FWR NEWSLETTER
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Welcome to the spring issue of the FWR Newsletter

Disinfection of water supplies has saved millions of lives since the discovery of its effectiveness against pathogenic microbes. However, in time it emerged that by-products were formed as a result of adding disinfectants to water. John Fawell takes us through the history of water supply disinfection and the implications of by-product formation.

Steve Bungay, our new Wastewater Section Co-ordinator, now takes on the Wastewater Matters column which Tim Evans started. In this issue he looks at the deregulation of sewage sludge treatment and creating a market for this product. Steve also provides a short account of the recent Wastewater Forum meeting.

In February the new RBMPs for the UK were published; these cover the second cycle of the Water Framework Directive from 2015–2021: see page 4 for further details. Also in February an India-UK Water Security exchange visit was held with the aim of developing knowledge-sharing links with policymakers, researchers and water industry specialists – you can read about this on page 5.

For information on events and news highlights please go to our website *www.fwr.org.* You can also contact us via email *(office@fwr.org.uk)* or telephone (01628 891589).

Maxine Forshaw - Editor

THIS ISSUE

DISINFECTION BY-PRODUCTS: WHERE DO WE STAND AFTER 40YRS OF RESEARCH?

John Fawell
Independent Consultant

A BRIEF HISTORY of waterborne disease, chlorination, and breaking the cycle of disease.

In the nineteenth century, as rural populations moved to the rapidly growing cities, providing sanitation and clean water supplies became a significant problem with the result that waterborne diseases such as typhoid were endemic and there were frequent outbreaks of cholera. The need to separate sewage from water sources, which was well known to the Romans, had been forgotten. Breaking the faecal/oral cycle of disease meant stopping pathogens entering drinking water sources or stopping pathogens entering drinking water from those sources, even though the cause of disease was unknown. Sources of clean water were limited and the authorities were compelled to find a way to deal with the latter.

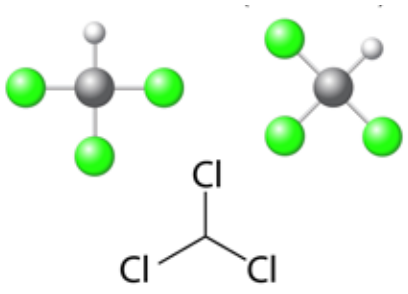
Filtration was the first step but when filtration alone was not as successful as hoped, disinfection was introduced in the form of chlorination The first continuous treatment for a municipal supply was established in Middelkerke in Belgium in 1902, with gaseous chlorine introduced in 1903. In the United States chlorination was first introduced in Jersey City in 1908 with dramatic effects. Both filtration and chlorination played an important role, particularly for surface water supplies. Fundamentally, microorganisms are particles and particle removal is an important component of water treatment, but filtration alone often proved inadequate and disinfection was a vital second barrier.

This pub is situated on Broadwick Street (formerly Broad Street) in Soho, London. This was the location of the Broad St. water pump, which Dr John Snow discovered was the source of a cholera outbreak; this proved his hypothesis that the disease was spread by contaminated water, not air. Credit: Ceridwen, geograph.org.uk Image of plaque is credited to Bob Baker from www.londonremembers.com

Since then, chlorination of drinking water has been a mainstay of disinfection to protect against waterborne disease in most parts of the world. Following its introduction at the beginning of the twentieth century there is no doubt that chlorination has contributed to saving countless lives, particularly among the young. Chlorination still remains one of the main components of a multi-barrier approach to treating drinking water because it is relatively cheap, easy to use and robust in its effectiveness. It can also be easily measured and has a residual action all of which make it very suitable for use in both high and low technology situations, including household treatment, all over the world. Even in developed countries we still see outbreaks of waterborne disease when chlorination has failed. Walkerton in Canada, where people died due to improper chlorination in May 2000, was a salutary reminder that we drop our guard against waterborne disease at our peril.

THE DISCOVERY OF DISINFECTION BY-PRODUCTS

In 1974 Rook discovered the presence of chloroform in the drinking water of Amsterdam and this curiosity was soon followed by independent confirmation in the USA. The discovery led to further research in a number of countries, including the UK, to investigate this strange phenomenon. It was soon recognised that chloroform was not alone and there were a number of other similar substances, the trihalomethanes, or THMs, containing bromine atoms in place of chlorine atoms. The game-changer, however, was the declaration in 1976 by the US National Cancer Institute, that chloroform was a carcinogen. The basis of this declaration was a study in mice given very large doses of chloroform in corn oil as a bolus direct into the stomach, which resulted in a significant number of liver tumours. The finding that chloroform apparently caused cancer when given to mice in long-term experiments also created a step change in the research activity directed at drinking water, which hitherto had been largely considered only in relation to pathogens. This research was of course facilitated by new developments in analytical chemistry, as continues to be the case today with a range of contaminants of emerging concern. There was an explosion in both health research to see what adverse effects might occur, and in chemical research to see what other substances might be present. Research was also instigated to try and find out how disinfection by-products were formed in drinking water.



Structural chemical formula and model of trichloromethane

These events changed the way we consider disinfection processes for ever and the term disinfection by-products or DBPs was coined to encompass all of the unwanted substances formed when disinfectants are used. Since those early studies there have been tens and possibly hundreds of new substances identified, mostly at trace concentrations and most at concentrations well below 1 µg/L. Many thousands of research papers and reports have been published on all aspects of DBPs, including their formation, occurrence and toxicology.

WHAT DOES ALL THIS RESEARCH TELL US?

Much of the early work on the toxicology of the THMs was shown to effectively be an artefact of the study protocols. The long-term and lifetime experiments in which rats and mice were given bolus doses of very high levels of THMs by gavage (stomach tube) in corn oil resulted in exacerbated toxicity and did not reflect the way in which these compounds are normally handled by the body. Later experiments in which chloroform was dosed in drinking water showed a much reduced level of carcinogenicity. This was reflected in the WHO (World Health Organisation) guideline value for chloroform increasing from 60 µg/L in the first edition of the Guidelines in 1984, to 200 µg/L in the second edition in 1993, and 300 µg/L in the third edition in 2004 as understanding of the mechanism of action increased and uncertainty decreased. The findings showed that chloroform is not a mutagen and does not cause cancer in animal studies by mutation but by an indirect mechanism of tissue damage and repair for which there is a threshold. Health Canada developed a separate health-based guideline value for bromodichloromethane based on an early cancer bioassay in which the compound was dosed in corn oil but quite properly withdrew this after a bioassay dosing the compound in drinking water failed to show any carcinogenic effect.

The original classification of chloroform as a carcinogen was the stimulus for a number of epidemiological studies looking at various cancer sites and either chlorinated drinking water, or later, THM concentrations. Some of these found weak associations with large bowel cancers but none of the findings were convincing. However, regulators began to develop standards for some DBPs in drinking water, particularly THMs and later the haloacetic acids (HAAs), which are the other major group of DBPs found in chlorinated drinking water. There is no clear explanation as to why the regulatory values are much lower than the toxicology would appear to suggest, ie 100 µg/L or less for total THMs. This is probably because there was originally some concern over the brominated compounds but also, as greater numbers of DBPs were identified, it is probable that THMs were being used as a surrogate for the overall load of DBPs and the regulatory values represent a pragmatic level of precaution while still allowing the use of chlorine. This lack of clarity does cause some confusion and, in spite of the evidence to the contrary, there are still statements appearing in the drinking water literature about the carcinogenicity of the THMs and

E. coli grown in MacConkey agar

that they cause cancer in humans at low concentrations. Such statements are at best misleading and at worst a deliberate distortion of the facts.

Another extensive area of research has centred on potential adverse reproductive effects in exposed populations, particularly stillbirth and low birth weight, following a number of positive associations in epidemiological studies. However, there was no supporting evidence from animal studies and more recent studies have tended not to support this contention. The weight of evidence seems to largely rule out adverse effects on reproduction as a plausible outcome.

Despite all of the above there is still evidence that DBPs may not be completely innocuous and this is, perhaps, the reasoning behind the standards for THMs and, in North America, HAAs. Among the cancer outcomes considered in epidemiological studies the one that remains most consistent is the association between THMs and bladder cancer. Up to 10 epidemiological studies of variable quality and statistical power show a relationship with bladder cancer. While the risk estimates from the epidemiological studies are small they are not negligible. This does not necessarily mean that there is a causal relationship because currently there is no supporting data that suggest a plausible mechanism by which this could happen, and there are many possible confounding factors. In particular, laboratory animal studies on the toxicity of the DBPs present in the greatest concentrations, both individually and as mixtures, do not show signs of bladder cancer. However, the possibility remains and dictates that sensible precaution should be the order of the day. This means finding an appropriate balance between being able to use chlorine and minimising unwanted by-products by a range of means, including the removal of the natural organic molecules that are the precursors. While THMs are not a good surrogate for HAAs, the question remains as to whether THMs and HAAs together are the most suitable markers for all DBPs arising from chlorination, and research is underway to confirm whether or not this is the case. This is an important question with a possible revision of the Drinking Water Directive on the horizon and the probability that HAAs will be added to THMs to improve the reduction in the overall load of DBPs from chlorination.

HOW DO WE STAND NOW?

All disinfectants produce some by-products but the database on chlorination reflects the fact that it has been studied much more extensively than others. However, other means of disinfection are generally much more expensive and difficult to manage, which is a major consideration in resource limited countries. Research is legitimate, but overstating the significance of the research is potentially dangerous if it is taken at face value and microbiological quality is compromised because of misplaced fear of the health impact of chlorination by-products. It is also important that research is not just about identifying problems but also identifying appropriate strategies for solving the problems. In addition, driving precautionary regulation also drives costs up and those increased costs will be passed on to consumers, impacting most heavily on the poorest in society. This is particularly true in countries where resources are limited.

The current position with chlorination and most other disinfection by-products is that potential risk is high because of the extensive exposure, but confidence about the probability that they do cause significant effects is low. By contrast we know that the risk from waterborne pathogens is similarly high but our confidence in the probability that pathogens cause adverse effects is also very high. So, the final questions are:

- Should we stop using chlorine because of disinfection by-products? **Absolutely not.**
- Should we ignore the potential adverse impact of disinfection by-products? **Absolutely not.**

Chlorine should be used carefully and reasonable efforts should be made to reduce the concentrations of disinfection by-products. The steps that can be taken to reduce disinfection by-products also have benefits in improving the general quality of drinking water but, particularly in resource limited countries, WHO's position that disinfection should never be compromised in trying to meet guidelines or standards for disinfection by-products remains as important now as it was when first stated.

Professor John Fawell is an independent consultant and visiting professor at Cranfield University. His primary interest is in drinking water quality and he is a member of the WHO Expert Committee on the Guidelines for Drinking Water Quality.

Clean water from a tap in the streets of the African city Bamako, Mali.

The New River Basin Management Plans

Maxine Forshaw, FWR

River Basin Management Plans (RBMPs) set out how organisations, stakeholders and communities will work together to improve our water environment. In the last issue of the newsletter (February 2016) Clare Rodgers from Royal HaskoningDHV provided our lead article, comprehensively guiding us through the next stage of river basin management planning. As the newsletter went to press, the plans for the second cycle of WFD (Water Framework Directive) were published.

Details from the gov.uk website state that *the new guidance is to help [the Environment Agency and Natural Resources Wales] carry out their river basin planning functions for 2015 to 2021.*

Defra explain: *these updated 2015 plans build on the work already done to protect and improve over 9,320 miles of our rivers over the last five years. They set out how a minimum of 680 (14%) of waters will improve over the next six years from around £3 billion investment.*

However, WWF-UK and the Angling Trust were disappointed with the plans, calling them 'woefully unambitious' and stating that *while these plans set out clearly the range and scale of the issues affecting rivers across the country, such as farm pollution, key effective solutions to tackle them are absent.* (In 2011 WWF-UK and the Angling Trust applied to take the government to Judicial Review over their first round of RBMPs, but this was halted following a commitment by Defra to a package of new measures to deliver WFD.)

See the River Basin Management Plans here:

https://www.gov.uk/government/collections/river-basin-management-plans-2015

River Trent at Gunthorpe, Nottinghamshire. Credit: Simon Blake

RBMPs in England and Wales: *Use the map to find your RBD.* There are 11 river basin districts in England and Wales. The Environment Agency manage the 7 RBDs in England. Natural Resources Wales (NRW) manage the Western Wales RBD. NRW and the Environment Agency jointly manage the Dee and Severn RBDs. See the RBMPs for Western Wales and Dee on the NRW website.

River Vyrnwy, Dolanog, Powys, Wales. Credit: Penny Mayes

RBMPs in Scotland: See the Scotland and Solway Tweed RBMPs on the SEPA website.
The Scottish Environment Protection Agency (SEPA) and the Environment Agency jointly manage the Solway Tweed RBD.

River Tummel, near Kinloch Rannoch, Perth & Kinross, Scotland. Credit: Richard Dorrell

RBMPs in Northern Ireland: There are three river basin districts – the North Eastern, the North Western and the Neagh Bann.

https://www.daera-ni.gov.uk/topics/water/river-basin-management

River Roe, north of Carrick Rocks, Northern Ireland. Credit: SK53, geograph.org.uk

India-UK Water Security Exchange Visit

February 2016

Martin Griffiths, *Independent Consultant*

Indian delegation (left to right: Mr M P Singh, Mr Hari Har Mishra, Prof R K Sinha, Mr R S Tyagi, Mr Dipankar Saha, Mr Suneel Dave, Prof Arun Kumar)

A WEEK-LONG VISIT TO THE UK by an Indian delegation of senior civil servants and research leaders with responsibility for the water sector took place in February. It achieved its objective to develop knowledge-sharing links with key UK policymakers, regulators, researchers and water industry specialists.

FWR, through Martin Griffiths and Chris Chubb, made a significant input into the structure and content of the visit. They used the FWR sponsored book *Regulation for Water Quality* to structure their presentations on the principles of good water regulation and governance; see *http://www.fwr.org/WQreg/* to access the book – available for download. Each Indian delegate was presented with a copy of the book. FWR Board Member, Tony Rachwal, attended one of the sessions and his links to the UK Water Partnership, NERC (Natural Environment Research Council) and FWR were invaluable in consolidating the networks required to deliver this unique event.

This potential visit and opportunity for co-operation was announced in a joint statement issued by Prime Minister Modi of India and David Cameron in November 2015, following the Indian State visit to the UK. The visit was primarily funded by the UK Prosperity Fund, NERC and the Scottish Government.

A top priority for India is to harness international capabilities across water science, management and policy so that it can apply this knowledge to hasten the clean-up of its own rivers, in particular the River Ganga, through the 'National Mission for Clean Ganga' strategy.

With pre-existing parallel administrative and legal systems to the UK, the opportunities for India-UK collaborations to build water research, regulation and environmental protection capabilities are considerable. Clear openings for the application of UK scientific, technical and governance expertise were identified following the wide-ranging presentations, seminars and workshops.

Once implemented, the water infrastructure and regulatory improvements will help deliver improved public health through better water supply and sewage treatment. These, and other improvements to the freshwater environment, will deliver enhanced water security and support economic development.

The UK Water Partnership, working with partner organisations, including NERC, CEH (Centre for Ecology & Hydrology) and Scotland Hydro Nation, played an important role to catalyse the initiative and help make it happen; the actual visit was run by CEH.

Deliverables from the visit will include a final report and summary of the main issues and future opportunities. There will be follow-up visits to India from NERC, CEH and Scottish Hydro Nation and we hope that business, regulatory and research links will be enhanced. The links developed through this initiative will help UK organisations and companies build collaborations which will be beneficial to both the UK and India.

Read the report on the visit and see the presentations at: *http://www.ceh.ac.uk/news-and-media/blogs/india-uk-water-security-exchange-initiative-report*

WASTEWATER FORUM REPORT

Steve Bungay, *FWR Wastewater Section Co-ordinator*

THE WASTEWATER FORUM was established by the Foundation for Water Research in 1995. The remit of the forum concerns integrated management of wastewater systems and water quality. This is a broad remit that engages a variety of experts in different areas within integrated wastewater management. At the latest Wastewater Forum in March its Terms of Reference were discussed to ensure they continue to be relevant in an evolving industry.

The overall aim of the forum is to improve and share scientific knowledge relating to wastewater, concentrating on emerging issues and knowledge gaps, working with all stakeholders including industry, academia, regulators and individual and community users of water, facilitating ways to find practicable solutions to future challenges facing the water industry. At the recent meeting it was agreed that the areas the forum covers should be revised slightly in response to a changing industry, and should include:

- Catchment, surface water, and related environmental issues
- Sewage and wastewater collection, and treatment
- Water and wastewater re-use
- Effluent and wastewater discharges to the environment
- Sludge, biosolids, and organic waste treatment and recycling
- Resource recovery
- Public engagement and perception.

Integrated management of wastewater is hugely important in the water cycle. It is essential in maintaining and improving the health of aquatic and terrestrial ecosystems, maintaining and improving drinking water quality, ensuring the security of food production, and maximizing flood control. Members of the forum have extensive industry experience. Given the resources of the forum, the aim will be to focus on particular topics or themes, whilst at the same time striking a balance between the knowledge, experience, and interest of the individual members of the forum.

The meeting also included technical presentations from Barrie Howe, Senior Advisor (Water Quality) at the Environment Agency, and from Professor Stephen Smith, Director of Environmental Engineering MSc Programme, Imperial College London. Both presentations can be found on the FWR website at: *http://www.fwr.org/wransom1.html*

FWR Wastewater
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WASTEWATER MATTERS

Ofwat: Towards Water 2020
Deregulation of Sludge Treatment

Steve Bungay, *FWR Wastewater Section Co-ordinator*

CREATING A MARKET FOR SLUDGE could provide the opportunity to revolutionize its wider perception and release its potential to be fully utilized as a resource. However, the route to a functioning sludge market also has significant challenges, both economically and practically. In December 2015, Ofwat published *Water 2020: Regulatory framework for wholesale markets and the 2019 price review.* This framework set out Ofwat's preferred options in relation to the design of the future regulatory framework for the industry, addressing both the role of markets and the role of regulation. Cyclical economic development naturally leads to deregulation. Deregulation in the water industry has been considered in America since the 1990s. It is only in the last decade, however, that deregulation of the sludge market in the UK has been considered.

In response to this consultation, CIWEM organised a technical seminar (January 2016) ***Towards a Market for Sludge: Challenges and Opportunities.*** The seminar sought views from representatives from each of the Water and Sewage companies (WaSCs), consultants, the Environment Agency and the Consumer Council for Water (CCWater), in particular looking at the environmental impact of the proposed reforms. Key elements of Ofwat's proposals include:

- Separate binding price controls for both sludge and water resources for PR19;
- In relation to sludge, Ofwat are proposing the introduction of an information platform;
- In relation to water resources, similarly Ofwat are proposing an information database; and
- For water resources, Ofwat are proposing to implement access pricing.

Deregulation in concept is a good idea to drive innovation and competition. However, the manner in which the proposals have been presented by Ofwat overly rely on market forces to drive an improvement in overall service. Experience in the commercial anaerobic digestion (AD) market shows that although the industry is thriving, the quality of the sludge recycled to land is deteriorating. The profit-driven industry is not taking the final stakeholder (the farmer) into account. If the trust of the agriculture industry is lost, then there will not be a major market for sludge. Deregulation should not erode the quality of the service provided to all customers and stakeholders, and it should not allow the erosion of environmental protection. My view is that the consultation document is flawed in that the questions are shaped to support the new proposal; there is too much emphasis on the concept that deregulation will create opportunities and drive innovation without any evidence to support this.

There are **significant challenges to developing a market for sludge**, including challenges with the environmental impact and risk, customers and stakeholders, application of markets, cost allocation, cost benefit, regulated capital value (RCV), AMP6 (Asset Management Period) investment, etc.

A harmonisation of regulations between England and Wales (and Scotland) would be beneficial. Without this, companies might be negatively impacted, especially those on the borders. There are also inconsistent regulations between WaSCs and other forms of organic waste (OOW) that need to be resolved. Currently, water companies own the risk associated with sludge recycling and manage it through asset investment to ensure that sludge will always be recycled or disposed of. Unlike in standard markets, the product will always be produced, regardless of the downstream demand. Should the downstream demand fall (eg due to external factors such as tariffs/energy prices) and sludge is no longer as valuable and there is no alternative asset base to handle the material – who then **owns the risk?**

Experience from the commercial AD market has shown that there has been a deteriorating quality in the final product not being biologically stable and containing high concentrations of glass. There are still issues that need to be resolved around the regulation of co-digestion. New entrants are likely to be solely driven by profits, rather than environmental performance and customer service.

Legislative Deregulation in Water Industry, Water Resources, and Sludge Markets

It has not yet been determined if the changes will provide a benefit and value for money for customers. As some companies would have a competitive advantage (eg existing headroom) on the commencement of a market, how will

Ofwat ensure a level playing field across water companies? There are perception issues around biosolids in the agricultural market and food chain which will need to be managed. Potential new market entrants advise that there is existing over-capacity within AD assets for food waste. They are already competing to fill digesters with ever-reducing gate fees so it may not be realistic that water companies will be able to co-digest with other wastes. The boundary between sludge and sewage treatment works will need to be defined, both physically and economically. This may prove difficult in practice. There may be difficulties around the structuring contracts, eg liquor treatment requirements for sludge. Sewage treatment works and sludge treatment facilities are intrinsically linked and it will be challenging to separate these to enable new market entrants to deliver services without a detrimental impact on the upstream sewage treatment works. If different companies operate the two works there are times where the transfer of sludge to the sludge works, and reciprocal transfer of liquors to the sewage works, could stop.

Private finance initiatives (PFIs) have been suggested as a means of funding investment and innovation. PFI contracts can become burdensome fairly early on in what tend to be long contracts. Private financing, by its very nature will also drive down quality. For example, commercial AD plants are not built to the *Water Industry Mechanical and Electrical Specifications,* and this is starting to have consequences. If deregulation is to work then it should not be solely financially driven. There is concern over the complexity of the legislation and the ability of companies (both incumbent and new market entrants) to apply it fairly and consistently. Ofwat will need to provide very clear guidance on how to determine cost allocations. How Ofwat will separate the cost elements in the market, for example, transport and treatment, needs to be carefully considered. The geographical extremes of the country (eg the South West) are likely to be disproportionately negatively impacted if transport costs are included within treatment; their operations will look considerably more expensive and less efficient. Costs may increase, as contracts will require management overheads. Additionally, the risk associated with duty of care might also increase costs. This is likely to be passed on to the customer. It has not yet been demonstrated that there is enough value in the market for customers.

Companies with more head-room will have a stronger position in the market. As they will have paid for this with customers' money (perhaps being rewarded for their own inefficiencies), Ofwat will need to consider how the benefits will be passed to customers. It appears that Ofwat are proposing to reallocate the **Regulated Capital Value** (RCV) to not skew existing assets in favour of the WaSCs, which is sensible. However, it appears that entrants are disproportionally encouraged through incentives. This could encourage the wrong entrants into the market, or entrants that do not have long-term water and sludge quality as their key driver. In collocated commercial AD plant where municipal headroom has been taken up by the commercial activity, it has become incredibly complicated regarding regulated and non-regulated business, and allocation of the RCV.

WaSCs currently have to make decisions about their AMP6 investment delivery, and a lack of clarity could lead to stranded assets. Guidance will be needed around asset investment decisions as companies are unclear how stranded assets will be handled. There is a concern that the calculated average asset life for stranded assets is unrealistic. Whilst an average, it does not take into account the impact on individual companies.

There are definitely **opportunities in developing a market for sludge.** The harmonisation of environmental regulations may be catalyzed, in particular the harmonisation of *The Sludge (Use in Agriculture) Regulations 1989 and The Environmental Permitting (England and Wales) Regulations 2010.* This may open up the opportunity to co-digest sludges with other wastes, such as food waste. There is also a greater potential for environmental improvements, eg carbon reduction in the move towards AD technologies.

Customers should pay less if markets are successful. The Biosolids Assurance Scheme is just about to launch. There is an opportunity for this to be rolled out to new market entrants and continue to maintain confidence with agricultural customers and food chain suppliers. WaSCs and Ofwat would understand the true costs of sludge treatment. Currently, costs are often tied up with sewage treatment and historically have been difficult to separate. Markets provide the potential to remove or diminish the five-year AMP cycles, which can stifle investment and reduce the appetite for risk for incumbent WaSCs, and new entrants may be less risk averse than WaSCs, helping to drive innovation.

Deregulation in concept is a good idea to drive innovation and competition. However, does Ofwat have the ability to manage this across the country? Is there a risk that the *Water 2020: Regulatory framework* has been packaged up too professionally to errone-ously show that market forces will drive an improvement in overall service? Deregulation shouldn't erode the quality of the service the water industry provides to its customers and stakeholders, and it shouldn't allow the erosion of the role as guardians of the environment. Like deregulation, PFIs seemed like a good idea at the time. So if we want deregulation to work, Ofwat need to ensure it isn't simply financially driven.

Credit: Zorba the Geek, geograph.org.uk

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An update on the activities of the FWR

Caryll Stephen
Chief Executive of the Foundation for Water Research

SPRING has been a long time coming, but at last it does seem to be almost with us.

As I mentioned in the previous newsletter, we are looking forward to this year's boat shows, festivals and exhibitions. There are a number of publications (both Reviews of Current Knowledge and Guides) in the pipeline; one that will be of particular interest to those who attend outdoor festivals is the guide on *Water Storage, Use and Wastewater Disposal for Leisure Boats and Caravans.* This will be available very shortly.

Our work on catchment studies is particularly interesting and 2015–16 has seen project work carried out on both the Pang and the Wye (see below). This is not only of technical interest, but is also a way of involving people at a practical level and encouraging younger people to understand more about catchments and the water environment.

On the overseas front, the India-UK Water Security Exchange visit was a great success and is hopefully the start of further collaboration in the future. At FWR we are expecting a couple of delegations from China during the summer to hear presentations on the Water Framework Directive and related subjects.

In the meantime, I wish you all a lovely summer and happy holidays.

Recent catchment work being carried out on the River Wye, near High Wycombe

Images by Maxine Forshaw, FWR

Wooburn Green

Funges Meadow

Time for a coffee break?

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