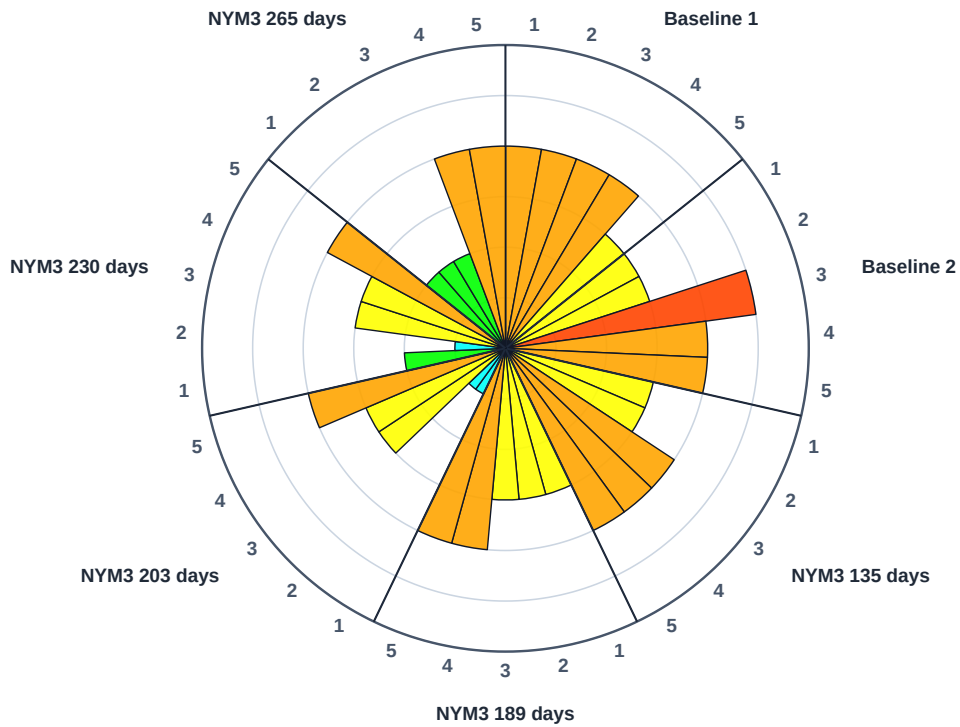


Ecotoxicology Analysis

During Remediation

Locality: Ferrara, Italy, ER-site
Method: In situ aerobic bioagumentation (NYM 3)
Bioremediation method: During Bioremediation
Sample type: water
Collection date: 2025-04-08 – 2026-04-13



ORGANISMS

- 1 *A. fischeri* 15
- 2 *A. fischeri* 30
- 3 *Daphnids*
- 4 *Algae*
- 5 *Lettuce aquatic*

CATEGORIES

- A Non-toxic
- B Low toxicity
- C Medium toxicity
- D High toxicity
- E Very high toxicity
- F Extreme toxicity

Category Distribution (% of organism readings)

A: 9%

B: 11%

C: 34%

D: 43%

E: 3%

Resulting category: **E** Very high toxicity

Test Organisms by Type

Consumers:	<i>Daphnids</i>
Producers:	<i>Algae, Lettuce aquatic</i>
Destruent:	<i>A. fischeri 15, A. fischeri 30</i>

Most sensitive organism: Daphnids

Critical ecotoxicological response recommended

Samples fall into category E. At 10% sample concentration inhibition is 51–100%, or EC50 is 1–10%. A severe toxic effect is present.

- It is recommended to implement immediate measures and conduct intensive monitoring.

Ecotoxicity Assessment Criteria

CATEGORY	DESCRIPTION	CRITERIA (ACTIVE RULES)
A	Non-toxic	Undiluted sample: inhibition / stimulation -19.99% – 19.99%
B	Low toxicity	Undiluted sample: stimulation 20% – 50%, or Undiluted sample: inhibition 20% – 50%
C	Medium toxicity	Undiluted sample: stimulation 51% – 90%, or Undiluted sample: inhibition 51% – 90%
D	High toxicity	At 10% sample concentration: inhibition / stimulation -50.99% – 50.99%, or EC50 10% – 50%
E	Very high toxicity	At 10% sample concentration: inhibition 51% – 100%, or EC50 1% – 10%
F	Extreme toxicity	At 1% sample concentration: inhibition 10.01% – 100%, or EC50 0% – 0.99%

Notes: A sample's category is the worst (most toxic) grade reached by any single test organism. Determination of EC50 takes precedence over the inhibition value. In a luminescence bacterial test, an undiluted sample corresponds to a sample concentration of 500 mL/L.

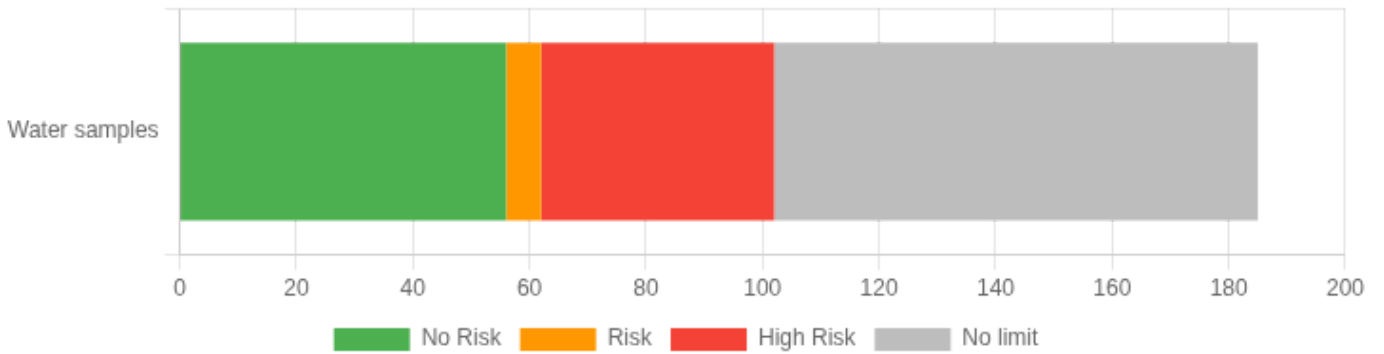
Chemical Risk Assessment

During Remediation

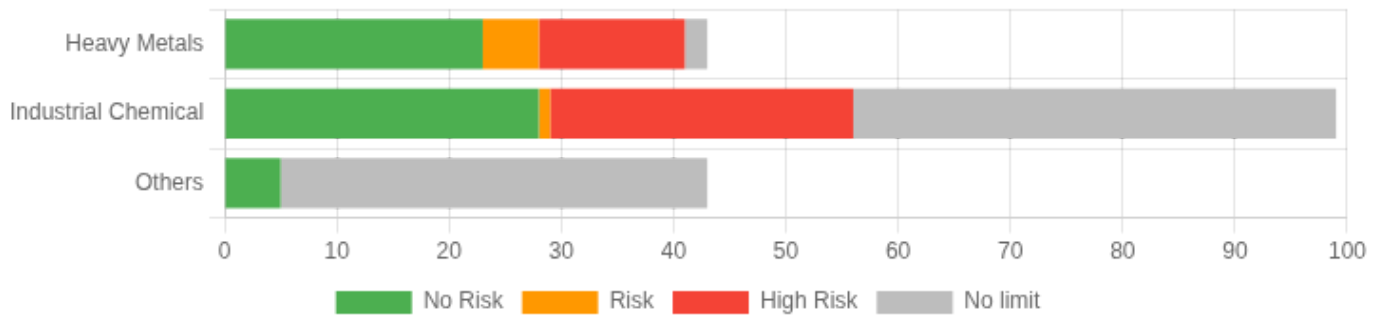
Locality: Ferrara, Italy, ER-site
Method: In situ aerobic bioagumentation (NYM 3)
Bioremediation method: During Bioremediation
Sample type: water
Collection date: 2025-04-08 – 2026-04-13

■ No Risk — at/below limit ■ Risk — over limit (up to 50%) ■ High Risk — more than 50% over limit
■ No limit — not defined

Risk distribution by sample type



Water samples



No risk 30%

Risk 3%

High risk 22%

No limit 45%

CLASS	NUMBER	OVER LIMIT	SUM CONCENTRATION
Heavy Metals	43	18	35409.531 µg/L
Industrial Chemical	99	28	526793.2269 µg/L
Others	43	0	3004.037 mg/L, 141400 µg/L, 333.4

SAMPLE	COMPOUND / ELEMENT	CLASS	MEASURED	UNIT
Baseline 1	Cobalt	Heavy Metals	825	µg/L
Baseline 1	Iron	Heavy Metals	9490	µg/L
Baseline 1	Manganese	Heavy Metals	1990	µg/L
Baseline 1	Nickel	Heavy Metals	47	µg/L
Baseline 1	1,1-Dichloroethylene	Industrial Chemical	2.3	µg/L
Baseline 1	Benzene	Industrial Chemical	4530	µg/L
Baseline 1	Benzo(a)pyrene	Industrial Chemical	0.048	µg/L
Baseline 1	Ethylbenzene	Industrial Chemical	9800	µg/L
Baseline 1	Toluene	Industrial Chemical	14000	µg/L
Baseline 1	Vinyl chloride	Industrial Chemical	9.98	µg/L
Baseline 2	Cobalt	Heavy Metals	1030	µg/L
Baseline 2	Iron	Heavy Metals	11500	µg/L
Baseline 2	Manganese	Heavy Metals	2270	µg/L
Baseline 2	Nickel	Heavy Metals	50	µg/L
Baseline 2	1,1-Dichloroethylene	Industrial Chemical	1.55	µg/L
Baseline 2	1,2,3-Trichloropropane	Industrial Chemical	2.32	µg/L
Baseline 2	Benzene	Industrial Chemical	2820	µg/L
Baseline 2	Benzo(a)pyrene	Industrial Chemical	0.0226	µg/L
Baseline 2	Ethylbenzene	Industrial Chemical	6650	µg/L
Baseline 2	Sum of organohalogen compounds	Industrial Chemical	34	µg/L
Baseline 2	Toluene	Industrial Chemical	12600	µg/L
Baseline 2	Vinyl chloride	Industrial Chemical	29	µg/L

SAMPLE	COMPOUND / ELEMENT	CLASS	MEASURED	UNIT
NYM3 135 days	Chromium VI	Heavy Metals	11.2	µg/L
NYM3 135 days	1,1-Dichloroethylene	Industrial Chemical	11	µg/L
NYM3 135 days	Benzene	Industrial Chemical	787	µg/L
NYM3 135 days	Sum of organohalogen compounds	Industrial Chemical	458	µg/L
NYM3 135 days	Toluene	Industrial Chemical	501	µg/L
NYM3 135 days	Vinyl chloride	Industrial Chemical	399	µg/L
NYM3 189 days	Cobalt	Heavy Metals	89	µg/L
NYM3 189 days	Benzene	Industrial Chemical	89	µg/L
NYM3 189 days	Toluene	Industrial Chemical	75	µg/L
NYM3 203 days	Cobalt	Heavy Metals	373	µg/L
NYM3 203 days	Iron	Heavy Metals	5270	µg/L
NYM3 203 days	Manganese	Heavy Metals	843	µg/L
NYM3 203 days	1,1-Dichloroethylene	Industrial Chemical	22.1	µg/L
NYM3 203 days	Benzene	Industrial Chemical	1430	µg/L
NYM3 203 days	Ethylbenzene	Industrial Chemical	275	µg/L
NYM3 203 days	Sum of organohalogen compounds	Industrial Chemical	921	µg/L
NYM3 203 days	Toluene	Industrial Chemical	1860	µg/L
NYM3 203 days	Vinyl chloride	Industrial Chemical	899	µg/L
Baseline 1	Arsenic	Heavy Metals	14.5	µg/L
Baseline 1	Benzo(g,h,i)perylene	Industrial Chemical	0.0114	µg/L
Baseline 2	Arsenic	Heavy Metals	11.2	µg/L
NYM3 135 days	Arsenic	Heavy Metals	14.5	µg/L
NYM3 189 days	Manganese	Heavy Metals	70	µg/L
NYM3 203 days	Nickel	Heavy Metals	25.8	µg/L
Baseline 1	Aluminium	Heavy Metals	10.6	µg/L
Baseline 1	Cadmium	Heavy Metals	0.165	µg/L
Baseline 1	Chromium VI	Heavy Metals	0.925	µg/L
Baseline 1	Copper	Heavy Metals	55	µg/L
Baseline 1	Lead	Heavy Metals	0.251	µg/L
Baseline 1	Benzo(a)anthracene	Industrial Chemical	0.093	µg/L
Baseline 1	Benzo(b)fluoranthene	Industrial Chemical	0.0248	µg/L
Baseline 1	Benzo(k)fluoranthene	Industrial Chemical	0.0068	µg/L
Baseline 1	Chrysene	Industrial Chemical	0.084	µg/L
Baseline 1	Dibenzo(a,h)anthracene	Industrial Chemical	0.0053	µg/L
Baseline 1	Indeno(1,2,3-cd)pyrene	Industrial Chemical	0.0079	µg/L

SAMPLE	COMPOUND / ELEMENT	CLASS	MEASURED	UNIT
Baseline 1	Pyrene	Industrial Chemical	0.4	µg/L
Baseline 1	Nitrites	Others	0.28	mg/L
Baseline 2	Aluminium	Heavy Metals	26.2	µg/L
Baseline 2	Cadmium	Heavy Metals	0.113	µg/L
Baseline 2	Copper	Heavy Metals	54	µg/L
Baseline 2	1,1-Dichloroethane	Industrial Chemical	1.55	µg/L
Baseline 2	1,2-Dichloroethylene	Industrial Chemical	1.52	µg/L
Baseline 2	1,2-Dichloroethylene	Industrial Chemical	0.47	µg/L
Baseline 2	Benzo(a)anthracene	Industrial Chemical	0.058	µg/L
Baseline 2	Benzo(b)fluoranthene	Industrial Chemical	0.0104	µg/L
Baseline 2	Benzo(g,h,i)perylene	Industrial Chemical	0.0062	µg/L
Baseline 2	Benzo(k)fluoranthene	Industrial Chemical	0.0033	µg/L
Baseline 2	Chrysene	Industrial Chemical	0.056	µg/L
Baseline 2	Indeno(1,2,3-cd)pyrene	Industrial Chemical	0.004	µg/L
Baseline 2	Pyrene	Industrial Chemical	0.36	µg/L
Baseline 2	Nitrites	Others	1.1	mg/L
NYM3 135 days	Aluminium	Heavy Metals	15.6	µg/L
NYM3 135 days	Cobalt	Heavy Metals	36.5	µg/L
NYM3 135 days	Copper	Heavy Metals	664	µg/L
NYM3 135 days	Iron	Heavy Metals	7.5	µg/L
NYM3 135 days	Manganese	Heavy Metals	2.71	µg/L
NYM3 135 days	Mercury	Heavy Metals	0.147	µg/L
NYM3 135 days	Nickel	Heavy Metals	7.32	µg/L
NYM3 135 days	1,2-Dichloroethylene	Industrial Chemical	16.7	µg/L
NYM3 135 days	Chrysene	Industrial Chemical	0.09	µg/L
NYM3 135 days	Ethylbenzene	Industrial Chemical	47	µg/L
NYM3 135 days	Pyrene	Industrial Chemical	0.068	µg/L
NYM3 135 days	Nitrites	Others	1.1	mg/L
NYM3 189 days	Aluminium	Heavy Metals	32.3	µg/L
NYM3 189 days	Arsenic	Heavy Metals	7	µg/L
NYM3 189 days	Copper	Heavy Metals	381	µg/L
NYM3 189 days	Iron	Heavy Metals	51	µg/L
NYM3 189 days	Nickel	Heavy Metals	18.7	µg/L
NYM3 189 days	Benzo(a)pyrene	Industrial Chemical	0.0031	µg/L
NYM3 189 days	Benzo(b)fluoranthene	Industrial Chemical	0.0026	µg/L

SAMPLE	COMPOUND / ELEMENT	CLASS	MEASURED	UNIT
NYM3 189 days	Chrysene	Industrial Chemical	0.006	µg/L
NYM3 189 days	Ethylbenzene	Industrial Chemical	37	µg/L
NYM3 189 days	Nitrites	Others	64	mg/L
NYM3 203 days	Aluminium	Heavy Metals	2.88	µg/L
NYM3 203 days	Arsenic	Heavy Metals	9.4	µg/L
NYM3 203 days	Copper	Heavy Metals	80	µg/L
NYM3 203 days	1,1-Dichloroethane	Industrial Chemical	4.6	µg/L
NYM3 203 days	1,2-Dichloroethylene	Industrial Chemical	14.1	µg/L
NYM3 203 days	1,2-Dichloroethylene	Industrial Chemical	10.9	µg/L
NYM3 203 days	Nitrites	Others	37	mg/L
Baseline 1	Dichloromethane	Industrial Chemical	1260	µg/L
Baseline 1	GRO as hexane	Industrial Chemical	98800	µg/L
Baseline 1	Hydrocarbons C10-C40 as n-hexane	Industrial Chemical	2250	µg/L
Baseline 1	Hydrocarbons C12-C14 (200–250 °C fraction)	Industrial Chemical	189.6	µg/L
Baseline 1	Hydrocarbons C14-C16	Industrial Chemical	87.6	µg/L
Baseline 1	Naphthalene	Industrial Chemical	488	µg/L
Baseline 1	Sum of polycyclic aromatic hydrocarbons	Industrial Chemical	0.051	µg/L
Baseline 1	Total hydrocarbons as hexane	Industrial Chemical	101000	µg/L
Baseline 1	Xylene	Industrial Chemical	17300	µg/L
Baseline 1	Ammonia nitrogen (as NH4)	Others	25.1	mg/L
Baseline 1	Chlorides	Others	230	mg/L
Baseline 1	Organic nitrogen	Others	1.88	mg/L
Baseline 1	Potassium	Others	2.4	mg/L
Baseline 1	TOC	Others	141	mg/L
Baseline 1	Total inorganic nitrogen	Others	19600	µg/L
Baseline 1	Total nitrogen	Others	22.2	mg/L
Baseline 2	Dichloromethane	Industrial Chemical	42	µg/L
Baseline 2	GRO as hexane	Industrial Chemical	92500	µg/L
Baseline 2	Hydrocarbons C10-C40 as n-hexane	Industrial Chemical	3580	µg/L
Baseline 2	Hydrocarbons C12-C14 (200–250 °C fraction)	Industrial Chemical	154	µg/L
Baseline 2	Hydrocarbons C14-C16	Industrial Chemical	46	µg/L
Baseline 2	Naphthalene	Industrial Chemical	698	µg/L
Baseline 2	Sum of polycyclic aromatic hydrocarbons	Industrial Chemical	0.0239	µg/L
Baseline 2	Tetrachloroethylene	Industrial Chemical	2.5	µg/L
Baseline 2	Total hydrocarbons as hexane	Industrial Chemical	96100	µg/L

SAMPLE	COMPOUND / ELEMENT	CLASS	MEASURED	UNIT
Baseline 2	Trichloroethylene	Industrial Chemical	1.16	µg/L
Baseline 2	Xylene	Industrial Chemical	15300	µg/L
Baseline 2	Ammonia nitrogen (as NH4)	Others	25.7	mg/L
Baseline 2	Chlorides	Others	200	mg/L
Baseline 2	Organic nitrogen	Others	0.077	mg/L
Baseline 2	Potassium	Others	2.5	mg/L
Baseline 2	TOC	Others	233	mg/L
Baseline 2	Total inorganic nitrogen	Others	20800	µg/L
Baseline 2	Total nitrogen	Others	20.8	mg/L
Baseline 2	Turbidity	Others	287	—
NYM3 135 days	Total chromium	Heavy Metals	20	µg/L
NYM3 135 days	GRO as hexane	Industrial Chemical	7900	µg/L
NYM3 135 days	Hydrocarbons C10-C40 as n-hexane	Industrial Chemical	320	µg/L
NYM3 135 days	Hydrocarbons C12-C14 (200–250 °C fraction)	Industrial Chemical	23	µg/L
NYM3 135 days	Hydrocarbons C16-C18	Industrial Chemical	40	µg/L
NYM3 135 days	Naphthalene	Industrial Chemical	242	µg/L
NYM3 135 days	Tetrachloroethylene	Industrial Chemical	48	µg/L
NYM3 135 days	Total hydrocarbons as hexane	Industrial Chemical	7900	µg/L
NYM3 135 days	Xylene	Industrial Chemical	273	µg/L
NYM3 135 days	Ammonia nitrogen (as NH4)	Others	72	mg/L
NYM3 135 days	Chlorides	Others	200	mg/L
NYM3 135 days	Organic nitrogen	Others	56	mg/L
NYM3 135 days	Potassium	Others	40	mg/L
NYM3 135 days	TOC	Others	367	mg/L
NYM3 135 days	Total inorganic nitrogen	Others	56400	µg/L
NYM3 135 days	Total nitrogen	Others	113	mg/L
NYM3 189 days	Total chromium	Heavy Metals	2.02	µg/L
NYM3 189 days	GRO as hexane	Industrial Chemical	790	µg/L
NYM3 189 days	Hydrocarbons C10-C40 as n-hexane	Industrial Chemical	31.7	µg/L
NYM3 189 days	Naphthalene	Industrial Chemical	0.125	µg/L
NYM3 189 days	Sum of polycyclic aromatic hydrocarbons	Industrial Chemical	0.0026	µg/L
NYM3 189 days	Total hydrocarbons as hexane	Industrial Chemical	31.7	µg/L
NYM3 189 days	Xylene	Industrial Chemical	74	µg/L
NYM3 189 days	Ammonia nitrogen (as NH4)	Others	14.5	mg/L
NYM3 189 days	Chlorides	Others	280	mg/L

SAMPLE	COMPOUND / ELEMENT	CLASS	MEASURED	UNIT
NYM3 189 days	Organic nitrogen	Others	9.1	mg/L
NYM3 189 days	Potassium	Others	8.2	mg/L
NYM3 189 days	TOC	Others	547	mg/L
NYM3 189 days	Total inorganic nitrogen	Others	25900	µg/L
NYM3 189 days	Total nitrogen	Others	1.75	mg/L
NYM3 189 days	Turbidity	Others	41	—
NYM3 203 days	GRO as hexane	Industrial Chemical	9880	µg/L
NYM3 203 days	Hydrocarbons C10-C40 as n-hexane	Industrial Chemical	196	µg/L
NYM3 203 days	Hydrocarbons C12-C14 (200–250 °C fraction)	Industrial Chemical	27.4	µg/L
NYM3 203 days	Hydrocarbons C14-C16	Industrial Chemical	45.6	µg/L
NYM3 203 days	Hydrocarbons C16-C18	Industrial Chemical	27.4	µg/L
NYM3 203 days	Hydrocarbons C18-C20 (300–350 °C fraction)	Industrial Chemical	28.8	µg/L
NYM3 203 days	Naphthalene	Industrial Chemical	0.103	µg/L
NYM3 203 days	Total hydrocarbons as hexane	Industrial Chemical	10100	µg/L
NYM3 203 days	Xylene	Industrial Chemical	674	µg/L
NYM3 203 days	Ammonia nitrogen (as NH₄)	Others	13	mg/L
NYM3 203 days	Chlorides	Others	200	mg/L
NYM3 203 days	Organic nitrogen	Others	1.15	mg/L
NYM3 203 days	Potassium	Others	6.8	mg/L
NYM3 203 days	TOC	Others	47	mg/L
NYM3 203 days	Total inorganic nitrogen	Others	18700	µg/L
NYM3 203 days	Total nitrogen	Others	19.4	mg/L
NYM3 203 days	Turbidity	Others	5.4	—

Chemical Assessment Criteria

Chemical data exceed the limit values

Exceedances of limit values indicate the presence of chemical risk. The remediation is insufficient or ineffective for the substances concerned. It is recommended to identify the source of contamination, reassess the remediation strategy, and propose additional measures. Exceedances are considered relevant above 0.5 µg/L for water samples and 0.5 mg/kg for soil samples.

Supportive Methods

During Remediation

Locality: Ferrara, Italy, ER-site
Method: In situ aerobic bioaugmentation (NYM 3)
Bioremediation method: During Bioremediation

Per-sample evaluation

Sample	Type	Diversity — Shannon (H')	Diversity — Simpson (1-D)	Nitrification	Respiration	Conformity
Baseline 1	Water	5.955 expected: Moderate or gradually increasing	0.9661 expected: Low to moderate	26.7% Exceeds ±20% — significant effect on the nitrifying community Nonconforming	QR 1.51 QR above 0.5 — verify the aerobic heterotrophic bacteria (AHB) count Nonconforming	Nonconforming
Baseline 2	Water	5.955 expected: Moderate or gradually increasing	0.9661 expected: Low to moderate	49.7% Exceeds ±20% — significant effect on the nitrifying community Nonconforming	QR 0.25 Acceptable — QR ≤ 0.5 Conforming	Nonconforming
NYM3 135 days	Water	6.6785 expected: Moderate or gradually increasing	0.9819 expected: Low to moderate	36.5% Exceeds ±20% — significant effect on the nitrifying community Nonconforming	QR 0 Acceptable — QR ≤ 0.5 Conforming	Nonconforming
NYM3 189 days	Water	6.0438 expected: Moderate or gradually increasing	0.9735 expected: Low to moderate			—
NYM3 203 days	Water	6.9008 expected: Moderate or gradually increasing	0.9822 expected: Low to moderate			—
NYM3 230 days	Water	6.4735 expected: Moderate or gradually increasing	0.9812 expected: Low to moderate			—
NYM3 265 days	Water	— expected: Moderate or gradually increasing	— expected: Low to moderate	11.1% Within ±20% Conforming	QR 0.21 Acceptable — QR ≤ 0.5 Conforming	Conforming

Diversity (Shannon / Simpson): read as a trend across the before / during / after phases (rising = recovery), compared with the expected level per phase. **Respiration:** QR ≤ 0.5 acceptable; above that the AHB count is checked (≥ 1000 CFU/g = not suitable, below = not suitable without microbial augmentation). **Nitrification:** inhibition / stimulation within ±20%.