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Design of Rainwater Harvesting System for NSS College of Engineering, Palakkad

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***Abstract*— The paper aims to optimize rainwater harvesting infrastructure for NSS College of Engineering, enhancing water resource management. The integration of Epanet software ensures precision in the hydraulic analysis of the pipe network, enhancing the overall efficiency of the rainwater harvesting system. Alongside the software-driven design, the project also includes the comprehensive planning and execution of a storage tank, contributing to sustainable water solutions for the college. Additionally, the project involves conducting a thorough cost estimation to ensure practical feasibility. The proposed rainwater harvesting system aims to address water management needs at NSS College of Engineering, contributing to sustainability and resource conservation in the region.**

***Index Terms*— EPANET Software, Rainwater Harvesting System, Storage Tank**

I. INTRODUCTION

Water is our most precious natural resource; its uses are innumerable, and its importance cannot be overestimated. Its role ranges from domestic uses, agriculture, and industry to religious ceremonies, recreation, landscape decoration and even therapy. Water is basic to life. Despite the obvious need for a sufficient, year-round water supply to sustain life, there is still a lack of water, much less clean water for many of the world's poor. The lack of water is bound to get worse. Estimates of the number of people without water put the number at about one-fifth of the world's population. For developing countries, the number could be one-half.

In many areas, rainwater harvesting has now been introduced as part of an integrated water supply where the town water supply is unreliable, or where local water sources dry up part of the year. But the technology is flexible and adaptable to a very wide variety of conditions. Rainwater harvesting is collecting the run-off from a structure or other impervious surface to store it for later use. Traditionally, this involves harvesting the rain from a roof. Rainwater collected in gutters that channel the water into harvesting system downspouts and then into some sort of storage tank.

The implementation of a robust rainwater harvesting system at NSS College of Engineering Palakkad stands as a pivotal endeavour in addressing the pressing need for sustainable water management. With a focus on environmental conservation and resource optimization, this project aims to design, develop, and implement an efficient rainwater harvesting infrastructure. NSSCE Palakkad, situated in a region susceptible to varying precipitation patterns, requires a comprehensive solution to harness and utilize rainwater effectively. This report outlines the meticulous planning, design, and cost estimation involved in creating a detailed pipe network, drainage, and recharge pit to capture, and harvest rainwater. By integrating innovative engineering and environmental consciousness, this initiative endeavours to not only conserve water but also mitigate flooding and replenish groundwater sources. This introduction sets the stage for a holistic exploration of the rainwater harvesting system, emphasizing its significance in promoting sustainable water practices within the NSSCE Palakkad community

A. Components of rooftop rainwater harvesting

A rooftop rainwater harvesting system relies on several integral components to effectively collect and store rainwater for various purposes. The process begins with the catchment area, usually the rooftop surface, which gathers rainwater during precipitation events. Gutters installed along the edges of the roof then channel this collected water towards downspouts or conduits. These downspouts act as vertical channels, guiding the water downwards towards conveyance pipes made of durable materials like PVC or metal. These pipes form the backbone of the system, transporting the rainwater from the downspouts to storage tanks or harvesting systems for later use.

One critical component within this system is the first flush device, strategically positioned at the entry point of the downspout or conduit. Its primary function is to capture and divert the initial portion of runoff, which may contain pollutants, debris, and contaminants accumulated on the rooftop between rainfall events. The device operates using a chamber or container with an inlet connected to the downspout and an outlet leading to the conveyance pipe or storage tank. As rainwater enters the device, it fills the chamber, triggering a float mechanism that seals off the inlet, preventing contaminated water from entering the main conveyance system or storage tank.

By separating and disposing of the initial flow of contaminated runoff, the first flush device plays a crucial role

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in improving the quality of harvested rainwater and minimizing the risk of contamination in storage tanks or harvesting systems. This simple yet effective mechanism ensures that the stored rainwater remains clean and suitable for various applications, such as irrigation, toilet flushing, or even potable water after proper treatment. Regular maintenance and cleaning of the first flush device are essential to uphold its functionality and ensure the continued purity of collected rainwater.

B. Objectives

- To Design Detailed Pipe Network for Rainwater harvesting system.
- To Design the Artificial Recharge System for Borewells.
- To Estimate the Cost Associated with The Entire Project.

C. Scope

- Building parameters surveyed include ground level, floor area, projected roof area, and building height for pipe network layout design.
- Data collection includes water demand calculation, rainfall data analysis over the last decade (2012 to 2022), and inventory of existing rainwater harvesting infrastructure.
- Rainwater discharge quantity was calculated to determine the volume of rooftop water.
- In-situ permeability test conducted on existing borewells to design recharge pit for groundwater replenishment

II. STUDY AREA

A. General

The study area is NSS College of Engineering, Akathethara, Palakkad, as well as the nearby areas as shown in figure 1 The climate of Palakkad is tropical, humid and dry. Apart from March and April, the temperature is moderate the entire year. The study area's geography is mountainous and in the highland region, with topographic elevations ranging from 80 m above mean sea level. The research area's rocks are part of the basement archaean metamorphic complex. They comprise the granulite group, gneisses, and schists, which are found atop laterite and alluvium. In the northeastern regions of the district, quartz veins and intrusive pegmatites are also typical. From Archaean crystalline (hard rock) through Recent alluvium (soft rock), all geological Formation contains groundwater.

Fig 1: College and college premises under satellite view

III. III. METHODOLOGY

A. Preliminary Survey of Land

Length, breadth, and diagonal of the survey field were measured using a measuring tape. The area of the survey field was determined.

B. Survey of Buildings

The survey was conducted using a dumpy level instrument in conjunction with a leveling staff to determine the reduced levels of various points across the college campus. This involved measuring both ground level and floor level for all buildings situated within the campus premises.

C. Data Collection

The data for the calculation of the water demand has been collected from the college office. The information gathered includes the overall count of students, faculty, and staff at the college. By completing a poll for five days and calculating the median of the results, it has been possible to estimate the number of students using the canteen service.

D. Water Demand Calculation

The water demand for all the students, faculty and staff in the college and for the college canteen has been calculated separately. The water requirement for the institutional buildings and food court has been taken from National Building Code (NBC) AND IS 1172:1993- Code of basic requirements for water supply, drainage and sanitation; which is used for the water demand calculation.

E. Rainwater Discharge Quantity Calculation

The quantity of rainwater discharge is computed to ascertain the volume of rainwater collected from the rooftop of buildings. Rational Method is the simplest method to determine the rainwater discharge which is given by: -

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

Where, Q = Discharge from roofs due to rainfall (m^3/year)
C = Runoff Coefficient
I = Intensity of Rainfall (m/year)
A = Area of Catchment (m^2)

Runoff coefficient for any catchment is the ratio of the volume of water that runs off a surface to the volume of rainfall that falls on the surface. Runoff coefficient accounts for losses due to spillage, leakage, infiltration, catchment surface wetting and evaporation, which will all contribute to reducing the amount of runoff.

F. Design of Recharge Pit

A recharge pit is a structure designed to allow rainwater to infiltrate into the ground, replenishing underground aquifers and helping to recharge the water table. The design of a recharge pit typically involves excavating a hole in the ground and filling it with a layer of coarse gravel or crushed stone. This layer serves as a reservoir for rainwater to collect before slowly infiltrating into the surrounding soil. Additionally, a perforated pipe may be installed at the bottom of the pit to facilitate the drainage of excess water and prevent waterlogging. The top of the recharge pit is often covered with a mesh or screen to prevent debris from entering and clogging the system while still allowing water to flow freely. Proper sizing and placement of the recharge pit are crucial to ensure effective groundwater recharge while minimizing the risk of flooding or erosion.

G. Pipe Network and Drainage Layout of Survey Field

The pipe network and drainage layout for the rainwater harvesting system were meticulously designed, considering the flow and pressure requirements. By analysing the anticipated water flow rates and pressure levels, engineers determined the optimal layout to ensure efficient distribution of rainwater to the recharge pit. Factors such as pipe diameter, slope, and junction points were carefully considered to maintain adequate flow rates and minimize pressure losses throughout the system. This comprehensive approach guarantees that the harvested rainwater can effectively replenish the recharge pit, contributing to sustainable water management practices while maximizing system performance.

H. Cost Estimation

Quantity and cost have been computed to assess the project's feasibility. The cost of materials was calculated as per Delhi Schedule of Rates (DSR).

IV. IV. PRELIMINARY SURVEY OF LAND

Length, breadth, and diagonal of the survey field as shown in Figure 2 were measured using a measuring tape.

Area of survey field

- ➢Length = 73m
- ➢Breadth = 20.5m
- ➢Diagonal = 75.83m
- ➢Area =73 x 20.5 = 1496.5 m^2

Fig 2: Survey field at NSSCE Palakkad

V. SURVEY OF BUILDINGS

Survey was conducted using a dumpy level instrument in conjunction with a levelling staff of least count 5mm to determine the reduced levels of various points across the college campus. Reduced level is determined by Height of Instrument method. Ground level and floor level of buildings is measured by using dumpy level in conjunction with a levelling staff and roof level is determined by adding the height of the building with ground level as shown in table I.

Table I: GL, FL and Roof level of building

Building no.	Building Name	Ground Level(m)	Floor Level(m)	Roof Level(m)
1	College main building	108.835	109.69	123.655
2	Library Block	108.8	109.215	118.676
3	Instrumentation & Control Block	108.49	108.965	118.33
4	Electronics & Computer science Block	108.23	109.09	119.985
5	Academic Block	106.95	107.53	113.005
6	Alumni Block	107.07	107.36	118.37
7	Placement Block	104.06	104.555	112.443
8	Mechanical Workshop 1	106.65	107.095	111.729
9	Mechanical Workshop 2	106.04	106.48	111.119
10	Civil Workshop	106.12	106.49	111.127
11	Electrical Workshop	107.315	107.93	112.532
12	Canteen	105.985	106.1	109.195
13	Structural Engineering Lab	106.445	106.935	111.962
14	Science and Humanities Block	107.845	108.355	113.819

A laser measure with a 40 m measuring range was used to measure the height of all institutional buildings and dorms. The values of the height of all institutional buildings and hostels are given in table II.

Table II: Floor level area, Projected roof area, Building height

Building no.	Building Name	Floor Level Area (m²)	Roof Area(m²)	Building Height (m)
1	College main building	2443.7	3054.625	14.82
2	Library Block	530	662.5	9.876
3	Instrumentation & Control Block	569	711.25	9.84
4	Electronics & Computer Science Block	794	992.5	11.755
5	Academic Block	491	613.75	6.055
6	Alumni Block	300	375	11.3
7	Placement Block	908.75	1135.9375	8.383
8	Mechanical Workshop I	1655	2068.75	5.079
9	Mechanical Workshop II	1484.18	1855.225	5.079
10	Civil Workshop	1322.87	1653.5875	5.007
11	Electrical Workshop	1614.71	2018.3875	5.217
12	Canteen	531.69	664.6125	3.21
13	Structural Engineering Lab	334.02	417.525	5.517
14	Science and Humanities Block	1574.484	1968.105	5.974

VI. VI. DATA COLLECTION

The data for the calculation of the water demand has been collected from the college office. The information gathered includes the overall count of students, faculty, and staff at the college. By completing a poll for five days and calculating the median of the results, it has been possible to estimate the number of students using the cafeteria service.

1. Total number of students = 2627
2. Total number of staffs = 268
3. Number of students using canteen service = 671

A. Details of Rainwater Harvesting Tank Existing in College Campus

Details of rainwater harvesting tank under construction in NSSCE Coordinates for the rainwater harvesting tank being constructed at NSSCE were collected using a total station ensuring accuracy and precision in the data acquisition process. Upon obtaining the coordinates, the data was meticulously input into ESurveyCAD software, a powerful tool tailored for such tasks, where it underwent thorough analysis. Through the software's capabilities, the area and volume of the tank were precisely determined, providing vital information for the construction process. However, ensuring the reliability and integrity of the obtained data was paramount. From the comprehensive analysis conducted using ESurveyCAD software, the area of the rainwater harvesting tank was determined to be 531m^2, while its volume was calculated to be 1134.931 m^3 shown in figure 3: A contour map of the rainwater harvesting tank was also diligently prepared shown in figure 4 with each contour representing a vertical interval of 1 meter. A total of 241 inputs were incorporated into the map, ensuring comprehensive coverage and accuracy. Through analysis, the contour map yielded a total of 6 distinct contours, with the lowest elevation recorded at 100.396 meters and the highest elevation reaching 106.0489 meters.

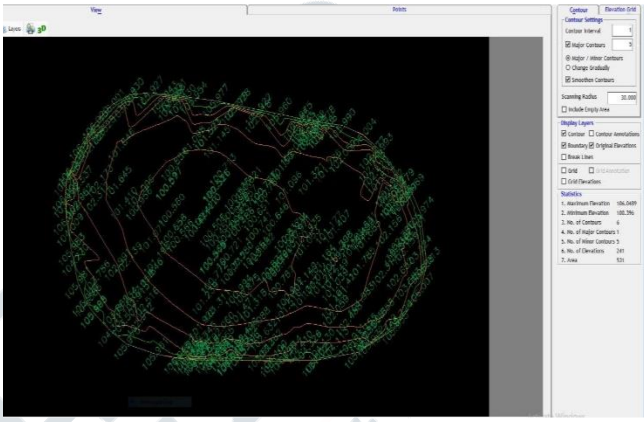

Fig 3: Area and Volume of rainwater harvesting tank determined through ESurveyCAD

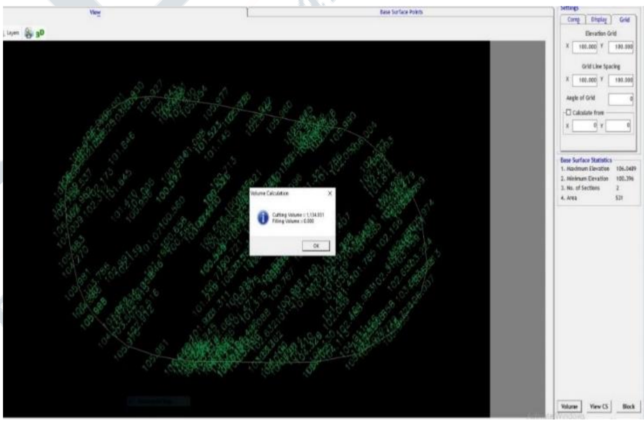

Fig 4: The contour map of rainwater harvesting tank under construction in NSSCE

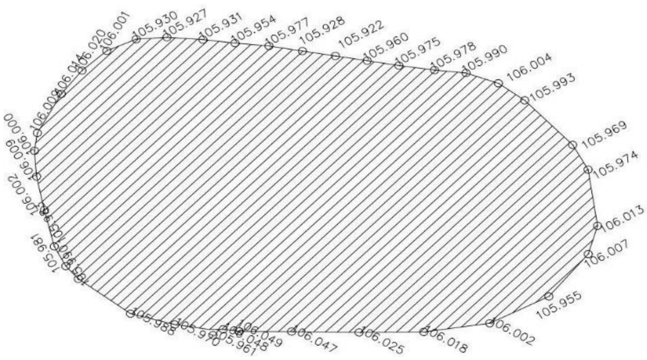

Fig 5: Auto cad drawing of rain water harvesting tank under construction in NSSCE

B. Rainfall data of the last 10 years (2012-2022)

The rainfall data, sourced from the Integrated Rural Technology Centre (IRTC) situated in Mundur, Palakkad, spans a comprehensive period from 2012 to 2022, encompassing a total duration of 10 years, providing a robust and extensive dataset for meteorological analysis and water resource management in the region shown in Table III.

Table III: Rainfall data of last 10 year average rainfall data obtained is 2281.964 mm/year.

Weather Report: Rainfall Data (in mm)													
Year\Month	January	February	March	April	May	June	July	August	September	October	November	December	Total
2012	0	0	7.1	80.8	81	337	355	277.3	172.6	140.2	66.4	1.1	1518.5
2013	0	37.4	0	0	182	722	632	276.2	335.1	201	43.5	1.6	2430
2014	0	0	0	72.2	112	361	763	600	259.2	322.7	23.8	37.4	2550.9
2015	0	0	7.6	111	40	451	189	207.4	195.4	146.4	105.8	32.2	1485.8
2016	0	0	0	1.8	188	398	435	171.7	58.6	59.6	60.6	61.6	1435.2
2017	0	0	170.2	0	160	412	357	332.8	340.4	148.3	17	34.2	1972.5
2018	0	71.6	87	90.4	407	730	989	1054	39.2	214.1	23.6	0.4	3706
2019	0	0	0	0	30	163	451	947.6	393.4	444.2	83.7	3.2	2516.1
2020	0	0	24.4	227	85	252	449	704.6	381.6	165.4	37.1	30.8	2356.5
2021	40.7	0	49.6	26.5	179	286	489	275.5	316	348.6	295.1	20	2326.3
2022	0	0	26.8	106	182	189	749	652.3	429.1	328.4	86.6	55.4	2803.8
											TOTAL AVERAGE=		2281.9636

VII. WATER DEMAND CALCULATION

The water demand for all the students, faculty and staff in the college, and for the college canteen has been calculated separately. The water requirement for the institutional buildings, and food court has been taken from National Building Code (NBC) and IS 1172:1993- Code of basic requirements for water supply, drainage and sanitation; which is used for the water demand calculation.

As per NBC and IS 1172:1993, water requirement for different types of buildings are as follows:

- Educational Buildings = 45 lpcd
- Food Court = 35 lpcd

Water demand can be calculated using the equation given below:

Water demand = Water Requirement/ Consumption x Number of consumers

Thus, water demand for the buildings is obtained as:
Water requirements for educational buildings = 45 lpcd
Total number of students, faculty and staff = 2895
Water demand for students and staff = 45 x 2895 = 130,275 litre/day
Water requirements for Food court = 35 lpcd
Number of students using canteen service = 671
Water demand for canteen service = 35 x 671 = 23,485 litre/day Total water demand = 153,760 litre/day
Water demand for 2 months of summer season =153,760 x 60 =92,25,600 litre.

VIII. RAINWATER DISCHARGE QUANTITY CALCULATION

The quantity of rainwater discharge is computed to ascertain the volume of rainwater collected from the rooftop of buildings. Rational Method is the simplest method to determine the rainwater discharge which is given by: -

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

Where,
Q = Discharge from roofs due to rainfall(litre/year),
C= Runoff Coefficient, I = Intensity of rainfall (m/year)
A= Projected roof area(m^2)

Runoff coefficient for any catchment is the ratio of the volume of water that runs off a surface to the volume of rainfall that falls on the surface. Runoff coefficient accounts for losses due to spillage, leakage, infiltration, catchment surface wetting and evaporation, which will all contribute to reducing the amount of runoff. Calculated rainwater discharge quantity shown in table I.

From Table 4.
Average rainwater discharge = 45,023.644 m^3/year
= 45,023.644 x 1000
= 45023644.1 litre/year

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Table IV: Rainwater discharge quantity calculation

Building No.	Building Name	Runoff Coefficient	Rainfall (m/year)	Roof Area (m^2)	Rainwater Discharge (m^3/year)	Rainwater Discharge (litre/year)
1	College main building	0.8	2.282	3723.670	6797.932	6797932.0
2	Library Block	0.8	2.282	801.200	1462.671	1462670.7
3	Instrumentation & Control Block	0.8	2.282	818.260	1493.815	1493815.5
4	Electronics & Computer science Block	0.8	2.282	1601.400	2923.516	2923515.8
5	Academic Block	0.7	2.282	637.660	1018.598	1018598.1
6	Alumni Block	0.8	2.282	412.000	752.147	752147.2
7	Placement Block	0.7	2.282	908.750	1451.637	1451637.3
8	Mechanical Workshop I	0.8	2.282	2560.138	4673.788	4673787.9
9	Mechanical Workshop II	0.8	2.282	2389.318	4361.939	4361938.9
10	Civil Workshop	0.8	2.282	2228.008	4067.451	4067451.4
11	Electrical Workshop	0.8	2.282	2194.170	4005.677	4005676.8
12	Canteen	0.8	2.282	964.530	1760.846	1760846.0
13	Structural Engineering Lab	0.8	2.282	551.180	1006.234	1006234.2
14	Science and Humanities Block	0.8	2.282	4691.274	8564.390	8564389.8
15	Survey Field	0.2	2.282	1496.500	683.003	683002.6
			Total Discharge		45023.644	45023644.1

IX. DESIGN OF RECHARGE PIT

In NSSCE 3 borewells are existing which are near PTIB, New block, and Main block in which one is active and other two is not active as shown in table V Images of the borewells are shown in figure 4.

Table V: Borewell details

Sl.no	Location	Co-ordinates	Current status
1.	Near PTIB block	10.823134,76.641323	Active
2.	Near New Block	10.825021,76.641725	not Active
3.	Near Main Block	10.824454,76.642946	not Active

Fig 6: Borewell near PTIB block, new block and main block

A. In-situ permeability test

In-situ permeability test conducted near borewells according to IS 5529:PART II (2006) standards. The test was conducted by digging a pit near the borewells and they were filled with water, and recorded the time taken for infiltration.

Permeability coefficient = Depth/Time. Permeability calculation shown in table VI.

Table VI: Permeability Coefficient Calculation

Sl. No.	Location	Diameter of the Pit (m)	Depth of the Pit(m)	Time Required (s)	Permeability Coefficient (m/s)
1.	Near PTIB Block	1.5	1	5271.43	1.897×10^{-4}
2.	Near New Block	1.5	1	15685.71	0.6375×10^{-4}
3.	Near Main Block	1.5	1	2571.428	3.89×10^{-4}

B. Design of recharge pit

When rain falls in area A's rooftop catchment with an intensity of R and for a period of T hours, the volume of a recharge pit should be big enough to hold all the water that falls there.

Capacity of the recharge tank, V1 = (R A T)/e

e = Void ratio of the materials filled in recharge pit like gravel, coarse sand and fine sand The soil permeability is considered to be during the period of collection, by considering permeability

Capacity, V2=Permeability coefficient x Area x Time Final Capacity = V1 -V2

The proportions of the fill material, which consists of gravel, coarse sand, and fine sand, will result in porosity of about 0.5. The capacity of the refill tank is designed to hold back runoff for at least 15 minutes of rainfall. According to CGWB guidelines, the maximum 15-minute rainfall rate is 20 mm/h.

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1. Design Of Recharge Pit Near Main Block

Details of buildings are shown in table VII.

Table VII: Details of building for the design of recharge pit near Main block

Sl. No	Building Name	Floor Area (m^2)	Inclined Area (m^2)	Projected Roof Area (m^2)	Runoff Coefficient
1.	College Main Building	2443.70	1279.74	3723.670	0.8
2.	Civil Workshop	1322.87	905.138	2228.008	0.8
3.	Mechanical Workshop I	1655.00	905.138	2560.138	0.8
4.	Mechanical Workshop II	1484.18	905.138	2389.318	0.8
5.	Canteen	531.69	432.840	964.530	0.8
6.	Structural Engineering Lab	334.02	217.161	551.180	0.8

Surface runoff from survey field is included, which has a total area of 1496.5 m^2 & runoff coefficient is 0.2

Total projected roof area = 12416.844 m^2

Volume of rainwater = (12416.844+1496.5) x 0.02 x 0.8= 222.613 m^3

Capacity of recharge tank V1=(R1A1T/e) +(R2A2T/e)

= (12416.844 x 0.8 x 0.02/0.5) +(1496.5 x 0.2 x 0.02/0.5)

= 409.311 m^3

Considering permeability,

Capacity, V2= Permeability coefficient x Area x Time

= 3.89 x 10^{-4} x 9 x 8.4 x 15 x 60= 26.47 m^3

Final Capacity= V1-V2= 409.311- 26.47= 382.841 m^3

Assume depth as 5m,

Area of recharge pit = 76.56 m^2

Dimension of recharge pit = 8.8 m x 8.7 m x 5 m. Sectional view of recharge pit near main block shown in figure 7.

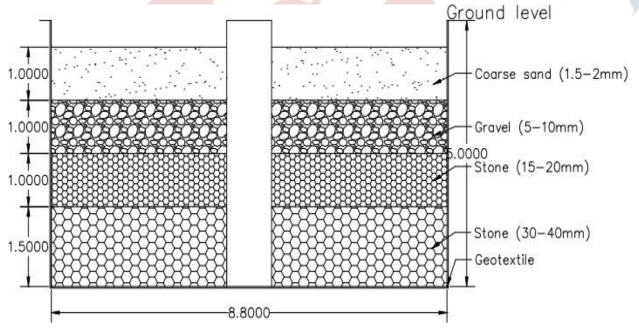

Fig 7: Sectional view of Recharge pit near Main block (all dimensions are in m)

2.Design Of Recharge Pit Near PTIB Block

Details of building for the design of recharge pit near PTIB block is shown in table VIII.

Table VIII: Details of building for the design of recharge pit near PTIB block

Sl. No.	Building Name	Floor Area (m^2)	Inclined Area (m^2)	Projected Roof Area (m^2)	Runoff Coefficient
1.	PTIB Block	908.75	-	908.750	0.7
2.	Alumni Block	300.00	112.00	412.000	0.8
3.	Academic Block	491.00	146.66	637.660	0.8
4.	Instrumentation & Control Block	569.00	249.26	818.260	0.8
5.	Electronics & Computer Science Block	794.00	304.80	1098.800	0.8
6.	Library Block	530.00	217.20	801.200	0.8

Total Projected Area =4676.67m^2 Consider 80% of total rainwater, Volume of Water = 4676.67x 0.02 x 0.8=74.827m^3

Capacity of Recharge tank, V1= (RAT/e) = (4676.67x 0.8 x 0.02/0.5) = 149.65m^3

Considering permeability,

Capacity, V2= 1.897 x 10^{-4} x 6.6 x 6 x 15 x 60= 6.76 m^3

Final Capacity= V1-V2= 149.65- 6.76= 142.89 m^3

Assume depth as 4m,

Area of recharge pit = 35.72 m^2

Dimension of recharge pit = 6.5 m x 5.5 m x 4 m

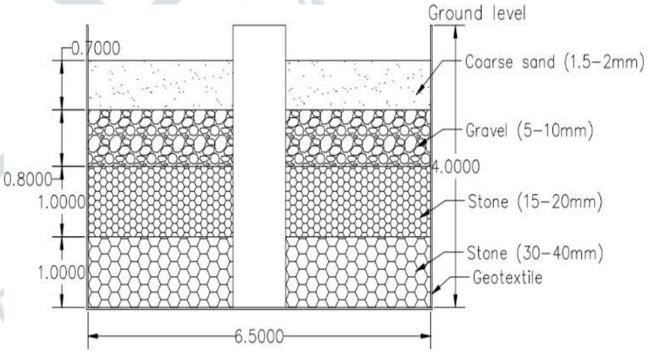

Fig 8: Sectional view of Recharge pit near Placement block (all dimensions are in m)

3.Design Of Recharge Pit Near New block

Details of building for the design of recharge pit near new block is shown in table IX.

Table IX: Details of building for the design of recharge pit near new block

Sl. No.	Building Name	Floor area (m^2)	Inclined Area (m^2)	Projected Roof area(m^2)	Runoff Coefficient
1.	Science & Humanities Block	1574.484	922.62	2497.104	0.8
2.	Electrical Workshop	1614.710	579.46	2194.170	0.8

Total Projected Area =4691.274m^2

Consider 80% of total rainwater,

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Volume of Water = 4691.274 x 0.02 x 0.8= 75.06m^3
Capacity of Recharge tank, V1= (RAT/e) = (4691.274 x 0.8 x 0.02/0.5) = 150.121m^3
Considering permeability,
Capacity, V2= 0.6375 x 10 $^{-4}$ x 5.8 x 5.2 x 15 x 60= 1.73 m^3
Final Capacity= V1-V2= 150.121-1.73= 148.39 m^3
Assume depth as 4.9m, Area of recharge pit = 30.28 m^2
Dimension of recharge pit **=** 5.5 m x 5.5 m x 4.9 m

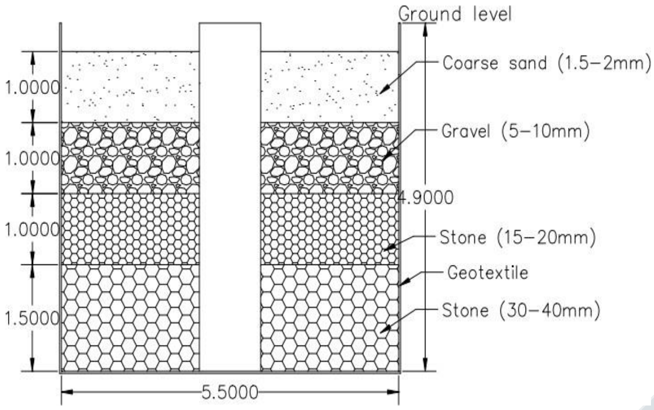

Fig 9: Sectional view of recharge pit near new block (all dimensions are in m)

X. PIPE NETWORK AND DRAINAGE LAYOUT OF SURVEY FIELD

Fig 10: Pipe network for rainwater harvesting system-NSSCE

The application of EPANET software within the context of designing a robust pipe network and drainage layout for NSS College of Engineering has yielded insightful results. Through meticulous data integration and simulation, we have effectively crafted a distribution system tailored to meet our specific requirements, focusing on efficient flow rates measured in liters per minute (lpm) and precise pressure measurements in meters (m). The results obtained from EPANET simulations offer valuable insights into the hydraulic behaviors and water quality dynamics of the system. By meticulously analyzing head and pressure values at junctions and pipelines, we can assess the performance of the distribution system and identify areas for optimization.

The EPANET software was effectively utilized with pipe diameters ranging from a minimum of 150mm to a maximum of 300mm, ensuring successful simulation runs. The execution of EPANET simulations, while adhering to specified pipe diameter constraints, underscores the effectiveness of our approach in designing a reliable and sustainable distribution system for NSS College of Engineering. In the planning and simulation of a pipe network using EPANET 2.2 software, (Environmental Protection Agency Network Evaluation Tool) the distribution system typically takes the form of either a tree system or a dead-end system.

This software facilitates the input of various data crucial for the analysis, including the number of nodes, demand at each node, elevation data, reservoir specifications (which represent catchment areas and recharge pits), and pipe configurations (represented as links connecting the nodes). In the specific design being discussed, there are 36 nodes and 29 reservoirs incorporated into the network. These reservoirs play a critical role in the overall functionality of the system, contributing to the management of water distribution and ensuring adequate supply to meet demand within the network. Through EPANET's simulation capabilities, engineers can assess the efficiency, reliability, and performance of the designed pipe network under various conditions, enabling informed decision-making and optimization of the water distribution infrastructure.

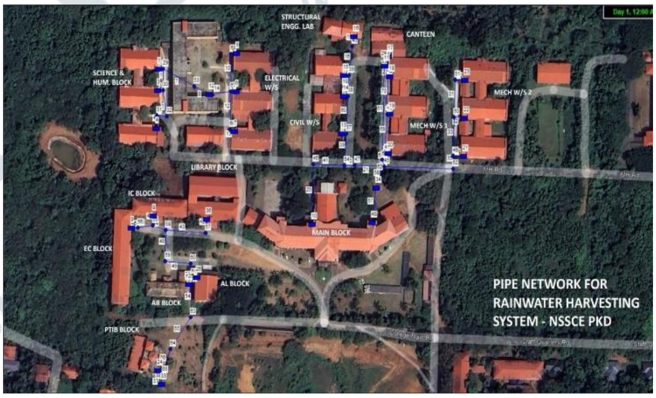

Fig 11: Analysis of pipe network for rainwater harvesting system

In NSS College of Engineering, the elevation of required points is measured using a dumpy level, ensuring precision in the installation of nodes. This process lays the foundation for establishing a comprehensive network of distribution within the campus. Each pipe's diameter is carefully adjusted based on the specific positions of buildings and the distance to recharge pits, optimizing the efficiency of water distribution. Rigorous pressure and velocity checks are then conducted, with adjustments made iteratively until the system runs smoothly and successfully. This approach ensures that the water distribution system not only meets the immediate needs of the college but also lays the groundwork for long-term sustainability and reliability.

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XI. COST ESTIMATION

Quantity and cost have been computed to assess the project's feasibility. The cost of materials was calculated as per Delhi Schedule of Rates (DSR-2018). Cost index applied for this estimate is 134.75 (Palakkad district) which is based on DSR 2018.

Estimated cost of the pipe = 35,14,572 /

XII. CONCLUSIONS

Based on the design and dimension determination of the recharge pits, alongside the analysis conducted using EPANET software, several key conclusions can be drawn from the project.

- Water demand for the 2 months of summer season is 92,23,800 litres/day, which reflects the increased need for water during warmer months.
- Rainwater harvested from all rooftops is 4,50,23,644.1 litre/year, so that the daily collection is sufficient to meet summer demand at NSSCE Palakkad.
- Allocating 222.613 m^3, 74.827 m^3, and 75.06 m^3 of water to recharge pits near the main, placement, and new blocks respectively strategically addresses specific water needs across the college.
- The dimensions of the recharge pits near the main block, placement block, and new blocks are 8.8x8.7x5m, 6.5x5.5x4m, and 5.5x5.5x4.9m respectively.
- The project’s estimated cost is 35,14,572/-, reflecting a significant investment in sustainable water management infrastructure.

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