Sustainable Stormwater Management Practices for Middle East Technical University, Northern Cyprus Campus

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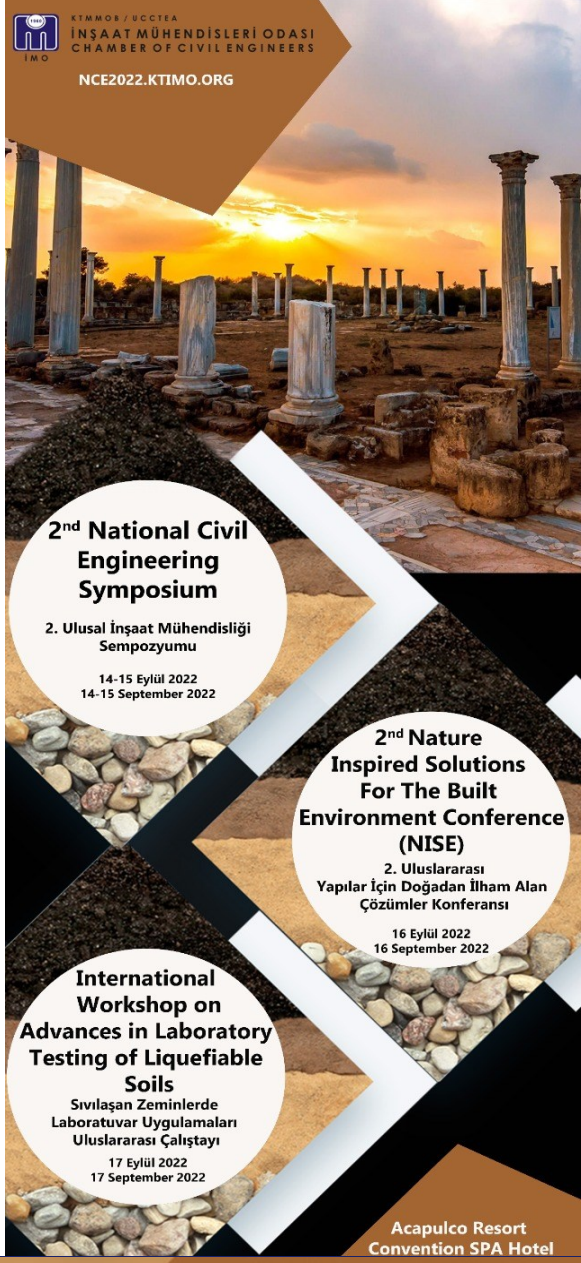

Outline

- **Climate change and Water Crisis**
- **Climate change effects in Cyprus**
- **Sustainable Stormwater Management**
- **SWMM Software**
- **SWMM Software Operations**
- **Research Area**
- **Methodology**
- **Results**
- **Conclusions**

Climate Change and Water Crisis

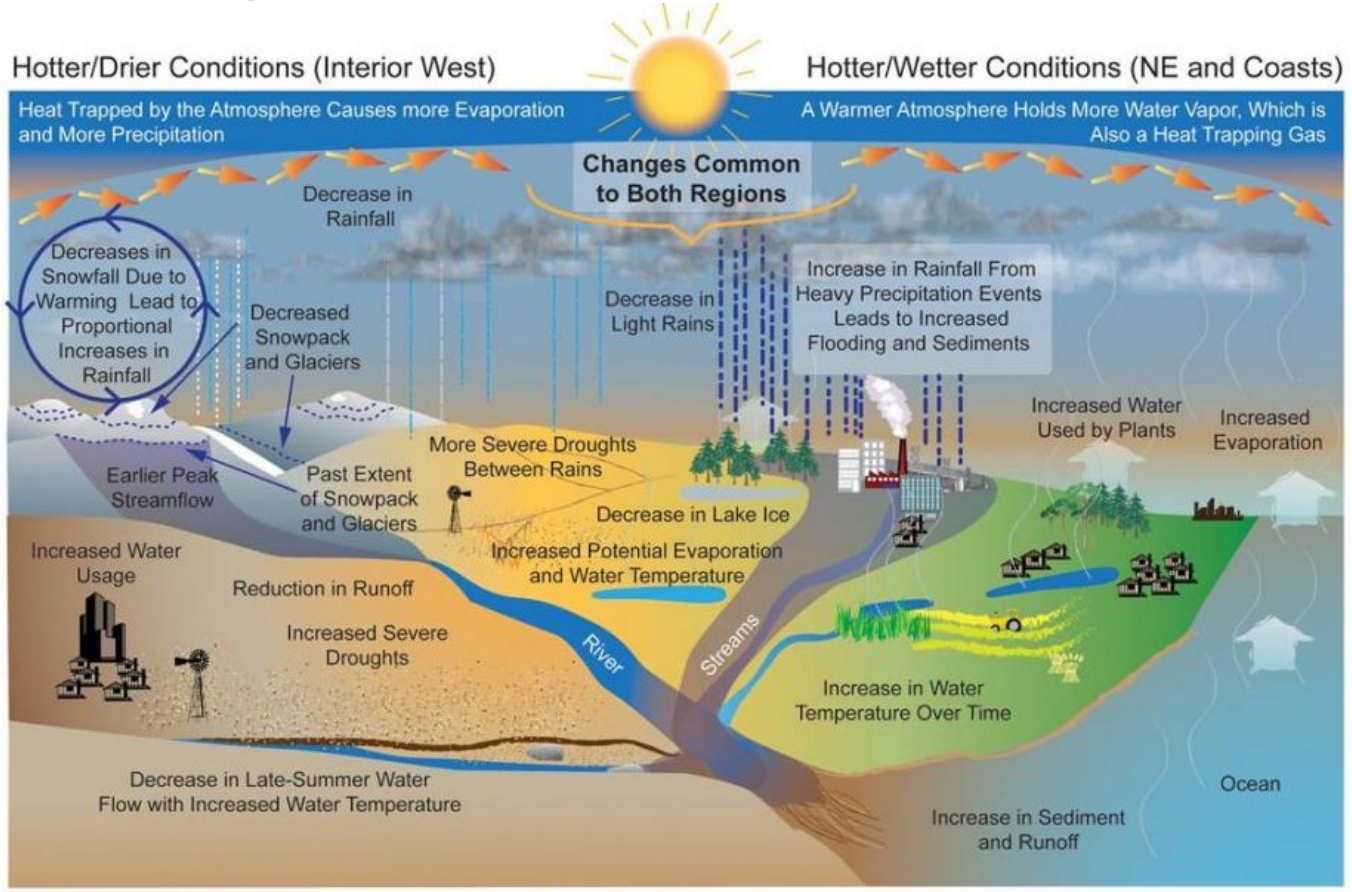

Figure 1. Projected changes in the water cycle [1].

Climate Change Effects in Cyprus

1. Increasing trend in annual mean temperatures with a rate of 0.01 ℃ per year [2].
2. There is an increase in the length and number of heatwaves by a factor of 6 to 8 since the 1960s in Eastern Mediterranean region [2].
3. Mean annual precipitation decreased during the last century by 1mm/year on average [2].
4. The groundwater is being depleted and the quality of groundwater has reduced due to over-pumping of the aquifers leading to the entry of salt water [3].
5. Unequal rainfall distribution may result in Urban flooding.

Sustainable Stormwater Management

- **Green Roof**

1. Reduce Heat Island effect.
2. Control the Effects of Atmospheric pollution.
3. Controls Urban runoff.

Sustainable Stormwater Management

- **Permeable Pavements**

1. Allows water to infiltrate in the soil**.**
2. The gaps/ pores are filled with Sand or Gravel**.**

Sustainable Stormwater Management

- **Bioretention Areas**

1. Shallow, Landscaped depressions which allows runoff to pond in a designated area.
2. Allows water to infiltrate through soil and Vegetation.

Sustainable Stormwater Management

- **Rainwater Harvesting (RWH)**

1. Allows storage of rain rather than allowing it to runoff.
2. Reduces the peak discharge.
3. Water collected can later be used in non-potable applications.

SWMM Software

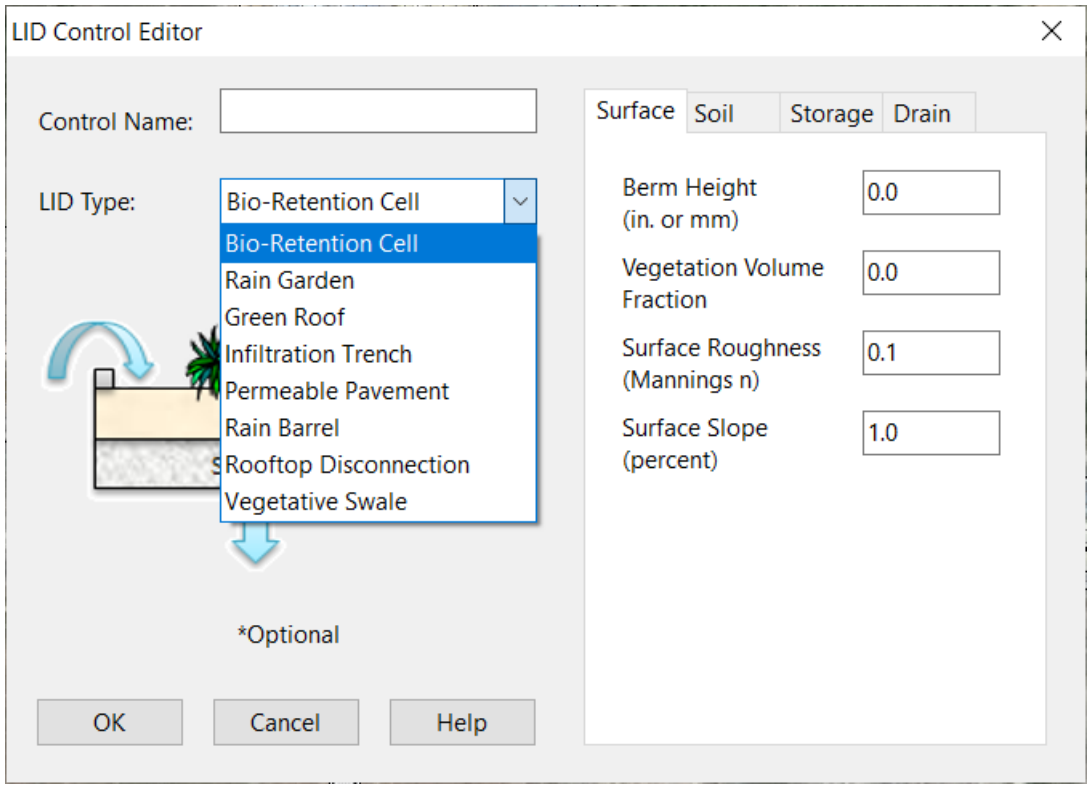

Figure 2. LID Control Editor Options [4].

SWMM Software Operations

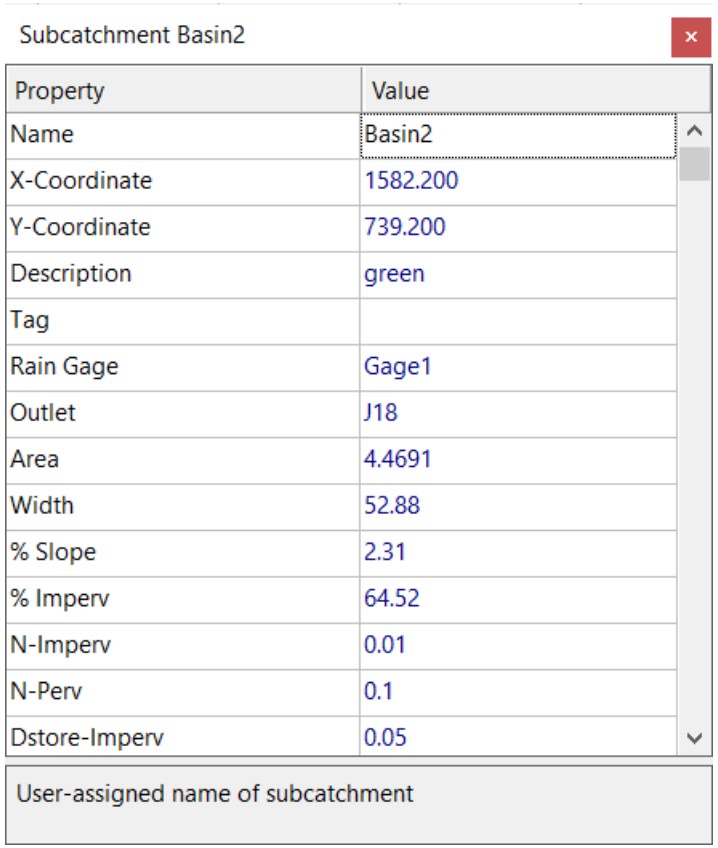

Figure 3. Sub catchment options [4].

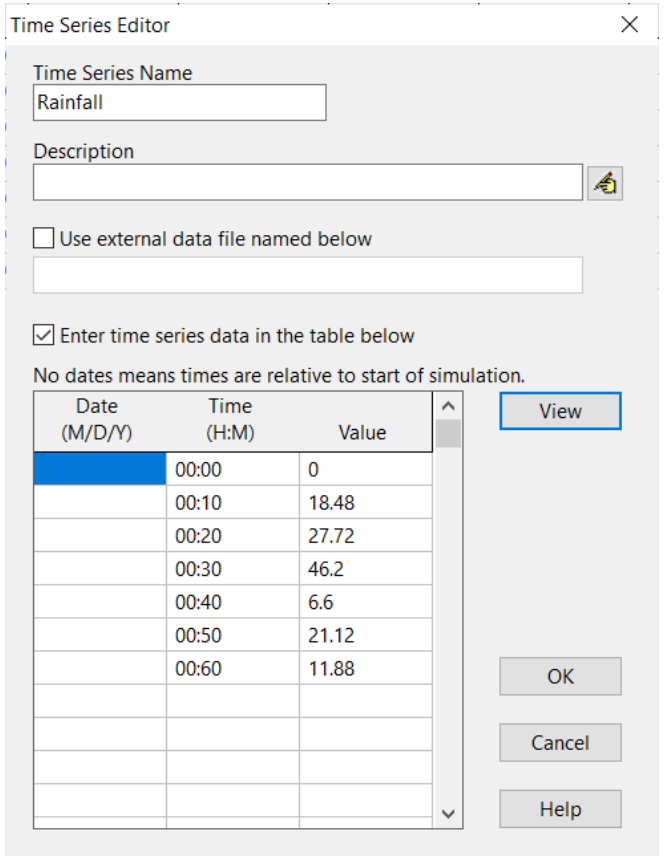

Figure 4. Rainfall options [4].

Research Area – METU (Northern Cyprus Campus)

Figure 5. Aerial view of Middle East Technical University [5].

Research Area – METU (Northern Cyprus Campus)

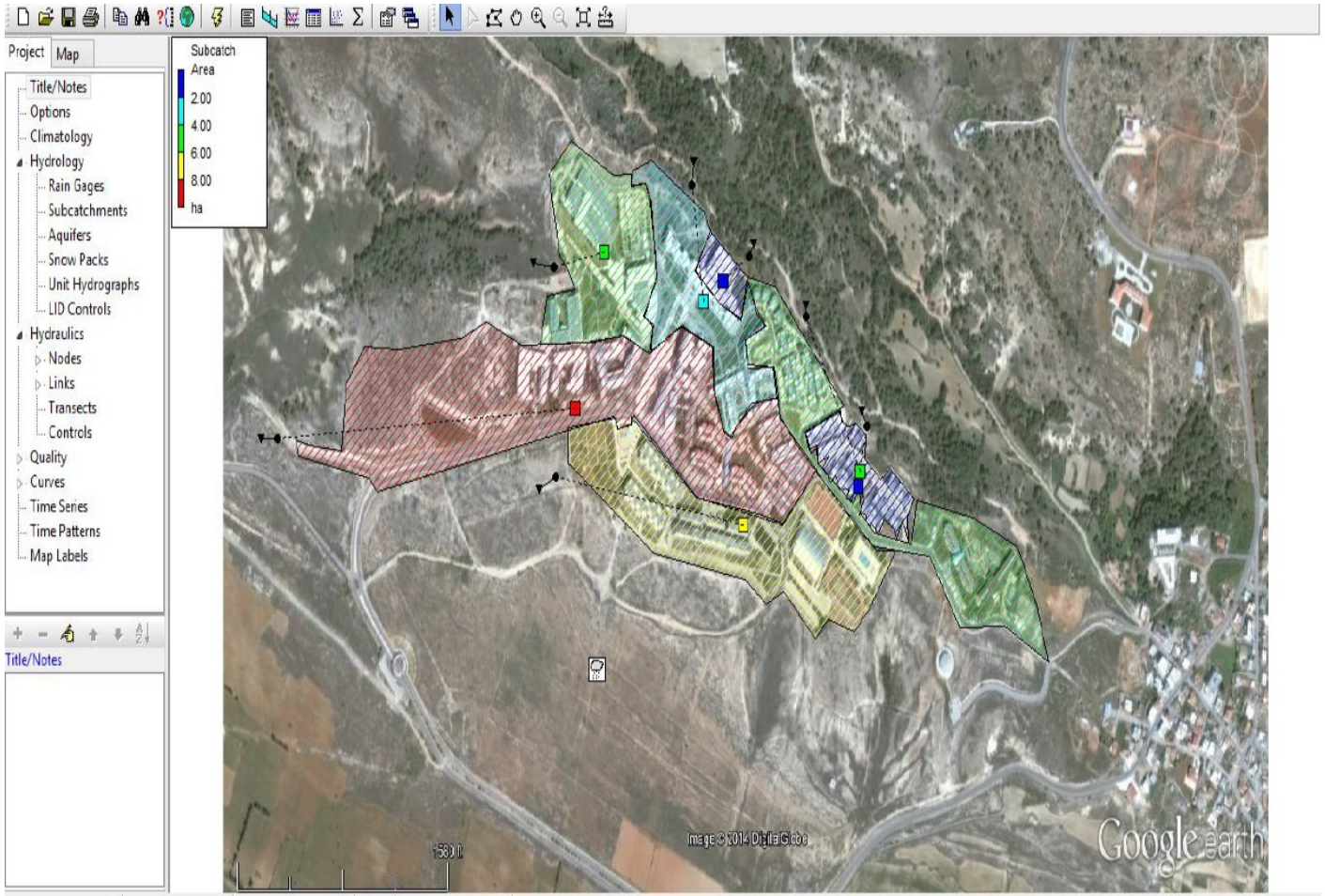

Figure 6. Basins of the research area [5].

Methodology

Results

- Without application of Sustainable stormwater management practices the total runoff is 280 m^3 and the Peak Discharge is 0.14 CMS.
- Total water stored is 120 m^3.

Table 1. Results after simulation for Basin 1.

Tank Size (m^3)	Total volume of runoff (m^3)	Total reduction of runoff (%)	Peak Discharge (CMS)	Total reduction in peak discharge (%)
1	250	10.7	0.14	0
2	220	21.4	0.14	0
3	190	32.1	0.11	21.4
4	160	42.8	0.07	50

Figure 7. Basin 1.

Results

- Without application of Sustainable stormwater management practices the total runoff is 750 m^3 and the Peak Discharge is 0.29 CMS.
- Total water stored is 180 m^3.

Table 2. Results after simulation for Basin 2.

Tank Size (m^3)	Total volume of runoff (m^3)	Total reduction of runoff (%)	Peak Discharge (CMS)	Total reduction in peak discharge (%)
1	720	4	0.29	0
2	690	8	0.29	0
3	660	12	0.29	0
4	630	16	0.23	20.6
5	600	20	0.20	31.1
6	570	24	0.17	41.4

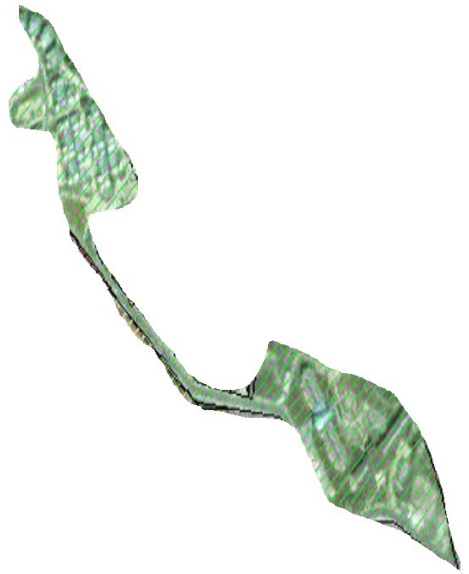

Figure 8. Basin 2.

Results

- Without application of Sustainable stormwater management practices the total runoff is 600 m^3 and the Peak Discharge is 0.28 CMS.
- Total water stored is 150 m^3.

Table 3. Results after simulation for Basin 3.

Tank Size (m^3)	Total volume of runoff (m^3)	Total reduction of runoff (%)	Peak Discharge (CMS)	Total reduction in peak discharge (%)
1	570	5	0.28	0
2	540	10	0.28	0
3	510	15	0.28	0
4	480	20	0.26	7.1
5	450	25	0.16	42.8

Figure 9. Basin 3.

Results

- Without application of Sustainable stormwater management practices the total runoff is 880 m^3 and the Peak Discharge is 0.42 CMS.
- Total water stored is 220 m^3.

Table 4. Results after simulation for Basin 4.

Tank Size (m^3)	Total volume of runoff (m^3)	Total reduction of runoff (%)	Peak Discharge (CMS)	Total reduction in peak discharge (%)
12	700	20.4	0.42	0
13	690	21.5	0.41	2.3
14	670	23.9	0.36	14.2
15	660	25	0.31	26.1

Figure 10. Basin 4

Results

- Without application of Sustainable stormwater management practices the total runoff is 1930 m^3 and the Peak Discharge is 0.68 CMS.
- Total water stored is 270 m^3.

Table 5. Results after simulation for Basin 5.

Tank Size (m^3)	Total volume of runoff (m^3)	Total reduction of runoff (%)	Peak Discharge (CMS)	Total reduction in peak discharge (%)
5	1760	8.8	0.68	0
6	1730	10.3	0.65	4.4
7	1690	12.5	0.53	22
8	1660	14	0.49	28

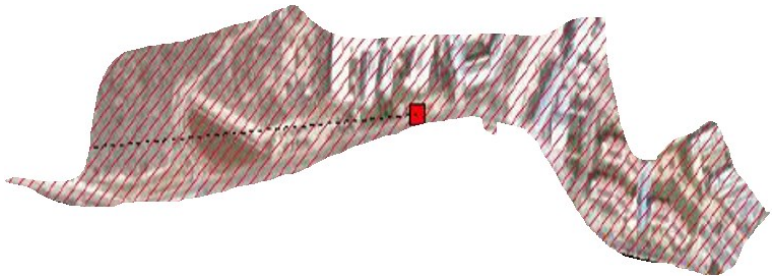

Figure 11. Basin 5

Results

- Without application of Sustainable stormwater management practices the total runoff is 1230 m^3 and the Peak Discharge is 0.49 CMS.
- Total water stored is 220 m^3.

Table 6. Results after simulation for Basin 6.

Tank Size (m^3)	Total volume of runoff (m^3)	Total reduction of runoff (%)	Peak Discharge (CMS)	Total reduction in peak discharge (%)
8	1070	13	0.49	0
9	1050	14.6	0.45	8.1
10	1030	16.2	0.39	20.4
11	1010	17.9	0.33	32.6

Figure 12. Basin 6

Results

- Without application of Sustainable stormwater management practices the total runoff is 140 m^3 and the Peak Discharge is 0.08 CMS.
- Total water stored is 60 m^3.

Table 7. Results after simulation for Basin 7.

Tank Size (m^3)	Total volume of runoff (m^3)	Total reduction of runoff (%)	Peak Discharge (CMS)	Total reduction in peak discharge (%)
12	100	28.5	0.08	0
13	90	35.7	0.07	12.5
14	90	35.7	0.06	25
15	80	43	0.04	50

Figure 13. Basin 7

Conclusion

1. With application of Sustainable stormwater management practices the total volume of 1220 m^3 is stored which is 21% of the total runoff produced.
2. The system is not only able to control the peak discharge from the rainfall event of 22mm/hr but will also control the peak discharge from events ranging from 28mm/hr to 30mm/hr.
3. Future work for this research would be finding an economically feasible solution by using other Sustainable Stormwater Management Practices like Green roof, Bioretention areas and permeable pavements.

References

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Thank you all for Listening