ZeeLung* MABR with zeeDENSE* Technology Intensifies Nutrient Removal at United Utilities Bolton Wastewater Treatment Works

CASE STUDY I Municipal

| Challenge

United Utilities (UU) provides water and wastewater services to approximately 7.3 million people in the North West of England. The Bolton Wastewater Treatment Works (WWTW) is located in the Greater Manchester area and serves approximately 446,000 PE (Population Equivalent, for 2035) with an Average Daily Flow (ADF) of 151 MLD (megalitres per day) and Flow to Full Treatment (FFT) of 279 MLD.

Due to a more stringent limit on effluent ammonia, from the previous target of 6 mg/L to current 2 mg/L, an upgrade to the existing conventional activated sludge plant was needed to increase nitrification capacity. United Utilities sought a solution that would increase the flexibility and resilience of the plant under a wide range of operating conditions.

When choosing a solution for the upgrade, United Utilities' selection criteria extended beyond achieving future compliance standards and operational improvements. The technology needed to support their environmental commitments, particularly in advancing sustainability goals and strengthening the facility's ability to withstand climate change challenges.

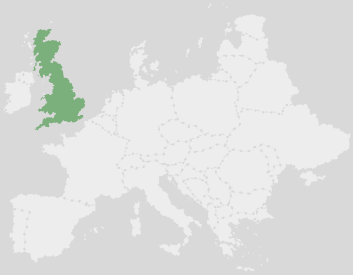
| Solution

United Utilities selected ZeeLung MABR (Membrane Aerated Biofilm Reactor) with zeeDENSE technology to intensify the biological and hydraulic capacity of the plant.

ZeeLung MABR with zeeDENSE couples the synergies of Veolia's ZeeLung MABR with continuous flow densification to intensify both biological and hydraulic treatment within the existing asset.

The Bolton WWTW is a conventional activated sludge system with 12 biological lanes, each with 10 reactors in-series, the first two being anoxic and the remaining eight aerobic.

The bioreactor is fed with primary settled wastewater and return activated sludge (RAS). Two groups of final settling tanks are operated in parallel.



Increased nitrification capacity in existing tanks

Up to 4X reduction in aeration energy & N_2O mitigation potential

Figure 1 – ZeeLung cassette during installation in anoxic tank

ZeeLung MABR cassettes will be installed in the anoxic zones of each treatment lane to (i) intensify the biological process, (ii) augment nitrification and (iii) ensure stable ammonia removal under most challenging winter conditions.

ZeeLung MABR utilizes a gas-permeable membrane which enables efficient nitrification as a combination of both direct nitrification by the biofilm that grows on the media surface and the seeding effect generated by sloughed biofilm, which augments the mass of nitrifiers in the activated sludge. The ZeeLung cassettes installed in the anoxic zones of the twelve lines provide an extra-nitrification capacity of about 800 kgN-NH4+/d. At the time of construction, Bolton was the largest MABR installation worldwide.

An additional benefit of the MABR upgrade is that the nitrification and denitrification occurring in the bulk liquid of the anoxic zone enable the denitrification of oxidized nitrogen, resulting in an increased total nitrogen removal. The efficient bubble-less oxygen transfer of ZeeLung technology reduces the energy consumption of the biological treatment process, thanks to its high aeration efficiency.

zeeDENSE racks are installed close to the new waste-activated sludge pumping station, which receives settled solids from the secondary settlers. ZeeLung MABR with zeeDENSE selectively wastes the light fraction of solids, which is detrimental to good performance of the solids/liquid separation. This improves sludge settleability and increases the hydraulic resilience of the plant and operational flexibility of the secondary clarifiers.

| Results

Since the commissioning of the ZeeLung MABR with zeeDENSE upgrade early 2025, it delivers the increased flexibility and resilience of the overall plant under the new range of operational conditions. The engineering support provided by Veolia includes detailed mechanical engineering, equipment and instruments selection, technical assistance on site during installation, commissioning and process optimization.

The ZeeLung MABR with zeeDENSE system ensures compliance with discharge regulations while minimizing carbon emissions. This aligns with United Utilities and Veolia's commitment to both pollution reduction and decarbonization, which are integral to our mission.

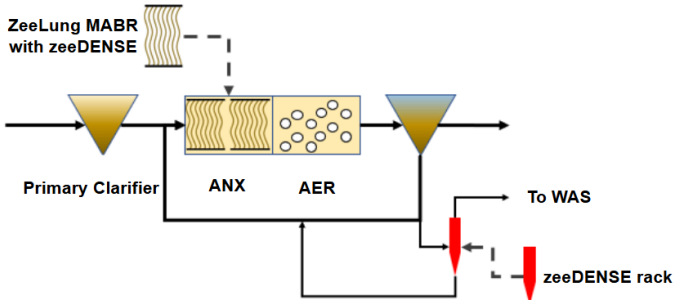


Figure 2 – Process Flow Diagram at Bolton WWTW

The ZeeLung MABR with zeeDENSE upgrade delivers multiple benefits to the Bolton WWTW including:

1. Augmenting nitrification capacity to meet the new more stringent effluent ammonia consent in the existing tanks
2. Increasing the process resilience by selecting a better settling sludge for more efficient secondary clarification
3. Intensifying existing wastewater infrastructure without the need for new civil works
4. Reducing energy consumption for the biological process thanks to the energy efficient bubble-less oxygenation provided by ZeeLung cassettes and the improved total nitrogen removal
5. Mitigating greenhouse gases (GHG) emissions, key to achieve carbon neutrality by 2030

| Contact Us

If you would like more information on implementing ZeeLung MABR with zeeDENSE at your wastewater treatment facility, contact your local Veolia representative or visit us at our website.