

Lough Owel WTW, C. Westmeath, Ireland using membranes as a cryptosporidium barrier

Cryptosporidium and other chlorine resistant microorganisms are increasingly a problem for water utilities worldwide. Faced with increasing public awareness and more stringent drinking water legislation, Westmeath County Council was challenged with upgrading their water supply at Lough Owel to eliminate the risk of cryptosporidium contamination of the water supplied by the Lough Owel works to the town of Mullingar and surrounding areas. The technology applied was a 22 Mld ultrafiltration plant, the largest such plant to be installed in Ireland.



Membrane Plant in six containers

Existing treatment

Existing treatment consists of screening of the raw surface water followed by chlorination and fluoridisation and provides no protection against cryptosporidium.

WS Atkins were The Employers Representative for the project with *Jones Environmental (Ireland) Ltd* appointed as the main contractor under FIDIC Conditions of Contract for Design, Build and Turnkey Projects. *Norit MT* were subsequently selected as sub-contractors to supply the membrane plant.

Due to the urgent nature of the water supply problem it was decided to adopt a partnering approach to the design and build process to maximise the benefits of team working and innovation through the integration of the parties which included *WS Atkins*, *Jones Environmental*, *Norit MT*, *Bowen Construction* and Westmeath County Council.

Whilst a cost effective solution was required it was essential that

the plant should be reliable, easy to operate and provide flexibility for the future. A great deal of care was, therefore, taken over the design of the new works and in particular selection of the membrane plant.

Due to the presence of cryptosporidium in the lake water, the water treatment plant was procured on an emergency basis and a modular factory-built arrangement was selected to allow future relocation if required.

The modular factory-built package plant approach gave a number of advantages:

- * full flow capacity was provided by six containerised UF plants with each stand alone unit capable of delivering 3.7Mld.
- * each containerised unit was factory built and tested prior to shipment;
- * the construction phase activities on site were minimised;
- * the modular plant is portable and can be relocated in 3.7Mld units to other sites as required in the future.



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Design & Construction

A design and construction contract for the complete works including membrane equipment, mechanical and electrical and civil engineering works was awarded in October 2002 following a competitive tendering process under emergency procedures. Planning permission was obtained in parallel within the design development phase of the project. Construction and installation of the plant equipment was substantially complete in July 2003. Commissioning is scheduled to be completed in August 2003.

Total scheme value is approximately 7 million Euros

Membrane plant

A number of important factors were considered to ensure that the membrane system would meet expectations and give a trouble free performance within expected costs. They include the following:

- * **plant output** – is required to a maximum of 22 Ml/d;
- * **washwater recovery** – only small quantities of wastewater could be accepted;
- * **cryptosporidium** – removal of at least 4 log for cryptosporidium sized particles;
- * **membrane integrity** - the membrane acts as an absolute barrier to cryptosporidium oocysts and it is essential that its integrity is maintained. An automated system was required to detect failures in the membranes;
- * **automatic cleaning in place** – a system was required to minimise manual input required to run the plant. A system to ensure that all cleaning chemicals are effectively removed before the unit is returned to service was also regarded as necessary to ensure the protection of water entering public supply;
- * **membrane life**
- * **support services.**

Process design

The surface water from Lough Owel is generally of good quality with low colour but has an occasional history of bacteriological and turbidity spikes, some of which can be directly related to rainfall. This also suggests the potential for Cryptosporidium contamination at certain times of the year. On occasions the raw water also contains significant colour and algal counts.

The scope of the project included construction of the new membrane filtration plant at Lough Owel which was able to deal with 1) Cryptosporidium 2) colour removal and 3) Algae removal. In addition, a waste minimisation system was specified which includes neutralisation, lamella thickening and sludge consolidation prior to disposal off site.

After piloting of the process a technical and commercial appraisal contract was awarded in December 2002 to the Dutch company *Norit Membrane Technology*.

The design is based on six stand-alone containerised primary ultrafiltration units, with a maximum net flux of 100 $\text{lm}^{-2}\text{h}^{-1}$. Automatic backwashing, chemical cleaning and an on-line membrane integrity system were included. A secondary membrane system was also housed in a separate 40ft shipping container whilst neutralisation plant for chemically enhanced backwash (CEB) waste from both Primary and Secondary Membranes was housed within a further container. The concept of delivering the plant within containers was to minimise the project programme by minimising site based construction activities, but also to enable the plant to be relocated on a modular basis at a later date to other sites if required. Whilst the plant is housed within dedicated containers, these were located in a purpose built plant

building to improve the environment for the operators and to minimise visual impact on the local environment. Waste from the secondary membrane plant is further treated in a lamella separator and sludge consolidation tank. These items are housed outside the main plant building to allow access for removal of sludge from the site.

The design phase required close teamwork involving the client, project manager, main contractor, civil works sub-contractor, civil works designer and membrane sub-contractor. After award of the membrane sub-contract further pilot work was carried out to provide additional information to aid design and commissioning.

Treatment plant

The treatment plant at Lough Owel is housed in a purpose built plant room. New intake pipelines and a new inlet pumping station were constructed to deliver raw water from Lough Owel into the pre-treatment micro-strainers which are located in the new plant room.

The common micro-strainer system is configured in a 3 x 50% arrangement and filter the raw water down to 90 microns. A small amount of coagulant is then added before a common pumping system delivers the screened water to each of the six primary units. Each primary unit is fitted complete with membranes, backwash tank and chemical backwash cleaning system and associated switchgear and control. The ultrafiltered water then passes into the treated water tank prior to chlorination and fluoridation before being pumped to intermediate service reservoirs.

The plant is backwashed periodically with water and chemically backwashed on a daily basis. All of the waste passes first into a system designed to neutralise the waste before being treated by a secondary membrane filtration system. Permeate from the secondary stage is recycled whilst waste from the secondary unit is pumped to the sludge treatment system.

The membranes themselves are a hydrophilic polyethersulphone blend with a pore size of 150,000 Dalton. This is roughly equivalent to 0.05 micrometer, one hundred times smaller than the size of the Cryptosporidium oocyst. The membranes are formed in the shape of hollow fibres, with an internal diameter of 0.8 millimetres. Ten thousand membrane fibres are bundled in a membrane module which contains 35m² of membrane area.

Each module has a diameter of 200mm and a length of 1500mm, identical to a RO module. Four modules will be fitted in one pressure vessel 6 metres long. The pressure housings will be mounted on racks with each rack holding twelve pressure vessels in two stacks of six vessels.. These units were fabricated in Holland and shipped to Ireland. All storage tanks are banded and dosing lines are dual sleeved to minimise risk of any environmental damage.

Conclusion

At 22 Ml/d (5.5 mgd) the Lough Owel Ultrafiltration plant is, to date, the largest in Ireland and has been successfully completed ahead of time and to budget. Early results with regard to operating performance and water quality from the membranes are very encouraging and mirror what was recorded during earlier pilot trials. The pilot work proved its worth. Membrane integrity is essential in maintaining an effective barrier to Cryptosporidium.

■ **Note on the authors:** *Simon Acheson is with WS Atkins Consultants Limited; Barry Hennigan, Jones Environmental Ltd; David Parocki, Norit MT and Noel Fay, Westmeath County Council. They wish to thank Mr Murty Hanley, Director of Services, Westmeath County Council for permission to publish this article.*