

PROJECT PAWD

Portable Automated Water Detoxification

Technical Brief: Emergency Nitrate Remediation Platform
February 2026 | Patent Pending | Deployment Ready Q2 2026

1. The Contamination Crisis

The Lower Umatilla Basin Groundwater Management Area (LUBGWMA) in northeastern Oregon contains some of the most severely nitrate-contaminated groundwater in the Pacific Northwest. Well tests document concentrations reaching **63–75.5 mg/L NO₃-N** — up to 755% of the EPA Maximum Contaminant Level (10 mg/L). The contamination stems from decades of agricultural nitrogen loading across the Basin's permeable soils.

Oregon's voluntary Groundwater Management Area action plan, now in its fourth decade, has not reversed contamination trends. Residents in Morrow County continue to depend on bottled water. Meanwhile, large-scale data center operations in the same corridor generate significant waste heat that is currently rejected to atmosphere — thermal energy that has direct value for biological water treatment.

2. Platform Architecture

PAWD uses Moving Bed Biofilm Reactor (MBBR) technology — the same proven biological process used in thousands of municipal wastewater treatment plants worldwide. Engineered biofilm carrier media (AnoxKaldnes K-series) provides high protected surface area for heterotrophic denitrifying bacteria in an anoxic, mixed environment. These organisms reduce dissolved nitrate (NO₃⁻) to nitrogen gas (N₂) using an organic carbon electron donor.

The innovation is thermal coupling. Biological denitrification rates roughly double with every 10°C increase (within the mesophilic range). By maintaining reactor temperature at 30–35°C using captured waste heat, PAWD achieves treatment velocities that ambient-temperature systems cannot match — critical when inlet concentrations are 6× the regulatory limit.

Dual Configuration

PAWD v1 (High-Volume): Optimized for rapid throughput where discharge temperature is not constrained. Targets agricultural reuse, aquifer reinjection, and industrial cooling water remediation. Operates at elevated metabolic temperatures for maximum denitrification rate.

PAWD v2 (Salmon-Safe): Includes an integrated absorption chiller loop and half-batch logic to ensure discharge meets thermal limits for sensitive receiving waters (<18°C). Designed for direct discharge to surface waters, tributaries, and salmonid habitat zones under Oregon DEQ and EPA thermal regulations.

3. Unit Specifications

Parameter	Specification
Container	40-foot modified shipping container
MBBR Reactor Volume	~11,010 gal (~41,670 L) gross
Cooling/Holding Tank	~5,505 gal (~20,835 L) gross
Working Volume (85% fill)	~14,040 gal (~53,140 L) combined
Half-Batch Cycle Volume	~4,680 gal (~17,710 L)
Batch Cycle Time	6–8 hours (temperature and carbon dependent)
Daily Treatment	~14,000 gal/day (3 batches at conservative 8-hr cycle)
Annual Treatment	~5.1 million gal/year
Inlet Range	10–75.5 mg/L NO ₃ -N (design midpoint: 25 mg/L)
Discharge Target	≤5 mg/L NO ₃ -N (capability: 2–3 mg/L)

Annual Nitrate Removal	~387 kg NO ₃ ⁻ converted to N ₂ gas
Households Served	~46 per unit (~149 people at 300 gal/day/household)
Reactor Temperature	30–35°C (thermally coupled to waste heat source)
Carbon Source	Sodium acetate (river-safe; no methanol toxicity risk)
pH Management	Sodium bicarbonate buffer (prevents overshoot vs. NaOH)
Biofilm Media	AnoxKaldnes K-series (protected surface area geometry)

All performance figures use conservative assumptions (8-hr cycles, 85% fill). Actual performance expected to exceed projections.

4. Sensor-Verified Discharge Safety

PAWD replaces statistical uncertainty with **Qualified Discharge**: every batch of treated water is individually verified by industrial-grade sensors before release. The system is “Fail-Closed” — the default state is locked. Discharge requires active sensor confirmation that all parameters are within specification.

Sensing Architecture

The control system is built on the Xylem/YSI IQ SensorNet platform with sensors at three measurement points (groundwater influent, reactor vessel, and post-treatment effluent):

- NitraVis 700 IQ optical nitrate probes (UV/VIS spectral, ultrasonic self-cleaning) — the discharge gate sensor
- TriOxmatic dissolved oxygen probes (verifying anoxic conditions in reactor)
- SensoLyt 700 IQ pH and ORP electrodes (process health monitoring)
- Temperature monitoring (reactor thermal control, discharge thermal compliance)
- IQ SensorNet 2020 3G controller with Modbus TCP/Ethernet interface for PLC integration

Hardware has been specified and quoted (\$77,317 via Whitney Equipment Company, regional Xylem/YSI distributor for OR/WA). Xylem corporate is conducting technical and strategic review for potential partnership.

5. EMERALD NEXUS: The Industrial Symbiosis Platform

EMERALD NEXUS is the infrastructure platform that thermally couples PAWD units to data center cooling systems. It is designed as a “built to fit” symbiotic integration — one facility’s waste heat becomes the thermal energy that drives biological water treatment, while optionally supporting controlled-environment agriculture and anaerobic digestion/CNG production from the same thermal input.

This model converts a cooling liability into a public health, agricultural, and ecological asset. Every NEXUS deployment specifies Xylem/YSI instrumentation across multiple product lines (sensing, pumps, mixers, valves), creating a scalable and repeatable equipment specification.

6. Ecological and Community Impact

Every kilogram of nitrate removed from groundwater is a kilogram that does not reach the Columbia River system. The EPA’s Columbia River nutrient study documents that nitrogen loading increases significantly from headwaters to mouth, driving algal blooms, eutrophication, oxygen depletion, and direct harm to salmonid populations critical to the region’s cultural and economic identity.

A single PAWD unit removing ~387 kg of nitrate annually represents a measurable, verifiable reduction in nutrient loading from one of the most contaminated groundwater management areas in the Pacific Northwest. At scale (25 units), the platform could serve ~3,725 people and remove nearly 10 metric tons of nitrate per year.

Community economic impact: Each unit eliminates an estimated \$33,000–\$55,000/year in bottled water costs for the 46 households served.

7. AI-Optimized Operation

PAWD incorporates a four-layer AI monitoring and optimization system, progressing from sensor fusion and anomaly detection through predictive process forecasting to reinforcement learning-based control optimization. All training occurs offline; all inference runs locally on embedded hardware with no cloud dependency. The system is

designed to learn optimal carbon dosing, mixing, and batch timing strategies from operational data, continuously improving treatment efficiency while maintaining conservative safety margins.

8. Current Status and Next Steps

- Three provisional patent applications filed (February 10–12, 2026)
- Sensor hardware specified and quoted (\$77,317 via Whitney Equipment / Xylem-YSI)
- Xylem corporate engagement active: technical and strategic review in progress
- Digital twin simulation under development for process optimization and AI training
- Pilot deployment target: Q2 2026
- Grant funding in pursuit: Oregon DEQ 319 Nonpoint Source, WA Industrial Symbiosis Program, federal water infrastructure programs
- Active engagement with regional stakeholders for pilot siting and co-application partnerships

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