

Supplementary Materials

Reducing or elevating? Divergent effects of UV-based AOPs on DOM removal and DBP formation for stormwater reuse safety

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Table S1. GC-ECD operating parameters for trihalomethane (THM) and haloacetonitrile (HAN) determination.

Parameters	Conditions	
	THMs	HANs
Column	HP-5MS capillary column	ZB-1MS capillary column
Injection volume	1 μ L	1 μ L
Detector temperature	210 $^{\circ}$ C	290 $^{\circ}$ C
Carrier gas	High-purity N ₂ (>99.999%)	High-purity He (>99.999%)
Carrier gas flow rate	1.2 mL/min	1 mL/min
Temperature program	Hold at 35 $^{\circ}$ C for 5 min, then increase to 115 $^{\circ}$ C at 20 $^{\circ}$ C/min and hold for 1 min, then increase to 245 $^{\circ}$ C at 40 $^{\circ}$ C/min and hold for 3 min.	Hold at 35 $^{\circ}$ C for 22 min, then increase to 145 $^{\circ}$ C at 10 $^{\circ}$ C/min and hold for 2 min, then increase to 225 $^{\circ}$ C at 20 $^{\circ}$ C/min and hold for 10 min.

Table S2. Average (standard deviation) water quality parameters of stormwater runoff for two rainfall events.

Parameters (n = 3)	First rainfall event	Second rainfall event			
	Composite sample	Residential zone	Commercial zone	Transportation zone	Educational zone
NH ₄ ⁺ -N (mg/L)	/	14.90 (0.16)	5.80 (0.85)	2.32 (0.77)	2.95 (0.85)
TP (mg/L)	/	0.16 (0.10)	0.16 (0.01)	0.25 (0.06)	0.18 (0.11)
DOC (mg/L)	47.93 (/)	201.60 (0.60)	111.95 (7.25)	71.96 (0.19)	63.82 (2.63)
UV ₂₅₄ (cm ⁻¹)	0.624 (/)	3.295 (0.09)	1.563 (0.30)	1.118 (0.09)	1.113 (0.13)
SUVA ₂₅₄ (L/(mg·m))	1.30 (/)	1.63 (0.05)	1.40 (0.18)	1.55 (0.13)	1.74 (0.13)

The symbol “/” indicates not detected or missing data.

Table S3. Average (standard deviation) concentrations of THMs and bromine incorporation factor (BIF) across four functional zones before and after AOP treatment.

Zone	Treatment	TCM	BDCM	DBCM	TBM	THMs	BIF
Residential	Raw	65.04 (1.29)	/	/	1.61 (0.12)	66.65 (1.40)	0.07
	UV/H ₂ O ₂	0.00 (0.00)	/	/	2.35 (0.26)	2.35 (0.26)	3.00
	UV/PDS	197.12 (2.64)	/	/	8.16 (0.58)	205.28 (2.06)	0.12
	UV/Fe(VI)	118.61 (1.30)	/	/	5.60 (0.52)	124.22 (1.82)	0.14
Commercial	Raw	0.00 (0.00)	/	/	0.46 (0.16)	0.46 (0.16)	3.00
	UV/H ₂ O ₂	364.58 (1.87)	0.10 (0.04)	0.11 (0.02)	/	364.79 (1.81)	0.00
	UV/PDS	25.53 (0.56)	/	0.11 (0.03)	/	25.64 (0.59)	0.01
	UV/Fe(VI)	212.66 (10.49)	/	0.16 (0.02)	/	212.82 (10.51)	0.00
Transportation	Raw	2972.57 (21.69)	269.16 (0.05)	29.91 (0.37)	8.04 (0.07)	3279.69 (21.95)	0.11
	UV/H ₂ O ₂	1212.59 (7.38)	2.87 (0.10)	/	/	1215.46 (7.48)	0.00
	UV/PDS	4589.43 (27.04)	25.20 (0.58)	0.36 (0.06)	1.48 (0.05)	4616.47 (27.61)	0.01
	UV/Fe(VI)	3262.23 (12.53)	29.30 (0.39)	0.72 (0.02)	4.24 (0.64)	3296.50 (13.58)	0.01
Educational	Raw	917.48 (50.06)	3.51 (0.14)	/	/	920.99 (50.20)	0.00
	UV/H ₂ O ₂	0.00 (0.00)	/	/	1.94 (0.06)	1.94 (0.06)	3.00
	UV/PDS	958.32 (9.32)	3.89 (0.00)	/	0.45 (0.07)	962.66 (9.39)	0.01
	UV/Fe(VI)	681.37 (17.98)	3.09 (0.05)	/	2.10 (0.05)	686.56 (18.08)	0.01

TCM, BDCM, DBCM, and TBM represent trichloromethane (CHCl₃), bromodichloromethane (CHBrCl₂), dibromochloromethane (CHBr₂Cl), and tribromomethane (CHBr₃), respectively. $BIF = ([BDCM] + 2 \times [DBCM] + 3 \times [TBM]) / \sum [THMs]$, calculated on a molar basis. Raw denotes untreated stormwater runoff. The symbol “/” denotes not detected and is treated as zero.

Table S4. Average (standard deviation) concentrations of HANs and bromine incorporation factor (BIF) across four functional zones before and after AOP treatment.

Zone	Treatment	DCAN	TCAN	BCAN	BDCAN	DBCAN	DBAN	TBAN	HANs	BIF
Residential	Raw	1.30 (0.46)	/	/	0.14 (0.00)	12.13 (0.97)	/	/	13.57 (0.51)	1.80
	UV/H ₂ O ₂	1.15 (0.01)	/	/	0.22 (0.08)	4.64 (0.94)	/	/	6.02 (1.01)	1.58
	UV/PDS	2.21 (0.60)	/	/	0.11 (0.00)	6.56 (1.64)	/	/	8.89 (2.25)	1.49
	UV/Fe(VI)	1.62 (0.36)	/	/	0.17 (0.02)	5.63 (0.25)	/	/	7.42 (0.62)	1.54
Commercial	Raw	0.52 (0.08)	/	/	0.04 (0.00)	0.53 (0.03)	0.07 (0.01)	/	1.17 (0.06)	1.07
	UV/H ₂ O ₂	7.96 (1.45)	2.09 (0.16)	/	0.31 (0.02)	2.75 (0.41)	0.07 (0.00)	/	13.18 (2.03)	0.45
	UV/PDS	3.56 (0.07)	/	/	0.14 (0.00)	/	0.12 (0.01)	/	3.82 (0.08)	0.10
	UV/Fe(VI)	10.41 (0.12)	/	/	0.16 (0.00)	/	0.12 (0.00)	/	10.69 (0.11)	0.04
Transportation	Raw	53.38 (1.39)	43.32 (0.18)	16.58 (0.01)	29.79 (0.03)	50.45 (1.98)	0.48 (0.04)	/	194.00 (0.71)	0.76
	UV/H ₂ O ₂	9.48 (4.04)	13.48 (0.65)	/	0.39 (0.11)	7.59 (1.93)	0.19 (0.02)	/	31.13 (6.72)	0.51
	UV/PDS	85.78 (8.23)	71.21 (0.77)	/	3.83 (0.05)	57.12 (1.81)	0.90 (0.00)	/	218.84 (10.87)	0.55
	UV/Fe(VI)	121.50 (70.70)	60.24 (13.45)	2.70 (0.81)	5.05 (1.53)	40.54 (6.75)	0.42 (0.03)	/	230.45 (78.10)	0.39
Educational	Raw	46.73 (1.09)	42.69 (0.27)	0.98 (0.01)	1.35 (0.01)	33.92 (1.08)	0.21 (0.00)	/	125.87 (2.46)	0.56
	UV/H ₂ O ₂	2.77 (0.38)	/	/	0.20 (0.00)	/	/	/	2.97 (0.38)	0.07
	UV/PDS	38.90 (18.04)	44.44 (0.14)	/	1.34 (0.26)	35.72 (0.48)	0.05 (0.00)	/	120.45 (18.93)	0.60
	UV/Fe(VI)	37.84 (1.09)	30.12 (0.26)	/	1.20 (0.02)	25.35 (0.35)	0.22 (0.00)	/	94.74 (1.20)	0.55

TCAN, DCAN, BDCAN, BCAN, DBCAN, DBAN, and TBAN represent trichloroacetonitrile (C₂Cl₃N), dichloroacetonitrile (C₂HCl₂N), bromodichloroacetonitrile (C₂BrCl₂N), bromochloroacetonitrile (C₂HBrClN), dibromochloroacetonitrile (C₂Br₂ClN), dibromoacetonitrile (C₂HBr₂N), and tribromoacetonitrile (C₂Br₃N), respectively. BIF = [BCAN] + [BDCAN] + 2[DBCAN] + 2[DBAN] + 3[TBAN] / $\sum$ [HANs], calculated on a molar basis.

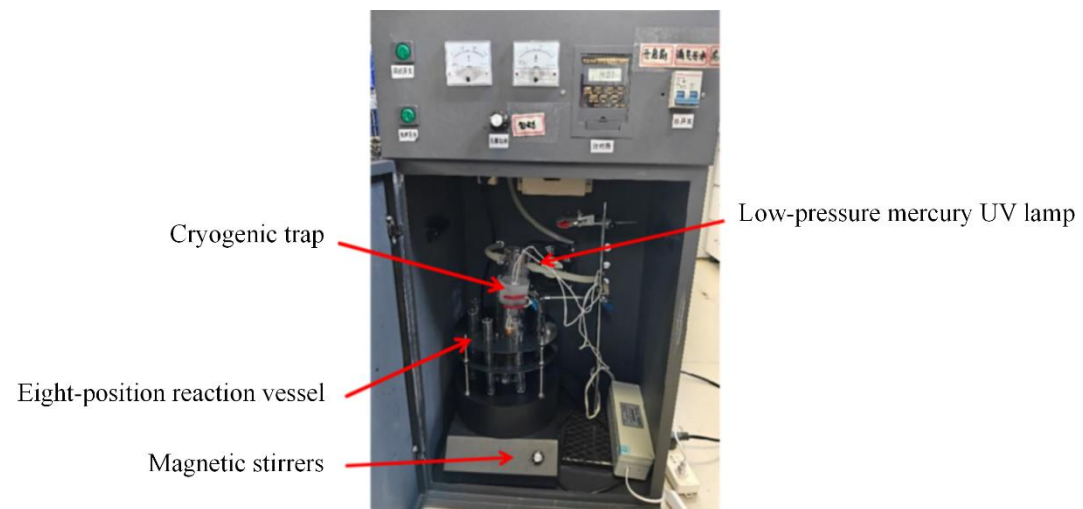


Fig. S1. Schematic diagram of the UV-based AOP photochemical reactor system.

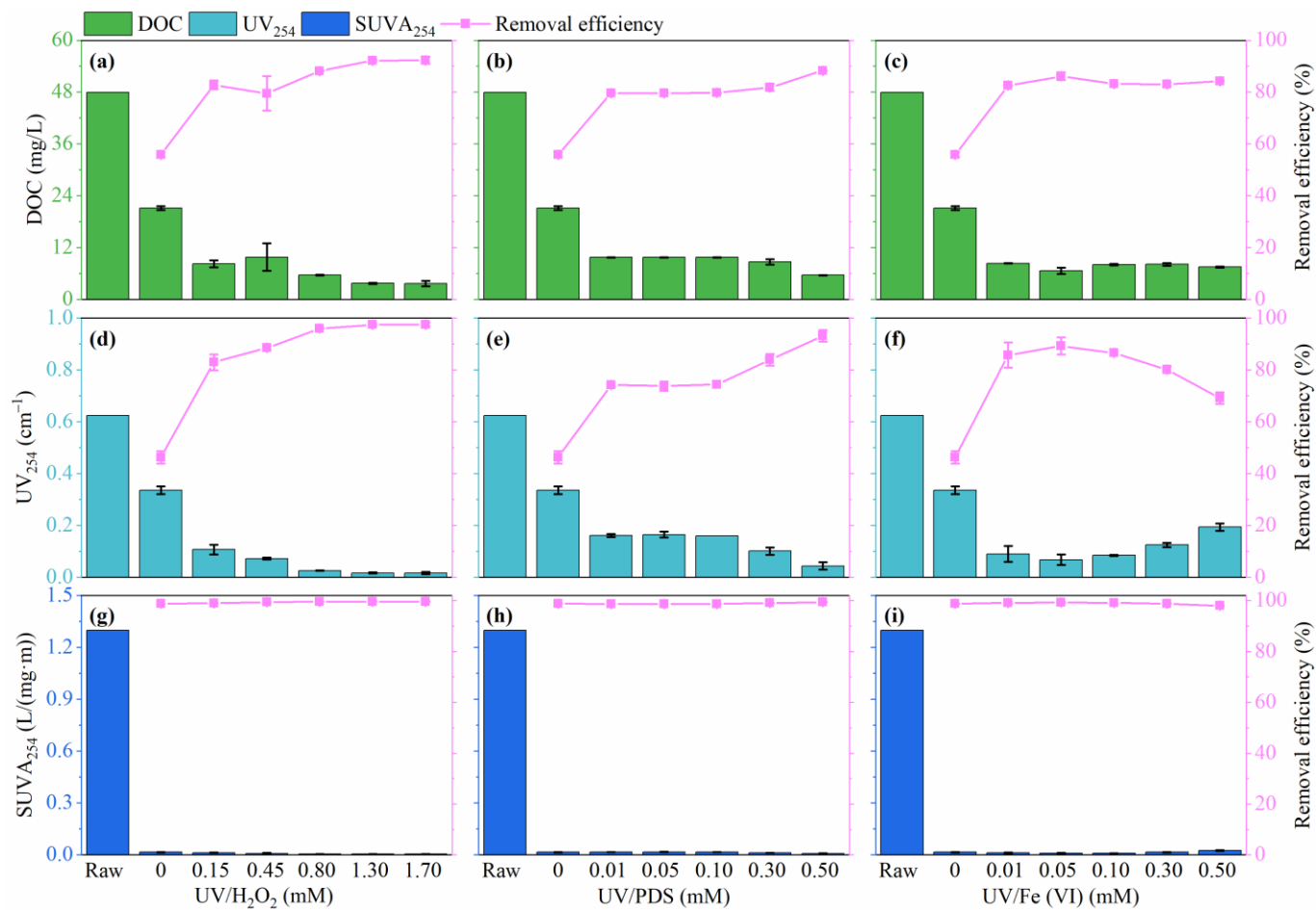


Fig. S2. Effect of oxidant dosage on (a–c) dissolved organic carbon (DOC) concentration, (d–f) UV_{254} absorbance, and (g–i) $SUVA_{254}$ of stormwater runoff before and after treatment with three UV-based AOPs, along with their respective removal efficiencies.

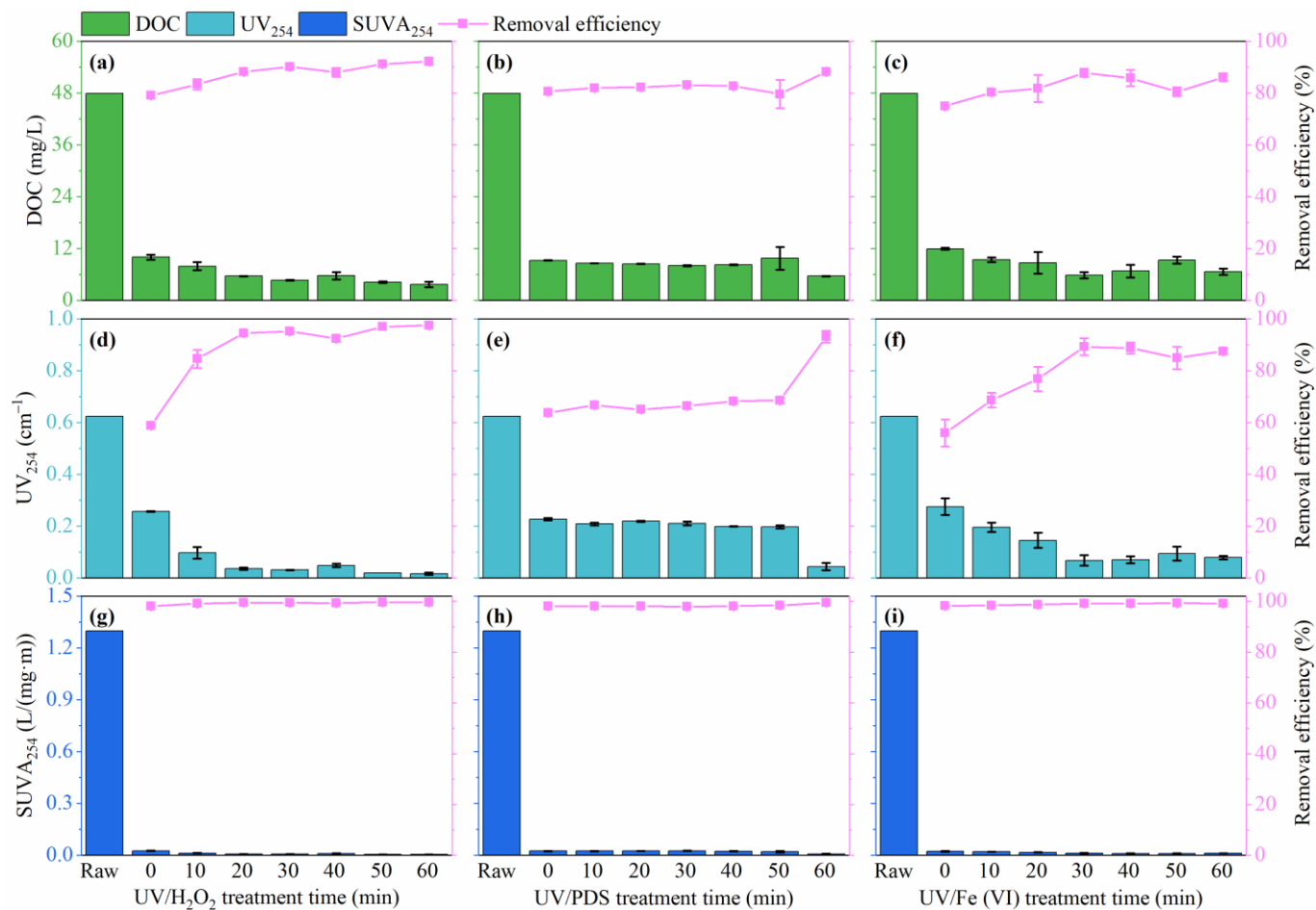


Fig. S3. Effect of reaction time on (a–c) DOC concentration, (d–f) UV₂₅₄ absorbance, and (g–i) SUVA₂₅₄ of stormwater runoff before and after treatment with three UV-based AOPs, along with their respective removal efficiencies.

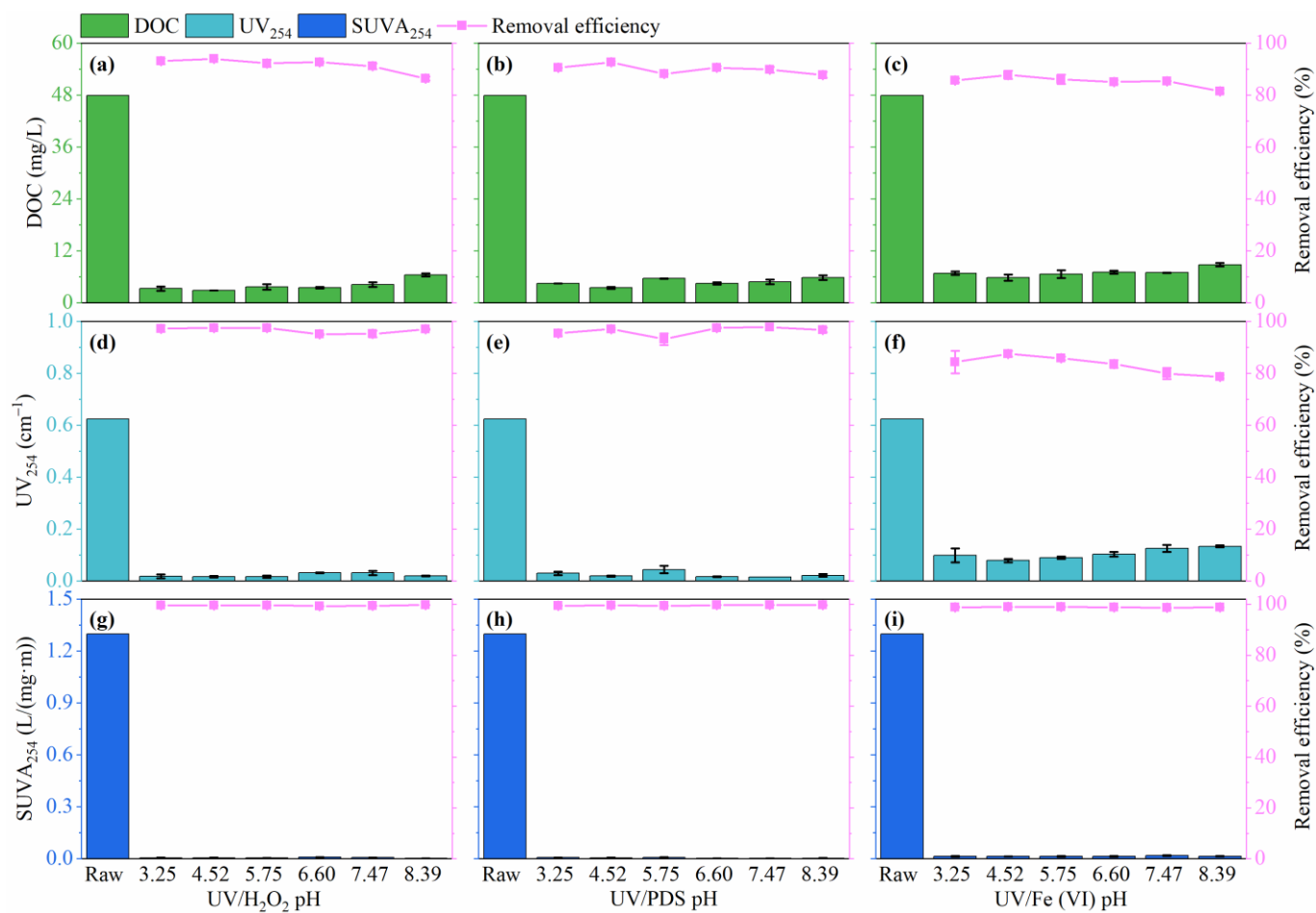


Fig. S4. Effect of pH on (a–c) DOC concentration, (d–f) UV₂₅₄ absorbance, and (g–i) SUVA₂₅₄ of stormwater runoff before and after treatment with three UV-based AOPs, along with their respective removal efficiencies.