

Resilience of Micropollutant and Biological Effect Removal in an Aerated Horizontal Flow Treatment Wetland

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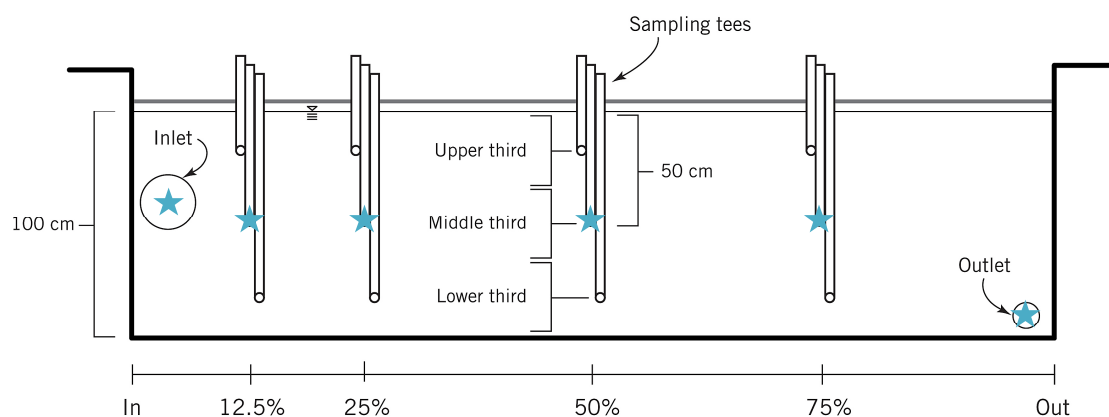


Figure S1. Profile view of horizontal subsurface flow treatment system with location of internal sampling tees (marked with stars). Modified from Nivala et al. [1].

Table S1. Analysis method limits of micropollutants and conventional wastewater parameters.

	Limit of Quantification (LOQ)	Limit of Detection (LOD)
	($\mu\text{g/L}$)	($\mu\text{g/L}$)
ACE	0.003 $\mu\text{g/L}$	0.001 $\mu\text{g/L}$
BTZ	0.34 $\mu\text{g/L}$	0.11 $\mu\text{g/L}$
CAF	0.49 $\mu\text{g/L}$	0.19 $\mu\text{g/L}$
CBZ	0.05 $\mu\text{g/L}$	0.02 $\mu\text{g/L}$
DCL	0.32 $\mu\text{g/L}$	0.12 $\mu\text{g/L}$
IBU	1.28 $\mu\text{g/L}$	0.81 $\mu\text{g/L}$
NPX	0.09 $\mu\text{g/L}$	0.06 $\mu\text{g/L}$
CBOD ₅	0.3 mg/L	-
TOC	0.15 mg/L	-
TN	0.02 mg/L	-
Ammonium	0.03 mg/L	-
Nitrate	0.3 mg/L	-
Nitrite	0.02 mg/L	-

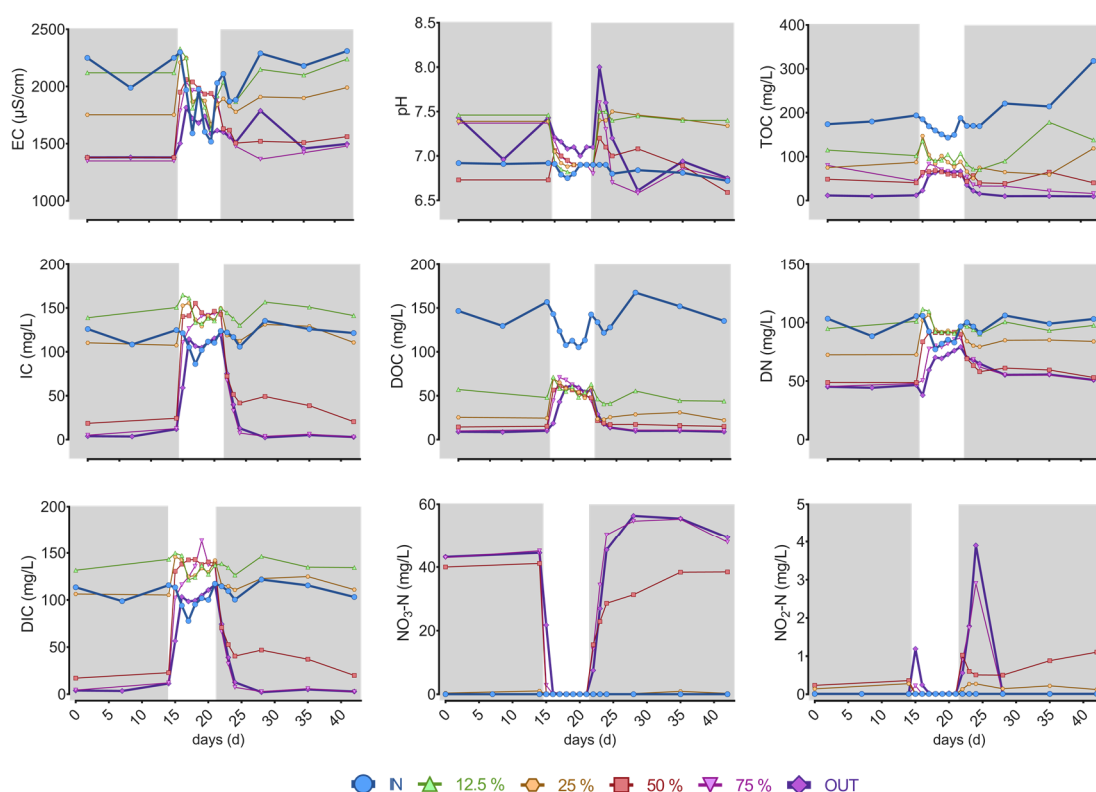


Figure S2. Water quality profiles. Grey areas represents days with aeration, light one interruption phase. Samples were taken at the wetland influent (IN), fractional distances 12.5%, 25%, 50%, 75%, and the wetland effluent (OUT).

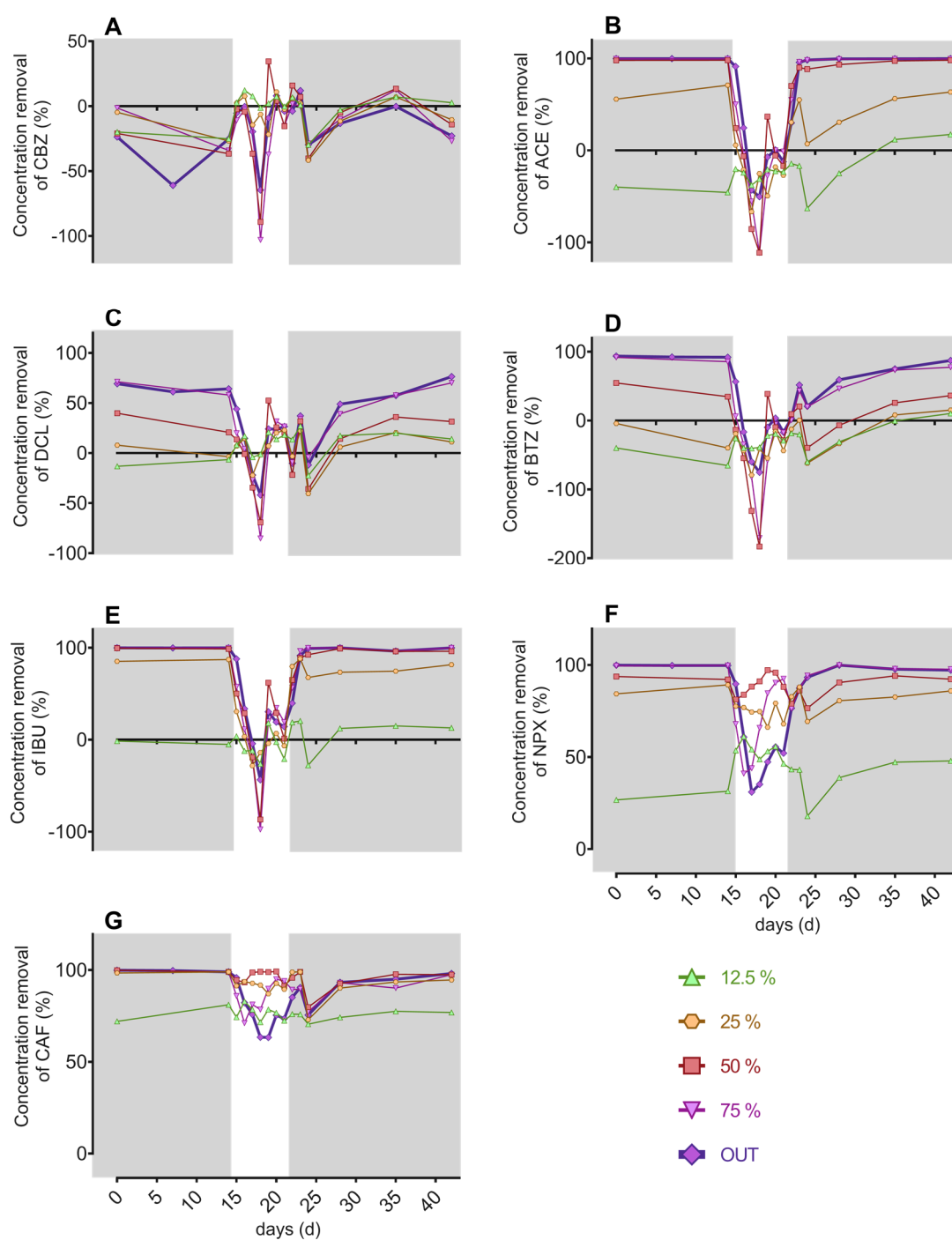


Figure S3. Internal profiles of concentration percent removal of indicator EOCs (CBZ, ACE, DCL, BTZ, IBU, NPX, CAF) in HA. Grey shaded areas represent days with aeration, no shading represents the interruption phase. Samples were taken at the wetland influent (IN), fractional distances 12.5%, 25%, 50%, 75%, and the wetland effluent (OUT).

Table S2. EC values $\pm$ standard errors in units of relative enrichment factor (REF). Cytotoxicity IC₁₀ values provided in brackets. No standard errors are given for the CAT because the EC₅₀ was derived from the log-logistic concentration response curve.

	EC _{IR1.5} for AREc32 (REF)					
Day	IN	12.5%	25%	50%	75%	OUT
0	0.19 $\pm$ 0.01	0.38 $\pm$ 0.02	0.71 $\pm$ 0.05	1.49 $\pm$ 0.07	2.61 $\pm$ 0.14	2.96 $\pm$ 0.13
14	0.13 $\pm$ 0.01	0.31 $\pm$ 0.02	0.65 $\pm$ 0.04	1.34 $\pm$ 0.04	4.24 $\pm$ 0.37	(IC ₁₀ -36)
16	0.26 $\pm$ 0.03	0.09 $\pm$ 0.01	0.27 $\pm$ 0.02	0.25 $\pm$ 0.02	0.25 $\pm$ 0.02	0.52 $\pm$ 0.04
18	0.29 $\pm$ 0.01	0.3 $\pm$ 0.01	0.26 $\pm$ 0.02	0.39 $\pm$ 0.02	0.39 $\pm$ 0.02	0.39 $\pm$ 0.02
20	0.41 $\pm$ 0.03	0.32 $\pm$ 0.02	0.36 $\pm$ 0.02	0.15 $\pm$ 0.01	0.27 $\pm$ 0.01	0.19 $\pm$ 0.01
21	0.2 $\pm$ 0.01	0.3 $\pm$ 0.01	0.3 $\pm$ 0.02	0.28 $\pm$ 0.01	0.34 $\pm$ 0.02	0.21 $\pm$ 0.02
22	0.2 $\pm$ 0.01	0.35 $\pm$ 0.02	0.54 $\pm$ 0.04	0.49 $\pm$ 0.03	0.64 $\pm$ 0.02	0.64 $\pm$ 0.03
24	0.36 $\pm$ 0.02	0.17 $\pm$ 0.02	0.39 $\pm$ 0.03	0.71 $\pm$ 0.04	(IC ₁₀ -32)	1.09 $\pm$ 0.02
35	0.17 $\pm$ 0.01	0.17 $\pm$ 0.01	0.39 $\pm$ 0.02	0.62 $\pm$ 0.02	(IC ₁₀ -37.3)	(IC ₁₀ -126)
42	0.27 $\pm$ 0.02	0.26 $\pm$ 0.01	0.44 $\pm$ 0.03	0.87 $\pm$ 0.04	(IC ₁₀ -56.4)	1.61 $\pm$ 0.06
	EC ₁₀ for AhR (REF)					
Day	IN	12.5%	25%	50%	75%	OUT
0	0.12 $\pm$ 0.01	0.34 $\pm$ 0.02	0.79 $\pm$ 0.03	0.56 $\pm$ 0.03	1.36 $\pm$ 0.05	1.68 $\pm$ 0.06
14	0.1 $\pm$ 0	0.34 $\pm$ 0.01	0.79 $\pm$ 0.05	0.8 $\pm$ 0.03	1.41 $\pm$ 0.09	1.19 $\pm$ 0.06
16	0.29 $\pm$ 0.01	0.23 $\pm$ 0.02	0.32 $\pm$ 0.01	0.33 $\pm$ 0.01	0.36 $\pm$ 0.01	0.46 $\pm$ 0.02
18	0.25 $\pm$ 0.01	0.35 $\pm$ 0.01	0.69 $\pm$ 0.02	0.61 $\pm$ 0.02	0.52 $\pm$ 0.02	0.65 $\pm$ 0.02
20	0.56 $\pm$ 0.03	0.24 $\pm$ 0.02	0.35 $\pm$ 0.01	0.39 $\pm$ 0.02	0.28 $\pm$ 0.01	0.4 $\pm$ 0.02
21	0.26 $\pm$ 0.02	0.15 $\pm$ 0	0.41 $\pm$ 0.02	0.42 $\pm$ 0.03	0.51 $\pm$ 0.02	0.3 $\pm$ 0.01
22	0.19 $\pm$ 0.01	0.18 $\pm$ 0.02	0.31 $\pm$ 0.02	0.5 $\pm$ 0.03	0.57 $\pm$ 0.05	0.35 $\pm$ 0.01
24	0.12 $\pm$ 0.01	0.41 $\pm$ 0.02	0.43 $\pm$ 0.03	0.54 $\pm$ 0.03	0.72 $\pm$ 0.05	0.76 $\pm$ 0.05
35	0.08 $\pm$ 0.01	0.15 $\pm$ 0.01	0.43 $\pm$ 0.02	0.39 $\pm$ 0.02	1.12 $\pm$ 0.07	0.86 $\pm$ 0.04
42	0.16 $\pm$ 0.01	0.22 $\pm$ 0.01	0.32 $\pm$ 0.01	0.48 $\pm$ 0.02	1.45 $\pm$ 0.17	1.21 $\pm$ 0.14
	EC ₁₀ for ER α (REF)					
Day	IN	12.5%	25%	50%	75%	OUT
0	(IC ₁₀ -0.33)		0.09 $\pm$ 0.01	1.05 $\pm$ 0.06	0.58 $\pm$ 0.03	(IC ₁₀ 6.11)
14	0.03 $\pm$ 0	0.07 $\pm$ 0.01	0.07 $\pm$ 0.01	1.6 $\pm$ 0.21	(IC ₁₀ 6.27)	4.32 $\pm$ 1.05
16	(IC ₁₀ 0.03)		0.04 $\pm$ 0	0.04 $\pm$ 0	0.07 $\pm$ 0	0.05 $\pm$ 0
18	0.05 $\pm$ 0	0.05 $\pm$ 0	0.03 $\pm$ 0	0.08 $\pm$ 0	0.06 $\pm$ 0	0.06 $\pm$ 0
20	0.04 $\pm$ 0	0.05 $\pm$ 0	0.07 $\pm$ 0	0.05 $\pm$ 0	0.06 $\pm$ 0	0.04 $\pm$ 0
21	0.04 $\pm$ 0	0.06 $\pm$ 0	0.07 $\pm$ 0	0.06 $\pm$ 0.01	0.1 $\pm$ 0.01	0.08 $\pm$ 0
22	0.05 $\pm$ 0	0.08 $\pm$ 0	0.06 $\pm$ 0	0.28 $\pm$ 0.01	0.71 $\pm$ 0.03	0.58 $\pm$ 0.01
24	0.02 $\pm$ 0	0.04 $\pm$ 0	0.2 $\pm$ 0	1.68 $\pm$ 0.04	(IC ₁₀ 6.07)	(IC ₁₀ 7.52)
35	0.02 $\pm$ 0	(IC ₁₀ -5.54)	0.16 $\pm$ 0.01	1.47 $\pm$ 0.03	3.46 $\pm$ 0.15	4.49 $\pm$ 0.2
42	0.01 $\pm$ 0	0.04 $\pm$ 0	0.18 $\pm$ 0.01	2.27 $\pm$ 0.18	(IC ₁₀ 6.19)	(IC ₁₀ 6.77)
	EC ₁₀ for PPAR γ (REF)					
Day	IN	12.5%	25%	50%	75%	OUT
0	0.09 $\pm$ 0.01	0.17 $\pm$ 0.04	0.2 $\pm$ 0.02	0.77 $\pm$ 0.14	1.48 $\pm$ 0.34	2.69 $\pm$ 0.61

14	16.14±4.67	0.08±0.01	0.1±0.01	0.86±0.13	1.89±0.27	2.3±0.76
16	0.1±0.01	0.1±0.01	0.09±0.01	0.09±0.01	0.08±0.01	0.12±0.02
18	0.03±0	0.1±0.01	0.04±0.01	0.06±0.01	0.17±0.02	0.07±0.01
20	0.1±0.01	0.02±0	0.18±0.03	0.1±0.02	0.15±0.01	0.17±0.03
21	0.08±0.01	0.16±0.03	0.07±0.01	0.21±0.03	0.17±0.02	0.12±0.01
22	0.04±0	0.07±0.01	0.08±0.01	0.59±0.06	0.27±0.04	0.25±0.04
24	0.08±0	0.26±0.04	0.24±0.03	0.96±0.11	1.11±0.08	1.22±0.1
35	0.14±0.02	0.11±0.01	0.18±0.02	0.82±0.18	1.77±0.26	2.8±1.09
42	0.17±0.02	0.22±0.03	0.38±0.05	0.76±0.3	0.74±0.36	(IC ₁₀ 3.29)
EC₅₀ for Inhibition IPAM 2 h (REF)						
Day	IN	12.5%	25%	50%	75%	OUT
0	14.40	16.42	21.14	22.51	30.73	35.67
14	9.76	10.55	17.55	21.95	36.40	30.80
16	7.58	11.98	9.72	17.33	14.25	19.10
18	11.80	13.04	14.06	17.66	16.09	12.01
20	16.28	18.57	15.70	15.81	18.02	15.84
21	14.74	15.18	13.75	13.84	16.78	14.83
22	14.03	15.31	16.19	21.89	19.19	18.26
24	8.12	9.11	12.80	14.43	17.28	20.06
35	13.37	19.74	21.04	19.99	21.91	27.32
42	9.54	11.56	18.89	16.47	25.67	29.35
EC₅₀ for Inhibition IPAM 24 h (REF)						
Day	IN	12.5%	25%	50%	75%	OUT
0	4.3	4.0	2.0	3.1	4.0	11.0
14	2.9	2.1	1.5	2.5	13.4	7.0
16	1.4	2.9	0.9	1.2	1.0	1.1
18	2.8	2.2	0.9	1.2	1.1	1.1
20	4.7	3.8	1.3	1.3	1.4	1.5
21	3.0	2.6	1.0	1.0	1.0	1.0
22	2.9	2.9	1.2	4.3	2.1	1.9
24	2.6	2.4	1.2	2.1	3.1	2.8
35	3.1	2.9	1.1	1.2	2.0	2.4
42	2.2	2.5	1.6	2.0	3.9	4.7
EC₅₀ for Inhibition of growth rate (REF)						
Day	IN	12.5%	25%	50%	75%	OUT
0	10.61	17.07	18.26	31.78	no effect	0.00
14	175.70	15.73	27.79	21.16	no effect	no effect
16	11.39	18.92	11.15	35.72	13.01	20.60
18	11.71	14.45	15.74	17.87	22.56	18.33
20	15.01	16.09	20.83	29.00	21.70	146.00
21	10.05	18.22	19.48	18.63	17.40	17.90
22	10.63	19.71	18.44	~ 39,36	470.90	262.60
24	11.28	18.80	17.13	41.84	~ 6,134e-012	577.60
35	15.47	20.19	17.06	59.98	44.32	34.18

42	30.04	30.48	25.51	77.22	416.90	9760.00
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Table S3. Removal efficacy of BEQ along the fractional length and over time calculated using Equation 2.

	AREc32					AhR				
Days	12.5%	25%	50%	75%	OUT	12.5%	25%	50%	75%	OUT
0	50.0	73.4	87.3	92.7	93.6	63.6	84.3	77.7	90.8	92.6
14	58.6	80.3	90.5	97.0		70.6	87.3	87.5	93.0	91.6
16	-199.7	2.7	-2.5	-2.5	50.4	-25.5	9.7	12.8	19.7	37.5
18	2.6	-12.2	25.5	25.5	25.5	30.6	64.6	59.6	53.1	62.5
20	-29.3	-13.5	-179.4	-50.1	-111.5	-134.9	-60.9	-44.3	-97.4	-39.9
21	32.7	32.7	28.0	41.0	5.5	-72.8	37.7	38.6	50.3	14.2
22	44.0	63.8	60.0	69.3	69.4	-9.3	36.4	61.1	65.8	43.9
24	-108.9	7.9	49.9		67.2	69.4	71.0	76.8	82.7	83.6
35	-2.9	55.4	72.1			42.9	80.4	78.4	92.4	90.1
42	-1.3	38.7	69.1		83.4	29.0	51.6	67.7	89.3	87.2
	ER α					PPAR γ				
Days	12.5%	25%	50%	75%	OUT	12.5%	25%	50%	75%	OUT
0						46.1	53.8	87.9	93.7	96.5
14	59.8	60.4	98.2	99.8	99.3					
16						7.1	-6.8	-0.4	-23.9	19.2
18	-1.1	-36.7	38.5	20.7	22.9	68.3	20.0	44.3	81.2	55.1
20	21.7	35.3	16.4	30.4	-11.9		43.2	3.7	31.6	42.2
21	23.5	32.9	30.4	53.1	41.5	52.7	-12.3	63.0	54.3	38.1
22	42.9	15.1	82.7	93.3	91.7	41.2	47.8	93.0	84.5	83.6
24	41.3	88.9	98.7			70.4	67.7	92.0	93.1	93.7
35			98.5	99.3	99.5	-32.7	23.7	82.9	92.1	95.0
42	66.3	91.7	99.4			19.8	54.5	77.3	76.7	
	CAT									
Days	12.5%	25%	50%	75%	OUT					
0	-8.0	-116.0	-40.0	-8.0	60.0					
14	-43.2	-94.6	-16.2	78.4	59.5					
16	51.9	-57.0	-13.9	-39.2	-27.8					
18	-28.2	-202.6	-141.0	-161.5	-148.7					
20	-21.7	-256.5	-252.2	-239.1	-226.1					
21	-13.9	-200.0	-200.0	-211.1	-197.2					
22	0.0	-148.6	32.4	-40.5	-54.1					
24	-7.3	-126.8	-24.4	12.2	4.9					
35	-5.6	-166.7	-147.2	-47.2	-27.8					
42	12.2	-38.8	-10.2	42.9	53.1					

REFERENCE

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