Case History

# Indirect Potable Reuse via Groundwater Recharge in Belgium

The Torreele water plant in Belgium, operated by the Intermunicipal Water Company of the Veurne Region (IWVA) since July 2002, reuses municipal wastewater effluent to produce infiltration water for an artificial groundwater recharge in St-Andre dune water catchments. This aquifer is used to extract potable water for nearby communities. Throughout the years, the levels of the ground water were decreasing and as the location is close to the Flemish coast, salt water intrusion presents a threat for continuation of the process. Without the artificial recharge with treated waste water, the use of catchments would no longer be possible.
The choice for membrane filtration, ultrafiltration (UF) and reverse osmosis (RO), was based upon the quality parameters set for the infiltration water. As this water is recharged in a dune area, which is of high ecological value, the infiltration water must have low levels of salts and nutrients. Reverse osmosis is the only technique currently capable of achieving these goals in one step.

## FILMTEC Membranes

The plant uses FILMTEC™ BW30LE-440 elements with enhanced membrane chemistry allowing lower pressure operation compared to the standard FILMTEC BW30-400. The BW30LE-440 element also provides higher productivity due to an increased surface area of 440 square feet (41 $m^2$) per element. The rate of membrane fouling therefore remains low, allowing for higher flow rates over time and prolonged element service life.

*Pressure vessels housing reverse osmosis elements at the water treatment facility (Photo courtesy of Intermunicipal Water Company of the Veurne Region)*

The productivity advantages of the FILMTEC BW30LE-440 element can be utilized in the design of new systems that produce the desired flow rate while operating at significantly lower feed pressures. This will result in savings due to lower energy consumption. The high surface area of the FILMTEC BW30LE-440 element permits designs of new RO systems that meet productivity targets with fewer elements than standard 8-inch elements resulting in lower installed system cost by reducing the number of system components and lower installation expense.

## Site Information

| | |
|---|---|
| *Location:* | Koksijde, Belgium |
| *Design Capacity:* | 2 x 185 $m^3/h$ |
| *Purpose:* | Produce infiltration water for an artificial ground-water recharge in eco-logically sensitive dune area |
| *Time in Operation:* | Since July 2002 |
| *Performance:* | - Stable permeate flow and salt rejection<br>- Low operational cost<br>- Higher groundwater levels and better drinking water quality |

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## Water treatment Process

The Torreele plant was built on the premises of the existing Wulpen waste water treatment plant operated by Aquafin, which treats domestic waste water with high salt and nutrient content as presented in Table 1. The existing treatment process consisted of a primary settlement, predenitrification, aerobic treatment followed by a clarifier. As the rainwater is collected in the same sewer system, the effluent water quality can vary largely.

### Table 1. Feed water analysis

| Parameter | Unit | Average | Minimum | Maximum |
|---|---|---|---|---|
| Temperature | °C | 15.3 | 9.8 | 22.3 |
| pH | — | | 7.06 | 7.88 |
| Total organic carbon | mg/L | 8.8 | 4.8 | 13.7 |
| Total nitrogen | mg/L | 12.1 | 2.6 | 37 |
| Total phosphorous | mg/L | 1.2 | 0.3 | 2.7 |
| Suspended solids | mg/L | 3 | <1 | 15 |
| Chemical oxygen demand | mg/L | 33 | <21 | 49 |
| Biological oxygen demand | mg/L | <5 | <5 | 9 |

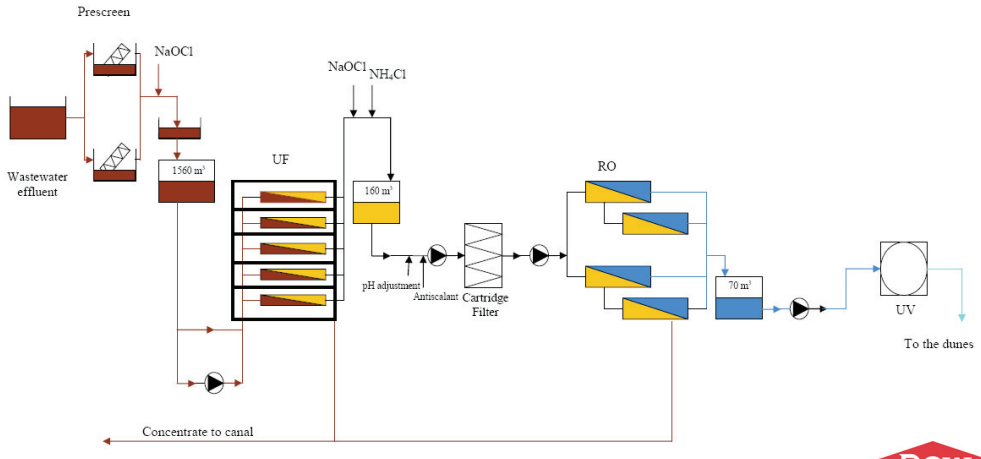
Data courtesy of Intermunicipal Water Company of the Veurne Region

Based on several pilot trials with different MF/UF and RO systems the final effluent treatment includes submerged ultrafiltration (UF), cartridge filtration, two stage reverse osmosis (RO) and ultraviolet irradiation (UV) as presented in Figure 1. The UV irradiation was discontinued in the mid 2004 due the constantly low bacteria counts in the RO permeate.

The process flow diagram (Figure 1) features:

- Municipal waste water effluent pre-screening
- NaOCl and $NH_4Cl$ pH and antiscalant adjustment
- Five UF pre-treatment trains
- Cartridge filter with 15µm pore size
- Two RO skids, with 36 vessels each. Of those, 30 are loaded with six BW30LE-440 elements each, two are loaded with six BW30LE-440i elements each (since 2005)
- The capacity of both skids can be enlarged by filling and using the remaining four pressure vessels
- Two-stage configuration 21:6 pressure vessels in the first pass and 11:6 pressure vessels in the second pass
- 15,744$m^2$ of active RO membrane area
- Design capacity: 2 x185 $m^3/h$

### Figure 1. Process scheme of the plant

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## Table 2. Recharge water quality

| Parameter | UF Filtrate | RO Filtrate | Infiltration Water |
|---|---|---|---|
| Conductivity (µS/cm) | 1,148 (481 – 1,474) | 23 (10 – 39) | 43 (16 - 94) |
| pH | 7.67 – 8.39 | 5.47 - 6.37 | 6.26 – 9.13 |
| Total Organic Carbon (mg/l) | 8.4 (4.3 – 11.8) | < 0.2 | < 0.2 |
| Total hardness (mg/l as $CaCO_3$) | 27.9 (13.3 – 37-6) | < 1 | < 1 |
| Total alkalinity (mg/l as $CaCO_3$) | 22.3 (9.0 – 31.2) | < 1 | 2.3 (1.3 – 4.7) |
| Chloride (mg/l) | 204 (74 – 286) | 2.9 (< 1 – 5.0) | 2.9 (1.5 – 4.6) |
| Total Nitrogen (mg N/l) | 8.0 (3.0 – 14.9) | < 2 | |
| Nitrate (mg $NO_3$/l) | | | 2.4 (< 1 – 6.3) |
| Ammonia (mg $NH_4$/l) | | | < 0.10 (< 0.05 – 0.23) |
| Total Phosphorous (mg P/l) | 0.7 (0.2 – 1.7) | < 0.1 | < 0.1 |
| Silica (mg $SiO_2$/l) | 19.0 (9.5 – 25.1) | 0.25 (< 0.1 – 0.4) | 0.23 (0.1 – 0.3) |
| Sodium (mg/l) | 144 (50 – 197) | 3.7 (1.4 – 6.4) | 10.3 (3.7 – 16.5) |
| Total Coliform (counts /100ml) | 0 | 0 | 0 |
| E. Coli (counts / 100 ml) | 0 | 0 | 0 |
| Heterotrophic plate count (22°C) | 8 (0 - 31) | < 1 (0 – 1) | < 1 (0 – 20) |

** Mean values are presented with minimum and maximum values provided in parentheses.*
*** Infiltration water consisted of RO filtrate to which sodium hydroxide was dosed.*
*Data courtesy of Intermunicipal Water Company of the Veurne Region*

## Summary

Torreele facility is a prime example of indirect potable water reuse in Europe. This treatment scheme can be leveraged to many regions, where it can help solve problems with inadequate water supply. In Torreele's case, the combined membrane treatment has proved to be a state-of-art technique continuously providing an excellent quality of infiltration water. The moderate design of the RO, good pretreatment and sufficiently performed cleanings have enabled stable operation and long membrane life time even with very high fouling potential feed water. The permeate production, salt passage and pressure drop (ΔP) are all within or exceeding the expected values.

## Literature

Van Houtte, E. and Verbauwhede J., *Torreele's water re-use facility enabled sustainable groundwater management in the Flemish dunes (Belgium)*, 6th IWA Specialist Conference on Wastewater Reclamation and Reuse for Sustainability, Antwerpen 2007.

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