Evaluation of Active, Beautiful, Clean Waters Design Features in Tropical Urban Cities: A Case Study in Singapore

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Table S1. Summary of monitored natural storm events.

Event Date	Event ID	Rainfall Duration (min)	Total Rainfall (mm)	Peak Rainfall Intensity, 5-min duration (mm/h)	Antecedent Dry Period (hours)
7 Mar 2018	*Event 1*	161	24.6	67.2	112
30 Mar 2018	*Event 2*	118	12.6	60.0	68
7 Apr 2018	*Event 3*	60	47.8	117.6	164
19 Apr 2018	*Event 4*	34	20.0	115.2	68
1 June 2018	*Event 5*	266	39.0	122.4	64
29 June 2018	*Event 6*	237	54.0	88.8	48
19 Jul 2018	*Event 7*	51	24.8	79.2	272
25 Jul 2018	*Event 8*	38	28.6	110.4	123
4 Sep 2018	*Event 9*	129	54.6	117.6	260
17 Oct 2018	*Event 10*	39	12.4	57.6	114
7 Nov 2018	*Event 11*	124	34.4	72.0	24
18 Jan 2019	*Event 12*	193	23.4	24.0	14

Table S2. Target pollutants concentration and dosing volume of challenge tests.

Water Quality Parameters	Singapore's Stormwater EMC 95th percentile	Singapore's Stormwater EMC 50th percentile	Worldwide stormwater pollutant levels [1,2]	Targeted Influent Pollutant Concentration
TSS	162.97 mg/L	42.78 mg/L	158.49 mg/L	**42.78 mg/L [a]**
TP	0.26 mg/L	0.10 mg/L	0.35 mg/L	**0.26 mg/L**
TN	2.47 mg/L	1.14 mg/L	2.43 mg/L	**2.47 mg/L**
ABCWDFs	**Pore Volume (m³)**	**1.1 x Pore Volume (m³)**	**90th percentile event volume (m³)**	**95th percentile event volume (m³)**
FB7	12.6	**13.86**	9.43	**15.27**
VS1	8.4	**9.24**	**14.85 [b]**	23.65

[a] 50th percentile was chosen due to resource and time limitations. Design features generally perform well in removing TSS in the literature, with both low and high TSS inflow concentration. Topsoil was sieved and used for TSS dosing based on the particle size distribution of sediment from a sedimentation forebay of a pilot local wetland at Grove Drive, Singapore. [b] 90th percentile event volume is chosen for VS1 to shorten the duration of the challenge test (within 8 hours from start to end of challenge test)

Table S3. Number of samples for challenge test events.

Challenge Test	Antecedent Dry Period (hours)	Actual volume of water added (m³) [a]	Number of composite inflow samples	Number of outflow samples	Volume interval for outflow samples collection (L)
VS-CT1	168	9	6	14	30 to 100
VS -CT2	12	12 [b]	6	13	100 to 200
VS -CT3	144	15	7	21	100 to 300
VS -CT4	144	12 [b]	6	17	100 to 200
FB-CT1	240	14	7	21	1500 to 2000
FB-CT2	16	14	7	22	1500 to 2000
FB-CT3	12	14	7	23	1500 to 2000
FB-CT4	144	15	7	21	2000

[a] Difference between actual volume of water added and pore volume of system is within 5% [b] As VS1 is unlined, extra 3 m³ of water was added to take into consideration of water loss from exfiltration and ensure sufficient outflow samples for testing.

Table S4. Test methods for water quality parameters.

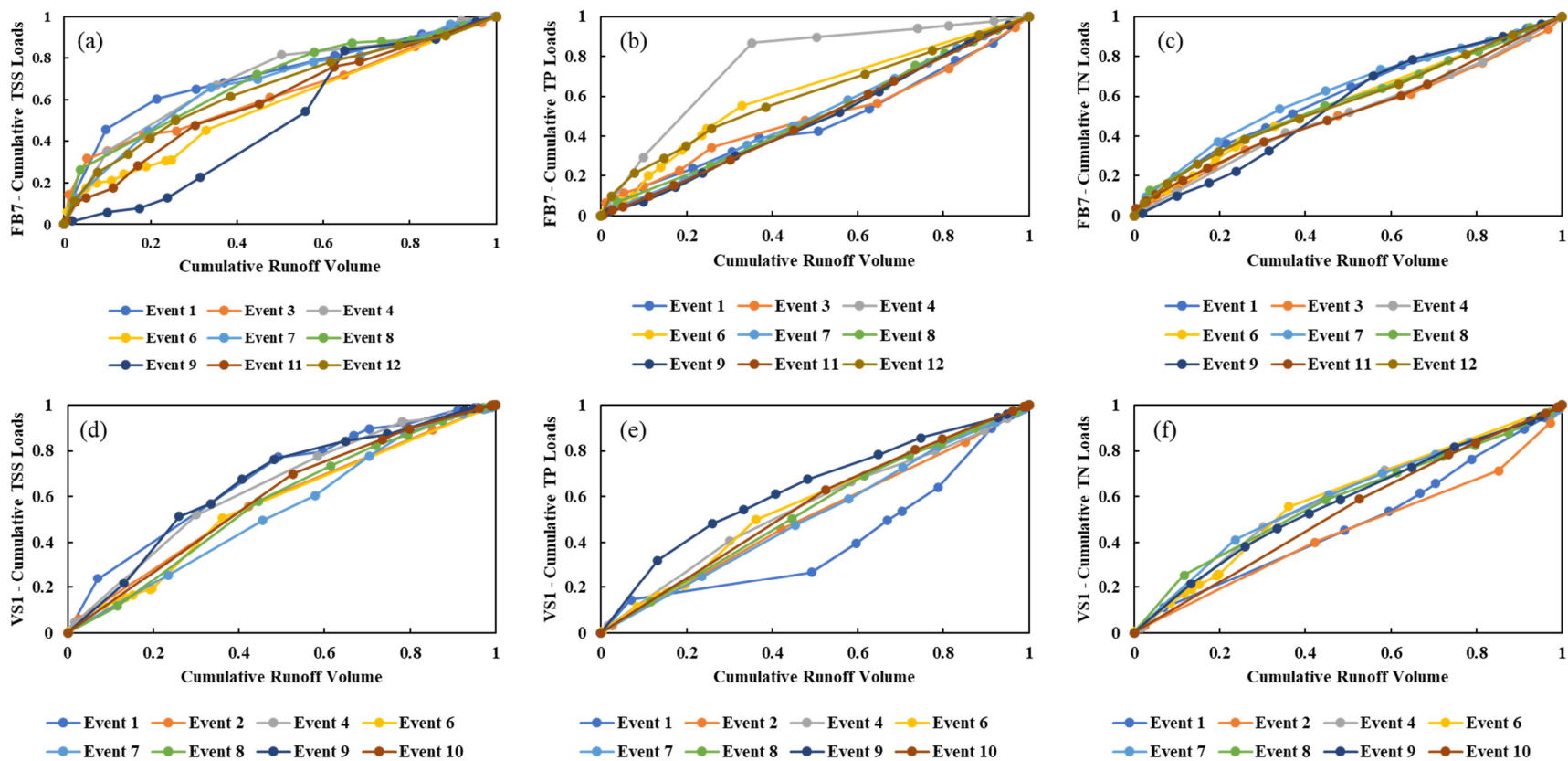| Water Quality Parameters	Test Methods	Detection Limit
Total Suspended Solids (TSS)	APHA 2540D	1.0 mg/L
Total Nitrogen as TN	APHA 4500-N (C)	0.01 mg/L
Ammonia as NH_3-N	APHA 4500-NH_3 (H)	0.01 mg/L
Nitrate as NO_3-N	APHA 4500-NO_3 (I)	0.015 mg/L
Total Phosphorus as TP	APHA 4500-P (H)	0.025 mg/L
Phosphate as PO_4-P	APHA 4500-P (G)	0.025 mg/L

Figure S1. First flush (MV curve) for TSS, TP and TN of FB7 (**a**–**c**); VS1 (**d**–**f**).

References

1. Duncan, H. (1999). Urban Stormwater Quality: A Statistical Overview. Cooperative Research Centre for Catchment Hydrology. Report 99/3.
2. Taylor, G. D., Fletcher, T. D., Wong, T. H. F., Breen, P. F., & Duncan, H. P. (2005). Nitrogen composition in urban runoff—implications for stormwater management. *Water research, 39*(10), 1982-1989. doi:https://doi.org/10.1016/j.watres.2005.03.022