

# Water Company

natural waste water treatment

# ARM Group Ltd

## natural wastewater treatment



Whether you're thinking about a new reed bed system, or you just want some timely expert advice about effective operation, we can help.



### Harnessing natural technology

**E**ver since natural waste water treatment systems came of age in the 1980s, ARM Ltd has led the way in reed bed and constructed wetland technology.

Working with the UK water companies, councils, contractors, industrial clients and research institutes, we have designed, built and maintained many hundreds of reed bed systems. These range in size from 10m<sup>2</sup> up to 20,000m<sup>2</sup>, and we have consulted on reed beds of many hundreds of hectares.

Harnessing natural processes, we engineer them to deliver all the advantages of cost-effective, versatile and sustainable wastewater treatment – and we guarantee the performance of every system we design and install.

As the largest dedicated UK company by far in this specialised field, with a reputation dating back to 1947, ARM brings you unique expertise and experience. We can support you at every stage of the process – from initial planning and design through construction and commissioning to ongoing maintenance – ensuring the optimum performance of your reed bed system.

We continue to pioneer new and innovative ideas. Recent developments include an aggregate recycling system to reduce landfill costs and material usage, and a plough to retrofit FBA™ airlines into existing reed beds.

### Why use reed beds?

**T**he Chinese used wetlands more than two thousand years ago for their impressive effluent and water treatment capabilities.

Reed beds provide an ideal environment for a wide range of treatment processes. The combination of micro-organisms, plant roots, rhizomes and substrate matrix remove contaminants in a variety of natural ways.

They treat waste water as it flows through the system just like the process in conventional sewage treatment, but without using energy-intensive machinery.

With low maintenance requirements,

low or zero power consumption and a long, productive lifespan, reed bed systems are both proven and sustainable, enhancing any landscape. Their removal mechanisms include settlement, filtration, biological and chemical action, containment and plant uptake. They can reduce levels of soluble organic matter, suspended solids, ammonia, pathogens, hydrocarbons, and metals.

The various types of reed bed can be used in different configurations to treat a variety of pollutants from industrial or municipal sources.

natural wastewater treatment



## Performance guaranteed

**O**ur reed beds are used at all stages of the sewage treatment process providing primary, secondary and tertiary treatment as well as sludge dewatering.

They can also extend the life of older treatment works by providing a tertiary polish to effluent, bringing it within regulator consent, and saving capital expenditure.

They are increasingly used for tackling industrial effluent. Uses range from treating fire-fighting foam and metal removal from minewater drainage, to reducing ammonia levels in leachate and removing hydrocarbons from groundwater.

Other applications include treatments connected with:

- agriculture
- pharmaceutical
- food processing
- chemicals
- refinery waste
- distillery wastewater
- airport run off
- Sustainable Urban Drainage Systems (SUDS)

They can also be used to create wetland habitats – enhancing bio-diversity.

*Whatever the application, we provide contractual guarantees of effectiveness, performance and quality – so you can be sure you're going to get the results you're looking for.*



## Our comprehensive range of services includes:

**Consultancy:** feasibility studies, process design, site surveys, landscape design, and advice on managing future changes

**Project management:** our experienced managers will look after your entire project from conception through to completion.

**Design and build:** our turnkey service delivers systems on time and within budget, including liaising with regulators and enforcement authorities on your behalf.

**Design and supply of materials and equipment:** a service we provide on request, for example to framework contractors.

**Construction service:** using our design or your own, we make it easy for contractors and save our clients significant amounts of money through design reviews based on experience – without compromising quality or performance.

**Field services for system maintenance:** we extend the life of your system, bring you peace of mind and help you get the best possible results.

**Asset assessment:** we evaluate process efficiency, check your system is operating at top performance, and make recommendations.

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# ARM Group Ltd

## About Us



ARM Group Ltd, a Staffordshire based privately owned company, is the leading designer and constructor of natural waste water treatment systems and associated technologies for the industrial and municipal waste water treatment market in the UK. The Company is noted for its invention and subsequent commercial development of equipment and processes within its chosen markets.

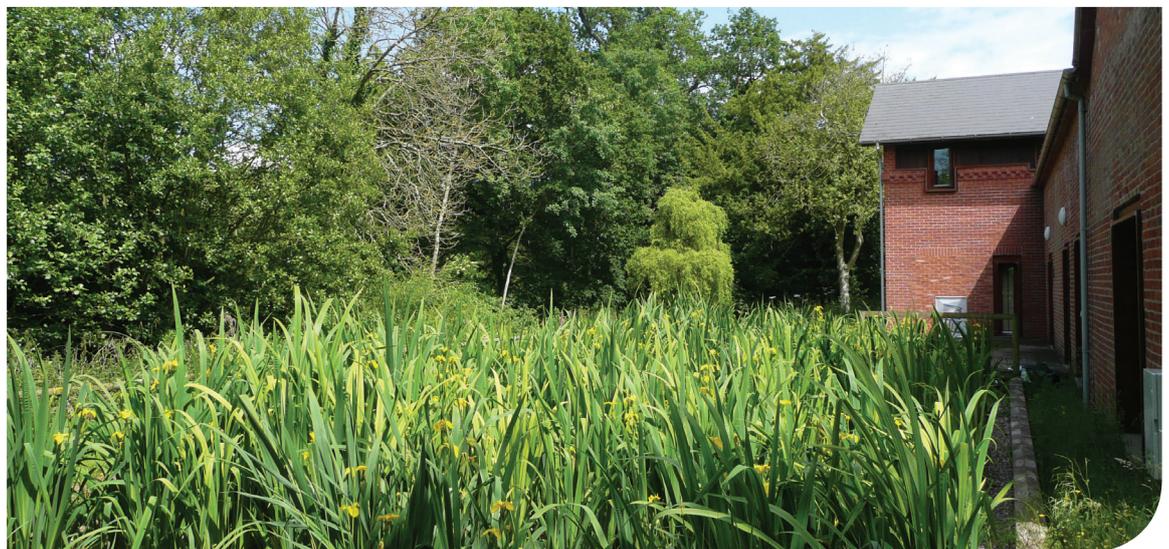
ARM Group Ltd has been trading since 1947 and was originally involved in development, design, manufacture, and construction within Agricultural Engineering. However, in the late 1980s ARM Group Ltd redefined its objectives and moved its customer and product bases into the global market of wastewater treatment specialising in the use of reed bed/wetland systems.

Today the Company operates out of offices in Rugeley, Staffordshire employing 21 people and using Associates and sub-contractors as required.



ARM Group Ltd is broadly divided into seven operating functions these can provide client support either individually, as a team, incorporating the requisite elements, or as a whole providing continuity of support for turnkey solutions from project conception through design construction, commissioning and maintenance, depending on the specific needs of the client. The functions are:

- Sales
- Design
- Project management
- Construction
- Research and Development
- Refurbishment and Maintenance
- Administration





## Experience

For the past 30 years ARM Group Ltd have specialised in reed bed and wetland systems having designed and installed over 700 beds during this period. This provides us with unique and extensive experience of their application, design and construction across the wastewater treatment spectrum. Our experience and knowledge has been accumulated through:

- Design and construction of reed bed systems
- Value engineering optimisation
- Application experience
- Working with academic institutions.
- The international constructed wetlands conference circuit
- Presenting papers
- Personal contact with leading researchers
- Working relationships with leading specialist in specific reed bed applications
- Founder member of the Constructed Wetland Association (CWA)
- Founder member of Global Wetland Technology (GWT)
- Over 1000 reed bed surveys

We have designed and constructed reed beds that provide treatment for:

- Mine water
- BOD and COD reduction
- Methanol removal
- Copper removal
- Pathogens
- Landfill leachate
- Hydrocarbons
- Septic tank waste
- Ammonia
- Surface water run off
- Solids
- Sludge dewatering
- Storm water
- Metals
- Glycol



# Birdlip

## Aerated saturated vertical flow: Municipal tertiary treatment



### Project

Birdlip, Severn Trent

### Location

Birdlip, Gloucestershire

### Project type

New build

### Wastewater type

Municipal, Tertiary

### Completion date

July 2012

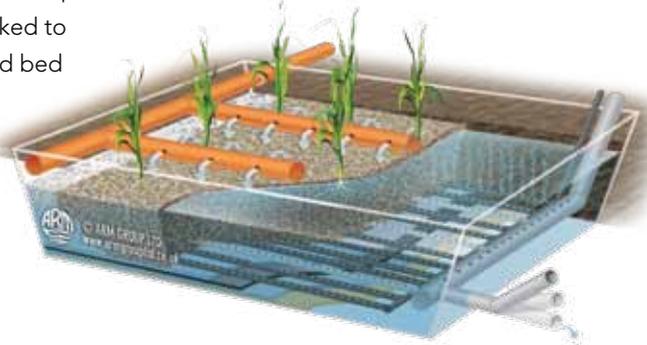
### Treatment

Aerated Saturated  
Vertical Flow

### Need

The Birdlip WwTW is operated by Severn Trent Water and serves a population of 394. Originally the works comprised a Primary Settlement Tank (PST), a Trickling Filter (TF) and a Humus Tank (HT) which discharged into a soakaway on site. The site supported a descriptive discharge consent. However, as loads increased the discharge consent became specified at 40 mg/l BOD, 60 mg/l suspended solids and 5 mg/l ammonia. Severn Trent Water reviewed options and decided to undertake a complete site refurbishment and install Rotating Biological Contactors followed by two reed beds.

The system was to be based on a predicted load of 454PE. The expected hydraulic load was 94 m<sup>3</sup>/d average with peak flows of 4.6 l/sec. ARM Ltd was asked to design and install the reed bed treatment element of the new works. Space was limited on site and the existing works would have to continue operating whilst the new works was constructed.



natural wastewater treatment



## Birdlip



### Solution

The jump from descriptive to a 40 mg/l and 5mg/l ammonia consent was significant and to ensure compliance ARM installed two aerated saturated vertical flow reed beds, using Forced Bed Aeration™. To accommodate the limited space on site the beds were of two different sizes and operated in parallel, one receiving one third of the site flow the other two thirds.

### Benefits

The use of Forced Bed Aeration™ in both beds allowed the application of reed bed technology on a small site which provided Severn Trent Water with a low maintenance, low carbon footprint solution which could provide effective nitrification to ensure compliance. Reed Bed technology is an appropriate solution at Birdlip as it suits the rural location allowing the works to blend into the local environment.



# Cowdenbeath

## Aerated saturated vertical flow: Combined sewer overflow



### Project

Cowdenbeath,  
Scottish Water

### Location

Cowdenbeath, Fife

### Project type

New build

### Wastewater type

Combined sewer overflow

### Completion date

March 2014

### Treatment

Aerated vertical flow

### Need

A major Scottish Water infrastructure development was undertaken in Cowdenbeath including the construction of two new Combined Sewer Overflows (CSOs) which collected additional surface water from within the town. Historically, waste water from Cowdenbeath had been treated at a Waste Water Treatment Works (WWTW) on the south-east edge of the town discharging into the Lochgelly Burn. As the town expanded this WWTW became undersized and was converted to a pumping station passing flows forward to a larger works at Glenrothes. A holding tank of 1200m<sup>3</sup> was retained for this purpose. The increased flows generated by the new CSOs, totalling 229,700 m<sup>3</sup>/annum, could not be managed by the pumping station or holding tank so a new treatment facility was required at the site to attenuate and treat the intermittent CSO flows prior to discharge into the Lochgelly Burn.

Scottish Water did not want to re-establish a full WWTW on the site and were therefore looking

	Flows	BOD	Total NH4	Unionised NH4
Loads	3000 m <sup>3</sup> /day	16,429 Kg/yr	625 Kg/yr	-
Consents	-	9.0 mg/l	1.5 mg N/l	0.04 mg N/l

for a low maintenance treatment solution which could handle intermittent flows and discharge, within consent, into the Lochgelly Burn. Modelled CSO flow and load data was provided for a nine year period and provided a basis from which to generate design parameters. These are summarised above.



## Cowdenbeath



### Solution

The proposed site for the treatment solution was to the east of the pumping station on an old landfill site which covered mine workings. This meant that significant project costs would be linked to ground remediation thus minimising the size of the treatment solution would be critical. Consequently an aerated vertical flow reed bed was the selected solution as this provides a high treatment capacity per unit area thus minimising the total land take. This was enhanced by making the bed much deeper than standard systems reducing the required treatment area further.

The data set was converted into cumulative summaries which determined that achieving complete treatment would not be cost effective as taking into account the highest flow outliers would greatly increase the size of the treatment area. The optimum treatment capability was concluded to be 79% of the annual BOD load, providing 95% overall compliance, and 100% of the ammonia load. The design solution was a two metre deep bed with a 4,000 m<sup>2</sup> process area which could treat 4000 m<sup>3</sup>/d.

Flows are fed forward to the bed at a maximum rate of 46 l/s from a 3000 m<sup>3</sup> holding tank. On the occasions where flow rates exceed the storage capacity flows will spill to the Lochgelly burn on the basis that they these will be rare events and the CSO will be significantly diluted.

### Benefits

The aerated reed bed system has provided Scottish Water with an effective low maintenance treatment solution at Cowdenbeath avoiding the need to construct a new WWTW to handle the significantly increased flow of waste water generated by the new CSOs in Cowdenbeath. Compared to the alternatives the system has a lower TOTEX and aesthetically and ecologically enhances the landfill site.

# Anglian Water, Earls Colne

## Vertical flow reed beds, tertiary sewage



### Project

Earls Colne, Anglian Water

### Location

Clochester, Essex

### Project type

Design and construct

### Wastewater type

Tertiary sewage

### Completion date

October 2004

### Treatment

Two vertical flow beds

### Need

Anglian water required a tertiary treatment solution for their site at Earls Colne in Essex. The discharge consents for the site were to be tightened by the Environment Agency. The site had no power available and the cost of introducing a power based tertiary treatment solution was prohibitive. The required improvements in the new discharge consent were focused on the solids and ammonia levels though some reduction in the BOD levels was also needed. The average flow through the works is 1,168 m<sup>3</sup>/d.

	INITIAL LIMITS (MG/L)	NEW DISCHARGE CONSENTS (MG/L)
BOD	30	20
Suspended Solids	60	40
Ammonia	15	10

### Solution

The addition of ammonia to the discharge consent specifies a system which will provide adequate oxygen transfer to achieve nitrification of the ammonia to nitrate thus a vertical flow reed bed system was selected. The requirement for tight control of solids meant that two separate beds operated alternately would be the best technical solution, as it would allow each bed to 'rest' during which time organic solids will break down preventing clogging of the surface.





The use of vertical beds requires batch feed so a siphon was installed to negate the need for batch pumping and power connection. Two beds of 20 m x 40 m were constructed totalling 1,600 m<sup>2</sup>. A stilling chamber

between the siphon and the beds was also installed to allow for some solids settling reducing the solids load passing forward onto the beds.

## Benefits

The use of passive vertical flow reed beds as a solution for the tertiary treatment of site effluent provided Anglian Water with a low maintenance gravity operated treatment system with no power requirement at Earls Colne. The addition of the tertiary reed bed treatment system avoided the significant capital costs that would have been associated with an upgrade of the secondary treatment process in order for the site to meet the tighter discharge consents set by the Environment Agency.

# Gaydon

## Aerated horizontal flow: Municipal tertiary treatment



### Project

Gaydon, Severn Trent

### Location

Gaydon, Warwickshire

### Project type

Refurbishment

### Wastewater type

Municipal, Tertiary

### Completion date

December 2010

### Treatment

Aerated Horizontal Flow

### Need

The Waste Water Treatment Works (WwTW) at Gaydon in Warwickshire serves the village and receives a population equivalent load of 394. The site comprises an integral Rotating Biological Contactor (RBC) followed by a 420 m<sup>2</sup> reed bed which provides

tertiary treatment.

Site performance had been dropping and the ammonia discharge was starting to breach consents.

This was linked to a reduction in performance of the RBC which consequently passed forward higher loads to the reed bed. As a result the reed bed became overloaded and clogged

Daily hydraulic load and consents	
Daily flow (m <sup>3</sup> )	90.6
BOD limit (mg/l)	25
Suspended Solids Limit (mg/l)(mg/l)	45
Ammonia limit (mg/l)	10

due to excessive biomass development. This, linked with a tightened discharge consent set for the site, necessitated the need for a reed bed refurbishment along with an RBC service.





### Solution

The existing bed had been designed and sized based on consents to discharge which had subsequently been tightened. This meant that the refurbishment would either require extending the area of the bed or enhancing treatment capability of the existing asset. The conversion of the bed to an aerated system using Forced Bed Aeration™ would not require an extension of the bed and would also provide higher, more consistent treatment capacity and was therefore selected as the optimum refurbishment option. In undertaking the refurbishment ARM Ltd were able to wash the gravel media and replace it rather than have to dispose of the clogged media to landfill and purchase fresh material. This provided considerable cost savings.

### Benefits

The conversion of the bed to an aerated system using Forced Bed Aeration™ allowed Severn Trent Water to make the most of their existing assets whilst extending and enhancing performance capability of the site to meet the tightened consents. The washing and replacement of the gravel media minimised the capital costs of the refurbishment project.



# Welsh Water, Kingstone and Madley

## Aerated saturated vertical flow: Tertiary sewage



### Project

Welsh Water, Kingstone & Madley

### Location

Kingstone & Madley,  
Herefordshire

### Project type

Upgrade

### Wastewater type

Sewage

### Completion date

March 2013

### Treatment

Tertiary

### Need

The Welsh Water operated Kingstone Madley Waste Water Treatment works was constructed in the late 1940s and has been modified on several occasions over the years to accommodate the increasing population in the area.

In the late 1980s four parallel horizontal flow passive reed beds were added to the system to provide a tertiary polish to the effluent prior to discharge to the local watercourse. These have performed well and are still in operation with discharge consent levels generally being maintained though there has been some loss of treatment capacity due to age and increased loading rates resulting in the short circuiting of flow across the reed bed surface. Some temporary remediation works had been undertaken to improve effluent distribution but ultimately a more significant refurbishment was needed.

Further predicted increases in local population and tightening discharge consents led to a review of the treatment process across the whole works to ensure compliant treatment of the additional loads. As a result a full site refurbishment and filter replacement was planned. Welsh Water were keen to employ existing assets where possible and, therefore, asked ARM Ltd to provide proposals for a reed refurbishment and upgrade.

The average daily flow to the reed beds is 332 m<sup>3</sup> with a peak flow of 16.6 l/sec. Influent loads and effluent requirements are given in the table right.

	INFLUENT (mg/l)	DISCHARGE CONSENT (mg/l)
BOD	30	7
Suspended solids	40	10
N as ammonia	8	3





## Solution

Following a site review ARM Ltd determined that with the use of Forced Bed Aeration™ (FBA™) only two of the four existing horizontal flow beds (approximately 1500m<sup>2</sup> total) would be required to treat the post refurbishment design load to the required consent levels. The chosen beds were in a very poor condition and would require complete refurbishment themselves including liner replacement, new media, distribution/collection system, duty/standby blowers and conversion from horizontal flow to saturated vertical flow operation.

The new system was designed based on the upstream process consisting of a primary settlement tank, refurbished trickling filters and humus tank. Effluent from the existing system is now fed into a newly built direction chamber which feeds into the retrofitted reed beds.

Delivered within just four months we were also able to keep the site fully operational which was vital for the uninterrupted treatment of wastewater.

## Benefits

The new FBA™ treatment reed bed provides Welsh Water with a robust, secure, high performance, tertiary treatment capability at the Kingstone Madley site providing long term compliance. Because only two of the beds were used the remaining two beds offer additional passive treatment if required and potential for significant additional capacity if refurbished.



# Lower Basildon

## Vertical flow reed bed: Municipal effluent



### Project

Lower Basildon,  
Thames Water

### Location

Lower Basildon, Berkshire

### Project type

New build

### Wastewater type

Municipal effluent

### Completion date

August 2013

### Treatment

Passive vertical flow

### Need

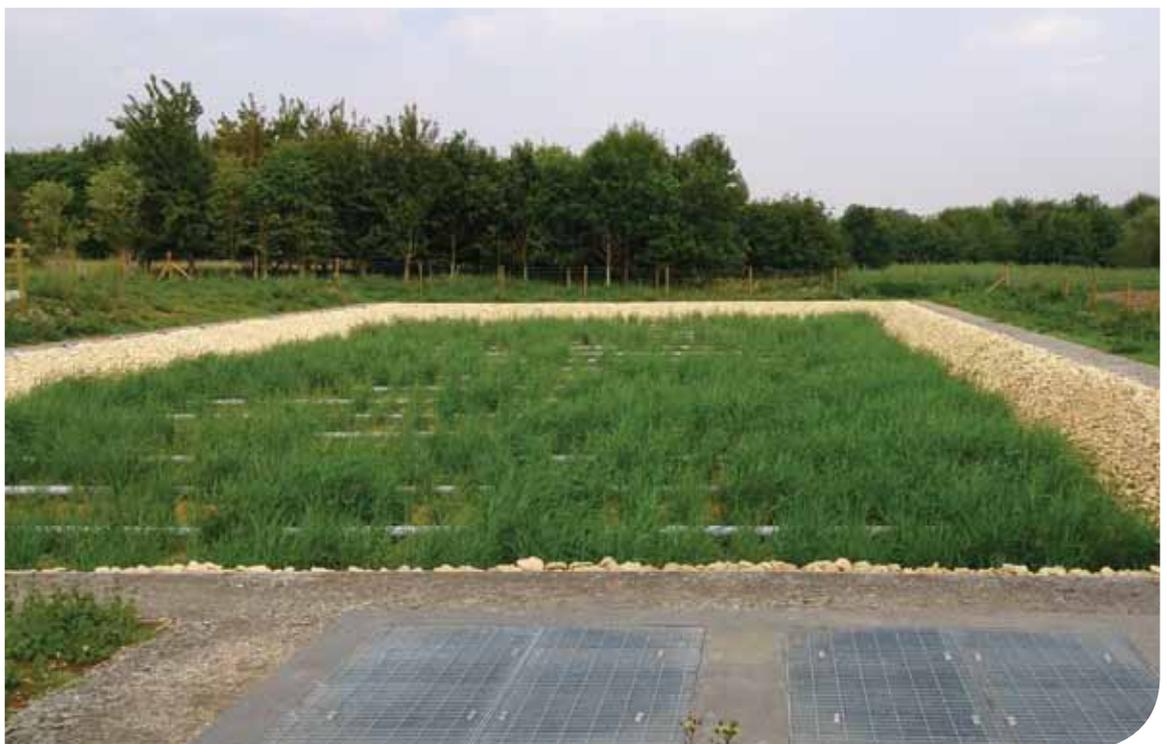
Lower Basildon WwTW is owned and operated by Thames Water and is situated within the grounds of Beale Park seven miles North West of Reading. The works serves a PE 166 (2011 – Average). Sewage is collected by gravity and conveyed to a coarse screen within a small rectangular chamber at the works. Screened sewage is then passed to six buried soak-away units. These tend to pool and flood during periods of high load.

The existing site has historically had no discharge consent, however, in 2011 the Environmental Agency (EA) introduced an indicative discharge consent of 30/45/5 (BOD/SS/NH3 mg/l) for groundwater. The groundwater consent was considered 'tight' and hence an indicative 95%ile new river discharge consent of 40/60 (BOD/SS mg/l) was also proposed to be effective from March 2014. The existing WwTW at Lower Basildon was unable to meet the requirement of either of the proposed consents and therefore Thames Water accepted the need for renewal of the current works under the quality driver for the future discharge to the River Thames.

Population Equivalents	2011 Average	2026 Average	2026 Summer Peak
Domestic	166	171	225
Trade	0	0	0
Total	166	171	225
DWF (m <sup>3</sup> /d)	26	24	31

Measured and predicted Population Equivalent loads

natural wastewater treatment



# Lower Basildon



The scope that was required to be delivered by the subcontractor for Lower Basildon sewage treatment works include outline design, detailed design and construction of a new sewage works adjacent to the existing Lower Basildon site, constructed and commissioned to the 2026 design horizon. The works was to be designed and constructed by the subcontractor as a 'turn-key' package as per the requirements of

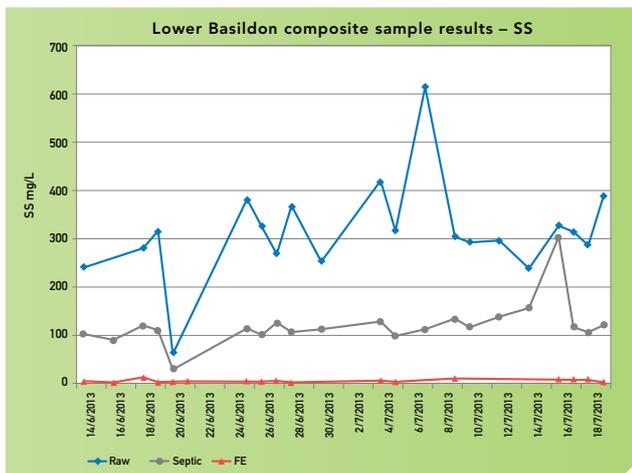
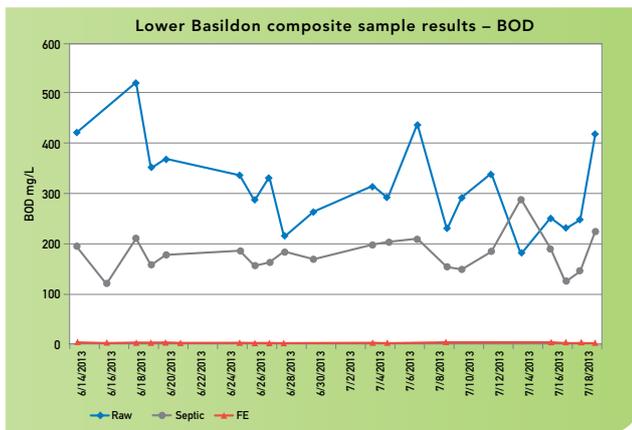
all applicable Thames Water standards. ARM Ltd was requested by Thames water contractor Black and Veatch to provide a suitable solution bearing in mind no power availability on site.

## Solution

The lack of power on site eliminated the potential for an aerated system which would minimise area requirements, so a passive treatment solution was sought. ARM Ltd installed a 40 m<sup>3</sup> septic tank followed by a COPASAC chamber (with bypass), a siphon chamber for batch flow generation and a 684 m<sup>2</sup> passive, vertical flow reed bed system which would discharge into the local water course.

## Benefits

The waste water treatment system installed provides Thames Water with the required no power solution for achieving the new consents specified by the EA based on loads predicted for 2026. Secure treatment has been provided with a minimal carbon footprint which is aesthetically appropriate for its location within a visitor park.



# Petersfield

## Aerated saturated vertical flow: Municipal tertiary treatment



### Project

Petersfield, Southern Water

### Location

Petersfield, Hampshire

### Project type

Refurbishment and upgrade

### Wastewater type

Municipal, Tertiary

### Completion date

November 2012

### Treatment

Aerated Saturated  
Vertical Flow

### Need

Petersfield Waste Water Treatment Works (WwTW) serves a population of 19,350. The WwTW comprises a Primary Settlement Tank (PST) a Trickling Filter and a Humus tank (HT). The average flow to the works is 3,500-3,900 m<sup>3</sup>/day with a maximum flow of 132 l/sec (11,405 m<sup>3</sup>/day pro-rata). Historically 10 % Of the flow discharged from the HT passed forward to a passive reed bed treatment system which had been constructed from the remains of an old sludge holding bed on site. The water which passed through the reed bed then re-blended with the bulk of the treated effluent from the HT prior to being discharged into a tributary of the River Rother.

The reed bed was not maintained and had become overgrown with saplings and other invasive weeds. Ultimately it was taken off-line and became disused. As the regulator is predicted to increase the stringency of discharge consents through the demands of the Water Framework Directive, Southern Water was keen to maximise the use of their assets on site and decided to refurbish the reed bed. ARM Ltd was asked to provide a refurbishment programme and re-design of the reed bed to maximise the treatment capability of the site as a whole. The refurbished reed bed was to receive 1,300m<sup>3</sup>/day.



## Petersfield



### Solution

ARM refurbished the existing passive reed bed treatment system and converted it to a 1,160 m<sup>2</sup> single aerated, saturated vertical flow bed. The aerated system maximises the treatment capacity of the limited area available whilst the vertical flow arrangement accommodates higher hydraulic loads and reduces the clogging rate of the reed bed.

### Benefits

The single bed, aerated reed bed solution makes best use of the area available to achieve the maximum treatment capability on site. Added benefits are the low maintenance and power requirements compared to the more mechanical alternatives reducing lifetime treatment costs as well as the added bonus of amenity and increase in site biodiversity.



# Scottish Water, Balhall

## Aerated saturated vertical flow: Secondary sewage



### Project

Scottish Water, Balhall

### Location

Mains of Balhall,  
nr Brechin, Angus

### Project type

Design and construct

### Wastewater type

Sewage

### Completion date

March 2012

### Treatment

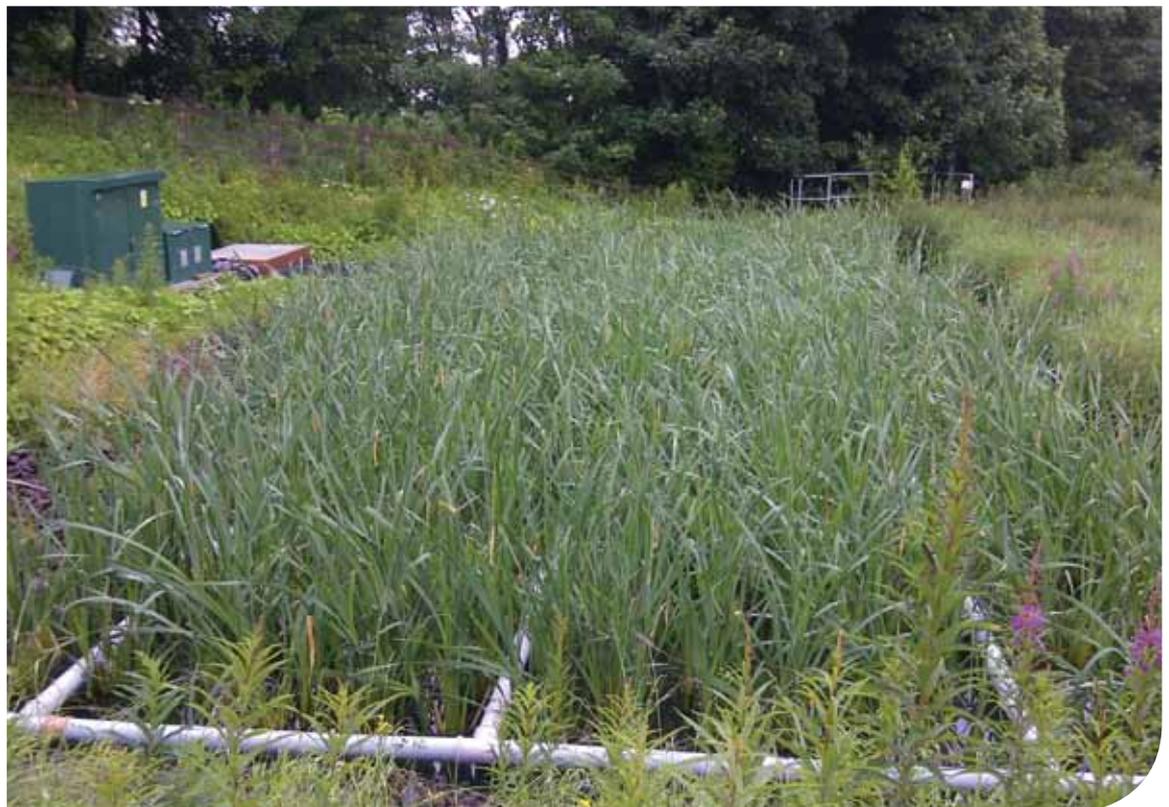
Saturated aerated vertical flow

### Needs

The wastewater treatment works at Balhall is operated by Scottish Water and serves a small hamlet and farm in Angus near Brechin. The site originally comprised a septic tank which discharged into a local stream. Subsequently a passive vertical flow reed bed system was installed post septic tank but this struggled to achieve the tight ammonia consent of 5mg/l. Further investigation highlighted an over estimation of the load at the works resulting in a significant oversizing of the system. This had been complicated by the system receiving rain water via roof connections to a newly installed sewer. Some modifications to the wetland system were undertaken but the site still failed to consistently achieve consent. In 2011 Scottish Water Solutions undertook a flow and load survey which more closely characterised the water passing forward to the works for treatment.

		RAW	DISCHARGE CONSENT
Average Flow	(m <sup>3</sup> /d)	4.7	–
Peak Flow	(m <sup>3</sup> /d)	37.8	–
BOD	(mg/l)	320	25
Suspended Solids	(mg/l)	400	100
Ammoniacal-N	(mg/l)	42.7	5

ARM Ltd was asked to provide a treatment solution with a performance guarantee, based on the new data.





### Solution

The existing treatment wetland comprised a two reed bed system operating in parallel. ARM Ltd were keen to maximise the use of this existing asset. Because of the stringent ammonia consent and the need for a process guarantee an aerated (FBA™), two stage saturated vertical downflow system operating in series was proposed. This was constructed by conversion of one of the existing reed beds on site, creating two beds of 171m<sup>2</sup> and 25m<sup>2</sup> with a pumping chamber in between. ARM Ltd also installed a new septic tank specifically sized to handle the higher flows associated with roof water catchment and avoid the scouring of solids. Duty standby blowers were installed with a control panel allowing timer controlled operation of the aeration system.

### Benefits

Maximum use was made of the existing asset on site and the remaining bed, currently unused, provides potential additional treatment capacity if required in the future. The FBA™ aeration technology provides Scottish Water with a more secure treatment solution to match the tight ammonia consent. Timer control of the aeration system offers flexibility of operation with the potential for optimum power usage. This along with the FBA™ technology gives Scottish Water a lower carbon footprint treatment solution compared to the alternative mechanical treatment solution which would most likely have been a Submerged Aerated Filter.

# Thames Water, Berkhamsted

## Horizontal subsurface flow: Tertiary sewage



### Project

Thames Water, Berkhamsted

### Location

Berkhamsted, Hertfordshire

### Project type

Design and construction

### Wastewater type

Sewage

### Completion date

May 2008

### Treatment

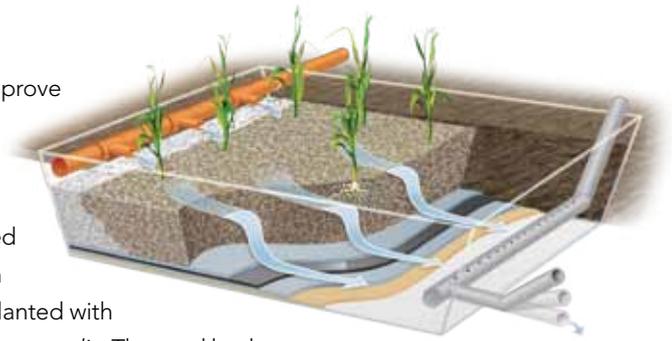
Horizontal subsurface  
flow wetland system

### Need

The Berkhamsted sewage treatment works operated by Thames Water had problems with high foam and ammonia discharges into the Grand Union Canal. The site serves a population equivalent of 24,000 with average flows of 11,000m<sup>3</sup>/d. Upstream treatment consisted of trickling filters and humus tanks. The discharge consent required for ammonia was 2 mg/L (95%ile).

### Solution

Following a successful trial to prove reed beds would remove foam, ARM designed and installed ten 1,600m<sup>2</sup> horizontal subsurface flow reed beds. The system is lined with LDPE, filled with gravel and planted with the common reed, *Phragmites australis*. The reed beds were designed for ammonia removal and foam reduction in order to enable the site to achieve the tighter discharge consents set by the Environment Agency.



### Benefits

The wetland solution at 1.6 Hectares is the second largest reed bed treating sewage in the UK and has reduced unsightly foam being discharged in to the Grand Union Canal whilst meeting discharge consent for BOD, SS and ammonia. It has also allowed increased levels of treated water to be discharged into the canal which has resulted in a reduction in the required abstraction volume taken from the local aquifer, thus providing further environmental benefit. By optimising the original design provided by the principle contractor, ARM have created a much more efficient water delivery system to the tertiary treatment reed bed.



# Uffington

## Aerated saturated vertical flow: Municipal tertiary treatment



### Project

Uffington, Thames Water

### Location

Uffington, Oxfordshire

### Project type

Design and construct

### Wastewater type

Municipal, Tertiary

### Completion date

April 2012

### Treatment

Aerated Saturated  
Vertical Flow

### Need

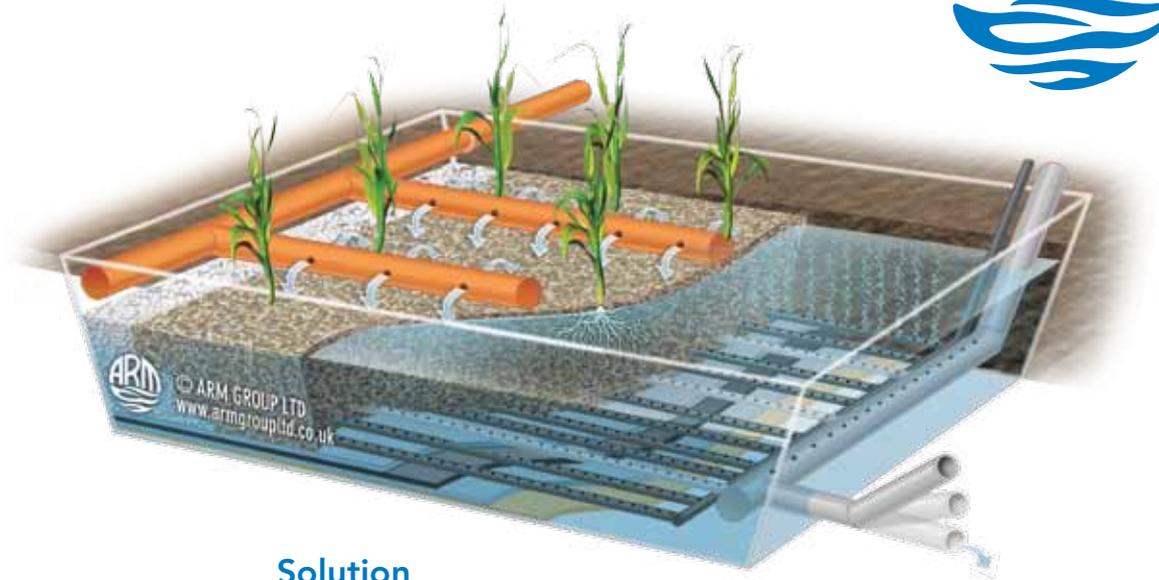
Uffington Waste Water Treatment Works (WwTW) is operated by Thames Water and serves a population of 700-800 in a rural situation. The WwTW comprised a Primary Settlement Tank, Filter Bed and Humus Tank. Due to its age and an increasing load from the village the works required chemical coagulant dosing to improve load removal through precipitation, settlement and filtration. The site was starting to breach consents occasionally and Thames Water was aware that discharge limits for the WwTW were likely to be tightened in the next few years. This would potentially require the need to upgrade the whole site. The cost of chemical dosing was also significant on what is a relatively small site.

Average flows were 174m<sup>3</sup>/day with a maximum of 347 m<sup>3</sup>/day, average loadings to the works are 45kg/d BOD and 6Kg/d Ammonia. The discharge from the filter and specified consents are given in the table below.

	DISCHARGE CONCENTRATION FROM HUMUS TANK	DISCHARGE CONSENT
BOD (mg/l)	18	20
Suspended solids (mg/l)	43	30
Ammonia (mg/l)	6.2	3

The BOD discharge was approaching consent whilst the solids and ammonia were in breach of consent.





### Solution

Rather than refurbish or replace the whole works ARM Ltd provided Thames Water with a long term solution through the design and installation of an Aerated Saturated Vertical Flow reed bed to operate as a tertiary final polishing system. The vertical flow orientation minimised the foot print of the required bed whilst the aeration provided enhanced microbial treatment to bring the BOD, suspended solids and ammonia site discharges comfortably into consent.

Two beds were installed, with a total footprint of 550m<sup>2</sup>.

### Benefits

The Forced Bed Aeration™ solution provided by ARM Ltd saved Thames Water the capital costs of complete replacement or refurbishment of the works whilst providing them with a long term low maintenance, low carbon footprint solution which not only secures consents but blends into the rural location providing additional biodiversity and amenity.



# Welsh Water, Crynant

## Vertical flow: Tertiary sewage



### Project

Dwr Cymru Welsh Water/  
Imtech Process,  
West Glamorgan

### Location

Crynant, West Glamorgan

### Project type

Design and construct

### Wastewater type

Sewage

### Completion date

December 2007

### Treatment

Vertical flow wetland system

### Need

Crynant sewage treatment works operated by Dwr Cymru Welsh Water needed to be upgraded to achieve a tighter consent for suspended solids and BOD. The treatment process at Crynant comprised primary settlement, biological filtration and humus settlement. The poor condition of the old process units and the imposition of a new discharge consent, including a first time ammonia standard, necessitated a complete redesign of the treatment process. The sewage works treat a population equivalent of 5,680 receiving average daily flow of 3,400 m<sup>3</sup>/d.

PREVIOUS CONSENT	NEW CONSENT
16 mg/L BOD	10 mg/L BOD
28 mg/L SS	15 mg/L SS
–	5 mg/L NH <sub>4</sub> -N

Dwr Cymru Welsh Water required a cost effective and efficient solution to their wastewater treatment needs which would also meets the carbon accounting requirements of OFWAT.

### Solution

The process selection and design was constrained by several complicating factors including high infiltration and difficult ground conditions. To minimise the footprint required as well as having a slightly lower capital (CAPEX) and operational expenditure (OPEX), ARM designed and constructed 2 vertical flow reed beds totaling 2,400m<sup>2</sup>. Only one bed operates at a time; each typically operated for a two week period during which the standby bed is allowed to rest, encouraging the biodegradation of any accumulated solids.





### Benefits

The Standard solution for this works discharge upgrade would have been the provision of an energy intensive activated sludge plant followed by sand filtration, including inter-stage pumping. However, in line with Welsh Waters Sustainable Strategy which includes responding to climate change, a low carbon footprint solution was installed comprising a rotating biological contactor (RBC) and reed bed. An initial comparative assessment considered emissions associated with cement (construction) and electricity consumption. This indicated that the reed bed option had lower emissions than the biofilter option (particularly for construction) and both had significantly lower emissions than a conventional nitrifying AS plant with tertiary filtration.

TREATMENT PROCESS	CONSENT	TOTAL	ELECTRICITY CONSUMPTION	OTHER	SLUDGE TRANSPORT	SLUDGE TREATMENT	SLUDGE DISPOSAL
Nitrifying RBCs & Tertiary Reed Bed	10 mg/l BOD 15 mg/l SS 5 mg/l AmmN	437	99	45	1	218	74
Nitrifying RASP & Tertiary RS and Filters	10 mg/l BOD 15 mg/l SS 5 mg/l AmmN	487	135	36	1	240	75
Biological Filters (Existing Process)	16 mgBOD/l 28 mgSS/l	375	66	36	1	199	73

Table quantifying the Carbon Footprint (CO<sub>2</sub> tonnes per year)



# Forced Bed Aeration (FBA)

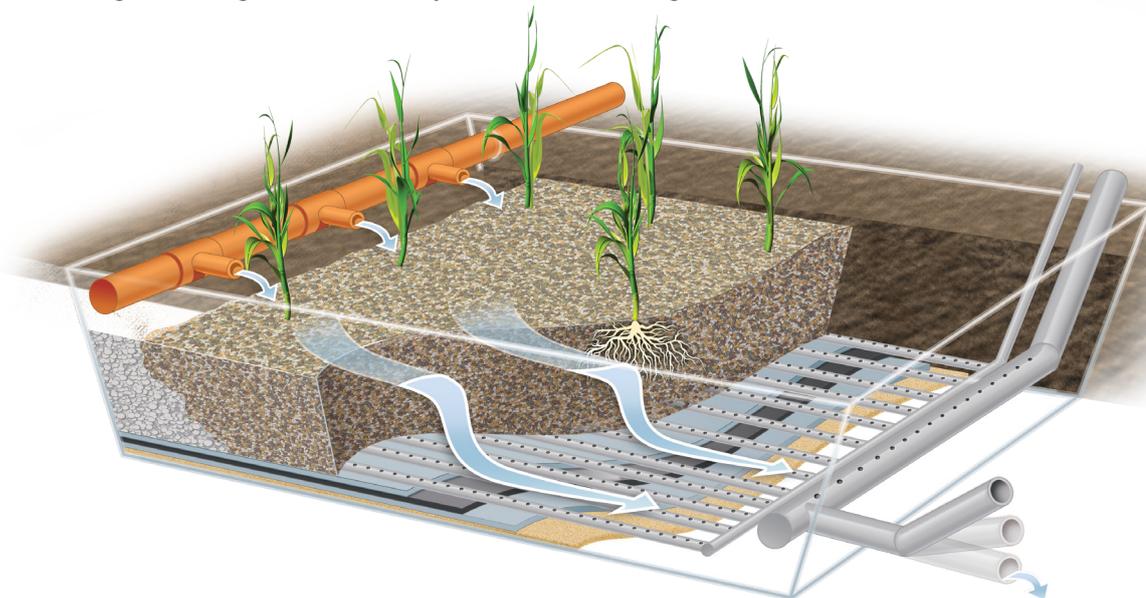
Forced Bed Aeration™ compliments and enhances existing reed bed technology, increasing treatment capacity by up to 15 times.



**F**orced Bed Aeration™ (FBA™) is a new wastewater treatment technology which enhances constructed wetland treatment performance. Significantly higher contaminant removal rates are attained along with an increased consistency of performance. Developed in the USA, by our partners Naturally Wallace, FBA™ can be used in both horizontal and vertical flow constructed wetland systems. Blowing air through the wetland system

makes the system oxygen unlimited increasing the treatment capacity by up to 15 times. This new technology can treat wastewaters high in BOD, SS, NH<sub>4</sub>-N and other organic contaminants.

Forced Bed Aeration™ reed beds can reach performance levels which have been unobtainable in standard reed bed systems with less performance variability. Aeration of horizontal and vertical flow reed beds has multiple advantages.



natural waste water treatment

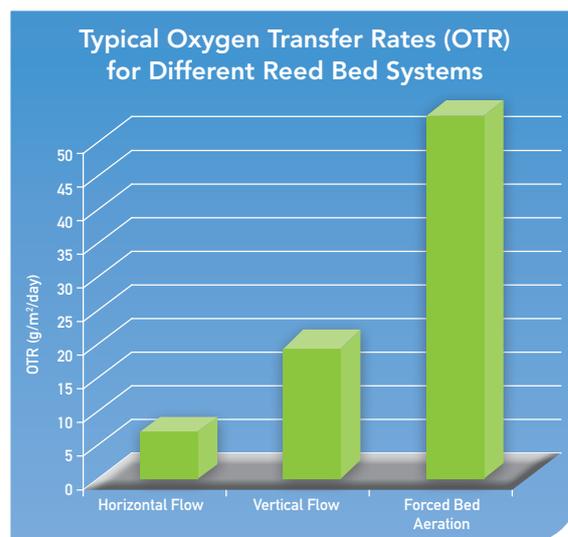


- FBA™ can completely nitrify wastewater
- FBA™ systems can be deeper than conventional reed beds therefore taking up 50% less space than passive systems.
- Plants thrive in FBA™ systems because the introduced oxygen prevents the formation of toxic products that can stunt plant growth in strongly anaerobic, passive system
- FBA™ reed beds can be divided into aerobic and anoxic zones to both nitrify and denitrify.
- FBA™ reed beds are ideal for treating fluctuating loads such as CSO's and locations with variable occupancy.
- Initial studies indicate FBA™ systems have reduced clogging rates extending the operational life of a treatment system.

technology prevents root rhizomes penetrating the emission points.

### Adapting FBA™

FBA™ can be retrofitted to existing reed bed systems, especially those which are overloaded. This prolongs the life of the reed bed and enhance effluent treatment.

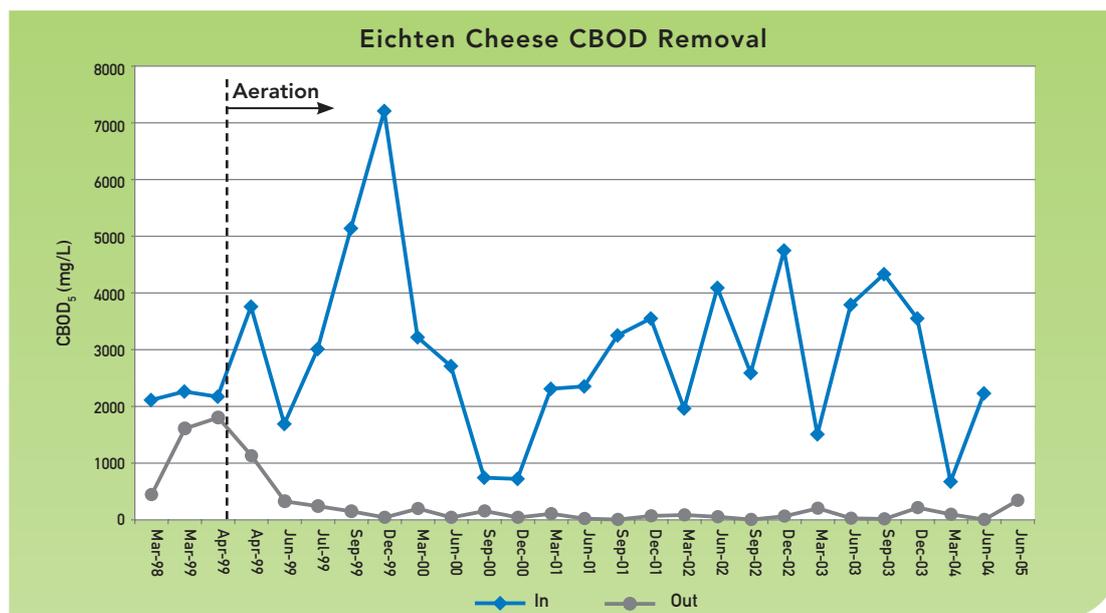


### Pipelines

FBA™ has a unique network of pipelines which provides a constant flow of oxygen into the reed bed. Patented rootguard

### FBA™:

- Improves treatment capability.
- Reduces clogging rates.
- Requires minimum power input.



Graph indicating the treatment performance of an FBA™ wetland system treating cheese production effluent

natural waste water treatment

## Asset Assessment & Support Package

Knowledge and proactive management of assets is a key area where water companies can cut operational and capital expenditure. The optimisation and enhancement of remote reed bed treatment systems can secure performance for many years without the need for full site refurbishment and the associated costs.



In the September 2012 issue of *Water & Wastewater Treatment* it was reported by the editor that knowledge by the majority of water companies of the condition of their assets is poor. According to the report from the consultancy company E C Harris, some 90% of maintenance in the UK water industry is reactive. Yet it is well known that proactive maintenance will cut costs by upwards of 50%.

Although this is not the case with all water companies we thought it would be an ideal opportunity to offer a simple solution. ARM Ltd have been designing, constructing, refurbishing and retrofitting reed beds for many of the UK's water companies

for decades. It is for this reason we feel best placed to offer you our new Asset Assessment and Support Package (**AASP**).

Reed beds are generally tucked away in Sewage Treatment Works and because they provide treatment with minimal maintenance requirements often get overlooked until the works are close to breaching consent. Our Asset Assessment and Support Package will highlight the condition of the system and give an indication of when refurbishment may be required. This allows expenditure to be planned and therefore controlled and ensures the works performs to its full capability.



Our Asset Assessment and Support Package works in two ways:

## 1. Asset Assessment

### Visual Appraisal

- Condition of the reeds
- Extent of sludge build up on and in the gravel matrix
- Condition of the flow path
- Site layout and accessibility
- Photographic evidence

### Fitness for Purpose

- Review design basis, 'as built' drawings and O & M Manual
- Review current and future loads and recent performance data

### Monitoring program

- Sampling and monitoring program to include influent flows/loads and discharge levels to characterise performance

### Reporting

- Verbal and written report of the assessment complete with conclusions, recommendations and indicative prices of any required remedial work

## 2. Support Service

- Asset longevity prediction
- Sampling and monitoring to establish performance
- Refurbish to 'as built'
- Re-engineering to improve performance
- Maintenance
- System operation
- Retrofit with latest technologies to enhance capability

We would be happy discuss any aspects of this service with you and can be contacted at [info@armgrouppltd.co.uk](mailto:info@armgrouppltd.co.uk) or telephone on 01889 583811.