



Reed Bed Treatment Solutions and Forced Bed Aeration

Reed Beds

General Introduction

Reed beds have been used informally for water treatment for thousands of years. The formalisation of this knowledge into an applicable technology in the 1960s has resulted in the rapid expansion of their use globally and their acceptance as a front line method of water treatment in both the municipal and industrial sectors.

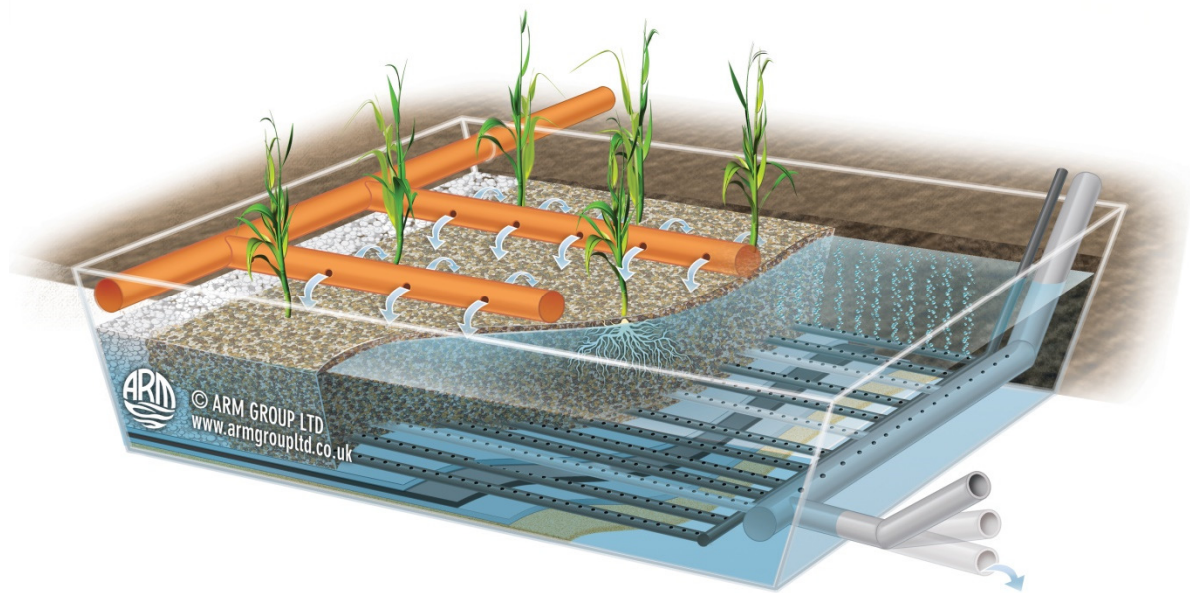
Initial systems were based very much on horizontal, saturated (flooded) flow across the reed bed, and these were very much reliant on the diffusion of air from the atmosphere into the bed to 'fuel' oxygen driven microbial degradation. These systems were, and still are, used for low level effluent 'polishing' treatment

Over the past 20 years the increased demand for more sustainable, low carbon footprint water treatment solutions has led to a sharp rise in the use of constructed Wetlands with a parallel increase in understanding how these systems function and can be optimised to provide much higher levels of treatment. Subsequent and ongoing client driven innovation has led to a range of different wetland system types and designs which can provide high levels of treatment across a broad range of effluents from the municipal and industrial sectors.

We now see wetland systems capable of treating raw sewage right through to discharge and including full sludge management. There are 3000 of these systems used in France alone. We see specialised sludge treatment reed bed systems which trap solids on their surface and compost them while liquors pass down through the bed for treatment by the microbial biomass which grows naturally in the beds.

More recently, within the past 10 years we have seen the development, and rapid uptake, of gently aerated reed bed systems which offer significantly more treatment capability along with much more consistent performance. This results in reduced size requirements which in turn, lowers capital costs and makes the technology viable for smaller sites.

Here is an example of an **aerated, vertical flow** reed bed.



As highlighted above the aeration effectively fuels the aerobic microbial degradation improving treatment capacity by up to 15 times per unit area compared to passively operated systems.

As opposed to horizontal flow systems, which receive flows and loads along one narrow edge, the **vertical flow** system distributes the effluent across the whole surface area of the reed bed resulting in a much lower hydraulic and contaminant load per square metre. This results in a reduced clogging rate, longer life and a broader and more efficient development of the biomass across the whole of the reed bed.

Solids are trapped on the surface of and within the bed medium (usually specified gravel) which acts as a filter and because solids comprise approximately 50% organic matter they are substantially degraded by microbial activity. The remaining inorganic/mineral matter is either filtered out in the bed as effluent moves down through it or settles to the bottom of the bed.

The effluent passes down through the bed washing over the microbial biomass which grows on the media and effectively degrades the BOD and ammonia. This process is fuelled by the oxygen carried in the air moving counter currently upward from the bottom of the bed.

A network of effluent collection pipes in the bottom of the bed collects the treated effluent and transports it to the next stage of treatment or to a local water course.

Why Use Them

Reed Bed Treatment systems...

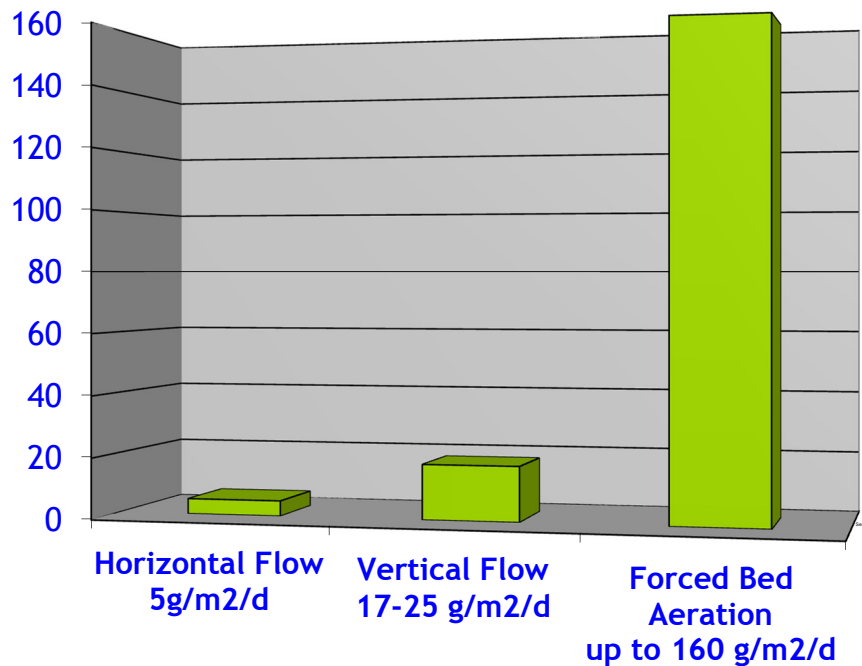
- Protect Environment
- Create Environment
- Provide a Sustainable alternative
- Have No moving parts
- Are Low Maintenance
- Require Low or no power
- Have Low lifetime costs
- Are Robust
- Provide Amenity

Their simplicity, with few or no moving parts make them a reliable, robust treatment solution with low maintenance and power requirements resulting in low lifetime costs compared to the mechanical treatment alternatives.

Performance

The chart below provides a comparison of oxygen transfer rates seen in passive wetlands and aerated systems using Forced Bed Aerated system (FBA) such as that proposed for Henlow.

Typical Oxygen Transfer Rates For Different Reed Bed Systems



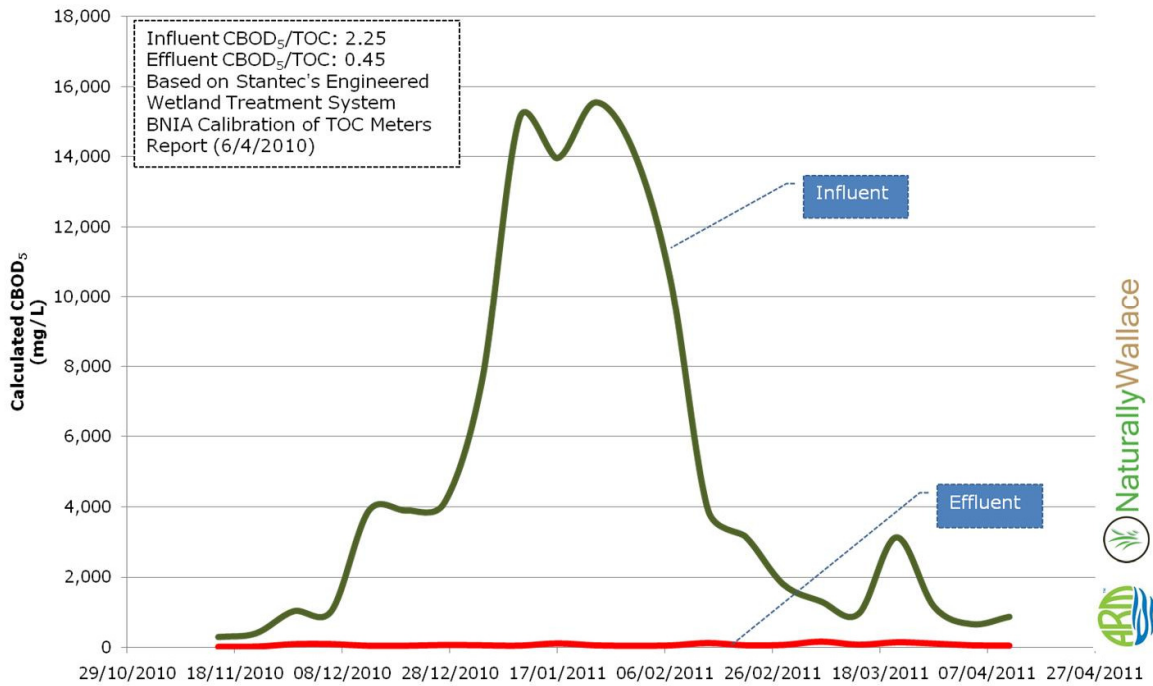
The use of lightly blown air also adds an element of flexibility in that we can potentially turn the air off and on as required e.g. in the case of Henlow we could turn the air off at night (by timer) when flows and loads are minimal. This can also be useful in the event of seasonal and other variations in load which may arise.

Below is some performance information from sites using FBA. We have also attached case studies for three of them, **Buffalo Airport**, **Uffington** and **Cowdenbeath**.

Buffalo Airport Washington State (USA)

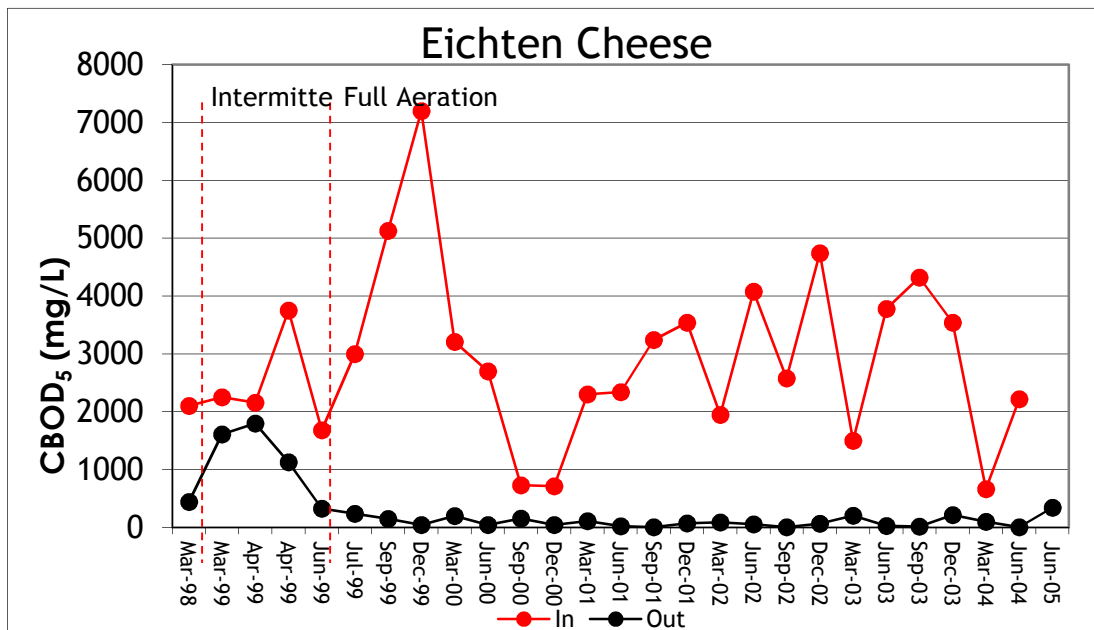
Buffalo Airport is in Washington State and generates significant loads of run off contaminated with anti-freeze. This had been a difficult issue to resolve in wintertime as large volumes of run off and snow melt required treating prior to discharge from site. As can be seen in the graph below the glycol based antifreeze reaches very high loading levels of up to 15,000 mg/l CBOD₅ which are managed very effectively by the wetland system.

Buffalo Airport Deicing Fluid Treatment 2010-2011 Engineered Wetland with Patented Forced Bed Aeration™



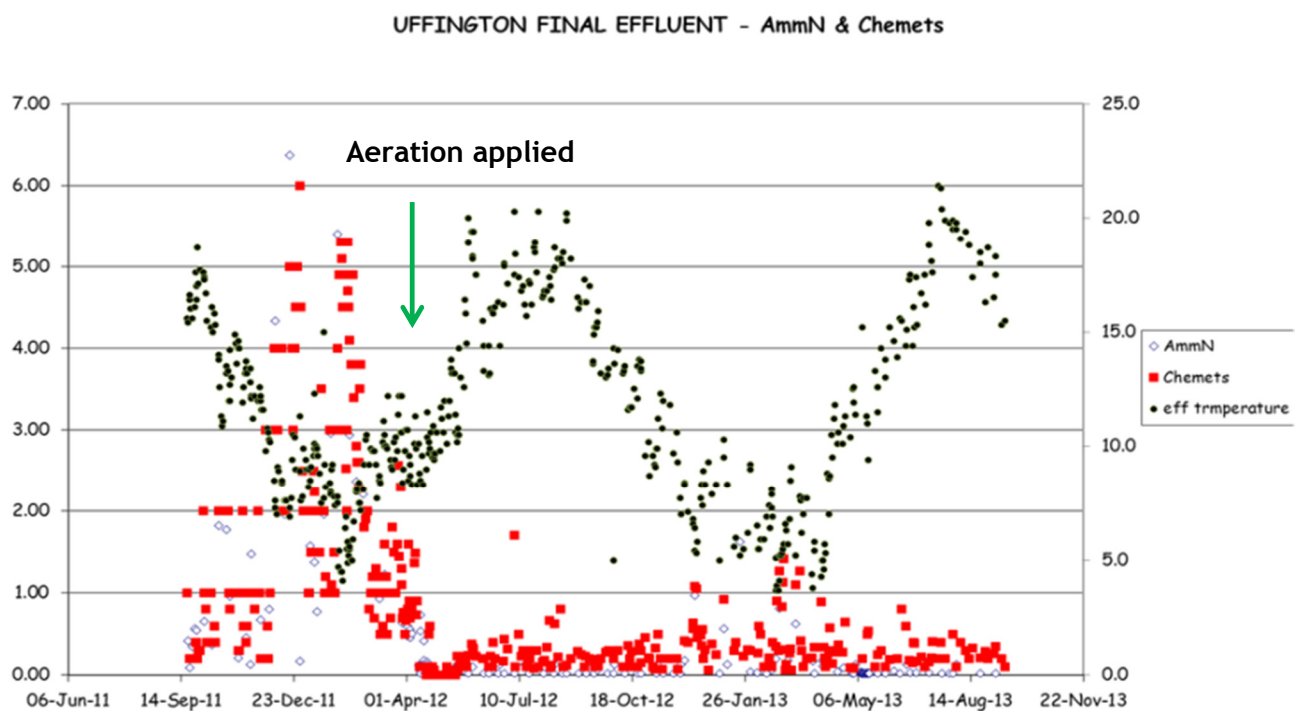
Eichten (Cheese factory USA)

Eichten Cheese Factory generates very highly loaded effluents, between 3,000-7,000 CBOD₅ mg/l which is controlled very effectively with an aerated reed bed.



Uffington WwTW (Thames Water)

Uffington Waste Water Treatment Works serves a population of 700-800 and receives an average flow of 174 m³/d. It had been operating within a 5mg/l ammonia consent which was lowered to a 3 mg/l. Two aerated vertical beds with a total area of 550m² were constructed for the provision of tertiary treatment on site. The chart below indicates the impact aeration had on the treatment capacity and consistency especially with reference to lower temperatures seen in winter.



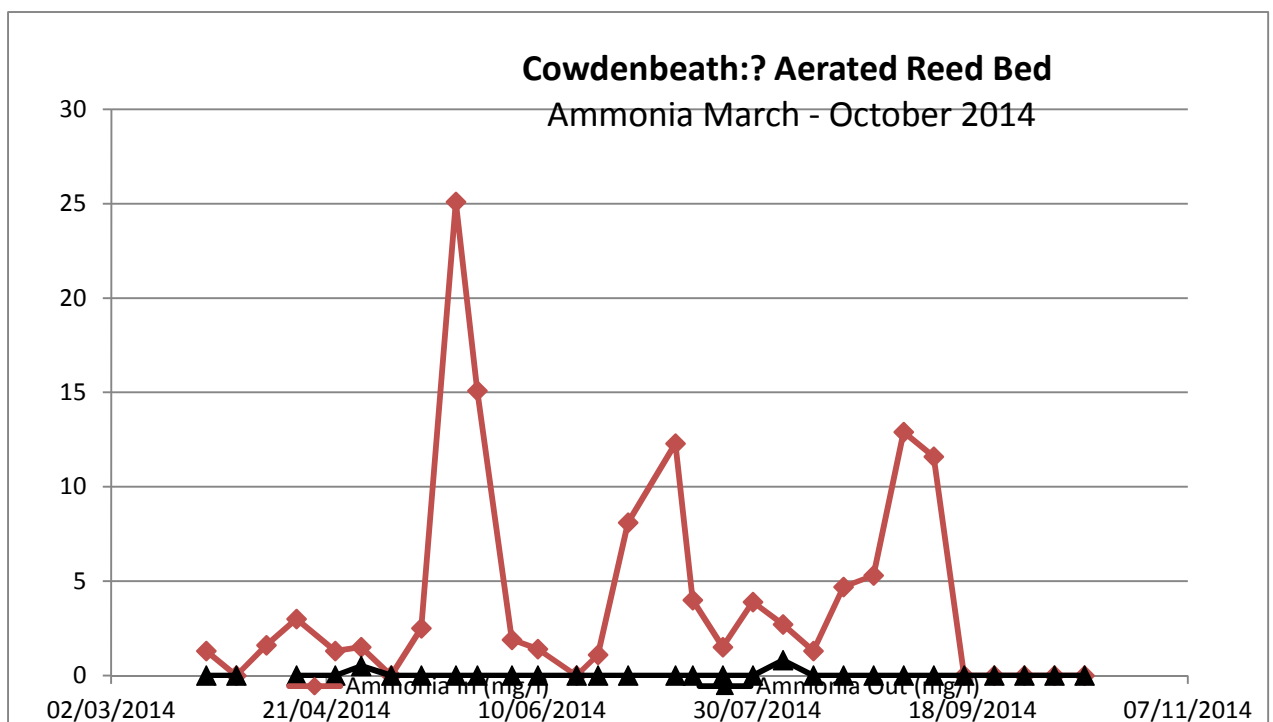
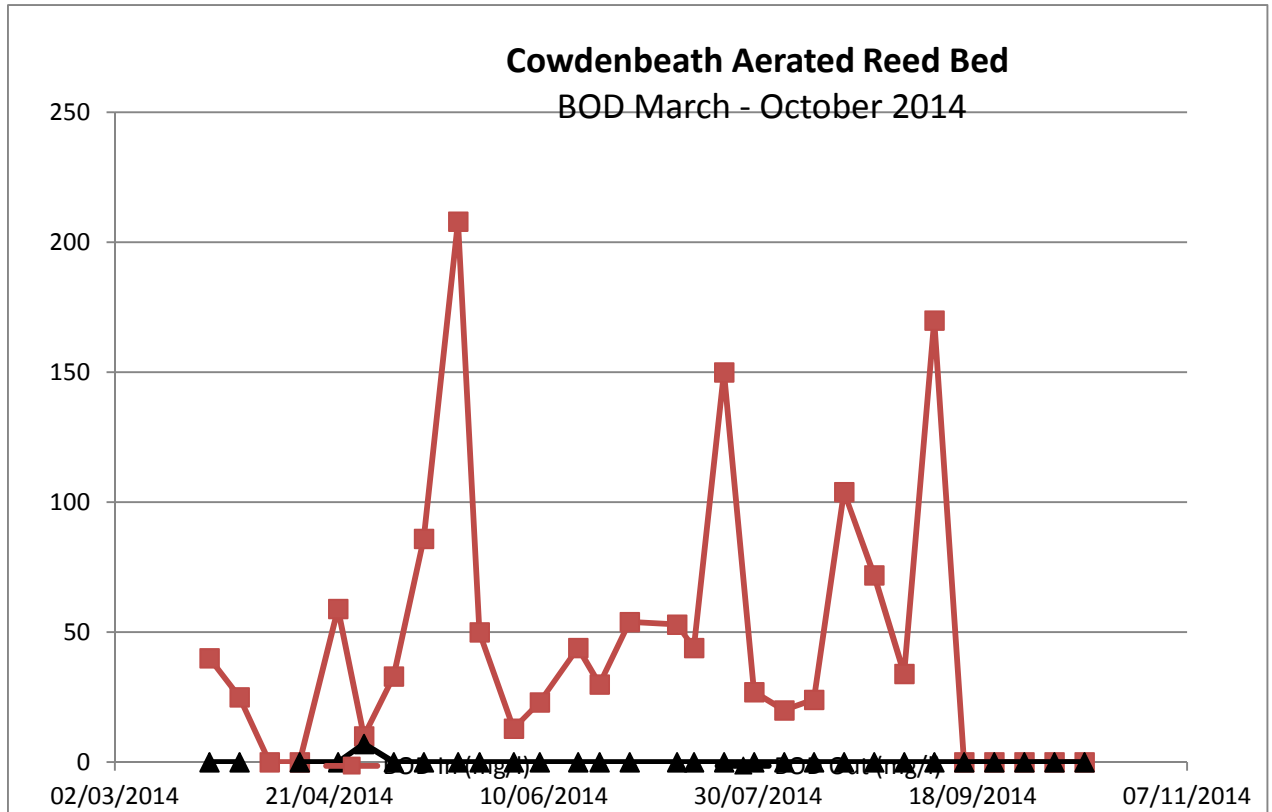
Cowdenbeath (Scottish Water)

Cowdenbeath had two new Combined Sewer Overflows constructed in the town and required a means of treating the variable flows of up to 4,000 m³ per day. A two metre deep, 4000m² aerated saturated vertical flow reed bed system designed to handle intermittent storm flows provided the solution.

The reed bed has to cope with storm flows as and when they occur so had to be flexible in operation. The aeration system was designed to maintain a 'ready' state in periods of no flow by controlled intermittent aeration but also to respond quickly with full aeration when a storm event occurred.

The graphed data below indicates the variable and intermittent nature of the flows and how well the system handled these loads.

The raw data used to generate these graphs is attached in a separate document and comes from an **independent consultant** who was tasked with monitoring the reed bed to prove the system prior to full handover.



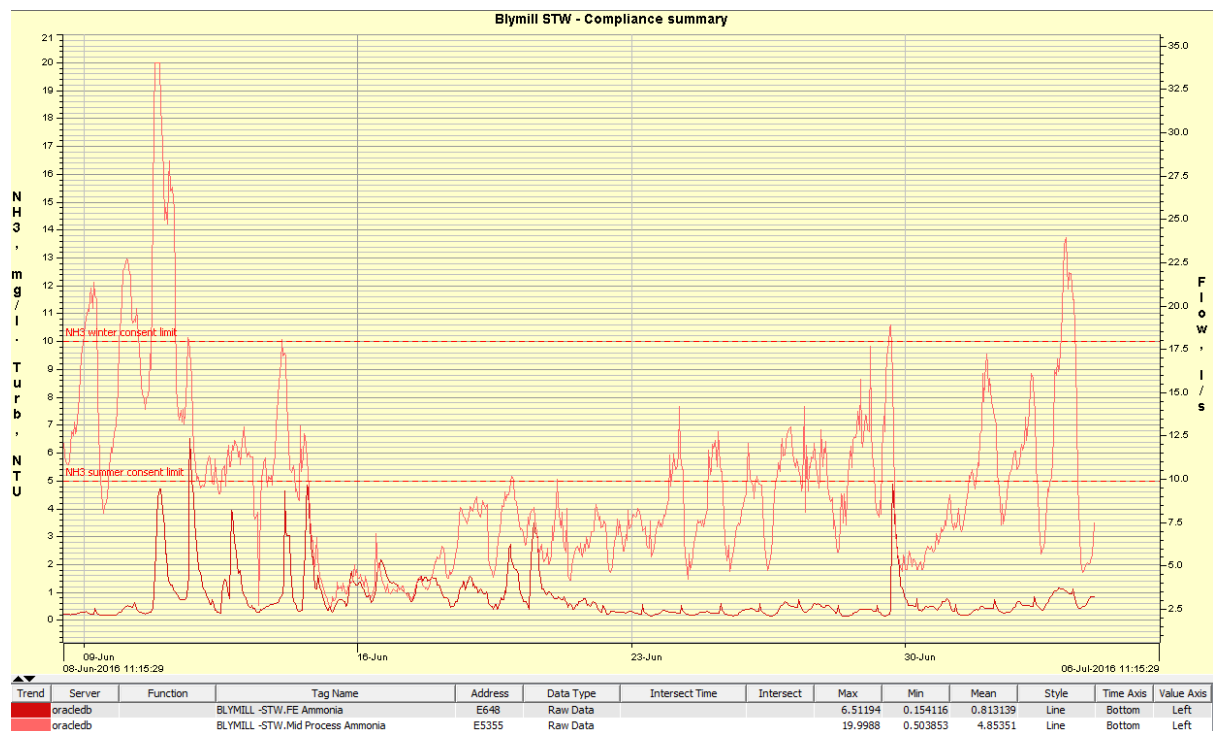
BlymHill (Severn Trent Water)

Blymhill based in Severn Trent Water (STW) operated with Rotating Biological Contactors (RBCs) followed by passive reed beds treating a flow from a population of 844. In 2015 new consents for the site were issued to include an ammonia discharge limit. The options for the site were to install new, nitrifying (ammonia reducing) RBCs or to add aeration to the existing reed beds. The latter option was chosen and the refurbishment to aeration took place in September 2015. The target discharge was set at 15 mg/l BOD, 25 mg/l suspended solids and 5mg/l ammonia. Three beds with a total area of 650m² receiving a variable flow rate with an average of 223m³/d were converted to FBA.

We understand that MWH has access to results data that ARM does not and suggest that they reference this as an **independent** source of information regarding the performance of these reed beds. We do note the comments of the STW Project Manager Fiona Sutton;

‘As you can see from the data below the combined (tertiary and storm flows) aerated reedbeds work really well, they were achieving almost complete ammonia removal within 9 days of flows and aeration being turned on!’

Some summary site readings on ammonia reduction are given below.



Iden Green (Southern Water)

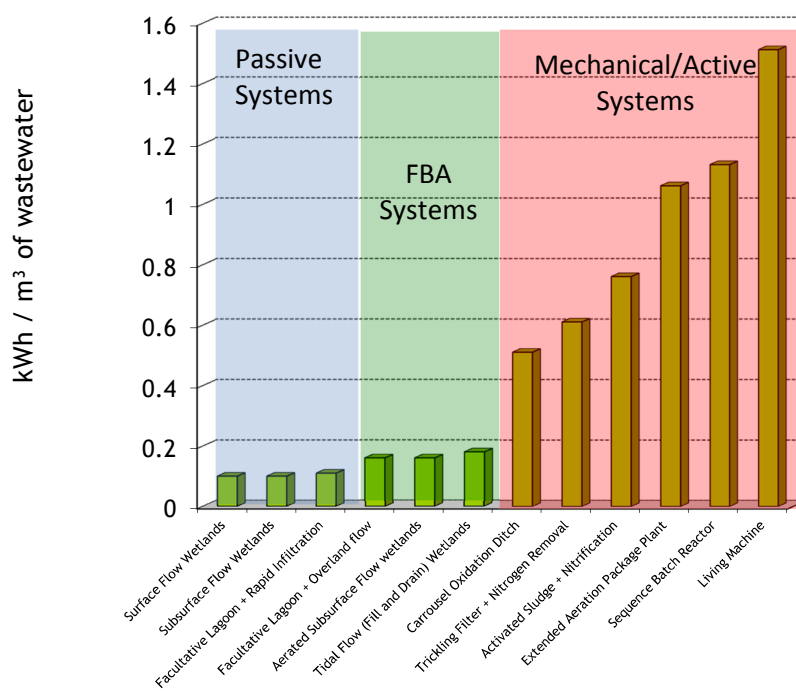
Iden Green was a design and build project for Southern Water which ARM undertook in February 2013. Two aerated beds were installed totalling 175m². The beds receive the the full flow to treatment of 80m³/d and the treatment consent is set at 10 mg/l BOD, 20mg/l suspended solids and 5 mg/l ammonia.

Again, ARM understand that MWH has access to results data that ARM does not and suggest that they reference this as an **independent** source of information regarding the performance of these reed beds. We do note the comments of the Southern Water Senior Process Engineer Susana Jarvis who commissioned the site;

'I was involved in the commissioning of the upgraded plant at Iden Green WTW in April 2013 (new septic tanks, refurbishment of TF arms, new conical tanks and new aerated reed bed). Everything went straight forward with the construction and commissioning of the beds- site achieved ammonia well below 5.0mg/l.'

Power Consumption

Forced Bed Aeration requires the use of a small blower system with a nominal rating of a few kW, the actual rating would be confirmed in detailed design. The power requirement for these systems is a small proportion of that required per unit of effluent treated in more mechanical systems such as SAFs or Oxidation Ditches. The chart below provides an indication of power usage comparison for different water treatment methods.



Effectively Forced Bed Aeration power consumption though slightly larger than that of passive wetland systems is a small proportion of that for standard mechanical treatment methods but provides a significant increase in performance from standard reed beds in terms of higher load capabilities and more consistent performance.