



In this Issue:

European Water & Health Protocol	1
Water and Health in Europe	2
Developments in Cryptosporidium	3
Viability Testing	
Benefit-Cost of US Water Rules	5
New Cryptosporidium Test for US	7
News Items	9
From the Literature	12
<i>Cancer</i>	
<i>Cholera</i>	
<i>Copper</i>	
<i>Cryptosporidium</i>	
<i>Cyanobacteria</i>	
<i>Disinfection Byproducts</i>	
<i>Outbreaks</i>	
<i>Policy and Regulation</i>	
<i>Water Quality</i>	
List of Articles	19

Editor	Martha Sinclair
Assistant Editor	Pam Lightbody

CRCWQT Internet address:

<http://www.med.monash.edu.au/epidemiology/crc>

European Water & Health Protocol

The Third Ministerial Conference on Environment and Health held in London on 16-18 June was attended by more than 70 health, environment and transport ministers from 51 countries, making this the largest event of its kind ever held in Europe. A major agenda item for the conference was a legally binding Protocol on Water and Health which aims to protect human health and well-being by improving the management of water resources, and reducing the incidence of water-related diseases.

Representatives from 35 countries signed the Protocol, and the document will become legally binding after 16 member governments formally ratify the agreement. Disputes over alleged breaches of the Protocol will then be subject to adjudication by the International Court of Justice.

The Protocol covers not only drinking water but also water used for recreation, aquaculture and shellfish harvesting, the transport of water, and the use of wastewater and sewage sludge for agricultural purposes. The agreement binds participating nations to take appropriate measures to provide all their citizens with:

- wholesome drinking water,
- adequate sanitation,
- effective protection of drinking water sources and ecosystems from agricultural and industrial pollution,
- safeguards against water-related diseases from recreational use, aquaculture, shellfish harvesting, and agricultural use of wastewater or sewage sludge,
- effective monitoring and response systems for water-related disease incidents and risks.

This agreement is an important acknowledgement of the importance of safe and reliable water supplies for health, social wellbeing and economic development. It is also a significant

step towards more integrated and ecologically sound systems for water supply management. The Protocol aims to promote this approach at all levels, from local and national, through to transboundary and international contexts.

The Protocol provides guidance on the principles and approaches to be adopted by participating nations on the following basis:

- the precautionary principle (ie preventive action should not await absolute scientific proof),
- the polluter-pays principle,
- the sovereign right of nations to exploit their own resources, and their responsibility to ensure that their actions do not cause damage to the environment of other states or beyond the limits of national jurisdiction,
- the management of water resources to provide adequately for the needs of future generations,
- recognition that preventive action to reduce or avoid disease is more efficient and cost-effective than remedial action,
- the management of water resources at the lowest appropriate administrative level,
- acceptable and sustainable management of water resources recognising social, economic and environmental values,
- promotion of efficient water use through economic instruments and awareness-building,
- public access to information and participation in decision making concerning water and health,
- integrated management of whole catchments or aquifers taking into account social and economic development as well as ecological and water resource factors,
- special consideration for the protection of people who may be particularly vulnerable to water-related disease,
- equitable access to water of adequate quantity and quality for all people,
- people and institutions with rights and entitlements to water should also contribute to the protection of the water environment and conservation of water resources,
- implementation of the required measures should take account of local problems, needs and knowledge.

The Protocol requires countries to establish targets and target dates within 2 years for the achievement of levels of performance to maintain or increase protection against waterborne disease, and to provide mechanisms for public participation in this process. Parties are obliged to collect and evaluate data on progress towards these targets, and to publish summary reports on progress in a standardised format.

The Protocol also requires the establishment of comprehensive national and/or local surveillance and early warning systems, and national and local contingency plans for dealing with waterborne outbreaks, incidents and risks. Parties must agree to promote public awareness, education, training, research and development, and public access to information. Provisions are also made for cooperation in relation to transboundary waters, international support for national action, reviews of compliance with the Protocol, and regular meetings of the parties to the agreement.

The Ministerial Conference was followed by a 2 day technical meeting, *Watershed 99*, which was charged with developing a consensus agenda of policy and research priorities to support the implementation of the Protocol. The 200 delegates who attended discussed global and local perspectives on sustainable use of water resources, and examined strategies for health risk assessment in relation to potable and recreational use of surface and ground water supplies.

Details of the Conference can be found at:
www.who.dk/london1999



Water and Health in Europe

Two months before the Third Ministerial Conference on Environment and Health, the WHO released a background report entitled *Water and Health in Europe* which details conditions currently prevailing in the member nations. The report highlights the contrast between some relatively affluent countries and their poorer counterparts with respect to the adequacy and quality of water supplies, and the incidence of waterborne disease. However even countries

regarded as having generally good quality water supplies suffer intermittent or localised problems affecting some of their population.

It is estimated that as many as one person in seven in the WHO European region does not have access to safe drinking water. Access to reliable supplies is a problem in many areas, and even those connected to reticulated systems may suffer frequent interruptions in supply. In a press release accompanying the report, Günter Klein, Director of Environment and Health at WHO's European office said *"If we persist with intensive agriculture, industrialisation and overexploitation of our water resources, it will become increasingly difficult to ensure a supply of safe water in many parts of Europe, including a number of big cities."*

A survey of member nations revealed a total of 710 water-related outbreaks (drinking and recreational water) recorded by 19 countries over an 11 year period. In a number of eastern European countries, there has been a resurgence of waterborne diseases usually associated with third world conditions including cholera, typhoid fever and hepatitis A. Surveillance and reporting mechanisms vary greatly in different countries, and it is likely that waterborne disease (and gastrointestinal disease from all sources) is significantly under-recognised and under-reported.

The Introduction to the report presents a succinct and frank appraisal of how these problems have developed over several decades. The provision of safe and reliable water supplies and adequate sanitation were key factors in the economic and social development of Europe in the first half of this century. Despite wide variations in pricing structures, water supply and sanitation services remain low in cost with most citizens paying less than 1% of annual income for access. However this very success may have contributed to the declining perception of the importance of water supplies among individuals and governments alike. Reliable cheap water supplies were taken for granted, and little importance was placed on

the technical or human resources required for their management.

Decreasing government involvement in western Europe, and political upheaval in eastern Europe have contributed to overexploitation and unsustainable management practices which have now reached a point where public health may be threatened. The report calls for recognition of the true social value of water, and highlights the cost-effectiveness of investment in water supply and sanitation as a public health measure.



Developments in *Cryptosporidium* Viability Testing

A central issue in assessing the health risk posed by *Cryptosporidium* in water supplies, is the problem of determining whether the oocysts are infectious to humans. The accepted "gold standard" for infectivity testing, the infection of laboratory animals such as mice is both slow and expensive, and until very recently has not been applicable to the "human" genotype of *C.parvum* (which does not normally infect other mammals).

A variety of methods have been developed to assess the condition of oocysts in environmental samples including excystation assays, "vital dye" stains and more recently, the presence of messenger RNA or ribosomal RNA sequences. However while each of these techniques provides some measure of metabolic activity and/or structural integrity, adequate validation against animal studies is lacking, and it is not clear how well these tests correlate with infectivity. This has contributed to uncertainty in both the interpretation of water testing results, and the assessment of the effectiveness of disinfection techniques for water treatment.

Researchers from Tufts University recently published some observations on the potential of ribosomal RNA (rRNA) and messenger RNA (mRNA) as markers of infectivity for *Cryptosporidium* oocysts⁽¹⁾. Both types of RNA have been shown to decay rapidly after death in mammalian tissues, and it has been generally assumed that this is also the case for oocysts.

However this study shows that decay rates differ markedly for different RNA transcripts.

The stability of two RNA markers was initially examined in *C. parvum* oocysts which had been heat inactivated⁽²⁾ (65°C x 15 min) then stored at room temperature for several weeks. It was found that beta-tubulin mRNA was not detectable even 1 hour after inactivation, whereas the small subunit (SS) rRNA persisted for at least 11 weeks. This gave an initial indication that beta-tubulin mRNA was relatively unstable and might be useful as a marker of infectivity.

Experiments were then done to test the persistence of beta-tubulin mRNA and SS rRNA in oocysts stored at room temperature or 4°C. A fresh preparation of oocysts from calves was assayed for excystation (90% excystation rate) and for infectivity in baby mice (8/8 mice infected with an inoculum of 10⁶ oocysts). The preparation was split into two portions with one being stored at room temperature and the other at 4°C. At various time intervals, duplicate aliquots were removed for infectivity testing and for storage at -70°C. RNA extractions from the stored aliquots were carried out in a single batch to minimise variations between samples, and RT-PCR was used to amplify the desired products.

At room temperature, oocysts retained some infective ability at Week 15 (20% of mice infected) but were not infectious at Week 20. The disappearance of beta-tubulin mRNA appeared to parallel the loss of infectivity with none detected at Week 15. The SS rRNA transcript persisted throughout the 20 week storage period. These observations were confirmed in a repeat experiment. Another mRNA transcript of unknown biological function was also tested, and was found to decrease on storage at room temperature but still remained detectable after infectivity was lost. At 4°C oocysts remained infectious for at least 39 weeks (100% of mice infected), and both beta-tubulin mRNA and SS rRNA remained detectable throughout this time.

As the oocyst suspension used in the experiments was much more concentrated than any environmental sample likely to be encountered,

the authors also tested serially diluted suspensions and found that the beta-tubulin PCR product was detectable at a level of 10 oocysts.

The authors believe the beta-tubulin mRNA transcript may be a useful marker for infectivity and are now assessing the suitability of the method for environmental samples. This particular marker has advantage due to the presence of an intron in the beta-tubulin gene which allows the PCR product from mRNA to be distinguished from the PCR product from DNA which may be co-purified during RNA extraction. DNA is more chemically stable than mRNA and generally persists longer in adverse environmental conditions, however the PCR product from beta-tubulin mRNA can be distinguished by its shorter length due to splicing out of the intron sequence.

Recent work on UV sterilisation of oocysts has shown that excystation and "vital dye stains" do not provide a sensitive measure of reductions in infectivity⁽³⁾. Oocysts of the Iowa isolate (also known as the Harvey Moon isolate) of *C. parvum* were subjected to UV irradiation from a medium pressure UV source, then assessed by excystation assay, DAPI-PI staining and infection of neonatal mice. Control experiments on untreated oocysts were used to determine that the experimental manipulations did not significantly reduce infectivity, and that the oocyst preparations displayed the expected infectious dose (dose to infect 50% of exposed mice = approx. 75 oocysts).

Four different UV doses were used in bench scale studies - 41, 82, 123, and 246 mJ/sq cm (1mJ/sq cm = 1mW/csq cm). For each UV dose, three dilutions of each sample of treated oocysts were used to inoculate neonatal mice (1,000, or 10,000 or 100,000 oocysts with 23-28 mice for each inoculum level).

There was a large discrepancy between in vivo and in vitro assays. DAPI-PI staining and excystation assay of oocyst suspensions from the 3 lowest UV doses suggested that only a low degree of inactivation had occurred (66-89% of oocysts still viable by DAPI-PI, 84-85% viable by excystation). At the highest UV dose DAPI-PI

staining suggested about 4% of oocysts were viable, while excystation indicated 1% viable.

However the mouse infection experiments showed a large decline in infectivity at all UV doses. At UV doses of 41, 82 and 246 mJ/sq cm, no mice were infected. At a dose of 123 mJ/sq cm, only 1 of 25 mice inoculated with 100,000 oocysts was infected. These observations suggest that at least 3.9 logs of inactivation was achieved at all UV doses tested here.

Similar results were obtained with a demonstration scale UV reactor with a flow rate of 814 L/min and UV doses between 19 and 159 mJ/sq cm. Again there was a large reduction in infectivity for all UV doses (around 4 logs) but DAPI/PI and excystation tests showed little effect at low doses and a maximum 2 logs inactivation at high doses. The UV doses delivered to oocysts in the reactor were calculated using a complex mathematical model to account for water turbidity.

The authors note that previous studies have suggested that very high UV doses are necessary to inactivate *C. parvum* oocysts, however such studies have employed low pressure UV with a narrow emission range while the UV source used here had a broad emission range and a higher irradiance. The earlier studies also used mainly in vitro methods to estimate inactivation, which as this study has clearly shown, do not accurately reflect the degree of change in infectivity.

(1) Widmer G, Orbach EA and Tzipori S. (1999) Beta-tubulin mRNA as a marker of *Cryptosporidium* oocyst viability. *Applied and Environmental Microbiology* **65** (4) p1584-1588.

(2) It should be noted that the authors use the word "viable" to mean "infectious", and "inactivated" to mean "noninfectious" although others sometimes distinguish between these terms.

(3) Bukhari Z, Hargy TM, Bolton JR, Dussert B and Clancy JL (1999) Medium-pressure UV for oocyst inactivation. *Journal of the American Water Works Association* **91** (3) p86-94.



Benefit-Cost of US Water Rules

As part of the consultation phase for the new Interim Enhanced Surface Water Treatment Rule and the Stage 1 Disinfectants / Disinfection By-products Rule⁽¹⁾, the US EPA carried out an analysis of the expected benefits and costs for implementation of these changes in regulation^(2,3). In both cases considerable uncertainty surrounds the degree of health risk, resulting in a wide range of possible benefit-cost ratios.

Disinfectants / Disinfection By-products Rule (D/DBP) The D/DBP Rule is aimed at lowering levels of disinfection byproducts in drinking water in order to reduce the potential risk of cancers which may be associated with prolonged exposure to high levels of these chemicals.

Information on the degree of risk comes from two different sources; animal toxicological studies, and human epidemiological studies. From the animal studies, it was estimated that between 0 and 100 excess cancer cases (all types) might be expected each year in the US population given current levels of DBPs in drinking water. This estimate takes into account uncertainty factors for extrapolation from short term/high exposure studies in laboratory animals to long term/low level exposure in diverse human populations.

From the epidemiological studies it was estimated that between 1,100 and 9,300 excess cases of bladder cancer might be expected each year, but as interpretation of these studies remains controversial it was not possible to exclude the possibility that no excess cases might arise. Only bladder cancer was considered as most studies with stronger methodology have focussed on this type of cancer.

Given the widely divergent estimates derived from these two lines of evidence, it was not possible to adopt a middle range consensus value for cancer risks. Therefore in subsequent analysis a possible range from 0 to 9,300 cancer cases per year was assumed.

From current knowledge of DBP levels and the predicted effects of changes in water treatment, a 24% reduction in DBP exposure across the US

population was estimated for implementation of the Stage 1 D/DBP Rule. It was then assumed that the percentage reduction in cancer risk would parallel the reduction in DBP exposure, corresponding to a reduction of between 0 and 2,232 cases of cancer each year. The distribution of fatal and non-fatal cases was assumed to be the same as for bladder cancer (23% fatal, 77% non-fatal cases).

The economic value of a reduction in the number of cancer cases was then calculated by assuming that each fatal case avoided had a value of \$5.6 million, and each non-fatal case avoided had a value of \$587,500. This yielded a range of possible benefits from \$0 to \$4 billion per year. These estimates assume immediate benefits, although it is recognised that any cancer-related health benefits would accrue gradually. The figures also do not take into account any other health benefits (ie reduction in non-cancer risks) that may also be achieved by reducing DBP levels in drinking water.

Calculation of the costs for implementation of the Stage 1 D/DBP Rule was somewhat more straightforward, with nationwide costs estimated at \$700 million annually (annualised at a 7% discount rate). About 84% of this amount would be required for installation, operation and maintenance of equipment, while 13% would be needed for system monitoring, and 2% for state charges.

Five different approaches were then used to compare benefits with costs. Explanation of these methods is beyond the scope of this summary, however they included overlap technique, break even analysis, household cost of compliance, a probability approach, and an approach to minimise maximum regrets.

The latter approach, known as "min-max regrets" is seen as perhaps providing the best illustration of balancing competing issues in public health protection. This analysis considered the overall effects of three regulatory options; no action, Stage 1 D/DBP Rule, or a more stringent Stage 2 Rule. For each option, the cost of compliance was added to the cost of remaining cancer cases

after compliance, for different assumed levels of cancer risk. This shows the "downside risk" or maximum social loss if the real health risks turn out to be very different from the assumed value.

Using this method of analysis, the Stage 1 Rule was deemed to provide the smallest maximum potential loss to society. Therefore the authors conclude that the benefit-cost analysis generally supports the incremental approach to DBP reduction that has been adopted in the US, where the initial step will be achieved without major changes in technology.

However they also note that definitive answers on health risks cannot be expected in the immediate future, and in fact recently raised concerns over short term health effects may broaden the estimates of risk even more. Further reductions in DBP levels beyond the Stage 1 D/DBP Rule will probably require substantial and expensive changes in technology, and it may become even more difficult to compare the potential benefits and costs.

Interim Enhanced Surface Water Treatment Rule (IESWTR) The IESWTR is targeted at achieving better control of pathogen levels in drinking water, and ensuring that control of pathogens is not compromised by the implementation of the D/DBP Rule. Several of the requirements of the IESWTR are specifically aimed at reduction of *Cryptosporidium* levels, although compliance is judged by surrogate markers (in particular turbidity) rather than by measurement of oocysts in water.

In estimating the benefits which may be achieved by the Rule, the authors considered only a reduction in *Cryptosporidium* infection although it would be expected that illness due other pathogens might also be reduced. The possible impact of avoiding waterborne outbreaks was not estimated, as the probability of such events could not be estimated.

A quantitative risk modelling approach was used to estimate the proportion of endemic illness that may be currently attributable to *Cryptosporidium* oocysts in drinking water. The inputs to the

model included dose-response information from the first published human volunteer study, daily water intake, oocyst numbers in raw water, removal by filtration, viability after water treatment, and percentage of exposed people who become ill. A Monte Carlo simulation was carried out to generate a probability distribution of the predicted number of infections and illnesses. The authors note that good quality data on many of these parameters is absent, and there is a large degree of uncertainty in the estimates. Therefore a number of different assumptions are presented in the paper to illustrate the range of benefits that may be achieved.

Using the assumption that filtration plants currently remove 2.5 logs of oocysts on average (with some plants better and some worse), it was predicted that 1.5 million *Cryptosporidium* infections might occur each year from drinking water systems affected by the IESWTR, with 643,000 of these resulting in illness. This figure is vastly in excess of the number of recognised case of cryptosporidiosis from all sources reported in the US each year, however it is known that laboratory diagnosed cases of gastrointestinal pathogens represent only a small fraction of all cases in the community. The true number of cases of *Cryptosporidium* infection in the US and the proportion attributable to drinking water are presently unknown.

Based on figures from the Milwaukee outbreak it was estimated that a fatality rate of 0.0125% might be predicted, although this figure is very tentative. Life threatening *Cryptosporidium* infections are limited to people with severely compromised immune systems (predominantly people with AIDS), and since many in this group currently avoid consumption of tap water they may not be exposed to infection via this route.

If it is assumed that implementation of the IESWTR will result in an improvement in average log removal by water treatment plants to 3.0 logs, then a fall to 208,500 illnesses per year would be predicted (ie 434,500 illnesses avoided). To convert these potential health benefits to economic costs, the authors assumed the mean

benefit for each illness avoided was \$2,000 (direct medical costs only) and the statistical value of a life saved was \$5.6 million. This yields a total annual benefit of about \$1.5 billion. The authors briefly discuss the special circumstances surrounding fatality risks from cryptosporidiosis (ie restriction of the risk to a small subgroup of the population who already face a shorter than normal life expectancy) but conclude that there is no accepted method to adjust economic values for these factors.

The cost of implementing the IESWTR is estimated at \$307 annually (using 7% cost of capital). Total capital costs are estimated at \$759 million, and operation and maintenance at \$106 million annually. Annual treatment costs will be \$192 million and turbidity monitoring \$96 million. The authors conclude that despite the large uncertainty in estimating the contribution of *Cryptosporidium* in drinking water to endemic illness, the value of the benefits of the IESWT Rule are likely to outweigh the costs.

(1) Refer to Health Stream Issue 13 for an outline of the changes under these Rules.

(2) Odom R, Regli S, Messner M, Cromwell J and Javdan M (1999) Benefit-cost analysis of the Stage 1 D/DBP Rule. Journal of the American Water Works Association **91** (4) p137-147.

(3) Regli S, Odom R, Cromwell J, Lustic M and Blank M (1999) Benefits and costs of the IESWTR. Journal of the American Water Works Association **91** (4) p148-158.



New *Cryptosporidium* Test for US

Dr Jennifer Clancy of Clancy Environmental Consultants (CEC) recently visited Sydney and Melbourne to present one day seminars on Method 1622 for the isolation of *Cryptosporidium* from water samples⁽¹⁾. Method 1622 was developed by CEC under contract to the US EPA to replace the current "ICR method"⁽²⁾ which has long been acknowledged as being unsatisfactory. Under the terms of the contract, CEC was required to develop and validate a more reliable

technique using commercially available technologies within a nine month timeframe.

The method has been subjected to blinded validation in 12 laboratories with satisfactory results. Dr Clancy reported that overall recovery rates for oocysts were in the range of 35% to 45%, based on the use of positive spikes of 100 oocysts in 10 litres of water. Common practice has been to use positive spikes several logs higher than this, but it is felt that recoveries calculated in this manner are not a valid indicator of the recovery levels in natural water samples which generally contain only low numbers of oocysts.

To date none of the participating labs have recorded any false positive or false negative results - indicating that the method is both reliable and specific. An immunomagnetic separation step allows oocysts to be separated from most contaminating materials and other microorganisms that might produce false positive results on microscopy. The relative absence of debris also allows the entire concentrate from 10 litres of water to be examined on 1 or 2 slides, removing the uncertainty associated with counting only a portion of the sample.

However Dr Clancy noted that the identification of protozoa still depends on the skill and experience of the microscopist, and emphasised the need for adequate staff training and periodic crosschecking of results with other observers.

The new method is being used in several large research studies in the US and Canada, and is expected to replace the ICR method in all US laboratories over the next few months.

A similar method (Method 1623) for combined isolation of *Cryptosporidium* and *Giardia* has been validated and is also in use in field studies. This method is identical to Method 1622 except that two types of immunomagnetic beads are used (specific for *Cryptosporidium* and *Giardia* respectively). Neither method is species-specific (ie oocysts/cysts from all *Cryptosporidium* species and all *Giardia* species will be detected, not just *C. parvum* and *G. lamblia* which can infect humans).

Following the experience with the Information Collection Rule, where regulatory inflexibility forced the continued use of a method which was known to be incapable of producing meaningful results, the US EPA has moved to adopt a "performance based measurement system" for *Cryptosporidium* detection techniques.

New regulations will allow the development and use of alternative isolation and detection methods providing they are validated in a similar manner to the Method 1622, and demonstrated to achieve the same level of reliability and specificity. This move has been welcomed by the water industry and the broader environmental management field, and it is hoped that a similar flexible approach will be adopted in other areas of EPA regulation.

(1) The Method 1622 protocol can be obtained from the US EPA Microbiology Home Page at:

<http://www.epa.gov/nerlcwww/>

(2) ICR = Information Collection Rule, a US EPA regulation which required larger water utilities to carry out an 18 month *Cryptosporidium* monitoring program from July 1997 to December 1998. The isolation technique specified under this Rule had variable and often very low recovery rates for oocysts, and was prone to both false positive and false negative results. (See Health Stream Issue 2 and Issue 4 for more details)

Comment: Health Stream does not promote any particular testing method for Cryptosporidium, but strongly endorses the need for adequate staff training, stringent quality assurance measures including "blinded" testing of positive and negative control samples, and the use of low level positive spikes to provide a meaningful measure of recovery rates.

Deficiencies in laboratory quality assurance have led to a number of notable false alarms over Cryptosporidium both in water supplies and in medical practice. Variability in testing methods and estimation of recoveries have also contributed to the uncertainty surrounding the public health significance of Cryptosporidium in water supplies.



News Items

Lower arsenic limit for US

The US EPA is likely to lower the current 50 microgram /litre standard for arsenic in drinking water following the release of a report by the National Academy of Sciences. The standard was set on the basis of evidence relating to arsenic-induced skin cancers, however according to the draft NAS report released on 24 March, prolonged exposure to arsenic contaminated water at this level may lead to elevated risks for lung or bladder cancers. Only about 1% of public water systems in the US have arsenic levels above 20 micrograms/ ml, however private water supplies may have higher levels of contamination. Proposals for the new standard will be announced in early 2000 following consultation with stakeholders.



New WHO publication on Cyanobacteria

The CRCWQT recently co-sponsored the Australian launch of a new World Health Organisation publication *Toxic Cyanobacteria In Water: A Guide To Their Public Health Consequences, Monitoring And Management*. Several CRCWQT researchers have made contributions to the book which is published by E&F Spon (<http://www.efnspon.com/>)

ISBN/ISSN: 0-419-23930-8.



Cryptosporidium outbreak hits UK

A *Cryptosporidium* outbreak suspected to be waterborne has affected the Cumbria region of north west England. Health authorities were notified of an unusually high *Cryptosporidium* reading (3.4 oocysts / litre) in a 10 litre grab sample taken by a local water company on 20 April. It was decided not to issue a boil water notice as the delay between sampling and obtaining a result meant that the affected water had already been consumed, and results from subsequent water samples were in the normal range for the supply (0.2 oocysts /litre or less).

Surveillance for cryptosporidiosis in the region was intensified, and it became evident that reported case numbers had risen sharply shortly after the contamination was detected. By 12 May a total of 217 cases had been identified in a region of 1.5 million people, corresponding to about 20 times the normal occurrence rate. Analysis of isolates from affected people has shown the presence of *C. parvum* genotype 2 which is transmitted readily between humans and other mammals. Initial investigations on the source of the contamination have focussed on sheep grazing in the catchment area.



Canada issues algal warning

Health Canada has issued a health warning to consumers of products containing blue-green algae (cyanobacteria), following the detection of microcystin toxins in some products. Tablets and powders made from blue-green algae grown in natural lakes or cultivated ponds have been promoted as dietary supplements and more recently (although without scientific foundation) for the treatment of Attention Deficit Disorder in children.

A preliminary survey undertaken by a researcher at the University of Alberta found that some naturally grown products exceeded the WHO and Health Canada microcystin guidelines for daily consumption. Consumers have been warned not to give the products to children as they may be more likely than adults to suffer liver damage from the toxin. Adult have also been advised not to consume the products on a long term basis. Health Canada is now undertaking a larger survey of blue-green algal products.



Moon probe to make a splash

The 18 month mission of the Lunar Prospector probe will come to a spectacular end on 31 July when NASA flight controllers deliberately crash the spacecraft onto the Moon's surface. The probe will be aimed at the 60 kilometre Mawson crater near the south pole, which is suspected to

contain a high concentration of water ice. Under the original mission plan, the probe would have been allowed to crash at random when its fuel supply was exhausted, however NASA decided to accept the new plan proposed by researchers at the University of Texas after it was endorsed by independent experts. Scientists are hopeful that the impact will cause the release of water vapour or its byproduct OH which could be detected by observatories on earth. This would provide definitive proof of water in the permanently shadowed craters at the Moon's poles.



Pure Drink or Pure Hype?

The US environmental lobby group, the Natural Resources Defense Council, has called for tightening of bottled water standards following a study of more than 1,000 samples of bottled water. The NRDC report, *Bottled Water: Pure drink or Pure Hype?*, forms part of a citizen's petition to the Food and Drug Administration. The NRDC tested 103 brands of bottled water and concluded that it was not necessarily cleaner or safer than most tap water.

The report highlights many anomalies in US federal and state regulations on bottled water, and notes that misleading marketing claims still abound despite some recent tightening of the rules governing advertising. The NRDC have recommended that regulation and testing requirements for bottled water should be made at least as strict as those for tap water, and that manufacturers should be required to disclose the water source and method of treatment.



London acts on ground water threat

The British government has approved a plan to extract millions of litres of water from the water table underneath London. Ground water levels beneath the city have risen about 50 metres since the 1960s as industrial use of ground water has declined. The extraction plan is designed to control water levels before they become a threat to infrastructure such as underground railways.

Fluoride in top 10 achievements

Fluoridation of drinking water has been included in the list of *Ten Great Public Health Achievements, 1900-1999* by the Centers for Disease Control and Prevention in the US. The achievements were selected on the basis of opportunity for prevention and the impact on death, illness and disability in the population. About 144 million of the US population receive fluoridated water, which is credited with a 40-70% reduction in tooth decay in children and a 40-60% reduction in tooth loss among adults.

The other topics making the list were vaccination, motor-vehicle safety, safer workplaces, control of infectious diseases, decline in deaths from heart disease and stroke, safer and healthier foods, healthier mothers and babies, family planning, and recognition of tobacco use as a health hazard.

Report urges abolition of irrigation subsidies

A report by the Australian Academy of Technological Sciences and Engineering and the Institution of Engineers has called for radical reforms in the irrigated farming industry. According to the report the industry accounts for over 70% of water use in Australia, but most farms use wasteful irrigation methods and seldom employ objective techniques for improving water efficiency. Significant changes in the urban water industry have occurred in recent years, the rate of reform in rural areas has been much slower, partly because of political sensitivities.

The report urges full cost recovery for irrigation schemes and cites Victoria's Goulburn Valley as an example of a region which is under paying for water use. The authors estimate that revenue from farmers in the Goulburn would need to double to provide adequate returns for the system. They advocate the inclusion of full costs for dealing with the environmental impacts of irrigation such as salinity, excess nutrients, toxins and drainage problems. The report also estimated that requirements for irrigation water could rise by 66% over the next 20 years, a rate of growth which would be unsustainable in some areas of Australia.

Sydney water health claims dropped

An Australian High Court class action suit against Sydney Water Corporation for illnesses allegedly suffered as a result of the water contamination incidents last year was withdrawn on June 18. It is believed that the legal firm representing the 400 claimants decided to drop the case after local and overseas experts advised that no causal link could be established between illnesses suffered by the claimants and consumption of tap water during the incidents.



Feeling thirsty?

A team of scientists from Australia's Howard Florey Institute and the University of Texas have found that the sensation of thirst is controlled by a complex interaction of neural signals. Volunteers were injected with a salt solution to stimulate thirst, then brain activity was monitored with a scanner which showed a pattern of stimulation and depression in several regions of the brain.

Changes in brain activity when subjects rinsed their mouth with water, or drank their fill showed that a combination of signals from the mouth, throat and stomach were required for the sensation of thirst to disappear.

It appears that the brain is able to gauge the volume of water consumed from these signals, and modulates intake even before water has been absorbed into the blood stream

The thirst reflex tends to decline with age, and may be exaggerated or reduced in patients with neurological or psychiatric disorders. In some cases, the resultant disturbances in blood chemistry can have serious health effects. The researchers hope that a better understanding of the mechanism of thirst will assist in the management of such illnesses.



Global warming security fears

Delegates at a Canadian Arctic security conference held in May have discussed the security implications for Canada if global warming should result in melting of the Northwest passage. Under United Nations conventions, countries are granted special rights over ice-covered waters adjoining their land mass. This has effectively given Canada control of the straits and islands of the region, however if the ice melts the sea lanes would become international waters, providing a new route for shipping between Europe and Asia.



Health Stream Circulation Report - Issue 14 , June 1999

Circulation for Health Stream has grown to 1539 for this issue. International readers in 43 countries comprise about one third of our circulation.

Current circulation figures:

Australia	1050	Germany	18	Mexico	1	South Africa	7
Argentina	1	Greece	4	Morocco	2	Sri Lanka	2
Austria	2	Hong Kong	20	Netherlands	8	Sweden	2
Belgium	2	India	11	New Caledonia	1	Switzerland	4
Brazil	3	Indonesia	7	New Zealand	19	Taiwan	18
Cameroon	5	Israel	11	Norway	4	Thailand	7
Canada	19	Japan	83	Palestine	1	Togo	1
China	5	Jordan	2	Papua New Guinea	4	UK	46
Czech Republic	1	Korea	1	Philippines	6	USA	82
Finland	2	Lesotho	1	Singapore	5	Vietnam	2
France	15	Malaysia	49	Slovak Republic	3	Yugoslavia	1



From the Literature

Cancer

Tetrachloroethylene-contaminated drinking water in Massachusetts and the risk of colon-rectum, lung, and other cancers.

Paulu C, Aschengrau A, Ozonoff D. *Environ Health Perspect* (1999) **107**(4) p265-271.

A population based case-control study was undertaken in Massachusetts to study the relationship between exposure to tetrachloroethylene (PCE) contaminated drinking water and cancer of the colon-rectum, lung, brain and pancreas. The PCE contamination of the drinking water occurred as a result of approximately 660 asbestos cement pipes with vinyl liners having been installed in five towns of the upper Cape Cod area, Massachusetts during the late 1960s. The Massachusetts Department of Public Health discovered elevated levels of cancer mortality in the Cape Cod area several years after the PCE contamination was found, and public concern was raised about health effects.

In this study, cases comprised permanent residents of the five upper Cape Cod towns with incident cancers reported to the Massachusetts Cancer Registry that had been diagnosed from 1983 to 1986. Cancer cases consisted of 326 colon-rectum cases, 252 lung cases, 37 brain and 37 pancreas cancer cases. Controls were selected from a variety of sources; 464 controls aged 65 and over were obtained from the Health Care Financing Administration, 723 were randomly selected from deaths recorded after 1983 by the Massachusetts Department of Vital Statistics and Research, and another 184 controls were obtained from random-digit dialling.

Addresses and telephone numbers of subjects and their next of kin were acquired and interviews were carried out. Exposure to PCE was estimated using a model that considered residential location, years of residence, water flow rate and pipe characteristics. A variety of latency periods

between exposure and cancer diagnosis were considered (0, 5, 7, 9, 11, 13 and 15 years).

The study found an association between high cumulative exposure to PCE contaminated drinking water above the 90th percentile and increased risk of lung cancer and possibly colon-rectum cancer. Adjusted Odds Ratios for lung cancer were moderately elevated in subjects whose exposure was over the 90th percentile whether or not a latent period was accounted for. Adjusted ORs for colon-rectum cancer did not show any elevation among subjects whose exposure level was over the 90th percentile when no latency was assumed. When 5 and 7 years of latency were assumed there was a moderate elevation which was not statistically significant. A moderate elevation in adjusted ORs for colon-rectum cancer was also seen among ever-exposed subjects as increasing years of latency were considered.

The authors note that the small number of cases falling into the highly exposed group resulted in a large degree of uncertainty in the findings, however they recommend that a larger follow up study is warranted to provide a better estimate of risk levels.



Cholera

Transmission of epidemic *Vibrio cholerae* O1 in rural western Kenya associated with drinking water from Lake Victoria: An environmental reservoir for cholera?

Shapiro RL, Otieno MR, Adcock PM, Phillips-Howard PA, Hawley WA, Kumar L, Waiyaki P, Nahlen BL, Slutsker L. *Am J Trop Med Hyg* (1999) **60**(2) p271-276.

This paper describes an outbreak of cholera in western Kenya between June 1997 and March 1998. There were 14,275 cholera admissions to hospitals in the Nyanza Province, and a total of 547 cholera-related deaths were reported. A case-control study to identify major risk factors was conducted at seven sites in the Asembo region, a

rural area bordering Lake Victoria. Independent risk factors for illness were found to be: drinking water from Lake Victoria or a stream, sharing meals with someone with watery diarrhea and attending funeral feasts. A larger geographical analysis showed that diarrhoeal patients who had *V. cholerae* were more likely to live in a village bordering Lake Victoria than were those with other pathogens identified. The authors speculate that infestation of the lake with water hyacinth may lead to improved survival of *Vibrio cholerae* bacteria and provide a reservoir of endemic infection. The importance of proper sanitation and safe drinking water to control and eliminate such outbreaks are emphasised.



Copper

Acute gastrointestinal effects of graded levels of copper in drinking water.

Pizarro F, Olivares M, Uauy R, Contreras P, Rebelo A, Gidi V. *Environ Health Perspect* (1999) **107**(2) p117-121.

This paper presents the results of the first in a series of volunteer studies on copper toxicity in drinking water which are being carried out in several countries. Sixty health adult women living in Santiago, Chile were randomised into four groups in a prospective double blinded study. Each group of 15 women received either tap water with no copper added, or with 1, 3 or 5mg Cu/l of added copper sulfate for each two week study period. The study went for 11 weeks and was divided into four two-week study periods with a rest week of standard tap water in between each period. Each group experienced all copper concentrations and acted as their own control.

Subjects were given flasks filled with a solution to add to 3 litres of drinking water for each day of the week. At the end of each day subjects recorded the amount of water consumed and any gastrointestinal symptoms. If symptoms of diarrhoea, vomiting or abdominal pain occurred, the participants was instructed to abstain from copper-containing water for 2 days. If the symptoms reappeared when copper dosing was

resumed, the participant was instructed to discontinue the experiment until the next two week cycle began.

Serum copper, ceruloplasmin and liver enzymes were measured from blood samples taken 1 week prior to the study beginning, on the final day of the first 2 weeks and on the last day of the study. No difference was found between final measurements and baseline levels. Tap water copper content was measured and found to be 0.1 mg/l and therefore not an important source of copper. Subjects consumed on average 1.64 litres of water per subject per day. Gastrointestinal symptoms were recorded by 21 (35%) of the 60 participants during the study.

No association was found between copper levels from 0-5mg/l in drinking water and diarrhea with or without vomiting or abdominal pain. Nausea, abdominal pain or vomiting were significantly related to copper concentrations in water at ≥ 3 mg Cu/l. The incidence rate for these symptoms was 5, 2, 17 and 15% when ingesting water with 0, 1, 3 and 5 mg Cu/L respectively. None of the subjects had episodes of diarrhea when ingesting water without copper added.

There was a decline in the reported rate of diarrhoea in all groups as the study progressed, although this was not observed for other symptoms. The authors suggest that adaptation to higher copper concentrations may be occurring and conclude that further studies with larger numbers are needed to determine the copper concentration threshold for different gastrointestinal symptoms and to be able to apply these findings to the whole population.



Cryptosporidium

Fate and transport model of Cryptosporidium

Walker FJ and Stedinger JR. *J Environ Engineering* (1999) **125** (4) p325-333.

Cryptosporidium parvum is capable of infecting a wide range of mammals, and dairy cattle have often been targeted as representing a major source of oocysts in drinking water supplies. The

authors of this paper have constructed a model for *Cryptosporidium* oocyst movement in the Catskill-Delaware watershed which provides about 90% of the water supply to New York City. The watershed contains about 400 dairy farms with over 40,000 cattle and 39 sewage treatment plants.

As the first step in the process, a hydrological model was constructed taking into account seasonal factors and land cover, the distribution of dairy farms, and other types of land use. A model for the distribution of manure was developed with the assumptions that fresh manure (<7 days old) would be restricted to dairy yards or barns, while some intermediate manure (7-13 days old) and old manure (\geq 14 days old) would be spread over fields. Based on observations of *Cryptosporidium* infection in dairy cattle it was assumed that only 1-3% of young calves would be infected at any given time.

The reduction in oocyst numbers in manure was modelled based on observations of the effect of aging of manure, ambient temperature, and desiccation on oocyst survival. The number of oocysts in sewage discharges in the catchment were also modelled based on discharge volumes and published figures for oocyst concentrations. All components were integrated into an overall model to estimate the daily and monthly averages for oocyst loads into watercourses in the catchment over the 32 year period from 1960 to 1991. The calculated figures were comparable with actual observations of oocyst concentrations in these water sources.

The daily averages did not show marked variations in oocyst loads, suggesting that short term fluctuations in weather conditions would not cause dramatic changes in loading rates. Seasonal fluctuations were also fairly modest. The model predicted that oocyst loads from dairy cattle would be several fold less than those from sewage effluent. The authors note that their model assumes "reasonable" farming practices (ie sick calves not permitted to defecate directly into watercourses) and consequent loss of oocysts through aging and desiccation of manure before

they can enter water supplies. If this assumption is discounted then cattle would contribute much larger numbers of oocysts than sewage discharges. This finding underlines the importance of good farm management practices in reducing pathogen loading to water supplies, and suggests that oocysts in sewage effluent should be targeted in management strategies.



Cyanobacteria

Development of health alerts for cyanobacteria and related toxins in drinking water in South Australia.

Fitzgerald DJ, Cunliffe DA and Burch MD. *Environ Toxicol* (1999) **14** p203-209.

This paper outlines the processes used by the South Australian Health Commission to develop acute health alert levels for cyanobacteria and cyanobacterial toxins in local water supplies. These alerts cover three cyanobacterial species which occur sporadically in this region; *Microcystis aeruginosa*, *Nodularia spumigena* and *Anabaena circinalis*. Data on animal and human toxicity for the toxins produced by these species were reviewed and alert levels for toxin concentrations in water were selected. The approximate cell densities corresponding to these toxin levels were then estimated from existing observational data or laboratory experiments to provide an alert level for algal cell densities.

M. aeruginosa - this species produces a number of structurally related toxins of which microcystin-LR is the best characterised and most toxic. The WHO recently announced a provisional guideline value of 1 microgram /litre for lifetime exposure to microcystin-LR in drinking water based on sub-chronic exposure data in mice and pigs. This value is derived from the NOAEL (no observed adverse effect level) from the animal experiments, and incorporates an "uncertainty factor" of 1000 to account for extrapolation from experimental animals to humans (10-fold), for variability between humans (10-fold), and for limitations in data on carcinogenicity and chronic toxicity (10-fold).

For selection of an acute alert level, it was decided that the uncertainty factor should be reduced to 100 and that correction should also be made for a higher average adult body weight for the Australian population (70Kg rather than 60Kg as assumed by WHO). This produced an alert level for microcystin-LR of 11.2 micrograms /litre which was then rounded down to 10 micrograms /litre. This level is proposed for toxicity of microcystin-LR equivalents to account for the presence of other toxins of this group.

Microcystis blooms are fairly common in South Australia, however microcystin toxins have never been detected in monitoring programs for drinking water storages (raw water) or finished water. The cell density equivalent to the microcystin toxin alert level was therefore derived from laboratory data, and was estimated to be 50,000 cells /ml.

N. spumigena - this species is most commonly found in brackish waters which are not suitable for drinking water supplies, however blooms have occurred in freshwater lakes in South Australia which are used for potable water. The nodularin toxin produced by this species has not been as extensively studied as microcystin-LR but is known to have similarities in structure and mode of action. Given that nodularin displays at least the same degree of hepatotoxicity as microcystin-LR, it was decided that the same alert levels should be selected for the toxin (10 micrograms /litre) and for cell density (50,000 cells /ml).

Surveys of affected waters in South Australia have shown extracellular nodularin toxin levels seldom reach the detection limit of 0.5 micrograms /ml, although cell densities may reach 80,000 cells /ml. Total toxin levels (intra and extracellular) up to 1.7 micrograms /litre have been detected in dense blooms.

A. circinalis - this species belongs to a group of cyanobacteria that are known to produce neurotoxins including the saxitoxins (also known as paralytic shellfish poisons) and anatoxins. To date, Australian isolates have not been shown to produce anatoxins. There is no evidence of human health effects caused by drinking water

containing saxitoxins, but consumption of shellfish which have concentrated the toxins by filter feeding can lead to severe neurological effects and death.

A review of the estimated doses associated with non-fatal human poisonings suggested a LOAEL (lowest observed adverse effect level) of 124 micrograms of saxitoxin for an adult. As the available data comprise observations of humans of differing age and gender, no allowance was required for interspecies extrapolation or variation between humans. Therefore an uncertainty factor of 10 was applied to yield a health alert level of 3.6 micrograms /litre (assuming 2 litres of water consumed per day and 70Kg body weight). The level was then rounded down to 3 micrograms /litre. As for microcystin, a number of saxitoxins with slightly different structure exist, therefore the alert level is expressed in terms of saxitoxin-equivalents. Consideration of monitoring and cell culture data resulted in selection of 20,000 cells /ml as the health alert level for *Anabaena circinalis*.

The authors note that high densities of cyanobacterial cells are generally accompanied by unpleasant tastes and odours which would deter people from consuming the water. However there is no absolute relationship between toxin production and taste/odour compounds, and the palatability of water is not necessarily a guarantee of safety in all circumstances. These health alert indicators will provide water utilities with trigger levels for notification of health authorities, who will then assess the situation and decide whether action is needed to safeguard public health. The designated alert levels will be reviewed in the light of operational experience and emerging data on human health effects of cyanobacterial toxins.

An overview of problems caused by toxic blue-green algae (cyanobacteria) in drinking and recreational water.

Falconer IR. Environ Toxicol (1999) **14**(1) p5-12.

This paper provides a brief review of the adverse health effects associated with cyanobacteria in

drinking and recreational water supplies, together with a description of their toxins and a summary of reported cases of human illness.

Reports of human toxicity attributed to blue-green algae in drinking water have been reported in the medical literature since the 1930s, although the author notes that in many cases information is incomplete and the possibility of alternative causal agents cannot be entirely eliminated. The toxins produced by these organisms can be divided into three groups; hepatotoxins (causing liver injury by inhibition of phosphatase enzymes), cytotoxins (causing generalised cell damage possibly by inhibition of protein synthesis), and neurotoxins (causing inhibition of nerve function through a variety of mechanisms). Algal isolates produce a mixture of structurally related compounds and for most species only the most abundant and/or most toxic components have been characterised.

Outbreaks of blue-green algal toxicity in chlorinated water supplies causing gastroenteritis and hepatointestinal illness have generally been linked to the natural death of algal blooms or the deliberate use of copper sulfate to destroy blooms (both events resulting in release of large quantities of intracellular toxins into the water supply). People who already have major illness, particularly kidney or liver ailments, are more susceptible to toxic blue-green algae than healthy people. Kidney dialysis patients are especially vulnerable as demonstrated by the recent occurrence of 55 fatalities in Brazil where dialysis water was contaminated with cyanobacterial toxins. In Asia, blue-green algae toxins have also been implicated as part of a complex of agents which contribute to the high incidence of hepatocellular carcinoma.

Contact with blue-green algae through recreational use of lakes and rivers has been linked with a number of adverse effects. Some of these may relate to allergic or irritant responses to cellular components as well as ingestion of specific toxins. The WHO recently established a the first provisional guideline value of 1 microgram /litre for the cyanobacterial toxin,

microcystin, for which the most substantial toxicity data is available.



Disinfection Byproducts

Exposure estimates to disinfection by-products of chlorinated drinking water.

Weisel CP, Kim H, Haltmeier P, Klotz JB. *Environ Health Perspect* (1999) **107**(2) p103-110.

This study examined how well drinking water concentrations of disinfection by-products (DBPs) measured in homes correlated with two sets of biomarkers and exposures estimated from a water usage questionnaire. The first biomarker studied was exhaled breath measurement of trihalomethanes (THMs), the second, urinary levels and creatinine-normalized concentrations of two haloacetic acids; dichloroacetic acid (DCAA) and trichloroacetic acid (TCAA).

Forty-nine female subjects were recruited from New Jersey homes known to represent a wide range of DBP levels in tap water. Participants collected a post shower breath sample the morning or evening prior to a home visit and a first morning urine sample. During the home visit a background breath sample, a time of visit urine sample, an air sample and a cold tap water sample were collected. A 48-hr recall questionnaire was also administered during the home visit with questions relating to water use, the subject's activities and the types and amounts of liquids consumed. It was found that the majority of background THM breath concentrations were below the detection limit of 1 microgram/m³. A strong relationship was found between the THM breath concentrations collected after a shower and both the THM water concentration and the THM exposure from showering.

Tap water concentrations of DCAA and TCAA were not correlated with DCAA and TCAA urinary excretion rates or creatinine-normalized concentrations. When the ingested dose of DCAA and TCAA were calculated taking into account heating of beverages and the effect of water filters, a correlation was found between

urinary TCAA excretion rates and ingestion exposure. The correlation was stronger for individuals who consumed beverages principally within their home where the concentration measurements were made. There was no correlation found between an average 48-hr exposure estimate and the urinary DCAA excretion rate whereas urinary TCAA excretion rate demonstrated a dose-response relationship with exposure. The differences observed between these two biomarkers could be due to their different biological half-lives.

The authors conclude that exhaled breath concentrations may provide a biomarker of THM exposure immediately following inhalation and dermal exposure, although very sensitive measurement techniques are needed. Water concentration, for the study population, seemed to be a good estimate of THM exposure associated with showering. However the homes selected for this study were not representative of the spread of DBP concentrations expected in any water supply system and the participants consisted only of females of a narrow age range. Thus the findings may be of limited application to the general population. The urinary TCAA excretion rate and creatinine-normalized concentrations appeared to be good biomarkers of chronic ingestion exposure to TCAA.



Outbreaks

Outbreak of gastroenteritis associated with contamination of a private borehole supply.

Reacher M, Ludlam H, Irish N, Buttery R and Murray V. *Commun Dis Pub Health* (1999) **2**(1) p27-31.

This paper describes an outbreak of gastroenteritis at a large UK biological research institute served by a private ground water supply. The institute employed about 500 staff with about 200 additional residents and children living on the grounds. Another 250 people lived in the adjoining village but were served by a public water supply. The private supply was drawn from two boreholes about 100m apart which were

alternated on a weekly basis. The water was treated with softener and then chlorinated before being stored in either of two holding tanks which each held about 8 hours supply.

Vomiting and diarrhoea among the 700 staff at the institute were first reported about 7 hours after a routine weekly switch was made from the "boiler house" borehole to the "carpark" borehole. Staff complained that the water smelled of the antiseptic TCP (trichlorophenol) which was routinely used in the laboratories on site. Inspection of the water storage tanks revealed a faint odour of TCP, and it was concluded that heavy vehicle traffic associated with recent construction work had damaged sewer pipes under the carpark and led to contamination of the nearby borehole. The water supply was switched back to the boilerhouse borehole and staff were instructed to boil water before consumption. Water continued to be pumped from the carpark borehole to a field 200 metres away to prevent underground spread of the contamination.

Staff continued to become ill and on the 4th day after the initial reports, an order was issued to stop drinking the water and bottled water was supplied. Local health authorities documented 58 cases of illness over 26 days among the 700 people using the private water supply, with most (41 cases) occurring during the 4 days when the contamination was evident. There was no gastrointestinal illness reported among the 250 village residents receiving the public supply over the 26 day period. Faecal specimens were collected from 24 cases, with 2 testing positive for *Campylobacter* and 2 for *Giardia*. A water sample taken from one of the buildings on the 4th day of the incident showed more than 1000 faecal coliforms per 100ml and total phenols of 0.56 micrograms /litre (slightly over the WHO guideline level).

Investigations showed that sewage pipes carrying a mixture of human and animal waste and laboratory effluent were badly located with one pipe passing within 1.5 metres of the carpark borehole. It was concluded that gross contamination of the carpark borehole with faecal

organisms and chemical wastes had occurred, and that the symptoms suffered by staff could have been attributed to a number of causes. Following the outbreak the institute was ordered to connect to the public water supply, with the private supply restricted to use for animals. The authors have recommended that regulations for large private water supplies should be broadened to ensure higher levels of safety in design and operation.



Policy and Regulation

European Community Water Policy Standards: Locked in or watered down?

Jordan A. J Common Market Studies (1999) 37 (1) p13-37.

This paper examines the political and historical background to EC water policies in the light of recently developed "historical institutionalism" (HI) political theory. It is rather heavy going for someone unfamiliar with the field and its jargon (ie Health Stream's editor), but provides some interesting insights on how the current situation has developed. The author illustrates the discussion with examples of the UK government's responses to EC bathing and drinking water directives.

Under traditional political theory, policies which are decided collectively by a number of nations will tend to reflect the lowest common denominator (least stringent implementation), and will be responsive to pressures for change. However EC water policy directives have remained virtually unaltered since their adoption despite harsh criticism by most member states, and charges that they are unnecessarily stringent, inconsistent and lacking in scientific foundation, and often lead to misallocation of resources.

The HI political theory postulates that institutions tend to channel subsequent development down particular paths, constraining the available options and making it virtually impossible to "backtrack" even when decisions are recognised as being incorrect. In this context the word "institutions" refers to formal and informal systems of rules, procedures and norms that bind

participants together rather than formal entities such as committees.

According to the author, the EC possesses four features which have led to gaps in state control and allowed the growth of institutional power. Firstly, most politicians have short time horizons and tend to concentrate on short-term payoffs rather than long term consequences. Secondly, government policies may to some extent reflect commitments by past administrations. Thirdly, few people were able to anticipate the long-term consequences of delegating power to supranational agents. Finally, supranational organisations tend to exploit gaps in state control to increase their own power and influence.

These factors led to member nations accepting directives which were widely acknowledged to be flawed in the belief that they were flexible statements of policy intent, rather than legally enforceable obligations. The growing influence of "institutions" together with the inflexibility of rules governing the EC policy development process has prevented effective reforms despite widespread discontent with existing policies.



Water Quality

Microbiological safety of drinking water: United States and global perspectives.

Ford TE. Environ Health Perspect (1999) 107(Suppl 1) p191-206.

This paper reviews current knowledge on waterborne disease in relation to surveillance, causative agents, the effects of water treatment, and the impact of new detection techniques. Following the introduction of water treatment and disinfection in the early 1900s the incidence of waterborne disease declined dramatically, however there is still concern over the microbiological safety of drinking water for the future in developed and developing countries.

The author discusses global estimates of mortality and morbidity from waterborne diseases and the difficulty in deriving reliable estimates in view of substantial underreporting. The state of

knowledge about specific waterborne pathogens is reviewed, and new research on the virulence and environmental persistence of cholera is discussed. Bacterial diseases less clearly associated with water are also considered as well as the environmental pathogens *Legionella* and *Mycobacteria spp.* Water treatment techniques and mechanisms affecting the survival of pathogens to water are discussed, and the advances and limitation in methodologies to detect the presence, viability and infectivity of pathogens are explored. Critical needs for the future microbiological safety of water are listed.

Diarrhoea prevention in Bolivia through point-of-use water treatment and safe storage: a promising new strategy.

Quick RE, Venczel LV, Mintz ED, Soletto L, Aparicio J, Gironaz M, Hutwagner L, Greene K, Bopp C, Maloney K, Chavez D, Sobsey M, Tauxe R. V. *Epidemiol Infect* (1999) **122**(1) p83-90.

The efficacy of a water quality intervention was tested in two communities in Bolivia. The intervention consisted of point-of-use water disinfection, safe storage of treated water and community education. The 127 households participating in the study were randomised into two groups, the intervention and control group. The intervention households received one container of disinfectant and two special 20 litre vessels, and were given an explanation on how to treat and store water. Community health volunteers visited once a week to remove old containers and distribute fresh disinfectant.

All participating households were visited at monthly intervals for six months to survey water-handling practices and to test stored and source water quality. Weekly visits were made to all households for 4 months to obtain information about all cases of diarrhoea. A 44% reduction in diarrhoeal disease episodes was found in the intervention group compared to the control group over a 5-month period. Significantly less diarrhoea was observed in the intervention group in infants <1 year old and children 5-14 years old when compared with the control group. The intervention appeared to specifically decrease

Campylobacter infection rates, and stored water was found to be less frequently contaminated with *Escherichia coli* in the intervention households. The authors conclude that this simple, inexpensive intervention offers an effective way to provide microbiologically safe water in developing countries.



List of Articles

Arsenic

Naturally occurring arsenic in the groundwaters in the southern region of Fukuoka Prefecture, Japan.

Kondo H, Ishiguro Y, Ohno K et al. *Water Research* (1999) **33**(8) p1967-1972.

Cryptosporidium and Giardia

Uses of protozoan monitoring data.

Clancy JL and Hansen J. *Journal of the American Water Works Association* (1999) **91** (5) p51-65.

Cyanobacteria

Microcystin-LR and liver tumour promotion: effects on cytokinesis, ploidy, and apoptosis in cultured hepatocytes.

Humpage AR and Falconer IR. *Environ Toxicol* (1999) **14**(1) p61-75.

Cyanobacterial toxins in Portugal: effects on aquatic animals and risk for human health.

Vasconcelos VM. *Brazil J Med Biol Res* (1999) **32**(3) p249-254.

Stability of cylindrospermopsin, the toxin from the cyanobacterium, *Cylindrospermopsis raciborskii*: Effect of pH, temperature, and sunlight on decomposition.

Chiswell RK, Shaw GR, Eaglesham G, Smith MJ, Norris RL, Seawright AA, Moore MR. *Environmental Toxicology* (1999). **14** p155-161.

Detection methods

Sensitive detection of *Escherichia coli* O157 : H7 in food and water by immunomagnetic separation and solid-phase laser cytometry.

Pyle BH, Broadaway SC, McFeters GA. *Applied & Environ Microbiology* (1999) **65**(5) p1966-1972.

Disinfection /Disinfection by-products

An overview of disinfectant residuals in drinking water distribution systems.

Trussell RR. *Aqua* (1999) **48**(1) p2-10.

Chlorine demands of biofilms in water distribution systems.

Lu W, Kiene L and Levi Y. Water Research (1999) 33(3) p827-835.

Drinking water disinfection byproducts: Review and approach to toxicity evaluation.

Boorman GA, Dellarco V, Dunnick JK, et al. Environ Health Perspect (1999) 107(Suppl 1) p207-217.

Drinking water chlorination and health.

Becher G. Acta Hydrochimica Hydrobiol (1999) 27(2) p100-102.

Economic analysis

Balancing: the economic approach to sustainable water management.

Braden JB and van Ierland EC. Water Science and Technology (1999) 39 (5) p17-23.

Radon

Radon in drinking water - Study finds health risk is small.

J Environ Health (1999) 61(8) p38-9.

Water Quality

Water pollution and human health in China .

Wu CH, Maurer C et al. (1999). Environmental Health Perspectives 107(4) p251-256.

Quantitative assessment of the inactivation of pathogenic and indicator viruses in natural water sources.

Nasser AM and Oman SD. Water Research (1999) 33(7) p1748-1752

A reassessment of the cost-effectiveness of water and sanitation interventions in programmes for controlling childhood diarrhoea.

Varley RCG, Tarvid J, Chao DNW. Bulletin WHO (1998) 76(6) p617-631.

Microbiological quality of drinking water from office water dispensers.

Hunter PR and Barrell RAE. Commun Dis Pub Health (1999) 2(1) p67-68.

Modelling and reliability analysis of water distribution systems.

Tanyimboh TT, Burd R, Burrows R and Tabesh M. Water Sci Tech (1999) 39(4) p249-255.

Water- and excreta-related diseases: Unitary environmental classification.

Mara DD and Feachem RGA. Journal of Environmental Engineering-ASCE. (1999) 125(4) p334-339.



Disclaimer

Whilst every effort is made to reliably report the data and comments from the journal articles reviewed, no responsibility is taken for the accuracy of articles appearing in Health Stream, and readers are advised to refer to the original papers for full details of the research.

Health Stream is the quarterly newsletter of Program 1 *Public Health Risk Assessment* of the CRC for Water Quality and Treatment. Health Stream provides information on Program 1 research activities, updates on the recent literature and topical issues in health research which are of particular relevance to the water industry.

The CRC for Water Quality and Treatment also produces the quarterly newsletter **Water Quality News** featuring current affairs, highlights from all 4 research programs of the CRCWQT, and information about CRCWQT partners

Both newsletters are available free of charge to the water industry, public health professionals and others with an interest in water quality issues.

To be placed on the Health Stream mailing list please contact:

Ms Pam Lightbody	Phone	+61 3 9903 0592
Epidemiology and Preventive Medicine	Fax	+61 3 9903 0576
Monash Medical School	email	pam.lightbody@med.monash.edu.au
Alfred Hospital, Prahran VIC 3181, AUSTRALIA		

To be placed on the Water Quality News mailing list please contact:

Mr Fred Lijauco	Phone	+61 8 8302 3068
School of Chemical Technology	Fax	+61 8 8302 3668
University of South Australia	email	fred.lijauc@unisa.edu.au
The Levels SA 5095, AUSTRALIA		