. Rainwater harvesting, a sustainable and eco-friendly practice, plays a crucial role in maintaining the groundwater table and recharging aquifers. Promoting this green practice through Community Development Programs can gain widespread support by highlighting its numerous benefits. It fosters collective thinking on environmental conservation, encourages innovative approaches to sustainability, and inspires a shared commitment to preserving water for future generations. Additionally, storing rainwater and stormwater runoff helps prevent soil erosion and flooding, while replenishing aquifers, thereby supporting the groundwater levels.

Urbanization has led to concentrated population densities in certain areas, resulting in uneven groundwater extraction. This has caused droughts and the drying up of riverbeds in regions with increasing domestic and industrial water demands. By shifting the focus to rainwater usage in these areas, groundwater levels could gradually return to normal, restoring ecological balance. The extensive and unplanned exploitation of groundwater has disrupted the natural water table, leading to contamination and rendering water unusable in many areas. Immediate measures are needed to allow groundwater to recover in these regions. Harvesting rainwater and stormwater runoff can significantly mitigate the risks faced by future populations. While water conservation is frequently discussed as a solution to water scarcity, it is insufficient without incorporating rainwater harvesting. Just as a bank balance grows by depositing more than is withdrawn, sustainable water management requires replenishing water resources through rainwater harvesting alongside conservation efforts.

Rainwater harvesting, besides being eco-friendly, is an economic practice as well. The cost of digging a catchment area even can be saved by roof-top collection of rainwater. The freshwater canals or rain-fed natural ponds too can be used for harvesting. The catchments and settlement tanks built in the area easily free the spot and the vicinity from the curse of flood or water logging, thus saving money of pumping out dirty muddy storm water . Presence of water body in the region also reduces the ground heat and act as a natural cooler. The best part of the practice of rainwater harvesting, however, is that one hand it is checking one from leaning towards using groundwater as rainwater is obtained in abundance in many countries; on the other hand, if remains unused or extra, these rainwater, collected in say natural ponds or even in artificial tanks can pour back to the ground thus charging the natural aquifer to boost the groundwater level.

The Guwahati city, the gateway of North East is spread over an area of about 300 Sq. Km on both banks of mighty Brahmaputra. The city is experiencing unprecedented population growth and rapid urbanization as well as industrial development during last 30 years. The city has got several water bodies like Deepor Beel, a Ramsar site, Soru Sola Beel, Bor Sola Beel etc. Within the city there are many man made fresh water tanks/ small lakes built in the long past including Dighalipukhuri, Silipukhuri, Jorpukhuri etc. Inspite of all these water sources, the city dwellers suffer from scarcity of water for drinking and other uses at their urban households. Government water supply schemes so far hardly meet the requirements of 30% of the population. The rapid depletion of the ground water in the city further adds to the water woes. And also artificial flood has been a constant problem of the city for ages now and with proper implementation of rain water harvesting and continuous improvements this problem can be solved.

This calls for in-situ rain water harvesting at every house hold. In fact, very little attempt has been made by Govt or private agencies to harness the abundantly available surface and rain water resources of Guwahati city. A recent study shows that with the rain water harvesting, while Delhi can have 1.13 as average yield factor, Guwahati goes up to 3.95 over the requirements. There are many examples of individual efforts could be seen in the city. One such effort could be seen at residence of Mr. G Patowary, Jt. Secretary, to Govt. of Assam, Health (Rtd.), Zoo japarigog area. He has converted his 4th floor into a roof garden and raising vegetables and flowers throughout the year. Water requirements of crops, washings etc are met with harvested rain with occasional supplements of piped water. It is in operation for last 20 years. Another attractive individual effort could be seen at House No.25 at Sewalipath, Hatigaon, Dispur. This is in operation since last 15 years. The house is four storied and roof gardens are raise in 1st, 2nd and 3rd floors with provisions to supply/ spray harvested rain water in place as and whenever necessary. In first floor, a tank for pisciculture has also been constructed and local verities of fishes like Magur(cat fish), Kaoi, Rahu, Puthi etc. are surviving for years. Gardens and fishery are supplied with rain water and occasionally supplemented by piped water.

So rain water harvesting is an essential step towards betterment of our future generation. Our study is to focus mainly on the AEC campus (as a part of the Guwahati city) and analyze the structure and implementation of rain water harvesting on this area in a suitable way.

1.2 OBJECTIVE OF THE STUDY

- Investigate rainwater harvesting as an alternative water source to address water scarcity.
- Examine the use of rainwater harvesting systems in promoting nature conservation.
- Analyse the implementation of a rainwater harvesting system at Assam Engineering College, Jalukbari, as a case study.
- Assess the efficiency of the rainwater harvesting system in fulfilling the water demand of the campus, including areas like parking, academic buildings, hostels, and the canteen.
- Explore the potential for implementing similar rainwater harvesting systems in rural areas, considering technical aspects and social requirements.

1.3 CHAPTERWISE PLANNING

- **Chapter 2**: Provides a brief review of existing literature in the field.
- **Chapter 3**: Discusses the components and methodologies used throughout the experiments.
- **Chapter 4**: Study area of AEC campus with measured maps.
- **Chapter 5**: Discusses the data collection and analyses of the same.
- **Chapter 6**: Provides the calculation of rainfall volume and size of the channel section.
- **Chapter 7**: Presents the conclusion and summary of the study, addresses the limitations of the study, and offers insights into the future scope of the research.

CHAPTER-2

LITERATURE REVIEW

Borah, J. (2017), "Groundwater Recharge through Rainwater Harvesting in Assam". Borah's research focuses on the potential of rainwater harvesting to enhance groundwater recharge in Assam, with a specific focus on Guwahati. The paper presents data on declining groundwater levels in the region and discusses the role of rainwater harvesting in addressing this issue. Borah analyses various recharge techniques, such as infiltration wells and recharge trenches, and their applicability in different urban settings. The study also evaluates the cost-effectiveness and feasibility of these systems, providing recommendations for their implementation. The paper concludes that rainwater harvesting is a viable solution for augmenting groundwater resources and ensuring water security in Guwahati.

Baruah, S. (2018), Baruah's article titled as "Community-Based Rainwater Harvesting Initiatives in Guwahati. International Journal of Community Water Resources" explores the role of community-based initiatives in promoting rainwater harvesting in Guwahati. The paper presents case studies of successful projects, such as neighbourhood water tanks, community-managed recharge ponds, and school-based rainwater harvesting systems. Baruah emphasizes the importance of community participation and local knowledge in the design, implementation, and maintenance of these systems. The study also discusses the social and economic benefits of community-based rainwater harvesting, including improved water availability, reduced dependency on municipal supplies, and enhanced social cohesion. The paper concludes that empowering communities and fostering local ownership are key to the sustainability of rainwater harvesting initiatives.

Das, M. (2021), Das's paper "Policy Framework for Rainwater Harvesting in Urban Areas of Assam. Indian Journal of Policy and Planning" provides a comprehensive review of the policy framework for rainwater harvesting in Assam, with a particular focus on urban areas like Guwahati. The paper discusses existing policies and regulations that mandate the incorporation of rainwater harvesting systems in new buildings. Das identifies gaps in policy implementation and enforcement, highlighting the need for stronger regulatory mechanisms and incentives for compliance. The paper also explores the role of public awareness campaigns, capacity building, and stakeholder engagement in promoting the adoption of rainwater harvesting. Das concludes with policy recommendations for enhancing the effectiveness of rainwater harvesting initiatives in urban areas.

Goswami, A. (2020), Goswami's article "The Role of Rainwater Harvesting in Sustainable Urban Development" investigates the contribution of rainwater harvesting to sustainable urban development in Guwahati. The paper highlights the multiple benefits of rainwater harvesting, including water conservation, reduction of urban flooding, and enhancement of groundwater recharge. Goswami argues that integrating rainwater harvesting into urban planning and infrastructure development can address various environmental and social challenges. The study also explores the role of green infrastructure, such as green roofs and permeable pavements, in complementing rainwater harvesting systems. The paper concludes with policy recommendations for promoting sustainable urban development through rainwater harvesting.

Hazarika, T. (2021), "Challenges and Opportunities in Implementing Rainwater Harvesting in Guwahati. Journal of Environmental Studies" Hazarika's paper discusses the practical challenges and opportunities in implementing rainwater harvesting systems in Guwahati. The study identifies key obstacles, such as lack of awareness, inadequate funding, technical barriers, and regulatory gaps. Hazarika also highlights the opportunities for promoting rainwater harvesting, including government incentives, public-private partnerships, and the use of innovative, low-cost technologies. The paper provides case studies of successful projects and best practices from other regions that can be adapted to Guwahati. Hazarika concludes with recommendations for overcoming the challenges and leveraging the opportunities to ensure the successful implementation of rainwater harvesting systems in the city.

Kalita, P. (2020). This journal "Impact of Climate Change on Water Resources in Guwahati. Climate and Water Journal" examines the impact of climate change on water resources in Guwahati, with a focus on rainwater harvesting as an adaptive strategy. Kalita discusses the changing rainfall patterns, increased frequency of extreme weather events, and their implications for water availability in the region. The paper reviews various rainwater harvesting methods, such as rooftop collection, surface runoff harvesting, and recharge pits, and their potential to mitigate the adverse effects of climate change. Kalita argues that integrating rainwater harvesting into urban planning can enhance the resilience of water systems to climate variability and ensure sustainable water supply.

Nath, D. (2019), "Rainwater Harvesting Techniques and Their Implementation in Guwahati" Journal of Water Science and Technology, This paper provides a technical analysis of various rainwater harvesting techniques used in Guwahati. Nath discusses methods such as rooftop collection, surface runoff harvesting, recharge pits, and percolation tanks, evaluating their efficiency and suitability for different urban settings. The paper provides detailed guidelines on the design, construction, and maintenance of these systems, along with case studies of successful implementations. Nath also examines the challenges faced in the adoption of rainwater harvesting, such as lack of technical expertise, financial constraints, and limited public awareness. The paper concludes with recommendations for overcoming these challenges and promoting wider adoption of rainwater harvesting in Guwahati.

Sarma, AK & Hazarika (2016), the paper entitled as "Potential impact of climate change on rainfall intensity-duration-frequency curves of Guwahati city" rreveals that climate change is expected to significantly alter rainfall patterns in Guwahati. Key findings include an increase in the frequency and intensity of short-duration, high-intensity rainfall events. These changes are likely to exacerbate urban flooding, strain existing drainage systems, and increase the risk of waterlogging and related urban issues. Hazarika also notes a shift in seasonal rainfall patterns, with more rainfall expected during shorter time spans, leading to increased runoff and reduced groundwater recharge. This has serious implications for water resource management, highlighting the need for improved rainwater harvesting and flood control systems.

The paper underscores the necessity of updating IDF curves to reflect these changes. Outdated curves, based on historical data, may no longer be adequate for designing resilient infrastructure. Hazarika argues for integrating climate projections into urban planning processes to mitigate the risks associated with changing rainfall patterns. the study advocates for the adoption of climate-resilient urban planning practices, such as the incorporation of green infrastructure, improved drainage systems, and enhanced rainwater harvesting. These measures can help mitigate the impact of increased rainfall intensity and frequency, ensuring sustainable urban development.

Sharma, R. & Dutta, P. (2018), in their journal "Traditional Water Management Practices in Northeast India. Environmental Conservation Journal." The authors delve into the indigenous water management practices prevalent in Northeast India, with a focus on Guwahati. The authors highlight the traditional methods of rainwater harvesting, which have been used for centuries to manage water scarcity. These methods include rooftop rainwater collection, bamboo-based storage systems, and earthen ponds. The book emphasizes the sustainability and adaptability of these methods to the local climate and geography. Sharma and Dutta argue that these traditional practices, if revitalized and integrated with modern techniques, can provide a sustainable solution to the growing water crisis in urban areas like Guwahati. They also discuss the socio-cultural significance of these practices and their role in community water management.

Singh, A. (2019), in his article "Rainwater Harvesting: A Sustainable Approach for Urban Areas. Journal of Urban and Environmental Engineering" explores the role of rainwater harvesting in urban water management, with a case study on Guwahati. Singh discusses the challenges posed by rapid urbanization, such as reduced groundwater recharge, increased water demand, and urban flooding. The paper evaluates various rainwater harvesting techniques, including rooftop harvesting, percolation pits, and rain gardens, highlighting their benefits in mitigating these challenges. Singh presents data on the effectiveness of these systems in reducing urban runoff and replenishing groundwater. The article also emphasizes the need for policy support and community participation to ensure the successful implementation of rainwater harvesting systems in urban areas.

CHAPTER-3

METHODOLOGY

3.1 OVERVIEW

Rainwater Harvesting is a method by which we collect the rainfall and give it treatment so that we can reuse the rain water for different purposes like drinking, washing, watering the plants etc. Simply rain water harvesting is the process of catching, collecting and storing for reuse. Water is generally collected from rooftops or upper platforms and hard surfaces etc.

Due to increase in population, increase in infrastructure development and increase in number of industries water demand is increasing day by day. Furthermore, due to fluctuation of climate and depletion of ground water level a huge number of populations faces water problem every year.

By applying **Water harvesting techniques** we can not only solve the problem of water demand increasing **by storing water** but also increase the water level by different **recharge mechanism**.

There are generally two ways harvesting rainwater. In urban areas, rainwater flows away as surface runoff which can be caught and used for recharging aquifers. In the second method, we use the rooftop as catchment and collected the rainwater from the roof top.

For Rain Water Harvesting, we can use easily available equipments. We can use our terrace as a catchment area to collect rain water and then it will connect to the pipes which will act as conduits. A mesh filter is provided at the mouth of conduit which filters the water coming from catchment. The water coming through pipes are collected at either

A. Storage Tank
B. Artificial Recharge System.

The rainwater water collected at the **storage tanks** are further purified by filter and then we can use them for immediate purpose. We can use the treated rainwater not only for cleaning, gardening and washing purpose but also for cooking and personal consumption.
Artificial Recharge systems like recharge wells, direct bore wells plays two major important rules such as:-

- It helps to control and mitigate flooding.
- Helps ensure rainwater percolates into ground water.

But the methods and techniques used for ground water recharge in urban areas which generally uses run-off rain water harvesting are different from rural areas.

URBAN AREAS	RURAL AREAS
• Recharge Pit • Recharge Trench • Tube Well • Recharge Well	• Gully Plug • Contour Bund • Gabion Structure. • Percolation Tank • Check damp • Recharge Shaft • Dug well Recharge • Ground Water Dams

3.2 TYPES OF RAINWATER HARVESTING

There are mainly 7 types of rainwater harvesting.

1. Water Butt
2. Direct-Pumped (Suction)
3. Indirect Pumped
4. Indirect Gravity
5. Gravity Only
6. Retention Ponds
7. In-ground Storage

1. **Water Butt** :It collects rain water in a from natural rain fall or drain pipes. It is a basic system of rain water harvesting. The collected water mainly used for garden purpose.

2. **Direct Pump** : It is of two types :
    - Submersible
    - Suction

   Submersible : this type of pump is placed within the underground tank the harvested water is directly pumped to the applications like WC which are used for domestic purposes.

   Suction : In this system the pump is not located inside the tank, instead it is located within a control unit within the house. This unit also work as a backup from mains water supply.

3. **Indirect pump** : In this type, the harvested rainwater is pumped to a tank which can be at any level in the building. Furthermore, a booster pump is used to pressurized water supply. The main advantage of this system is that it provides flexibility to tailor the booster pumps to adjust the flow and pressure requirement of the building.

4. **Indirect Gravity :** In this arrangement, the harvested rain water is first pumped to the header tank (high level tank) , then allowed to supply the outlets by gravity alone. The pump of this arrangement will work only when the header tank needs filling. And also, the mains water is fed directly to the header tank , not to the main harvesting tank.

5. **Gravity Only :** In this type, the storage tank is located below the level of the gutters, yet higher that the outlets that it will supply. The rain water is collected from a part of the roof which has gutters above the filter and collection tank is above all the outlets. As only power of gravity is used for this type, it is very energy efficient .

6. **Retention Pond :** Retention ponds are a blue/ green infrastructure designed to store water. After the collection of surface run-off water , we can improve the quality of water by natural processes like sedimentation, solar disinfection, decomposition, and soil filtration etc. The most common use of pond harvesting is water livestock.

7. **In-Ground Storage** : In the areas where the majority of rainfall occurs in one single season, underground storage tanks are commonly used. The advantages of underground tanks are that
   - They are insulated.
   - They have a very low rate of evaporation.
   - The water stored in the tanks does not freeze , if it is buried in the frost line.

An electric pump is connected to the underground storage tank, to ensure the supply of the stored water to the outlets.

Broadly there are two types of rain water harvesting :

1) Surface rain water harvesting : The rainwater flows away in urban areas. This runoff water can be caught and used for recharging aquifers with appropriate methods.
2) Rooftop water harvesting : In this type, the rainwater falls, are caught in the catchment, and the collected rainwater is used for different purposes.

3.3 COMPONENTS OF RAINWATER HARVESTING

The Rainwater Harvesting begins with collection of rain water from catchment surface, conveyance of water, storage, treatment and finally the end use. The basic components of typical RWH systems are:

1. Roof Catchment
2. Drain Pipes
3. Gutters
4. Downpipes
5. First Flush pipes
6. Filters
7. Storage

1. **Roof Catchment area** : Roof Surface, Hill slopes and agricultural watershed act a catchment area. The sustainability of roofs as a catchment are determined by the style, construction and material of the roof. The rooftop should not contain any toxic material and surface should be smooth, hard and dense.

2. **Drain pipes:** These are pipes provided to drain off the roof top water to the storm drains. They are of suitable size , made up of PVC / Stoneware.

3. **Gutters:** To collect and transport the rainwater from roof to storage tank some channels are fixed at the edge of the roof, these channels are called gutters. Its shape can be rectangular or semicircular shapes. These gutter channels can be made by Galvanized Iron sheets or cut PVC pipes or split bamboo.

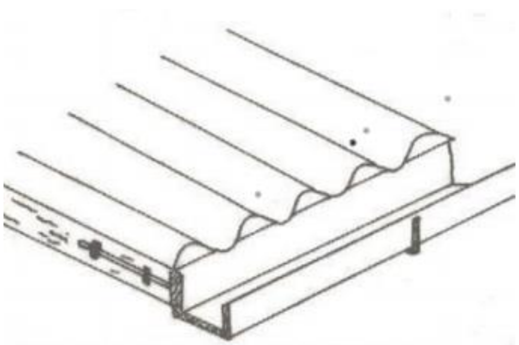

Fig 3.1 Rectangular Gutter

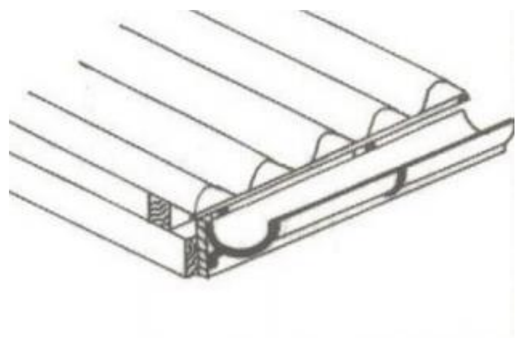

Fig 3.2 Semi-circular Gutter

4. **Downpipes:**

   Downpipe carries the rain water from the gutters to the storage tanks. It is joined with gutters at one end. Depending upon the relative positions and shape of tank and roof the arrangement and orientation of the downpipes are done.

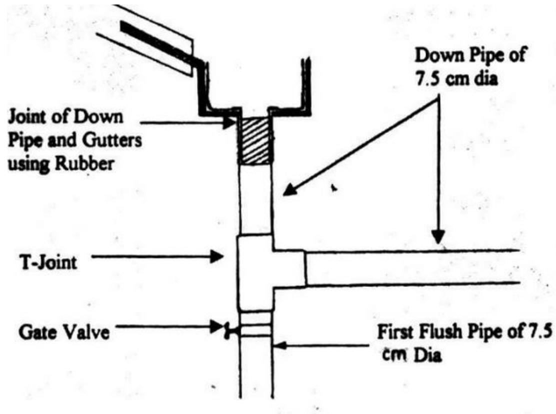

Fig 3.3 Downpipes

5. **First flush Pipes**: After the first rain arrive, debris, dirt and dust are collected on the roof. These unwanted materials should not be entered to the tank and for this we put first flush pipes. There are two systems for it. The first one is simple, manually operated arrangement, whereby the downpipe is moved away and replaced again once the first flush water has been disposed. In another system, below the T junction of downpipes, a separate vertical pipe is fixed with a valve. By this bypass system, undesirable matters from the catchment area are prevented to enter into the tank.

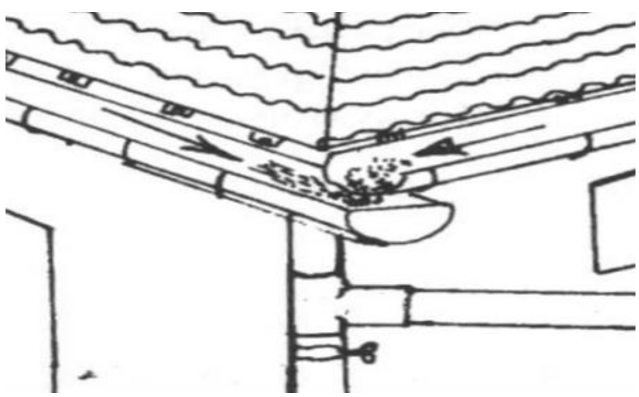

Fig 3.4 First flush Pipes

6. **Filters:** Filtration is the process of suspended and colloidal impurities for water purification. Water is allowed to pass through a filter media e.g. sand or 'anthrafilt' made from anthracite (stone-coal). The biological and chemical properties of water can be changed or achieved desirable qualities by mechanical straining, sedimentation, biological metabolism and electrolytic changes.

   Mechanical straining involves removal of suspended particles which cannot pass through the voids of the filter media. Sedimentation happens in the voids between sand grains in the filter unit. Biological metabolism in filter involves the formation of a zoological jelly or film containing large colonies of bacteria around the sand grains. Those microorganism in the presence or absence of oxygen extract carbon from organic matter and form biomass. Electrolytic changes involve neutralization of ionic charges in impurities of dissolved or suspended particles. Neutralization happens when impurities react with sand particles having opposite charges.

Classification of Filter: -

A. Slow sand filter
B. Rapid sand filter
C. pressure filter

A. Slow sand filter:

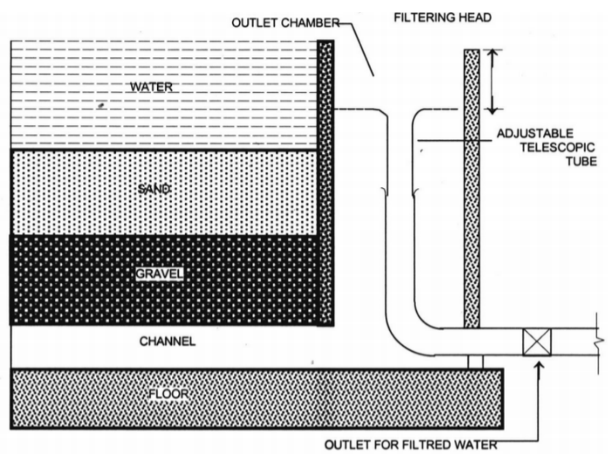

Fig 3.5 Cross- section of Slow sand filter

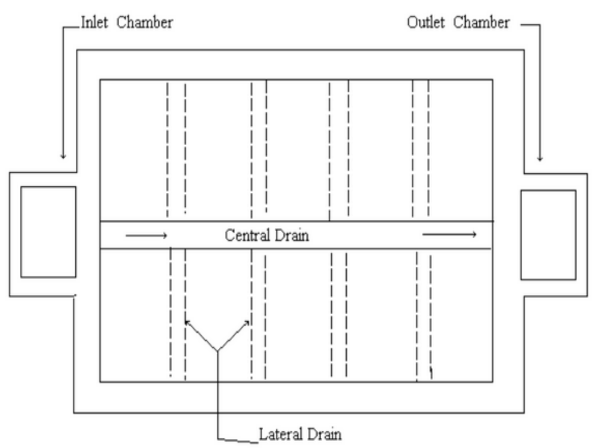

Fig 3.6 Plan view of slow sand filter

slow sand filter consists of

a) An encloser tank
b) Under- drainage system
c) Base- material
d) Filter media
e) Appurtenances

One of the major disadvantages of this filter is that it requires considerable space for installation. For places where large space is not available, makes it uneconomical or costly. This disadvantage can be minimized by increasing the rate of infiltration. We can increase the rate of infiltration by increasing the grain size of sand used as filter media or by allowing water to pass under pressure through the filter media.

B. **Rapid Sand Filters** : It is basically a bed of sand supported in a bed of gravel embedded in which there is a system of undrains. The whole is enclosed in an open concrete chamber. This filter is developed by increasing the infiltration rates by increasing the size of the filter media.

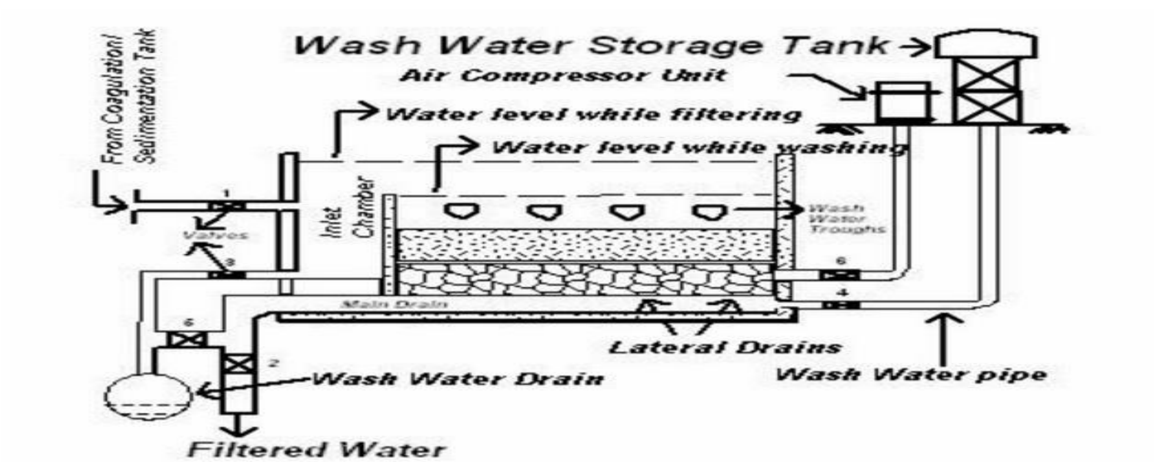

Fig 3.7 Cross- section view of rapid sand filter

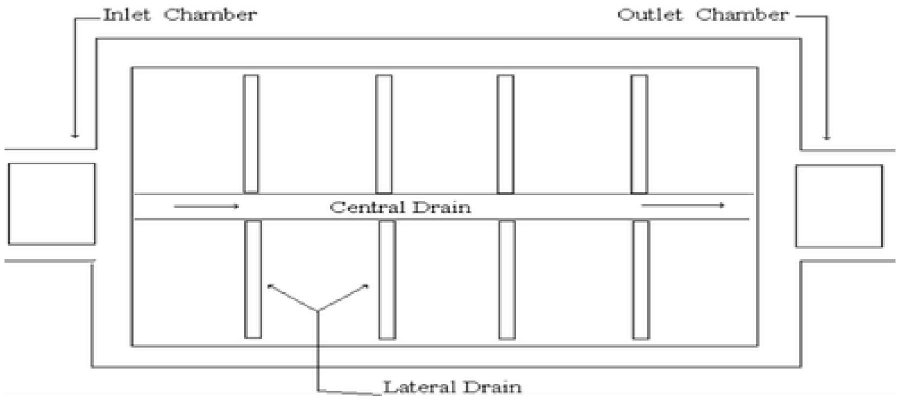

Fig 3.8 Plan of under drainage system of rapid sand filter

7. **Storage tank :** Collected water from roof tops can be stored in storage tanks. Different types of storage tanks are available for storing roof top rainwater
   i. RCC
   ii. Masonry
   iii. Ferro Cement
   iv. PVC

There are different number of options to construct storage tanks with respect to shape (rectangular, cylindrical and square), the size (capacity from 1,000-15,000 litre or even higher) and the material of the construction (brick, stone, cement concrete).

CHAPTER-4

CASE STUDY ON RWH IN AEC CAMPUS

4.1 STUDY AREA (AEC) WITH CALCULATED MAPS

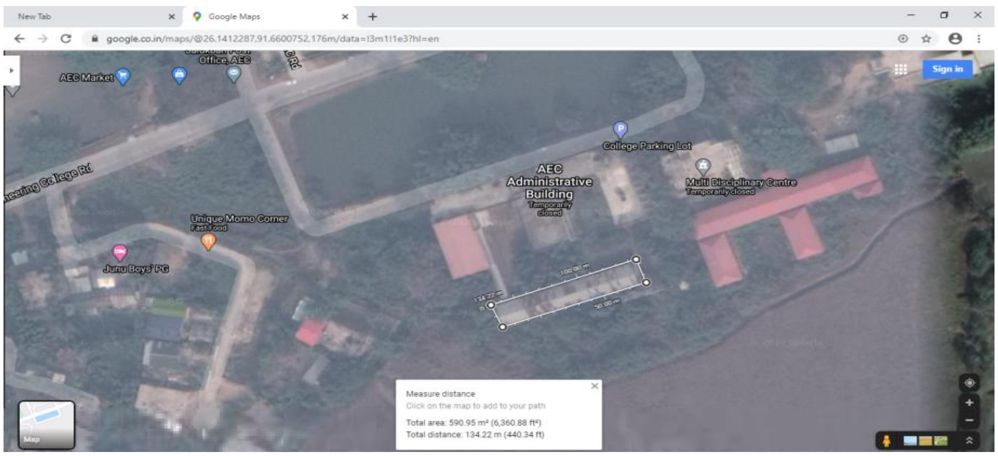

Fig 4.1 AEC Main building

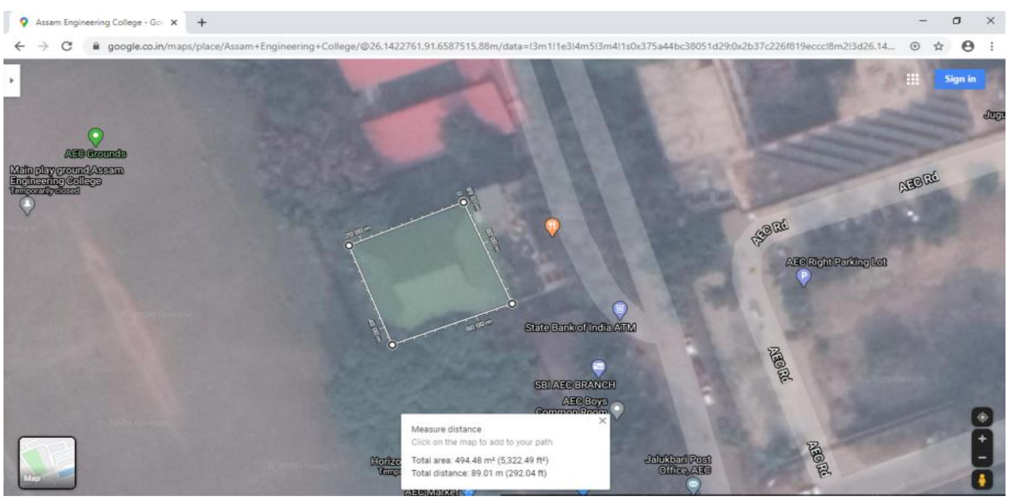

Fig 4.2 AEC Canteen

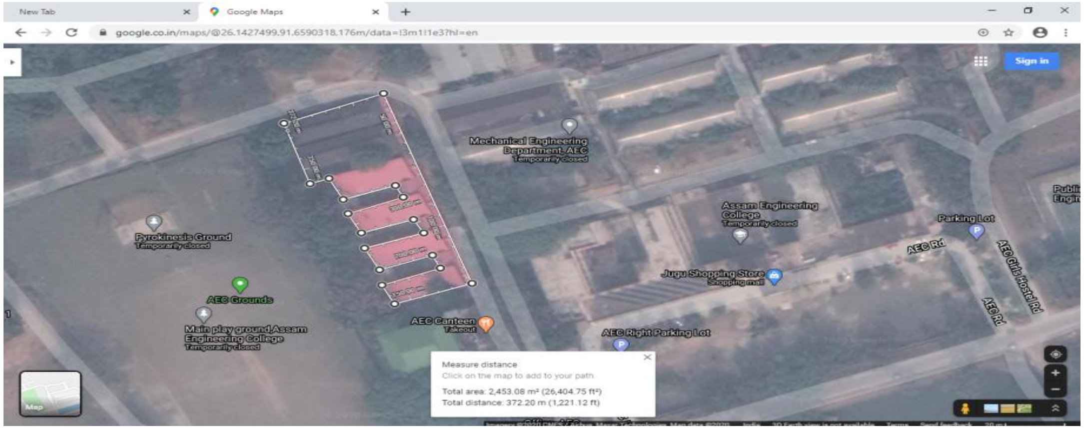

Fig 4.3 Workshop building

Fig 4.4 Hydraulics Lab

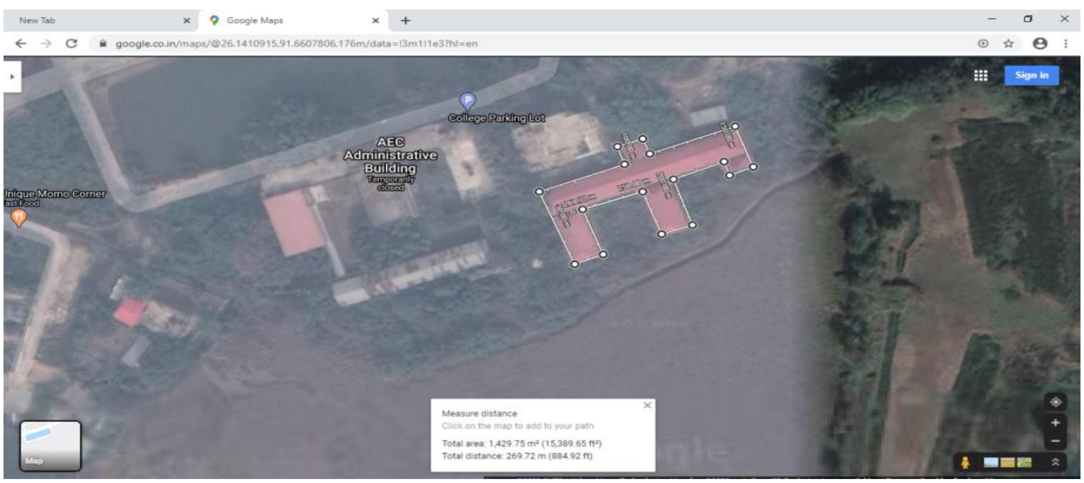

Fig 4.5 Chemical Building

Fig 4.6 Hostel 7

Fig 4.7 Hostel 5

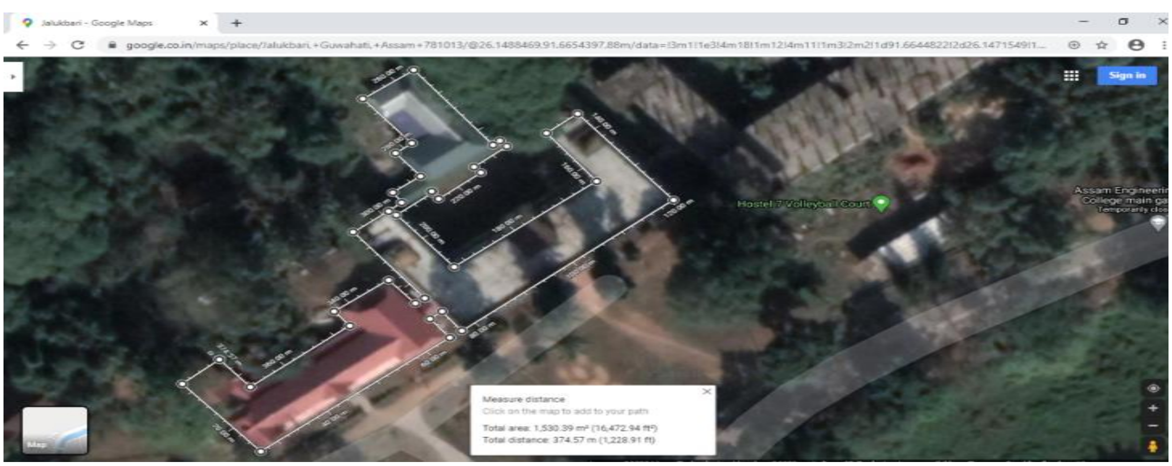

Fig4.8 Hostel 7-I

Fig 4.9 Hostel 3

Fig 4.10 Hostel 6

Fig 4.11 Hostel 9

Fig 4.12 AEC Main building-II

Fig 4.13 Physics and Chemistry Lab

Fig 4.14 MDC Building

Fig 4.15 Administrative Building

Fig 4.16 CSE Building

Fig4.17 Hostel 8-I

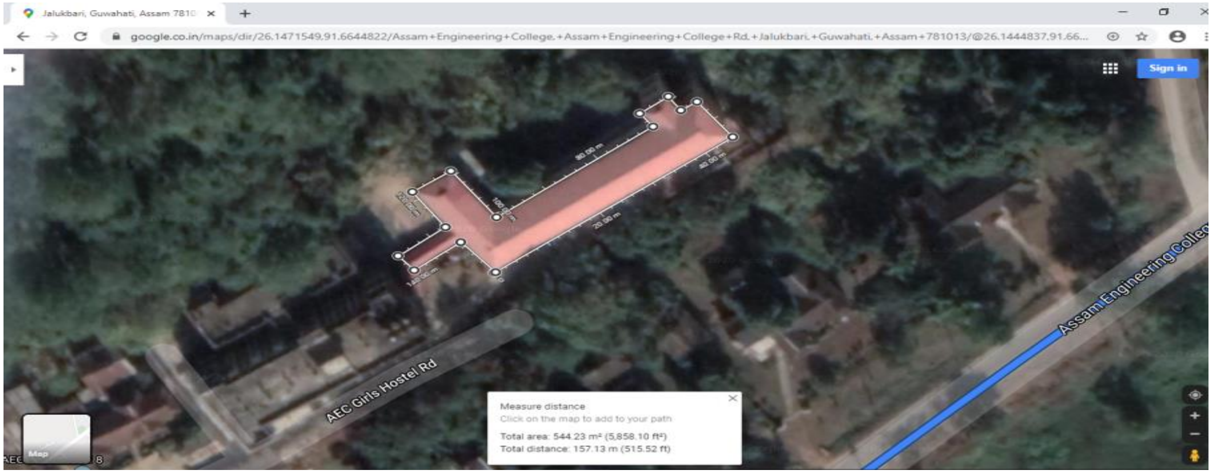

Fig 4.18 Hostel 8-II

Fig 4.19 Hostel 2

Fig 4.20 Hostel 1

CHAPTER-5

DATA COLLECTION (RAIN FALL DATA, STUDY AREA DATA)

5.1 RAINFALL DATA

Table 5.1: Rainfall Data in Guwahati

Year/Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1969	21.9	0	67	89.5	62.2	426.2	353.4	303.1	229.7	69.5	23.1	0.4	1646
1970	21.9	23.7	22.6	60.5	136.4	438.5	422.9	353.7	155.7	161.1	36.7	0	1833.7
1971	4.1	1.1	67	171	185.7	331.4	330.7	302.2	110.5	77.8	81.6	6.3	1669.4
1972	10.5	29.4	64.4	204.7	223.4	336.2	307.1	268.8	105.9	21.4	21.1	0	1592.9
1973	5.7	35.7	34	161.9	380.8	271.8	299.7	122.1	254.8	83.4	54.1	37.3	1741.3
1974	28.9	0	23.8	126.3	234.2	412.2	561.4	211.2	182.8	141.3	5.7	0	1927.8
1975	6.4	1	14.5	52.6	235.2	291.1	392.8	173.3	189.4	91	0.3	0.9	1448.5
1976	6.8	36.4	48.8	158.9	121.4	447.1	254	273.4	118.3	58.9	12.3	0.6	1536.9
1977	12.9	2.1	0	427.6	223.8	466.3	646.7	272.1	92.6	237	44.9	11.4	2437.4
1978	0	2.6	18.9	62.4	249.7	360.7	308.8	238	247.2	33.2	44.5	0	1566
1979	1.3	10.6	8.2	71.1	208.8	258.4	355.3	70.6	150.1	105.2	20.4	22.2	1282.2
1980	0	46.6	65.5	92.8	281.3	428	410	386.4	85.5	85.6	0	0	1881.7
1981	31.4	16.4	52.4	152.2	210.9	101	411.1	219.7	189	2.6	0.8	66	1453.5
1982	0.1	16	39.7	221.5	148.1	390.9	192.8	355.9	131.7	62.4	63.4	0.1	1622.6
1983	11.8	55.3	68.4	180	322.7	251.3	223.1	264.7	288.5	159.6	0	14.7	1840.1
1984	28.8	1.8	14.8	164.6	260.5	447.5	420.6	152.6	329	67	29.2	7.5	1923.9

1985	0	34.8	44.6	130	142.4	221.3	476.3	119.1	264.2	9.3	4.2	22.8	1469
1986	3	4.3	5.4	215.8	98	193.9	208.8	255	185.4	231.3	26.5	1.6	1429
1987	12.6	24.9	121.7	246.7	115.7	139.5	500.4	203.2	351.4	127.8	6	0	1849.9
1988	11	33.7	76.6	168.7	588.7	329.5	349.8	323.3	140.7	71.5	88.1	1.4	2183
1989	5.9	43.4	13	163.8	221.8	354.9	448.8	239.2	352.4	113.6	1.4	5	1963.2
1990	1.2	20.4	87	334.9	106.5	193	580.3	67.3	203.7	145.1	0	0.3	1739.7
1991	0.3	7.9	54.3	137.5	520.7	211.1	216.6	352.2	177	318	0	11.7	2007.3
1992	9.9	32.9	19.3	88.7	203.3	404.6	367.1	366.9	185.9	55.3	7	16.5	1757.4
1993	78.1	61.3	83.3	98.9	422.4	609.5	431.7	513.3	242.8	19.8	0	0	2561.1
1994	19.4	22.5	86.3	156.4	170.9	476.7	199.8	469.1	28.2	141.2	6.7	0	1777.2
1995	10.4	13.5	37.4	132	157.3	555.7	792.1	362.6	587.4	33	37.9	3.7	2723
1996	10.2	31.3	36.3	28.5	511.6	262.3	325.4	183.1	121.2	164.5	0	0	1674.4
1997	14.3	20	30.1	187.2	208	226.7	203.4	228.9	224.7	12.1	3.3	29	1387.7
1998	0.5	12.7	103.9	149.1	144	164.4	260.8	284.3	213	192.5	1.1	0	1526.3
1999	0	0	13.2	25.8	372.3	286	358.7	384.6	189	134.1	45.8	0.9	1810.4
2000	4.6	22.8	46.1	220.2	367.1	357.9	201.2	373.3	159.5	43.2	1.7	0.6	1798.2
2006	0	11	18.1	54	298.7	0	247.2	162.7	88	119.9	15.9	6.7	1022.2
2007	0	96.1	29.8	286.6	96.2	294.2	286.8	122.8	315.9	118.7	32.2	0	1679.3
2008	39.5	3.5	152.1	0	112.1	319	233.9	266.5	101.9	51.2	8	5.2	1292.9
2009	0	0	43.6	65.6	143.2	118	388.3	336	180.7	196.3	7.3	6.7	1485.7
2010	0.4	0	50	369.7	0	468.6	306.6	213.2	252.8	121	1.8	2.2	1786.3
2011	14.6	23.4	53.6	26.5	132.7	231	190.9	0	227.2	7.2	0	1.5	908.6
												Average=	1716.728947

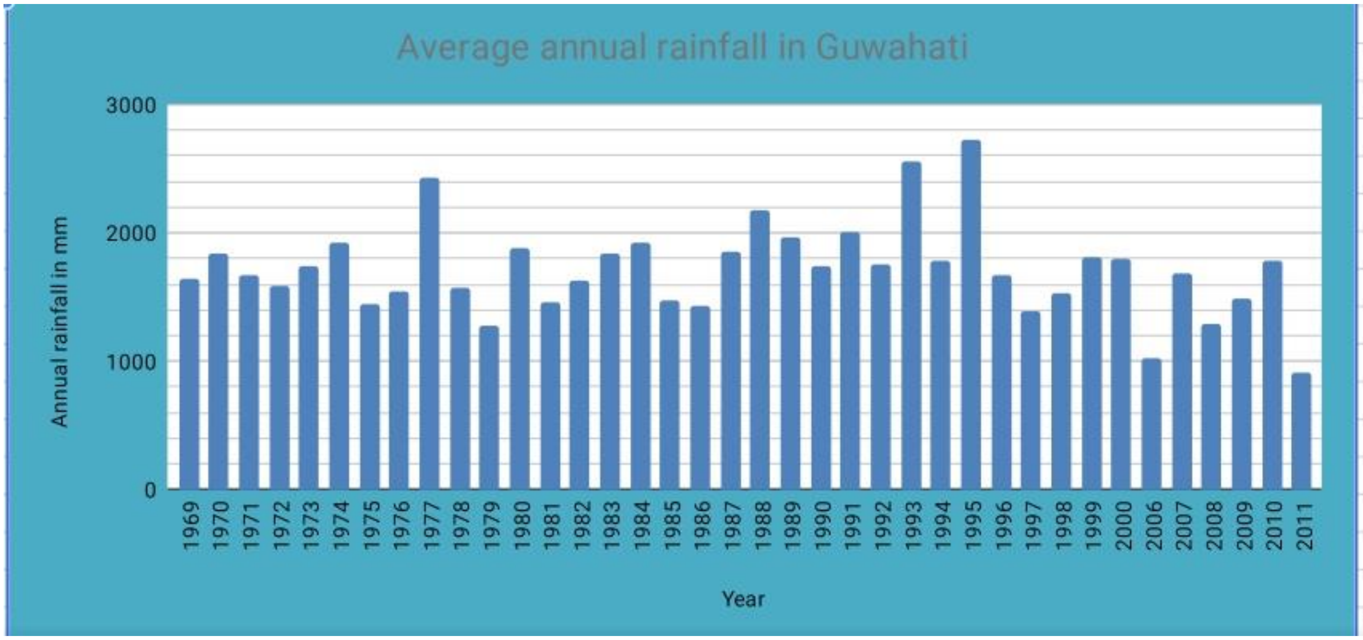

Fig 5.1 Average annual rain fall in Guwahati

Fig 5.2 Average monthly rainfall in Guwahati

5.2 TEMPERATURE ANALYSIS

Table 5.2: Average monthly temperature in Guwahati

Daily mean temperature in Guwahati (°C)												
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
17.3	19.8	23.1	25.4	27	28.7	29	29.2	28.4	26.4	22.7	18.7	24.6

Fig 5.3 Average monthly temperature in Guwahati

CHAPTER-6

CALCULATION AND ANALYSIS

6.1 RAIN WATER HARVESTING POTENTIAL (CALCULATION OF VOLUME)

Annual rainwater harvesting potential is given by:-

$V = K \times I \times A$

Where, V=Volume of water that can be harvested annually in m^3 .

K = Runoff coefficient

I = Annual rainfall in (mm)

A = Catchment area in (m^2)

For AEC Main Building:

Total catchment area A = 4447.14m^2

The roof is made of concrete so K=0.7

Annual rainfall in Guwahati I_1=1.716m

Monsoon rainfall in Guwahati I_2=1.507m

Annual rain water harvesting potential i.e. $V=K \times I_1 \times A= 0.7 \times 1.716 \times 4447.14$

$=5341.9m^3$

And,

Monsoon rain water harvesting potential i.e. $V=K\times I_2 \times A= 0.7 \times 1.507 \times 4447.14$

$= 4691.29m^3$

Similarly for all the other building catchments we can easily calculate annual and monsoon rainwater harvesting potential, which have been represented in tabular form below:-

Table 6.1: Annual and Monsoon rainwater harvesting potential

Sl No.	Building Name	Type of roof surface	Runoff cofficient (K)	Annual rainfall (I1)(m)	Monsoon rainfall (I2)(m)	Area (A) (m^2)	Volume V(annual)(m^3)	Volume V(monsoon)(m^3)
1	AEC Main Building	Concrete	0.7	1.716	1.507	4447.14	5341.9	4691.29
2	Canteen	GI Sheet	0.9	1.716	1.507	494.48	763.67	670.66
3	Chemical	Concrete	0.7	1.716	1.507	1850.83	2223.22	1952.44
4	MDC	Concrete	0.7	1.716	1.507	491.87	590.83	518.87
5	NAT Building	GI Sheet	0.9	1.716	1.507	1492.75	2305.4	2024.62
6	Workshop	GI Sheet	0.9	1.716	1.507	2453.08	3788.54	3327.11
7	Hostel 1	GI Sheet	0.9	1.716	1.507	1463.73	2260.58	1985.26
8	Hostel 2	GI Sheet	0.9	1.716	1.507	1726.94	2667.09	2342.25
9	Hostel 3	GI Sheet	0.9	1.716	1.507	2099.42	3242.34	2847.44
10	Hostel 4(I)	GI Sheet	0.9	1.716	1.507	881.98	1362.13	1196.23
11	Hostel 4(II)	GI Sheet	0.9	1.716	1.507	224.96	347.43	305.11
12	Hostel 5	GI Sheet	0.9	1.716	1.507	1054.72	1628.91	1430.52
13	Hostel 6	GI Sheet	0.9	1.716	1.507	1362.57	2104.35	1848.05
14	Hostel 7(I)	GI Sheet	0.9	1.716	1.507	536.94	829.25	728.25
15	Hostel 7(II)	Concrete	0.7	1.716	1.507	706.3	848.41	745.08
16	Hostel 7(III)	GI Sheet	0.9	1.716	1.507	260.15	401.78	352.84
17	Hostel 8(I)	GI Sheet	0.9	1.716	1.507	2286.92	3531.92	3101.75
18	Hostel 8(II)	Concrete	0.7	1.716	1.507	544.23	653.73	574.11
19	Hostel 9	GI Sheet	0.9	1.716	1.507	907.20	1401.07	1230.43
20	Chemical back	GI Sheet	0.9	1.716	1.507	590.95	912.66	801.51
21	CSE & ETE	Concrete	0.7	1.716	1.507	870.20	1343.93	1180.25

	Building							
22	Main building back	Concrete	0.7	1.716	1.507	3548.43	4262.37	3743.24
23	Main building back1	Concrete	0.7	1.716	1.507	1372.34	1648.45	1447.68
24	Main building back2	Concrete	0.7	1.716	1.507	1025.24	1231.52	1081.53
						Total	**42946.48**	**37715.84**

6.2 CALCULATION OF DISCHARGE IN DIFFERENT BUILDINGS

Discharge Calculations: -

To find out the required diameter of the pipe to be used for draining the rainwater down from the roof first we need to calculate the discharge Q i.e. given by :-

$Q = C \times I \times A$

Where,

Q= Discharge from roofs due to rainfall in(m^3/s)

C= Coefficient of runoff

I= Intensity of rainfall

A= Area of catchment

For AEC Main Building:

DISCHARGE Q is given by:

Area, A = $4447.14 m^2$

For Intensity we are taking 24 hour intensiy for 5 years return period and 10 year return period

Intensity, I =0.000001464 m/s [For 5years return period]

I =0.000001676 m/s [For 10 years return period]

Coefficient C =0.7 (As the roof is made up of concrete)

$$Q = C \times I \times A$$

$$Q = 0.7 \times 0.000001464 \times 4447.14 \quad \text{[Using I = 0.000001464 m/s]}$$

$$Q = 0.0046 \text{ m}^3/\text{s}$$

Again, $Q = C \times I \times A$

$$Q = 0.7 \times 0.000001676 \times 4447.14 \quad \text{[Using I = 0.000001676 m/s]}$$

$$Q = 0.0052 \text{ m}^3/\text{s}$$

Similarly discharge Q from each building can be calculated. Here is a tabular representation of the same:-

FOR 5 YEARS

Table 6.2: Discharge calculation for 5 years

Sl No.	**Building Name**	**Type of roof surface**	**Runoff coefficient (C)**	**Intensity (I) (m/s)**	**Area (A) (m^2)**	**Discharge (Q) (m^3/s)**
1	AEC Main Building	Concrete	0.7	0.000001464	4447.14	0.0046
2	Canteen	GI Sheet	0.9	0.000001464	494.48	0.0007
3	Chemical	Concrete	0.7	0.000001464	1850.83	0.0019
4	MDC	Concrete	0.7	0.000001464	491.87	0.0005
5	NATBuilding	GI Sheet	0.9	0.000001464	1492.75	0.002
6	Workshop	GI Sheet	0.9	0.000001464	2453.08	0.0032
7	Hostel 1	GI Sheet	0.9	0.000001464	1463.73	0.0019
8	Hostel 2	GI Sheet	0.9	0.000001464	1726.94	0.0023
9	Hostel 3	GI Sheet	0.9	0.000001464	2099.42	0.0028
10	Hostel 4(I)	GI Sheet	0.9	0.000001464	881.98	0.0012
11	Hostel 4(II)	GI Sheet	0.9	0.000001464	224.96	0.0003
12	Hostel 5	GI Sheet	0.9	0.000001464	1054.72	0.0014
13	Hostel 6	GI Sheet	0.9	0.000001464	1362.57	0.0018
14	Hostel 7(I)	GI Sheet	0.9	0.000001464	536.94	0.0007
15	Hostel 7(II)	Concrete	0.7	0.000001464	706.3	0.0007
16	Hostel 7(III)	GI Sheet	0.9	0.000001464	260.15	0.0003
17	Hostel 8(I)	GI Sheet	0.9	0.000001464	2286.92	0.003
18	Hostel 8(II)	Concrete	0.7	0.000001464	544.23	0.0006
19	Hostel 9	GI Sheet	0.9	0.000001464	907.20	0.0013
20	Chemical back	GI Sheet	0.9	0.000001464	590.95	0.0008
21	CSE & ETE Building	Concrete	0.7	0.000001464	870.20	0.0012
22	Main building back	Concrete	0.7	0.000001464	3548.43	0.0036
23	Main building back1	Concrete	0.7	0.000001464	1372.34	0.0014
24	Main building back2	Concrete	0.7	0.000001464	1025.24	0.0011

FOR 10 YEARS

Table 6.3: Discharge calculation for 10 years

Sl No.	Building Name	Type of roof surface	Runoff coefficient (C)	Intensity (I) (m/s)	Area (A) (m^2)	Discharge (Q) (m^3/s)
1	AEC Main Building	Concrete	0.7	0.000001676	4447.14	0.0052
2	Canteen	GI Sheet	0.9	0.000001676	494.48	0.0007
3	Chemical	Concrete	0.7	0.000001676	1850.83	0.0022
4	MDC	Concrete	0.7	0.000001676	491.87	0.0006
5	NAT Building	GI Sheet	0.9	0.000001676	1492.75	0.0023
6	Workshop	GI Sheet	0.9	0.000001676	2453.08	0.0037
7	Hostel 1	GI Sheet	0.9	0.000001676	1463.73	0.0022
8	Hostel 2	GI Sheet	0.9	0.000001676	1726.94	0.0026
9	Hostel 3	GI Sheet	0.9	0.000001676	2099.42	0.0032
10	Hostel 4(I)	GI Sheet	0.9	0.000001676	881.98	0.0013
11	Hostel 4(II)	GI Sheet	0.9	0.000001676	224.96	0.0003
12	Hostel 5	GI Sheet	0.9	0.000001676	1054.72	0.0016
13	Hostel 6	GI Sheet	0.9	0.000001676	1362.57	0.0021
14	Hostel 7(I)	GI Sheet	0.9	0.000001676	536.94	0.0008
15	Hostel 7(II)	Concrete	0.7	0.000001676	706.3	0.0008
16	Hostel 7(III)	GI Sheet	0.9	0.000001676	260.15	0.0004
17	Hostel 8(I)	GI Sheet	0.9	0.000001676	2286.92	0.0034
18	Hostel 8(II)	Concrete	0.7	0.000001676	544.23	0.0006
19	Hostel 9	GI Sheet	0.9	0.000001676	907.20	0.0015
20	Chemical back	GI Sheet	0.9	0.000001676	590.95	0.0009
21	CSE & ETE Building	Concrete	0.7	0.000001676	870.20	0.0014
22	Main building back	Concrete	0.7	0.000001676	3548.43	0.0042
23	Main building back1	Concrete	0.7	0.000001676	1372.34	0.0016
24	Main building back2	Concrete	0.7	0.000001676	1025.24	0.0012

6.3 SIZE OF CHANNEL CALCULATION

To find out the required diameter of channel, first we need to calculate the discharge by assuming different diameter. Then we have to compare this discharge with the previous one as we get it before.

$$Q = A \times V$$

Where,

Q = Discharge from the roofs due to rainfall

A = Area of the channel

V = velocity of flow

Assuming the slope of the collector channel as 5 cm for 1 m, i.e. 1 in 200

For AEC MAIN BUILDING:

Providing a collector channel of 0.15 m diameter

Cross sectional area of the channel (A) = 0.0088 sq m

Perimeter (P) = 0.2355 m

Hydraulic Mean depth (R) = A/P

= 0.0374 m

For slope of 1 in 200 for the collector channel,

Velocity of flow $V = \frac{R^{\frac{2}{3}} S^{\frac{1}{2}}}{n}$ (from Manning's Formula

n = Manning's coefficient = 0.015)

$= 0.52$ m/s

Discharge (Q) = AX V

$= 0.0088 \times 0.52$

$= 0.0046$ m3/s

As this corresponds well with the designed discharge, this channel diameter is acceptable.

The channel may be made of plain Galvanized Iron (G.I) sheet. Width of the G.I. sheet required for channel is the perimeter of the channel.

P = 0.2355m = 235.5 mm

Providing 25 mm extra for fixing with rafters / purlins,

Total width required = 235.5 + 25 = 260.5 mm = Say 261 mm

FOR 5 YEARS

Table 6.4 : Size of the channel calculation for 5 years

Size of channel										
Sl y N o.	**Building Name**	**Discharge (Q) (m3/s)**	**Diameter (d) (m)**	**Cross Sectional Area (A) (m^2)**	**Perimeter (P)(m)**	**(R)Hydraulic mean depth**	**velocity(V) (m/s)**	**Discharge (Q) (m^{3}/s)**	**width of channel (P+25)(mm)**	**Final Width of channel (mm)**
1	AEC Main Building	0.0046	**0.15**	0.0088	0.2355	0.0374	0.52	0.0046	260.5	**261**
2	Canteen	0.0007	**0.08**	0.0025	0.1256	0.0199	0.34	0.0009	150.6	**151**
3	Chemical	0.0019	**0.11**	0.0047	0.1727	0.0272	0.42	0.002	197.7	**198**
4	MDC	0.0005	**0.07**	0.0019	0.1099	0.0173	0.31	0.0006	134.9	**135**
5	NATBuilding	0.002	**0.11**	0.0047	0.1727	0.0272	0.42	0.002	197.7	**198**
6	Workshop	0.0032	**0.14**	0.0077	0.2198	0.035	0.5	0.0039	244.8	**245**
7	Hostel 1	0.0019	**0.11**	0.0047	0.1727	0.0272	0.42	0.002	197.7	**198**
8	Hostel 2	0.0023	**0.12**	0.0057	0.1884	0.0303	0.45	0.0026	213.4	**213**
9	Hostel 3	0.0028	**0.13**	0.0066	0.2041	0.0323	0.47	0.0031	229.1	**229**
10	Hostel 4(I)	0.0012	**0.09**	0.0032	0.1413	0.0226	0.37	0.0012	166.3	**166**
11	Hostel 4(II)	0.0003	**0.05**	0.001	0.0785	0.0127	0.25	0.0003	103.5	**104**
12	Hostel 5	0.0014	**0.1**	0.0039	0.157	0.0248	0.4	0.0016	182	**182**
13	Hostel 6	0.0018	**0.11**	0.0047	0.1727	0.0272	0.42	0.002	197.7	**198**
14	Hostel 7(I)	0.0007	**0.08**	0.0025	0.1256	0.0199	0.34	0.0009	150.6	**151**
15	Hostel 7(II)	0.0007	**0.08**	0.0025	0.1256	0.0199	0.34	0.0009	150.6	**151**
16	Hostel 7(III)	0.0003	**0.05**	0.001	0.0785	0.0127	0.25	0.0003	103.5	**104**
17	Hostel 8(I)	0.003	**0.13**	0.0066	0.2041	0.0323	0.47	0.0031	229.1	**229**
18	Hostel 8(II)	0.0006	**0.07**	0.0019	0.1099	0.0173	0.31	0.0006	134.9	**135**
19	Hostel 9	0.0013	**0.1**	0.0039	0.157	0.0248	0.4	0.0016	182	**182**
20	Chemical back	0.0008	**0.08**	0.0025	0.1256	0.0199	0.34	0.0009	150.6	**151**
21	CSE & ETE building	0.0012	**0.1**	0.0039	0.157	0.0248	0.4	0.0016	182	**182**
22	Main building back	0.0036	**0.14**	0.0077	0.2198	0.035	0.5	0.0039	244.8	**245**
23	Main building back1	0.0014	**0.1**	0.0039	0.157	0.0248	0.4	0.0016	182	**182**
24	Main building b2	0.0011	**0.09**	0.0032	0.1413	0.0226	0.37	0.0012	166.3	**166**

FOR 10 YEARS

Table 6.5: Size of the channel calculation for 10 years

Sl No.	Building Name	Discharge (Q) (m3/s)	Diameter (d) (m)	Cross Sectional Area (A) (m^2)	Perimeter (P)(m)	(R)Hydraulic mean depth	velocity (V) (m/s)	Discharge (Q) ($m^{3/}s$)	width of channel (P+25)(mm)	Final Width of channel (mm)
1	AEC Main Building	0.0052	**0.16**	0.01	0.2512	0.0398	0.54	0.0054	276.2	**276**
2	Canteen	0.0007	**0.08**	0.0025	0.1256	0.0199	0.34	0.0009	150.6	**151**
3	Chemical	0.0022	**0.12**	0.0057	0.1884	0.0303	0.45	0.0026	213.4	**213**
4	MDC	0.0006	**0.07**	0.0019	0.1099	0.0173	0.31	0.0006	134.9	**135**
5	NATBuilding	0.0023	**0.12**	0.0057	0.1884	0.0303	0.45	0.0026	213.4	**213**
6	Workshop	0.0037	**0.14**	0.0077	0.2198	0.035	0.5	0.0039	244.8	**245**
7	Hostel 1	0.0022	**0.12**	0.0057	0.1884	0.0303	0.45	0.0026	213.4	**213**
8	Hostel 2	0.0026	**0.12**	0.0057	0.1884	0.0303	0.45	0.0026	213.4	**213**
9	Hostel 3	0.0032	**0.14**	0.0077	0.2198	0.035	0.5	0.0039	244.8	**245**
10	Hostel 4(I)	0.0013	**0.1**	0.0039	0.157	0.0248	0.4	0.0016	182	**182**
11	Hostel 4(II)	0.0003	**0.05**	0.001	0.0785	0.0127	0.25	0.0003	103.5	**104**
12	Hostel 5	0.0016	**0.1**	0.0039	0.157	0.0248	0.4	0.0016	182	**182**
13	Hostel 6	0.0021	**0.12**	0.0057	0.1884	0.0303	0.45	0.0026	213.4	**213**
14	Hostel 7(I)	0.0008	**0.08**	0.0025	0.1256	0.0199	0.34	0.0009	150.6	**151**
15	Hostel 7(II)	0.0008	**0.08**	0.0025	0.1256	0.0199	0.34	0.0009	150.6	**151**
16	Hostel 7(III)	0.0004	**0.06**	0.0014	0.0942	0.0149	0.28	0.0004	119.2	**119**
17	Hostel 8(I)	0.0034	**0.14**	0.0077	0.2198	0.035	0.5	0.0039	244.8	**245**
18	Hostel 8(II)	0.0006	**0.07**	0.0019	0.1099	0.0173	0.31	0.0006	134.9	**135**
19	Hostel 9	0.0015	**0.1**	0.0039	0.157	0.0248	0.4	0.0016	182	**182**
20	Chemical back	0.0009	**0.08**	0.0025	0.1256	0.0199	0.34	0.0009	150.6	**151**
21	CSE & ETE	0.0014	**0.1**	0.0039	0.157	0.0248	0.4	0.0016	182	**182**
22	Main building back	0.0042	**0.15**	0.0088	0.2355	0.0374	0.52	0.0046	260.5	**261**
23	Main building back1	0.0016	**0.1**	0.0039	0.157	0.0248	0.4	0.0016	182	**182**
24	Main building back2	0.0012	**0.09**	0.0032	0.1413	0.0226	0.37	0.0012	166.3	**166**

CHAPTER-7

CONCLUSION

7.1 DISCUSSION

To determine the necessary pipe diameter for draining rainwater from the roof, we first calculated the discharge (Q) using the 24-hour rainfall intensity for both 5-year and 10-year return periods. We then compared these values with the discharge obtained by testing various pipe diameters through a trial-and-error method. From the two sets of data for different buildings on the AEC campus, it is evident that the required pipe diameter for the 5-year return period is smaller than that for the 10-year return period. This is because the 24-hour rainfall intensity for the 5-year period is lower than that of the 10-year period. Therefore, the diameter and width of the channel for collecting rainwater are determined by the rainfall intensity associated with the chosen design period.

7.2 SUMMARY AND FUTURE SCOPE OF THE STUDY

Rainwater harvesting (RWH) typically involves the immediate collection of rainwater from surfaces where it falls directly. It is one of the most effective solutions to the global issue of water scarcity, made even more crucial by urbanization. In Guwahati, the AEC campus has experienced significant population growth and rapid urbanization, highlighting the need for RWH.

According to the report, the entire campus, including all college buildings and nine hostels, has the potential to harvest approximately 42,946 cubic meters, or 42,946,000 liters, of rainwater annually. It was concluded that implementing a rainwater harvesting project on the AEC campus would be an excellent strategy to address the current water scarcity. This initiative is not only financially advantageous but also ensures the optimal use of land resources. By adopting rainwater harvesting, the campus can contribute positively to water conservation, benefiting both the students and the environment.

REFERENCES

1) **Agarwal, A., & Narain, S. (1997)**. "*Dying Wisdom: Rise, Fall and Potential of India's Traditional Water Harvesting Systems*." Centre for Science and Environment.
2) **Bora, K., and Choudhury, P., (2015).** "Estimation of Annual Maximum Daily Rainfall of Silchar, Assam." International Conference on Engineering Trends and Science and Humanities, Imayan College of Engineering, Tamil Nadu, India, 12-16.
3) **Borah, J. (2017),** "Groundwater recharge through rainwater harvesting in Assam." *Journal of Environmental Studies*.
4) **Baruah, S. (2018).** "Community-based rainwater harvesting initiatives in Guwahati", *International Journal of Community Water Resources*.
5) **Das, R., Goswami, D., and Sharma, B. (2016).** "Generation of Intensity Duration Frequency Curve using Short Duration Rainfall Data for Different Return Period for Guwahati City." International Journal of Scientific and Engineering Research, 7(7), 908-911.
6) **Goswami, A. (2020).** "The role of rainwater harvesting in sustainable urban development." *Journal of Urban and Environmental Engineering*.
7) **Gupta, S. K., & Deshpande, R. D. (2016)**. "*Water Harvesting and Sustainable Water Management in India: A Review*." *International Journal of Environmental Science and Development*, 7(3), 248-254.
8) **Hazarika, T. (2021).** "Challenges and opportunities in implementing rainwater harvesting in Guwahati." *Journal of Environmental Studies*.
9) **Nath, D. (2019).** "Rainwater harvesting techniques and their implementation in Guwahati." *Journal of Water Science and Technology*.
10) **Prasad, H., & Raju, K. D. (2018)**. "*Legal Framework for Rainwater Harvesting in India: Challenges and Opportunities*." *Indian Journal of Environmental Law and Policy*, 5(2), 45-56.
11) **Reddi, P.J. (2002).** A Text Book of Hydrology. Laxmi Publications Pvt. Ltd., New Delhi.

12) **Sarma, A. K., & Hazarika, T. (2016).** “Potential impact of climate change on rainfall intensity-duration-frequency curves of Guwahati city.” *Journal of Climate and Water Resources*.

13) **Sharma, S. K., & Kansal, A. (2011)**. “*Assessment of Rainwater Harvesting Potential in the Urban Area of Delhi*.” *Water Resources Management*, 25(14), 3753-3764.

14) **Sharma, R., & Dutta, P. (2018).** “Traditional water management practices in Northeast India.” *Environmental Conservation Journal*.

15) **Singh, R., & Jain, M. K. (2015)**. “*Rainwater Harvesting in India: A Review of Current Research and Implementation*.” *Journal of Water Resource and Protection*, 7(1), 17-25.

16) **Tiwari, A., & Mishra, P. (2017)**. “*Potential and Prospects of Rainwater Harvesting in India: A Case Study of Rajasthan*.” *Indian Journal of Traditional Knowledge*, 16(1), 12-20.