

**BUSITEMA
UNIVERSITY**
Pursuing excellence

FACULTY OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF WATER RESOURCES ENGINEERING

FINAL YEAR PROJECT

**DESIGN AND CONSTRUCTION OF DRIP IRRIGATION AND STORM
WATER HARVESTING SYSTEM FROM DRAINAGE CHANNELS**

OKELLO PASCAL

BU/UG/2019/2312

pascalokello2@gmail.com

YEKO OSCAR

BU/UG/2019/0007 yekooscar@gmail.com

MWANGA LEONARD

BU/UP/2019/1866

mwangaleonard26@gmail.com

ODONGO JIMMY RONALD

BU/UP/2019/2484

Odongojimmyronald3@gmail.com

**A final year project submitted in partial fulfilment for the award of a Bachelor of
Science in Water Resource Engineering of Busitema University**

September 2023

ABSTRACT

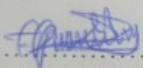
As the scarcity of water is rapidly increasing everyday particularly during the summer season, the demand for water also sustainable increases.in most cases during the dry periods of the year usually in the month of December to February in Busitema university farmers usually face a challenge of water stress on the crop that is to say water either available or not available cannot meet the demand of the crops and thus as a result in the design and construction of a storm water harvesting system to store the water during seasons of much runoff or more water to be used in seasons of less or no water so as to ensure a sustainable agricultural production. The study's objectives included assessing the crop water requirement, conducting topographical surveys, calculating the estimated runoff volume and the design and construction of the underground tank and its apertures and then designing the overhead tank which will then temporally store the water and then by gravity water can be supplied to the farm using drip irrigation.

Key words: water scarcity, irrigation

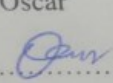
DECLARATION

We (Okello Pascal, Yeko Oscar, Mwanga Leonard, Odongo Jimmy Ronald) declare that this report is our own research and has not been either used nor submitted in any institution or university for any academic award.

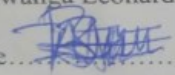
Name: Okello pascal

Signature:  Date: 13/02/24

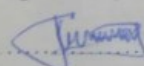
Name: Yeko Oscar

Signature:  Date: 13/02/24

Name: Mwanga Leonard

Signature:  Date: 13-02-2024

Name: Odongo Jimmy Ronald

Signature:  Date: 13/2/24

APPROVAL

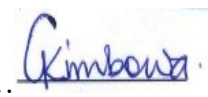
This research has been conducted and written under the supervision of;

Name: Eng Muhammad Badaza



Signature: Date:

Name: Mr. Kimbowa George

Signature:  Date:

Name. Mr. Ologe Hector Daniel

Signature: Date

ACKNOWLEDGEMENT

First, we would like to thank the almighty God for his overwhelming Grace and Love, guidance, protection during the compilation of this report.

We would like to express our genuine gratitude and appreciation to our supervisors Mr. Eng Muhammad Badaza, Mr. Kimbowa George, Mr. Hector Daniel Ologe. And the entire department of water resources engineering, for their encouragement, guidance and support from the initial stage of writing and for accepting us to work as a team. They enabled to develop and understand the subject matter as well as the appropriate form of delivery of this research and above all realize that two heads are better than one.

Contents

ABSTRACT.....	i
DECLARATION	ii
APPROVAL	iii
ACKNOWLEDGEMENT.....	iv
1.0 CHAPTER ONE: INTRODUCTION.....	1
1.1 BACKGROUND	1
1.2 PROBLEM STATEMENT	2
1.3 JUSTIFICATION	2
1.4 Significance	3
1.5 OBJECTIVES OF THE STUDY	4
1.5.1 Main Objective	4
1.5.2 Specific objectives.	4
1.6 SCOPE OF THE STUDY	4
1.6.2 Time scope.	4
1.6.3 Geographical Scope.....	4
1.7 CONCEPTUAL DIAGRAM	5
SCHEMATIC DIAGRAM SHOWING STORM WATER HARVESTING AND IRRIGATION SYSTEM	6
2.0 CHAPTER TWO:	7
2.1 LITERATURE REVIEW	7

2.1.1 Introduction.	7
2.1.2 Factors affecting the runoff volume.	7
2.2 RUNOFF	9
2.2.1 Rational method characteristics	10
2.2.2 Irrigation Scheduling	10
2.2.3 Advantages of Irrigation Scheduling	11
2.2.4 Techniques Used to Determine When to Irrigate	11
3.0 CHAPTER 3: METHODOLOGY.	12
3.1 METHODOLOGY FOR SPECIFIC OBJECTIVE 1	12
1 METHODOLOGY FOR OBJECTIVE ONE	13
DESIGN AND CONSTRUCTION OF DRIP IRRIGATION SYSTEM.....	13
Requirements for the Design of Drip Irrigation System	13
Lay-Out of Drip System	13
Objective	13
Considerations During the Design	13
Crop type	14
Varieties of tomatoes	14
IRRIGATION WATER REQUIREMENT.....	15
Introduction	15
Irrigation Water Requirement Analysis	15
Potential crop evapotranspiration (ET _o)	16
Effective rainfall	18
Ground Cover Reduction Factor (K _r).....	19
Crop Water Requirements (CWR)	20
Net Irrigation Water Requirement.....	20
Gross Irrigation Water Requirement (IR _g)	21
Irrigation frequency (I _f) at peak demand and irrigation cycle	21
Daily Water Demand	22
Irrigation duration (T _a) at peak demand	23
System component design.....	23
Design standards	23
Design economic life	23
Hydraulic Design	24
Design of Critical Blocks	24

Design Of Drip Lines / Laterals	24
Flow in the Block (Qb)	25
Head losses in different pipe sizes and selection of pipe diameters to be used	25
Main pipe size	26
Supply main pipe size.	27
Power Requirement	28
Design of a 10 by 10-meter drip irrigation system	29
Crop Water Requirements (CWR)	29
Net Irrigation Water Requirement.....	29
Gross Irrigation Water Requirement (IRg)	29
Irrigation frequency (If) at peak demand and irrigation cycle	29
Daily Water Demand	30
Irrigation duration (Ta) at peak demand	30
System component design	31
Design economic life	31
Head losses in different pipe sizes and selection of pipe diameters to be used	32
Main pipe size	33
Installation of drip irrigation system	35
Installation of Filters and Fertigation Equipment.	35
Installation of mains and sub-mains.	35
Installation and testing of the driplines	36
Installation of mains and submains	36
Installation of overhead tank	36
Planting of tomatoes	37
Material selection	38
Irrigation Test Results	38
3.2 METHODOLOGY FOR SPECIFIC OBJECTIVE 2	40
Existing drainage channel.	41
Equipment and devices used for the survey operation	41
Data and information collection procedures and steps	41
Survey Steps and procedures	42
The contour map.	54
Elevation profile.	56
Procedures used to draw and determine elevation profile of stormwater drainage channels using civil 3D software.	57
The stormwater drainage elevation profile	57

Drainage layout.....	57
Determining the hydraulic parameters of the existing drainage channel.	71
3.3 METHODOLOGY FOR SPECIFIC OBJECTIVE 3	74
3.3.1 To determine the runoff volume	75
3.3.2 Rational method	75
3.3.3 Components of the Rational Formula	75
3.3.4.1 C- The runoff coefficient	76
3.3.4.2 I -rainfall intensity	77
3.3.5 Using IDF Curves to get the intensity.	78
3.3.6 Gumbel distribution Theory	78
The discharge can now be calculated.....	80
3.4 METHODOLOGY FOR SPECIFIC OBJECTIVE 4	80
3.4.1 To construct runoff storage tank and drip irrigation system	80
DESIGN OF REECTANGULAR CHANNEL AND WEIR.	81
3.4.2 Sizing of the underground tank.....	84
3.4.3 Design of the underground tank.	84
PUMP SIZING AND SELECTION	86
Design of the underground tank.	89
Conclusion	92
Design of the elevation tank stand	92
Conclusion	93
Bearing capacity of soil for the underground tank construction	94
Sizing of the submersible pump	94
4.0 CHAPTER FOUR	98
4.1 COST AND BENEFITS ANALYSIS.	98
The total operation and maintenance costs.,	98
4.11 BUDGET.	101
RECOMMENDATIONS.....	103
CONCLUSIONS.....	103
4.12 References:	103

List of tables

Table 1. Research gap	3
Table 2. Showing the runoff coefficients	

List of figures

Figure 1. Showing conceptual frame work	5
Figure 2. Showing Schematic diagram of storm water harvesting system and drip irrigation system	
6 Figure 3. Showing the runoff flow	9
Figure 4. Catchment delineation using GIS	10
Figure 5: Showing flow chart for methodology one	12
Figure 6: Showing flow chart for specific objective two.	40

1.0 CHAPTER ONE: INTRODUCTION

1.1 BACKGROUND

Several traditional runoff techniques have been practiced for centuries to capture and conserve runoff water for various purposes by using indigenous knowledge and local available materials as part of tradition to cope with variability and drought. (Kester et al., 2021). Traditionally, communities and private individuals have owned and managed water sources with minimal government support. Rain water harvesting technologies which included banana stems and collection in containers like saucepans and pots were very common. (Ministry of Water and Environment, 2016). There are several factors that lead to degradation of water resources, this includes growing water demand for domestic use, industrial uses, development of irrigation and tourism zone and climate change. In Uganda delays in onset and early cessation of rainfall affects farmers. (FAO and Plan Bleu, 2018). Runoff harvesting not only has the potential to reduce water demand but also contributes to other sustainable objectives, including reducing stormwater pollutant loads, reducing erosion, and inducing natural flow regimes by means of flood control, in urban streams. (Islam et al., 2013) Rainwater harvesting is defined as the process of collecting and storing water for later productive use. The term water harvesting refers to collection and storage of natural precipitation. It also defined as the process of collection and storing water from the area that has been treated to increase precipitation runoff to be collected. (Mohammad et al., 2017)

Runoff harvesting can best be described as all activities to collect water resources, temporarily storing excess water for use when required, especially in periods of drought or when no perennial resources are available. The starting point is the collection of natural water resources from rain water, runoff which otherwise would have escaped. (Ahmed & Gemedda, 2021). As the global population continues to grow and advance, more and more strain is being placed on natural resources. Fortunately, there is also growing awareness concerning renewable energy and resources. (Gates et al., 2008). Integrated urban water management (IUWM) concepts consider storm water as water resources and not as waste. These resources can provide support in reducing the load on freshwater resources based on fit for purpose applications. storm water is of significant importance when thinking about our future. (Day & Sharma, 2020). The practice of Runoff water harvesting has been gaining popularity as the usage of runoff water is much cleaner and safer (in terms of carbon dioxide emissions) than the usage of municipal water supplies. like other water conservation techniques, RWH is considered to be viable means to manage urban water resources more efficiently. (Ahmed & Gemedda, 2021)

	Transport			100,000	100,000
Total initial investment					4,100,000

RECOMMENDATIONS

There should be an improvement on the drainage channels to reduce on the losses.

The system should be automated

Fertigation system may be introduced into the drip irrigation system The wash out for the siltation trap may be introduced for easy cleaning.

CONCLUSIONS

The intended purpose of the was successful such as runoff water harvesting, water storage with no seepage and drip irrigation system

4.12 References:

9. (n.d.).

Ahmed, B., & Gameda, F. (2021). Design, Construction and Evaluation of Runoff Water Harvesting Pond for Smallholder Farming. *International Journal of Research - GRANTHAALAYAH*, 9(9), 30–39. <https://doi.org/10.29121/granthaalayah.v9.i9.2021.4223>

Day, J. K., & Sharma, A. K. (2020). Stormwater harvesting infrastructure systems design for urban park irrigation: Brim bank Park, Melbourne case study. *Journal of Water Supply: Research and Technology - AQUA*, 69(8), 844–857. <https://doi.org/10.2166/aqua.2020.047>

FAO and Plan Bleu. (2018). *State of Mediterranean Forests 2018*. <http://www.fao.org/docrep/017/i3226e/i3226e.pdf>

Gates, P., Gates, P., Gravatt, L., Mellos, T., Miller, A., & Turjanski, D. (2008). *Digital Commons @ Trinity Design of a Rainwater Collection System for Irrigation Purposes Design of a Rainwater Collection System for Irrigation Purposes*.

Hayes, D. C., & Young, R. L. (2005). Comparison of Peak Discharge and Runoff Characteristic Estimates from the Rational Method to Field Observations for Small Basins in Central Virginia. In *USGS Scientific Investigations Report 2005-5254, U. S. Geological Survey*. [https://doi.org/Scientific Investigation Report 2005-5254 Introduction](https://doi.org/Scientific%20Investigation%20Report%202005-5254%20Introduction), A. (2013). Runoff and Peak Flow. *Book*, 1–13.

Islam, S., Lefsrud, M., Adamowski, J., Bissonnette, B., & Busgang, A. (2013). Design, construction, and operation of a demonstration rainwater harvesting system for greenhouse irrigation at McGill University, Canada. *HortTechnology*, 23(2), 220–226. <https://doi.org/10.21273/horttech.23.2.220>

Koster, R. D., Reichle, R. H., & Liu, Q. (2021). *Technical Report Series on Global Modeling and Data Assimilation , Volume 59 Observation-Corrected Precipitation for the SMAP*

Level 4 Soil Moisture (Version 6) Product and the GEOS R21C Reanalysis November 2021 NASA STI Program ... in Profile. 59(November).

Ministry of Water and Environment, U. R. of U. (2016). *Handbook on Rainwater Harvesting Storage Options. 79.*

Mohammad, M. J., Sai Charan, G., Ravindranath, R., Reddy, Y. V., & Altaf, S. K. (2017). Design, construction and evaluation of rain water harvesting system for SBIT Engineering College, Khammam, Telangana. *International Journal of Civil Engineering and Technology*, 8(2), 274–281.

National Oceanic. (2013). National Engineering Handbook – Part 650 – Engineering Field Handbook Chapter 2 : Estimating Runoff and Peak Discharges. *National Engineering Handbook*, 8, 1–43.

Rugumayo, A. I. (2012). *An Introduction to Hydrology and Water Resources Engineering in Uganda* (Issue June).

9. (n.d.).

Ahmed, B., & Gameda, F. (2021). Design, Construction and Evaluation of Runoff Water Harvesting Pond for Smallholder Farming. *International Journal of Research - GRANTHAALAYAH*, 9(9), 30–39.
<https://doi.org/10.29121/granthaalayah.v9.i9.2021.4223>

Day, J. K., & Sharma, A. K. (2020). Stormwater harvesting infrastructure systems design for urban park irrigation: Brimbank Park, Melbourne case study. *Journal of Water Supply: Research and Technology - AQUA*, 69(8), 844–857.
<https://doi.org/10.2166/aqua.2020.047>

FAO and Plan Bleu. (2018). *State of Mediterranean Forests 2018*. <http://www.fao.org/docrep/017/i3226e/i3226e.pdf>

Gates, P., Gates, P., Gravatt, L., Mellos, T., Miller, A., & Turjanski, D. (2008). *Digital Commons @ Trinity Design of a Rainwater Collection System for Irrigation Purposes Design of a Rainwater Collection System for Irrigation Purposes.*

Hayes, D. C., & Young, R. L. (2005). Comparison of Peak Discharge and Runoff Characteristic Estimates from the Rational Method to Field Observations for Small Basins in Central Virginia. In *USGS Scientific Investigations Report 2005-5254, U. S. Geological Survey*.
[https://doi.org/Scientific Investigation Report 2005-5254 Introduction](https://doi.org/Scientific%20Investigation%20Report%202005-5254%20Introduction), A. (2013). Runoff and Peak Flow. *Book*, 1–13.

Islam, S., Lefsrud, M., Adamowski, J., Bissonnette, B., & Busgang, A. (2013). Design, construction, and operation of a demonstration rainwater harvesting system for greenhouse irrigation at McGill University, Canada. *HortTechnology*, 23(2), 220–226.
<https://doi.org/10.21273/horttech.23.2.220>

Koster, R. D., Reichle, R. H., & Liu, Q. (2021). *Technical Report Series on Global Modeling and Data Assimilation , Volume 59 Observation-Corrected Precipitation for the SMAP Level 4 Soil Moisture (Version 6) Product and the GEOS R21C Reanalysis November 2021 NASA STI Program ... in Profile. 59(November).*

Ministry of Water and Environment, U. R. of U. (2016). *Handbook on Rainwater Harvesting Storage Options. 79.*

Mohammad, M. J., Sai Charan, G., Ravindranath, R., Reddy, Y. V., & Altaf, S. K. (2017). Design, construction and evaluation of rain water harvesting system for SBIT Engineering

College, Khammam, Telangana. *International Journal of Civil Engineering and Technology*, 8(2), 274–281.

National Oceanic. (2013). National Engineering Handbook – Part 650 – Engineering Field Handbook Chapter 2 : Estimating Runoff and Peak Discharges. *National Engineering Handbook*, 8, 1–43.

Rugumayo, A. I. (2012). *An Introduction to Hydrology and Water Resources Engineering in Uganda* (Issue June).