COST BENEFIT ANALYSIS OF ROOF TOP RAIN WATER HARVESTING SYSTEM USING DIFFERENT MATERIALS

By
Mehedi Hassan
Sohage Shakhe
Md. Rafiqul Islam
Sazzad Hasan
Sujan Mia

A thesis submitted to the Department of Civil Engineering in partial fulfillmentfor the degree of Bachelor of Science in Civil Engineering



Department of Civil Engineering
Sonargaon University
147/I, Green Road, Dhaka-1215, Bangladesh
Section: 21A
Semester: Spring-2024

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By

Mehedi Hassan	BCE2003021073
Sohage Shakhe	BCE2003021008
Md. Rafiqul Islam	BCE2003021064
Sazzad Hasan	BCE2002020083
Sujan Mia	BCE2003021078

Supervisor
Md. Lutfor Rahman
Associate Professor
Head of the Department
Department of Civil Engineering
Sonargaon University

A thesis submitted to the Department of Civil Engineering partial fulfillment for the degree of Bachelor of Science in Civil Engineering.

Department of Civil Engineering
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BOARD OF EXAMINERS

The Thesis Titled “Cost benefit analysis of roof top rain water harvesting system using different materials” Submitted by Mehedi Hassan, Student ID: BCE2003021073, Sohage Shakhe, Student ID:2003021008, Md. Rafiqul Islam, Student ID: BCE2003021064, Sazzad Hasan, Student ID: 2002020083, Sujan Mia, Student ID: 2003021078, has been accepted as satisfactory in partial fulfillment of the requirement for the degree of Bachelor of Science in Civil Engineering.

……..
1. Md. Lutfor Rahman
Chairman
Associate Professor
Head of the Department
Department of Civil Engineering

……..
2.Internal/External Member
Member

……..
3.Internal/External Member
Member

DECLARATION

This is to declare that, except where specific references are made to other investigators, the work embodied in this thesis paper is the result of an investigation carried out only by the author under type supervision of Associate Prof. Md. Lutfor Rahmann , Head of the Department of Civil Engineering, Sonargaon University (SU). Neither the thesis nor any part of it has been submitted to any other universities or other educational institution for a degree, diploma or other qualification.

STUDENT NAME	STUDENT ID	SIGNATURE
Mehedi Hassan	BCE2003021073	
Sohage Shakhe	BCE2003021008	
Md. Rafiqul Islam	BCE2003021064	
Sazzad Hasan	BCE2002020083	
Sujan Mia	BCE2003021078	

Dedicated

To

“ Our Beloved Parents”

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ABSTRACT

The study was conducted to cost benefit analysis of rainwater harvesting for different roof top materials at different existing proposed project & find out the which roof top materials is better & benefited for rain water harvesting & find the quality of rain water. Firstly, we selected four existing proposed projects at Hobiganj, Mymensingh & Pabna district which is four type of roof top surface such as RCC, Metal, Patent stone & water proof paint surface). For rain water harvesting we have considered manual based rain water harvesting system (RHS) at every project. Then we make approximate materials requirement & roof top preparation cost for rain water harvesting at every project & fixed total implement cost. Then we collected our project-1 rain water and test chemical parameters. We test four (04) parameters as PH value, Total dissolve solid, Conductivity and Chloride of these sample. All values are nearest with WHO standard.Lastly, we calculated individual project benefit against yearly rainwater harvesting and got metal roof surface is benefited among four roof top surfaces for rain water harvesting.

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CHAPTER 1
INTRODUCTION

1.1 Background

Bangladesh has an emerging problem with water supplies not adequate to meet even the minimum requirements for potable water. Surface water is being continuously contaminated by both industrial and human pollutions rapidly increasing demands due to population explosion results in withdrawal of ground water at a faster rate thanit is replenished by recharge. There are several roofing materials that can used for rain water harvesting such as concrete surface, lime tracing, metal profile sheet & water proofing paint surface. Rainwater harvesting, the long traditional wisdom, might be a solution to the problem. Rainwater harvesting means proper use of rainwater by storing for domestic uses & recharging groundwater table.

1.2 Research Objective

The research objective of the research are as below.

To be aware about rainfall harvesting system.
To analyze cost benefit of different type of roof top materials.

1.3 Organization of Thesis

Cost benefit analysis of roof top rainwater harvesting system using different materials is a good system or method for find out the which roof materials will be benefited for roof rainwater harvesting also aware to people about rain water harvesting.
The thesis is organized into five unique chapters that each address one of the following issues:

Chapter 01: Introduction and Objective

With the increase of population with the increase of water supply demand water layer is getting lower each year at a noticeable rate & surface water is being continuously contaminated by both industrial and human pollutions rapidly. Roof top rainwater harvesting system is long traditional wisdom to be solution water crisis & reduce the ground water. Our main objective is to be aware people about rainfall harvesting & cost benefit analysis of different type of roof top materials.

Chapter 02: Literature Review

Many countries in the world have implemented RWH system. We learn about their system. There have many types of roof top surface such as RCC, Metal, Patent stone & water proof paint. So we try to analysis which roof top materials is benefited for roof top rain water harvesting system.

Chapter 03: Methodology

Throughout comprehension findings, we tried to evaluate a cost effective & benefited of roof top rainwater harvesting system usings different materials. For this we collected our individual four project rainwater harvesting related dada, fix the roof preparation cost, plumbing cost & total project implement cost so that we can find out the which roof top materials is benefited the rainwater harvesting among the four projects.

Chapter 04: Result and Discussion

In this chapter we collected individual four project data and analysis the four projects for find out the which roof top materials is benefited for roof top rainwater harvesting.

Chapter 05: Conclusions and Recommendation

In this chapter, the outcomes of the study have been conclude obtained from our research and background study. We find out the metal roof top surface is benefited among the four proposed study project. Thereby more future studies should be done for more effectively implement RWH system for treated drinking water, 3D model & others.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Rainwater harvesting is a common practice in the countries and areas where the annual precipitation is high and pure drinking and usable water is scarce. All over the world, economical condition has prompted the low-income groups to harvest the rainwater for household and essential uses. We have worked different three area for roof top rain water harvesting at Hobiganj, Mymensingh & Pabna district & analyze cost benefit successfully.

2.2 Some RWH system in Bangladesh & others countries.

Some industrial building roof top & residentials building root top have RWH system in Bangladesh.

Roof top rainwater harvesting for sustainable water use in residential buildings for climate resilient city building at Rajshahi [1]. Rajshahi is located in the Barind region and global climate change, this region is moving towards desertification day by day. Also, with the increasing number of building, footpaths and paved surfaces in the city area, the chances of percolation of rain water in the ground area decreasing

Design of rooftop rainwater harvesting a case study on Halishahar Chittagong residential area [2]

In the present context, rainwater harvesting is bring seriously considered as an alternative option for water supply in Bangladesh and prevents the water crisis. Although the cos of this method is burden for low-income group, rooftop in buildings can be designed to collect rain water solving the challenging issues of minimizing the store cost and management and allocation the water use by water quality. In the case of a builder, at an initial stage of construction, investment in time, design and money are minimal for adopting rainwater harvesting. An investment has been done to find out the condition of water supply and people's interest about the roof top rainwater harvesting in three different places named Bahaddarhat, Halishahar and Potenga. According to CWASA, weekly the people of Halishahar are getting water 3 days only which is not sufficient. The aim is to provide sustainable and sale pure water for drinking and cooking in water scarce areas, due to this Halishahar area is chosen.

Rainwater harvesting is a sustainable and viable way to supplement water supply in Australia. With rapidly increasing population growth, climate change, and longstanding academic research into the topic of rain harvesting, it has been made easier than ever to properly capitalize on rainwater that falls onto our homes. Rooftop rainwater harvesting can be easily implemented within households without needing extensive technical knowledge or equipment. This means more households are able take advantage of this process and effectively manage their use of natural resources for activities such as watering gardens, toilets, laundry and irrigation. All these activities require a lot of water; but if it is harvested during rain seasons, it could be available

throughout the year for these activities - even during droughts! It just goes to show how essential education about rainwater harvesting is in many parts of Australia now [3].

South Africa faces numerous water scarcity issues due to climate change, population growth and frequent droughts. Rainwater harvesting is one solution to these problems, offering the country a cost-effective means of gathering valuable resources that would otherwise be lost. By trapping excess rainwater on the roof of a building—or in other containers—rain harvesting can provide an additional supply of drinking water, improve sanitation and help replenish local rivers and ground waters. As technology advances, investing in rainwater harvesting systems such as tanks and filtration devices also promises to significantly reduce bills for water collection and storage. Now more than ever, South Africa is seizing the opportunity to adopt rainwater harvesting as a secure source of drinking water for its citizens [3].

Rainwater harvesting is an important element of ecological protection in China. In recent years, rain harvesting has become increasingly popular as a way to reduce water shortages and conserve water resources. The Chinese government has implemented many incentives and initiatives to encourage citizens to use rainwater for their everyday needs, such as growing crops and meeting other domestic requirements. Rainwater harvesting helps ensure greater sustainability and also puts less pressure on main sources of water like rivers, lakes and aquifers. By storing this water in conventional containers like dams or rain barrels, it can be used efficiently when rainfall is low. Moreover, the installation of rain tanks and other systems that collect rainwater enables the utilization of groundwater resources more effectively while still making sure they last longer. All in all, rainwater harvesting strengthens China's commitments towards adequate water availability in the future by ensuring maximum conservation of existing resources [3].

Bangladesh used the surface water as the principal source for drinking water up to therecent past. But nowadays, withdrawal of groundwater has become norm. One of the major problems with groundwater is arsenic contamination. Almost 50 percent of the country suffers from this contamination. Rooftops in buildings may be designed to collect rainwater solving the challenging issues of minimizing the storage cost and management. If the system is incorporated inthe design and construction process of buildings, cost of such a system could be very minimal

2.3 Summary

With the increase of water demand the more water is being taken out from ground water for many purposes. To ensure the supply of this water we need to continuously recharge ground water with the maximum amount of safe water we can get. Rain water is already safer from various source of water. So, if we aware about roof top rainwater harvesting system & cost benefit analyze

CHAPTER 3

MATHODOLOGY

3.1 Introduction

This chapter we will know about our proposed different project roof top rainwater harvesting system using different materials. Also we show our individual project details, pluming cost, roof surface preparation cost & others cost details. We know many types of RWH system in Bangladesh but we have work one selected manual based RWH system [4] .

3.2 Our Different proposed project roof top surface & proposed RWH system.

Project-01

RCC Roof top surface & Rain water harvesting Study Project

Building Name: RFL#11 (Tyre Tube)

Location: Hobiganj Industrial Park, Shayestaganj, Olipur, Hobiganj

Roof Area: 306.5'(93.45m) x 115'(35m)= 3270.75 m^2

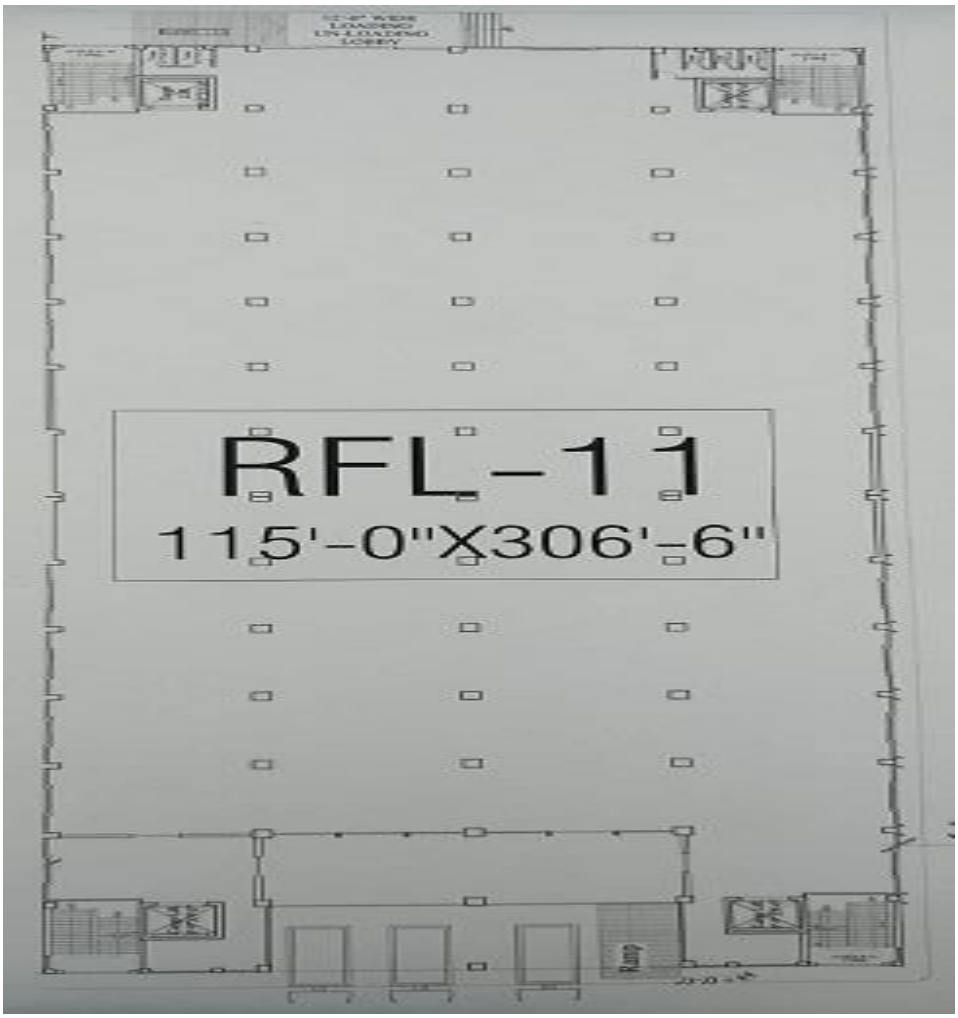


Figure 3.1: Roof plan of study building



Figure 3.2: Roof top view of study building.



Figure 3.3: Roof top view of study building.

Table 3.1 Run off coefficients [5]

Runoff Coefficients For Common roof Materials	
Metal	0.95
Asphalt	0.9
Concrete	0.9
Tar and gravel	0.80-0.85



Figure 3.4: Down pipe & side view of study building.



Figure 3.5: Down pipe & side view of study building.



Figure 3.6: Down pipe & side view of study building.

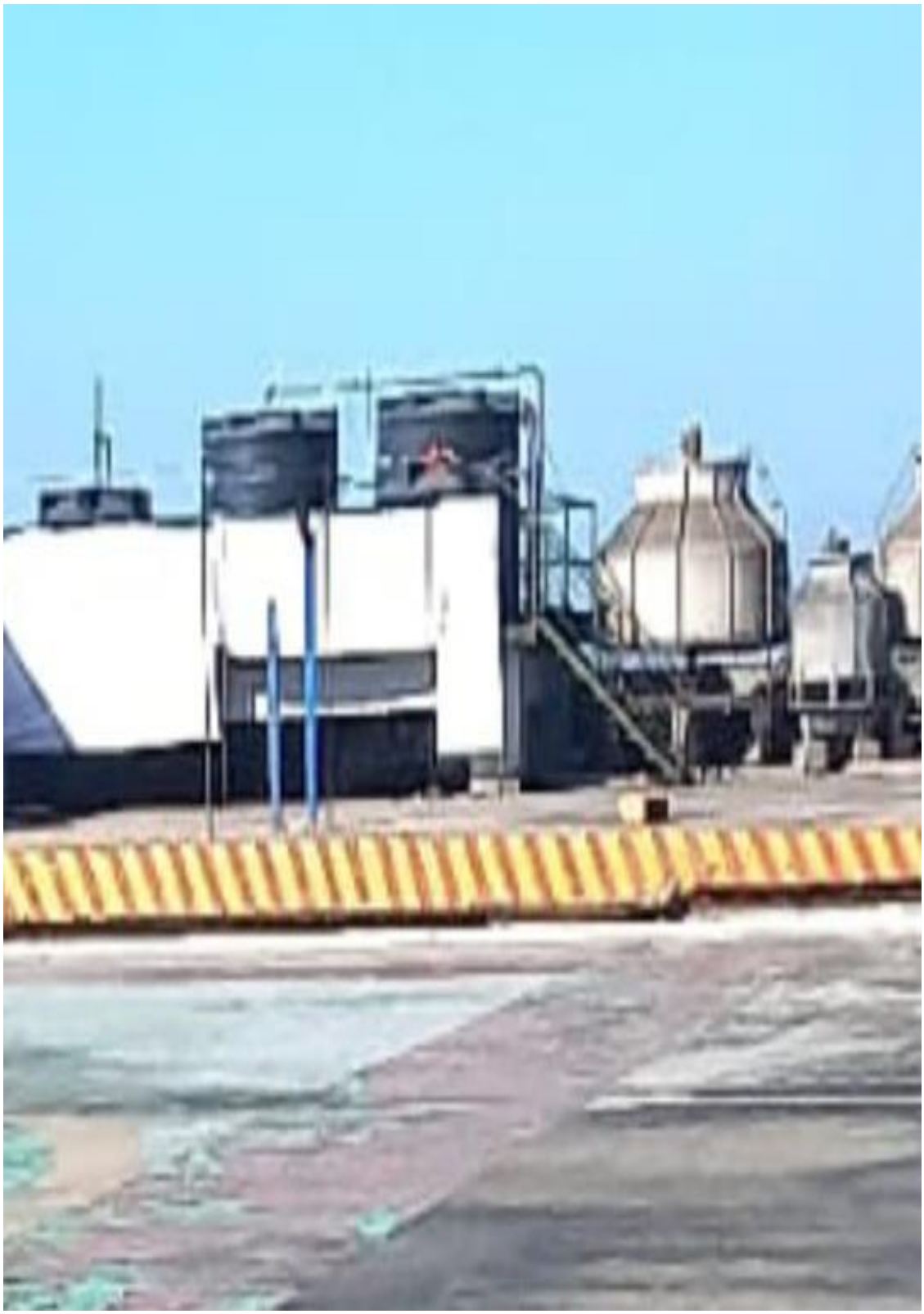


Figure 3.7: Overhead water reservoir



Figure 3.8: Delivery Pump



Figure 3.9: Delivery Pump

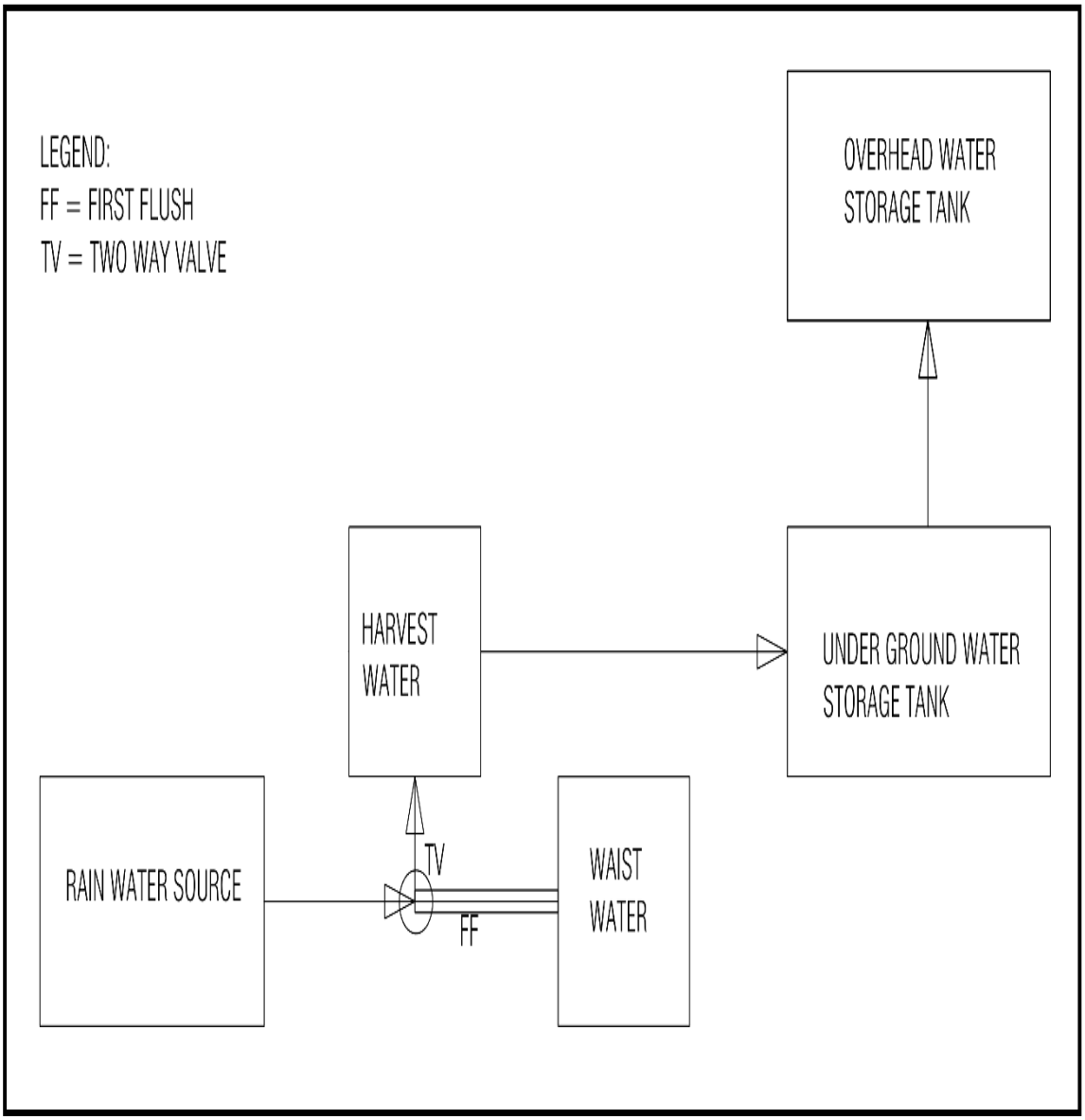
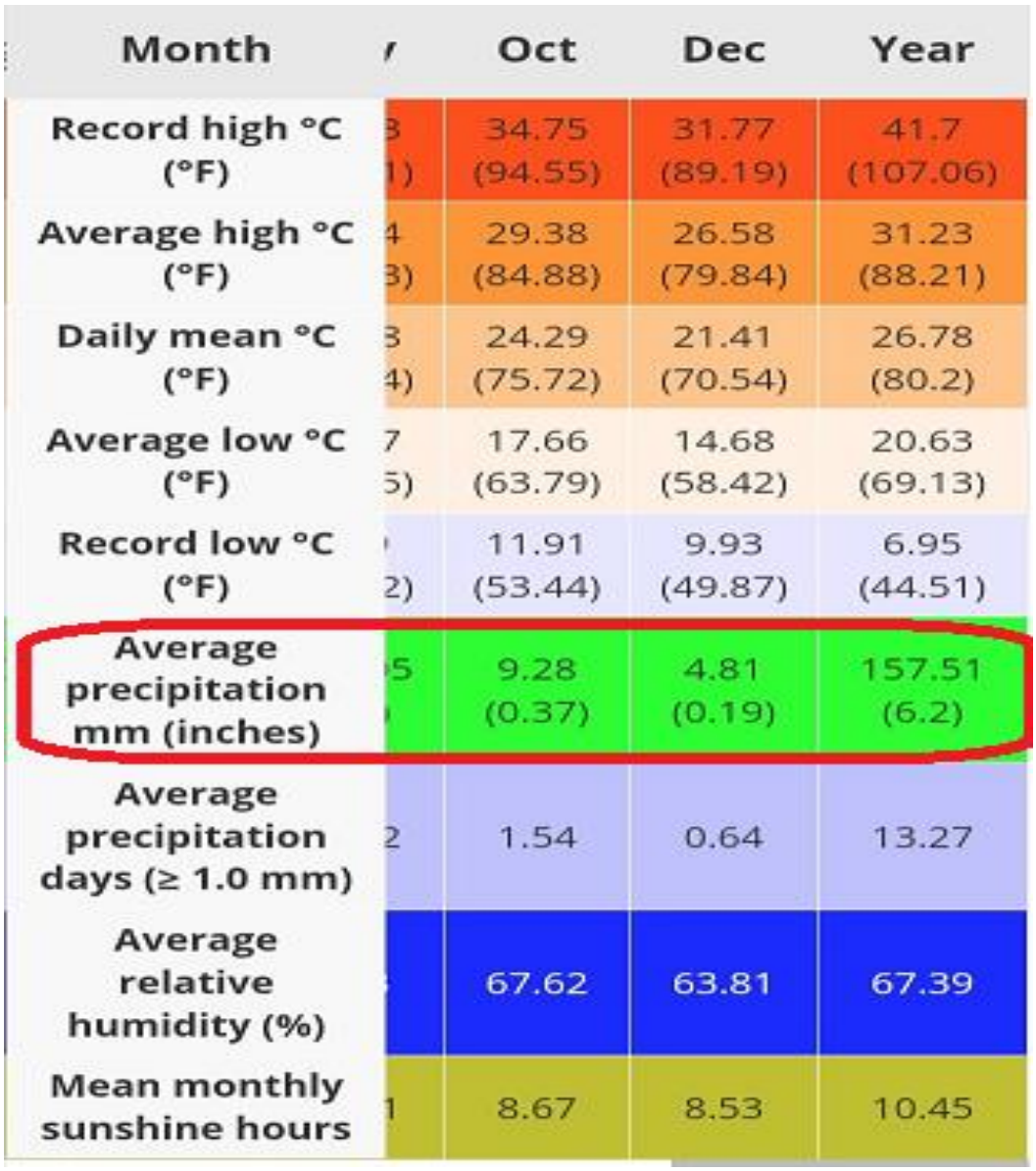


Figure 3.10: Process diagram of rain water harvesting



Month	/	Oct	Dec	Year
Record high °C (°F)	3 1)	34.75 (94.55)	31.77 (89.19)	41.7 (107.06)
Average high °C (°F)	4 3)	29.38 (84.88)	26.58 (79.84)	31.23 (88.21)
Daily mean °C (°F)	3 4)	24.29 (75.72)	21.41 (70.54)	26.78 (80.2)
Average low °C (°F)	7 5)	17.66 (63.79)	14.68 (58.42)	20.63 (69.13)
Record low °C (°F)	 2)	11.91 (53.44)	9.93 (49.87)	6.95 (44.51)
Average precipitation mm (inches)	5 	9.28 (0.37)	4.81 (0.19)	157.51 (6.2)
Average precipitation days (≥ 1.0 mm)	2	1.54	0.64	13.27
Average relative humidity (%)		67.62	63.81	67.39
Mean monthly sunshine hours	1	8.67	8.53	10.45

Figure 3.11: Monthly average rain fall data of Hobiganj district [6]

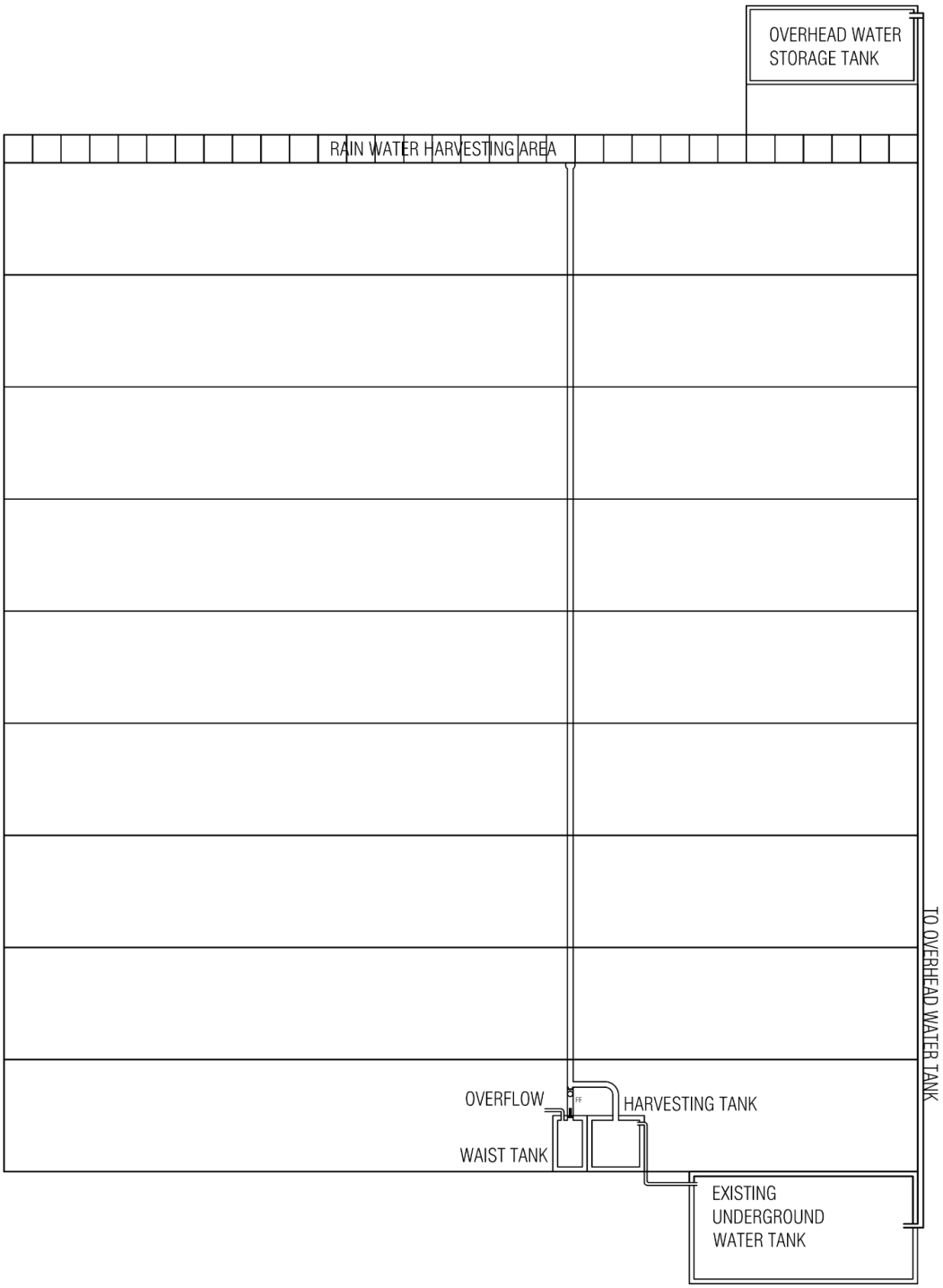


Figure 3.12: Sectional elevation of rain water harvesting study project.

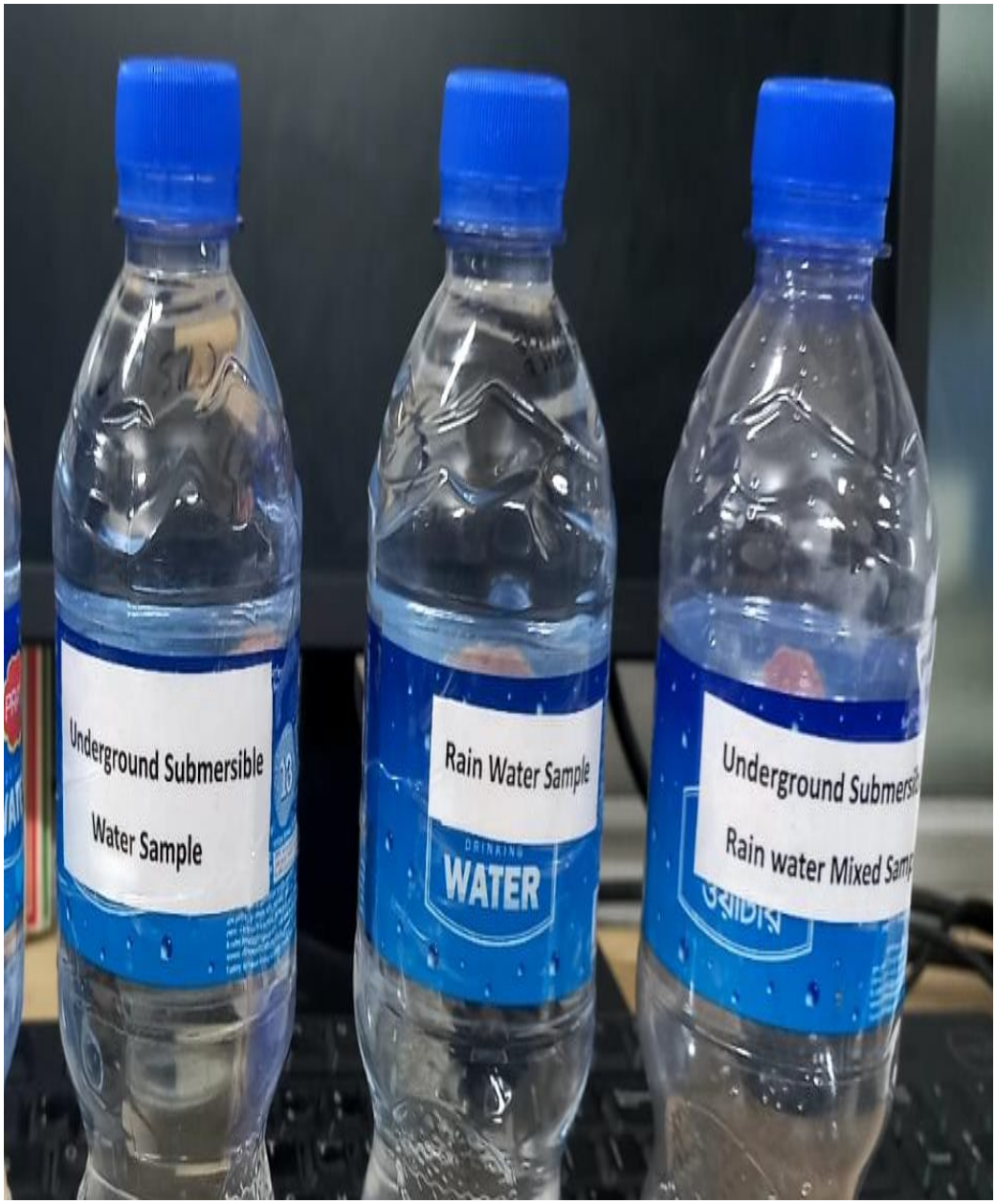


Figure 3.13: Samples of water

Table 3.2 RCC roof preparation cost for rain water harvesting.

SL NO	Item Name	Unit	Length (Feet)	Wide (Feet)	Depth (Inch)	Qty	Rate/ Unit	Total Amount (Tk)	Remarks
1	Ready mix CC casting Included admixture such as Nirman1500 , Sika 2064 F'c= 3500 psi Fy=60 ksi	CFT	306'-6"	115'-o"	0'-2"	5874.5	306	1,797,597	
2	Casting & finishing cost.	SFT	306'-6"	115'-o"	-	35247.5	8	281,980	

(Total Amount = 2,079,577 Tk)

In word: Twenty lakh seventy-nine thousand five hundred seventy-seven taka only.

Table 3.3 Plumbing item cost details for rain water harvesting.

SL NO	Name of item	Unit	Qty	Rate/unit	Total amount (Tk)	Remarks
1	UPVC pipe 6”	Pcs	183	2,805	513,315	
2	UPVC Elbow 6”	Pcs	50	260	13,000	
3	PVC pipe 8” (B Class)	Pcs	38	4,200	159,600	
4	Joint brick pit(2’-6”x2’-6”)	Pcs	30	7,000	210,000	
5	Royale bolt 8 mm	Pcs	5856	8.83	51,708	
6	PVC solvent cement 500 ml	Pot	50	342	17,100	
7	Cost for pit making (2’-6”x2’-6”)	Pcs	30	2,200	66,000	
8	Down pipe fitting charge 6”	RFT	3652	32	116,864	
9	PVC pipe fitting charge 8”	RFT	760	38	28,880	

(Total Amount=1,176,467 Tk)

In word: Eleven lakh seventy-six thousand four hundred sixty-seven tala only

Project-02

Metal Roof top surface & Rain water harvesting Study Project

Building Name: RFL#02 (Bizli Cable)

Location: Hobiganj Industrial Park, Shayestaganj, Olipur, Hobiganj

Roof Area: 344’(104.88m) x 150’(35m)= 4796.16 m^2

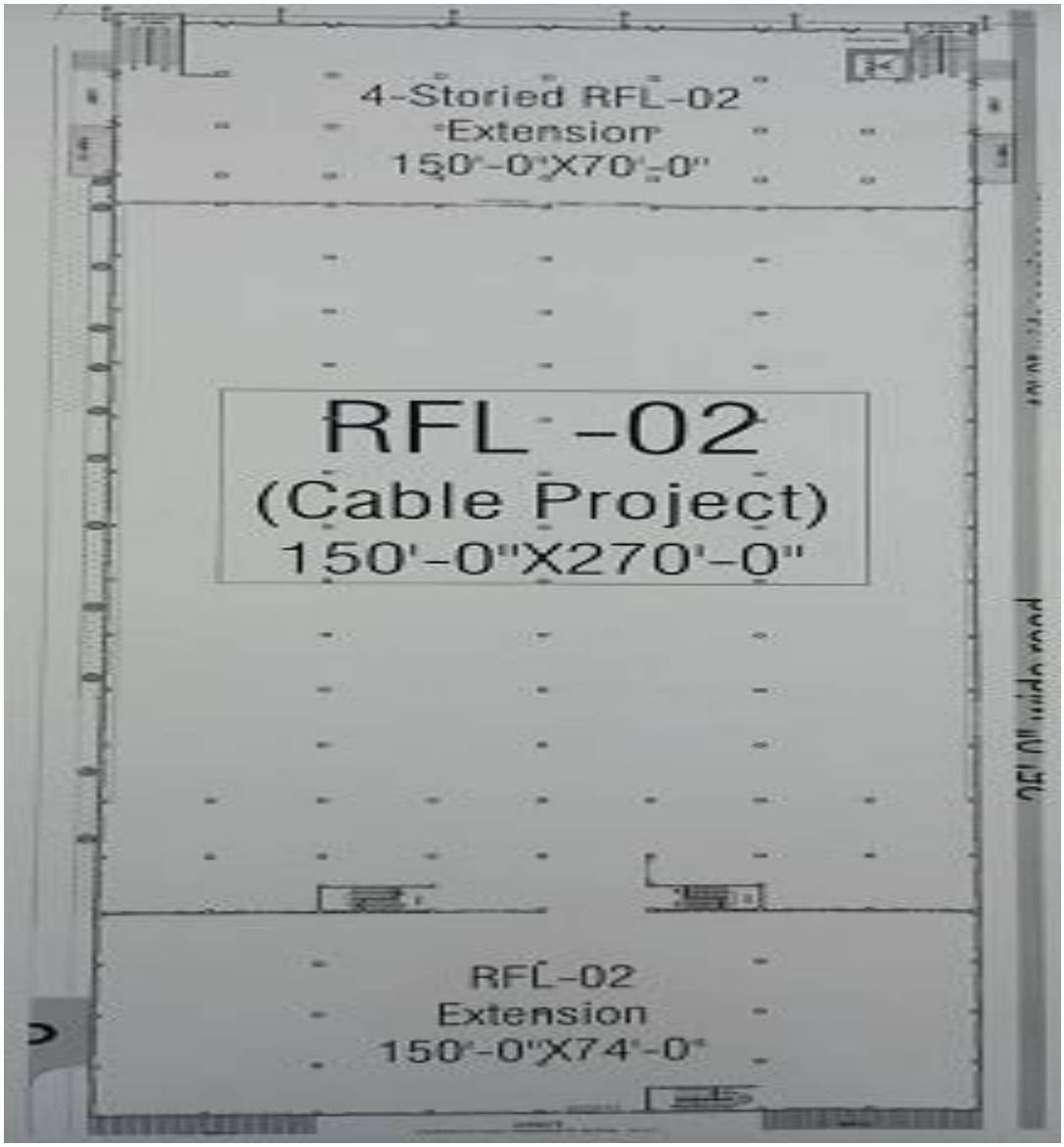


Figure 3.14: Roof top plan of study Project.



Figure 3.15: Roof top view of study Project.



Figure 3.16: Rain water gutter, down pipe & side view of study Project.



Figure 3.17: Rain water gutter, down pipe & side view of study Project

Table 3.4 Metal roof top preparation cost details for rain water harvesting at study project.

SL NO	Item Name	Unit	Length (Feet)	Wide (Feet)	Qty	Rate/Unit	Total Amount (Tk)	Remarks
1	Red oxide primer	Gallon	-	-	129	1,460	188,340	
2	Enamel paint green	Gallon	-	-	94	1,460	137,240	
3	Thinner (T6)	Gallon	-	-	45	660	29,700	
4	Roof sheeting work cost	SFT	344	150	51,600	4.6	237,360	
5	Painting charge (2 coat)	SFT	344	150	51,600	4.2	216,720	

(Total Amount= 809,360 Tk)

In word: Eight lakh nine thousand three hundred sixty taka only.

Table 3.5 Plumbing materials cost details of study Project.

SL NO	Name of item	Unit	Qty	Rate/unit	Total amount (Tk)	Remarks
1	UPVC pipe 6”	Pcs	35	2,805	98,175	
2	UPVC Elbow 6”	Pcs	35	260	9,100	
3	PVC pipe 8” (B Class)	Pcs	38	4,200	159,600	
4	Joint brick pit(2’-6”x2’-6”)	Pcs	21	7,000	147,000	
5	Royale bolt 8 mm	Pcs	350	8.83	3,090	
6	PVC solvent cement 500 ml	Pot	15	342	5,130	
7	Cost for pit making (2’-6”x2’-6”)	Pcs	21	2,200	46,200	
8	Down pipe fitting charge 6”	RFT	875	32	28,000	
9	PVC pipe fitting charge 8”	RFT	750	38	28,500	
10	Gutter	RFT	688	250	172,000	

(Total Amount= 696,795 Tk)

In word: Six lakh ninety-six thousand seven hundred ninety-five taka only.

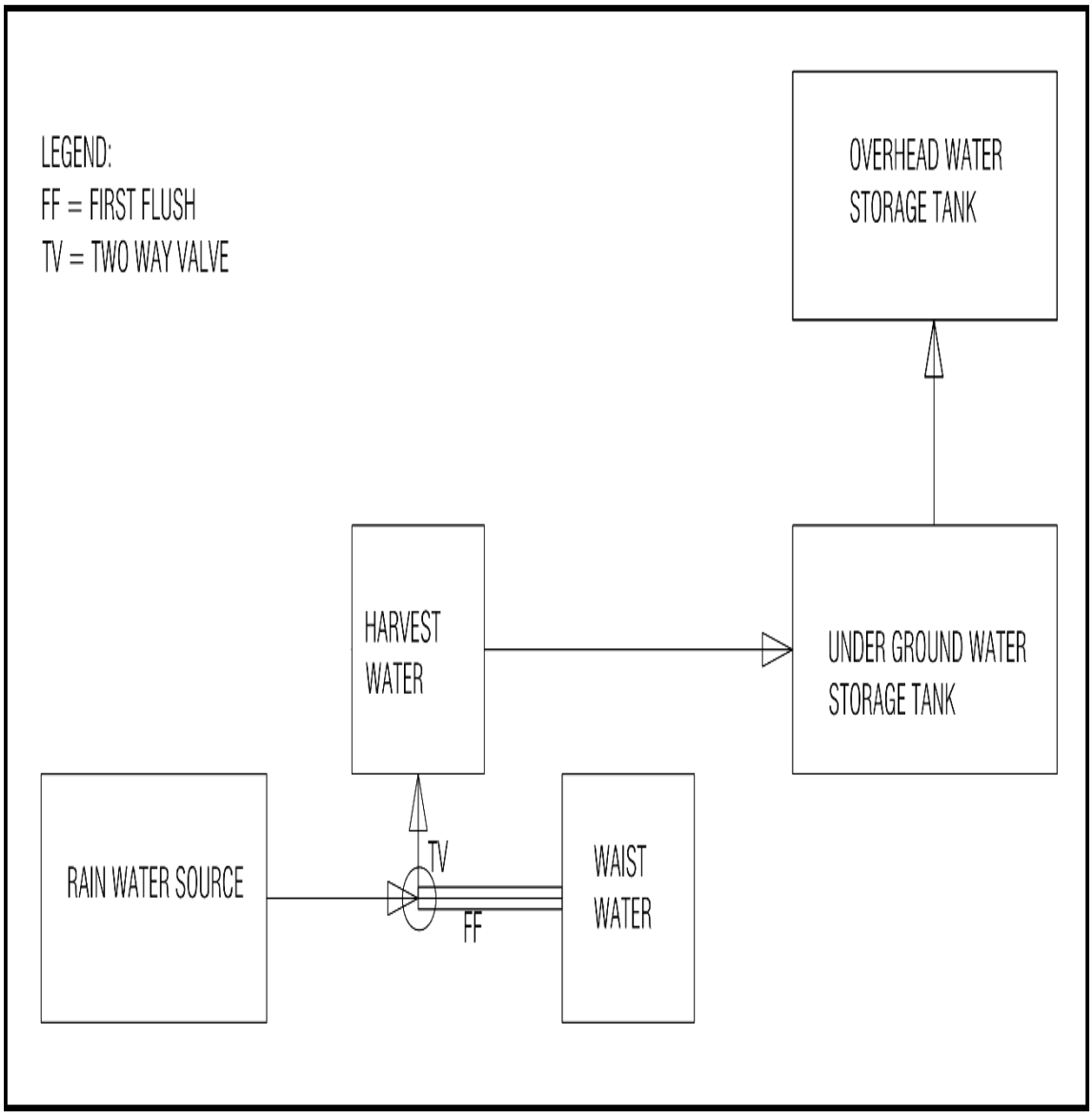


Figure 3.18: Process diagram of rain water harvesting

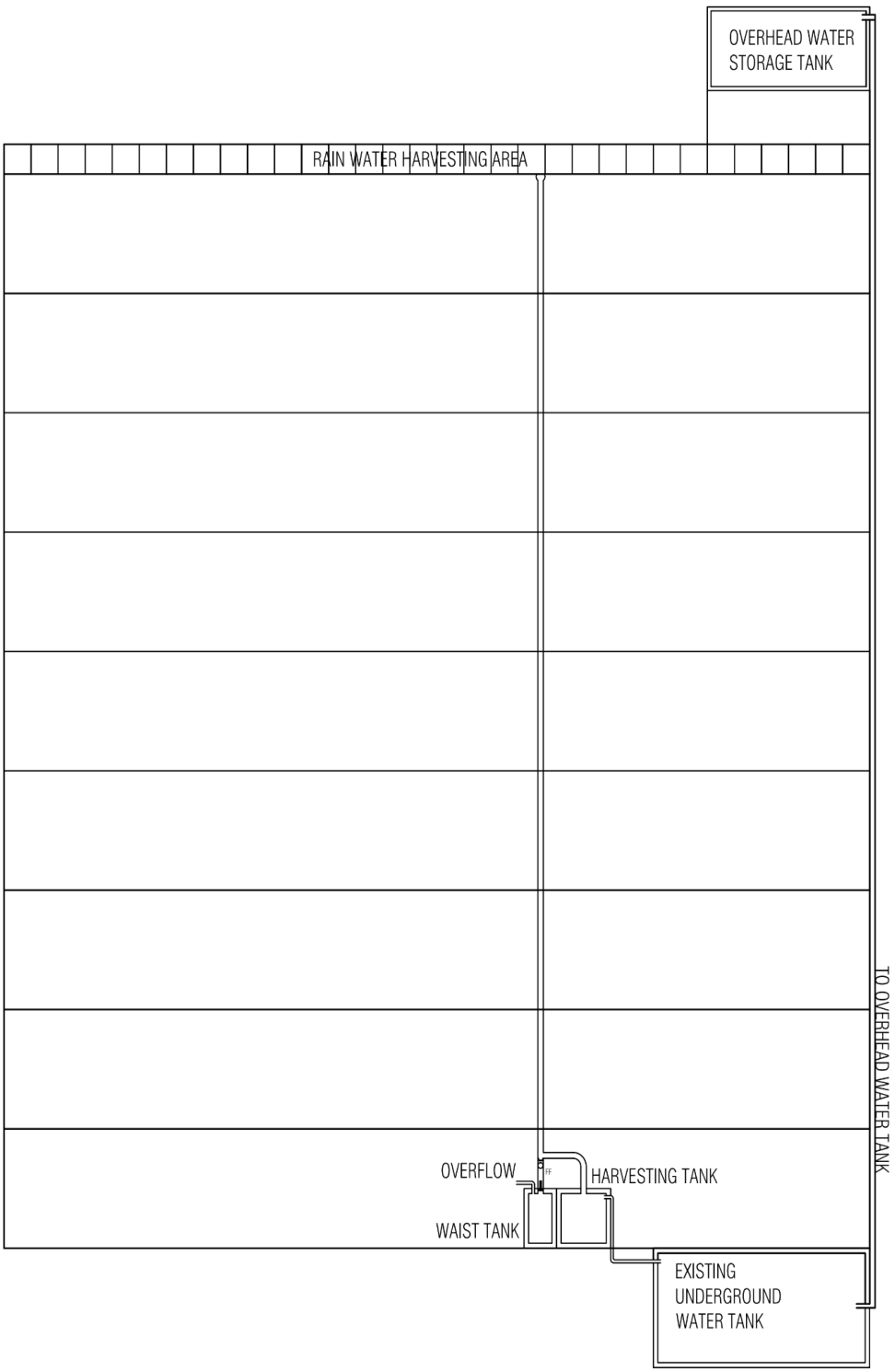
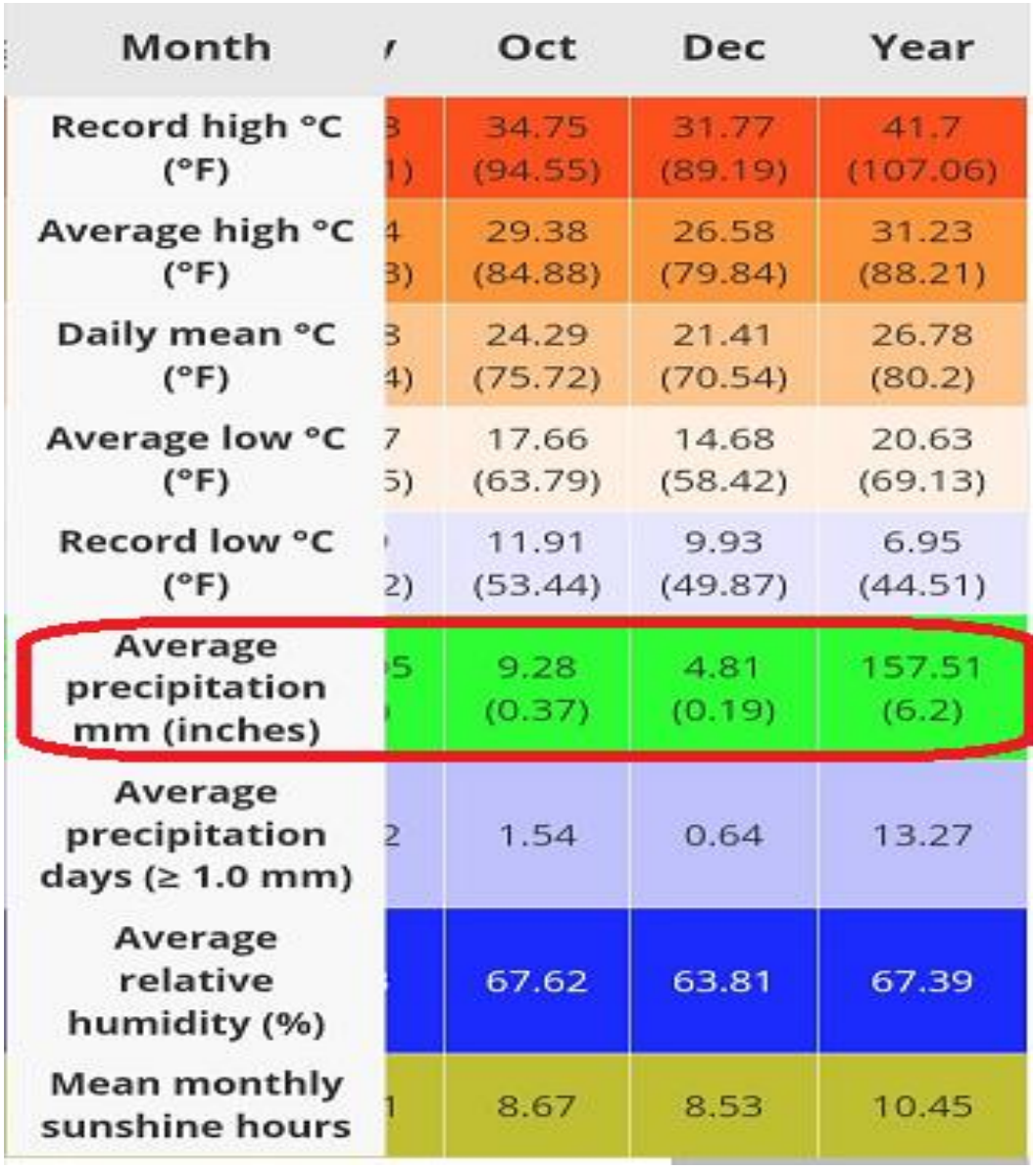


Figure 3.19: Sectional elevation of rain water harvesting study project



Month	/	Oct	Dec	Year
Record high °C (°F)	3 1)	34.75 (94.55)	31.77 (89.19)	41.7 (107.06)
Average high °C (°F)	4 3)	29.38 (84.88)	26.58 (79.84)	31.23 (88.21)
Daily mean °C (°F)	3 4)	24.29 (75.72)	21.41 (70.54)	26.78 (80.2)
Average low °C (°F)	7 5)	17.66 (63.79)	14.68 (58.42)	20.63 (69.13)
Record low °C (°F)	 2)	11.91 (53.44)	9.93 (49.87)	6.95 (44.51)
Average precipitation mm (inches)	5 	9.28 (0.37)	4.81 (0.19)	157.51 (6.2)
Average precipitation days (≥ 1.0 mm)	2	1.54	0.64	13.27
Average relative humidity (%)		67.62	63.81	67.39
Mean monthly sunshine hours	1	8.67	8.53	10.45

Figure 3.20: Monthly average rain fall data of Hobiganj district [6]

Project-03

Patent stone roof top surface for rain water harvesting at study Project.
Building Name: Academic Building of Mymensingh Polytechnic.
Location: P.O-Mymensingh Sodor, Mymensingh.
Roof Area: 60.3m x 17.5 m= 1055.25 m^2

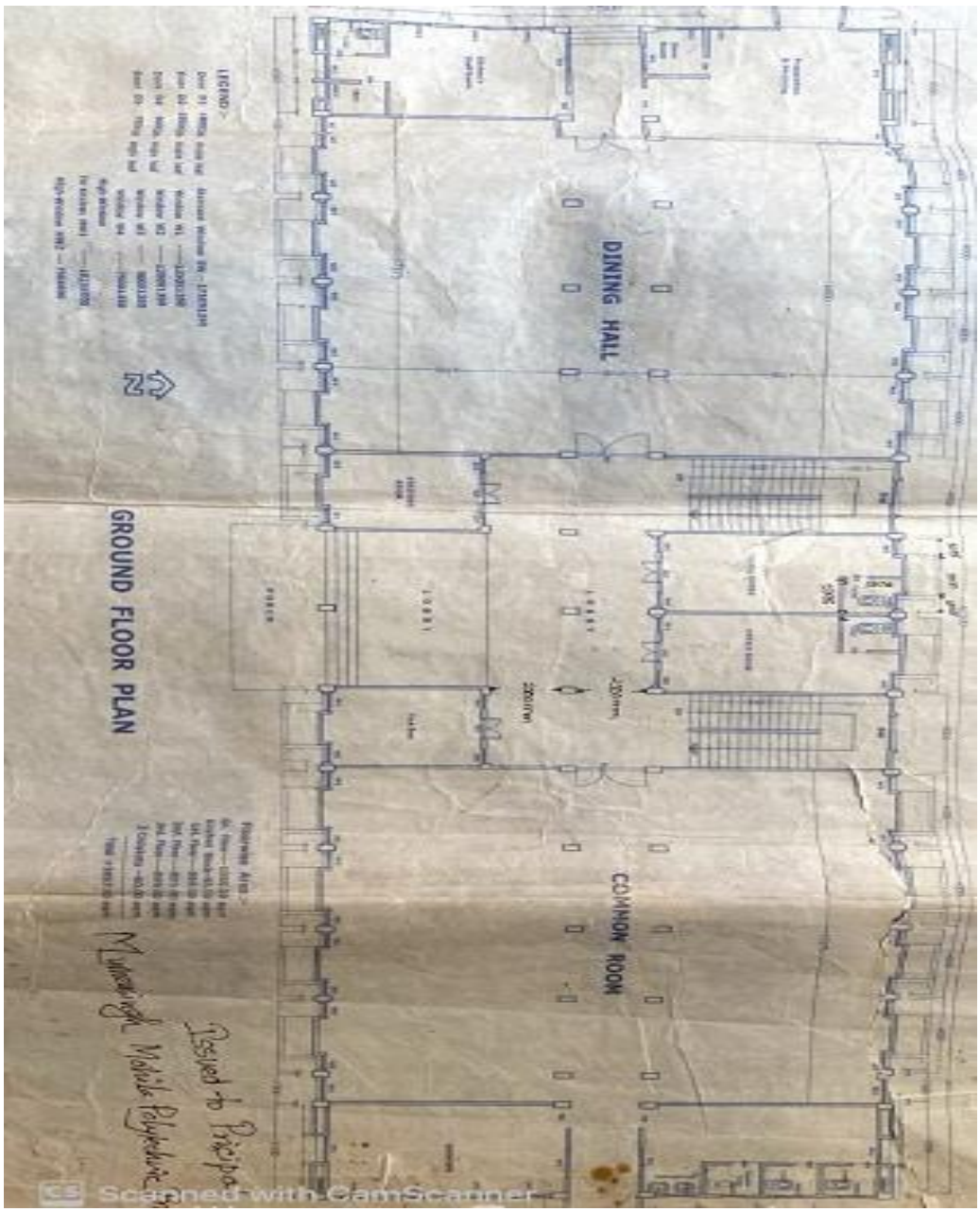


Figure 3.21: Roof plan of study Project



Figure 3.22: Roof top view of study Project

Table 3.6 Patent stone roof top preparation cost for rain water harvesting at study Project.

SL NO	Item Name	Unit	Length (Meter)	Wide (Meter)	Depth (Inch)	Qty	Rate/ Unit	Total Amount (Tk)	Remarks
1	Patent stone materials & labor finishing charge.	sqm	60.3	17.5		1055.25	500	527,625	Thickness 1.5”

(Total Amount=527,625 Tk)

In word: Five lakh twenty-seven thousand six hundred twenty-five taka only.



Figure 3.23: Down pipe & side view of study Project.



Figure 3.24: Down pipe & side view of study Project.

Table 3.7 Plumbing materials cost details of study Project.

SL NO	Name of item	Unit	Qty	Rate/unit	Total amount (Tk)	Remarks
1	UPVC pipe 4”	Pcs	25	1125	28,125	
2	UPVC Elbow 4”	Pcs	25	260	6,500	
3	Joint brick pit(2’-6”x2’-6”)	Pcs	15	7,000	105,000	
4	Royale bolt 8 mm	Pcs	150	8.83	1,324	
5	PVC solvent cement 500 ml	Pot	10	342	3,420	
6	Cost for pit making (2’-6”x2’-6”)	Pcs	15	2,200	33,000	
7	Down pipe fitting charge 6”	RFT	500	28	14,000	
8	PVC pipe fitting charge 6”	RFT	750	28	21,000	

(Total Amont= 212,369 Tk)

In word: Two lakh twelve thousand three hundred sixty-nine taka only.

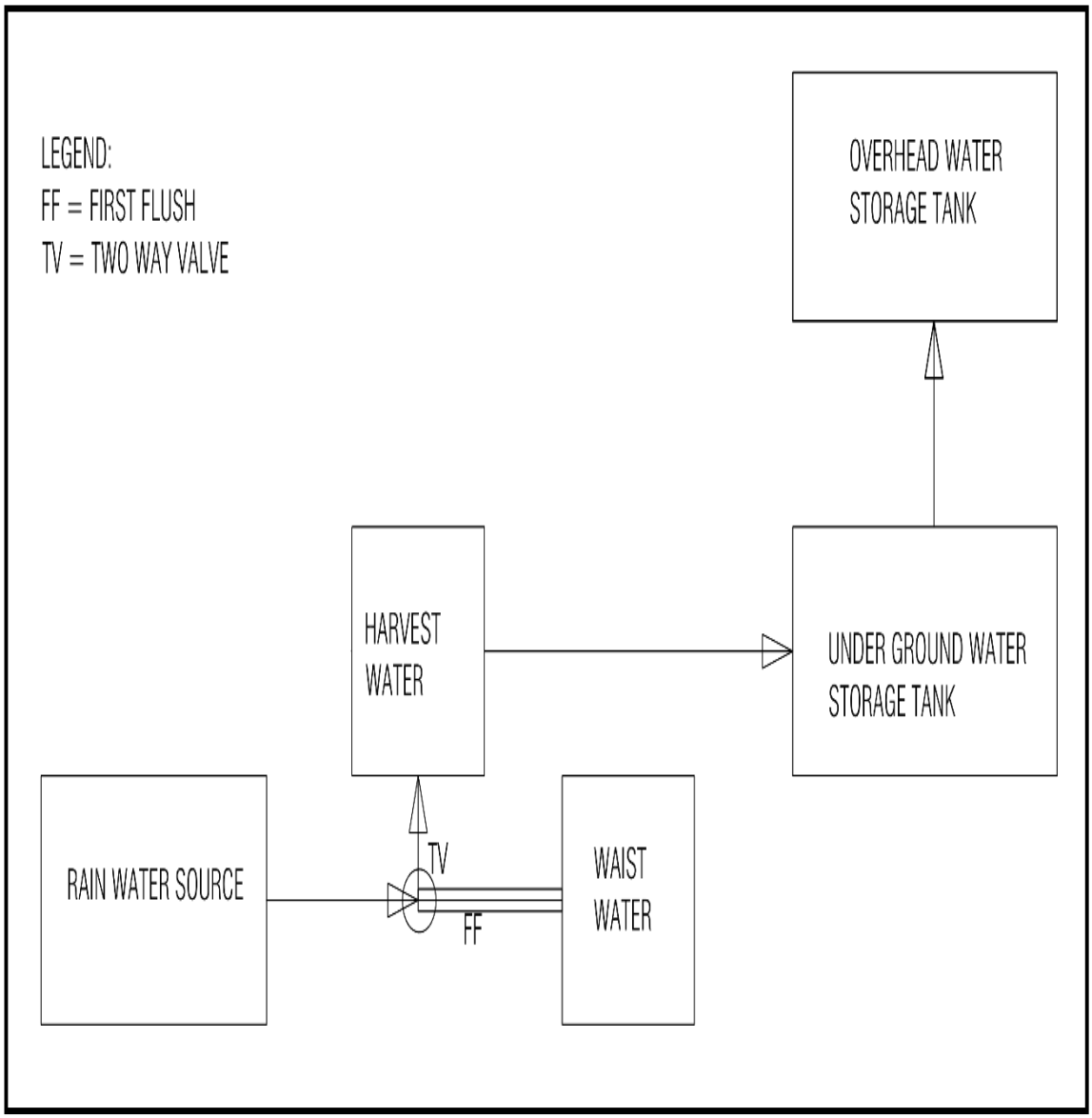
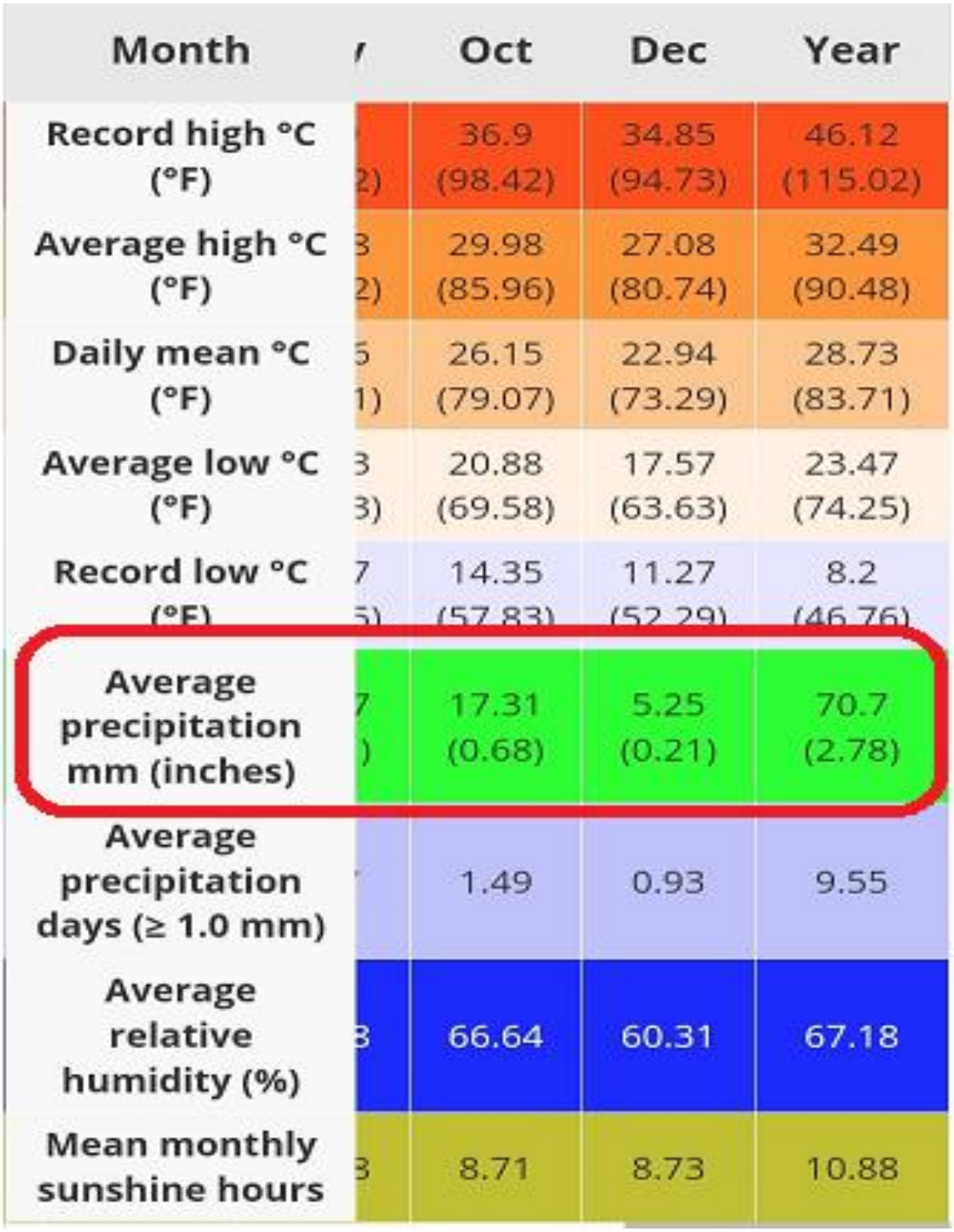


Figure 3.25: Process diagram of rain water harvesting.



Month	/	Oct	Dec	Year
Record high °C (°F)	2)	36.9 (98.42)	34.85 (94.73)	46.12 (115.02)
Average high °C (°F)	3 2)	29.98 (85.96)	27.08 (80.74)	32.49 (90.48)
Daily mean °C (°F)	5 1)	26.15 (79.07)	22.94 (73.29)	28.73 (83.71)
Average low °C (°F)	3 3)	20.88 (69.58)	17.57 (63.63)	23.47 (74.25)
Record low °C (°F)	7 5)	14.35 (57.83)	11.27 (52.29)	8.2 (46.76)
Average precipitation mm (inches)	7)	17.31 (0.68)	5.25 (0.21)	70.7 (2.78)
Average precipitation days (≥ 1.0 mm)		1.49	0.93	9.55
Average relative humidity (%)	3	66.64	60.31	67.18
Mean monthly sunshine hours	3	8.71	8.73	10.88

Figure 3.26: Monthly average rain fall data of Mymensingh district [7]

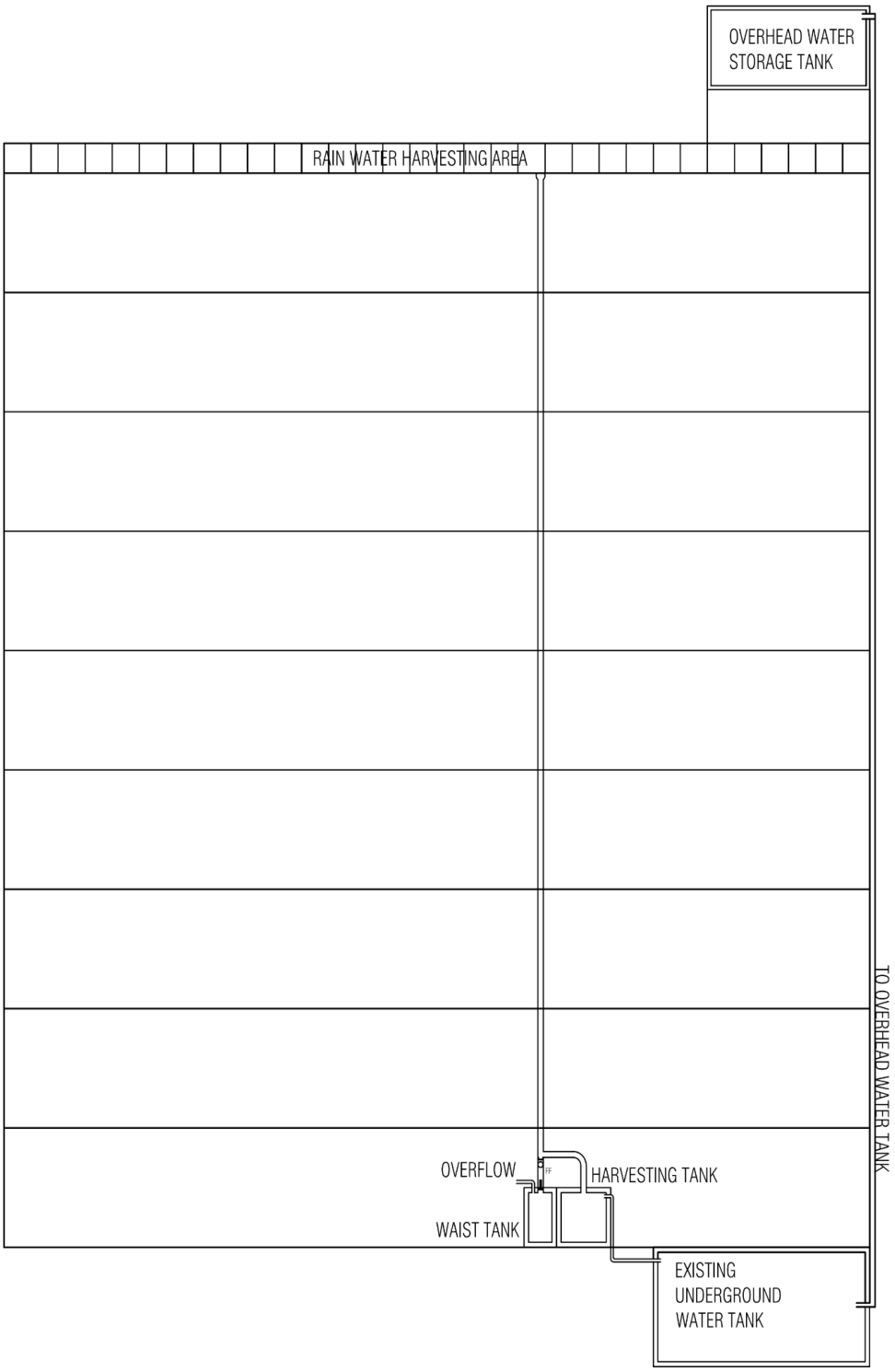


Figure 3.27: Sectional elevation of rain water harvesting study project.

Project-4

Water proof paint surface roof top for rain water harvesting at study building.

Building Name: Police officers Quarter

Location: Tebunia, Pabna

Roof Area: 24.4m x 14.6m= 356.24 m^2

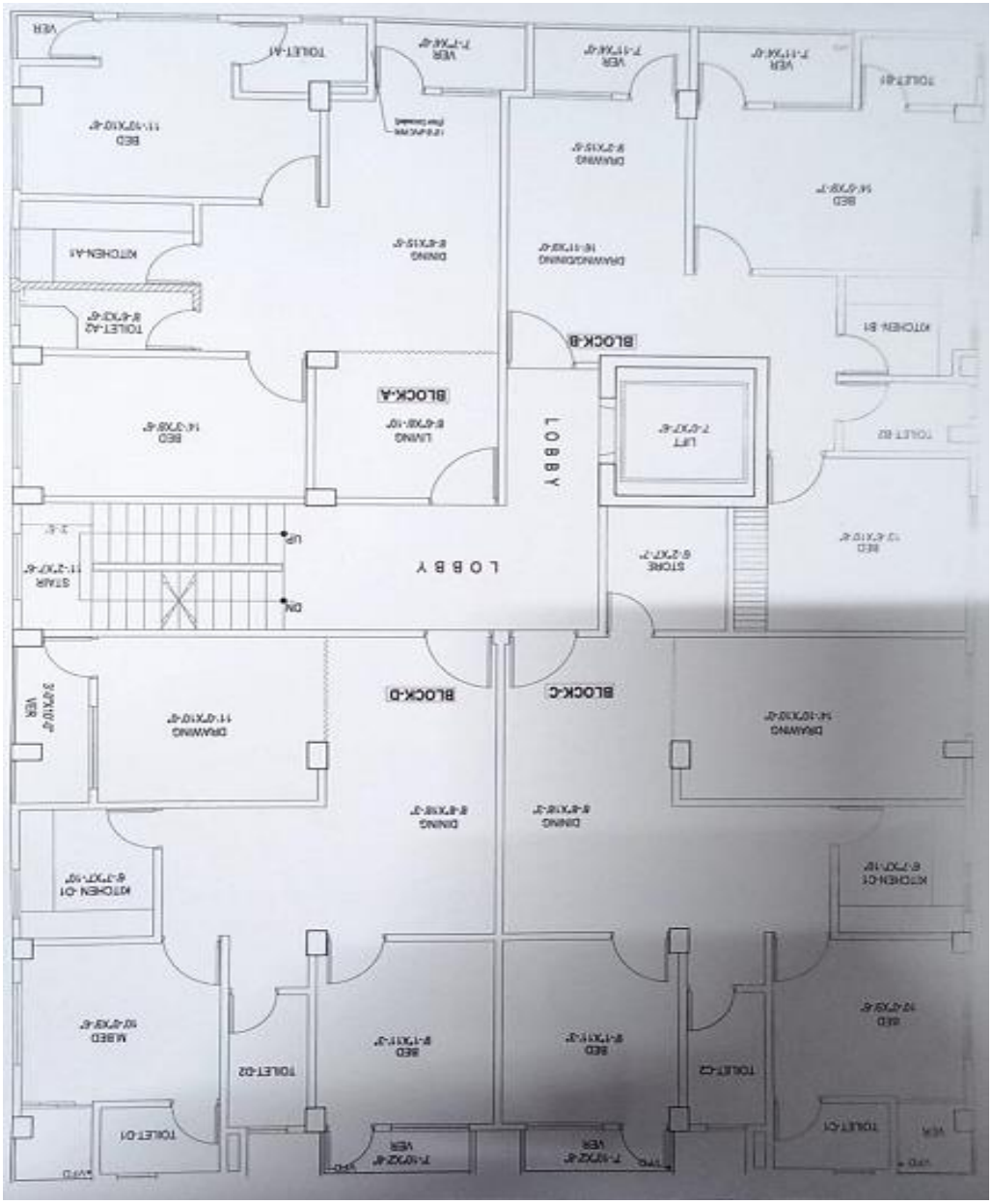


Figure 3.28: Roof plan of study building.

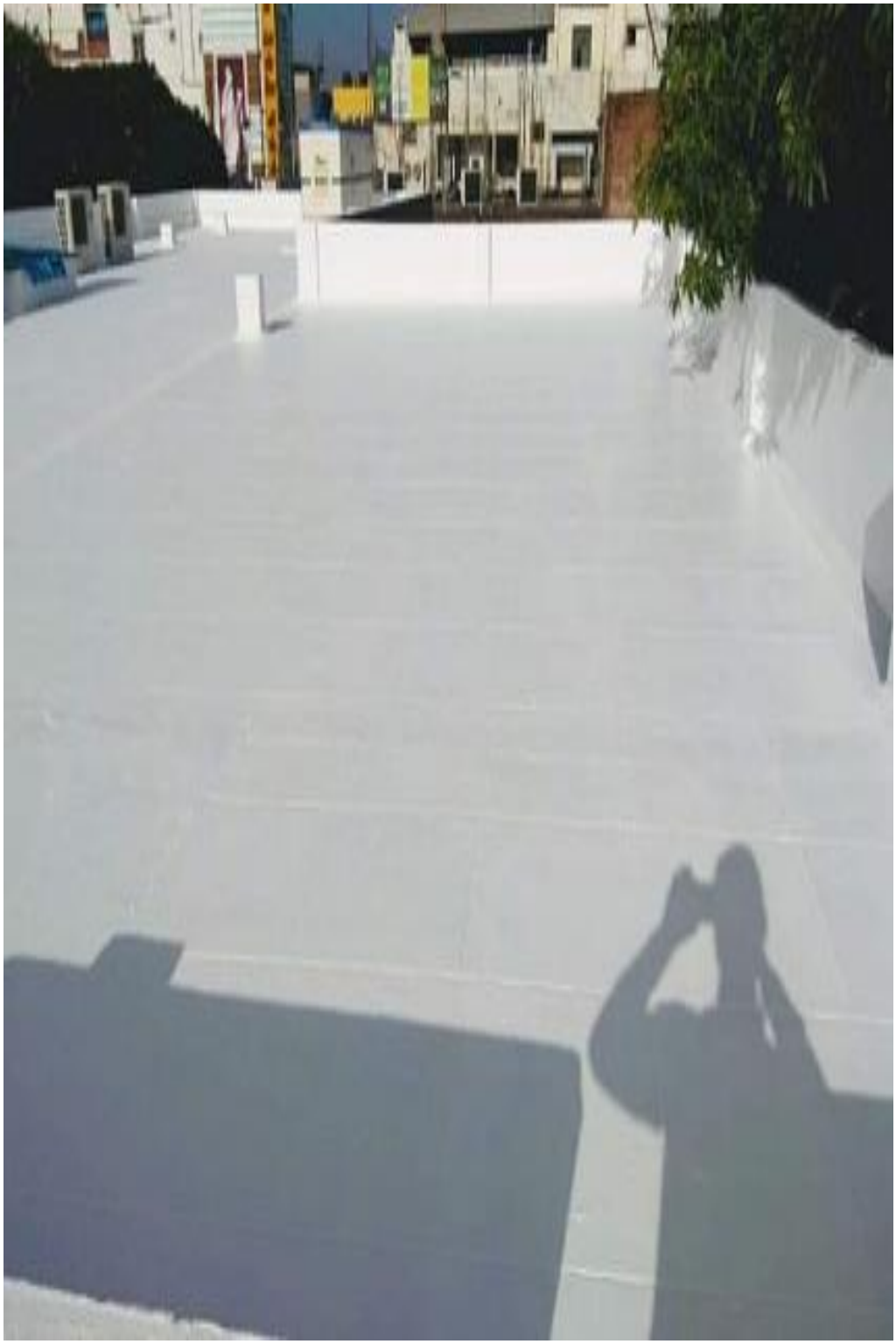


Figure 3.29: Roof top view of study building.

Table 3.8 Water proof paint surface roof top preparation cost for rain water harvesting at study building.

SL NO	Item Name	Unit	Length (Feet)	Wide (Feet)	Depth (Inch)	Qty	Rate/Unit	Total Amount (Tk)	Remarks
1	Burger flexible roofing compound	sft	80	48		3,840	30	115,200	
2	Application Charge	sft	80	48		3,840	8	30,720	

(Total Amont=145,920 Tk)

In word: One lakh forty-five thousand nine hundred twenty-taka only.



Figure 3.30: Side view of study building.

Table 3.9 Plumbing materials cost details of study Project.

SL NO	Name of item	Unit	Qty	Rate/unit	Total amount (Tk)	Remarks
1	UPVC pipe 4”	Pcs	15	1,125	16,875	
2	UPVC Pipe 6”	Pcs	10	2,805	28,050	
3	Joint brick pit(2’-6”x2’-6”)	Pcs	10	7,000	70,000	
4	Royale bolt 8 mm	Pcs	120	8.83	1,059	
5	PVC solvent cement 500 ml	Pot	7	342	2394	
6	Cost for pit making (2’-6”x2’-6”)	Pcs	10	2,200	22,000	
7	Down pipe fitting charge 4”	RFT	300	28	8,400	
8	PVC pipe fitting charge 6”	RFT	200	28	5,600	

(Total Amount= 154,378 Tk)

In word= One lakh fifty-four thousand three hundred seventy-eight taka only.

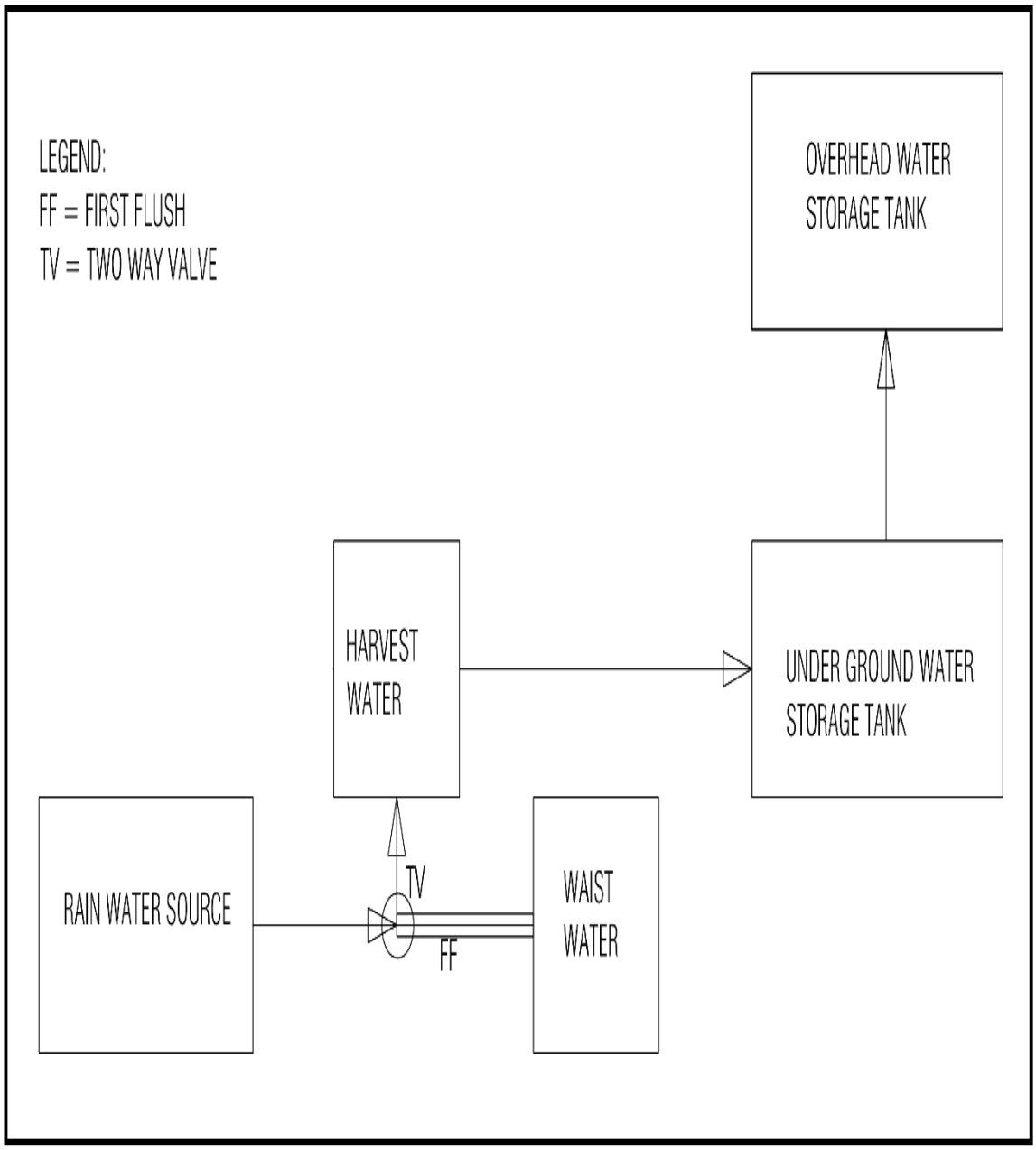
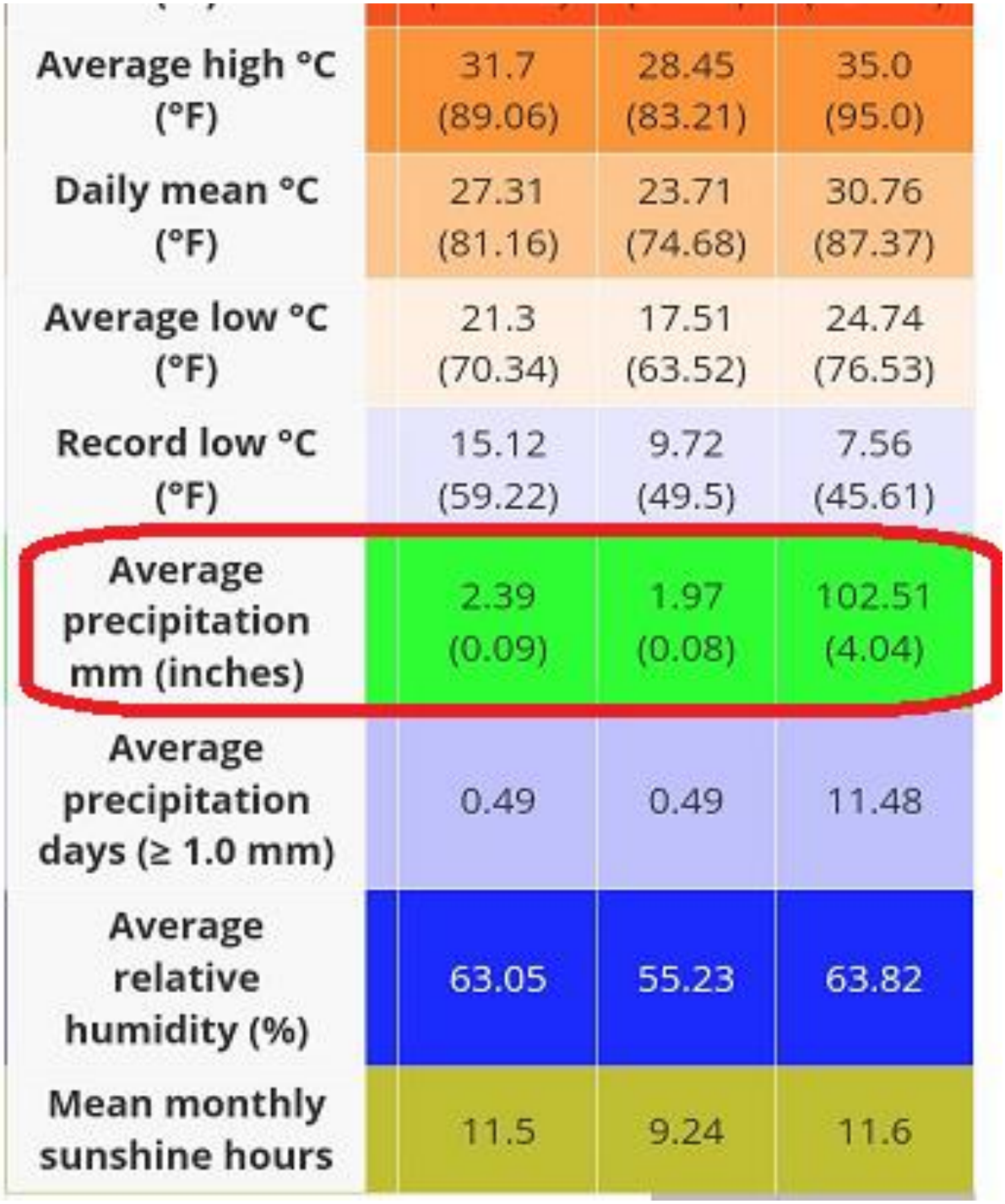


Figure 3.31: Process diagram of rain water harvesting



Average high °C (°F)	31.7 (89.06)	28.45 (83.21)	35.0 (95.0)
Daily mean °C (°F)	27.31 (81.16)	23.71 (74.68)	30.76 (87.37)
Average low °C (°F)	21.3 (70.34)	17.51 (63.52)	24.74 (76.53)
Record low °C (°F)	15.12 (59.22)	9.72 (49.5)	7.56 (45.61)
Average precipitation mm (inches)	2.39 (0.09)	1.97 (0.08)	102.51 (4.04)
Average precipitation days (≥ 1.0 mm)	0.49	0.49	11.48
Average relative humidity (%)	63.05	55.23	63.82
Mean monthly sunshine hours	11.5	9.24	11.6

Figure 3.32: Monthly average rain fall data of Pabna district [8]

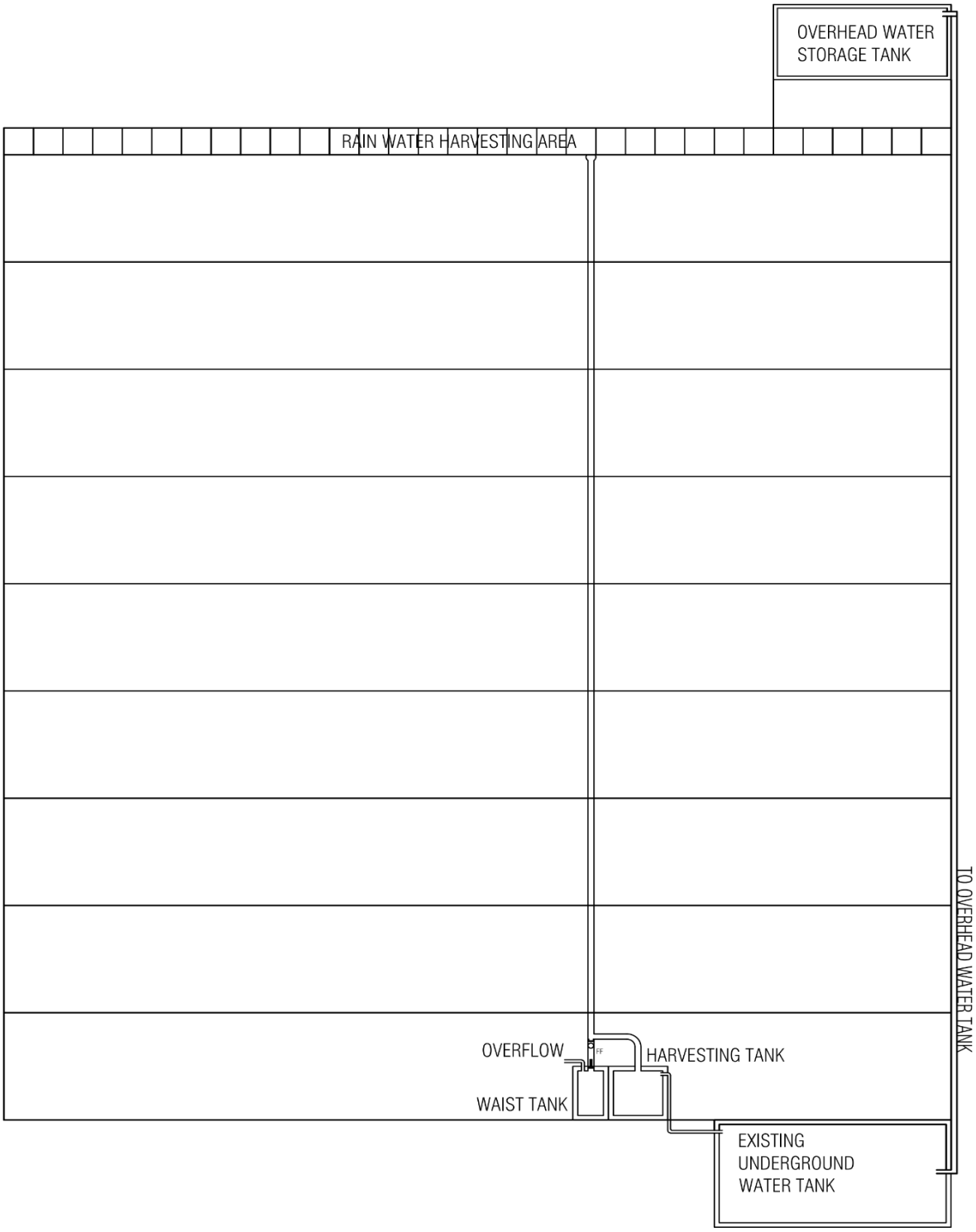


Figure 3.33: Sectional elevation of rain water harvesting study project

3.3 Potentiality of RWH

Rainfall is an unpredictable variable to calculate the potential of rainwater harvesting of an area. In this study, we take every project area last year average monthly rainfall data from individual district weather info. The rooftop of the building were considered as catchment area. The rain that falls on those rooftops were considered for calculating the rainfall potential. Rainwater harvesting potential was measured by using the formula,

Runoff (Potential for Harvesting) = AxRxC

Where,
A=Area in sq. m
R=Annual Rainfall in mm
C=Runoff Coefficient

Project-01

Total Rainwater harvesting per year = 3270.75 x 1.89 x .9 = 5563.5 m3/y
Total Project Implement Cost=3,256,044 Tk
Total water consumption (400 person) per year=19710 m3/y

Project-02

Total Rainwater harvesting per year = 4796.16 x 1.89 x .95 = 8611.5 m3/y
Total Project Implement Cost=1,506,155 Tk
Total water consumption (250 person) per year= 12,318 m3/y

Project-03

Total Rainwater harvesting per year = 1055.25 x .848 x .9 = 805 m3/y
Total Project Implement Cost=739,994 Tk
Total water consumption (100 person) per year= 4927.5 m3/y

Project-04

Total Rainwater harvesting per year = 356.24 x 1.23 x .95 = 416 m3/y
Total Project Implement Cost= 300,298 Tk
Total water consumption (25 person) per year= 1231.8 m3/y

Rainwater Parameters

We took only project-1 rain water sample and tested rainwater chemical characteristic parameter as below listed for checking purpose.

- pH value
- TDS
- Conductivity
- Chloride

Rainwater quality tests were performed as the RFL ETP lab at Hobiganj Industrial Park, Olipur, Shatestaganj, Hobiganl [9]. After result we got acceptable limit of rainwater of project-1.

Table 3.10 Water Consumption rate [10]

Sl.no	Use	Consumption (l/p/d)
1	Drinking	5
2	Cooking	5
3	Washing clothes	20
4	Bathing (including ablution)	55
5	Washing utensils	10
6	Cleaning house	10
7	Toilet flushing	30
	Total	135

Table 3.11 Chemical Characterization of rain water [4]

SI.NO.	Test Parameters	Results	Acceptable Limit		Remarks
			BSTI BDS1240:2001ECR (1997)	WHO(1993, 1997,1998, 2011)	
01	pH value	6.5	6.4-7.4	6.5-9.2	Value is within BDS Standard& WHO Guideline value 1998.
02	Total dissolved solids, mg/l	8.0	500.0(Max.)	500	Value is within BDS Standard& WHO Guideline value 1997.
03	Conductivity ,µS/cm	5	6.0(Max.) (ECR-1997)	4-6	Values are within BDS Standard & WHO Guidelinevalue 1998.
04	Chloride, mg/l	Less than 4mg/l	400.0(Max.)(ECR-1997	300	Value is less than BDS Standard & WHO Guidelinevalue 1993.

CHAPTER 4

RESULT AND DISCUSSION

4.1 Introduction

Our study main aim is cost benefit analysis of roof top rain water harvesting system using different materials in our four studies projects. After visiting individual project, data collecting and RWH system implement we may find out the cost & benefit the individual project.

4.2 Cost benefit analysis of proposed study four (4) project.

Cost benefit analysis of four different project as given below table.

Table 3.12 Cost benefit analysis of different proposed project

Project No	Project Name	Total Project implement cost (Tk)	Total Rain Water Harvesting(m3/y)	Water Rate (Tk)/m3	Total Amount (Tk)/y	Cost Return Period (Year)	Remarks
1	RCC roof top at RFL#11 Tyre tube (HIP-Hobiganj)	3256044	5563.5	13	72326	45	We considered water rate Tk/m3 from RFL central Utility consumption Bill month of March,2024. [11]
2	Metal roof top at RFL#2 Bizli Cable (HIP-Hobiganj)	1506155	8611.5	13	111950	14	
3	Patent store rooftop at Mymensingh Polytechnic, (Mymensingh)	739994	805	13	10465	71	
4	Water proof paint roof top at Police Quater, (Pabna)	300298	416	13	5408	56	

4.3 Summary

After analysis the individual four project we find out the project-2 (Metal roof surface) is benefited for rainwater harvesting.

CHAPTER 5

RECOMMENDATION AND CONCLUSIONS

5.1 Conclusions

In this chapter, the outcomes of the study have been concluded obtained from our research and background study.

- We come to know about roof top rainwater harvesting in different area in Bangladesh.
- Metal roof is the best among the four-study project. We analyzed the four different roof top materials but we have more roof top materials for future work.

5.2 Recommendations for Future Works

The recommendation for future works is following

- Rain water may be used potable as well domestic by potable water treatment plant.
- A 3D model may be developed for the solution of RWH system to make it easily to comprehensive to the user.
- RWH project can be implemented which area underground water table has lowered.
- Large factory can be implemented RWR project for reducing their utility cost.

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