Cog Moors Storm UV Disinfection

sustainability through new technology and seasonal consenting

by
Nick Barcock and Claire Scannell

There is a perception that UV disinfection systems consume large amounts of energy and are not 'green'. They are also considered difficult to maintain and operate. These perceptions are not necessarily applicable when using UV to disinfect storm discharges; here, UV treatment can offer an effective, low carbon alternative to large storage tanks. This article discusses the Storm UV Disinfection Plant installed at the Cog Moors WwTW, located near Barry in South Wales.

Cog Moors WwTW Storm UV Plant *Courtesy of Metoc plc*

Location

The Cog Moors Wastewater Treatment Works (WwTW) was constructed by Dwr Cymru Welsh Water (DCWW) in 1997 and was fully operational by 1998. The WwTW serves the catchments of Barry, Dinas Powys, Penarth, Cardiff West, and Sully, and provides secondary treatment, storm storage and a sludge treatment centre. The treatment process consists of an inlet works, screening / screenings handling plant, storm overflow (2050 l/s), 4 No. primary settlement tanks, 5 No. activated sludge lanes, 8 No. final settlement tanks and a final effluent pumping station. Treated and storm effluent are discharged to the Bristol Channel via a 4.2km sea outfall at Lavernock Point.

Cog Moors WwTW design flows (2016 horizon)	
Population Equivalent	240,000
Maximum flow to works	4,195 l/s
Dry Weather Flow DWF	1,003 l/s
Flow to Full Treatment(FFT)	2,167 l/s
Storm Storage	16,450m^3 (10 tanks)

Background to the scheme

The construction of Cog Moors WwTW, and improvements at other assets, delivered mandatory bathing water compliance at local EU designated beaches: Jackson Bay, Whitmore Bay and Cold Knap. However, Guideline quality was only achieved at Jackson Bay.

In 2002 DCWW, and their delivery partner Morgan Est, began detailed design works to achieve Guideline Standards at the Barry beaches. The design strategy considered all catchments impacting the bathing waters and was underpinned by integrated sewerage, river and coastal models, covering a length of over 40km of coastline. These models were used to assess impacts from DCWW assets and provide a basis for solution development. CSO improvements were prioritised based on impact:

- non-significant impactors were to meet local aesthetic standards;
- significant impactors were to meet a three spills standard;
- remaining impacts were grouped as Intermediate.

Intermediate design solutions, including Cog Moors, were combined in a holistic strategy to optimise spill frequency and volume to achieve bathing water compliance. The result was a risk based solution delivering greatest environmental benefit at least capital and carbon cost.

UV storm treatment

To effectively reduce the impact of Cog Moors, storm discharges would have required a minimum 25,000m^3 of additional storm storage, and a 15% increase in FFT (to 2,500 ls^{-1}). This was impracticable within the constraints of the site. Metoc evaluated a range of alternatives to storage against impact on the bathing waters. A UV storm treatment process, capable of delivering a 2 log reduction in bacteria, was deemed the most effective solution, and provided other benefits:

- small footprint;
- low carbon footprint (construction and operation);
- low construction cost;
- low operational cost;
- treatment of all storm flows;
- bacteria reduction close to secondary treatment;
- flexibility (treatment can be increased in response to catchment pressures).

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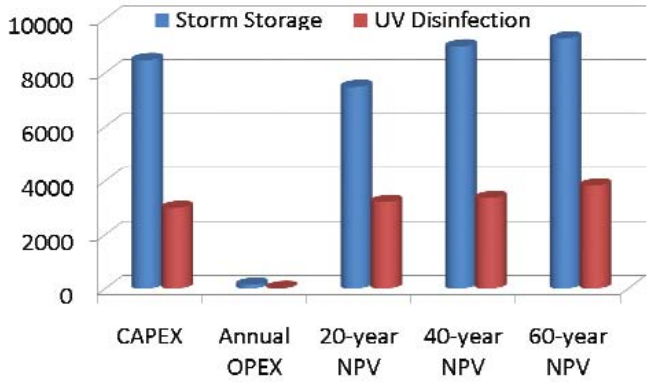
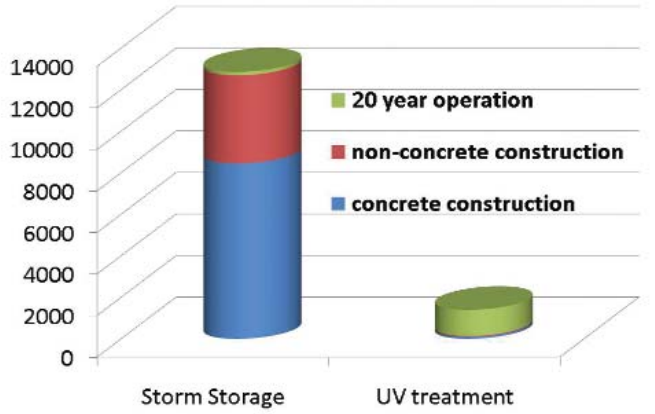


Cost comparison: storage 'v' UV *Courtesy of Metoc plc*



Total carbon emissions: storage 'v' UV *Courtesy of Metoc plc*

The benefits of UV storm treatment over storage, in terms of overall cost and carbon footprint can be seen in the comparisons above.

Pilot trials during summer 2008 demonstrated the effectiveness of the process and a discharge consent was granted by the Environment Agency. Design and construction were undertaken by Imtech Process and Morgan Est, and completed in readiness for the 2009 bathing season.

Specification and operation

The plant selected was a Trojan UV4000PLUS packaged UV storm water treatment plant. The plant comprises three parallel 1,190 l/s capacity channels, each enclosing 5 No. modules of No. 22 medium pressure lamps and an array of static mixers that prevent the formation of blind spots. The full installation provides a duty/duty/standby arrangement. The rate of flow through the duty channels is equalised and monitored by level sensors. UV dose is controlled by flow rate, transmissivity and intensity recorded in real time by in situ sensors. The minimum applied power rating is 30% of full rating. In the event of a control failure the UV lamps are operated at full power rating.

During storms, the existing storm tanks are operated as normal. As

Trojan UV4000PLUS unit in situ. Channel lies below deck, inlet penstock control at front of photo *Courtesy of Metoc plc*

Single bank of 22 lamps, fitted with hydraulic wipers and static mixers. Lamps can be easily lifted for maintenance *Courtesy of Metoc plc*

the storm tanks overflow the UV lamps are activated and the storm tank discharge (up to 2,380 l/s) is diverted to the UV plant. Utilising the existing storm tanks provides initial settlement of the storm effluent, increasing transmissivity, requiring less power consumption by the UV lamps.

Since commissioning, the UV plant has operated successfully. Routine monitoring of effluent quality has shown the plant meets, and frequently exceeds, the required log reduction in bacteria. In 2009, despite the wet summer, all three bathing beaches achieved excellent (Guideline) compliance for the first time. Under the revised Directive (2006/7/EC) Whitmore and Cold Knap achieved Good status, while Jackson achieved Sufficient.

However the story does not end here.

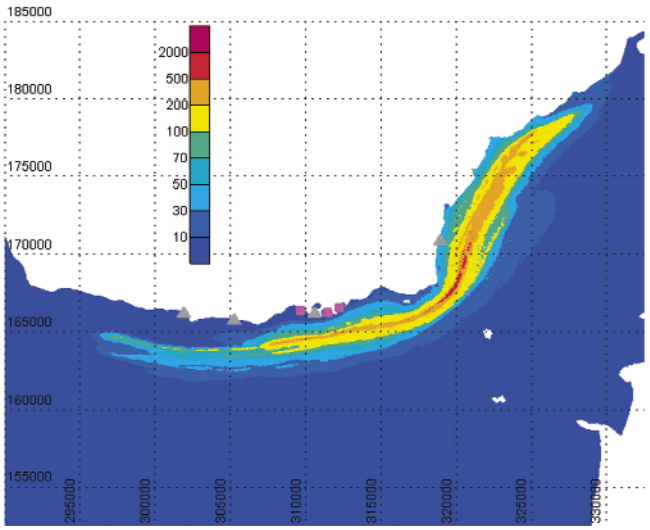
Seasonal consenting

The UV plant was constructed to meet the EU Bathing Waters Directive (76/160/EEC, 1976). The standards under the Directive only apply to the summer months, when large numbers of people use the bathing waters and are at risk from viruses and pathogens present in sewage discharges. If a case could be made for operating the storm UV plant only during these critical summer months, significant energy and emissions savings could be made. While there are a number of UK sites where conventional UV disinfection is seasonally varied, Cog Moors, being the UK's first storm UV plant, presented a unique set of conditions. Firstly, there was no established guidance for seasonal consenting of storm discharges; more significantly, the UV plant replaces storage that would operate all year round. Initial discussions on seasonal consenting were held with the Environment Agency during 2008 / 2009 and a set of guidelines agreed, based on normal seasonal UV requirements. During the winter of 2009 - 2010 a series of field and desk studies were undertaken to support the

UV plant Inlet. The shed, rear left, housed the original pilot plant *Courtesy of Metoc plc*

application for seasonal consent. The studies addressed three key areas of concern to the Agency and DCWW:

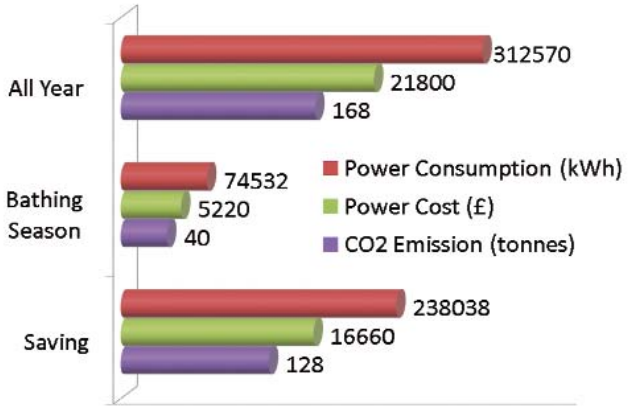
- **Plume Impact**
  The coastal model was used to define the impact envelope of the storm discharge and demonstrate that impacts on the coastline and beaches between Barry and Penarth are generally low. Due to the long sea outfall and high natural dispersion in the Bristol channel, impacts were within the standards set out in the current and revised Bathing Waters Directives.



Modelled storm plume envelope and beach use monitoring sites. (faecal strep / 100ml) *Courtesy of Metoc plc*

- **Beach use**
  Spot surveys were conducted throughout winter 2008 / 2009 to estimate the number of people involved in water based activities. Contact water activity was very low. Organised club activities (e.g. life saving) move indoors during winter months. Dinghy sailing, a charity Boxing Day swim and the occasional surfer or kayaker accounted for the majority of water use. Most activity (>60%) occurred over three days in March and April, as spring brought improved weather during the Easter holidays.

- **Carbon emissions**
  While not a specific criterion for determining consent, carbon savings were the key driver for seeking seasonal consent. UK water companies are now obliged to make energy savings under the CRC Energy Efficiency Scheme. Seasonal consenting reduces UV plant power consumption by 75%, saving 128 tonnes of CO_2 emissions per year. When seasonal UV treatment is compared to the original storage option, the total emissions (construction and operation) are cut by 11,500 tonnes CO_2 over a 20 year period, a 90% reduction.



Annual carbon, energy and CO_2 estimates for all year and seasonal disinfection (2007 storm data, minimum UV power 30%, energy cost £0.07/kWh) *Courtesy of Metoc plc*

Metoc prepared the case for seasonal consent during summer 2009. This was submitted to the Environment Agency in November 2009, and the seasonal consent granted in December 2009. The UV plant is now operated from four days before Good Friday until the end of September, to cover the bathing season and extended into the busy Easter period.

Conclusion

UV treatment of storm effluent is now a viable alternative to large storage volumes, and offers:

- significant reductions in storm storage volume;
- greater improvements in coastal microbiological water quality;
- significant capital cost reductions;
- significant reductions in total carbon emissions.

Where appropriate, seasonal consent provides further reductions in energy consumption and CO_2 emissions. Since the construction of Cog Moors, DCWW has commissioned two further storm UV plants. These provide equivalent levels of water quality compliance to over 40,000m^3 of storm storage, while reducing CO_2 emissions by at least 20,000 tonnes over the next 20 years.

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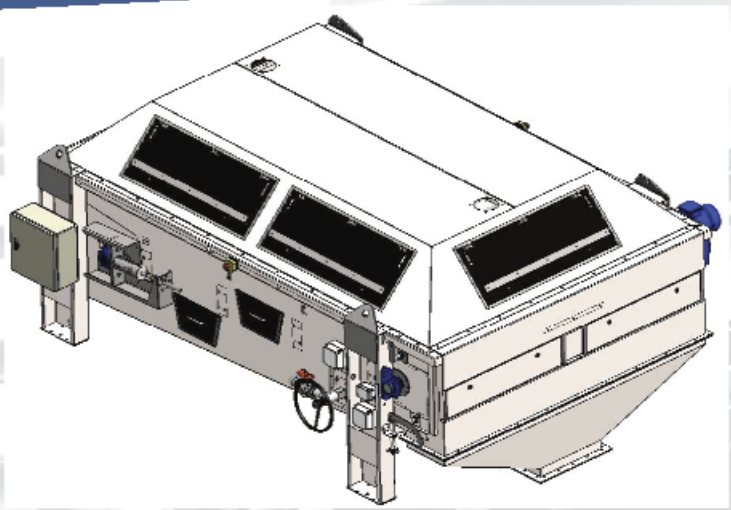

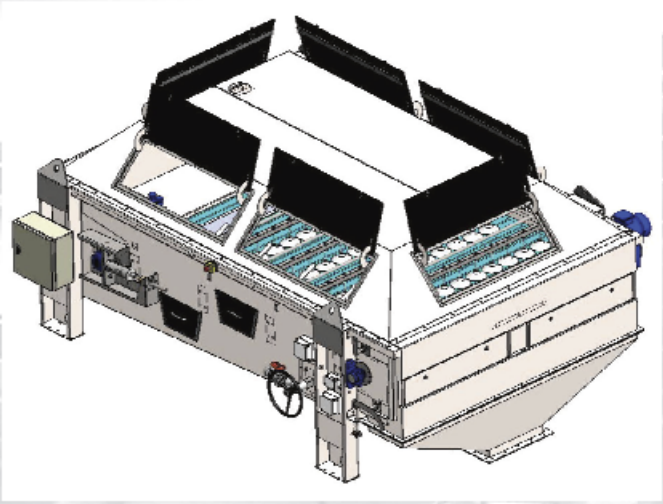

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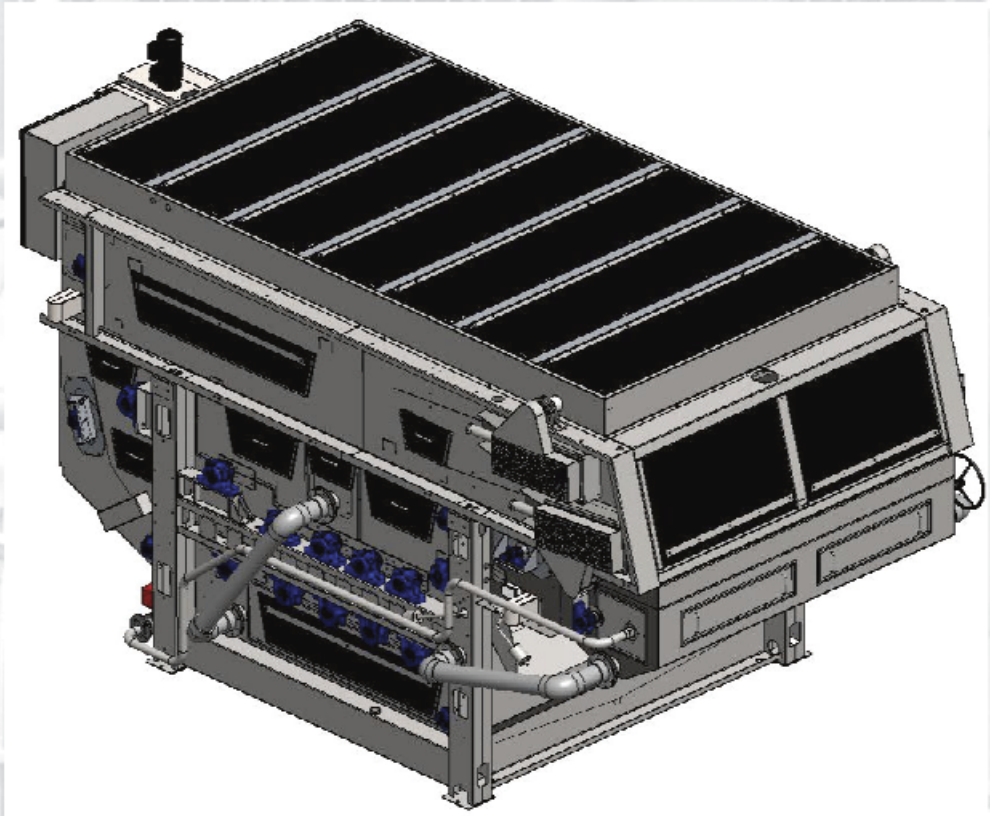

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