Table S1. The primers information used for qPCR in this study.

Name	Sequence (5'-3')	Types	PCR Products (bp)
nirS	TTCRTCAAGACSCAYCCGAA	Forward Primer	331
	CGTTGAACTTRCCGGT	Reverse Primer	
nirK	ATCATGGTSCTGCCGCG	Forward Primer	165
	GCCTCGATCAGRTTGTGGTT	Reverse Primer	
nosZ	CGYTGTTCMTCGACAGCCAG	Forward Primer	252
	CGSACCTTSTTGCCSTYGCG	Reverse Primer	

Table S2. Hydrodynamics and water physico-chemistry in the Qi River and the three inoculated reaches (Wang et al., 2021). Values in bold and different letters indicate significant differences ($p < 0.05$).

River and Reach	River	Reach 1	Reach 2	Reach 3
Temperature (°C)	15.06 ± 8.31	17.80 ± 7.16	14.23 ± 6.84	15.12 ± 9.03
Pressure (mmHg)		**736.73 ± 4.57 b**	**700.2 ± 9.04a**	**703.8 ± 7.04 a**
Turbidity (NTU)		**0.61 ± 0.12 ab**	**0.34 ± 0.17 a**	**1.33 ± 0.87 b**
Water velocity (m s^{-1})		0.23 ± 0.2	0.17 ± 0.11	0.29 ± 0.15
EC (µs cm^{-1})		**409.63 ± 40.92 b**	**235.48 ± 25.89 b**	**229.13 ± 14.88 a**
pH	8.18 ± 0.24	8.54 ± 0.14	8.50 ± 0.17	8.49 ± 0.36
ORP (mv)		282.2 ± 45.99	281.45 ± 43.67	283.22 ± 43.21
TC (mg L^{-1})		26.8 ± 8.65	24.21 ± 8.72	21.95 ± 5.99
TIC (mg L^{-1})		9.7 ± 12.6	8.87 ± 10.33	6.97 ± 8.03
TOC (mg L^{-1})		17.09 ± 4.19	15.34 ± 6.14	14.97 ± 7.02
DOC (mg L^{-1})	2.47 ± 1.27	13.08 ± 5.53	13.08 ± 8.35	10.90 ± 5.79
TN (mg L^{-1})	3.80 ± 1.45	1.66 ± 0.9	2.89 ± 0.95	2.47 ± 2.39
NH_4^+-N (mg L^{-1})	0.50 ± 0.34	0.12 ± 0.15	0.08 ± 0.06	0.10 ± 0.12
NO_3^--N (mg L^{-1})	1.63 ± 0.81	**0.16 ± 0.16 a**	**1.55 ± 0.42 b**	**0.97 ± 0.50 ab**
TP (mg L^{-1})	0.03 ± 0.02	0.02 ± 0.01	0.02 ± 0.01	0.03 ± 0.02
DO (mg L^{-1})	9.48 ± 1.59	11.42 ± 3.83	10.18 ± 2.64	11.12 ± 1.96

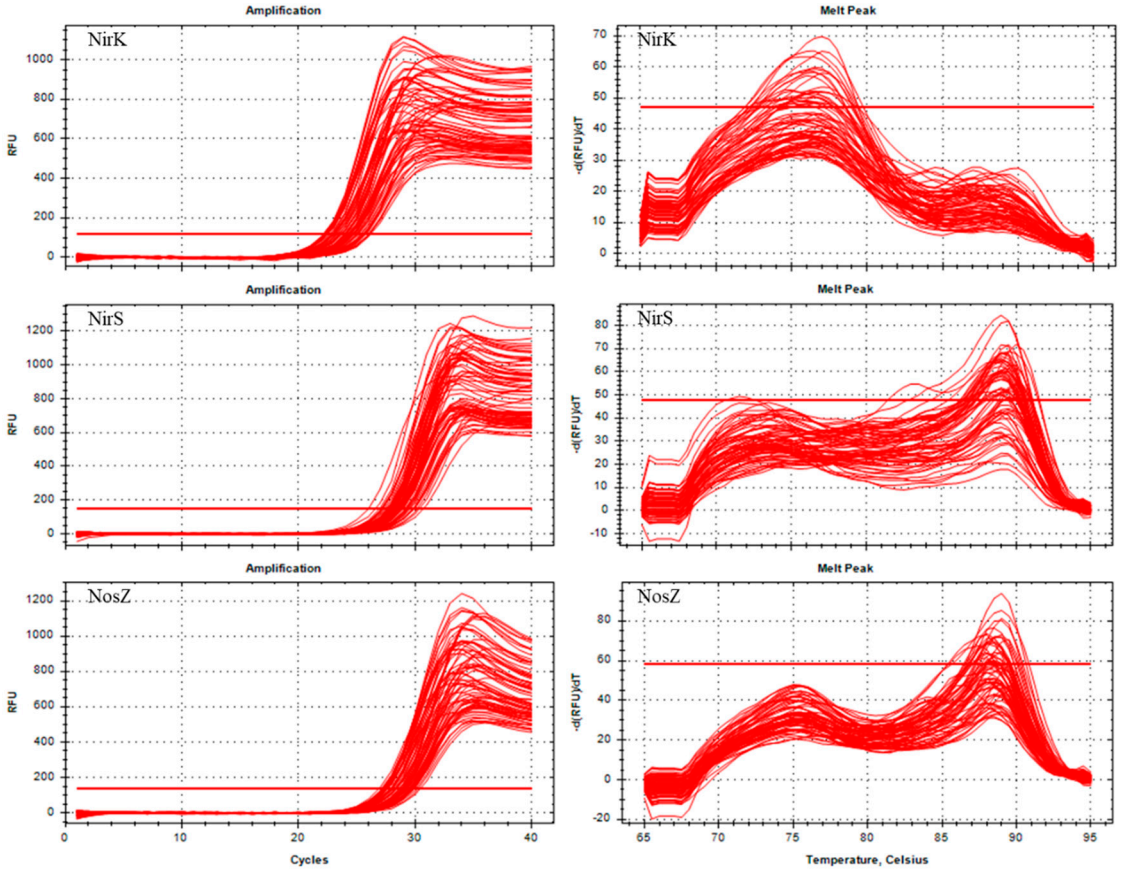


Figure S1. The amplification and dissociation curves of the qPCR.

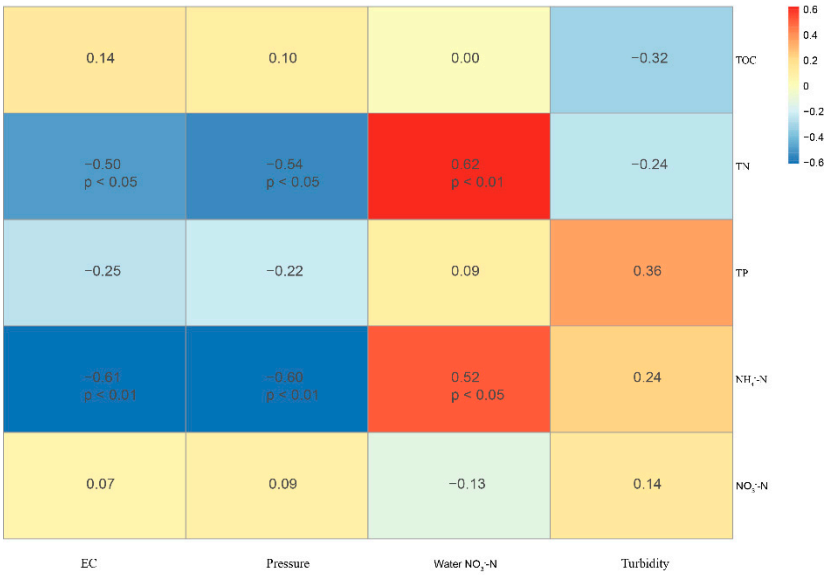


Figure S2. Correlations between water chemistry and sediment chemical characteristics.

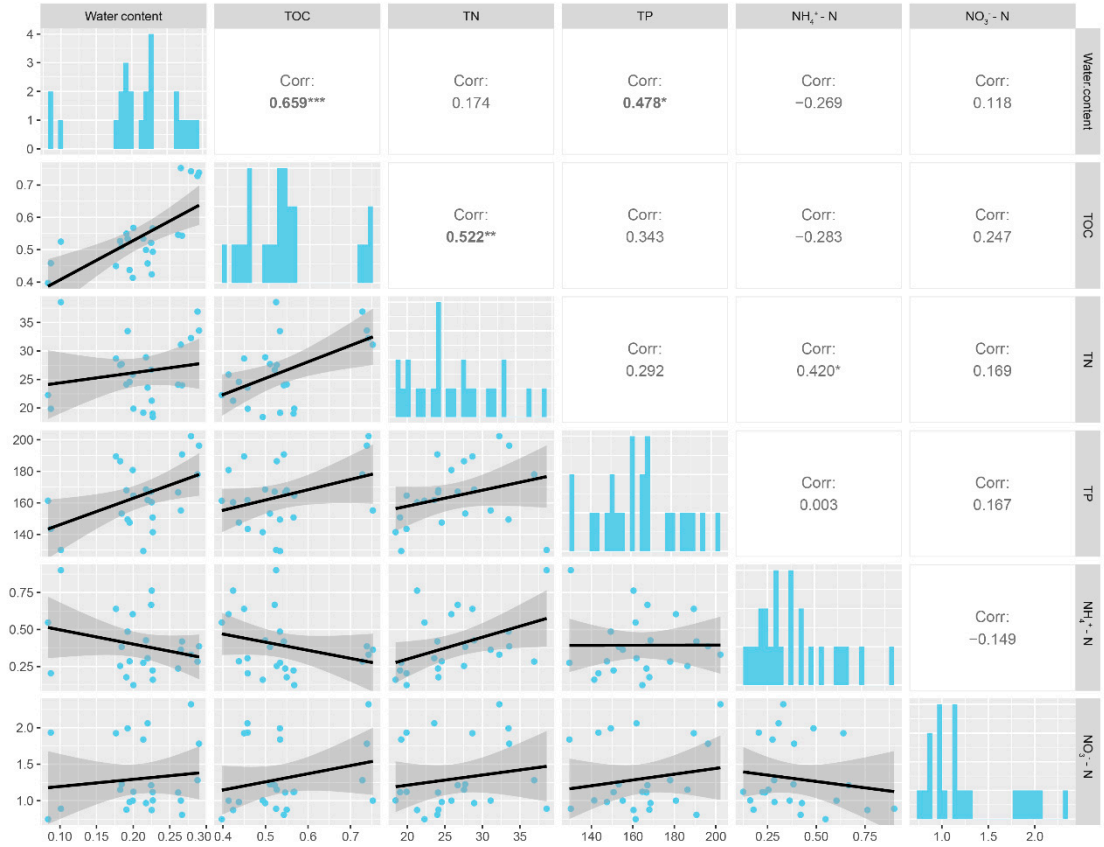


Figure S3. Correlation matrix of sediment physical and chemical characteristics. * significant level < 0.05; ** significant level < 0.01; *** significant level < 0.001.

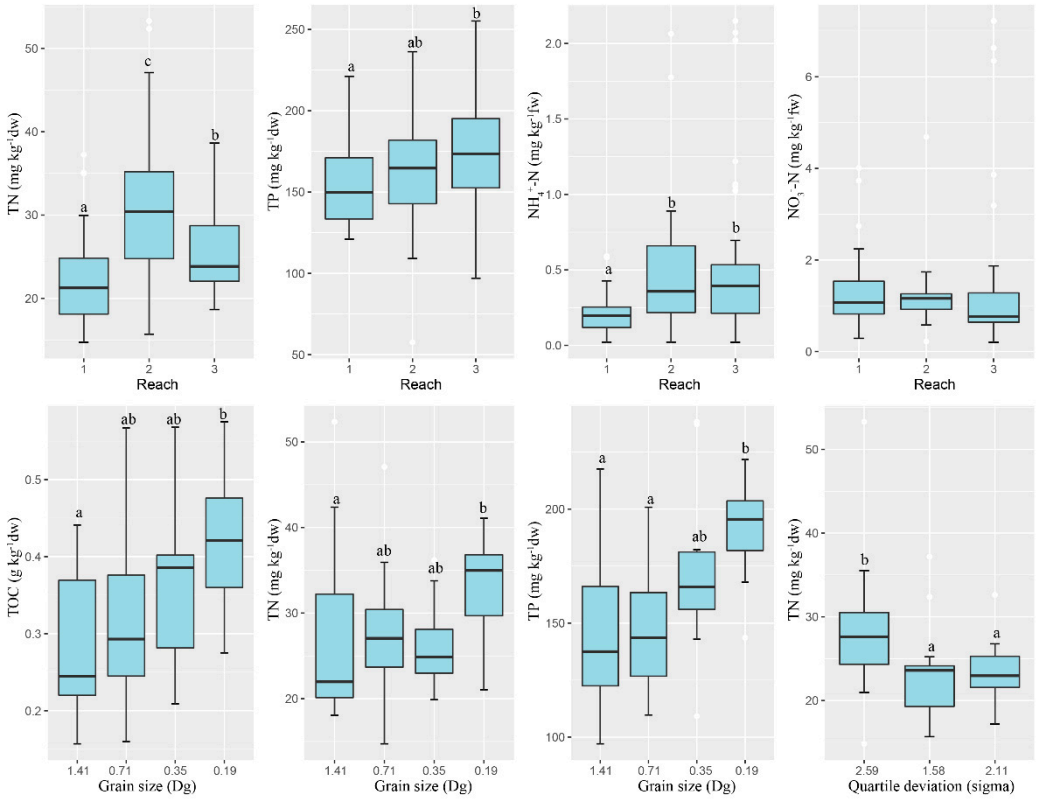
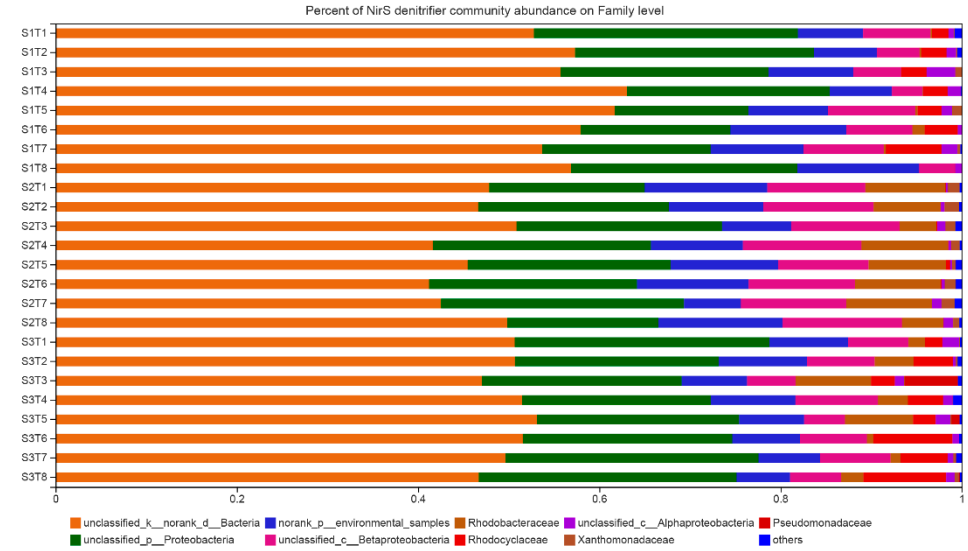
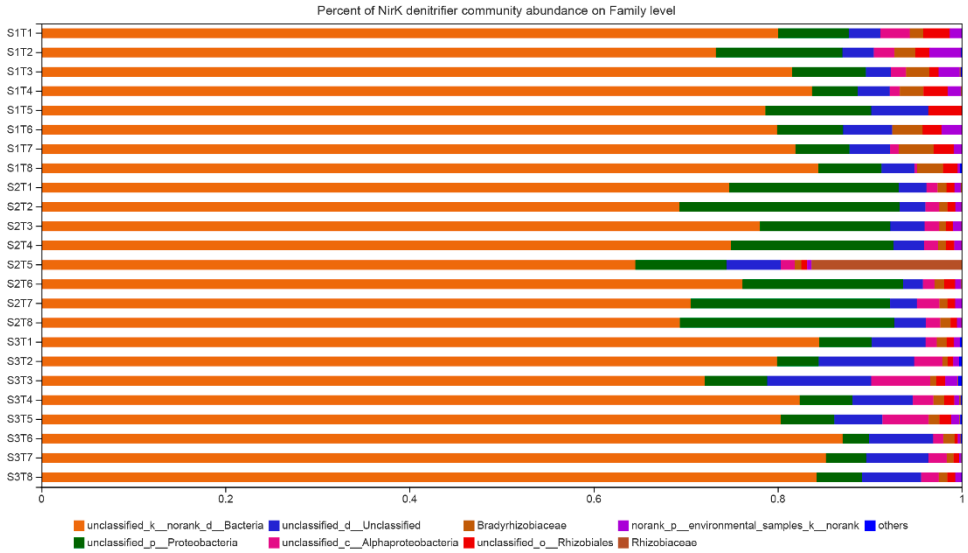


Figure S4. The chemical parameters of the sandy sediment with different reaches, particle median sizes, and heterogeneities. Different letters indicate significant differences ($p < 0.05$).





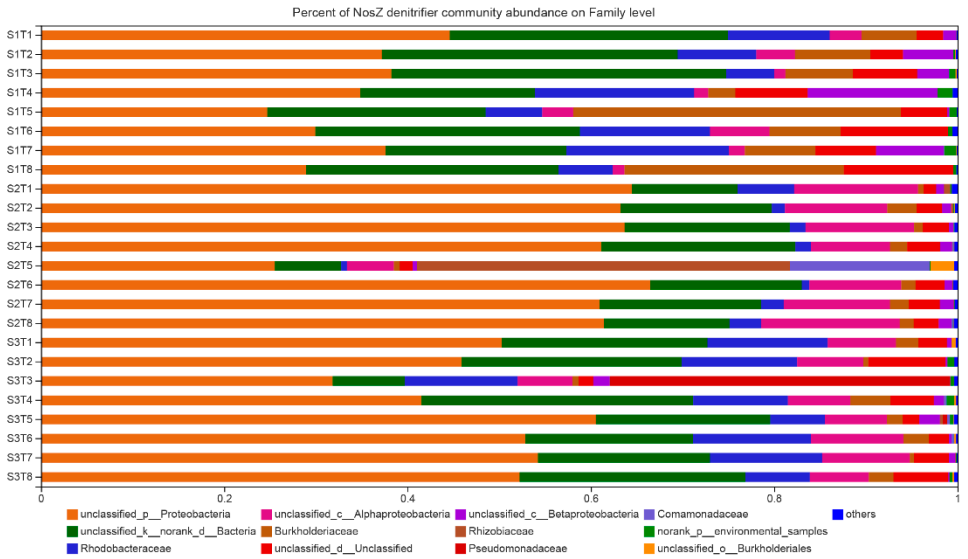


Figure S5. Three denitrifier community compositions (at the family level) within 24 different treatments.