

# water21

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*Prospects for a  
nuclear boost to  
water resources*

*Disinfection progress  
for wastewater*

*The private  
sector debate*

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**Water21 Casebook**  
Features appearing in the Water21 Casebook section are intended as useful contributions on current practice in the water sector and are screened by the Editorial Panel. Prospective authors should contact a panel member or the Editor with their suggestions. Guidelines for authors can be found on the IWA homepage.

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*Sizewell B power station in the UK. Expansion of nuclear power around the world may enhance prospects for nuclear desalination to provide water*

See page 16.

Credit: British Energy

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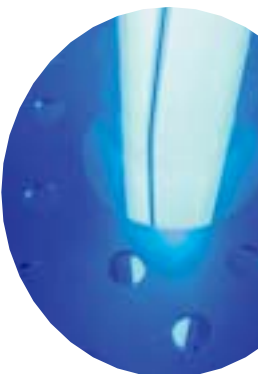
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## Report highlights Walkerton failings

The Part 1 Report of the inquiry into the 'Walkerton incident' in Ontario, Canada, was published in January. It reveals that serious contamination of Walkerton's public drinking supply in May 2000 resulted from a catalogue of operating and management system failures.

Seven people were killed in the incident and nearly half of the 4800 population made ill when high levels of *Escherichia coli* O157:H7 and *Campylobacter jejuni* entered the distribution system from a surface-influenced groundwater intake.

This Part 1 Report deals only with

the events leading up to and causing the outbreak, including the part played by local management and operating staff and the effects of overlying government policies, procedures and practices.

It shows that immediate cause of the incident was a failure on the part of operators to measure chlorine residual at the intake well in question. Heavy rainfall was then bringing contaminants into the well from animal manures properly applied to adjacent farmland in accordance with good practice. The levels of contamination were sufficient to overwhelm the chlorine dose then being applied,

allowing pathogens to enter the distribution system.

Although proper site practice would have prevented or at least significantly reduced the extent of the incident, the Report points to many shortfalls in the practices and policies of off-site bodies up to and including Ontario's Ministry of Environment (MOE) which stands accused on many counts.

Most importantly the Ministry had not checked or insisted that the source well was fitted with continuous chlorine residual and turbidity monitors although the well had been recognised as vulnerable to surface inflows since its

construction in 1978. Provision of such instrumentation had been a provincial requirement since the Ontario Drinking Water Objectives were amended in 1994.

In a summary statement the Inquiry Commissioner, Dennis R. O'Connor, says 'I am satisfied that if the MOE had adequately fulfilled its regulatory and oversight role the Walkerton tragedy would have been avoided or at least significantly reduced in scope'.

A Part 2 report will recommend actions needed to secure the future safety of public water supplies in Ontario.

**Bill McCann**

## Australian funding for salinity

The Federal government in Victoria, Australia, has announced the first tranche of almost Aus\$16M in funding for salinity and water quality projects under the state's National Action Plan.

The Federal Minister for Environment and Heritage, Dr David Kemp and Minister for Agriculture, Fisheries and Forestry, Warren Truss, recently announced the successful projects identified as priorities.

Dr Kemp said six catchment management authorities (CMAs) in Victoria's four National Action Plan priority regions will receive a total of \$10.7M for 'foundation funding'.

The four priority regions and six

CMAs targeted by the National Action Plan in Victoria are two Lower Murray CMAs; the Glenelg-Corangamite CMAs; the Goulburn-Broken CMA; and the Avoca-Loddon-Campaspe North Central CMA. Local communities can start work immediately on the priority projects.

Under the plan, joint funding from the Commonwealth and Victoria will see over \$304 million spent in the state's rural communities over the next seven years for work to tackle salinity and water quality.

Dr Kemp said: 'In recognition of the fact that there is no one-size-fits-all answer, the funding will help communities develop unique

regional plans for accreditation by the Commonwealth and Victorian Governments.'

'These grassroots-up strategies cover a range of natural resource management issues in each region and are the basis for most decisions about funding for the National Action Plan.'

'Key activities for CMAs in Victoria's four priority regions include a review of existing plans, filling information gaps and developing baseline data, vegetation and biodiversity mapping and encouraging community involvement.'

Mr Truss said over \$3.1 million has been approved for six community-targeted works to

reduce salinity, improve water quality and benefit biodiversity. 'These projects have been selected because they have been identified as priorities by the communities themselves, not politicians or bureaucrats, and work can begin on them straight away,' he said.

A further \$250,000 has been allocated for projects across Victoria to help determine further priority areas, and to ensure local government recognition of the community catchment plans.

The Victorian Department of Natural Resources and Environment will also implement a range of other state-wide projects, worth \$1.75 million.

## UK faces up to sewer flooding challenge

Water regulator for England and Wales, Ofwat, is consulting with the industry on the problem of sewer flooding. The number of customers affected is put at two to three out of every 10,000, but there is concern that insufficient progress is being made to reduce the problem.

The current five year spending plans of the main water companies, those that provide sewerage services, already include provision for expenditure on the problem. Ofwat allowed a total of £140M to achieve a net reduction in the number of properties at risk by 4500. Companies had however

sought a total of £370M to deal with 7200 properties. Investment was expected to be made over the next three years.

Ofwat anticipates that some £230M could be needed to deal with the remaining properties at risk of flooding at least twice in ten years. This assumes a capital cost of £50,000 per property. The corresponding figure for properties at risk of flooding at least once in ten years is put at £570M.

Thames Water is the company with by far the biggest problem with sewer flooding. Figures presented to Ofwat for the 2000/01 reporting period said there were over 18,000

properties at risk, although the company has since reduced this number to around 8000. The company has recently been sued by an individual because of repeated external sewer flooding. Ofwat states that 'the judgement makes it easier for aggrieved parties to sue sewerage undertakers for sewer flooding'.

The total for all the other main water companies is around 7300 companies, split evenly between the once in ten year and twice in ten year categories. This total is reduced from the figure for 1995/96, since when the number in the twice in ten year category has

approximately halved and the once in ten year category increased from around 2400 to around 3700. Ofwat wants the water companies' business plans for 2005-2010 to include a prioritised list of projects and the associated costs.

As part of the sewer flooding initiative, Ofwat is seeking a law change to enable the water companies to limit the connection of storm or surface water drains to combined sewers. It also wants the companies to be statutory consultees in the planning process to help take account of the impact of new developments on sewerage infrastructure.

## Cost put on Millennium targets

The World Bank estimates that financing the successful achievement of a key set of development targets known as the UN Millennium Development Goals could cost in the range of \$40 to \$60 billion a year in extra aid for the next 15 years.

The goals call for a halving of extreme poverty and for substantial improvements in health and education in developing countries by 2015. The environmental goal of universal access to water and sanitation by 2015 was calculated to cost \$30 billion for universal coverage or \$9 billion for basic levels of coverage.

The Bank warns that while this level of funding is crucial to meeting targets, developing countries would also need to reform their health, education, and institutional policies to improve the effectiveness of development aid.

World Bank President James Wolfensohn said: 'These numbers show that without additional resources we will not meet the development goals. But they also

underscore why success lies in a partnership of action between developing countries and rich countries.'

He called on rich countries to double their overseas aid from its current level of about \$57 billion a year and dramatically cut agricultural subsidies, saying: 'Since 11 September, there has been a strong sense of global solidarity that the world's poor need better health, good quality education, and more promising lives not only as a moral principle but also because these are the ingredients for a more stable, secure world.'

'As we now see, this global solidarity has a price. It may look intimidating in total but it may prove to be one of the most profoundly transforming investments the world community ever makes.'

The report emphasises that money alone will not be enough - gains in sub-Saharan Africa and South Asia outside India would be hampered by inadequate infrastructure and require hefty investment in this area.

## Water link to ship illness

A recently released WHO literature review has identified over 100 disease outbreaks associated with ships since 1970.

This is seen as probably an underestimate because many outbreaks are not reported and some could go undetected. These outbreaks are of concern because they could have potentially serious health consequences and high costs to industry.

The main diseases associated with ships are gastrointestinal disease and Legionnaires' disease. Both the passenger and cargo shipping industries are expanding. In 2000, 10 million people took cruises, a figure that is expected to double by 2010. Some 1.2 million people are employed on general cargo vessels and naval vessels also carry numerous staff, sometimes more than 5,000 on one ship.

Gastrointestinal diseases caught on cruise ships include *Cryptosporidium*, *Giardia lamblia* and *E. Coli* 0157.

Many of the outbreaks were linked to food or water consumed on the ships, factors included contamination of bunkered water, inadequate disinfection of potable water, potable water contaminated by sewage, and poor design and construction of potable water storage tanks.

The WHO review showed that over 50 incidents of Legionnaires' disease, involving over 200 cases, have been associated with ships in the past three decades.

Cargo ships have also been found to have drinking water and air conditioning systems contaminated with Legionella.

WHO is updating its Guide to ship sanitation, the official reference for health requirements for ship construction and operation, in collaboration with the International Labour Organisation and the International Maritime Organisation. The revisions are scheduled for publication in 2003.

Trials of a cholera vaccine made in Vietnam at a cost of just 20 cents a dose have produced encouraging results, particularly for children, according to a WHO report.

An international team of researchers reveals in the latest issue of the WHO's Bulletin that the vaccine has been found to be 'safe and immunogenic' and 'could elicit robust immune responses'.

The two trials reported in the Bulletin were carried out in Hanoi and involved about 144 adults aged between 17 and 25 years and about 103 children aged one to 12 years. The trials were conducted by scientists from Vietnam, Sweden, the US, the Republic of Korea, the International Vaccine Institute in South Korea and the WHO.

The researchers found that the Vietnamese vaccine was associated with no side-effects and caused a better immune response in children than in adults, for reasons that were unclear.

The scientists say in the Bulletin that 'the safety and immunogenicity of the vaccine, especially its ability to elicit robust responses, are encouraging, particularly because of its low cost of production (around \$0.20 per dose) in Vietnam.'

The United Nations has called for an entirely new approach to helping the millions of people affected by the Chernobyl nuclear accident, saying that 16 years after the incident they remain in a state of 'chronic dependency', with few opportunities and little control over their destinies.

The United Nations warned that populations in Belarus, the Russian Federation and Ukraine would continue to experience general decline unless significant new measures are adopted to address health, the environment and unemployment.

The emergency phase of the response is now over, the report argues, and a new ten-year recovery phase must gradually replace it. The report calls for a series of national workshops in the three countries most affected - Belarus, the Russian Federation and Ukraine.

Among the report's proposals are a call for a long-term, independent, properly funded and internationally recognised programme of research on the lasting environmental and health effects of Chernobyl. The report also calls for ongoing research into the impact of radioactive contamination on the environment, including water, with special attention paid to the impact on those who rely on the land.

The UK government has designated 180 out of almost 500 bathing waters around England and Wales as sensitive areas under the EU Urban Waste Water Treatment Directive.

According to the Environment Agency, the designation by the Department for the Environment, Food and Rural Affairs covers all of the locations where water quality is affected by wastewater treatment plants at which tertiary treatment has been installed. The move is said to follow a reasoned opinion (a precursor to legal measures) issued by the European Commission against France with respect to the directive.

The improvements have been carried out under the EU Bathing Waters Directive. Sensitive areas can be designated under the UWWTD where sewage treatment beyond tertiary treatment is needed to meet other directives, such as the Bathing Waters Directive. It remains to be seen whether the European Commission will be happy with the UK interpretation of the UWWTD on this matter.

## UN calls for Palestinian territories study

The governing council of the United Nations Environment Programme (UNEP) has expressed concerns about water pollution, waste dumping, loss of vegetation and pollution of coastal waters in the occupied Palestinian territories.

A decision to assess the environmental situation in the territories was taken at a special session meeting of the council in Cartagena, Colombia.

Israel and the Palestinian Authority have undertaken a ground-breaking initiative by inviting UNEP's executive director Klaus Topfer to visit the area and agreeing to work jointly on improvements.

UNEP experts will also carry out a desk study of the area. Their findings will be used to pinpoint hot spots that

require ground studies to establish likely effects on the environment.

The decision plans for recommendations on how areas of environmental concern can be improved, and calls for existing agreements in the area to be implemented.

Mr Topfer said: 'I am delighted that we managed to secure this important decision. I pay tribute to the countries that backed this proposal, and to the Israelis and Palestinians for their cooperation. Without their joint support, the likely success of any scientific visit to the area would be questionable.'

'It is our sincere hope that our work will lead to an improvement in the environment and the quality of life for people in the area and that

other wider benefits may also emerge as a result of this cooperation between Israelis and Palestinians.'

Yousef Abu Safieh, the Minister of Environmental Affairs for Palestine, said: 'The build-up of hazardous wastes, the contamination of shared water aquifers and other environmental damage in the occupied territories threatens this generation and future generations in Palestine and in Israel.'

'If we are to live together on this piece of land, we need to respect the shared natural resources here. We applaud UNEP in helping countries to reach this important decision and that the consensus of all nations was secured. This is unique in the Palestinian question.'

Valerie Brachya, Deputy Director-

General of the Ministry of Environment in Israel, said: 'The environment is a trans-boundary issue that affects us all. The task of preserving the environment is twice as difficult during times of conflict, when good will is at a premium.'

'The outbreak of violence in September 2000 abruptly halted cooperation on environmental protection issues, which had been established on the basis of signed agreements between the parties.'

'The decision taken by the UNEP Governing Council in Cartagena links scientific study of environmental issues with the implementation of existing agreements. We sincerely hope that the study will help to improve the environmental situation in the area.'

## Support for rural India

The World Bank has approved loans for India to improve incomes and fight rural poverty in Rajasthan and Uttar Pradesh through two water restructuring projects, worth a total of \$289.2 million.

The two credits, for \$140 million and \$149.2 million respectively, are being provided by the International

Development Association (IDA).

Rajasthan is a desert state with scarce water resources, much of which are used by agriculture, a key employer and contributor to the economy. Some 77% of the population is rural, and mostly poor.

The state is suffering increased water scarcity and frequent droughts.

The Rajasthan water sector restructuring project aims to promote more sustainable development and use of the state's scarce water resources by improving management, particularly of irrigation.

In Uttar Pradesh the problem is again one of an under-performing but key agricultural sector and

considerable poverty. Irrigated agriculture-driven growth has been hampered by a failing public irrigation and drainage system.

The Uttar Pradesh water sector restructuring project aims to initiate fundamental reforms in resources management and irrigation to improve living standards for the poor.

## REUSE MONITOR

### Design boost for GREAT scheme

Funding has been approved for an initial design phase for a key component in a major groundwater and wastewater scheme in California, USA.

A grant of \$1.5M has been approved by the US Department of Agriculture under its rural economic and community development programme. Along with some smaller contributions, this will allow the City of Oxnard's Water Division to design a regional groundwater desalination facility.

The facility is to be central in the city's Groundwater Recovery Enhancement and Treatment project. This is expected to see a coalition of water agencies in Ventura County spend \$50M over the next five years.

The desalination plant will allow water beneath Oxnard Plain to be used for drinking.

Alongside this, the city's wastewater treatment plant is to be upgraded. Wastewater currently discharged to the ocean will in future be treated, and the treated water then transferred to the desalination plant for further treatment and subsequent use for irrigation in agriculture. During rainy months, the treated wastewater will instead be pumped into the ground to help prevent saline intrusion into the area.

The GREAT programme also has a wetlands restoration component. This will involve the reuse of the brine discharges from desalination.

## WHO focus on hazards to children

Inadequate drinking water and sanitation, indoor air pollution, and accidents, injuries and poisonings are three causes of the three million deaths each year of children under five that are ascribed to environmental hazards.

A new WHO publication, 'Health and environment in sustainable development - five years after the earth summit', reports that 1.3 million children under five in developing countries died from diarrhoeal diseases caused by unsafe water supply, sanitation and hygiene in the year 2000.

The loss of activity that children suffer from environmental degradation is vast but until recently no specific efforts had been made to address the environmental hazards that specifically affect children, it says. The publication notes that children are particularly vulnerable to acute and chronic effects of

pollutants in their environments.

WHO has just completed the first major event in its strategy to protect children's health, an international conference on Environmental Threats to the Health of Children, in Bangkok, Thailand. Over 300 participants from around the world took part.

Special emphasis was given to environmental problems in the Asia-Pacific countries such as arsenic in drinking water, which is a persistent problem in Bangladesh and India.

In some countries, there are concerns about lead exposure and in China alone, an estimated 2.7 million people suffer from skeletal fluorosis, a crippling condition caused by drinking fluoride-rich water.

WHO plans to launching pilot projects to help countries assess and improve children's environmental health in the near future.

## IN BRIEF

Research from German consumer protection organisation Stiftung Warentest has found that tap water in Germany is as good as mineral water for drinking.

In the latest issue of Stiftung Warentest's Test magazine, an analysis of various mineral waters led it to conclude that tap water is the equal of mineral water.

The main pollutants are lead, copper, and zinc from pipes in buildings in some areas, which contaminate drinking water. Lead pipes in particular are a cause for concern.

The European Commission has decided to take further legal action against France, Greece, Germany, Ireland, Luxembourg, Belgium, Spain and the UK for non-compliance with a long list of EU water quality legislation - the Surface Water, Bathing Water, Drinking Water, Shellfish Water, Urban Wastewater and Nitrates directives.

Legal action also relates to an agreement on the protection of the Mediterranean Sea.

Commenting on the decisions, Environment Commissioner Margot Wallstrom, said: 'It is essential that all Member States adhere fully to these legislative measures if we are to ensure a sustainable management of water quantity and quality in Europe.'

Long term monitoring of groundwater is going to be essential in order to provide assurance over the environmental impacts of the UK's outbreak of Foot and Mouth disease, according to the Environment Agency.

The Agency has been carrying out some monitoring around farms on which carcasses and ash were buried, but longer term monitoring will be needed because of the time it would take for any problems to become apparent, the Agency states in a report 'The environmental impact of the foot and mouth disease outbreak: an interim assessment'.

Monitoring of surface and groundwaters will also be needed for a number of years around mass burial sites.

Some six million animals were slaughtered as part of efforts to control the outbreak, which at its height affected one third the land area of England and Wales. Approximately 61,000 tonnes of carcasses were disposed of at four mass burial sites and there was burial on farms at over 900 sites. In addition an estimated 1.3MI of disinfectants (before dilution) were used.

Over 200 water pollution incidents occurred, of which only three were classed as serious. Nearly half of all incidents were caused by farm slurry. Controls on movement led to storage problems with farm wastes.

Twenty million children in developing countries will die over the coming decade unless improvements in sanitation are made, two UK agencies warn in a report issued on the UN World Water Day on March 22.

The report from WaterAid and Tearfund is intended to apply pressure on the UK government to take action at the World Summit on Sustainable Development, to be held in Johannesburg later this year.

The report, *The Human Waste*, calls on governments to promote and secure an international agreement and action plan to halve the number of people without adequate sanitation by 2015. It calls on governments to secure adequate sanitation for all by 2025. And it calls on the UK government to increase its development aid, and to prioritise water and sanitation in official development aid and urge other developed countries to do the same.

## COMMENT



There is something paradoxical about the case made by Public Services International for water services provision remaining fully in the hands of the public sector (see *Public? Private?*, page 13). The union-backed pressure group sets great stall by the fact that this essential service is already overwhelmingly in the public sector. The

implication is that, this being the case, it should continue to be so in the future. PSI raises a whole range of concerns about the private sector but, given that the private sector accounts for a relatively small proportion of water services provision, the many shortcomings that exist with services provision must therefore lie mostly with the public sector.

PSI concedes that the public sector must indeed face up to these deficiencies. It argues that the answer should not be to view the private sector as the only viable solution, and here it is particularly critical of the policies of the World Bank. Rather, the public sector should be encouraged to improve, drawing on the experiences of those with success stories to share.

Rightly so, and even the private sector operators would probably agree that this will still leave them with ample scope to grow their businesses.

But while there may indeed be a need for improvement within the public sector, it is the private sector debate which dominates. This debate has really come to the fore since the Hague World Water Forum in 2000, and it will certainly continue at the international meetings on the immediate horizon.

An important facet of this debate is that it can only increase the questioning that will take place at a local level. The private sector is well able to respond and put forward its case, and this is a case that is being strengthened thanks, for

example, to contracts that include extending services to poor areas. In arguing against private sector involvement, as tends to be the way with pressure groups, they will have to state more clearly what it is that they do want. The challenge for the public sector is to be able to enter this debate on a case by case basis and demonstrate it can offer an attractive alternative.

All of which indicates there is a part which IWA can play in securing improvements in water services provision. This is a debate which needs to be better informed than it is at present, and sharing of experiences – both public and private – has to be an important part of that.

*Keith Hayward, Editor*

## ANALYSIS

# Government's role in Walkerton

● **BILL McCANN** reviews findings in the first official report on the Canadian incident.

The Part 1 Report of the inquiry into the 'Walkerton incident' (News, page 4) makes it clear that responsibility for the tragedy can by no means be placed solely on the Public Utilities Commission (PUC) operating staff.

Yes, responsible action by competent, well trained staff was what was lacking on the day. But the Commissioner found that the Ministry of the Environment (MOE) 'could not reasonably expect operators in small waterworks like Walkerton to have the training or expertise to recognise the vulnerability of a source like Well 5 (the affected well)'.

For that reason it was quite wrong for the government to argue that the Walkerton PUC or their General Manager were solely responsible for the incident.

The MOE, with prime responsibility for making regulations and for enforcing laws, regulations and policies was itself guilty of two serious failures:

it had not ensured that continuous chlorine residual and turbidity monitors were installed at the well (a Provincial requirement since 1994 for sources of this type); and despite inspections in 1991, 1995 and 1998 it had failed to identify improper chlorination and water quality monitoring practices which had apparently been the norm at the plant for many years and which were easy to detect from an examination of the daily operating sheets.

The technical background to the incident is quite straightforward but the underlying contributory factors as exposed in this Report show just what can happen when a complete system becomes caught in the trap of unquestioning continuation with past practice and unaltered routines.

Evidence of this recurs throughout the Report, fuelling the conclusion that Walkerton was an incident waiting to happen and only good fortune delayed the occurrence until May 2000:

- Under the hand of the PUC General Manager the Utility 'had engaged in a host of improper operating practices' but many of these 'were the norm' when he was appointed in 1988.
- The Public Utility Commissioners were responsible for establishing and controlling PUC policies but they tended to focus only on financial matters, knew little about water safety and 'performed their duties in much the same way their predecessors had'. Thus they did nothing when the 1998 MOE inspection report spoke of serious operating deficiencies and finding *E.coli* in a significant number of treated water samples.
- The role of the Public Health Authorities was passive rather than active. Local staff had no clear direction as to how they should respond to adverse reports on water quality or from an MOE inspection. Thus

the local Public Health Inspector was not at fault by assuming such reports would be followed up by the MOE but the fact is that many such reports in the mid- to late-1990s gave clear indication that Walkerton water quality was deteriorating.

At the head of this falsely contented system the MOE failed in its oversight role and with others of its programmes and policies was deficient by omission or by failure to act. The Commissioner speaks specifically of shortcomings in managing information, training personnel and in reliance on a voluntary approach to compliance.

In the years before May 2000 Walkerton had failed sampling and chlorine residual requirements on several occasions but there had been no enforcement action.

That was, he says, 'consistent with the culture in the Ministry of the Environment at the time'.





# The quality debate – thinking beyond professional boundaries

Responding to Mark Buehler's excellent article (Tap water versus drinking water: is it time to have the debate?) in the previous issue (Opinion, page 8), I agree entirely that it is time to have the debate. We should be having the debate, quite independently of the ramifications of 11 September, because of the aesthetic issues associated with tap water, and a consumer trend, in the more developed world, towards both bottled water and a do-it-yourself approach to water quality through the use of in-house filters.

For many countries, including the UK, taking precautions against terrorism is not a new requirement, with work on threats and precautions having taken place over many years. The events of 11 September required that the protection measures be reviewed.

One very relevant aspect is the likely impact on consumers' confidence in the ability of the 'authorities' to put in place and maintain adequate safeguards. Should the media run 'scare stories', the less robust consumers will tend to want to take 'control'

themselves, through purchasing bottled water, or through the use of plumbed-in or jug filters. I believe that what we are dealing with is human behaviour, with the security aspects being just one factor in their attitude to tap water.

What I would like to do, in attempting to add to the debate kicked off by Mark Buehler, is to consider a few of the issues around the quality of tap water as they affect consumer satisfaction and responses.

## Drinking water quality standards and compliance

I begin with standards, achieving them and asking whether, as a result, consumers have improved confidence in tap water.

There is the scientific basis to establishing standards and there is the real world. We professionals strive to have standards based on

the best science. In practice, standards take these into account but, on occasions, they result from governments reacting to consumers' fears or are an attempt to achieve an improved environment.

Using drinking water quality standards to see environmental improvements is not an effective approach because it doesn't direct the required actions to prevent chemicals polluting the environment, but instead results in additional costs in water treatment, without improving the environment. One interesting example in Europe of a non-scientific based standard is that of 0.1 mg/l for all individual pesticides, set in the 1980 European Directive. This could not be justified on health grounds and, in the UK alone, it resulted in additional capital expenditure on drinking water treatment of £1 billion. But consumers fear such chemicals; after all, they say, pesticides are designed to kill.

Whatever professionals might think, I believe that consumers feel that the money has been well spent. Everyone feels very comfortable that I am now able to report that 'pesticides have been virtually eliminated from our tap water'.

The monitoring and enforcement programme in the UK means that we are close to 100% compliance with our regulations. Through reporting openly the information on drinking water quality, before and after compliance with regulations, coupled with the provision of other information and effective enquiry services, the Drinking Water Inspectorate and the water companies together have made significant advances in achieving consumer confidence in tap water.

A few days ago I was reminded of how it used to be when I came across a colour supplement of one of our Sunday newspapers, published in 1989, which had on the front cover, in large print, the title 'Poison on Tap'. Inside was an attack on tap water across the country. We

have moved a long way since that time. So with greater confidence in the safety of water, are consumers happy with the quality of their tap water? No they are not!

## Consumer expectations

Even since 1989, consumer expectations have grown. They have learnt, indeed have been told, that the customer is 'king'. They no longer accept what they are given, and they complain if a product does not meet their expectations. Privatisation of water has changed the language from 'consumer' to 'customer'. They now compare the quality with what they can get elsewhere, thus the highlight on bottled water. This has brought the aesthetic quality of tap water into focus, with chlorine, and other tastes and odours, becoming unacceptable. Tap water must now appear crystal clear. Consumers complain about mineral deposits in hard water supplies affecting the quality of beverages, with complaints about 'scum on tea'. This problem seems to have become more prevalent with plastic kettles. Specific problems may be peculiar to individual countries, but where there is dissatisfaction, and where growth in incomes allows consumer choice, there is a trend towards bottled water and do-it-yourself filters.

One of the strange characteristics of human beings is that we feel we are better at protecting ourselves than relying on others. Many become fearful of air travel whilst being perfectly happy to drive a car – the accident statistics don't support that confidence in ourselves. So many feel that going to the supermarket and buying bottled water must be safer than taking tap water. Because it is in a bottle hardly anyone questions whether it meets the required standards, or whether the sources are adequately protected from environmental or deliberate contamination. In the recent debate on risks to water supplies, I don't recall any reference to the protection of bottled waters. It might be easier to contaminate a small source used for bottled water than a large public water supply.

## The debate

I don't believe that delivering a non-potable tap water is an acceptable solution. It is not possible to guarantee that it will not be consumed. Equally, as Mark is asking, how do we control inhalation and skin exposure risks? It would be possible for malevolent people to contaminate water to achieve a risk to health through skin absorption, or through inhalation, so consumers could be at risk without the water being consumed. Nor do I believe that bottled water provides a risk free alternative due to the questions I have raised above. I believe that in the future bottled water will come under equal scrutiny, as indeed it should.

So what is the solution to providing consumers with an aesthetically good tap water, water in which consumers also feel confident that it has not been contaminated? Firstly, consider the aesthetic aspects. Disinfection is one of the key safeguards, so this must be maintained, but chlorination in particular must be controlled carefully, using the best methods available, including the use of water quality network models. We need to carry out more research on so-called 'off-tastes', on what causes them and on how they can be controlled.

In my view, we also need to consider the water quality aspects 'beyond the tap' or what Mark would call 'beyond the faucet'. We can no longer say that our interest stops at the point of delivery. We cannot leave consumers to decide what sort of filter to use, because they are unlikely to know what units to buy, and retailers generally only know the selling price, not how the units work or the quality of the outlet water. So should utilities consider in-house units as part of their distribution systems? This should not mean that those units are necessary to meet standards, although they could remove lead, but would be installed to enhance the aesthetic quality. Water utilities might offer this as an added value service.

There needs to be a lot of thought and research as to what units to use, particularly if they are also to give protection against deliberate

**Should utilities consider in-house units as part of their distribution systems?**

contamination of supplies. Reverse osmosis is an obvious candidate, although it does not create good tasting water. Also, if all of the supply is to be treated, current units result in about 30% of the supply being discharged to waste, so they would not be acceptable in areas with water resource problems. The inclusion of activated carbon might be considered essential. The usual concern, over the microbiological risks of filters not being replaced regularly, would not exist if water

utilities were supplying and maintaining the units. Consideration of whether this is a sensible way to go would justify an IWA workshop.

There are some easier beyond the tap issues to be addressed on general aesthetic quality. Chlorine residual complaints are often solved by consumers allowing the water to stand for a couple of hours before consumption. If the water is also cooled in a refrigerator during this period, there would be a further improvement as cool water always

tastes better. Strangely many refrigerators are designed without even a good location for a water jug. We should discuss this requirement with the manufacturers. In the UK, and in other tea drinking countries, we need to solve the 'scum on tea' problem in hard water areas. Part of this might be discussing the problem with kettle manufacturers. These are just trivial examples to demonstrate the need to be more pro-active in working to satisfy consumers.

In this short response to Mark's

article I have only been able to touch on the issues. I hope that Mark's article is the beginning of a major debate, because I believe that we must begin to think beyond our traditional professional boundaries.

**The author:**

**Michael Rouse is head of the UK's Drinking Water Inspectorate and a vice president of IWA. The views expressed here are his own.**

LETTER

## Good water for everyone: solidarity from the rich to the poor

Despite many promises and good intentions from our leaders, wealth is still badly distributed in the world. And this is also reflected in the drinking water quality. Where in Europe and North America there is an ongoing trend for more stringent drinking water standards, according to the latest WHO data (2000) 2.4 billion people in developing countries have no access to safe drinking water. The consequences are dramatic as every year millions of people suffer or die from waterborne diseases. Many people in developing countries depend on (shallow) aquifers and these are often contaminated due to discharge of domestic waste, due to polluted rivers, solid waste and overexploitation. In many cases water is captured from dug wells that are very susceptible to contamination. Climate change, now recognised as being a reality, will only add to the problem as both flooding and drought will occur more frequently and both are a threat to the quality and/or quantity of the water resources.

Techniques are available to make sure that everyone could benefit from an acceptable quality at low cost. However in many regions the resources to achieve the necessary solutions are lacking and the companies that can offer solutions are not interested in projects at high (financial) risk. And if they are interested it is only to provide profitable drinking

water, not in taking back and treating the sewage.

Many initiatives have been taken to launch programmes, the IWA Foundation and AWWA's 'Water for people' being examples of them. But the success and the importance always depends on the generosity of individual companies or persons. More solidarity from the rich to the poor could help a greater number of people. This could be achieved by creating an international fund with contributions for every cubic metre of drinking water that is sold in developed countries. This contribution should be in the order of 0.02 to 0.05 Euro or US\$ and should benefit projects in developing countries.

The main objective of this fund should be to give as many people as possible access to safe drinking water. The projects would not necessarily lead to the high quality as we know it in Europe and North America, but it should lead to an acceptable water quality in the aquifer or rivers that are the sources for drinking water production. This water could be used for domestic use and smaller modules could produce limited amounts of drinking water quality for specific uses, e.g. hygiene, food.

The aim is to use simple, approved and robust techniques that local people can easily handle and understand. The solutions should be adapted to

and benefit from the local circumstances, e.g. possible use of alternative energy, and should be cost-effective, especially limiting the operational cost as this will benefit the success of projects on the longer term. However if high tech solutions would be necessary in some places, e.g. to face the huge arsenic problem in Bangladesh, it should be taken into consideration as high tech should not be the privilege for the rich only.

To benefit local people it is important that projects are sustainable. Therefore an integrated approach is needed, not limited to only drinking water production, but also taking into account the wastewater treatment (wastewater if not properly managed can contaminate water resources) and all other factors that contribute to a sustainable development of the drinking water sources. Having in mind that many developing countries face water scarcity and that many aquifers face depletion, closing the water cycle by localised water reuse should be the ultimate goal. Water reuse can also benefit agricultural practices. It is obvious that education of the local people concerning water use and water quality is also very important from the long-term success of the projects.

The resources of the fund should only be used for real investments and maintenance

costs of finished projects. Costs for studies, management and travel expenses should be financed by other means. This ensures good use of the funds and limits the risk of abuse. Individual companies could give support through their technicians; the governments and international organisations (UNESCO, WHO, IWA) could create a structure to manage this fund. Collaboration with organisations working on the field, like NGOs do, would be preferable.

The idea is to help the poor people who cannot afford it and desperately need good water by the mechanism of solidarity. Therefore in the richer 'donor countries', like the European Union, Canada, the United States, Japan, Australia and New Zealand, people should pay a fixed contribution on drinking water consumption creating a fund for projects in developing countries. As this yearly budget would be relatively stable - it could be as high as 1 to 3 billion Euro every year depending on the contribution - long-term planning would become possible and projects will not rely anymore on generosity alone. A backup of the projects that have been achieved is necessary to benefit to other projects and to avoid making the same mistake twice.

**Emmanuel Van Houtte  
Belgium**

# Public? Private?

● One of the messages from last year's International Conference on Freshwater held in Bonn, Germany, was that there is a need for greater debate on the involvement of the private sector in water services provision. **KEITH HAYWARD** spoke with representatives of two of the highest profile players in this debate, Vivendi Water and Public Services International.

Charles de Maud'huy is as close as anyone to the participation of the private sector in water services provision. He has been on the board of Buenos Aires operator Aguas Argentinas, in which Vivendi has a 7.5% holding, since its creation. He was in charge of acquisitions in the US during his first ten years with Generale des Eaux. He is also chairman of Aguas del Aconquija, which ran the concession in Tucuman, Argentina, until Vivendi terminated the ill-fated concession. Given all of this, the role of the private sector in water is among the topics covered in de Maud'huy's role as advisor to Vivendi Water chairman Henri Proglie.

Such involvement of the private sector is however increasingly attracting criticism around the world. 'For me the discovery of the other side was in the Hague, where we were astonished and we discovered, firstly, the degree of aggressivity of the critics and, secondly, the ignorance about what operators are really doing,' says de Maud'huy, referring to the emergence of critics at the Second World Water Forum in the Hague in 2000. There are, he perceives, two sorts of critics. One is the unions, while the other comprises non-governmental organisations (NGOs) and the thinktanks close to the antiglobalisation movement.

Falling into the first of these groupings, some of the most concerted criticism of private sector involvement in water comes from Public Services International, which describes itself as 'the global confederation that represents the world's water workers', through its 587 affiliated

unions in 146 countries (see [www.world-psi.org](http://www.world-psi.org)). PSI supports research at the University of Greenwich in the UK, and many of the papers put out by the unit cover the water sector (see [www.psiu.org](http://www.psiu.org)).

David Boys is PSI's spokesman on utilities and pension funds and was amongst the most vocal critics at the Hague. He was also at the International Conference on Freshwater held in Bonn last year, where he feels it was demonstrated that this new input to international meetings is starting to make its mark: 'The first major sign of progress was when it was readily accepted that full cost recovery should not be a barrier to access for the poor. The second very important move forward was the statement that country loans should not be made conditional on privatisation on water,' explains Boys.

Another message to come from the Bonn meeting is that there is a need for greater debate on the role of the private sector in the provision of water services. De Maud'huy for one sees the need for further debate. 'I think there is a lot of ignorance about what an operator does. To take an example, we don't own the water, we don't own water rights, so all the issues about the commodification of water or the petrolisation of water, which is a very big issue for a lot of critics, don't touch us,' says de Maud'huy. 'As a water operator whose main activity is the delegation of service, we don't own assets,' meaning, he says, 'we have little problem' with critics on issues such as transfer of ownership.

De Maud'huy makes the point that there are in effect two water cycles in the debate. One is at the level of water resources and the river basin, while the other operates within that, at the level of water supply and sanitation provision. Many of the concerns, on the part of non-governmental organisations, for example, relate to the first of these, he says. 'As a water operator, we are almost exclusively involved in the small cycle of water.'

Vivendi Water is, however, very much in the line of fire as far as PSI is concerned, as shown in the PSIRU document 'Water in public hands', launched in June of last year and endorsed by PSI.

PSI's concerns operate at two levels. One is the contracts that are awarded to the private sector and the companies that participate in them. The other is the role of financing organisations, particularly the World Bank.

As far as contracts are concerned, PSI's case includes the claim there are too few players for there to be sufficient competition between bidders, and that this problem is compounded by subsequent construction contracts being awarded to companies within the same group. Water prices, it says, are higher, in part because of the need to return profits. It is difficult for contracts to be cancelled, even if there is a problem. The PSIRU report cites cases where it believes contracts have not succeeded in delivering the anticipated benefits. There are concerns over whether poor households benefit sufficiently from contracts. The public sector may be called on to provide financial support to the

private sector. Lack of regulation and lack of accountability, including confidentiality of contract documents, mean there is insufficient scrutiny of private operators. And then of course the report cites cases of corruption.

Given there is a need for debate, and the claims above, Vivendi Water is going to have to engage in a debate that includes issues such as corruption, competition, accountability and transparency, provision of services to the poor, and whether indeed the private sector brings the benefits it claims. De Maud'huy says Vivendi is ready to engage on these issues, and more besides – the wider issue of gender, for example. As an example of how the company is ready to do so, de Maud'huy points out that shortly after giving this interview he was due to share a platform with Maude Barlow, a leading Canadian critic who authored the 1999 report *Blue Gold* on the commodification of water.

The benefit of taking part in such debates is, says de Maud'huy, that 'I think on each of these occasions each party learns a little more about the preoccupations of the other.' But can a consensus be achieved? 'I think that it is too early to know,' he says.

As far as competition is concerned, the criticism, certainly from PSI, is that there are just too few players in the international water services market for there to be sufficient competitive pressures and that concession contracts in particular operate over a long period and are difficult to terminate. De Maud'huy disputes this, saying that the process of bidding for contracts brings competition. He

says that in any one year a significant proportion of Vivendi's contracts will come up for renewal. Typically, he says, Vivendi will be unsuccessful in 10% of cases, with half of those contracts lost going to a competitor and half reverting to municipal operation. The result he says is that there is indeed pressure on the company to deliver on price and level of service. 'In my view, the possibility for an operator to lose his contract is the best way of measuring the existence of real competition... When you have a world leader which loses 10% of its contracts when they come up for renewal, it's significant. Secondly, it's very important for our reputation, because when we lose a contract it's known everywhere.'

When asked for his thoughts on transparency and accountability – another of PSI's concerns – de Maud'huy widens the issue to the concept of legitimacy. Any water service, public or private, needs this, he says, and it is something that requires transparency, a partnership between the public, the government and the service provider, as well as congruency – a structure consistent with the prevailing situation in any particular country.

'There is a real need for transparency about the water industry, whether the operator is public or private. I don't think this need is limited to the fact that the operator is private,' says de Maud'huy. He adds that if the private sector is to be brought in to deliver the service, the public needs to know about the conditions under which this is taking place. However, he does not see the need for every detail of how a service provider is to deliver that service should be made public. But is giving the public access to information something that has happened sufficiently to date? 'I think we are all working on that,' he says.

De Maud'huy's doubts about whether a consensus can be achieved certainly seem well-founded as far as PSI are

concerned, particularly with regard to some of the more fundamental aspects of the debate.

PSI is, says Boys, against privatisation. What PSI means by this is made clearer in the preface to 'Water in public hands', where PSI's general secretary, Hans Engelberts, states 'Water should remain a public good, owned and operated by the public sector'. Similarly, the literature PSI distributed in the Hague was headed 'No profits from water'. 'When we're talking about privatisation, our definition is not only ownership of assets... The essential for us is that the decisions made over the water utility are made by a management that is working for profit,' says Boys, pointing out that he feels the private companies are trying to define privatisation narrowly, as ownership of assets.

Boys is not, he says, against the private sector per se: it can be brought in on construction contracts, for example. His concern is that water service provision takes in multiple decisions on issues such as water for the poor, cross-subsidies and democracy in decision making that he says private companies are ill-equipped to deal with.

Vivendi Water, on the other hand, is clear that it is not about privatising water services. Shortly after the Hague World Water Forum, for example, the company issued a booklet 'Municipal water services: how to take up the challenge'. This examines the issues and options facing municipalities and sets out the case for public private partnerships as the way forward. This positions Vivendi Water as a contracted provider of water services, albeit one that sometimes provides financing.

It may not be necessary for both sides to find a term they can share in order for progress to be made, but evidently neither is happy with the terminology the other uses. 'Private sector participation' may come closer as a middle ground. This issue aside, de Maud'huy highlights the need for greater

comprehension through dialogue by commenting: 'In the case of the delegation of services, a lot of the criticism of the unions is based on ignorance. They believe that delegation of services is like privatisation.'

Both sides agree however that financing is one of the main areas where progress needs to be made.

'We are not convinced that in poor countries or developing countries that all private or all public is the solution,' says de Maud'huy. 'We believe that mixing financing, some public and some private, makes much more sense.' Private sources might be competitive for funding treatment plants, for example, while public sources might be better for buried assets with longer depreciation periods. Similarly, de Maud'huy has doubts about concessionaires carrying exchange rate risks, as costs will ultimately be passed on to consumers.

De Maud'huy anticipates that the panel chaired by Michel Camdessus, former general manager of the International Monetary Fund, which is due to report at the Third World Water Forum in Kyoto next year, should provide a useful contribution. 'I think a lot of work will have to be done to see if mixing public financing and private financing is not a much better solution in the case of PPP than putting everything on the head of the concessionaire,' he says.

PSI's main concern on financing is that financing institutions, particularly the World Bank, make bringing in the private sector a condition of loans being granted, and that such policies may well deter other lenders. The effect is that public water utilities are cut off from major sources of funding, and Boys is not optimistic that there is any significant shift underway on the part of the World Bank.

Boys, who describes the World Water Council as 'a front for the companies', comments: 'The solution is not to privatise. The solution is to do the hard work to reform the public entities... We've

got to look at how we get this massive investment capital that's sitting in Wall Street and looking for new opportunities, how do we get that into infrastructure.'

PSIRU does put forward positive messages in its documents about the contribution that the public sector has to play and measures that could help bring about improvements. Alongside this the report sets out the range of financing options that can be used by the public sector to support investment, and it promotes the idea of public-public partnerships to help in capacity building.

This potential of the public sector is something that is presently overlooked, feels Boys. He says there is a 'huge, huge gap' at international meetings as far as examining the public option is concerned. What is needed, he says, is 'a serious look at what successful public water managers do, especially in the developing world, and what can the international community do to help them, for example, on finance for infrastructure.'

'I know the public [sector]'s got to clean up their act. There's no doubt about it,' concedes Boys, but adds, 'We've got good examples of public companies doing a good job in very, very tough conditions,' citing the example of SABESP in Sao Paolo.

And de Maud'huy too advocates the need for change in the public sector. As he says, there is a need for greater transparency when a private operator is brought in but, equally, similar rules should be applied to public sector operations. He is also, he says, in favour of 'reversibility', where the private operator can lose its contract to the public sector and which in effect puts the private and public sectors in competition with each other.

But he is, says de Maud'huy, 'totally optimistic' about the future, because of the 'huge need for professional operators'. This is not meant to mean public or private, but 'just good management'. ●

# Nuclear power's resource prospects

● Reviled by environmental campaigners, nuclear power's fortunes may improve because of controls on greenhouse gases. This in turn may boost prospects for nuclear desalination, where waste heat from nuclear power generation is used in the desalination of water.

**BILL McCANN** reviews the issues.

Given the controversy that has always surrounded the world's nuclear industries, it is not surprising to record that, at the most recent meeting of the Commission on Sustainable Development, in New York in April 2001, nations could not even agree whether nuclear power is a sustainable option. The issue was said to be one of the most controversial items discussed.

What then are the prospects for nuclear desalination? They are of course inseparable from the main question: desalination can only be by a distillation or membrane process and the input

electrical power and process heat can come only from a fossil fuel or nuclear generating plant.

To date the contribution of nuclear powered desalination has been insignificant. One very large plant was commissioned in Kazakhstan in 1973 and operated successfully until shut down in 1999. A daily output of 120,000 cubic metres was produced from multi-effect and multi-stage flash distillation streams.

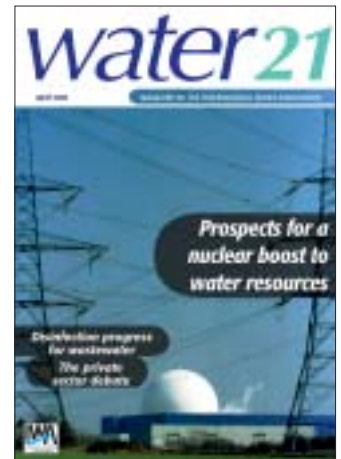
With that closure the remaining world capacity in nuclear desalination plants stands at a mere 13,500m<sup>3</sup>/day, all in Japan. Of that total 6500 m<sup>3</sup>/day comes from the Ohi-1 plant in Fukui, and the remainder from five separate generating plants where the water output is either 1000 or 2000 m<sup>3</sup>/day.

In comparison, according to the International Atomic Energy Agency (IAEA), the total worldwide operating output of desalination plants is some 20million m<sup>3</sup>/day within a current contracted capacity of around 26 million m<sup>3</sup>/day.

Informal projections from the same source indicate the latter figure rising to nearly 40 million m<sup>3</sup>/day by 2010. Whether or not nuclear energy will play a meaningful role in that expansion depends on the usual doubts and fears, but there are some signs that the future for this technology will be brighter than the past.

The principal reason for optimism is Kyoto and the greenhouse gas issue. Quite simply, nuclear power emits almost no greenhouse gases. As the IAEA is quite fond of saying, the currently operating nuclear plants are reducing annual global carbon emissions by around 600million tonnes.

But before last July's Bonn Agreement on implementation rules for the Kyoto Protocol on greenhouse gases, those savings or any more that might be achieved in future did little to advance the cause of the global nuclear industry



## COVER STORY

because, in economic terms, they were invisible.

By setting the rules on restricting emissions and particularly on emissions trading, Bonn changed that situation significantly. In future, providing the Protocol is finally ratified, countries will be free to trade their reductions in greenhouse gas emissions on the international market and nuclear power is included as an area in which countries can gain a saleable credit. Thus, for the first time, an economic value can be attached to the environmental benefit of a nuclear power plant and added into the equation when the economics of such plants are being weighed against fossil fuel alternatives.

In specific instances this might be instrumental in swinging the choice to nuclear since, in general, desalinated water costs and associated electricity costs are said to be in the same range for nuclear or fossil fuelled plants.

There are other indications that, for purely practical reasons, nuclear generation will have to play a bigger part in the longer term future. On current trends, IAEA sees nuclear's 16% share of all generation falling to between 9 and 12% by 2020, but the fact is that, given the increasing global demand for electricity, undue reliance on fossil fuelled generation might be incompatible with sustainability and the commitments to Kyoto.

Within the EU, for example, the IAEA prediction, based on current trends, will no doubt take account of the position in individual EU states - Germany has agreed on a total phase-out of nuclear power and the UK has recently placed very onerous obligations on the industry that raise questions about its future. For reasons

Gundremmingen nuclear power plant, Germany. (courtesy IAEA)



such as that the EU has also predicted a fall-off in nuclear power, from 15% of total EU generation in 2000 to around 6% in 2030.

But in the November 2000 Green Paper making that prediction it was also concluded that the decrease would cause a 5% rise in EU greenhouse gas emissions by 2010 whereas the EU's Kyoto commitment is for an 8% reduction.

Other analyses into the longer term future by groupings outside IAEA conclude that meeting the twin objectives of sustainability and increased power demand will mean a bigger part for the nuclear sector. Within these confines the most recent assessments of the Intergovernmental Panel on Climate Change offer scenarios in which nuclear's market share would have a mean value of 17% in 2050 and 19% in 2100.

The November 2000 World Energy Assessment (WEA) goes further. Commissioned in 1998 by several UN agencies and the World Energy Council, this projects sustainable scenarios in which nuclear power could contribute a 29 to 33% share of all generation in 2050 and 38 to 46% in 2100.

An assumption in one of these WEA frameworks is that, in the intervening years, a new generation of small nuclear power plants will be developed and become widely accepted. In the context of nuclear powered desalination that will be an important and often a necessary development: large reactors such as have been the norm in America, Europe or Japan would not be appropriate in many of the remote areas where water demands might be critical but connections to a power grid unavailable.

In other instances in the developing regions, where many of the most dire water needs are set to come, a grid might be available but too small to take connection from a large co-generating power and desalination plant - a power input can be no more than 10-20% of the grid capacity.

Within the industry there is said to be already a growing interest in small and medium size units and there are other ongoing technological development efforts relevant to the desalination market. Several of these concern high temperature gas reactors (HTGRs) where the waste heat would be sufficient for vacuum distillation. Desalination would then be available without interference to



Ohi nuclear power plant, Japan. (courtesy IAEA)

electricity production, obviating the usual need in co-generation plants to balance the generation output between water and electricity demands.

An IAEA technology review published in late 2001 records recent advances in HTGR technology as significant amongst around 25 innovative reactor design and development efforts ongoing in various parts of the world.

South Africa, France and the Netherlands are said to have HTGRs under consideration for desalination purposes.

Argentina has identified a site for a small reactor appropriate for desalination and is amongst several countries, including the Republic of Korea, Russia, Canada and China, having nuclear desalination plants under design. India has gone further and is constructing a demonstration plant with a design water output of 6300 m<sup>3</sup>/day. Desalination will be by a hybrid distillation/membrane process with power and heat coming from an existing pressurised hot water reactor.

Other R&D efforts centred on nuclear desalination are said to be under way in Indonesia, Pakistan and Saudi Arabia and a much more extensive list of countries has expressed interest in the potential for the technology in their locality.

Since the nuclear/fossil fuel cost comparisons for desalination generally are in the same range, the cost aspect will come down to site-specific factors but, if nuclear desalination is to become a reality, in some regions more important issues than end cost will come into the reckoning.

Safety of nuclear plants has always been at the heart of public misgivings about the technology and has equally dominated the thinking of national and international regulatory bodies. 'Proliferation' is an oft-repeated word in the literature of these bodies and, as the spokesman for one such

organization told *Water 21*, the meaning of that word is better understood if it is preceded by the word 'weapons'. Amongst the advantages claimed for HTGRs is their 'proliferation resistance'.

The Nuclear Non-Proliferation Treaty of the late 1960s required signatory countries to limit their development of nuclear technology to peaceful means. With one or two notable exceptions many states made that commitment.

But following the events of September 2001 there will be need for heightened vigilance and monitoring effort from international bodies. There are certainly areas of the world where the water needs are great but the underlying intentions and goodwill of some countries are, to say the least, open to question.

In other cases the potential for nuclear desalination to do good may be limited quite simply because the country concerned does not have the institutional capacity to safely operate, maintain and regulate a nuclear facility.

Future water security for all will depend on implementing some exceptional measures. Gas emissions from fossil fuel generation are likely to ensure that nuclear powered desalination becomes one such measure but it will have to be within a framework of international controls that ensure overall public security. ●

*An international conference, Nuclear Desalination - Challenges and Options, will be held in Marrakech, Morocco, 16/18 October 2002. Organisation is jointly by the World Council of Nuclear Workers (WONUC) and the Association of Moroccan Nuclear Engineers (AIGAM), with the co-operation of IAEA and the World Water Council.*

See: [www.wonuc.org](http://www.wonuc.org)

# Latin lessons for the private sector

● Latin America's quest for better water management and more investments provides ample, but tricky, prospects for foreign operators. **PETER REINA** reviews developments.



*Images of the San Martín water treatment plant, Buenos Aires, Argentina. All pictures courtesy of Ondeo Services / Thierry Duvivier.*

With widely varying national expectations and institutional capacities, Latin America is no place for feint hearted investors in municipal water and wastewater provision. The region's taste for privatising its infrastructure has made it a magnet for commercial loans since early last decade, but even the most sophisticated operators have stumbled at the many hurdles.

Presenting a now largely outdated

caricature of Latin American instability, recent street violence and political chaos in Argentina nevertheless provide a chilling reminder of the region's potential pitfalls. Yet the huge demands for improved water management and investment are inescapable.

Latin America is 'without doubt one of the biggest growth areas of the world for appreciation for the need for good sanitation', says Kevin Starling, Anglian

Water's regional director, based in Santiago de Chile. He represents a crop of mainly European-led companies patiently picking off water sector concessions and privatisations as they arise around the region.

As fertile ground for free market thinking, Latin America has most actively courted private interest into its basic assets of all kinds, attracting investment growth from \$13,000M to \$286,000M in the last



decade, according to the World Bank. In the water sector, massive urban drift and a receptive political climate combined to stimulate demand for reform.

According to officials at the Inter-American Development Bank (IADB), Latin America remains 'hobbled' by weak water management that threatens to worsen as more people migrate to cities. Around 80% of Brazil's 170M already live in cities and their ever sprawling outskirts. Across the region, a quarter of the 500 million people lack access to sanitation and nearly 80 million have no potable water connections, says the bank.

'Everybody complains about the quality, but you can't really say if it's serious because nobody publishes figures,' says Paulina Beato, a Principal Economist in IADB's infrastructure section in Washington. Environmental legislation varies widely across the region, with Colombia ranking among the best, but policing is generally absent or weak, she adds.

Uneconomic prices, poor management, obsolete technologies and political interference are among Latin America's commonly cited ills. And with limited public budgets allowing asset deterioration to continue, the cycle of resistance to higher tariffs seems set to perpetuate.

'There is a general culture of not paying,' says Beato. Of 25 Peruvian companies she reviewed last year, only five generated positive cash flows, she says. But Brazilian utilities are among the most financially robust, often able to cover

current costs and debt servicing from revenues, she adds. Supporters of private sector participation, including IADB, argue the approach provides better efficiency and incentives, while introducing external financing, backed by adequate pricing.

But there are institutional obstacles. Lack of long-term local financing has forced investors to less attractive short-term or foreign loans. And, with some exceptions, poor economic regulation is widely perceived as a stumbling block to private participation, particularly in Brazil and Mexico. And critics believe official efforts in various countries to clarify regulation have yet to gain credibility. Chile, where regulation emulates UK practice in some aspects, is well regarded.

With ownership of the assets often separated from responsibility for service provision, the industry is institutionally difficult to reform, says Beato. 'It's a real problem that has stopped many privatisations,' she says. And fickle political support and the perception that privatisation creates tariff rises have also taken their casualties.

Among these was the seasoned French operator Vivendi, which came unstuck with Argentina's disastrous Tucumán concession, awarded in 1995. It collapsed with recriminations early in its planned 30-year life. Work towards a rebid was abandoned, leaving the utility in public hands. A newly hostile local government, following elections, and a tariff rise of nearly 70% were among the contract's

cited flaws.

A similar fate befell UK-based International Water in Cochabamba, Bolivia, two years ago. In that case street violence and death threats preceded the cancellation of Aguas del Tunari's 40-year concession. Again, lack of political support and large tariff rises after the concession signing characterised the failure.

In Argentina, meanwhile, the ill-fated US corporation Enron made one of its many corporate errors when its subsidiary Azurix bid richly in the late 1990s for a 30-year concession serving nearly two million people in parts of Buenos Aires province. The price, well over \$400M, was widely viewed as lavish. Unable to make the concession work, the company decided to pull out, after an unhappy, but brief interlude.

Even the better founded concession for Argentina's capital, Buenos Aires, has taken a beating during the current economic crisis. Aguas Argentinas' credit rating has been tumbling since last summer, being downgraded more than once by the New York-based rating agency Standard & Poor's.

Joint investor in Aguas Argentinas, Suez Lyonnaise des Eaux, recently raised loss provisions for its water, power and other businesses in the country, while saying the Buenos Aires company was contractually protected from currency shifts. But other infrastructure concessions have been weakened by the decoupling of the local currency from the US dollar, and subsequent devaluation impeding foreign debt servicing.

In Latin America, 'I think there is a lot of risk, as Azurix found out,' says Tony Hill, managing director of the UK-based Severn Trent International. Latin America was one of his first foreign targets in the 1980s. But the company's vision shifted to the more developed markets of North America and Western Europe. After walking into the Mexican economic crises, the company 'got fed up' and sold out its stake in a company targeting work in the capital.

Others have persevered with varying success. Starting in 1993, Suez Lyonnaise des Eaux (Ondeo) has acquired concessions covering over 23M people in Argentina, Bolivia, Brazil, Chile and Colombia. They include Bogotá, La Paz, Santiago and Buenos Aires. Valuing the region's water market at \$12,000M over a





decade, the company in 1998 helped establish a special purpose company for private equity investment in the region.

Ondeo's arch rival, Vivendi, now tracks Latin America exclusively through Proactiva Medio Ambiente, a Madrid-based company owned equally with the Spanish construction group Fomento de Construcciones y Contratas (FCC). At Proactiva's creation in 1999, the two companies pooled their existing Latin American water and wastewater interests.

The joint company now has three operations in Mexico, including water supply to one quarter of the capital city. In Colombia, Proactiva has two contracts, one providing water and wastewater services to some 300,000 in the north coast city of Montería, won in 1999. The company later secured a 30-year concession in Catamarca, Argentina, and is working in Puerto Rico.

As a 'role model' for water privatisation, Chile has become the base for Anglian Water, says Starling. But after trailblazing utility privatisation, Chile changed track last year when the government brought water privatisation to a halt, switching instead to long-term concessions.

By then, Anglian had bought a slice of Empresa de Obras Sanitarias de Valparaiso S.A. (ESVAL), the country's first regional water privatisation. In 1999, Anglian and the Chilean corporation Enersis, acting as Aguas Puerto, bought a minority stake in the utility serving 1.5M people in and around the port city of Valparaiso, in the country's 5th. Region. Anglian later raised its interest in ESVAL to just under 50% by buying out Enersis.

'A year prior to our takeover, the company lost 11,000M pesos (\$16M), and within 18 months it turned in a profit of 10,000M pesos. It also needed a lot of investment. We invested heavily, particularly in wastewater, over the last two years and that will continue,' says Starling.

Chile's main water sector prize, Santiago's five million population, went to Ondeo operating jointly with Aguas de Barcelona a few months after the ESVAL sale. The concession company Aguas Andinas won a bid for a minority share in the utility Empresa Metropolitana de Obras Sanitarias. As well as improving the supply system, the arrangement calls for major investment in three wastewater treatment plants during this decade.

Thames Water and Electricidade de

Portugal control Empresa de Servicios Sanitarios del Libertador S.A. (ESSEL), serving 0.5M people in Rancagua, just south of Santiago in Chile's 6th. Region. London-based Thames, a division of Germany's RWE, also control's Empresa de Servicios Sanitarios del Bio-Bio (ESSBIO), serving 1.5 million people in Concepción, Chile's second largest water operation. Geographically between these businesses, Thames later secured a 30-year concession (ESSAM) based in the city of Maule, in the 7th. Region, serving 560,000.

While 'everything is on hold' in Chile's free-market neighbour, according to Starling, Argentina had been as busy before the crisis. Argentina was among the first to procure private sector involvement in water, starting some 12 years ago in a cross-sector wave of privatisation.

The Buenos Aires concession 'has been extremely good - in lot of ways it's been a model concession,' says Starling. Anglian has a small stake in Aguas Argentinas. 'It's unfortunate that they economic climate in the country is not very favourable'. Before the crisis, Aguas Argentinas claimed to have extended water connections to over 1.5 million new consumers while keeping tariffs to pre-concession levels of 1993.

Ondeo and Aguas de Barcelona followed the Buenos Aires deal over the next few years by winning other contracts, serving 14 provincial communities in Santa Fé province, including the city of Rosario, and also a separate concession covering 1.2 million customers in the country's second largest city, Cordoba.

Elsewhere in Latin America, the introduction of private sector interests has been less concerted. Paraguay is developing some arrangements, likely to be on a concession basis, for the water services of the capital Asunción. Puerto Rico has attracted international interest in one or, possibly, two 10-year operation and maintenance contracts for the whole island, representing \$500M in revenues and involvement in managing some \$2,000M of government capital investment.

Colombia's privatisation ambitions have been undermined by worsening security, deterring foreign investors. And Mexico, like Brazil, is throwing up various ideas for private sector participation, but unclear regulation remains an obstacle.

In Brazil Ondeo has long-term water and wastewater contracts serving 1.5 million in the Amazon city of Manaus, and another 240,000 further south



in Limeira.

Anglian acquired a small company operating in the coastal city of Brusque, in Santa Catarina state, some five years ago to 'to get an understanding of the issues,' says Starling. 'Brazil, to say the least, is a complicated country,' he says. Increased clarification of Brazil's water regulation is a precondition for the company to deepen its interest there. 'It goes one step forward and two steps back,' adds Starling.

Bolivia's other concession, meanwhile, has been relatively calm since starting five years ago. The Aguas de Illimani consortium, led by Ondeo and including Latin American partners, serves some 1.3M people in administrative centre, La Paz, and its neighbouring El Alto. Meanwhile, having hit the buffers in Cochabamba, IWL is now raising financing for its Ecuadorian concession covering the city of Guayaquil, won last year.

The inter-American Development Bank played a typical role in the Guayaquil deal, starting with an initial \$40M loan to help with the restructuring of the municipal utility Empresa Cantonal de Agua Potable in Alcantarillado de Guayaquil and the procurement of the 30-year concession. IADB also provided loans for both Buenos Aires, and La Paz contracts, though privatisation accounts for only a tiny fraction of the \$35,000M the bank has pumped into the region's water and wastewater sector over 40 years. ●

# The Dialogue on Water and Climate

● Climate variability and change are affecting water resources and water security throughout the world.

**HOLGER HOFF** describes the Dialogue on Water and Climate, an initiative to help promote understanding of this issue, and highlights related activities in Central and South America.

Water resources and water supply critically depend on the climate. As the primary driver of the hydrological cycle, the climate determines how much - or how little - water a region will receive over a given period, as well as precipitation intensity. In many parts of the world, increasing variability in climate conditions is already having major impacts on water resources. These impacts are many, but the link to water management problems is obvious and profound. Floods, droughts and other extreme climate events are all too familiar. Every year they inflict severe damage on humans and the environment in many parts of the world, although there are 'hot spots' where the frequency of occurrence is greater and the devastation more severe.

The boxed text presents a recent statement of the Intergovernmental Panel on Climate Change (IPCC) on the effects of climate on water resources (1,2)

The international Dialogue on Water and Climate (DWC; 3) is an initiative that aims to provide a better understanding of climate-induced effects on water resources. Partners in the Dialogue consortium include organisations such as the WMO (World Meteorological Organization), IPCC (Intergovernmental Panel on Climate Change), GWP (Global Water Partnership), WWC (World Water Council), WWF 3 (World Water Forum 3), IUCN (World Conservation Union), and the World Bank. The Dialogue offers a platform through which water resources managers and policy makers have access to relevant and integrated information, generated by scientists and other experts, for instance from climatology, meteorology, hydrology and other disciplines. Regional knowledge is also made available to be transferred to other regions. With that knowledge and information, the capacity of water resources management to cope with climate effects can be

increased considerably.

The knowledge base developed by the Dialogue contains state of the art information and tools, such as:

- databases, for instance on indicators, and visualisation tools
- critical regions where vulnerability of water resources to climate impacts are particularly severe
- weather and climate forecasting tools
- hydrological models
- scenario analysis
- techniques for risk evaluation, adaptation and mitigation

The Dialogue provides this information in generic format and also in a region-specific format, through case studies and regional dialogues.

The very successful launch event of the DWC during the International Conference on Freshwater in Bonn, Germany in December 2001, emphasised that a wealth of scientific information, experience and tools are available, but largely under-utilised by water managers.

The following example statements from the DWC launch in Bonn illustrate this:

- through climate change and other trends... many countries, including most developing countries, will be confronted with serious water problems by the middle of the century. These problems include lack of access to water, over-abstraction, pollution, drying up of rivers and wetlands, and spreading of water-related diseases
- poor resource management practices will exacerbate the vulnerability of water resources to increased climate variability and climate change. The poor of the world are most vulnerable... but they have the least capacity to cope
- political and institutional dimensions are critical elements in coping with climate effects in water management
- a paradigm shift is required in water

## Climate change and water resources

The impacts of climate change will depend on the baseline condition of the water supply system and the ability of water resource managers to respond not only to climate change but also to population growth and changes in demands, technology, and economic, social and legislative conditions. In some cases - particularly in wealthier countries with integrated water-management systems - improved management may protect water users from climate change at minimal cost; in many others, however, there could be substantial economic, social and environmental costs, particularly in regions that already are water-limited and where there is considerable competition among users.

management strategies towards living with floods and droughts, that is, flexible adaptation mechanisms to increased exposure

- innovative approaches and partnerships have been identified for providing more investment in water infrastructure and environmental protection
- an impressive catalogue of specific measures that some water managers routinely use to deal with present-day climate variability can also take us a long way towards coping with climate change
- although long-term climate scenarios cannot meet the needs of today's water managers, short and medium term weather and climate forecasts have improved considerably and enhance adaptive capacity enormously

It was recognised that Integrated Water Resources Management (IWRM) is a prerequisite for adapting to climate

*Drought in North-east Brazil (Axel Bronstert, University of Potsdam, Germany)*



Flooding in Venezuela: Matthew. (C Larsen, US Geological Survey, USA)



variability and change, and that IWRM can help to reduce the vulnerability of water supply systems (4). To provide the basis for IWRM, close dialogue and exchange of information between science and water managers is required.

The dialogue on water and climate is now engaging with stakeholders from water utilities and water boards. For example, a set of activities at the IWA World Water Congress in Melbourne in April provides the opportunity for IWA and DWC to jointly identify climate and water information requirements and align the knowledge base development accordingly.

A synthesis of dialogue results and selected regional case studies will be presented at the 3rd World Water Forum in Japan in March 2003.

One of the regions in which climate variability and change play a critical role in water resources is Central and South America. Climate variability, for example El Niño phenomena, together with land use changes, such as deforestation and population growth and urbanisation, strongly affect water resources. In the section below are examples of regional research initiatives that focus on climate and water issues in this context of change.

Global change and water resources in Central and South America: how can science support integrated water resources management?

Regional water resources are subject to a number of environmental stresses such as climatic change and variability, and changes in land use, and others. These in turn can lead to changes in flood and drought regimes, and an overall deterioration of water quality. In recent years, hydrological extreme events, often in combination with water quality problems, have increasingly turned into disasters, causing severe health impacts, death and large economic losses. In particular the rapidly growing population in Central and South American cities is becoming more and more vulnerable to water-related disasters.

Science can and should play a strong role in support of integrated water resources management. This was

emphasised, for instance, by the Global Water Partnership in its Vision to Action for South America (2000), which requests 'orientation of scientific and technological activities following demands for use of water resources' and at the 4th Inter-American dialogue on water management, at Foz do Iguacu, in September 2001. This said: 'water management strategies...need...to cope with uncertainties regarding medium and long-term climate prediction.'

Below are some regional examples of research that addresses uncertainty and risk, and provides a scientific underpinning to integrated water resources management.

#### Caracas

Scientists at the Simon Bolívar University in Caracas, Venezuela, together with North American colleagues, are mapping vulnerability of different South American regions to extreme rainfall events. They combine topographic information with long term rainfall time-series from gauging stations, recent satellite precipitation data (GOES), population information and reports on damage, and the numbers of people affected by natural disasters (international databases). By integrating this information they derive geographically explicit vulnerability maps. The results of this work, undertaken under the auspices of the International Geosphere-Biosphere programme (IGBP), provide a better estimate of uncertainty in frequency and intensity of future extreme rainfall events. This information can be used when designing protective measures against floods and their damaging effects. (For more information contact Lelys Bravo de Guenni, lbravo@cesma.usb.ve)

#### La Plata basin

Activities within the World Climate Research Programme (WCRP) are aimed at improving the understanding of warm season precipitation during the South American monsoon, its variability and possibly human-induced changes, and the way in which such variability affects regional water resources. An example of this is the impact of El Niño events on water resources. Useful predictions of El Niño can be made up to six months in advance and there is a potential that at least part of its effects on water resources could be equally predictable. For the La

Plata basin, the second largest river basin in South America, scientists have been able to demonstrate that water flows in the major rivers vary on decadal timescales, which are also linked to ocean anomalies. River flows tend to be low when the tropical Atlantic ocean is particularly cold and vice versa. Current research is focusing on better understanding these relationships to improve long-range planning of water resources in this densely populated region. (For more information contact Carlos R Mechoso, mechoso@atmos.ucla.edu)

#### Brazil

Brazilian scientists, led by the Center for Weather Forecast and Climatic Studies (CPTEC) in Cachoeira Paulista, are monitoring rainfall in the dry north-eastern states of the country to improve soil moisture estimates. Within the Proclima programme, soil moisture maps are being produced, using real-time meteorological monitoring data from the Brazilian meteorological service and a cooperative network of stations in the north-eastern states (mainly rain gauge measurements made by local communities). From these maps, areas of critically low water availability for agriculture can be identified. This information is combined with socio-economic data in a geographical information system, in order to derive early warning indicators for droughts and to provide decision support to policy makers for priority regions and drought mitigation action. (For more information contact Javier Tomasella, javier@cptec.inpe.br) ●

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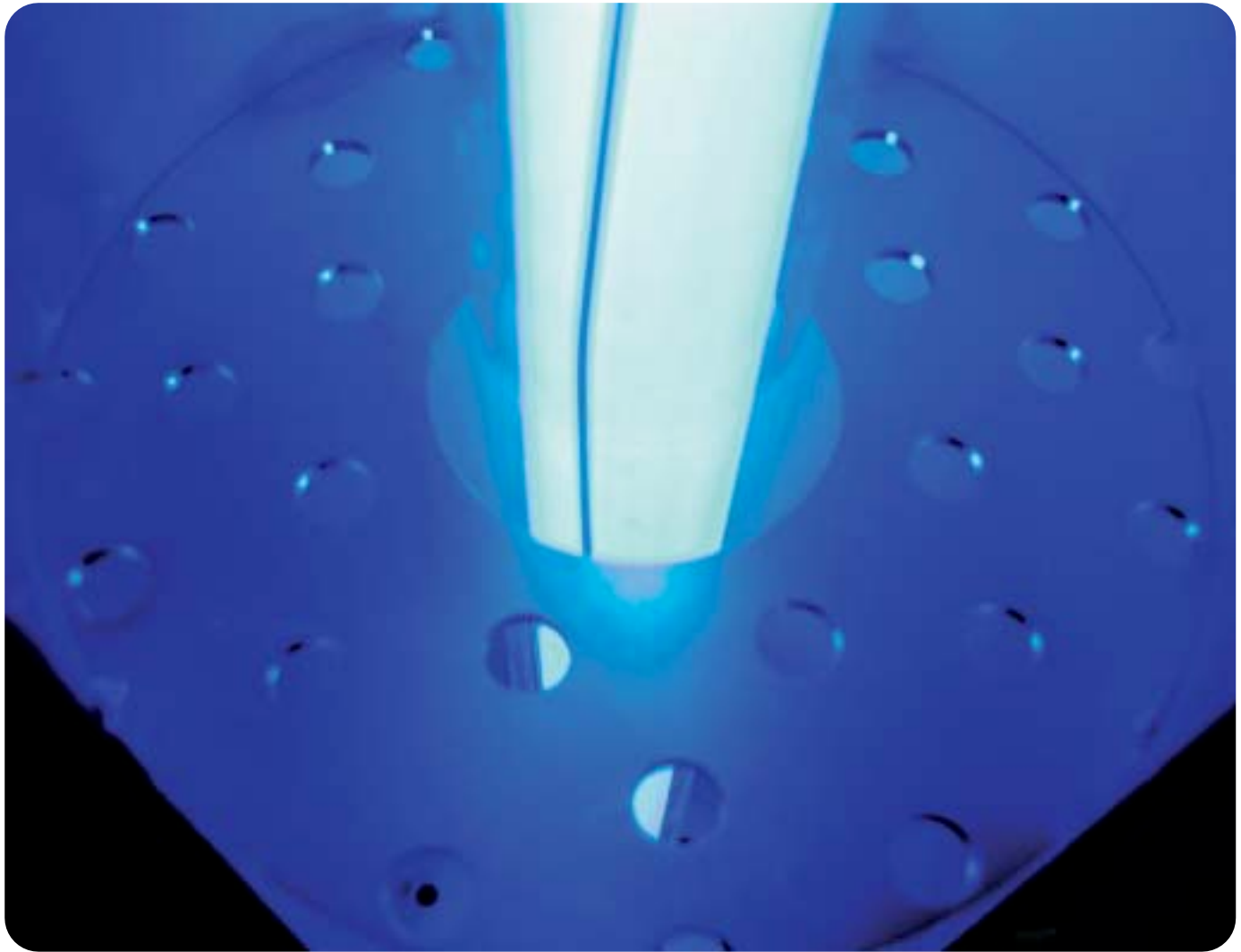
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#### The author:

**Holger Hoff is IGBP-BAHC executive officer for the Potsdam Institute for Climate Impact Research, Potsdam, Germany.**

# Disinfection developments

● Likely developments in the field of wastewater disinfection will include refinement of UV treatment and better understanding of the target organisms. **BILL McCANN** spoke with disinfection specialists **RHODES TRUSSELL** and **JOE JACANGELO**.



SEWAGE TREATMENT

Making water microbiologically 'safe' has been a primary treatment objective for a hundred years or more and, as the 20th Century progressed, there was increasing recognition that disinfection processes should not be limited to potable supplies.

Many countries now practice wastewater disinfection, seeing it as another important component in disease prevention by reducing discharge of pathogens into the natural environment.

Over the same period disinfection technology has itself been subject to great change, particularly over the last 40 years when 'new' pathogens have successively

exposed the limitations of one or other disinfection agent.

Even the word 'agent', implying a chemical additive, is no longer entirely appropriate. Physical processes such as sedimentation and filtration were initially entirely overtaken by the finding that chlorine provided the complete answer to killing or inactivating pathogens. Subsequently the concerns over disinfection by-products (DBPs) and then the issue of harmful protozoa have brought physical means forcefully back into consideration in the form of membranes and ultraviolet (UV) radiation.

One conclusion of the International

Report (IR) on disinfection, presented at IWA's Berlin Congress last October, was that the coming years will see continuing growth in application of UV radiation as an important means of disinfecting wastewater. Of the 22 countries covered in that report, 70% of those treating wastewater were using a UV process. Further anticipated improvements in the technology components such as lamps and reactor design were seen as factors in lowering capital and running costs, increasingly turning the tide against the current main competitor, chlorine.

The IR was collated and presented to the Congress by disinfection specialists

*Picture courtesy of Wedeco AG, Germany.*

Rhodes Trussell and Joe Jacangelo of international consultancy Montgomery Watson Harza. Trussell also led the Congress track on water and wastewater disinfection.

Speaking subsequently to *Water21* he said the important lesson of disinfection history was that we should not, as we did with chlorine, treat any approach as the panacea. The arrival of new organisms over the years had brought in a more conservative attitude as to effective treatments. Something could come along that exposes limitations or difficulties with any one of them.

'For example right now, as far as we know, there is no organism that can pass through an ultrafilter and probably one is unlikely to arrive, but something could come up that is insensitive to UV light. Therefore look to disinfect by whatever means seems appropriate. Do not discount any method. The best approach is a balanced one - reducing contamination at the source, improving both physical removal and inactivation processes, improving monitoring techniques and, for potable supplies, trying to improve protection in the distribution network. In short, look to improve all the separate components of the protective system,' says Trussell.

For wastewater the DBP issue does not give rise to the level of concern that has spawned a more conservative use of chemical disinfectants in potable water treatment. DBPs might well be present in chemically disinfected sewage effluents but their volatility and dilution in the

receiving waters is regarded as effective in reducing potential to harm.

According to Jacangelo there are nevertheless concerns about environmental impacts close to effluent outfalls. One of the bigger issues, he says, is fish toxicity both from DBPs and from chlorine residual. It is in avoiding both these dangers that UV provides a considerable advantage, combined with its ability to act against bacteria, viruses and protozoa.

And, as indicated in the IR, it has the potential even to be more cost effective than chlorination. Historically the latter has been less expensive to install and operate but, with more knowledge and more concerns about toxicity in the environment, it is now often necessary to add dechlorination at the discharge point to control residual. Increasing safety regulations are also adding costs, now typically requiring scrubber installations and other precautions to protect operators.

Regarding the overall worth of sewage disinfection there are clearly health benefits wherever members of the public can come into direct or indirect contact with treated effluent, such as in bathing waters or in association with irrigation re-use.

Another direct benefit quoted by Jacangelo occurs where effluents are discharged in proximity to shellfish areas. But here some very much wider issues can come into play. There are times, he says, where the best efforts to provide a pathogen-free wastewater effluent can be confounded by contamination from direct surface run-off into the same fishery.

Non-point discharges are seen as one of the major challenges for the industry in the coming years and, in the context of wastewater disinfection, another is the whole question of indicator organisms. Efforts have been made to correlate indicator organisms with actual measurements of bacterial pathogens, protozoans and viruses in the water body concerned. Investigators have found that the traditional indicators often do not provide a good assessment.

In one such project the objective was to control operation and UV dosage to achieve set levels of pathogen inactivation based on a prior risk study of people who would be exposed to the treated effluent. The risk study assessed the limits to which specified pathogens must be controlled in order to prevent disease.

To arrive at the correct inactivation dosage the team directly monitored

pathogens in the works' influent. They looked also at levels of the traditional indicator organisms in the influent and found that, if these had been relied upon, the UV dose indicated would not have been sufficient to give satisfactory levels of inactivation.

These issues of indicator organisms and pathogens in non-point discharges are tied to what Trussell sees as a future need for increasingly closer monitoring of the influence of sewage discharges on water supplies. Within that general area there is what he describes as the 'conundrum of cryptosporidium'. When infection comes from water, the original pollution generally comes from a sewage discharge 'but it is not yet clear that you only get sick from the human variety'. This means typing the cryptosporidium strain as to origin. Type 1 is human parvum, type 2 is cow parvum. 'Incidence of disease in normal people is almost always associated with type 1'.

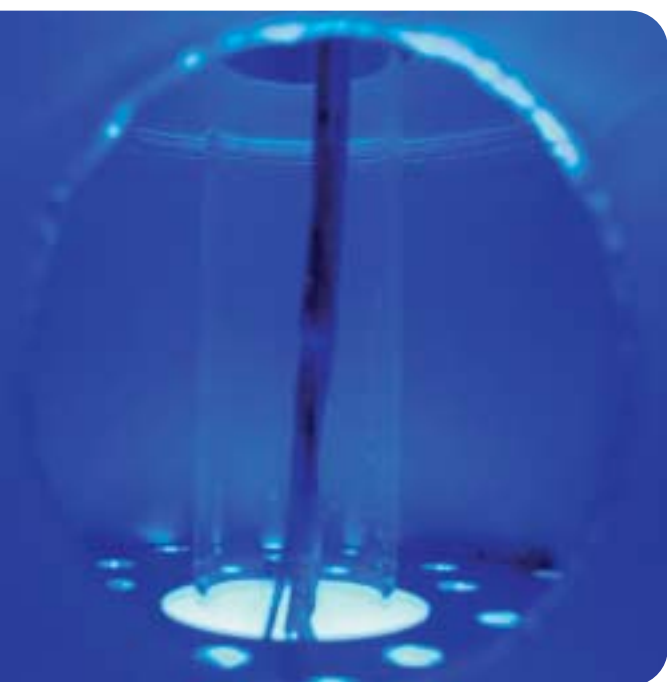
In a future in which Jacangelo sees the focus of water/health issues being more on microbial than chemical safety, another prime need is for improvements to the robustness and affordability of currently available technologies. Most of the disinfection issues can be addressed he believes but a number of technologies are available only in the richer regions. 'We must increase the range of end users'.

For Trussell overall progress on disinfection is more advanced in water than in wastewater. In his view that is due to the greater historical attention given in water treatment to protecting the public from microbial disease. Investment in wastewater research had been in other directions, only latterly looking more at pathogen releases into the environment.

In disinfection research generally, Jacangelo sees a need for more fundamental research into the mechanisms by which our disinfection agents inactivate the problem organisms.

He believes there had been too great a tendency to simply go for the practical approach each time: 'When a new danger organism is isolated we just see which technique does the best job on inactivating it. So we spend several years on that exercise for each organism. But they are all composed of biological materials; so we should be aiming for a more basic understanding of how the molecular structures and metabolic processes are affected when they react with disinfectants'. ●

Picture courtesy of Wedeco AG, Germany.



# Nutrient removal for sewage treatment

● Addition of a tertiary process provides one means of upgrading a sewage treatment plant's performance.

HANS WOUTERS looks at how this can be done using enhanced control.

Many of the activities in, for example, the UK water industry's current investment programme relate to upgrading sewage treatment plants to meet tighter discharge criteria for BOD, nitrogen, phosphate and suspended solids (TSS). A number of solutions can be implemented to upgrade current treatment plants to address these requirements, such as:

- increasing the (aerobic) bioreactor volume
- introducing biological P-removal
- introduction of biological denitrification, using selectors
- enlarging post-sedimentation, improving settling efficiency

In addition to these options, it is also possible to consider whether implementing a completely new process, going beyond improving the existing infrastructure, will be necessary in some cases.

Basically, there are two further options:

- introduction of a completely new bioreactor approach, such as a membrane bioreactor
- introduction of a tertiary treatment process or processes, leaving the (improved) existing infrastructure unchanged

In this paper we will focus on the latter, as this seems to be the most realistic and economic option for a large number of plants. More specifically, we will highlight the use of moving bed (bio)filtration (Figure 1). This type of filtration has already proved very effective for final removal of N, P, BOD and TSS without producing an excessive capital cost for the user. Both Dutch and UK experiences provide indications of the operating window and the costs. Special attention is given to the following applications:

- biological denitrification
- phosphate removal
- suspended solids/BOD removal
- biological nitrification

## Design criteria for tertiary processes

By introducing a tertiary treatment process, the unit will preferably meet the following criteria:

- stable effluent concentrations under varying process conditions, meeting the consent level(s) for the parameter(s) under consideration
- it should be a low-attendance system, as most of the treatment plants are small and site attendance has to be minimised;
- low operating costs, especially with respect to energy and chemicals (if needed);
- small footprint, in order to incorporate the process component within the existing plant lay-out
- the facility to combine process functions within the same reactor, for instance, combining removal of N, P and TSS.

The filter may be used for solids removal alone, but can also be used for, or in combination with, biofiltration. In a biofilter the biomass grows on and between the grains. The growth of the biomass is balanced against the continuous discharge of biomass into the washer at the top of the filter. As there is a constant balance between the solids/biomass in the feed water and the solids/biomass discharge in the continuous washwater flow, filter bed resistance is more or less constant

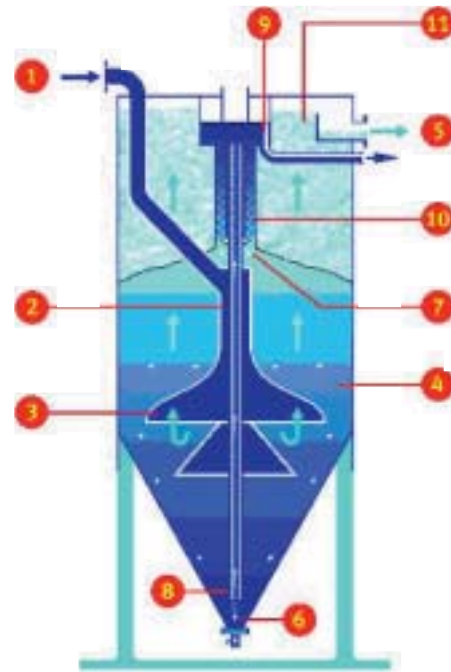


Figure 1 Astrasand moving bed filtration, operating features.

In the moving-bed filter, the water to be treated enters the device via feed pipe (1), supply pipe (2), and distributor (3). It flows in an upward direction through the sand bed (4) in a cylindrical vessel. The filtrate is discharged in the upper part of the filter (5).

The filter bed is continuously moving downward. In the bottom of the filter dirty sand (6) is abstracted from the sand bed and washed, after which it is released back on the top of the sand bed (7). The sand circulation is based on the airlift principle, forcing a mixture of dirty sand and water upward through a central pipeline (8).

The intensive scouring movements separate the impurities from the sand particles. At the top of the pipeline the air is released and the dirty water is discharged (9).

The sand settles in the washer (10) with its well-designed hydraulic features. The grains fall through the washer, where they are finally washed by a small amount of clean filtrate, flowing through the washer countercurrently. That flow is generated by a difference in discharge levels between the filtrate (11) and the wash water (9).

during normal operation. This means that relatively high hydraulic/solids loadings can be dealt with compared to the loads that static bed sand filters can absorb.

The continuous washing of the filter grains also has a disadvantage: given the wide variations in the treatment plant feed flow range (which can go from zero at

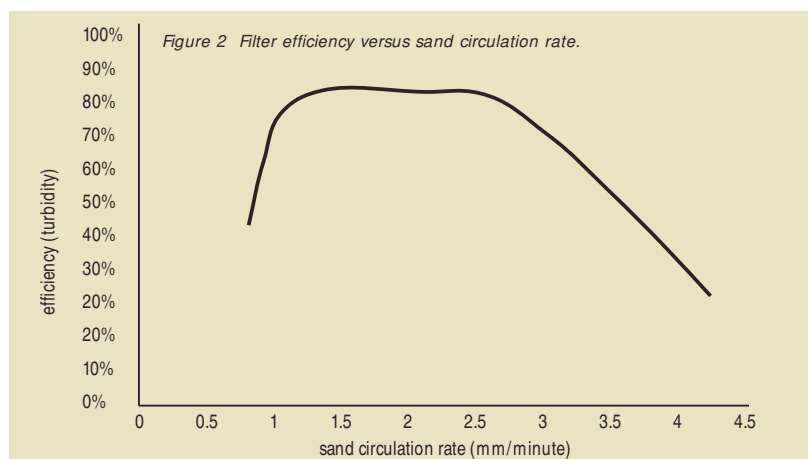


Figure 2 Filter efficiency versus sand circulation rate.

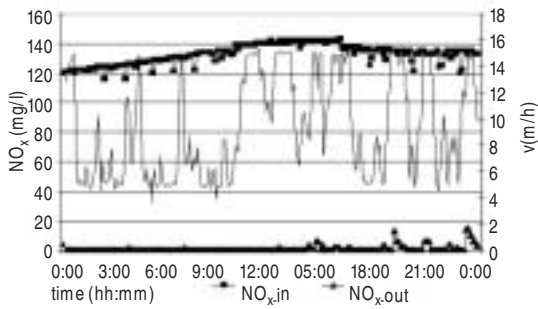


Figure 3 Denitrification performance at high biomass content within the filter.

night to maximum design flow during the day) the continuous sand circulation and grain washing might produce a poorer performance. This is shown in Figure 2 for a typical plant with phosphate removal, using iron as a flocculant.

Figure 2 indicates that the optimum sand circulation rate (the solids/ biomass removal rate) differs depending on the actual operational conditions. If the sand circulation rate is too low, solids breakthrough will occur; if it is too high, performance decreases due to poor pore filling. With biofiltration, this might result in a limited biomass volume, with limited conversion rates.

A control mode has been developed, which is particularly suitable for optimising the filtration performance of the moving bed. The Astracontrol continuously adjusts the sand circulation rate to maintain a fixed amount of solids/biomass within the filter.

The control mode's efficiency is illustrated in figure 3, based on biological denitrification at De Groote Lucht sewage treatment plant, in The Netherlands. The figure shows the unit's denitrifying performance given a hydraulic load with a high biomass content. By using the Astracontrol, it is possible to aim for a continuously high biomass content. As the filter's performance is controlled to ensure it is continuously high, the filter volume is 20 to 30% smaller than in an uncontrolled filter. Furthermore, as peak loads are handled efficiently, methanol dosage is optimised and there is negligible residual COD in the filtrate.

Figure 4 Birds-eye view treatment plant Ruurlo (picture by De Jong Luchtfotografie), filtration section indicated with a circle.



**Operating window**

The (bio)filtration operational window is summarised in Table 1.

In the table typical chemical dosages are given for the distinctive applications, in order to achieve the typical filtrate quality as indicated. With biological nitrification oxygen is either dosed in-line, under pressure as pure oxygen, or by dosing air within the filter. In the latter case the higher gas flows will cause a slight decrease in solids biomass removal. A few actual cases are indicated below.

**Phosphate removal**

In the Netherlands a number of treatment plants discharge their effluent into receiving waters with low flows. To avoid algal blooms, stringent N and P criteria are set locally by the water boards. At the Ruurlo treatment plant, which is operated by the Rijn en IJssel water board, a tertiary moving bed filtration system has been put in place to give a 0.15mg/l P and 5mg/l

section is designed for a dry weather flow (DWF) only, as the N-total target level of < 10 mg/litre N is based on an annual average. Figure 2 gives some performance data for the system. The plant reduces NO<sub>x</sub>-N levels in the feed of 25 to 35mg/litre N down to 1 to 4mg/litre N. TSS levels are also reduced from 5 to 15 mg/litre to 2 to 4 mg/litre. The filter plant's capacity is 3,600m<sup>3</sup>/h, and it contains six filter units with a filter area of 40m<sup>2</sup> each and a bed height of 3.6m. The average N loading is 2kg N/m<sup>3</sup>/day. Methanol is used as the carbon source, dosed according to the NO-N feed concentration: 3mg/mg N.

**Biological nitrification**

Foulridge treatment plant in the UK (which has a full flow to treatment of 17 litres/sec) consists of primary settlement, trickling filters and secondary settlement. The works needed to be upgraded in order to meet a stringent 9 mg/l BOD and 5 mg/l

Table 1 Typical operating window for Astrasand moving bed filtration

Process	Parameter	Typical conc. (mg/l)		Added chemical	Typical dosage
		In	Out		
Biological denitrification	NO <sub>x</sub> -N	10-50	0-5	C-Source eg. CH <sub>3</sub> OH	2.5 mg/mg
		5-10	0-1		3 mg/mg
Phosphate removal	PO <sub>4</sub> -P	5-10	1-2	Fe, Al	2-3 mg/mg P
		1-2	0.1-0.2		4-6 mg/mg P
Suspended solids removal	TSS	40-200	10-50	Fe, Al	0.2-1.0 mg/mgTSS
		10-40	1-10		
Biological nitrification	NH <sub>4</sub> <sup>+</sup> -N	5-20	1-5	O <sub>2</sub>	7-8 mg/mgN

N-total consent level during the summer. Figure 4 gives a birds' eye view of the plant, which has been in operation since 1998. The treatment plant consists of an aerobic activated sludge reactor with an anoxic zone for denitrification, followed by post-sedimentation and moving bed filtration. The filters are constructed in a concrete shell and fed by gravity from the post-sedimentation tank. The plant is designed for 9,460 population equivalents, with a maximum feed flow to the filter section of 410 m<sup>3</sup>/h. The filter area installed is 27 m<sup>2</sup>, the maximum hydraulic load equals 15 m/h. Phosphate levels are reduced from 1 mg/l P down to 0.15 mg/l P.

**Biological denitrification**

At the De Groote Lucht treatment plant, in The Netherlands (280,000 PE) a biological denitrifying moving bed filtration plant has been installed and has been in operation since 1999. The filter

ammonia-N consent. For this purpose a nitrifying moving bed filter has been installed, designed to be able to handle FFT and ammonia influent concentrations up to 13 mg/l N. The filterbed volume is 15 m<sup>3</sup>, with an installed filter area of 5 m<sup>2</sup>. The design specific loading rate is 0.5-1.5 kg N/m<sup>3</sup>/d.

Data from the first three months of operation show a relatively weak influent to the sand filter with the ammonia load averaging 1.8 kgN/d (equivalent to 0.12 kgN/m<sup>3</sup>.d). Consistent nitrification to effluent levels less than 0.6 mgAmm. N/l has been achieved. The filter was challenged by a problem at the works, increasing the influent load to 14 kgN/d. The filter responded well to the sudden increase in load, and a composite sample of the final effluent was 5.9 mg/l Amm.N.

**Specific costs**

Based on the actual references, specific

**Table 2 Specific operational costs (£/pe).**

Application	Filter feed level	5,000 PE	10,000 PE	50,000 PE	100,000 PE
Biological denitrification	10-50 mg/l N	3.38	3.19	2.81	2.67
	5-10 mg/l N	2.43	2.27	1.93	1.82
Phosphate removal	5-10 mg/l P	3.99	3.80	3.42	3.27
	1-2 mg/l P	2.76	2.59	2.26	2.14
Suspended solids removal	40-200 mg/l SS	3.37	3.21	2.88	2.75
	10-40 mg/l SS	3.05	2.81	2.33	2.15
Biological nitrification	5-20 mg/l N	4.14	3.90	3.40	3.22

operating costs have been calculated for different plant sizes and are presented in Table 2, expressed as population equivalents. Similar applications, as indicated in Table 2, have been used to calculate the specific costs. The cost components involved are:

- capital costs (given a depreciation period of 20 years, at 8% interest)
- energy costs
- chemicals cost (methanol, FeCl<sub>3</sub>, oxygen)
- maintenance and operation costs.

The calculated costs all relate to the removal of one particular parameter; where more than one parameter is

involved (for instance, removal of both N and P), the costs are not given as the sum of the indicated specific costs. Where that happens, the costs have to be re-calculated based on the maximum acceptable solids load for both N and P removal. The costs given in the table are derived from overall cost data for both the investments and the operational costs, and have been verified using the actual cost data from the constructed plants. These may be used as indicative figures for design purposes.

#### Conclusions

Moving bed (bio)filtration has proved to be a reliable, compact and cost-effective technology for removing N, P, BOD and

TSS from treatment plant effluent. Used together with the enhanced control mode, it has been shown to be a very robust system, capable of handling large variations in loading. Because of the system's continuous operation and the absence of moving parts within the filter, down-time is minimised and site attendance is minimal. ●

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# Sensitivity and sustainable development

● Modelling and simulation tools provide a means of helping focus sustainable development efforts, including in the area of wastewater treatment, and sensitivity analysis is a means of improving the results obtained.

STIJN VANHOUTTE and YURI AMERLINCK explain.

There are many ways to define sustainable development. A frequently used definition is quoted from the report *Our common future* (also known as the Brundtland Report): 'Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.'

The Brundtland definition implies a very important shift from an idea of sustainability as primarily ecological, to a framework that also emphasises the economic and social context of development.

Modelling and simulation are interesting tools in the search to quantify sustainability. The mathematical models used are composed of parameters that each individually have a relationship to the end result.

When running simulations one has to take into account a whole range of parameters, so it is interesting to know which have the greatest effect on the behaviour of the model results. Through a sensitivity analysis, one can determine the important model parameters.

Sensitivity analysis is used to increase the confidence in the model and its predictions, by providing an understanding of how the model responds to changes in the input or in the model parameters. Nowadays sensitivity analysis is also used, besides studying the effect of uncertainties in the input variables and model parameters, to verify the uncertainty in the concept of the model (that is, the model structure and assumption).

The outcome of the sensitivity analysis can be used in a parameter estimation experiment to fine-tune the model. Once the model behaviour (perfectly) fits the behaviour of the real system, it can be used for simulations, which describe the system accurately (within a particular context).

## Indicators of sustainability

An indicator quantifies and simplifies the behaviour of a complex system and helps us to understand it. Designing good sustainability indicators is a tremendous task. These indicators are grouped in three major classes - environmental, social and economic issues. Indicators are also grouped by the way they represent the links between and among the considered systems.

High-level decision-makers prefer a small number of indices (combinations of a number of indicators) that are easy to understand and use in decision-making. Even though they are sceptical that a single number can assess something as complex as sustainable development, they would prefer a single indicator.

An impact matrix of the defined components that lead to those indicators needs to be constructed to determine how sensitive the indicators are in relation to one another and to the end value.

In a recent study, the Water Environment Federation established, in coordination with Yale and Columbia University, an international environmental sustainability index (ESI). The ESI measures overall progress toward environmental sustainability for 142 countries. Environmental sustainability is measured using 20 'indicators', each of which combines two to eight variables, for a total of 68 underlying data sets.

The model used to come to this index is a function composed of five elements:

- the state of the environmental systems, such as air, soil, ecosystems and water,
- the stresses on those systems: pollution and exploitation levels,
- human vulnerability to environmental changes: loss of food resources, exposure to environmental diseases
- the social and institutional capacity to cope with environmental changes

- the ability to respond to the demand for collective efforts to conserve international environmental resources such as the atmosphere

## Sustainable development as a 'two sided market process'

The sustainability development process is mainly driven by the supply side. That is, the market is primarily driven by legislation and the marketing strategy of IT companies.

The legislative framework created to support this process needs to be efficient. In order to check its impact and the improvement on this process, reliable data and simulations are necessary.

In the past, evaluation of this process was mainly organised by the government through control and penalisation. The tendency now is for this to shift towards the demand side of the market. The demand side then realises the overall importance of sustainable development and starts to invest and co-operate to create new tools to support this process.

Sustainable development means more than conformity with legislation. It means a proactive approach from every partner involved in the process (both on the supply and the demand side).

Whether this push towards sustainability is driven from the demand or supply side, a number of general rules (keys) need to be taken into account.

The World Business Council for Sustainable Development defined these general rules into seven keys towards sustainable development.

## Innovate

Technological and social innovation can do much to improve people's quality of life and tackle the depletion of resources and the build-up of pollution. But any innovation process must be open and

sensitive to the interests of the public

**Practice eco-efficiency**

Eco-efficiency means creating more value with less impact. It can open up significant business opportunities and its predominant goal is to help economies grow qualitatively, not quantitatively

**Move from stakeholder dialogues to partnerships for progress**

It is now time to move beyond talking to one another to acting together for the purpose of sustainable development. Partnerships for progress are built on common goals, empathy, open feedback, flexibility, ability to compromise, and sharing rewards.

**Provide and inform consumer choice**

Individuals will change their consumption practices when they realise that they can gain financial benefits, better quality of life and security from sustainable behaviour. Consumer choice helps achieve sustainability via a triple-win: by improving quality of life, reducing adverse environmental and social impacts, and increasing the market

**Environmental sustainability index building blocks**

Component	Indicator	Variable
Environmental systems	Air quality	Urban SO <sub>2</sub> concentration
		Urban NO <sub>2</sub> concentration
		Urban Total Suspended Particulates concentration
	Water quantity	Internal renewable water per capita
		Per capita water inflow from other countries
	Water quality	Dissolved oxygen concentration
		Phosphorus concentration
		Suspended soils
		Electrical conductivity
	Biodiversity	Percentage of mamals threatened
		Percentage of breeding birds threatened
	Land	Percent of land area having very low antropogenic impact
Percent of land area having high antropogenic impact		

share of sustainability-minded companies.

**Improve market framework conditions**

Sustainability is hindered by monopolies, corruption, perverse subsidies, and prices, which do not reflect real economic, social and environmental costs. Legislation and regulations should promote competition, effective intellectual and physical property rights, reliable contractual terms, fair and transparent accounting standards, accountability for government intervention, freedom and democracy, and full-cost pricing of goods and services

**Establish the worth of the earth**

The market system needs accurate and timely price signals so that resources are not wasted and future opportunities squandered. Markets need to reflect the true environmental and social costs of goods and services. Proper valuation will help maintain the diversity of species, habitats and ecosystems, conserve natural resources, preserve the integrity of natural cycles, and prevent the build-up of toxic substances in the environment

**Make the market work for everyone**

Poverty is one of the single largest barriers to achieving sustainability through the market. The market does create enterprises and jobs, but there will be rewards for companies that deliberately create more opportunities for the poorest. Protectionism makes it harder for business to seize such opportunities. Making the market work for everyone involves two basic measures: enabling access to effective markets and spreading consumer purchasing power.

**Sustainability of natural resources (water)**

Since water is such a scarce natural resource, it is one of the first fields in which sustainable development became a

priority. Access to clean and fresh water is essential for everyone.

This precious resource has been poorly managed by a variety of sectors around the world and other factors, such as population growth and industrial expansion, have had a significant impact on water quality. Beside their negative impact on the water quality, they also have an impact on the available quantity of water: the growth in population and industry results in an increasing demand for fresh water.

It is of great importance that water quality in receiving bodies is of a standard that allows constant sustainable development. These receiving bodies are the supplies of fresh water needed for applications ranging from drinking water, bathing water, rivers and lakes, to the sewer system and industrial usage.

In order to reuse polluted water for these purposes, a wastewater treatment plant has to treat the water to the required level of water quality. In the wastewater treatment process, it is essential to analyse all of the sub-processes (biological nutrient removal, settling, and so on) to determine their relationship and their impact on the end result. Hemmis has developed a software tool called West specially for these purposes (Worldwide Engine for Simulation, Training and automation. See [www.hemmis.com](http://www.hemmis.com)).

**Sensitivity analysis applied to a wastewater process**

Few processes are as complicated to analyse as a wastewater treatment process. Besides choosing the right conceptual model, the interaction of the various parameters on the function and the end-result of the function need to be defined. Therefore, a physical model or a mathematical model will be needed to



Example WEST outputs

simulate all interactions present in the process.

One example, where Hemmis provided its modelling and simulation technology to achieve this, is the Aucowaco project. The Aucowaco project is an EC supported project in the Life framework, which Hemmis undertook in co-operation with EPAS NV, Seghers Better Technology for water and the Haacht brewery. Life is a European Commission (EC) programme that gives support to innovative and demonstration activities in the environmental field.

Aucowaco stands for 'optimal and autonomous control of wastewater treatment plants with structural and intelligent communication with the production'.

Three main areas of development were considered in this project:

- development of a software package for automatic information exchange between the production activities and the wastewater treatment plant
- development of a new intelligent

adaptive monitoring and control system for the wastewater treatment plant. The monitoring and control system allows an optimal and constant effluent quality. The adaptive control also ensures efficient energy use

- development and selection of the best clean water purification and production process for the brewery project. Advanced techniques such as membrane filtration and oxidation and disinfection techniques will be used to produce highly purified water that can be used as process and cleaning water (water re-use)

These developments allow totally integrated water management, which reduces groundwater intake, wastewater discharge and energy use. For more information on this topic, please contact the author.

#### Conclusion

Sustainable development is extremely difficult to measure - there are a lot of parameters that have an impact on the process. Modelling and simulation are

interesting tools to use to quantify sustainability. When running simulations it is necessary to take into account a whole tranche of parameters, so it is interesting to determine, using sensitivity analysis, which parameters have the greatest effect on the behaviour of the model results. ●

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# Research extends understanding in MBR applications

Included in presentations to the recent IWA-backed membrane technology symposium in Tel Aviv, Israel\*, were two interesting papers covering progress and latest advances of the technology in Italy. Common to both was reference to the Zenogem membrane bioreactor (MBR) technology, based on membranes produced by Zenon Environmental.

Speakers from the Zenon company with colleagues from the universities of Venice, Ancona and Verona reviewed the application of Zenogem MBRs to municipal wastewaters, tip leachates and effluents from the pharmaceutical and food industries.

They spoke also of the early results from pilot scale testing on a mixed municipal and industrial effluent being discharged into the highly sensitive waters of the Venice lagoon, a project covered specifically and in more detail in a second paper by the university speakers.

A concentration on plants treating pharmaceutical effluents was clearly indicated with results presented from nearly 20 Italian installations in which design throughputs varied from 50 to 2760 m<sup>3</sup>/day, with many in the 150 to 500 m<sup>3</sup>/day range. Process parameters were equally wide-ranging, organic loading varying from 1.4 to 4.3kgCOD/m<sup>3</sup>/day, hydraulic retention time from 33 to 168hours and sludge retention time from 30 to over 200 days.

Across this range the plants recorded satisfactory performances, generally removing 90 to over 98% of COD and almost all ammoniacal nitrogen.

Less data was produced for plants treating food industry effluent or landfill leachates. In relation to the latter it was noted that input to a treatment plant is significantly influenced by the phase of decomposition within the landfill. In one 300m<sup>3</sup>/day Italian plant referenced here the influent COD and TKN were recorded as 6600mg/l O<sub>2</sub> and 4500mg/l N respectively. Treatment removed 99.8% of the nitrogen but only 66.7% of the COD, mainly due it was said to the presence of 'highly recalcitrant' compounds.

While Zenon produces a 21mm tubular membrane, the Permaflow, it was noted that the alternative hollow fibre membrane, the ZeeWeed, is more applicable to the larger flows generally generated in municipal wastewater systems. This type of ultrafiltration membrane, mounted vertically within modules submerged within the biological reactor, is the configuration in use for experimental work on a mixed municipal and industrial effluent discharging into the Venice lagoon.

This output from the Fusina wastewater treatment plant has to be brought into compliance with a July 1999 government decree tightening the standards for nutrients

and certain micropollutants in the treated effluent.

The works uses sequential batch reactors (SBRs) and secondary clarifiers and the pilot plant imitates this with an SBR but with solids separation by membrane rather than settling. Flow rate into the 1.4m<sup>3</sup> pilot SBR was 2.4m<sup>3</sup>/day and, during the initial work reported here, the emphasis was on simulating current conditions in the full-scale plant. Thus the membrane eliminated the potential for problems associated with final settling, particularly rising sludge overflowing into the final effluent, but sludge was surplussed so as to keep mixed liquor suspended solids (MLSS) at a level reflective of conditions in the main plant.

Influent to the pilot unit came from the balancing tank of the main plant, so was screened and dewatered. The pilot was initially seeded with nitrifying activated sludge from the main reactors where MLSS were 3.4g/l with about 62% volatile solids. During the 15 days of experimentation MLSS in the pilot plant stabilized at around 3.6g/l with about 83% volatiles.

Amongst encouraging indications from the work were an average carbon removal efficiency of around 91% and a steadily rising ammonia uptake rate.

Biological phosphorus removal, recorded at around 62%, while

typical of that seen in conventional activated sludge plants, is expected to be significantly enhanced during subsequent phases of experimentation when MLSS concentrations will be increased and the effects of longer sludge retention times tested.

To these advantages must be added the positive effects of practically 100% solids retention by the membrane with correspondingly high levels of removal of microorganisms, trace metals and other micropollutants. **BM**

\*Membrane Technology for Wastewater Treatment and Reuse, Tel-Aviv, Israel, 9-13 September 2001, co-sponsored by the International Water Association.

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*Start-up and preliminary results of a submerged ultrafiltration membrane SBR for the treatment of domestic and industrial wastewater discharging into Venice Lagoon (Italy).* L. Innocenti and D. Bolzonella (University of Verona), P. Pavan (University of Venice), and F. Cecchi (University of Vermao).

## Privately funded project underway in China

Construction on what is described as one of the first privately funded municipal wastewater projects in China is underway, following the ground-breaking ceremony held at the end of last year on the Xi Lang treatment plant for the city of Guangzhou.

Guangzhou is a major international trade centre for Southern China. Nearly five million people live in the city, which is located on the Pearl River, some 190 km from Hong Kong.

The treatment plant is being

built under a design, build, finance and operate contract awarded to US-based Earth Tech. The 20-year, \$120 million joint venture agreement is said to be the first Sino-American agreement of its kind.

The new treatment plant is to be completed in two phases. The first will treat 200,000 m<sup>3</sup>/day (52MGD) and serve most of the city's Fang Cun District, described as the largest and fastest-growing district in Guangzhou. This phase is scheduled for completion in two years, after which Earth Tech will

manage and operate the system for 18 years.

The second phase will provide treatment of an additional 200,000 m<sup>3</sup>/day of wastewater.

Earth Tech president Diane C Creel commented: 'This is a significant project not only for Earth Tech and Guangzhou but for the global marketplace as well. It demonstrates the kind of infrastructure improvements that can be realised through teaming relationships with private and public sector groups.'



She continued: 'As a thriving metropolis, Guangzhou is growing at a rate of 13% annually, but faces severe environmental challenges. Earth Tech's financing capabilities and expertise in total water management enables us to help the people of Guangzhou manage these challenges efficiently.'

## Granular improvement to activated sludge

Research at Zagreb University, Croatia, is claimed to have led to development of a new technology for the biological treatment of industrial and municipal wastewaters.

Called Argus (Aerobic Granules Upgrade System) the technology depends on use of a granular biomass instead of a conventional floc in the activated sludge reactor.

Of the two principal advantages claimed for the development one is the high rate of settling obtainable, allowing for a reduction in size of the settling tanks and faster recycling of the active biomass.

In addition the granular formation is said to maintain a variety of microorganism strains, especially of those species capable of degrading specific compounds and those with low specific growth rates that would be vulnerable to undesirable washout from conventional treatment systems.

In the latter category come the autotrophic microorganisms essential to the nitrification process. Thus Argus can protect against inhibition of nitrification and, because of this maintained variety of microorganism strains, is said also to be better able to withstand shock loads and to be capable of degrading xenobiotics.

The Zagreb team has built on earlier work on the 'spontaneous conglomerate forming phenomenon', from the early 1990s reports of such structures in the anaerobic treatment of sugar industry wastewaters to more recent research on granulation associated with aerobic biomass.

Their pilot plant studies have used mixed cultures of selected nitrifying and denitrifying bacteria in association with a synthetic mineral medium of ammonium, potassium, magnesium, iron,

sodium and calcium compounds. The mixed culture granules were formed under controlled conditions of temperature, pH, dissolved oxygen and ammonia in the medium.

They worked with wastewaters from the pharmaceutical industry producing antibiotics, vitamins, and various chemically synthesised compounds, and have reported positive results from a pilot nitrification/denitrification plant in which the reactors for pre-denitrification, nitrification and settling had volumes of 30, 230 and 50 litres respectively.

They concluded that addition of the nitrifying/denitrifying mixed culture granular biomass significantly improved process efficiency over conventional activated sludge and that granule quality remained stable even at significant changes in wastewater quality and system operating conditions.

A further conclusion was that aerobic granulation showed good potential for treatment of different industrial wastewaters, especially those from pharmaceutical and chemical processing. In such wastewaters a high content of xenobiotics can inhibit conventional biological treatment.

Results of the development work are being presented at a UK conference this month and are said to be already in course of application to the upgrading of several pharmaceutical and chemical wastewater treatment plants in Croatia.

The combined development team, from The Faculty of Food Technology and Biotechnology at Zagreb University and the Croatian Company EcoEngineering Ltd, expect the first results from these full-scale plants to be reported next year. **BM**

## Wastewater solution for Illawarra

A A\$197 million infrastructure project, the Illawarra Wastewater Strategy, is being undertaken for Sydney Water Corporation by the Walter-Vivendi Water Joint Venture. The project focuses on the region just south of Sydney, Australia, and will protect the ocean environment, clean up the beaches and save drinking water.

The project is due to be completed in late in 2004, when the city of Wollongong will have one of the most technologically advanced coastal treatment plants in the world.

Currently wastewater from the Illawarra region receives treatment at three separate facilities (Wollongong, Port Kembla and Bellambi) prior to near-shore ocean discharge. The project involves the consolidation of flows from these three sewerage catchments and their transfer, via new pipelines, to an upgraded facility at Wollongong for high-level treatment and re-use.

The existing treatment plants at Bellambi and Port Kembla will be decommissioned and converted into specialised storm plants,



which will operate only in extreme wet weather conditions. This will result in a combined total of six discharge events per year at these two sites.

The Bellambi storm plant will be constructed underground, allowing the return of this picturesque area of coastline to the public for recreational use. The plant will use high rate ballasted sedimentation technology, Actiflo, in combination with ultraviolet (UV) disinfection.

The upgraded facility at Wollongong is designed to treat flows of up to 177 ML/d (three times average dry weather flow (ADWF)) in the biological plant. This is followed by sand filtration

and UV disinfection.

The design maximum capacity of the new Wollongong treatment plant will be 320 ML/d. The flow in excess of the biological systems capacity will be treated with the same combination of technologies as the Bellambi storm flow treatment plant, that is Actiflo and UV disinfection.

The works will include the augmentation of the existing conventional activated sludge plant, by the provision of a new biological nutrient removal plant encompassing biological nitrogen and phosphorous removal (BioDeniph). Single media sand filters will be constructed to provide tertiary treatment and

effluent will then either undergo UV disinfection prior to discharge through a new deep-ocean outfall, or be processed further by a newly constructed Water Recycling Plant (WRP).

The WRP will utilise Memcor continuous membrane filtration (CMF) and reverse osmosis (RO) to produce 20 ML of reclaimed effluent a day for use at the nearby BHP steel mill. It is one of the largest wastewater reuse facilities in Australia, and has the dual environmental benefit of decreasing average ocean discharge volume by 40%, while also decreasing the use of potable water in the steel manufacturing process by greater than 60%.

The existing Wollongong (LEFT) and Bellambi treatment plants



# Modelling advance for river quality

● The IWA's Task Group on river water quality modelling has developed a base from which standardised and consistent models can be formulated. **PETER SHANAHAN**, a member of the group, looks at the group's advances and ongoing work.

*The Lahn River, one of the original case study locations. (Picture courtesy Dietrich Borchardt)*

A newly published IWA Scientific and Technical Report has launched the next phase in the work of the Association's Task Group on River Water Quality Modelling. The Task Group was chartered in 1997 under the former IAWQ 'to create a scientific and technical base from which to formulate standardised, consistent river water quality models and guidelines for their implementation.' Its goal was to create a river water quality model that was compatible with and derived from similar principles to the highly successful IAWQ activated sludge models (ASM-1, ASM-2, and ASM-3). The recent publication of Scientific and Technical Report No. 12, River Water Quality Model No 1, achieved that initial goal and the Task Group is now seeking to foster model implementation and testing by cooperating with researchers throughout the profession.

The original impetus to develop a new river water quality model came from work by Professor Laszlo Somlyódy, head of the Department of Sanitary and Environmental Engineering at the Budapest University of Technology and Economics in Hungary. During the early 1990s, Professor Somlyódy led a research project at the International Institute for Applied Systems Analysis (IIASA) in Laxenburg, Austria, which was looking for efficient ways to improve environmental water quality in the transition economies of Central and Eastern Europe. He found that one key element was not addressed by existing commonly available water quality modeling tools: a direct link between wastewater treatment system models and river water quality. This gap made it difficult to determine, for example, the levels of wastewater treatment that would be most cost-effective in improving river water quality. Professor Somlyódy made developing such a model the goal of the IWA Task Group, which he has chaired since its inception in 1997. The other members of the Task Group are Dr Dietrich Borchardt of Kassel University in Germany, Professor Mogens Henze of the Danish Technical University, Professor



Wolfgang Rauch of the University of Innsbruck in Austria, Dr Peter Reichert of EAWAG in Switzerland, Dr Peter Shanahan of MIT in the United States, and Professor Peter Vanrolleghem of Ghent University in Belgium.

Virtually all river water quality models follow the basic principles established over 75 years ago by WB Streeter and EB Phelps. They developed a mathematical representation of dissolved oxygen relations in the Ohio river in the United States and published their work in 1925 in a now-classic report by the US Public Health Service. Their formulation represented biodegradable waste as biochemical oxygen demand-BOD-and considered the balance established between depletion of dissolved oxygen by BOD and its replenishment by oxygen from the atmosphere. The basic concepts and principles established by Streeter and Phelps continue to be the core of the standard approach to river water quality modeling.

Despite this long history, the classic Streeter-Phelps formulation is not without its limitations. River water quality models use BOD to represent biodegradable matter and thus does not allow for mass balances for any of the components, while ASM models use chemical oxygen demand, COD. COD was

chosen for the ASM model because of its fundamental advantages: it provides a link between electron equivalents in the organic substrate, the biomass, and the oxygen utilised, and mass balances can be formulated in terms of COD. However, there is no simple and consistent translation between BOD and COD and thus no clear link between wastewater treatment system models and the river models. The use of BOD also creates other problems. BOD is the result of a bioassay test and is not a uniquely defined chemical constituent. Thus, mass balances between, for example, the water column and riverbed cannot be closed. This means that if a poorly-operating wastewater treatment plant is upgraded to eliminate settlement of biodegradable matter to the stream bottom, a BOD-based model cannot be formulated to correctly account for the reduction in dissolved oxygen demand by riverbed sludge deposits. When drastic changes in wastewater treatment are being considered, as was contemplated in Central and Eastern Europe during the IIASA study, existing river water quality models cannot be truly predictive.

These and other problems with river water quality models diminish the forecasting ability of existing models, particularly when significant changes alter

the river's pollutant load, stream flow, morphometry, or other basic characteristics. Identification of these inadequacies in existing river water-quality models led the Task Group to re-evaluate the approach to water quality modelling and suggest a new alternative. The Task Group had these specific goals:

- to re-evaluate models developed during the past three decades and to eliminate such inherent inconsistencies as the lack of closed mass balances
- to guarantee compatibility with the IWA activated sludge models to enable integrated analysis of wastewater treatment and receiving water quality impacts
- to include and improve process descriptions such as nitrification, denitrification, and those related to sediment, benthic fluxes, attached bacteria and algae, and macrophytes

The initial result of this effort is River Water Quality Model 1, RWQM1.

Compatibility with the activated sludge models was a key goal. The ASM approach is attractive in that it is based on variables that are precisely defined and are fundamental quantities rather than bioassay indicators like BOD. Variables include COD, nitrogen (N), phosphorus (P), and biomass, all of which are related stoichiometrically. Dissolved and particulate fractions are represented separately, a formulation that provides flexibility for modelling sediment deposition and erosion and thereby benthic processes. The STR also includes guidelines for simplifying the model when appropriate by leaving out those processes that are not needed in a particular river system.

The Task Group has named its model RWQM1, a name deliberately similar to ASM1, which it emulated not just in formulation but also in publication. Like the ASM models, RWQM1 is a conceptual model rather than a computer program. The Scientific and Technical Report (STR) describes the foundation and formulation of the model - it defines the water quality components that the model simulates; it gives the equations for modeling water quality processes; and it defines the parameters that govern process rates and component transformations. These are given in sufficient detail that other researchers can construct models within

their own software frameworks.

RWQM1 is a first step and can be improved upon. The Task Group identifies areas of possible additional effort in the STR. The representation of benthic processes could include potentially important detachment and resuspension phenomena, and more sophisticated models of the dependence of rate constants on environmental factors could be developed. Additional processes could be added to the model, including anaerobic processes, luxury uptake of nutrients by organisms, macrophytes, and silica cycling. With such ideas in mind, the Task Group looks forward to continuing development efforts within and outside its own number.

The Task Group's aim now is to encourage further research and application of the model by others. Task Group members are themselves continuing to develop and apply the model, as described further below, but are particularly hopeful that others will take up the model and experiment with it in a variety of new settings and problems. The STR includes a range of suggestions for future research, but routine applications of the model to new case studies would be highly beneficial. Given the historical emphasis on BOD for river water quality modelling and assessment, there are relatively few datasets that include COD. Identification of additional datasets and testing of the model against them would provide valuable assessment of the new model.

As mentioned above, the work by the Task Group continues and individual members are working with the model. Peter Reichert of EAWAG is the primary author of RWQM1 and he is directing his attention to further improvements to the model's formulation. Prior to publication of the STR, Dr Reichert prepared an RWQM version of EAWAG's AQUASIM computer code and applied it to the river Glatt in Switzerland. He and Martin Kuehni of EAWAG are researching additional enhancements to the model formulation that will improve the representation of benthic and sediment processes as well as anaerobic mineralisation based on sulphate, manganese oxide, iron hydroxide, and methanogenesis.

Dietrich Borchardt continues his work on surface water connectivity with the hyporheic zone of rivers together with Detlev Ingendahl, a post-doctoral Fellow

at the Institute of Water Resources Research and Management, at the University of Kassel, after his research visit with Peter Reichert's group. They are prepared to extend the simulation of oxygen balances towards nitrogen components, including studies regarding impacts of wastewater treatment plant effluents and combined sewer overflows on river sediments over a range of spatial scales. A second study intends to develop RWQM1 as a tool for river basin management within the new European water legislation (the EU Water Framework directive). The test basin is the river Werra in central Germany.

Two projects are underway at BIOMATH, the Department of Applied Mathematics, Biometrics and Process Control at Ghent University under the direction of Peter Vanrolleghem. In one study, Veronique Vandenberghe is using RWQM1 in her PhD study 'Sensitivity and uncertainty analysis in river water quality modelling'. She completed earlier research with a BOD-based model - a version of the US EPA QUAL2E model implemented in an extension of USDA's ESWAT, the Extended Soil and Water Assessment Tool - modified to allow for integrated modelling of the water quantity and quality processes in river basins. She now plans to use an RWQM1 model implemented in ESWAT for comparison with the QUAL2E approach, using the small Dender river catchment in Belgium (1384km<sup>2</sup>) as a case study. Further research will focus on a global sensitivity analysis for the RWQM1 parameters.

In a second study at BIOMATH, Tolessa Deksissa Chuco is using the RWQM1 implementation in the WEST modelling and simulation package as a basis for a dynamic fate model for point source pollutants. The necessary extensions deal with the specific removal processes for these particular pollutants, consider the sediment and bulk water interactions, and will be expanded to focus on water-sediment interactions for xenobiotic organic pollutants. This study will also allow examination of the compatibility issues found when linking RWQM1 and ASM-type models.

Arjun Nair, a graduate student at the Massachusetts Institute of Technology, is working with Peter Shanahan to develop a RWQM1 version of the US EPA WASP (Water-quality Analysis Simulation Program) model. The program code is

being modified to place the RWQM1 kinetic functions into the WASP framework, which is familiar to many water-quality modellers in the US. The program will be applied to a case study in a small river basin in Massachusetts that is threatened by excessive nutrient loads. Coding is expected to be completed by May 2002, at which time the program source code will be available on the RWQM website. Also planned at MIT is a test of the model on some recently identified river water-quality datasets from the 1980s which include COD.

Mogens Henze at the Technical University of Denmark is looking into incorporating RWQM into the Danish Hydraulic Institute software. At the Budapest University of Technology and Economics, Laszlo Somlyódy and his PhD student, Mark Honti, will be conducting a systematic study of the sensitivity of the RWQM to input parameters and an analysis of historical oxygen household data for the Sajó river in the north of Hungary, which was one of the most polluted rivers in the country before the political changes. Wolfgang

Rauch at the University of Innsbruck will be investigating possible extension of the model to enable RWQM to comply with the targets of the EU Water Framework directive.

Laszlo Somlyódy will host an RWQM workshop in Budapest in September 2003. The purpose of this event is to gather together active and prospective RWQM users and researchers to exchange ideas, computer code, and application results and to plan further cooperative efforts with the model. Interested participants should get in touch with Professor Somlyódy at [somlyody@vcst.bme.hu](mailto:somlyody@vcst.bme.hu). A preliminary list of workshop topics includes the following: case study applications; comparison of simple and more complex model structures and their applications; sediment and benthos related studies; estimation of impacts of emission reduction measures; calibration, validation, sensitivity and uncertainty studies; and efforts towards creating various extensions.

These activities represent only a small subset of the areas for further research

identified in the RWQM1 STR, and there are many opportunities for interested researchers to work with RWQM1. We encourage potential cooperators to contact us via the RWQM website, which can be found at <http://biomath.rug.ac.be/~peter/strwqm1.html>

**The author:**

**Dr Peter Shanahan is with HydroAnalysis Inc, Acton, MA, and is a Senior Lecturer at the Department of Civil and Environmental Engineering, MIT, Cambridge, MA.**

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# Are you certain about uncertainty?

● There are hundreds of meters to choose from, so in theory flow measurement has never been easier, but understanding actual performance is more complex.

JOHN MILES explores the issue of uncertainty.

How often have you been confronted with a flow measurement problem and thought the answer was going to be simple, only to find that the results were not what you expected? Of course there are plenty of sales people, armed with very impressive literature from the meter manufacturers, ready to convince you that their product is just what you want. It is unlikely that any of them will tell you that another meter will do the job better than theirs, so how can you make the right choice? This article will try to look behind the headline figures to study the more important issues to be addressed.

When a purchaser prepares a metering specification, it is likely to include parameters such as line diameter, maximum and minimum flow rates, line temperature and pressure, and a number of other parameters connected with the specific application. There may also be a reference to the required measurement accuracy.

The last item in this abbreviated list may sound simple, but is often the cause of greater misunderstanding than any other. In the first place, it is impossible to determine the accuracy of a measurement since that would demand a prior knowledge of the true value, thereby rendering the actual measurement pointless. In the flow measurement industry, the use of the term uncertainty is therefore gaining acceptance. Uncertainty defines the range of errors within which a measurement can be expected to fall. It is determined statistically and must therefore be qualified by a confidence statement. Thus an uncertainty may be quoted as  $\pm 1\%$  at the 95% confidence level, meaning that a particular meter can be expected to show errors within  $\pm 1\%$  on 95% of occasions.

The statistical basis for the definition of uncertainty implies that in this example, measurement errors will generally be well below 1%, but larger errors will occur and on occasions they may actually be greater than 1%.

In the water supply industry, uncertainty requirements for meters may be specified by government regulation, by commercial agreement or by the company's internal

standards. An installed measurement uncertainty of  $\pm 2\%$  is sometimes specified. This figure may be contrasted with custody transfer requirements in the oil industry, where measurement uncertainties closer to  $\pm 0.2\%$  can be achieved. It may therefore be thought that the water industry specification is easy to meet, until it is considered that a typical custody transfer metering system for oil operates within a tightly-defined range of conditions and may cost over £1 million. These are hardly realistic considerations for water measurement.

It is also very easy to be misled by manufacturers' specifications, which often show impressive 'accuracy' figures. In the first place, confusion can arise from the use of percentage reading, percentage rate and percentage FSD to define these figures. The first two are really saying the same thing, that is, that any errors in the meter's performance are constant in percentage terms over the meter's operating range. The third definition, on the other hand, means that the errors are a fixed percentage of the maximum flow rate over the range of operation. This means that if a meter has an error of 1% at maximum flow rate, its error will be 2% at 50% of maximum and 10% at 10% of maximum. Clearly this meter should be avoided unless it will be operated at maximum flow rate at all times.

Having uncovered one source of confusion, we now need to question how the figures were actually derived. It may be that the meter was calibrated on the manufacturer's in-house facility and the results produced from a comparison against the facility's reference standard. Leaving aside for a moment the fact that this standard introduces its own errors, the quoted accuracy figures may be little more than a statement of the range of errors experienced in a series of tests against the standard. Depending on how the figures are presented, it is possible that they simply duplicate data for the meter's repeatability and linearity.

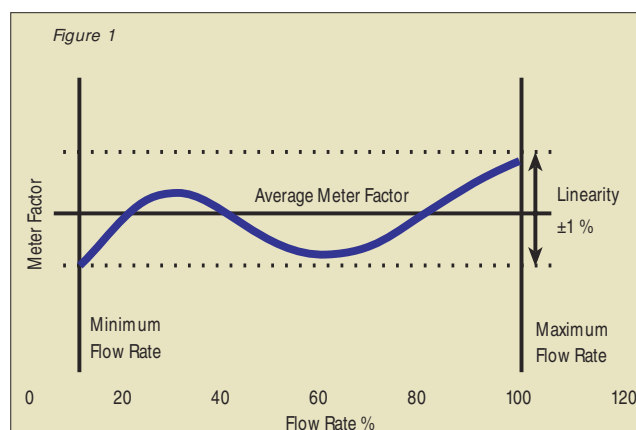
Repeatability defines the range of the results of a number of consecutive tests

conducted with the same operating conditions, whilst linearity specifies the range of meter factors or errors within which a meter calibration curve fits between specified maximum and minimum flow rates. Figure 1 illustrates the linearity of a meter and indicates how an average meter factor may be used to represent the meter's performance over its working range.

In reality there are many factors that affect a meter's installed uncertainty, and some of them are much more significant than those discussed above. The more important factors are described below.

## Pipeline installation effects

Most meters are designed to accept a fully developed velocity profile, that is, the velocity distribution that occurs at the downstream end of a long uninterrupted run of straight pipe. Unfortunately velocity profiles can be severely distorted by the presence of a bend, a valve, a reducer or a branch in the pipeline, and the performance of many types of meter used in the water industry will be compromised when installed downstream of such components. This means that meter factors and other performance parameters derived on a flow test facility are not replicated in the field and the metering uncertainty increases accordingly. The commonly accepted requirement for 10D (10 pipe diameters) of straight pipe upstream and 5D downstream of the meter should be regarded as the absolute minimum.



**Deposits within the pipeline**

In certain situations deposits can build up within a pipeline, effectively reducing its diameter. Even relatively small deposits can affect the performance of a meter and in extreme cases flow areas have been reduced by more than 50%, creating huge measurement errors.

**Meter sizing and flow rates**

Meters are usually sized according to the anticipated maximum flow rate. In some instances this flow rate occurs only rarely and the meter operates well away from its optimum condition for much of the time, especially at night, thereby increasing the uncertainty. This is a particular problem with turbine-type meters since their errors can increase significantly at low flow rates. Even electromagnetic meters, which have a relatively large working range, can be affected because they may be operated in a region where the average meter factor (see figure 1) is not appropriate.

**Calibration**

In the ideal world meters should be calibrated in situ under operational conditions. Although this may not always be possible, reliance on the manufacturer's data (which may be quite realistic for the test facility on which it was derived) makes no allowance for the various effects discussed above and inevitably compromises measurement uncertainty. Calibration methods that address only the meter's electronics should be treated with caution since they take no account of installation effects or the build up of deposits over time. It should also be noted that the use of insertion probes should only be regarded as a spot check on the meter's performance. Such probes are likely to have a significantly greater uncertainty than the installed meter, so treating them as calibration devices can produce misleading results. Even differences of 5% between the installed meter and the

traverse probe may well due to the probe rather than the meter. Of course it is possible to traverse an insertion probe across a pipe diameter. This provides more information and allows velocity profile comparisons to be made against previous traverses, but it is still not a calibration.

If some or all of these factors are ignored or simply overlooked, it is very easy to find that measurement uncertainties have drifted well outside +/-2% and that it becomes impossible to achieve a balance across a zone or to identify leaks before they become serious. Given all the variables involved, the only realistic way of resolving such problems is to have the system audited by a specialist company such as SGS. They will take account of the basic capability of the meter, all the installation effects, flow rate variations over time and any other relevant information to arrive at a figure for the installed measurement uncertainty. If this uncertainty is not acceptable then recommendations can be made for improvement, with priority given to the biggest improvements for the lowest cost.

To close this paper it is worth looking at some of the practical benefits of focusing on measurement uncertainty. Consider the simplified zonal metering system consisting of one inflow meter and ten independent outflow meters as shown in Figure 2. Assume that the total outflow is divided equally between the outflow meters and that each meter (inflow and outflow) has an uncertainty of 2%. Since the outflow meters operate in parallel the overall uncertainty of outflow measurement,

$$U_{out} = +/- 2 / \sqrt{10} = +/- 0.63\%$$

The zone balance is obtained by comparing the inflow with the total outflow and any leakage or loss in the zone is determined from the difference between these quantities. The uncertainty in the loss figure is derived from a combination of the inflow and outflow uncertainties:

$$U_{loss} = \sqrt{((U_{in})^2 + (U_{out})^2)} \\ U_{loss} = \sqrt{4.4} \\ U_{loss} = +/- 2.1\% \text{ of inflow}$$

This means that where differences of less than 2.1% between the inflow and total outflow are observed, it is impossible to determine whether they are due to leakage

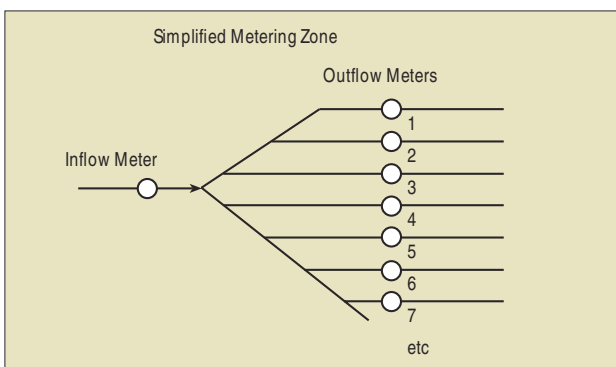
or measurement error. It is clear that the major contribution to the loss uncertainty comes from the inflow meter, and this should be the first priority for improvement. If the inflow uncertainty is reduced to 0.5% by installing a better type of meter and by giving detailed attention to the factors discussed earlier, then the loss uncertainty reduces to +/-0.8%.

Admittedly this is a simplified example, and in practice the flow is unlikely to be split equally between the outflow meters. However, a real life situation is also amenable to an analysis of this kind and the method can be combined with the audit procedures described above to provide optimum solutions for metering problems in the water industry.

Finally, we can summarise all these arguments in three key statements:

- information in the meter manufacturer's literature can only give us an indication of the meter's capability. It cannot possibly tell us what the installed uncertainty of the meter will be
- we can best establish the meter's installed uncertainty through an in situ calibration using a traceable reference standard. Insertion probes and calibrations of the meter's electronics do not achieve this.
- accepting that in situ calibrations may not be possible in the water industry, we can obtain a realistic estimate of a meter's installed uncertainty through a full audit of the system. This takes account of all the relevant variables and provides the necessary information to reduce uncertainty and improve zone balance data.●

Figure 2



**The author:**

**Dr John Miles is consultant to SGS Redwood Services. He joined SGS in 1980 and retired from the company at the end of 1999, having been Group Technical Director and a Divisional Director of the company.**

# Global moves on metering

● How one company is working to move the global metering market forward.

*FAR RIGHT: STS metering services managing director Alex Elder. RIGHT: One of STS' SmartMeter range.*

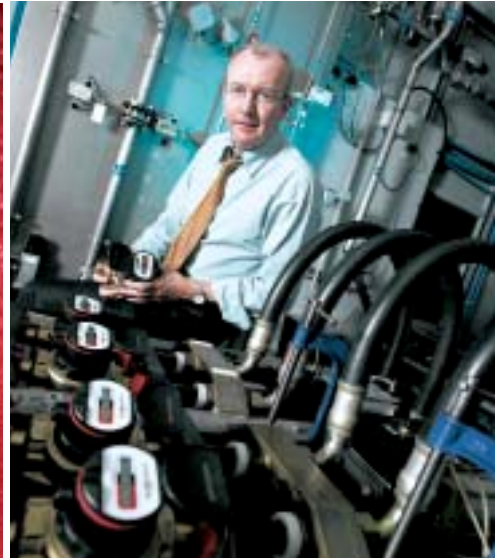
**S**evern Trent Services, through its Metering Services division, has announced some important developments that it hopes will provide the company with the means to enter new markets worldwide.

The developments all relate to the company's SmartMeter technology, its meters that use the principle of fluidic oscillation to measure flow. With no moving parts, the meter is not affected by grit and is said to maintain performance throughout its 15-20 year life, during which time the meter's battery should only need replacing once. Not only this, the technology allow low flows to be measured, as well as only registering true flow: air flow does not register.

The first development is that STS is offering the SmartMeter technology on a leasing basis. The company offers a range of options, from acquiring a meter to a complete installation service that includes a call centre service. STS says the service could even extend to providing a meter reading service, delivering a specified number of readings in the required format, all for an annual charge.

The company's decision to offer the leasing option stems, it says, from a growing trend in the industry to move away from asset ownership. This is combined with the characteristics of the product, such as its lifespan, which it says makes it suitable for a leasing agreement.

As a broad indication of likely costs, STS says it envisages that a complete



installation programme, fitting encoded meters internally, wired to external meter reading pads, could be achieved for less than £20 per year per installation. It says that building a complete automatic meter reading system onto this basic meter installation programme would add approximately £10 a year to costs. In all this would give a guaranteed 12 readings per year automatic meter reading programme for around £30 a year, including all software and network costs.

Interest is already said to have been expressed from the US, the UK and other European countries in the leasing option.

In a further development, STS has just signed an agreement with Yu Cheon Ltd of Korea. Under this deal, the two parties will jointly develop a large network meter based on the SmartMeter technology for the world market. The development work is to be carried out at Cranfield University in the UK.

Alex Elder, managing director of metering services at STS explains that Yu Cheon is a market leader in South East

Asia and brings both expertise and the potential for market penetration to the agreement. Under the venture, Yu Cheon is to provide production of the network meters, being provided with components for assembly.

STS has also succeeded in winning a contract for the sale of 4500 meters to serve an area in Chicago City in the US. The deal was for the company's SE700 units, and STS presents the win as a demonstration of the attractiveness of the technology even in mature markets. The decision to trial the technology, says STS, was based on the combined impacts of the issues of maintenance and replacement costs alongside revenue loss due to under-reading.

Alex Elder, who joined STS in April last year from the fork lift truck industry, emphasises the importance of the ability of the SmartMeter to deal with grit and air as far as the world market is concerned, and he predicts that in ten years' time this type of technology is likely to be the standard. ● KH



*FAR RIGHT: Signing of the cooperation with Yu Cheon Ltd of Korea. RIGHT: Cost comparisons with leasing.*



# Low cost water treatment in the Mekong basin

● Rural areas in the Mekong river basin are some of the poorest in the world and many living there lack access to safe drinking water. **TIM WRIGLEY** looked at a low cost means of improving water quality.

About 60 million people live in the Mekong basin. Over the last decade or so, the basin population has been growing comparatively rapidly at 2% per year, and pressure on the natural resource base is increasing.

The rural areas in all of the riparian countries of the Mekong river basin rank amongst the poorest in the world, with an average annual per capita income of only \$200 to \$400. Real GDP per capita is lowest in Cambodia, followed by Vietnam.

Social indicators, such as literacy, health and access to safe drinking water, are low in most of Cambodia and Laos. In Thailand and Vietnam, these indicators are generally low within the basin compared to areas outside it. Poverty is a universal aspect of the mainly rural areas of the lower basin. It is estimated that 30% of households in the Mekong Delta live below the poverty line.

The health situation in the lower basin is generally considered to be serious and is expected to deteriorate further unless significant investments are made to provide safe drinking water and appropriate sanitation, and to control disease. Infant and maternal mortality rates are still very high in Laos and Cambodia. The basin is host to a large number of endemic tropical diseases, many of which are related to contaminated water.

## Low cost sustainable treatment at the village level

A field study looked at the use of alum ( $Al_2(SO_4)_3$ ) by villages living on the water and other rural people to purify the water from Tonle Sap lake, a large freshwater lake in the southern region of the



Mekong basin, and the Mekong river and its tributaries.

This treatment process consists of using small lumps of alum about the size of a baseball, held by two twigs and stirred in a bucket of sediment-laden lake or river water. The stirring takes two to three minutes. Almost immediately, the sediment drops to the bottom of the bucket. The water is allowed to stand for some hours and is sometimes boiled before consumption.

It is a well-documented fact that disease-causing bacteria adhere to suspended particles, so flocculating these particles should remove a high proportion of the bacteria from the water column (see Table 1).

Not all rural people treat their water in this way, with many drinking directly from contaminated water sources. If it could be shown that sediment flocculation and 'disinfection' of contaminated water occurred as a result of the alum stirring, this could be used to encourage a low-cost water treatment process sustainable at the village level.

The baseball-sized amount of alum costs between 800-1000 reils (25 US cents) and lasts for up to three months. The annual cost of alum would be in the order of \$1 or \$2 per household.

## Laboratory studies

A series of tests were undertaken in the microbiological laboratory at the Cambodian Ministry of Environment, with the aim of determining the bacterial quality of water after alum stirring and sediment flocculation.

Sediment-laden water was collected from the Tonle Sap river, which flows through Phnom Penh. The water was brought back to the laboratory, where turbidity and alum stirring, as observed in

*Treatment is by stirring for two to three minutes*

*Life on the river*

**Table 1 An example of performance objectives for removal of turbidity and thermotolerant coliform bacteria in small-scale water treatment (WHO, 2001)**

Stage and process	Turbidity			Thermotolerant coliform bacteria		
	Removal (%)	Average loading (NTU)	Maximum loading (NTU)	Removal (%)	Average loading (per 100 ml)	Maximum loading (per 100 ml)
Plain sedimentation	50	60	600	50	1000	10 000



The low cost approach provides treatment for villages living on the river.

**Table 2** Turbidity levels in waters of the Tonle Sap river after stirring with alum.

Initial turbidity concentration in raw river water (NTU)	Stirring time with alum (min)	Turbidity (NTU) after using alum - one hour after mixing and the control.	Turbidity (NTU) after using alum - six hours after mixing and the control.
157	no alum stirring	148	131
	1	60	33
	2	28	16
	3	24	14

the field, took place. Sterile equipment was used to transfer treated and control water to bacterial plates. Turbidity, total bacterial numbers and total coliform mean probable number were measured according to the American Public Health Association's Standard methods for the measure of waters and wastewaters (2000). All tests were undertaken in triplicate.

The laboratory tests confirmed that both total bacterial numbers and coliform bacterial numbers were reduced sufficiently after a standing period of six hours to enable the water to meet drinking water criteria. The differences in total bacterial numbers and total coliform

MPN may be due to the specific total bacteria agar constituency, which might not measure all of the coliform bacteria.

The results indicate that a high proportion of bacteria is removed by flocculating the sediment. This appears to be a cost-effective way of providing microbiologically safe water for large numbers of people to drink, particularly if



**Table 3**

**Total bacteria and total coliform numbers in waters of the Tonle Sap River after stirring with alum.**

Total bacteria numbers/100ml in raw river water (three replicates)	Total bacteria numbers/100ml in river water after one hour using three minutes of stirring with alum (three replicates)	Total bacteria numbers/100ml in river water after six hours using three minutes of stirring with alum (three replicates)
200 x 10 <sup>4</sup>	0	0
15 x 10 <sup>4</sup>	0	0
595 x 10 <sup>4</sup>	0	0

boiled water is unavailable. The process is likely to be more effective in the field if the treated water remains in the sun, where UV disinfection can also occur.

Recent studies indicate that aluminum is unlikely to be responsible for Alzheimer's disease. It is also likely that the aluminum is bound to the sediment particles, and is not present in the water column. Follow-up studies looking at the aluminum concentration in the drinking water should be undertaken.

water is then used for drinking after a period of several hours. Laboratory testing of the microbial removal properties of this technique indicated that WHO drinking water standards can be met. This technique is simple, cost effective and culturally acceptable among the people of the Mekong river basin. NGOs, state governments and other international organisations such as the United Nation should consider further encouraging this process as part of a public education campaign. ●

**Conclusions**

Small pieces of alum are used to flocculate out sediments from the muddy rivers and lakes of the Mekong river system. This

**The author:**

**Dr Tim Wrigley is with engineering company Lambert and Rehbein, Brisbane, Australia.**



Alum held with twigs for stirring.

**Table 4** Total coliform MPN waters of the Tonle Sap River after stirring with alum.

Total coliform MPN/100ml in raw river water (three replicates)	Total coliform MPN/100ml after one hour using three minutes to stir with alum (three replicates)	Total coliform MPN/100ml after six hour using three minutes to stir with alum (three replicates)	WHO Drinking Water Criteria for Total coliform MPN/100ml
9.3 x 10 <sup>4</sup>	2.3 x 10 <sup>2</sup>	<30	0
21 x 10 <sup>4</sup>	1.5 x 10 <sup>2</sup>	<30	0
15 x 10 <sup>4</sup>	36	<30	0

## Protected pipeline roll-out

French pipeline company Saint-Gobain Pipelines has advanced the roll-out of its PAM Natural protected ductile iron pipeline system with the launch of the product in the UK.

PAM Natural features a new coating, an 85% zinc / 15% aluminium alloy. The presence of aluminium extends the lifespan of



the galvanic protection provided by zinc, by slowing the conversion process by forming a passive layer of aluminium oxide.

In addition to this development, the alloy is applied at an increased weight of 400 g/m<sup>2</sup>, to improve coating durability, with an additional external blue epoxy

## UV awards in Belgium

Wedeco's Dutch subsidiary, Wedeco BV, has announced a major new contract in Belgium.

According to Wedeco BV director Michael Baas, the UV disinfection technology manufacturer has been awarded its third major contract to build a

## Speedy leak surveys in Sweden

In the demanding arctic conditions of northern Sweden, water leak noise loggers from Palmer Environmental have dramatically increased the speed and efficiency of leakage surveys.

Following the deployment of Permalog loggers in the town of Kiruna and its surrounding area, surveys that previously required four nights' work by three engineers can be carried out by a single operator in around six

coat for extra robustness.

Introduction of the new coating follows an accelerated testing programme as part of which coated pipes were buried for 14 years in the marine sludge soils near Mont Saint Michel in northern France. Testing also included scrape tests and stone drop tests.

PAM Natural is aimed in particular for use in soils where currently pipes with a zinc and a bitumen coating or a zinc coating with polyethylene sleeve are used. The aim is to provide a product with longer protection than zinc alone and one which is mechanically superior to a pipe with polyethylene coating. The PAM range also includes push-fit and flanged fittings.

PAM Natural was launched in France about a year ago. Saint Gobain Pipelines says that the sales of PAM Natural now account for 95% of sales in the diameter range launched (DN60 – DN300). The system has been launched in the UK in the ranges DN80 – DN400, and the company claims the product can be used in 85% of all soil conditions. Forthcoming markets for production include Spain, Italy and Germany.

*Reader Enquiry No 516*

UV drinking water disinfection system, by Antwerp-based water supplier PIDPA.

The Westerlo water treatment works, east of Antwerp, will disinfect drinking water using the new medium pressure UV technology.

*Reader Enquiry No 517*

daytime hours. Initial estimates suggest that the system will have reduced the town's leakage figure by approximately 20% over the first year of operation.

Unlike traditional loggers, which have to be removed for interrogation, Permalog units remain in place and transmit leak data to a portable receiver called a Patroller, which is carried in a moving vehicle.

*Reader Enquiry No 518*

## Rhizofilters for France

Lyonnaisse des Eaux (Ondeo) has patented a new low-tech wastewater treatment technique to treat domestic wastewater, whose first application has been in the small town of Neuvy-Bouin in France.

Rhizopur combines two known processes that have not previously been used together: a bacterial bed followed by reed filter beds (rhizofilters). The first stage provides treatment for dissolved and colloidal carbonaceous matter on a bacterial bed. The second stage refines and completes the treatment while filtering the matter

present - matter in suspension at the intake and biomass arising from the bacterial bed.

The advantages are said to be its reliability with regard to eliminating BOD, COD and matter in suspension. As the bed operates continuously at a constant flow rate, variations in hydraulic load do not have an impact on the operation of the installation.

There is no sludge loss either: all sludge is trapped on the rhizofilters and cannot be discharged into the environment.

*Reader Enquiry No 519*

## Design services for Gary

Earth Tech is to provide engineering design services to the US Army Corps of Engineers, Chicago District and the Gary, Indiana Sanitary District, for evaluation and design improvements at the Gary wastewater treatment plant.

Improvements that Earth Tech

will address at the facility include design of a new headworks facility and flow equalisation basin. Currently, the facility's sanitary sewers experience some overflow into local waterways during heavy rains.

*Reader Enquiry No 520*

## Phosphorus analysis at ppb

Agilent Technologies Europe has announced the development of a new approach for the analysis of phosphorus at parts-per-billion (ppb) concentrations in environmental samples.

An Agilent 7500 ICP-MS has now been used with the Agilent ShieldTorch system to determine trace phosphorus in wastewater.

The ShieldTorch system narrows the energy distribution of ions entering the mass spectrometer,

thereby increasing the resolution between adjacent masses. Consequently, potential interferences arising from intense matrix-based signals at masses adjacent to phosphorus were eliminated.

Calibration plots down to concentrations as low as 500 parts-per-trillion phosphorus were constructed followed by accurate quantitation at the single ppb level.

*Reader Enquiry No 521*

## Dewatering pump release

ITT Flygt is releasing two new slim-line pumps from its Bibo range, for use in active dewatering. The new models can operate in pipes ranging between 300mm and 500mm in diameter.

The new Bibo submersible pumps are designed to handle liquids containing high amounts of clay, stone chips, drilling fines or other solids. Operating in all corners of the world, over 1 million Bibos have already been made to date.

The new models, which range between 3.7kW and 8kW, can handle up to 55 litres per second and pump at heads up to 70 metres. They are made from cast aluminium and have an outer casing of

stainless steel. Their multi-vane impellers are made from hardened cast iron to withstand the tough operating conditions.

As standard, the pumps have Flygt's double sealing system - two seals that work independently but provide double protection, as well as Spin-out, which expels particles from the seal chamber.

*Reader Enquiry*

*No 522*



## Multiple point measurement

New from Pollution and Process Monitoring is the IQ Sensor Net system for on-line monitoring of water and wastewater quality.

The new IQ Sensor Net system, manufactured by WTW and distributed in the UK by PPM, is said to be a revolutionary new concept for multiple point and multiple parameter measurement. The modular system comprises a local controller display unit and stacking modules for power supply and signal outputs.

This approach not only significantly reduces the cost of installation but also the capital procurement costs, while

maintaining the highest technical standards. The design is a direct response to the market demanding maximum specification at minimum cost.

The C184 controller of the IQ Sensor Net enables up to four sensors to be either directly or remotely connected using special junction boxes.

The more powerful C200 controller will expand this number to 20 and will additionally offer data recording of 60,000 values, modem, RS232 and Profibus DP communication. This will be available early 2002.

*Reader Enquiry No 523*

## Membranes for pharmaceuticals

PCI-Water has broken new ground by winning a contract to supply its first Fyne membrane water treatment plant to be installed in the Republic of Ireland. Featuring tubular nanofiltration membranes, the Fyne system will supply up to 480m<sup>3</sup> in 24 hours of potable-quality water to Schering Plough (Avondale) Company's pharmaceutical manufacturing facility at Rathdrum, County Wicklow.

The Fyne plant will remove colour and other trihalomethane precursors from organic-rich river water, enabling the treated product to be used as process

water in pharmaceutical manufacturing processes, and also as feedwater to a purified water generation system.

Fyne tubular systems are exceptionally robust and have an outstanding record of reliability, so they can be operated with low staffing levels. The plant also has a small footprint that enables civils work to be kept to a minimum.

*Reader Enquiry No 524*



## AMR metering for St Louis

Automatic meter reading (AMR) technology from Advanced Technology RAMAR is being installed in the US city of St Louis, Missouri. The city has selected the company's 900 series AMR product line to automate the data collection of its commercial and industrial water meters.

The city's strategy called for a new-generation AMR system that was scalable and built on an open system philosophy, allowing it to use existing meters and meter-reading equipment.

The project called for 18,000 meter interface units to be

installed over a two-year period. Implementation began in summer 2001, and is scheduled for completion in September 2002.

St Louis currently uses touch read meters and a limited number of AMR units from another manufacturer. In evaluating proposals from several AMR providers, St Louis chose Advanced Technology RAMAR on the strength of its proposed solution of an open and competitively priced system designed to meet the future needs of the company.

*Reader Enquiry No 525*

Routine monitoring of the quality of treated sewage effluent can be easily accomplished with the SP304 test kit from Palintest.



The kit includes all the tests commonly required to optimise the efficiency of sewage treatment plants and to help ensure that final effluents meet discharge consent limits.

The tests have been designed to deliver reliable results quickly. Equipment is simple to use and needs no formal operator training in water analysis. Tests are based on published methods recommended by the UK's Defra and the WRc.

*Reader Enquiry No 526*

Water suppliers affected by the impending reduction in arsenic content to 10ppb have a new option available to them now from Severn Trent Services.

STS, in association with chemical company Bayer, has developed a process and filter media that looks set to be a lifeline for some supply operators. The Sorb 33 system, developed over the past five years, reduces levels to less than 3ppb and is now being installed at 16 sites in the UK.

A combination of process technology from STS and media from Bayer have proved highly effective. Reductions of arsenic from 20ppb to under 3ppb are achieved even after treatment of 75,000 bed volumes.

*Reader Enquiry No 527*

ABS has acquired Sopprime, a French manufacturer of pumping stations. The acquisition is a result of The ABS Group's



intensified focus on service and after sales. ABS has also set up a subsidiary in Portugal to increase market presence.

*Reader Enquiry No 528*

Palmer Environmental has set up a new service for UK water companies to enable permanent leak monitoring without

needing to use in-house personnel and equipment. PalmerLog service users will have a network of leak noise loggers installed, maintained and patrolled on their behalf.

*Reader Enquiry No 529*

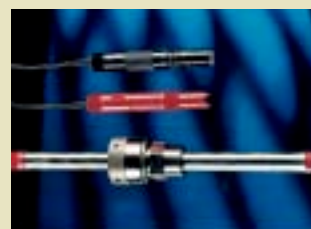
The Chem-Feed C-1100X is a high volume, high pressure rated metering injector with a manual mechanical control. It has pressure



ratings up to 150PSI and outputs up to 360GPD. Additional benefits of the new series include Blue-White's heavy duty double ball valve head.

*Reader Enquiry No 530*

ABB is now producing a new series of combination probes to provide OEMs and process users with a cost-effective solution for general-purpose pH measurements. The



new ABB AnalyzeIT AP300 series of combination pH/Redox sensors is of compact design to provide maximum flexibility and economy without compromising high functionality.

*Reader Enquiry No 531*

Thermo LabSystems has announced that ALcontrol Laboratories, one of the largest independent testing organisations in Europe, has selected its Nautilus LIMS (Laboratory Information Management System) as its application of choice.

*Reader Enquiry No 532*

Severn Trent Services has installed two of its UltraDynamics UV disinfection systems in the town of Sterling, Massachusetts' water treatment works, a 1.5 million GPD facility.

Sterling has a population of 7,500, and the new systems are part of the complete plant upgrade to provide easy operation, low risk, and the elimination of disinfection byproducts.

*Reader Enquiry No 533*





In recent years, independent regulatory commissions (IRCs) have used benchmarking to induce water and wastewater utility companies to become more efficient and control their costs. Benchmarking is a process that measures the products, services and operational practices of a given company. A company's recent performance may be compared to its past performance to reflect changes in production efficiencies and service quality. Its performance may also be compared to that of a sample group of firms or to industry averages to depict its relative standing. The benchmarking data are performance indicators used to analyse a company's operational components and identify those components needing improvement. If benchmarking and the resulting scorecards contribute to improving a company's investment plan and strengthening the organisation's operating efficiencies, customers will ultimately benefit when savings are reflected in lower prices.

Why is benchmarking an important regulatory tool? An

## Scorecards for utilities and regulators

● Benchmarking is one of several regulatory tools to encourage continuous improvement of water utility operations and to evaluate utility performance. Regulators of water utilities can use benchmarking, in conjunction with incentive regulation, to reward efficient utilities that provide high quality service. However, benchmarking requires careful planning. In the fourth in a series about the best practices of independent regulatory commissions, **SANFORD BERG** and **LYNNE HOLT** outline the issues regulators might consider in adopting a benchmarking programme.

informational asymmetry exists between regulators and regulated utility companies. Because water utilities have a monopoly on information about their operations, benchmarking can promote both information sharing and a transparent reporting system. Benchmarking should make the regulatory process more credible by providing a relatively objective ranking of utility performance; this ranking will simulate competition in a sector where little or no competition exists.

The widespread availability of reliable information along a number of dimensions - represented by performance indicators - puts regulators and the media in a position to inform citizens how their local water utility compares with others in similar circumstances. Consumers support such comparisons because they have some information of the service level they are paying for in their monthly bills. In addition to consumers, international funding agencies have supported benchmarking initiatives because, from their perspective, well-managed utilities will make better use of external funding.

### IRC 'Best Practices'

In designing a benchmarking tool,

regulators need to address the following questions:

- what is the IRC trying to measure?
- what is the best methodology to measure utility performance?
- how does the IRC verify the data used for performance analysis?
- how does the IRC report results?
- how does the IRC ensure that utilities actually use the results?
- how are a utility's performance outcomes shared?
- how does the IRC elicit consumer participation?

The Office of Water Services (Ofwat), the regulator of water and wastewater companies in England and Wales, is used as an example throughout this article because Ofwat has successfully integrated benchmarking into many aspects of its regulatory oversight responsibilities. Other countries have initiated similar but less encompassing programmes.

### Performance Indicators - what is the IRC trying to measure?

First, the IRC must decide which utility processes will be subject to benchmarking (what the utility will try to improve). Often, decisions of this sort are the result of complex and extensive taskforce

and workshop deliberations. For example, in its benchmarking initiative (Manual of Best Practice, 2000), the International Water Association (IWA) identified the organisational functions of water supply companies. These functions were further categorised into partial functions and sub-functions. The IWA also identified a total of 133 indicators to help managers assess the performance of water company functions and categorised these indicators as: water resources, personnel, physical, operational, quality of service, and finances. Of that total, 26 indicators were identified as being of greatest importance to managers. In addition to being assigned a level of importance (of three possible levels), each indicator was defined in a quantifiable manner. For example, the number of billing complaints during the year divided by the number of registered customers captures the concept of billing complaints.

According to a recent World Bank report (Kingdom and Jagannathan, 2001), performance indicators should not only be quantifiable, they should also be meaningful and draw on data that are reliable, relatively easy to collect, and not susceptible to

multiple interpretations. Indicators should reflect the obvious features of the product or service that would allow customers and other stakeholders to understand variations in service performance between different utilities and over time. Moreover, they should reflect conditions over which the utility has control. It is better to have a few indicators that are truly informative than a mass of data full of measurement errors.

### What is the best methodology to measure utility performance?

Two broad categories of benchmarking methodologies - frontier and average benchmarking - are applicable to utility incentive regulation (Jamasp and Pollitt 2001). Frontier benchmarking identifies or estimates the efficient performance frontier of an

industry or sample of companies. The efficient frontier is the benchmark against which the relative performance of companies subject to the comparison is measured. Frontier benchmarking places a greater focus than average benchmarking on performance variations among companies. This approach may be suitable at the initial stages of regulatory reform when the most pressing objective is to reduce the performance gap among a selected group of utilities. The main frontier benchmarking methods are Data Envelope Analysis, Ordinary Least Square, and Stochastic Frontier Analysis. The authors explain these statistical models and review their strengths and weaknesses.

Average benchmarking methods may be used to mimic competition among firms with relatively similar costs or when there is a lack of sufficient data and sample size of comparable firms for the application of frontier methods (Jamasp and Pollitt 2001).

The selection of appropriate statistical models involves several steps, in addition to careful thought and planning. The flow chart illustrates the steps used to derive the econometric models forming much of the basis for efficiency comparisons among water companies regulated by Ofwat.

### How does the IRC verify the data used for performance analysis?

In benchmarking, data used for company comparisons should be reliable and accurate; otherwise, the credibility of the performance analysis and the regulatory process will be compromised. For example, Ofwat subscribes to the following verification procedure. Independent consulting engineers (reporters), nominated and paid for by the water companies and approved by Ofwat, assess information collection procedures and their accuracy. Ofwat specifies reporting requirements and the reporters check that information supplied by companies conforms to the established methodologies. Specifically, reporters check and

report on: whether companies have systems to collect and record accurately the required information; whether they have allocated expenditures correctly; and whether their progress and performance, particularly with respect to capital investment programmes and standards of service to customers, is properly demonstrated. The companies also appoint auditors who, among other responsibilities, work with reporters in scrutinizing the financial aspects of companies' business plans (Ofwat, Information Note No. 28, April 1994; revised September 1999).

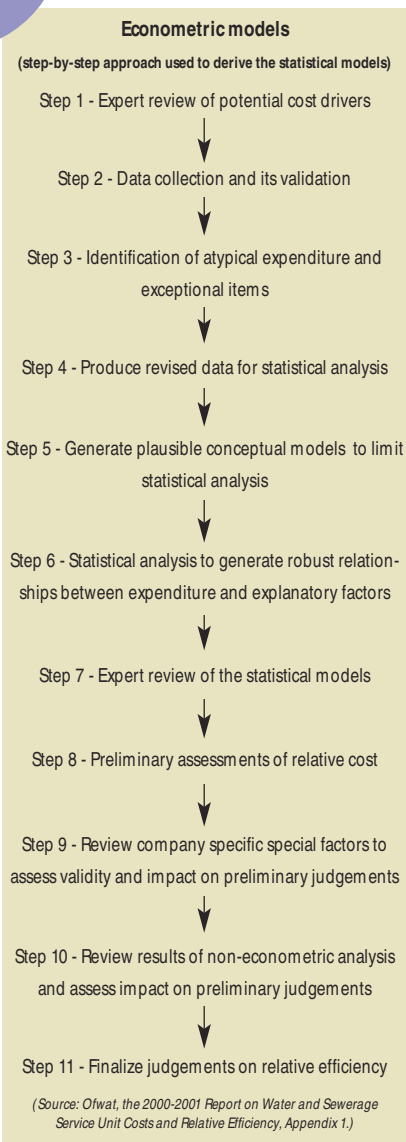
### How does the IRC report results?

Regulators often publish indicators to reward utilities for good performance and encourage them to improve substandard performance. For example, Ofwat has institutionalised the practice of benchmarking in annual reports. Each year in June, the water companies in England and Wales provide information to Ofwat on their performance with respect to various aspects of service. Ofwat has annually published a scorecard or Overall Performance Assessment of key aspects of a company's performance into a single measure. In addition, Ofwat provides tabular data and assesses the performance of 23 water companies against eight levels of service indicators: inadequate pressure; unplanned interruptions to supply; water-usage restrictions; properties at risk of and experiencing sewer flooding (overloaded sewers and other causes); response to billing contacts; response to written complaints; bills for metered customers; and ease of telephone contact (Ofwat, Information Note No. 40, March 1998; revised October 2000). For every indicator but one, performances are rated as good, acceptable, or needs improvement (Ofwat, Levels of Service for the Water Industry in England and Wales 2000-2001, July 2001, revised September 2001. See Table 2). Ofwat's assessments

of the efficiencies of licensed companies are also reported annually. The methodology for those and other assessments is outlined in analytic reports, such as its annual reports on water and sewerage service unit costs and relative efficiency.

### How does the IRC ensure that utilities actually use the results?

Collection of the data is only one part of an effective benchmarking programme. Regulators should ensure that performance data are used effectively within the utility, as well as in the price-setting process. For example, research on water utilities and government entities conducted in the United States reveals that only a slight majority of survey respondents use performance measures<sup>1</sup>. Thus, the gap between those companies that have performance measures and those that use and report them is apparent. In a survey conducted by the Government Accounting Standards Board, 421 utilities used reporting measures but only 216 reported them to elected officials. In addition, 25 percent reported outcome measures to internal management. In the Water and Wastewater Utility Survey, 44 percent of the utilities indicated that their measurement efforts did not find practical use or acceptance by the staff (Paralez, 2001). These findings were also supported by the experiences of the Western Regional Water Utilities Benchmarking Group, a consortium of water utilities in the western United States. Such a disconnect (between data collection and its use) suggests that water utilities must integrate their performance indicators into the planning process. Not only should benchmarking data be used for internal management purposes but regulatory incentives should exist to ensure that the data serve as the basis for a utility's corrective actions. For example, Ofwat's performance measures have a bearing on the price caps it sets during its periodic review of water companies. Those companies that



increase their efficiencies beyond a predicted level have been allowed to retain their profits for a specified time period. More stringent operating efficiency targets are applied to poorly performing utilities.

In contrast, the link between regulatory incentives and performance measures in Peru is tenuous, at best. Peru's regulatory agency, SUNASS, developed a system of productivity indicators in 1999, and applied them under a benchmarking scheme to stimulate and improve management of 45 municipal utilities. An analysis of various performance indicators pointed to problems in the water companies' quality and continuity of service and disclosed a lack of connection between company performance efficiencies and profits. The Peruvian water companies had little incentive to curb costs as they expanded. SUNASS lacked the necessary regulatory tools to reward water companies that performed efficiently and to penalise companies that did not (Corton, 2000).

#### How are performance outcomes shared?

Reports published on the Internet can foster development of benchmarking initiatives in the water sector. The World Bank has an online benchmarking initiative that facilitates the sharing of cost and performance information between utilities and countries through a network of linked web sites. Each web site presents values for a set of core cost and performance indicators for a utility, or utilities, in that particular region or country. Each data base specifies: the utility size band (population range served by utility); range of service provided (water only; sewerage only; water and sewerage; or water, sewerage and other); and the extent and type of private sector participation (none, multiple service contracts, management contracts, lease contracts, concession contracts, BOOT/BOT, or full divestiture to private sector. (See <http://www.world>

[bank.org/html/fpd/water/topics/um\\_bench.html](http://bank.org/html/fpd/water/topics/um_bench.html).) Moreover, many regulatory agencies publish reports on the Internet.

The Association of Water and Sanitary Regulatory Entities of the Americas has been created at the initiative of the Colombian Regulatory Agency ([www.cra.gov.co](http://www.cra.gov.co)). ADERASA's main objective is to promote the sharing of information and experience. We can expect to see more collaborative efforts as countries discover the importance of careful yardstick comparisons.

#### How does the IRC elicit consumer participation?

The greatest pressure for improved utility performance ultimately comes from the consumer. In England and Wales, consumers are represented by the Ofwat National Customer Council and ten regional Customer Service Committees (CSCs) that report to Ofwat and are funded and supported by Ofwat but speak independently of the regulator. CSCs actively monitor and assess the quality of service provided by water companies through customer surveys and reviews of company responses to customers' complaints. (Ofwat, Information Note No. 33, January 1996; revised September 2000). Through surveys and complaint reviews, regulators can determine customers' needs and their willingness to pay for certain services. These factors must be weighed against quality of service considerations since higher quality generally means higher price.

Consumer participation is also bolstered by a guaranteed set of government standards pertaining to quality of service. (These standards also correspond to the measures used as part of the benchmarking process.) For example, if a customer complains in writing about water and sewerage services, the company must reply within ten working days from the date of receipt of the letter. If the company fails to comply within that timeframe, residential and business customers are entitled to monetary compensation (Ofwat, Information

Note No. 4, May 1991; revised September 2001).

#### Concluding thoughts

A successful benchmarking programme includes:

- Stakeholder awareness: campaign, with media assistance, to promote improvements in utility operations;
- Technical skills: a comprehensive understanding of the water utility's processes and operations;
- Benchmarking data: the identification of comparable performance indicators;
- Yardstick comparisons: the selection of the appropriate comparison group of companies or standard (depending on the benchmarking method selected);
- Data collection: a procedure for collecting, verifying and comparing data;
- Information dissemination: a procedure for analysing and sharing data;
- Rewards and penalties: a procedure for planning and implementing incentives and corrective actions;
- Performance review: a process for monitoring and evaluating performance outcomes.

The IRC can be instrumental in spearheading many of these activities. However, benchmarking will be much more effective if two points are met. First, regulated companies must cooperate with regulators and subscribe to improvement objectives and processes. Second, formal mechanisms need to be established for consumers and other affected parties to raise concerns and suggest modifications to the process. Through incentive regulation and an appropriate price cap formula, regulators can use findings from benchmarking reports to reward high performance companies. They can also pressure laggard companies to promote cost-containment and the improvement of service quality. A properly designed benchmarking system should prevent poorly

performing companies from increasing prices as much as the 'average' water utility to which they have been compared. If companies operate more efficiently, customers will benefit from lower prices and should continue to expect and receive high quality service. The resulting system is likely to be sustainable - promoting further network expansion and the adoption of best practice by most water utilities. Regulators who accomplish these tasks deserve high marks. ●

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**The 12th International Training Program on Utility Regulation and Strategy will be held on June 10-21, 2002, in Gainesville, Florida.**

Notes  
See Paralez (2001) for a summary of findings of a custom survey - the Water and Wastewater Utility Survey; research sponsored by the Government Accounting Standards Board of 26 state and local governments in 1998-99; and case study profile information gained through benchmarking studies conducted by the Western Regional Water Utilities Benchmarking Group over a five-year period.

# Forthcoming features for 2002

**water21**  
MAGAZINE OF THE INTERNATIONAL WATER ASSOCIATION

## **February**

Industrial pollution control  
Environmental monitoring  
Sewers  
Area focus: Australasia  
*Feature deadline:* 16 November

## **April**

Sewage treatment  
Catchment & river basin management  
Water metering  
Area focus: Central and South America  
*Feature deadline:* 18 January

## **June**

Drinking water treatment  
Stormwater management  
Instrumentation & control  
Area focus: Africa and Middle East  
*Feature deadline:* 15 March

## **August**

Water conservation & reuse  
Coastal areas  
Monitoring & analysis  
Area focus: Europe  
*Feature deadline:* 17 May

## **October**

Water resources  
Odour control  
Landfill management  
Area focus: Asia  
*Feature deadline:* 19 July

## **December**

Sludge treatment & management  
Water supply networks  
Remediation  
Area focus: North America  
*Feature deadline:* 13 September

The topics listed above represent the main themes of each issue, but are only a guide to what will be covered in Water21. If you are interested in submitting an article on these topics or any other suitable subject, please contact:

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# Regulatory role for Jakarta

● New agreements for the water concessions in Jakarta, Indonesia, have been accompanied by the creation of a new regulatory body. **PETER REINA** reports on developments.

After a tumultuous first few years, the long-term water supply concessions for the Indonesian capital Jakarta held by two international companies are being revised. Economic crisis and political upheaval have tested the original contracts, revealing fundamental flaws. They may now be remedied, partly by the creation, for the first time, of an independent Regulator.

Heading a small team of 14 people with an annual budget of US\$ 400,000, Achmad Lanti is now bedding down the new regulatory regime for the Jakarta concessions, serving nearly 10 million people. Lanti is keen for his office to build up its resources and skills before embarking on contentious work. To err now, in the formative period, may damage the Regulator's future credibility, he fears.

Lanti's role as Chairman of the Jakarta Water Supply Regulatory Body emerged from the new arrangements that have been negotiated between the two concessionaires and the city's publicly-owned water company, PAM Jaya, and agreed last September.

As part of the transition to the new deal, the original concession terms have been suspended for the final two years of the first five-year investment period, ending this coming New Year's eve. 'The regulation of the operators in this period will be in effect be under a 'management contract' regime, where incentives are minimal, as are the risks,' according to Lanti.

During the transition, the operators will 'continue to invest and develop the facilities,' says PAM Lyonnaise Jaya, the company serving Jakarta's west half. 'However the expenses are discussed and mutually agreed before implementation... Then we will go back to a full concession

framework based on objectives rather than means to reach these objectives'.

According to Lanti, the transition lull is needed 'to gain better information about the system and the rebuild trust between the parties'. The parties in question are the local subsidiaries of Thames Water, UK, and France's Ondeo on one side, and PAM Jaya on the other.

In early 1998, PAM Lyonnaise and Thames PAM Jaya replaced PAM Jaya as the operators, taking over the west and east half of the city respectively. Immediately they were hit by a wave of trouble. As one of the worst victims of the region's economic crises, inflation was raging while the currency value was in free fall. Then, the old Soharito regime was evicted from government and the long tentacles of its family interests were severed.

The concession companies survived all of these disturbances, as well as some legal challenges, though they had to shed their local partners in the process. A year after initially securing the 25-year contracts, on a negotiated basis, the companies went back to work in June 1998, agreeing to reframe the contracts after negotiations, starting in 2000.

'All the basic assumptions of the initial contract became obsolete and had to be reviewed,' according to PAM Lyonnaise. And 'as it was the first water concession in Indonesia, several fundamental principles for this type of delegation of services needed a complete overhaul,' it adds.

Under the original contract, all assets, old or new, would remain publicly owned. Operators earned fees on a cost plus basis, with risks being limited to operations. With tariffs, now between Rp. 375/m<sup>3</sup> and over 5,000/m<sup>3</sup>, being

determined by PAM Jaya, revenues go into a joint Escrow bank account, from which the concession companies' periodic fees are paid.

Among regulatory weakness in the original Jakarta agreements identified by Lanti was lack of clarity over the operators' economic incentives. Operators' prices were to be regulated using a rate of return incentive, though the exact mechanism was unclear. This may be corrected next year when the regulation is likely to shift to a price cap rather than rate of return approach, according to Lanti.

Other regulatory issues also needed resolving. With operator charges not linked to user tariffs, the incentive for cost recovery was reduced. And while day to day performance incentives were of the command and control style, they were weak, reducing leverage on the operators, he adds. And a serious issue, that worried the operators particularly, was the dual role of PAM Jaya, as a party to the contracts and the regulator.

'As the previous operator and part of the executive government of Jakarta, PAM Jaya cannot (act) as independent as a regulator appointed by the legislative body of the city because a conflict of roles and responsibilities would result,' says PAM Lyonnaise. Also, PAM Jaya's regulatory role seemed further undermined by its terms of reference as a monitor, believes Lanti. No provisions were set for serious dispute adjudication.

With tariff changes remaining the responsibility of PAM Jaya, though this may become a regulatory decision later, Lanti's initial role is limited. As Regulator, he will focus mainly on independent mediation and on ensuring technical targets and service standards are appropriate to the tariff levels set.

Otherwise, he sees his role as one of co-ordination.

But the legal basis for Jakarta's regulation is only interim, emanating from a Governor's decree.

Parliamentary enabling legislation would be better suited to entrench the Regulator in 'the legal and administrative system for it to withstand the many challenges it will face', suggests Lanti. One reason to buttress the Regulator's authority is to establish its independence, he adds.

'Bureaucrats in charge of establishing regulation have great difficulty in accepting that the Regulator is anything other than a servant of his masters, and practical steps to impose accountability need to be continually reinforced,' believes Lanti. He acknowledges that the Regulator needs to be accountable, but believes control should not be 'of the type traditionally reflected in the 'command-line' approach to the exercise of government power'.

The long bout of negotiations of the water agreements has demonstrated to Lanti the difficulty in determining fair expenses for the operators, especially as original prices were set without competitive bidding. The unequal access to information by the operators also stood out, as officials attempted to garner operational data. Now 'we are working hard together, under the auspices of the Regulatory Body, to implement what has been agreed...and make this cooperation successful and sustainable,' says PAM Lyonnaise.

Meanwhile, Lanti is convinced of the importance of benchmarking operators' performance. He will use a system developed by Indonesia's Water Supply Enterprises Association. And to gain credibility in the eyes of Jakarta's water users, Lanti knows he must establish effective conduits for consultation and information. The acid test of the Regulator's acceptance will come next year, when tariffs are set to rise by 8% and then by 35% in 2004. Lanti knows that 'getting the public support to achieve these increases is vital'. ●

### Water Pollution and Water Quality Law

W. Howarth, D. McGillivray

This book recognises that environmental law has evolved a more purposive approach towards environmental protection. The key questions addressed are the quality of water to be met by rivers, bathing water, drinking water, etc. and the legal ramifications of a particular water failing to meet a defined standard. Water Pollution and Water Quality Law is a comprehensive study of the relevant national law and the international and European Community contexts in which this national law is placed. It provides an authoritative exposition and analysis of the law of the kind that is needed by an increasing body of legal, environmental and other practitioners who are involved in this area as part of their daily work.

*Shaw & Sons 2001.*

*ISBN: 0 7219 1102 1*

*1,328 pp Hardback £85.00*

*Shaw & Sons Ltd, Shaway House, 21 Bourne Park, Bourne Road, Crayford, Kent DA1 4BZ.*

*Fax: +44(0)1322 550553*

*Email: sales@shaws.co.uk*

### Water on the Great Plains: Issues and Policies

Editors: Peter J. Longo,

David W. Yoskowitz

The need for water has long been the dominating issue throughout the Great Plains of N. America. Local and state governments have attempted to allocate water rights, but their efforts have largely unsuccessful. In the absence of a coherent policy for protecting water resources, supplies are depleted, and what is left becomes increasingly polluted by industrial, agricultural, and biological waste products. The Great Plains is on the brink of a silent water crisis that threatens the health of people, environments and economies.

In this book the editors have collected current scholarship on the cultural economic, environmental, legal and political implications of water policy. The

authors of the ten essays that make up the book sound an urgent call for wise management to preserve available water resources for the use of future generations.

*Texas Tech University Press 2002*

*160 pages. ISBN: 0 89672 459 X*

*Texas Tech University Press, Box 41037, Lubbock, TX 79409-1037*

*USA. Tel: +1 800 832 4042*

*Email: ttup@ttu.edu*

*Web: www.ttup.ttu.edu*

### Governing High Seas Fisheries: The Interplay of Global and Regional Regimes

O. Schram Stokke

Leading scholars of international law and relations explain the wave of regional disputes that arose in the 1990s over fish stocks that straddle both national waters and the high seas. The focus rests on whether and how evolving regimes, including that based in the UN Fish Stocks Agreement, meet the scientific, regulatory, and compliance-related goals of effective management - and the significance of regime interplay in this regard.

*Oxford University Press 2001*

*320 pages Hardback*

*ISBN: 0-19-829949-4, £65.00*

*Great Clarendon Street, Oxford OX2*

*6DP, UK. Fax: +44(0)1865 267244*

### Wastewater Treatment: Biological and Chemical Processes

M. Henze, P. Harremoes, J. Cour Jansen, E. Arvin

This book gives a detailed presentation of the theories behind modern wastewater treatment processes. It presents an up-to-date description of wastewater characteristics and the theories of biological processes and their modelling. The quantitative information density is unique due to the numerous tables, figures and examples. The book is primarily intended for graduate and PhD students, but would also be valuable for consulting engineers and other wastewater treatment professionals.

*Springer-Verlag 2002.*

*430pp ISBN: 3-540-42228-5*

*Hardcover*

*£59, Euro 79.95*

*Springer-Verlag*

*Tiergartenstraße 17, 69121*

*Heidelberg, Germany.*

*Fax: +49 6221 487141*

### Keep It Working: a field manual to support community management of rural water supply

E. Bolt and C. Fonseca

This book provides useful insights for project field staff, staff of support organisations working with communities in the key issues related to community management of water supply. It offers practical tools to facilitate communication and community decision-making processes and checklists that will help field staff to organise their work. The combination of fact sheets, tools and checklists makes this book a 'must' for every field worker assisting communities to better manage their own water supply.

*IRC 2001.*

*174 pages. ISBN: 90-6687-030-3*

*IRC International Water and Sanitation Centre, P.O. Box 2869, 2601 CW Delft, The Netherlands.*

*Fax: +31 15219 0955*

### Watershed: Deciding our Water Future

Ticky Fullerton

Water is one of the most powerful and controversial issues in Australia today and this book aims to tackle conflicting interests. Watershed examines the rise of water moguls and explains why water pitches state premiers against each other and the Commonwealth.

The who's who of water, from business powerbrokers and environmentalists to politicians and scientists, put forward their views within the book and clear warnings are issued of the great environmental challenges facing the nation: dams, salination, pollution and conservation, and clean water for cities.

*ABC Books 2001.*

*354 pages. ISBN: 0 7333 0999 2*

*Australian Broadcasting Corporation, GPO Box 9994, Sydney NSW 2001, Australia*

### Compensating for Wetland Losses under the Clean Water Act National Research Council

Recognizing the importance of wetland protection, in 1988 the Bush administration endorsed a policy of "no net loss" of wetlands. The national commitment to this policy has now been carefully studied and evaluated. This book explores the adequacy of science and technology for replacing wetland function and the effectiveness of the federal program of compensatory mitigation in accomplishing the nation's goal of clean water. It examines the regulatory framework for permitting wetland filling and requiring mitigation, compares the mitigation institutions that are in use, and addresses the problems that agencies face in ensuring sustainability of mitigated wetlands over the long term. This book offers 10 practical guidelines for establishing and monitoring mitigated wetlands. It also recommends that federal, state and local agencies undertake specific institutional reforms. It will be of interest to policy makers, regulators, environmental scientists, educators and wetland advocates.

*National Academy of Sciences 2001*

*322 pages. ISBN: 0 309 07402 0*

*£30.95 Hardback*

*National Academy Press, 2101*

*Constitution Avenue, NW, Box 285, Washington, DC 20055.*

*Web: www.nap.edu*

*Also from National Academy Press:*

### Arsenic in drinking water - 2001 update

Report by the Committee on Toxicology Subcommittee to Update the 1999 Arsenic in Drinking Water Report. *National Academy of Sciences, 2001*

*225 pages. ISBN: 0 309 07629 3*

### Classifying drinking water contaminants for regulatory consideration

Report by the Committee on Drinking Water Contaminants. *National Academy of Sciences, 2001*

*239 pages. ISBN: 0 309 07408 8*

# Strategic support in the US

● The US National Research Center's board dealing with water issues has to identify and support investigations into topics of national interest.

**BILL McCANN** spoke with its current chair, **RICHARD LUTHY**.

At a time when security matters are a high priority in the United States it is not surprising to hear that the Water Science and Technology Board (WSTB) of the country's National Research Center will 'very likely undertake a study on the issue of water security'.

That, anyway, is the opinion of Richard Luthy, current chairman of the board. And, if that does happen, says Luthy, 'we might look to the AWWA Research Foundation to help support the study, and other possible support might come from the Environment Protection Agency (EPA) or the Department of Defense'.

He explains that the board of 16 members - all volunteers - does not undertake any original research. Rather it evaluates issues based on the work of co-opted sub-committees of experts, who are also volunteers.

While a major international issue such as the water problems of the Middle East might on occasion be the subject of a study, the board is usually dealing with matters of national interest. The WSTB mission is, after all 'to look at important questions associated with the efficient management and use of water resources'.

Typically work starts with a direct request from Congress or in response to an indirect approach via a federal agency such as the EPA or the Geologic Survey, or a government department like the Department of Agriculture or Energy. Some studies are initiated by the board as part of regular strategic planning.

The majority of study funding comes from the government, with contributions also from private parties.

Each study costs roughly \$500,000 and the agency posing the initial question might contribute 25 or 30% of that, the rest coming from other bodies

with linked interests. Studies are usually broadened from the initial specific question so as to accommodate associated matters in that subject area. From time to time this might mean that funding is drawn in from some sector of manufacturing industry, from a utility grouping or from some other representative body such as the American Petroleum Institute.

Such was the case in a recent study dealing with natural attenuation of contamination plumes relative to groundwater bodies. Several industrial consortia had an interest in the outcomes, as did the EPA and the Department of Energy.

The board's role says Luthy is to think strategically, to look at the initial request, to say 'What is Congress asking for and how should our response be framed in terms of important questions for a study?; then who should chair that study and who should be involved in the study team. The board writes the study prospectus, typically about six pages, defining the problem, the key questions, how the study should be organised and what the effective outcomes should be.' There will be no more than four or five questions - but 'very specific, detailed questions'.

After that document is 'pretty carefully scrutinised', the board steps back and expects the selected committee chair and staff of the NRC to manage the study appropriately.

Luthy is effusive in his praise for the latter. It is they who do the day to day work needed to keep the WSTB functioning and they work also on the study committees, helping to ensure that development of the end report progresses as intended.

Initially the board will advise the NRC as to who should be approached to chair the study

committee and serve on it; they might also suggest possible funding sources.

Individual study committees usually have 12 or 15 members and the board aims for a range of interests and specialisms - 'scientists, engineers, public interest groups, people in practice, people in academia'. What they do not want, says Luthy, are any conflicts of interest. 'We would not, for example, want a committee member who was closely connected to one of the study sponsors'.

The study chair is not necessarily a WSTB member, but in one ongoing project Luthy is in that position as the project concerns the bioavailability of contaminants in soils and sediments. That is a subject that has attracted his interest since his early career, after degrees in chemical and environmental engineering led first to work on industrial contaminants and later to the physical and chemical processes that bind such compounds into sediments.

As a Professor of Civil and Environmental Engineering at Stanford University, California, he leads a research group on the same subject. One interesting outcome of that work has been that materials such as charcoal, coal or coke found in urban sediments absorb and bind a disproportionate amount of compounds like PCBs and PAHs, much reducing their availability to water and benthic organisms.

'We are working to get a better understanding of that phenomenon and then in answering the question - what would happen if clean coke was added to sediments to act as an in situ stabilisation medium?'

It is important, he says, to test these issues in the field; in this case his team are working in San Francisco Bay in the sediments of



a former naval shipyard.

Another principle of the 'Luthy approach', probably stemming he says, from his laboratory background, is that of 'adaptive management'.

'In water management we are, after all, dealing with systems in which it may not initially be possible to project the best course. For example, we have not done a good job on watershed management - we need a better understanding of the links and conflicts involved in managing the water within existing political and administrative jurisdictions in a basin.'

'In the 21st Century we really do have to take the watershed view and we should be looking at water institutions in a new light. When you recognise an important problem, one approach is to try an experiment that will do some good in its own right. It must have clear measures of outcomes that can be assessed to see how effective the strategy is. Then assess and refine the approach according to what is learned.'

These practical views back the impression that Luthy is a man who has very successfully integrated a distinguished career in academia with earlier highly practical work in industry and as a naval diver inspecting the structural integrity of sub-sea installations in many parts of the world. So, a broad background and a practical outlook: qualities that most would see as highly relevant as the WSTB addresses America's national research needs at the beginning of the 21st Century. ●

## Solar pond cuts desal brine output

Disposal of brine, the inevitable and unwanted by-product of desalination, is likely to become a more widespread problem as more recourse is made to desalination, especially in inland locations. Such difficulties are already being experienced in parts of the USA. Traditional inland disposal options - evaporation ponds or deep well injection - cause environmental impact and are costly.

A positive alternative suggested by a two year study at the University of Texas, El Paso (UTEP), is to link

an 'enhanced' desalination process to a 'solar pond'.

In this way the by-product volume is reduced to only around 4% of feed water volume, compared to the 25% surplus typically seen from a reverse osmosis (RO) plant.

This is achieved by passing the 25% RO brine output into a multi-stage flash (MSF) evaporator. Here another 20% of original feed water volume is converted. The surplus 5% is then routed to a brine concentrator where a further 1% of useful water is obtained.

Hot brine slurry is discharged to the solar pond where the salinity gradient through the 3m pond depth reverses the normal reaction of less dense, warmer water rising to the surface.

Here the hotter but more concentrated brine congregates at the pond bottom and temperature in these lower layers is further increased (to between 140° and 194°F, even in winter) by solar energy passing through the less dense upper layers.

In effect there is little convected

or conducted upward heat loss as the surface layers act as an insulating blanket.

Heat so produced is used in the MSF and brine concentration units.

According to the researchers the overall system for brine disposal is cheaper than either of the traditionally used options.

**UTEP solar pond desalination system eliminates brine discharge. See:**  
[www.cerm.utep.edu/solarpond](http://www.cerm.utep.edu/solarpond)  
*US Water News, January 2002, Vol.19, No.1.*

## Pesticide benefits of soil filtration

Work by researchers at CSIRO, Australia, has proved the benefits of soil filtration to reduce pesticide loading in irrigation water discharges.

The system, called Filter (Filtration and Irrigated cropping for Land Treatment and Effluent Reuse), was originally developed to treat sewage effluent for reuse but has proved to be a useful option for crop irrigators who had previously to rely on on-farm storage ponds to bring pesticide discharge levels within regulatory limits.

Filter is a very basic system in which the pesticide-laden irrigation drainage is surface applied to plots

with close-spaced drains about a metre below soil surface.

Drain outlets are initially closed. Pesticides are absorbed and adsorbed in the soil bed and are said to degrade naturally.

The method is said to achieve 98 to 100% reduction for a range of pesticides including chlorpyrifos, endosulfan, atrazine, malathion and diuron

**Novel solution for cleaning up contaminated water.**  
*CSIRO Land and Water News, December 2001.*

**Dr. Tapas Biswas:**  
[tapas.biswas@csiro.au](mailto:tapas.biswas@csiro.au)

## Soil amendment benefits

Research on the regeneration of degraded and desertified soils seen in many parts of the Mediterranean region has shown that such soils respond well to amendment by addition of either fresh or composted organic municipal waste.

Experiments were made on soil samples from an arid area in Murcia, south-eastern Spain. The soil had an organic content of only 0.33% and nutrient values of 76mg/kg total N, 180mg/kg total P and 689mg/kg total K. Separate samples of the material were amended with the organic fraction of a municipal solid waste, a sewage sludge and a compost of a 1:1 by weight mixture of the two. The samples and an unamended control were held under laboratory conditions for 360 days and studied for total and immobilised urease and phosphatase.

After 360 days it was observed that

all of the amended soils showed greater total and immobilised enzymatic activity than the control soil, indicative of biogeochemical regeneration.

Persistence of these properties was significantly greater in the compost-amended sample.

It was concluded that organic amendment, particularly with a composted additive, could be used to reactivate soil nutrient cycles.

**Persistence of immobilised and total urease and phosphatase activities in a soil amended with organic wastes.**  
*J.A.Pascual (jpascual@natura.cebas.csic.es), J.L.Moreno, T.Hernandez and C.Garcia*  
*Department of Soil and Water Conservation and Organic Wastes Management, CEBAS-CSIC, Murcia, Spain Bioresource Technology 82 (2002) 73-78. Elsevier Science.*

## Biotech link for researcher

German biotech company Vermicon AG, has concluded an agreement with Professor Dr Amann, principal of the Department of Marine Microbiology at the Max-Planck-

Institute in Bremen, under which an intensive transfer of knowledge from research to the company will take place to promote advances in its detection technology.

## JUST OUT IN AQUA

### Better design of biofilters

A perceived empirical approach to the design of biofilters for potable water treatment has led American researchers to design and develop a simple-to-use mechanistic model that takes into account all the key phenomena of the biofiltration process.

Referring to the need for such a model they point to the wide use of biofilm processing across the world and to the advantages this brings to potable water treatment by allowing much reduced levels of chlorine residual in the supply

network. They note that, in Europe where filtration is more commonly used to remove biodegradable organics, chlorine residuals are often ten times lower than the levels typically seen in North America.

Their Integrated Biofilm Model (IBM) incorporates all the major chemical, physical and biological variables of the filtration process from the most basic reaction of substrate oxidation to fuel bacterial growth through to the processes that occasion loss of

biomass - physical detachment and endogenous respiration or decay.

The IBM is described as a multi-species biofilm model designed as a practical tool for analysis and design of biofilters for potable water treatment.

The model is solved via an Excel spreadsheet\* and also provides a graphical output in a form convenient for analysis of reactor performance and observation of trends in the data. (\**The spreadsheet and guidelines on parameter values can be*

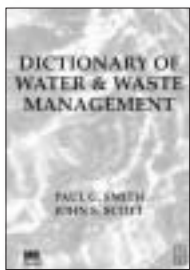
*obtained from Dr. Rittmann - see below)*

**Modelling biological processes in water treatment: the integrated biofiltration model.**

**Bruce Rittmann**  
*(b-rittman@northwestern.edu)*  
*and Douglas Stilwell,*  
*Department of Civil Engineering,*  
*Northwestern University,*  
*Evanston, Illinois, USA.*  
*Journal of Water Supply: Research and Technology - AQUA Vol.51.1.2002. IWA Publishing 2002.*



# New Books from IWA Publishing...



## Dictionary of Water and Waste Management

Authors: *PG Smith, JS Scott*  
NEW UPDATED VERSION FOR 2002

The first edition of the Dictionary of Waste and Water Treatment was published in 1981 and was aimed at treatment and treatment design. Over the last 20 years, areas such as air pollution control, solid waste management, hazardous waste management, pipeline management (leakage control, pipeline and sewer renewal) and environmental management systems have all become increasingly important. To reflect this shift, this completely revised and updated edition now covers water and waste management as well as treatment.

waste management covering the following areas;

Water resources and hydrology, Drinking water quality, Waterborne diseases, Public Health, Water treatment, Wastewater treatment, Sludge treatment, Air pollution & air pollution control, Solid Waste Management, Hazardous Waste Management, Pipeline Management (leakage control, pipeline & sewer renewal), Environmental Management systems (ISO 14000, EMAS)

March 2002  
Pages: 448  
ISBN: 1843390159  
Hardback

IWA Members Price:  
£27.00 / US\$41.00

Non Members Price:  
£35.00 / US\$53.00

This new edition refers to US/ UK and European standards, legislation and spelling and includes illustrations throughout aid the reader's understanding of the explanations. There are over 7000 terms on water quality, engineering and

The dictionary has been completely revised and updated to encompass all the changes of the last 20 years to become the most comprehensive dictionary of water and waste management available.



## Anaerobic Digestion Model No.1 (ADM1)

Author: *IWA Task Group for Mathematical Modelling of Anaerobic Digestion Processes*

The IWA Task Group for Mathematical Modelling of Anaerobic Digestion Processes was created with the aim to produce a generic model and common platform for dynamic simulations of a variety of anaerobic processes. This book presents the outcome of this undertaking and is the result of four years collaborative work by a number of international experts from various fields of anaerobic process technology.

Engineering, Biotechnology, and Chemical and Process Engineering departments.

### CONTENTS

Introduction, Nomenclature, State Variables and Expressions, Biochemical Processes, Physicochemical Processes, Model Implementation in a Single Stage CSTR, Suggested Biochemical Parameter Values, Sensitivity and Estimation, Conclusions, References, Appendix A: Review of Parameters, Appendix B: Supplementary Matrix Information, Appendix C: Integration with the ASM, Appendix D: Estimating Stoichiometric Coefficients for Fermentation, Full Contents

February 2002  
Pages: 80  
SBN: 1900222787  
Paperback

IWA Members Price:  
£37.50 / US\$57.00

Non Members Price:  
£50.00 / US\$75.00

ADM1 will be a valuable information source for practising engineers working in water treatment (both domestic and industrial) as well as academic researchers and students in Environmental Engineering and Science, Civil and Sanitary

Scientific & Technical Report No.13



## Basic Water Treatment 3rd edition

Authors: *C Binnie, M Kimber, G Smethurst*

Fully revised and extensively updated to take account of current water quality standards and treatment technologies, Basic Water Treatment 3rd edition provides contemporary practical guidance in this comprehensive new edition. A best-selling text, the book has been developed by three of the world's leading experts in the field of water treatment and remains the definitive reference for all those involved in water treatment systems.

processes and treatment and disposal of wastes, and water demands are also now covered.

Basic Water Treatment 3rd edition is an essential purchase for water engineers at all levels – A textbook for the student, a handbook for the young engineer or chemist, but essentially, an indispensable guide full of useful practical information for the established practitioner.

February 2002  
Pages: 292  
ISBN: 0727730320  
Paperback

IWA Members Price:  
£25.00 / US\$38.00

Non Members Price:  
£33.00 / US\$50.00

The new edition has a similar approach to previous editions, focussing on the issues of most interest to practising engineers, summarising the key issues and criteria in short and accessible sections, but with additional theory to explain and support the treatment processes considered. Coverage has been expanded in some key areas, notably water quality standards, coagulation and flocculation, and disinfection; new topics covered include membrane

### CONTENTS

Introduction, Quality of Water, Overview of Water Treatment, Pretreatment, Coagulation and Flocculation, Coagulants and Coagulant Aids, Theory and Principles of Clarification, Types of Clarifiers, Filtration, Membrane Processes, Other Processes, Disinfection, Waterworks Wastes and Sludges, Water Demand and Use, Appendices: Sample calculations, WHO; USA, and EU water quality standards; Glossary



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## Industry focus on endocrine disrupters

Endocrine disruption is one of four main areas of interest in the Long-range Research Initiative (LRI) of the European Chemical Industry Council (CEFIC) and is the focus of the recently published second issue of the Council's new newsletter, *Update*.

The subject has been of rising concern in industrial countries for several years since American biologists noticed signs of feminising in alligators close to a DDT spill. Similar signs were subsequently seen in male fish close

to sewage works outfalls in the UK.

Fears have also been raised about rising levels of sterility in men although, the newsletter points out, there is currently no evidence to connect this or any other adverse health effect with exposure to low levels of chemicals with hormone-like properties in the environment.

But that matter has to be further explored as an important part of the fundamental question of whether exposure to small amounts of man-made chemicals

in air, water and food interfere can with the hormonal systems of humans and wildlife to cause adverse effects.

Within the LRI the search for answers began in 1998 and the importance attached to the subject might be judged from the fact that, in 2001, it absorbed some 42% of the initiative's total budget of Euro6.7million.

The research taking place under the LRI is divided into three main areas and a total of 21 projects involving over 20 research insti-

tutes in seven countries.

The subject areas are: male reproductive health (11 projects), environment and wildlife (six projects) and testing protocols (four projects).

Projects generally run for one to three years. Seven have been finalised, with results published or about to be published in peer-reviewed journals - the principles of the LRI require an open and transparent research process and timely publication of results.

*See: [www.cefic.org/lri](http://www.cefic.org/lri)*

## EU sludge under scrutiny

An enforced delay\* to revision of the European Union's 1986 directive on Sewage Sludge Use in Agriculture has enabled an extended period for research in several key areas, particularly on pathogens, organics and heavy metals.

Towards the end of last year a Brussels workshop, Researching the Sludge Directive, allowed the Commission and stakeholders to hear of progress and preliminary conclusions of some of the

research programmes.

The workshop heard that projects in all three key areas were in progress in the UK.

In one of these the abilities of the common sludge treatment processes to inactivate a range of bacterial, viral and protozoan pathogens had been tested. The output data had been used to produce risk assessment models for prediction of pathogen loading on crops in sludge-treated soils.

These had demonstrated that risks

were significantly reduced by use of the multi-barrier approach recently instituted in the UK in which pathogen-reducing treatments are combined in a matrix with regulatory controls specifying permitted crop types and intervals between sludge application and grazing or harvesting.

In a second study organics limit values proposed in the last (April 200) EU Draft Working Document were being critically evaluated. This is looking at how

the currently proposed standards have been derived, at the science basis for the proposals and at the practical implications of implementation.

Further stages of this project would attempt to derive loading rates for a range of compounds and assess the related implications for sustainable management of sludge treated soils. **BM**

*\*The revision process has given way to a priority need to produce a European Soil Strategy.*

## WATER21 INTERNET

The Helsinki Commission, which protects the Baltic marine environment, has launched a new website for those fishing for information about the Baltic Sea environment.

The website has been designed to provide the latest news and comprehensive background articles about key issues related to the Baltic marine environment.

Details of the latest periodic assessment of the Baltic environment are available, along with latest news on developments and a list of the Helcom recommendations and the Helsinki Convention terms for those who need a reminder.

There are also details of all the parties to the Convention, and of the working groups and task force, as well as a site search facility and more.

The website of Health Canada's Water Quality Program may well be of interest to readers of *Water21*. It provides the supporting documents for various drinking water and recreational water quality guidelines, the minutes of the meetings of the Drinking Water Subcommittee (the federal / provincial / territorial group

responsible for the development of drinking water quality guidelines), and various fact sheets directed to the public.

[www.hc-sc.gc.ca/waterquality](http://www.hc-sc.gc.ca/waterquality)

Osmonics now offers online shopping on its website. Existing customers can access the secure online environment to make transactions that could only be previously taken by phone or fax.

The online application enables Osmonics to do business with its distributors, resellers and other business partners in a private e-marketplace that connects directly to Osmonics' existing Enterprise Resource Planning (ERP) system. It allows customers to view up-to-date business data, as well as conducting transactions securely over the internet.

Partners can undertake real-time order entry and order tracking, view product availability and pricing, create personal shopping lists, change unshipped orders and receive order updates.

Osmonics manufactures and markets high-technology water purification and fluid filtration, fluid

separation and fluid handling equipment, as well as the replaceable components used in purification, filtration, and separation equipment for the world market.

[www.shop.osmonics.com](http://www.shop.osmonics.com)

GFJ provides consulting civil engineering and project management services in South Africa, with increasing involvement in Africa. The company specialises in water supply and water and wastewater treatment.

[www.gfj.co.za](http://www.gfj.co.za)

If your organisation has a Web homepage or if you know of interesting sites, let us know the address. Send details to: Keith Hayward, Editor Water21, by email to: [khayward@iwap.co.uk](mailto:khayward@iwap.co.uk)

And don't forget the Association's three linked websites with their growing range of new features:

[www.iwahq.org.uk](http://www.iwahq.org.uk)

[www.iwapublishing.com](http://www.iwapublishing.com)

[www.iwafoundation.org](http://www.iwafoundation.org)

The Helsinki Commission website is at: [www.helcom.fi](http://www.helcom.fi)

# From Buenos Aires to Melbourne: then on to Marrakech and Beijing

The decision to merge the International Association on Water Quality (IAWQ) and the International Water Services Association (IWSA) was sealed with a signing in Paris on 23 January 1998 between Mr Nicholas Hood and Professor Thomas Keinath. This International Water Association (IWA) was then launched in Buenos Aires, in no small part an IWSA World Congress that was devoted to the IWA. This was then followed by two previously scheduled congresses of IAWQ and IWSA, in Paris in 2000 and in Berlin last year.

This year's Melbourne Congress was originally planned as an IAWQ event. But thanks to the enormous efforts of Dr David Garman, the Melbourne Congress president, and other members of the Organizing Committee for the IWA 3rd World Water Congress and five participating environmental associations for Enviro 2002, we are now wrapping up the process of making the IWA a truly integrated organization. This is very wonderful progress.

Based on the outcome of our formal meeting in Windsor in the UK from 30 November through 4 December 1999 concerning future plans for the IWA, we moved through a transition period that lasted until the meeting in Berlin. Two councils—the Management and Policy Council (MPC), under the chairmanship of Mr Jerome B Gilbert, and the Scientific and Technical Council (STC), under the chairmanship of Professor Laszlo Somlyódy, played a central role in the association's activities and supported its numerous thriving committees.

Prior to the Berlin Congress,

co-presidents from our two former organizations—first Professor Keinath of IAWQ and Mr Hood of IWSA and then their respective successors, Dr Piet E Odendaal and Mr Vincent J Bath—were the driving force carrying out the merger. Backed by the Board and Executive Committee meetings, the new IWA moved forward with the support of Executive Director Mr Anthony Milburn, Deputy Director Mr Mike Slipper and their staff of the London office.

At our meeting in Berlin, we shifted to a structure with only one president, and I was elected to fill that post for a term of one and a half years. During that meeting we also merged our two councils, MPC and STC, into a single chamber, the Strategic Council, under the chairmanship of Professor Somlyódy.

In addition, we streamlined our line-up of specialist groups and then launched the new IWA structure along with its new Executive Committee. Dr Michael Rouse, our vice-president, assumed the office of treasurer, replacing Mr Peter Scherer, who since the start of the transition period made a tremendous contribution to IWA in his capacity as treasurer and then eventually as the Berlin 2001 Congress president.

Our president-elect is to be chosen during the Melbourne Congress. Our Vice-Presidents, for the term March 2003 to September 2004 (Marrakech) are to be elected by the Board meeting on the occasion of the 3rd World Water Forum in Kyoto in March of 2003. The filling of these posts will complete the creation of our new executive body, which will serve over a period of one and a half years leading

up to the Marrakech Congress.

The new IWA is gradually forming a culture and a structure of its own. Our Marrakech World Water Congress in 2004 will be the first IWA World Congress planned from the outset by IWA. We will then meet again at our Beijing World Water Congress in 2006. Starting with the Marrakech Congress, we will select our president, whose term will be two years, at each World Congress. The Executive Committee roster will also change every two years.

I am hoping to build the skeleton of IWA on the stages of the Melbourne World Water Congress and do the following starting on the full scale with the Marrakech Congress. First, I want academic specialists, technical experts and administrators to highly refine their individual areas of expertise. And at the same time I would like universities, research institutes, water and wastewater utilities, environmental regulatory agencies, civic organizations, national government entities, and international organizations to strive to cooperate in a balanced manner and collaborate by capitalizing on their individual characteristics.

I ask everyone to join forces and endeavour to establish the tradition of a World Congress that is truly worthy of the new IWA. I hope that our association, through the Beijing Congress, will develop into the world's largest and most powerful entity of water specialists and water-related enterprises.

Water, it is thought, will be the single greatest factor in terms of supporting the sustainability of the world and human health and welfare in the 21st Century. Now, for the first time ever, our 'Water



Planet' is facing a global-scale water crisis. I want IWA to make an all-out effort to promote symbiosis between human civilization and other forms of life by combining our strength and extracting wisdom. IWA's numerous specialist groups are producing an abundance of impressive results, and this association's activities are attracting the world's attention. We should take pride, for example, in the honour bestowed upon Dr Takashi Asano of University of California, Davis, California in USA when he was awarded the Stockholm Water Prize for 2001. I wish to offer my congratulations and express my pleasure in this regard to Dr. Asano, who has for many years led the Re-Use Committee.

On the occasion of the meeting in Melbourne Congress, Dr Milburn steps down and is replaced by a new Executive Director of IWA. Dr Milburn has worked on behalf of IAWQ for an extended period, and his legacy as Executive Director includes IWA's establishment - a major accomplishment. I would like to express profound gratitude to him for his many years of service.

See you in Melbourne, my friends! ●

**Professor Norihito Tambo**  
President, International Water Association, and President, University of the Air, Japan

## New group on sustainable sanitation

IWA's Executive Committee has approved the formation of a new Specialist Group on Sustainable Sanitation. The group is to direct its focus towards sanitation systems

permitting nutrient reuse, mainly by source separation. The full range of solutions, from high- to low-tech and decentralised to centralised solutions, will be covered.

Chair of the new group is Professor Ralf Otterpohl of Germany's Technical University of Hamburg-Harburg. Co-chair of the group is Hakan Jonsson, associate

professor at Sweden's Department of Agricultural Engineering, SLU.

Contact Professor Otterpohl on: tel: +49 40 42878 3207, fax: +49 40 42684, email: otterpohl@tuhh.de

# IWA - Promoting Water Management Worldwide

## What is IWA?



The International Water Association (IWA), an international membership organisation, is dedicated to promoting best practice in water supply, wastewater collection and treatment, water pollution control and water quality management. It was formed by the merger of two esteemed international organisations, the IAWQ (International Association of Water Quality) and the IWSA (International Water Services Association).

## Who are the members?

Engineers, scientists, managers, economists, administrators - working in water and wastewater utilities, consulting companies, academia and research, manufacturers and suppliers, government departments and agencies. IWA has country members, corporate members (for organisations) and individual members in over 130 countries worldwide.

## Can IWA help me?

IWA's unique international coverage and high quality information services guarantees you access to the world's best expertise and contacts providing you with excellent opportunities for personal, professional and business expansion and growth.

<http://www.iwahq.org.uk/>

The IWA web site gives you immediate access to information on association activities, including membership of its Specialist Groups, full conference details and 'call for papers'.

## IWA Publishing [www.iwapublishing.com](http://www.iwapublishing.com)



IWA Publishing provides high quality information on all aspects of water and related environmental fields. The IWA Publishing programme encompasses a wide range of journals, books, reports and electronic products. *All IWA products are available to members at substantial discounts.*

## Network with the best at:

**Biennial World Congresses** – major international events attended by over 2000 delegates with comprehensive technical programmes, workshops and seminars and associated water technology exhibitions.

**Regional Conferences** – local practitioners and international experts meet to discuss regional issues and examine the best available solutions and strategies.

**Specialised Conferences** – leading experts and managers discuss approaches to current concerns and advances in methods and best practice.

**Workshops & Seminars** – ideal forum for training and the transfer of skills and knowledge

## Advocacy & Exchange of Ideas

IWA maintains good relations with the principal multi-lateral & bi-lateral agencies and other associations to enable members to influence future policy and decision-making.

## IWA Specialist Groups

As one of IWA's greatest strengths, the Specialist Groups focus on specific topics that not only provide you with access to the very best expertise but also with powerful networking opportunities.

## IWA Foundation



The IWA Foundation supports water professionals in developing countries and emerging economies. It works through partnerships to transfer and develop local knowledge and skills. Key themes are to strengthen the management and operation of existing facilities, sustain management of water resources and extend services to the urban poor.

## What does the IWA membership package include?

Your annual membership fee includes the following benefits:

- Free bi-monthly membership magazine, *Water 21*
- Free copy of the IWA Yearbook & Directory of Members
- Free membership of up to 5 of our 50 Specialist Groups
- Up to 25% discount on books published by IWA Publishing
- Discounts on IWA conference registration fees
- Option to subscribe to electronic delivery of journals
- Free subscription to 'ContentsAlert'

In addition to the above benefits **corporate/institutional** members also receive:

- The opportunity to nominate up to 10 additional employees to receive *Water21*
- Free subscription to one Journal of choice
- 10% discount on the institutional rate for all IWA journals
- Discounts on advertising in *Water21* and the *IWA Yearbook*
- 30 word entry into *IWA Yearbook*
- Optional inclusion in Corporate Member Service Directory and IWA website
- Opportunity to obtain a site licence for electronic delivery of journals

## So, how do I become a member?

To join the IWA, either

- Complete the application form overleaf and return it to the address given on the form
- or
- Submit your application via the IWA website at [www.iwahq.org.uk](http://www.iwahq.org.uk)

**Corporate Application Forms are available to download from the website or from the IWA Headoffice.**

**If you require further information or additional application forms please contact the IWA at:**

Alliance House, 12 Caxton Street, London, SW1H 0QS, UK  
Tel: +44 (0)20 7654 5500  
Fax: +44 (0)20 7654 5555  
Email: [water@IWAhq.org.uk](mailto:water@IWAhq.org.uk)  
Web: [www.iwahq.org.uk](http://www.iwahq.org.uk)

*We look forward to welcoming you as a member.*



# IWA Individual Membership Application Form 2002

## Section A: Membership

Please tick the box below to indicate the level of membership you want (includes Water21, IWA Yearbook and membership of 5 Specialist Groups):

- Individual Membership for 2002 (Jan-Dec) £34  
 Student Membership\* for 2002 (Jan-Dec) £17

\* To qualify for Student Membership you will need to supply a supporting letter from your supervisor or head of department confirming that you spend at least half your time on academic work and meet the conditions for student status.

## Section B: Journal Subscriptions

Add one or more subscriptions to your core membership package.  
 Tick box to indicate required journal(s):

One year's subscription to:	Ind/Student
Water Science and Technology	<input type="checkbox"/> £72
Water Research	<input type="checkbox"/> £66
Water Science & Technology:Water Supply	<input type="checkbox"/> £90
Journal of Hydroinformatics	<input type="checkbox"/> £58
Journal of Water Supply: Research and Technology - AQUA	<input type="checkbox"/> £73

### Special Electronic-Only Offer:

Water Science & Technology and Water Science & Technology:Water Supply  £99

### Electronic Journal Delivery

	Ind	Student
		(50% Discount)
Water Science and Technology	<input type="checkbox"/> £50	<input type="checkbox"/> £25.00
Water Research	<input type="checkbox"/> £66	<input type="checkbox"/> £33.00
Water Science & Technology:Water Supply	<input type="checkbox"/> £80	<input type="checkbox"/> £40.00
Journal of Hydroinformatics Online	<input type="checkbox"/> £50	<input type="checkbox"/> £25.00
Journal of Water Supply: Research and Technology - AQUA	<input type="checkbox"/> £50	<input type="checkbox"/> £25.00

Please note, if you require your journal in hard copy and by electronic delivery then you must enclose payment for both.

## Section C: IWA Specialist Group Membership

### Specialist Groups

The Specialist Groups are self-managing, assisted by the Association's central resources of publicity, finance, publications and administration to run activities including conferences, workshops, seminars, newsletters, scientific and technical reports, development and publication of position papers. Spread across IWA's membership in more than 100 countries, the Groups provide a sound structure of networks for specialists from around the world to share information and skills, and make good professional and business contacts. Each IWA member may join up to five Groups of their choice. Simply circle the numbers of the groups you wish to join.

<b>Sources and Effects of Pollution</b>		<b>Management/Control/Training</b>	
● Biofouling and Biocorrosion	34	● Environmental Engineering Education	30
● Chemical Industries	19	● Hydroinformatics	36
● Contaminated Aquatic Sediments	31	● Information Systems	39
● Diffuse Source Pollution	27	● Instrumentation, Control and Automation	06
● Environmental Restoration	25	● Management and Institutional Affairs	21
● Eutrophication	24	● Public Relations	38
● Groundwater	48	● Reservoir Protection, Management and Water Treatment	26
● Hazard Assessment and Control of Environmental Contaminants	07	● River Basin Management	09
● Health-Related Water Microbiology	05	● Statistics and Economics	37
● Landfill Management of Solid Wastes	32	● Systems Analysis and Computing	10
● Forest Industry	18	● Water and Waste Technology and Management Strategies for Developing Countries	20
● Surface Water	47	● Watershed and Reservoir Management	50
● Tastes and Odours	11	● Wastewater Reclamation, Recycling and Reuse	14
● Urban Drainage	12		
● Volatile Atmospheric Emissions from Wastewater Systems	03		
<b>Treatment Processes</b>		<b>Network Management</b>	
● Activated Sludge Population Dynamics	17	● Planning and Construction	44
● Adsorption	35	● Operations and Maintenance	45
● Advanced Treatment	42	● Materials and Corrosion	46
● Anaerobic Digestion	01		
● Biofilm Processes	23		
● Design, Operation and Costs of Large Wastewater Treatment Plants	04	<b>Additional Specialist Group Membership</b>	
● Design and Operation of Small Wastewater Treatment Plants	28	(£5 per group) - If you wish to join any additional Specialist Groups, please print the code number for the group(s) in the space below:	
● Disinfection	41		
● Dissolved Substances Removal	40		
● Membrane Technology	29		
● Nutrient Removal from Wastewaters	08	<b>Specialist Group Newsletter Delivery</b>	
● Particle Removal	49	Specialist Group Newsletters are sent out to members of the groups. Please indicate below how you would like to receive your newsletters, please tick only one box:	
● Particle Separation	02	<input type="checkbox"/> E-mail (recommended, don't forget to include your email address below)	
● Pretreatment of Industrial Wastewaters	33	<input type="checkbox"/> Post	
● Sludge Management	22		
● Standards and Monitoring	43		
● Use of Macrophytes in Water Pollution Control	13		
● Waste Stabilisation Ponds	16		
● Wastewater Treatment Systems Utilising Submarine Outfalls	15		

## Section D: Personal Details

Surname/Family name:

Title:  Forenames:

Address:

Country:  Postcode/ZIP:

Tel:

Fax:

E-mail:

Web:

Is this your home or work address? HOME / WORK (delete as applicable)  
 If you are using your work address please give your Position and Company name:

Position:  Company:

Under the UK Data Protection Act we require your permission to print your telephone, fax and e-mail address in the IWA Yearbook/Directory of Members. (which may be sold)  
 Please tick this box if you do not wish to have your contact details printed in the yearbook

## Section E: Occupation

In order for us to best serve your information needs, please tick one box in each list that best describes your organisation and your role within it:

<b>My organisation is:</b>	<b>My primary work role:</b>
<input type="checkbox"/> Research Institute/Organisation (W1)	<input type="checkbox"/> Scientist (P1)
<input type="checkbox"/> Sewerage/Water Authority (W2)	<input type="checkbox"/> Engineer (P2)
<input type="checkbox"/> Federal/State Government (W3)	<input type="checkbox"/> Consultant (P3)
<input type="checkbox"/> Consultancy (W4)	<input type="checkbox"/> Researcher (non-academic institution)(P4)
<input type="checkbox"/> Industry (Process, Manufacturing, etc.)(W5)	<input type="checkbox"/> Researcher (academic institution)(P5)
<input type="checkbox"/> University or School (W6)	<input type="checkbox"/> Manager (P6)
<input type="checkbox"/> Regulatory, River or Local Authority (W7)	<input type="checkbox"/> Information (P7)
<input type="checkbox"/> Supplier/Contractor (W8)	<input type="checkbox"/> Education/Student (P8)

## Section F: Payment

Please add together the costs of any items that you have selected from Sections A, B and C:

Total Section (A)\* £ \_\_\_\_\_

Total Section (B)\*\* £ \_\_\_\_\_

Total Section (C)\*\*\* £ \_\_\_\_\_

**Total:** £ \_\_\_\_\_

\* Membership subscription \*\* Journal Subscription \*\*\* Additional Specialist Group Membership (£5 per group)

### Methods of Payment

**Cheque** made payable to 'International Water Association' drawn on a UK bank.

**Credit transfer** to Portland Customer Services, Account Number **01863630**, Sort Code **60-06-60**, National Westminster Bank Plc, 25 High Street, Colchester CO1 1DG, UK. Please include your full name and reason for transfer, ie. Individual IWA membership. Supply us with details of your transfer, date of transaction, amount and bank from which it is coming. Please note that any bank charges should be included with your payment.

### Credit Card

Card Type: Visa / MasterCard / American Express / Diners Club / Delta / Switch / JAB (delete as applicable)

Card Number:

Expiry date:  Issue Number:

Cardholder's Name:

Cardholder's Address:

Cardholder's Signature:

### Sponsors

If you were introduced to IWA by one of our members please give his/her name and address  
 Name  Address

This section must be completed for your sponsor to collect his/her prizes in the Membership Recruitment Competition.

### Please return the completed form and payment to:

IWA Membership, c/o Portland Customer Services, Commerce Way, Colchester CO2 8HP, UK. Tel: +44 (0)1206 796351, Fax: +44 (0)1206 799331, E-mail: iwamembership@portland-services.com

IWA Head Office: Alliance House, 12 Caxton Street, London SW1H0QS, UK. Tel: +44 (0)20 7654 5500, Fax: +44 (0)20 7654 5555, E-mail: water@iwhq.org.uk. Company Limited by guarantee. Registered in England No. 3597005. Registered office as above. Registered Charity (England) No. 1076690. VAT Registration No. GB 740 4457 454

## COMING SOON

**Biological Activated Carbon Filtration Workshop****29-31 May 2002, Delft, The Netherlands**

Contact: Rene van der Aa, Amsterdam Water Supply, branch Weesperkarspel Provincialeweg 21, 1108 AA Amsterdam Zuidoost, The Netherlands.  
Tel: + 31 20 65 10 386, Fax: +31 20 69 76 880, E-mail: r.vd.aa@gwa.nl

**Marine Waste Water Discharges 2002 - Outfalls' and Sealines' Technologies****16-20 September 2002, Istanbul, Turkey**

This conference will be focused on the scientific, technical and technological aspects of sealines and outfalls, and particular attention will be given to the recent years' scientific developments and to recent project information and case stories. The papers and posters will cover the following aspects: design; materials and equipment; installation, operation, maintenance, hydraulics, stability, diffuser and discharge evaluation and technology; monitoring and environmental impact.

Contact: Dr. Eng. Carlo Avanzini, Haldun Taner Sok, Süha Apt. 10/7  
81060 Caddebostan, Istanbul, Turkey.  
Tel: +90.216.4113704 – 3602011  
Email: mecc.ist@superonline.com  
Web: www.mwwd2002.com

**5th International Conference On Hydro-Science & Engineering****18 – 21 September 2002, Warsaw, Poland**

The themes of the conference will include:

- Hydro-Science and Engineering in the Changing World
- Challenges, Opportunities and Constraints  
Special emphasis will be laid on water-related issues relevant to quickly developing transition economies.

Contact: Faculty of Environmental Engineering, Warsaw University of Technology, 20 Nowowiejska Street, 00 - 653 Warsaw, Poland.  
Tel: (+48 22) 621 45 60; 660 53 36  
Fax: (+48 22) 625 73 77,  
Email: dziekan@is.pw.edu.pl

**International conference 'From Nutrient Removal to Recovery'****2-4 October 2002, Amsterdam, The Netherlands**

Organized by IWA in Cooperation with the

Netherlands Association on Water Management (NVA) and Aquatech 2002, this event aims to give an overview of the present situation with relation to improved nutrient removal or recovery technologies.

- Nutrient (N,P,S) recovery and re-use technologies
- Centralized and decentralized techniques
- Hygienic aspects of re-use of nutrients
- Public perception of nutrient re-use
- Quantification and evaluation of sustainability aspects of nutrient recovery
- Modelling tools to implement nutrient recovery and re-use technologies
- Life cycle analysis of nutrient recovery technologies
- Novel biological, physical or chemical techniques for nutrient removal

Contact: Conference Secretariat, Buerweg 51, 1861 CH Bergen, Netherlands.  
Tel: + 31.20.4602466 Fax: + 31.20.4602475  
Email: r.r.kruize@inter.nl.net

**VII Latin America Workshop and Symposium on Anaerobic Digestion****22-25 October 2002, Merida, Mexico**

This will be the 7th event in this biennial series of meetings. A one-day workshop will promote open discussion between experts with invited presentations. The symposium will include the following themes:

- Microbiology & biochemistry of anaerobic digestion
- Molecular biology applied in anaerobic digestion
- Modelling and control of anaerobic reactors
- Anaerobic digestion of municipal wastewaters
- Innovative configurations & technology developments
- Biogas management and odour control
- Full scale experiences

Contact: Adalberto Noyola, Institute of Engineering, National University Of Mexico, Apartado Postal 70-472, Ciudad Universitaria, Coyoacán 04510 D.F., Mexico.  
Tel: +52 5622 3324/5622 3325  
Fax: +52 5616 2798  
Email: daal2002@pumas.iingen.unam.mx  
Web: www.iingen.unam.mx/daal2002

**16th European Junior Scientist Workshop - Real time control of urban drainage systems****7-10 November 2002, Catania, Italy**

The European Junior Scientist Workshop aims to establish an opportunity for young researchers

and practicing engineers interested in research to have, at low cost, some days of intensive professional discussion on the topic of real time control of urban drainage systems. The topics cover real time control in all its aspects, e.g. hardware and software, simulation, optimisation, implementation, administration, etc.

The work activity will be complemented with hikes through the breathtaking nature of the Mount Etna.

Contact: Alberto Campisano, University of Catania, Italy. Email: acampisa@dica.unict.it  
Tel: +39 95 7382711, Fax: +39 95 7382748

**5th IWA Chemical Industry Group Conference: Trends in sustainable production - from wastewater diagnosis to toxicity management and ecological protection****13-15 November 2002, Nimes, France**

Topics at this event are due to include:

- New tests and analysis for characterisation
- Online monitoring
- Process control (treatment plant)
- Waste reduction
- Spills detection
- Toxicity evaluation
- Relation between composition and toxicity of wastewater
- Plant operation for toxicity reduction
- Value added products

Contact: Prof. Olivier Thomas, Ecole des Mines d'Ales, 6, avenue de Clavieres, 30319 Ales cedex, France. Tel: 33 466782704. Email: olivier.thomas@ema.fr Web: www.aghtm.org

## DEADLINES

**30 April 2002** for submission of abstracts for *5th IWA Chemical Industry Group Conference: Trends in sustainable production (13-15 November 2002, Nimes, France)*

Contact: As above

**31 July 2002** for submission of abstracts for *1st IWA Conference on Scaling and Corrosion in Water and Wastewater Systems (25-27 March 2003, Cranfield University, UK)*. **30 April 2002** for registration of interest.

Contact: As above

**11 September 2002** for submission of abstracts for *6th International Symposium on Strong Nitrogenous and Agro-Wastewater (11-13 June 2003, Seoul, Korea)*

Contact: Prof. Zuwhan Yun, The Institute of Environmental Technology and Sustainable Development, Korea University, 5-1 Anam-dong, Sungbuk-ku, Seoul 136-701, Korea.  
Fax: +82 2 929 5391, Tel: +82 2 3290 3979.  
Email: zyun@korea.ac

## MAY

**The Sulfur Cycle in Environmental Biotechnology: Options for sulfur and metal removal/recovery**

12-17 May 2002, Wageningen, The Netherlands  
 Contact: Prof. Piet Lens. Email: Piet.Lens@Algemeen.MT.WAU.NL

**IFAT 2002 - 13th World Trade Fair for Environment, Wastewater and Wastewater Disposal: Water, Sewage, Refuse and Recycling**

13-17 May 2002, Munich, Germany  
 Contact: Messe München GmbH, Messeglände, D-81823 München, Germany.  
 Tel: +49 89 949 20600 Fax: +49 89 949 20609  
 E-mail: info@messe-muenchen.de  
 Web: www.ifat.de

**12th European Water, Wastewater and Solid Waste Symposium during IFAT**

13-15 May 2002, Munich, Germany  
 Contact: European Water Association, Kirsten Overmann, Theodo-Heuss-Alle 17, 53773 Hennef (Germany).  
 Tel: +49 2242872-189 Fax: +49 2242872-135  
 Email: overmann@atv.de  
 Web: www.EWAonline.de

**Automation in Water Quality Modelling**

21-22 May 2002, Vienna, Austria  
 Web: www.iwga-sig.boku.ac.at/autmonet/  
 Email: Mail@iwga-sig.boku.ac.at  
 Tel: +43 (0)136006 5800 Fax: +43 (0)13689949

**6th World Plumbing Conference**

22-25 May 2002, Berlin, Germany  
 Contact: Zentralverband Sanitär Heizung Klima, Rathausallee 6, D-53757 St. Augustin, Germany.  
 Tel: +49 2241 92990, Fax: +49 2241 21351,  
 E-mail: info@zentralverband-shk.de  
 Web: www.6WPC-org.de

**2nd International Conference on Waters in National Parks**

23-26 May 2002, Cavtat, Croatia  
 Contact: Gorana Cosic-Flajsic, Croatian Water, Ulica Grada, Vukovara 220, 10000 Zagreb, Croatia. Tel: +38 5 16307333 Email: gcosis@voda.hr

**Water Africa Exhibition and conference**

29-31 May 2002, Dar es Salaam, Tanzania  
 Contact: ACE  
 +44 151 7099192 Fax: +44 151 7098748  
 Email: info@ace-events.com  
 Web: www.ace-events.com

## JUNE

**4th International Symposium on Water**

3-7 June 2002, Cannes, France  
 Email: water-cannes-symposium@wanadoo.fr or Cannes2002@unice.fr  
 Web: www.unice.fr/H2O or www.symposium-h2o.com

**ECWATECH 2002 5th International Congress and Trade Fair Water: Ecology and Technology**

4-7 June 2002, Moscow, Russia  
 Contact: Sergey Malugin, SIBICO International Ltd, PO Box 173, Moscow, 107078, Russia.  
 Tel/Fax: +7(095) 975 1364, 975 5104  
 Email: ecwatech@sibico.com  
 Web: www.sibico.com/ecwateche/index.htm

**Response to New Pollution Challenges**

4-7 June 2002, London, UK  
 SENSOPOL: European Network on Sensors for Monitoring Water Pollution  
 Contact: Dr SJ Alcock, Cranfield Biotechnology

Centre, Cranfield University, Silsoe, Bedfordshire, MK45 4DT, UK.  
 Email: s.alcock@cranfield.ac.uk  
 Web: http://www.cranfield.ac.uk/biotech/sensopol.htm

**Management of Productivity at Water Utilities**

12-14 June 2002, Praha, Czech Republic  
 Contact: Katerina Slavickova, Aquion s.r.o., Delnicka 38, CZ-170 00 Praha 7, Czech Republic.  
 Tel: +420 283872265 Fax: +420 283872266  
 Email: ManProWU@aquion.cz  
 Web: www.cziwa.org

**International Short Course on Anaerobic Treatment of Industrial Wastewater: Options for resource recovery**

10-21 June 2002, Wageningen/Delft, The Netherlands  
 Contact: International Institute for Infrastructural Hydraulic and Environmental Engineering, PO Box 3015, 2601 DA Delft, The Netherlands.  
 Email: ihe@ihe.nl Web: www.ihe.nl

**10th IQPC Sewage Sludge Treatment and Use**

24th-25th June 2002, Cafe Royal, London  
 Contact: Katrina Gregory, IQPC, Anchor House, 15-19 Britten Street, London, SW3 3QL, UK.  
 Tel: +44 (0) 20 7368 9300,  
 Fax: +44 (0) 20 7368 9303,  
 Email: katrina.gregory@iqpc.co.uk  
 Web: www.iqpc.co.uk/GB-1771/ediary

**European conference on Filtration and Separation**

24-26 June 2002, Gothenburg, Sweden  
 For more information:  
 www.kat.chalmers.se/ecfs2002/  
 Email: ecfs2002@kat.chalmers.se

## JULY

**ICOM 2002 The International Congress on Membranes and Membrane Processes**

7-12 July 2002, Toulouse, France  
 Contact: European Membrane Society, Universite Paul Sabatir, 118 route de Narbonne, 31078 Toulouse cedex 4, France. Fax: +33 561 5561 39  
 Email: icom@gc.ups-tlse.fr

**Solving Coastal Conundrums: 28th International Conference on Coastal Engineering**

7-12 July 2002, Cardiff City Hall, Cardiff, Wales  
 Contact: Sue Frye, Conference Office, Institution of Civil Engineers, One Great George Street, London SW1P 3AA, UK.  
 Tel: +44 (0)20 7665 23152,  
 Fax: +44 (0)20 7233 1743,  
 Email: ICCE2002@ice.org.uk  
 Web: www.icenet.org.uk

**An International Perspective on Environmental Engineering**

2002 Joint CSCE/ASCE International Conference  
 21-24 July 2002, Niagara Falls, Canada  
 Contact: Prof. Richard G. Zytner.  
 Tel: 001 519 8244120 Fax: 001 519 8360227  
 Email: rzytner@uoguelph.ca

**18th ICID Congress "Food Production Under Conditions of Water Scarcity and Increasing Population and Environmental Pressures"**

21-28 July 2002, Montreal, Canada  
 For more information see:  
 www.cancid.org/index.html  
 Email: Montreal2002@cancid.org

**3rd International Conference on Water Resources and Environment Research (ICWRER) Water Quantity & Quality Aspects in Modelling and Management of Ecosystems**

22-26 July 2002, Dresden, Germany

Contact: Cathleen Schimmek, Conference Secretariat ICWRER 2002, Institute of Hydrology and Meteorology, Dresden University of Technology, 01187 Dresden, Wuerzburgerstr. 46, Germany.  
 Fax: +49 (0)351 4637162  
 Email: cs30@rcs.urz.tu-dresden.de  
 Web: www.tu-dresden.de/fghihm/hydrologie.html

**2nd World Engineering Congress**

22-25 July 2002, Sarawak, Malaysia  
 Contact: The Secretary of the Organising Committee (Prof. Bujang Bin Kim Huat) c/o faculty of Engineering, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia.  
 Email: bujang.eng.upm.edu.my  
 Web: www.eng.upm.edu.my/wec2002/

**Hydroinformatics 2002 - 5th International Conference on Hydroinformatics**

1 - 5 July 2002, Cardiff, UK  
 Contact: Cherrie Summers, Conference Secretariat, ENGIN, PO Box 925, Newport Rd, Cardiff CF24 0YF, UK.  
 Tel/Fax +44 (0)29 20874421  
 Email: summersc@cardiff.ac.uk  
 Web: www.cf.ac.uk/engin/news/conf/hydro

## AUGUST

**AEESP/AEE Conference 2002 Integrated Environmental Teaching and Integrated Environmental Teaching and Research: Linking Engineering and Science to Address Complex Problems**

11-13 August 2002 Toronto, Canada  
 Web: www.ecf.utoronto.ca/apsc/misc/envenv/enviro/

**12th Stockholm Water Symposium: Balancing Competing Water Uses - Present Status and New Prospects**

12-15 August 2002, Stockholm Sweden  
 David Trouba, Manager, Press and Information, Stockholm International Water Institute, Sveavägen 59, SE 113 59 Stockholm, Sweden.  
 Tel: +46 (0)8 52213989, Fax: +46 8 52213961.  
 Email: dave.trouba@siwi.org  
 Web: www.siwi.org

**Biogeomon 2002 4th International Symposium on Ecosystem Behaviour**

17-22 August 2002, Reading University, UK.  
 Contact: Biogeomon 2002, The Department of Geography, The University of Reading, Whiteknights, Reading RG6 6AB, UK.  
 Email: biogeomon@reading.ac.uk  
 Web: www.rdg.ac.uk/biogeomon

**Biofilms in Industry, Medicine and Environmental Biotechnology: The Science (EU Summer School)**

24th - 29th August 2002, Galway, Ireland.  
 Contact: Dr. Therese Mahony  
 Email: therese.mahony@nuigalway.ie  
 Web: www.nuigalway.ie/microbiology/mel800/bio-imeb.html

**3rd International Conference & Exhibition on Integrated Environmental Management in Southern Africa**

27 - 30th August 2002, Johannesburg, South Africa  
 Contact: Prof. P. Marjanovic, SCIEEM Centre for Innovative Environmental Management, School of Civil & Environmental Engineering, University of the Witwatersrand, WITS 2050, Johannesburg, South Africa.  
 Tel: +27 11 7177123, Fax: +27 11 4038851,  
 Email: cems2002@civil.wits.ac.za  
 Web: www.cems2002.org

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