PRODUCTIVITY COMMISSION

Arrangements for Setting Drinking Water Standards

International Benchmarking

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Publications Inquiries:
Media and Publications
Productivity Commission
Locked Bag 2 Collins Street East
Melbourne VIC 8003

Tel: (03) 9653 2244
Fax: (03) 9653 2303
Email: maps@pc.gov.au

General Inquiries:
Tel: (03) 9653 2100 or (02) 6240 3200

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The Productivity Commission

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Foreword

This study forms part of a continuing program of research benchmarking the performance of economic infrastructure industries. Earlier studies have focused on information about outcomes, such as prices and productivity. This study of the water sector, however, compares regulatory processes for the development and enforcement of quality standards, in Australia and overseas, against accepted best practice principles.

Consultations with governments and industry identified this as a particularly useful area for examination at this time. The urban water sector is faced with having to make large additional investments in treatment facilities if there is a rise in required water quality standards. The magnitude of the investments and the cost to consumers will be affected by the quality of regulatory decisions. What this study reveals is that there is considerable scope to improve regulatory processes, and in particular to draw on benefit-cost analysis to identify appropriate standards.

Research for the study was undertaken by the Economic Infrastructure Branch, with Dr Neil Byron as mentoring Commissioner. The Commission is grateful for the advice and assistance provided by government and industry bodies. Universally, those approached cooperated openly and constructively.

The Commission welcomes feedback on this report, consistent with its objective to improve the information base on key issues affecting Australia's economic performance and community living standards.

Gary Banks
Chairman

April 2000

Contents

Abbreviations

AATSEIE	Australian Academy of Technological Sciences and Engineering Institute of Engineers
ABCRN	Australian Broadcasting Commision–Radio National
ABS	Australian Bureau of Statistics
ACCC	Australian Competition and Consumer Commission
ACTEW	Australian Capital Territory Electricity and Water
ADI	Acceptable Daily Intake
AFFA	Department of Agriculture, Fisheries and Forestry (Australia)
ACPW	Advisory Committee of the Purity of Water
ANZFA	Australia and New Zealand Food Authority
ARMCANZ	Agricultural and Resource Management Council of Australia and New Zealand
AS	Australian Standard
AWWA	American Water Works Association (US)
BAT	Best Available Technology
BOOT	Build-Own-Operate-Transfer
BRTF	Better Regulation Task Force (UK)
BWSA	Bulk Water Supply Agreement
CCL	Contaminant Candidate List (US)
CCP	Critical Control Point

CDC	Centres for Disease Control and Prevention (US)
CHO	Chief Health Officer (NSW)
CMA	Catchment Management Authority
COAG	Council of Australian Governments
CRCWQT	Cooperative Research Centre for Water Quality and Treatment
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CWMB	Catchment Water Management Boards (SA)
CWW	City West Water
CWWA	Canadian Water and Wastewater Association
DASS	Direction Départementale de l'Action Sanitaire et Sociale (France)
DBP	Disinfection by-products
DETR	Department of Environment, Transport and the Regions (UK)
DG	Directorate-General (EU)
DGWS	Director-General of Water Services (UK)
DGXI	Directorate-General of the Environment, Nuclear Safety and Protection (EU)
DHHS	Department of Health and Human Services
DHS	Department of Human Services
DLWC	Department of Land and Water Conservation (NSW)
DNRE	Department of Natural Resources and Environment (Vic)
DPH	Director of Public Health (Tas)

DWC	Drinking Water Committee (US)
DWEL	Drinking Water Equivalent Level
DWI	Drinking Water Inspectorate (UK)
DWSRF	Drinking Water State Revolving Fund (US)
EA	Environment Australia
EC	European Commission
EHO	Environmental Health Officer (Tasmania)
EHU	Environmental Health Unit (DHS (Vic))
EPA	Environmental Protection Agency
ESR	Environmental Science and Research (NZ)
EU	European Union
FDA	Food and Drug Administration (US)
FPS	Federal–Provincial Subcommittee (Canada)
GAC	Granular Activated Carbon
HACCP	Hazard Analysis and Critical Control Points
HAWQ Committee	Health Aspects Water Quality Committee (SA)
HWC	Hunter Water Corporation
IARC	International Agency for Research on Cancer
IC	Industry Commission
ICR	Information Collection Rule
ICRP	International Commission on Radiological Protection
IESWTR	Interim Enhanced Surface Water Treatment Rule (US)
ILGRA	Inter-Departmental Liaison Group on Risk Assessment

IPART	Independent Pricing and Review Tribunal (NSW)
ISO	International Standards Organisation
LOAEL	Lowest Observed Adverse Effects Level
MAC	Maximum Admissible Concentration (EU)
MAV	Maximum Acceptable Value
MCL	Maximum Contaminant Level (US)
MCLG	Maximum Contaminant Level Goal (US)
MIB	Methyl isoborneol
ML	Megalitre
MMA	Melbourne Metropolitan Area
MoE	Ministry of Environment (NZ)
MoH	Ministry of Health (NZ)
MoU	Memorandum of Understanding
MWC	Melbourne Water Corporation
MWQS	Melbourne Water Quality Study
NATA	National Association of Testing Authorities
NCOD	National Contaminant Occurrence Database (US)
NDWAC	National Drinking Water Advisory Council (US)
NHMRC	National Health and Medical Research Council
NMUs	Non-Metropolitan Urbans (Victorian regional suppliers)
NOAEL	No Observed Adverse Effects Level
NPDWR	National Primary Drinking Water Regulation (US)
NRA	National Registration Authority (for Agricultural and Veterinary Chemicals)

NSDWR	National Secondary Drinking Water Regulation
NTU	Nephelometric Turbidity Unit
NZS	New Zealand Standard
OECA	Office of Environment and Compliance Assurance (US)
OFWAT	Office of Water Services (UK)
OGWDW	Office of Ground Water and Drinking Water
ONCC	OFWAT National Consumer Council (UK)
ONZPCE	Office of the New Zealand Parliamentary Commissioner for the Environment
ORD	Office of the Research and Development (US)
ORG	Office of the Regulator-General, Victoria
ORR	Office of Regulation Review
OWR	Office of Water Regulation (WA)
OXERA	Oxford Economic Research Associates Ltd (UK)
PC	Productivity Commission
pers.comm.	Personal Communication
PHS	Public Health Service (US)
PHSP	Public Health Service Provider
PHU	Public Health Unit (NSW)
PWS	Public Water Systems (US)
RFD	Reference Dose (US)
RIA	Regulatory Impact Assessment
RIS	Regulatory Impact Statement
RIU	Regulatory Impact Unit (UK)

SAB	Science Advisory Board (US)
SCA	Sydney Catchment Authority
SEQWB	South East Queensland Water Board
SEW	South East Water
STP	Sewerage Treatment Plant
SWAP	Source Water and Assessment Protection Program (US)
SWC	Sydney Water Corporation
SWTR	Surface Water Treatment Rule
TDI	Tolerable Daily Intake
THMs	Trihalomethanes
TIA	Tobacco Institute of Australia
TLA	Territorial Local Authorities (NZ)
UV	Ultraviolet
UWC	Urban Wate Cycle
VOAG	Victorian Office of the Auditor-General
WA	Western Australia
WAMC	Water Administration Ministerial Corporation (NSW)
WAWC	Western Australia Water Corporation
WTEDA	Water Treatment and Economic Development Agreement (SA)
WHO	World Health Organisation
WINZ	Water Information New Zealand
WSAA	Water Services Association of Australia
WSC	Wyong Shire Council

WTEDA	Water Treatment and Economic Development Agreement (SA)
YVW	Yarra Valley Water

Glossary

Administrative Order	Administrative orders formal enforcement actions, issued by the US EPA or the US States to address the non-compliance of a Public Water Suppliers, usually by means of a schedule with enforceable milestone dates.
Benefit-cost analysis	A systematic compliation of net social benefits and costs associated with a project or policy change.
Biofilm	Biologically active films that form on the inside of water distribution mains and which may harbour pathogenic micro-organisms.
Coliform	A group of related bacteria whose presence in drinking water may indicate contamination by disease-causing micro-organisms.
Cryptosporidiosis	The disease resulting from infection by *Cryptosporidium parvum*.
Cryptosproidium parvum	The only member of the Cryptosporidium family confirmed as pathogenic to humans.
Cysts	Lifecycle stage of a micro-organism during which it is enclosed by a cellular membrane.
Determinand	Chemical substance, microbiological organism, or some other characteristic of the water that can be measured.
Dose-response assessment	Test to determine the relationship between the amount of chemical or number of organisms consumed and the severity of the resultant health impact.
E. coli	A particular bacterium associated with diseases of the gut.
Endemic	Prevalent and ongoing.
Enteric	Pertaining to the intestines.

Epidemic	Widespread outbreak of disease, usually of limited duration.
Epidemiology	The study of diseases in populations and their causes.
Externality	The consequence of an action by either a producer or a consumer affecting other producers or consumers that is not accounted for in the market price.
Faecal coliforms	A particular bacterium indicating water contaminated with material of faecal origin.
Floc	Coalescence of finely divided precipitates into larger particles.
Genotoxic	Able to disrupt genetic material in cells.
Giardia lamblia	Disease-causing organism that affects the human gut.
Granular Activated Carbon	Carbon particles used to remove contaminants by adherence to the material.
Helminth	Parasitic worm.
Inorganic contaminants	Mineral-based compounds such as metals, nitrates and asbestos. These compounds are naturally occurring in some water, but can also occur through farming, chemical manufacturing, and other human activities.
Micro-organism	Tiny living organism or microbe that can be seen only with the aid of a microscope. Some micro-organisms cause health problems when consumed in drinking water.
Nano/ microfiltration	Membrane filtration. Pore size is smaller for nano-filtration than for microfiltration.
Oocysts	Lifecycle stage of *Cryptosproidium parvum*.
Organic polymers	Man-made chemicals with a long-chain molecular structure.
Organic contaminants	Carbon-based chemicals, such as solvents and pesticides, from cropland runoff or discharge from factories.
Oxidisation	Chemical change brought about by the addition of oxygen to the molecular structure of a chemical compound.

Ozonisation	Process of introducing ozone to disinfect drinking water — usually less harmful than chlorination.
Pathogens	Disease-carrying organisms.
pH	A measure of the acidity of a solution.
Quasi-regulatory instruments	Instruments such as operating licences that contain requirements of a regulatory nature but do not possess the legal status of regulation.
Radionuclides	Any man-made or natural element that emits radiation that may cause cancer after many years of exposure through drinking water.
Sanitary survey	An on-site review of the water sources, facilities, equipment, operation and maintenance of a public water system for the purpose of evaluating the adequace of the facilities for producing and distributing safe drinking water.
Sewage	Human effluent.
Sewerage	Infrastructure by which human effluent is transported and treated.
Thermotolerant coliforms	Bacteria that are heat-resistant that are typically associated with warm blooded animals.
Total coliforms	Collective term referring to a specified list of coliform bacteria.
Toxicology	Study of poisons, their effects, antidotes and detection.
Turbidity	The cloudy appearance of water caused by the presence of tiny particles. High levels of turbidity may interfere with proper water treatment and monitoring.

Key messages

- This study has revealed a diversity of approaches to developing, promulgating and enforcing standards, both within Australia and across the benchmarked countries.
- In Australia, as in most of the countries examined, there is considerable scope to improve processes for the development and enforcement of water standards
  - apart from the United States, benefit-cost analysis is rarely used in developing standards.
- Compared to some other countries, relatively little resources are devoted to regulatory development and enforcement activities in Australia.
- In the absence of rigorous regulatory assessment, it is difficult for authorities to fully justify existing standards, which vary across and within jurisdictions
  - it is also difficult to make sound decisions about infrastructure investments, in the face of pressures to adopt new technology.
- Any further increase in standards is likely to require significant additional investment in water treatment infrastructure, with cost implications for consumers. The cost to smaller communities would be relatively large because of scale disadvantages.
- There is a dearth of information on the quality of drinking water in different parts of Australia and the accompanying risk levels. This is an impediment to effective consultation to ascertain community preferences — a necessary part of ensuring that new standards are appropriate.
- In addition to lack of transparency, divided responsibilities for water regulation can diminish accountability.

Overview

Australia-wide, the urban water sector faces the prospect of having to make large investments in treatment technologies, because of an increase in the scope and stringency of water quality standards. Given the magnitude of potential costs and the importance of public health objectives, it is timely to explore how higher standards are developed, how risks are analysed, and how decisions are taken to implement higher standards.

Benchmarking can help improve processes.

This study was undertaken following consultations with a number of jurisdictions. Approaches to drinking water regulation in Australia and other selected countries, were compared against established 'best practice' principles of regulation making. The benchmarking is described in box 1. Benchmarking can provide insights into ways to improve institutional settings and regulatory processes with a view to achieving better health outcomes. The best practice principles used are outlined in box 2.

Box 1 **Benchmarking approach and scope**

- Regulatory arrangements and processes for establishing and enforcing drinking water standards in Australian jurisdictions were compared with those in Canada, France, New Zealand, the UK and US. The purpose was to compare regulatory process — not standards, the gap between standard requirements and actual water quality or public health outcomes, for which data are not generally obtainable.
- Information was collected on the organisations involved in developing, promulgating and enforcing drinking water standards. The information includes details of these organisations' responsibilities, processes and accountabilities.
- Differences were examined against best practice regulation making and enforcement. Widely accepted criteria for determining best practice were used.
- As a benchmarking study, there was no attempt made to develop an ideal Australian regulatory model. In any event, there is insufficient information to do so and it is unlikely that a single model would suit all jurisdictions and circumstances.
- The Commission consulted widely with relevant organisations during development of the study approach.

Box 2 **Best practice principles**

The following principles are widely recognised by Australian governments as best practice in government administration and regulation making.

Institution settings

- *Clearly defined objectives.* The success of an institution is judged by the extent to which it achieves clearly defined regulatory objectives.
- *Avoidance of shared responsibility.* Shared responsibilities can lead to confusion and a lack of accountability for regulatory outcomes.
- *Transparent processes.* Accountability requires processes that are transparent and a clear understanding of who is responsible for what.

Regulatory process

- *Adequate communication and consultation.* Community acceptance of regulation and the incorporation of design features that recognise any relevant constraints in its implementation, are best achieved if there is adequate communication and consultation with those affected by the regulation, prior to its finalisation.
- *Clearly defined regulatory objectives.* The desired objective(s) of all proposed regulation should be identified and clearly defined so that it is possible to assess how effective proposed regulation would be in the achievement of objectives.
- *Identification of regulatory alternatives*. A range of regulatory options that represent viable means of achieving the desired objectives should be identified. Regulators should look beyond regulatory approaches used in the past.
- *Benefit–cost assessment of all proposals.* Regulatory options should be subject to benefit–cost assessment. This enables alternatives to be ranked and the expected net benefits of the proposed regulation to be confirmed. Without this assessment process, resources may be wasted in developing and complying with a regulation that does not achieve its intended purpose.
- *Flexibility, provided that it is compatible with objectives*. Regulations should focus on outcomes that are consistent with the regulatory objectives, but subject to this constraint, they should be sufficiently flexible to allow different means of compliance that are cost effective.

Source: ORR 1998, Audit Office of NSW 1997.

Background

Drinking water quality guidelines and standards are set for microbiological, chemical and radiological contaminants, as well as physical characteristics such as odour, taste and clarity. Guidelines and standards are promulgated by the National Health and Medical Research Council (NHMRC) and State and Territory governments respectively. The distinction between guidelines and standards is set out in box 3.

Box 3 **Drinking water guidelines and standards**

Guidelines and standards establish quantitative limits or values for individual drinking water contaminants. In the case of chemicals, these values generally represent the concentration of a contaminant that would not result in any significant risk to health if consumed over a lifetime.

Guidelines are non-enforceable, with discretionary compliance. They may be adopted as goals to be achieved over time.

Standards have the force of law, must be complied within a specified timeframe and are usually backed by penalties for non-compliance.

Guidelines may also differ from standards in the way they are established, with no formal requirement for a Regulatory Impact Statement (RIS).

Guidelines and standards are generally set to protect the health of the population. However, not all individuals benefit equally, as some groups, particularly those who are immuno-compromised, require higher quality drinking water than others in the community.

Standards are becoming more stringent.

Over the last twenty years the stringency of drinking water standards in developed countries, including Australia, has increased considerably and their scope has widened. This has been in response to increasing contamination of source water in some areas, combined with a greater understanding of the effects of microbiological pathogens on health.

Developments in the science of detecting contaminants and improvements to technology to remove them — as well as an increase in community awareness and demand for cleaner water — have also played a role.

Water treatment costs can be expected to increase.

It is estimated that $400 million is spent annually on water treatment in Australia. If a higher level of water safety is desired, costs could be expected to increase. Any degradation of source water caused by human activity is also likely to result in higher treatment costs.

Additional treatment facilities can involve large capital expenditures. For example, it has been estimated that up to $500 million would be required to filter all of Melbourne's water.[1]

Consumer confidence may have decreased.

Industry leaders consulted by the Commission observed that consumer confidence in the safety of Australian drinking water has decreased, even though there is very little evidence of deteriorating quality or adverse health effects.[2]

Broad regulatory approach

The approach differs among countries.

There are significant differences among countries in the approaches to setting, promulgating and enforcing standards. These differences reflect a divergence in regulatory processes or philosophy (see box 4).

In Australia, a 'light-handed' regulatory approach has evolved, with water suppliers cooperating with government bodies. This approach results in lower compliance costs by providing greater flexibility to set standards according to local circumstances, particularly the cost of treatment. However, there may also be less certainty of compliance and less transparency and accountability.

1 A study of the possible health benefits of filtering Melbourne's water is currently being undertaken by the Cooperative Research Centre for Water Quality and Treatment.

2 The 1998 Sydney water crisis is likely to have contributed to a loss of confidence.

Box 4 **Key differences between countries**

The benchmarking revealed that Australia, along with most of the other countries benchmarked, is unlikely to be at best practice in the regulatory assessment of drinking water standards.

- The Australian Guidelines are based mainly on scientific assessment. In contrast, the US Environmental Protection Agency (US EPA) is required to undertake detailed benefit–cost evaluation of its regulatory proposals, which it publishes.
- Standards are promulgated in Australia using a variety of quasi-regulatory instruments, under which legal responsibilities are not always clear and rigorous assessment is lacking. In other countries, national legislation is the norm.
- In the US and EU, standards are promulgated in national legislation. In Australia, Canada and NZ, guidelines are developed at the national level and are promulgated — sometimes as standards — at a State, provincial or local level.
- The regulations in Australia are not as strictly enforced as in France, the UK and US and there is often no separation between the agencies responsible for promulgation and enforcement.
- In France, the UK and US, where private sector involvement in water supply is greater, regulators have the legal power to impose substantial penalties for non-compliance.
- Self-reporting of compliance occurs in all of the countries studied including Australia, but test results are more closely monitored overseas.

The NHMRC develops guidelines on what constitutes safe water.

The NHMRC is the expert technical body that develops Australia's Drinking Water Guidelines. The Guidelines include lists of recommended maximum values for contaminants, as well as information on water quality management practice and monitoring.

Guideline values are the maximum recommended concentration of a contaminant deemed unlikely to produce an adverse health effect.

The status of the Australian Guidelines is often misunderstood. The values listed in the Guidelines have no binding status. In practice, most suppliers try to comply with a version of the Guidelines, although not necessarily the most recent.

The need for flexibility in implementation is recognised.

The NHMRC acknowledged in the 1996 Guidelines that water quality improvement works may have to be phased in gradually over a number of years. In effect, this introduces flexibility to accommodate variations in the quality of source water, and the financial capacity of local communities to meet the costs. Similar regional variations and constraints are recognised overseas.

Implementation is a State and Territory responsibility ...

Under Australia's Constitution, water quality is a State and Territory responsibility. Consequently, those jurisdictions determine whether and how the Guidelines are to be implemented.

… which has led to differing approaches in Australia.

Most jurisdictions, consistent with the NHMRC's approach,` have viewed the Guidelines as long term goals — to be adopted as enforceable standards as quickly as possible (see box 5). This has led to considerable differences in regulation and water quality across Australia.

Versions of the Australian Guidelines have been adopted in some jurisdictions as enforceable standards without regulatory assessment, using a variety of quasi-regulatory instruments such as operating licences and memoranda of understanding (see box 5).

From a national perspective, implementation looks haphazard, but the resulting variation in water quality can be expected to reflect local circumstances and preferences to some extent. Nevertheless, differences in the quality of water across the country may prove to be contentious in the future unless the public understand the reasons.

Box 5 **Guidelines promulgated as enforceable standards**

Jurisdiction	*Supplier(s)*	*Enforceable standard* [a]	*Guidelines achieved* [b]
New South Wales	Sydney Water	NHMRC 1996	NHMRC 1996
	Hunter Water	NHMRC 1994	NHMRC 1996
	Wyong Shire Council		NHMRC 1996
	Gosford City Council		NHMRC 1996
	Non-metropolitan suppliers		NHMRC 1987 and 1996
Victoria	Melbourne Water		NHMRC 1987
	City West Water	NHMRC 1987	
	South East Water	NHMRC 1987	
	Yarra Valley Water	NHMRC 1987	
	Non-metropolitan suppliers		WHO 1984
Queensland	South East Queensland Water		NHMRC 1996
Western Australia	Water Corporation	NHMRC 1987	
South Australia	SA Water		NHMRC 1996
	United Water	NHMRC 1996	
	Riverland Water	NHMRC 1996	
Tasmania	Suppliers of potable water		NHMRC 1996
Northern Territory	Power and Water Authority		NHMRC 1987
Australian Capital Territory	ACT Electricity and Water		NHMRC 1996

[a] This is the Guideline version that is generally adopted as a standard by governments. [b] This is the Guideline version currently met by water suppliers. These are non-enforceable and there is discretion in compliance.

In Australia and overseas, there are protocols for dealing with public health problems once they have been detected. These protocols provide a mechanism for addressing system failures. They are an acknowledgment that it is unrealistic and impracticable from a technical and economic viewpoint to ensure that standards are always met. The acceptance of possible system failures might also imply that the consequences of the residual risks are not considered to be serious.

There is an acceptance that risk cannot be eliminated entirely.

This approach means that the public bears some risk that not all drinking water hazards can be foreseen and that there may be (rare) failures in the detection and treatment of contaminants.

How standards are set

Ideally the processes followed to arrive at standards (maximum levels of contaminants) should include scientific assessment, economic evaluation and consultation. The extent to which all three processes are undertaken differs among countries.

The NHMRC is responsible for scientific assessment.

In Australia, health specialists and practitioners from government-owned water supply authorities throughout the country assist the NHMRC in the ongoing development of the Guidelines.

Risk assessment procedures are used to evaluate health hazards in drinking water. In doing so, the NHMRC sets its guidelines at levels judged to represent an 'acceptable risk'.

Most countries, including Australia, rely heavily on existing assessments by the World Health Organisation. In contrast, the US develops many of its own standards using the considerable resources of the US EPA.

No evidence of rigorous evaluation in Australia.

State and Territory governments do not appear to subject the NHMRC's guidelines to rigorous economic assessment when adopting them as standards — despite inter-governmental agreements that this should happen with all regulation making.

More extensive use is made of benefit–cost analysis in the US. Under the more stringent regulatory approach found in the US, benefit–cost evaluation is mandated.

Without economic evaluation or an appreciation of risk preferences, it is difficult to determine the level of resources that should be devoted to water quality. That said, benefit–cost analysis in this area is not straightforward, partly because of scientific uncertainty concerning the relationship between standards and health outcomes (see box 6).

Box 6 **Benefit–cost assessment under scientific uncertainty**

- The link between different drinking water standards and health outcomes is not well understood. The evidence supporting such linkages is mainly inferential — derived from animal experiments at dose rates that are unlikely to be encountered by humans in drinking water supplies.
- Uncertainty provides no excuse for not identifying and, where possible, evaluating the benefits and costs of standards; or conversely, for not implementing standard values for certain contaminants. Indeed, the evaluation of the benefits and costs within an assessment framework can make the limitations imposed by uncertainty more explicit.
- That said, taking a conservative approach to setting standard values without a benefit–cost evaluation — through the adoption of safety factors, for example — may be necessary when knowledge about events and effects is particularly limited.
- The precautionary approach to environmental health management recognises that policy must always be of a provisional nature, pending the results of further research and information. Thus, research and information should be seen as tools for reducing uncertainty and improving decision making.

Broad community consultation is relatively limited in Australia ...

Consultation helps to ensure that standards are effective and efficient. In Australia, consultation by the NHMRC is mainly with health and water quality experts. Although this is true of most of the countries studied, the US has very comprehensive processes that examine both technical and economic issues.

… as is risk communication.

Consumers have the right to information about risks. Compared with some overseas countries, Australian consumers receive relatively little information on risks, expected changes to health outcomes and costs. Consequently, there is no basis for communicating their preferences when guidelines or standards are developed.

With greater transparency, water suppliers are more effectively accountable for their performance. Also, consumers are less susceptible to 'scare campaigns' about the safety of drinking water.

New Zealand and the US were found to be leaders in providing readily understood consumer information on water quality. The NZ system of grading water quality and providing a broad indication of risks is outlined in box 7.

Promulgation and enforcement

There are many institutional models.

The institutional arrangements for promulgating and enforcing standards differ among countries. In the US, the EPA promulgates standards on a national basis, whereas in Australia and Canada, standard promulgation is the responsibility of State (and Territory) and Provincial governments respectively.

Control by central governments varies.

In France, the UK and US, central governments retain a strong role in regulation, even where enforcement functions are devolved to State or regional levels. The opposite is true in Australia, New Zealand and Canada.

There is institutional fragmentation within jurisdictions in promulgating and enforcing standards in Australia. Health departments, water resources departments and the water suppliers are all involved. This sharing of responsibility potentially lessens accountability for public health outcomes.

Moreover, drinking water standards are often established in Australia through instruments that are not scrutinised through normal parliamentary processes (see box 8).

An advantage of operating licences and memoranda of understanding is that they are easier, and less costly, to change as circumstances alter. However, there is uncertainty about the legal force of these instruments and the obligations that they impose.

In addition, the process of 'referencing' standards in operating licences or memoranda of understanding does not provide for the same level of transparency and accountability as that achieved in countries where standards are set out in regulation.

Box 7 **New Zealand's water supply grading program**

New Zealand water quality is graded by the Ministry of Health for the purpose of:

- assessing whether a particular drinking water supply consistently delivers a safe wholesome product; and
- ensuring that communities are provided with reliable information about the quality of their water supply.

The grading system assesses separately the source and treatment part of the water supply system, as well as the distribution system. A two letter grading is designated, such as Aa, Cb, Ed. The capital letter (A1, A, B, C, D or E) represents the grade of the water coming into the zone (source quality and treatment) while the lower-case letter (a, b, c, d, or e) indicates the quality of the water received at the consumer's tap.

Both gradings are presented in the *Register of Community Drinking-Water Supplies in New Zealand*, which is accessible through public libraries.

The description of the grades for source and treatment is as follows:

A1 Completely satisfactory, negligible level of risk, demonstrably high quality

A Completely satisfactory, very low level of risk

B Satisfactory – low level of risk

C Marginal – moderate level of risk

D Unsatisfactory – high level of risk

E Completely unsatisfactory – very high level of risk

The evaluation of the distribution system uses a system of demerit marks for factors in the distribution of the water supply which adversely affect, or put at risk, the quality of the distributed water.

The description of the distribution grading is similar to the source and treatment description and uses letters a to e, with the smallest number of demerit marks receiving an 'a' grade.

Source: ONZPCE (1996).

Box 8 **Regulating water quality requirements in Australia**

State and Territory governments have taken diverse approaches to committing water suppliers in their jurisdictions to the Australian Guidelines. In most cases, governments have used quasi-regulation such as operating licences, charters, memoranda of understanding and customer contracts.

The instruments employed vary not only between States and Territories, but also within some jurisdictions. Often some combination of these instruments is employed. One jurisdiction (South Australia) has commercial contracts with the private sector, while three other jurisdictions (Queensland, ACT and NT) currently have no regulatory requirements in place.[a]

Jurisdiction	*Supplier(s)*	*Instruments*
New South Wales	Sydney Water and Hunter Water	Operating licence, memorandum of understanding, customer contract
	Wyong Shire Council	Water supplier business plan
	Gosford City Council	City Management Plan
Victoria	City West Water, South East Water and Yarra Valley Water	Operating licence, *Health (Quality of Drinking Water) Regulation 1991*[b], Customer contract
	Melbourne Water	Memorandum of understanding
	Non-metropolitan suppliers	Memorandum of understanding
Queensland	South East Queensland Water	No regulatory arrangements in place.
South Australia	SA Water	Charter, performance agreement
	United Water	Commercial contract
	Riverland Water	Commercial contract
Western Australia	Water Corporation	Operating licence
Tasmania	Suppliers of potable water	*Public Health Act 1997 — Guidelines for Water Quality*
Northern Territory	Power and Water Authority	No regulatory arrangement in place.
Australian Capital Territory	ACT Electricity and Water	No regulatory arrangement in place.

a The ACT is about to introduce a Code of Practice. **b** Regulations establish monitoring arrangements only.

Australia and most of the other countries studied make provision for the enforcement of drinking water standards. However, enforcement mechanisms in the US and UK are much stricter, and larger penalties are applied when non-compliance occurs.

Enforcement is less strict in Australia.

Approaches to monitoring and enforcement usually depend on whether standards are backed by the force of law, and whether there are associated agencies responsible for enforcement. In Australia, governments typically rely on cooperation between State Health Departments and government-owned water suppliers.

Australian governments also rely on self-reporting by the industry. Although similar approaches are used in the UK and the US, in Australia there do not seem to be the processes in place to scrutinise the information provided to the same degree.

The Australian industry is self-reporting.

Suppliers in most Australian jurisdictions, and in the benchmarked countries, are required to report instances where standards are significantly exceeded. When this occurs, they are required to take action to mitigate risk.

In Australia, however, sanctions for non-compliance are generally not imposed and there is more scope for administrative discretion about compliance.

Findings and policy issues

The benchmarking revealed that the regulatory assessment of water quality standards does not satisfy important best practice criteria in most countries, including Australia. An exception is the US, which consults widely and has a very transparent process of rigorously assessing standards. The overall findings and some of the issues arising out of this study are outlined in the key messages box before the overview.

Australian regulatory processes are not at best practice.

Standards should be rigorously assessed ...

The benchmarking results suggest that there is scope to inject greater rigour into Australian regulatory processes for establishing and enforcing drinking water standards. This would be particularly important if there were proposals for new standards requiring substantial investment in new water treatment facilities.

... along with the approach …

Of particular importance is to assess whether the cooperative approach is the most effective means of achieving efficient outcomes. Also, whether the relative emphasis on output (maximum levels of contaminants) and process regulation (requirements to have quality assured risk management plans) is effective and efficient.

In Australia, compliance costs are lower and there is greater flexibility to set standards according to local circumstances. However, there is less certainty about whether compliance has been achieved and institutional responsibilities remain unclear compared with overseas regimes.

... and instruments.

The 'right' balance between specific regulation and general consumer protection law is also important. This is best resolved by assessing regulatory options as part of the regulatory assessment process.

Further industry reform will necessitate better regulation making.

Moreover, the current approach to standards setting in Australia, which appears to be predicated on government ownership, may not be sustainable if parts of the industry undergo further restructuring and commercialisation, or even privatisation. For example, the public would be likely to expect governments to take a more formal approach to regulation and monitoring with private ownership.

With greater private sector involvement, greater specificity would also be necessary. For example, the extent to which some standards are to be met over a period of time would have to be precisely specified to ensure enforceablity.

Evolving information poses new challenges.

The development of new contaminant detection techniques and treatment technologies creates a number of additional challenges. For example, there is some industry concern that extensive training would be required to upgrade competencies of staff to operate some new technologies.

Also, there are understandable commercial incentives for developers of new technology to push for more stringent standards that make use of their equipment. In the absence of information to assess whether it is cost effective to increase standards, these pressures may be hard to resist.

Institutional arrangements could be improved.

A key requirement of reform in this area, as in others, is to establish effective institutional structures and appropriate objectives.

The threshold institutional issue in Australia is the respective roles and responsibilities of the NHMRC and the State standard setting bodies.

Responsibility for drinking water regulation is effectively shared between the NHMRC and the States and Territories, when NHMRC guidelines are adopted as standards without formal regulatory assessment. Shared responsibility makes it difficult to apportion responsibility for poor outcomes.

The NHMRC's role should complement the State and Territory responsibility for setting water quality standards and administering public health. Specifically, one of the NHMRC's objectives in developing the Australian Guidelines should be to reinforce State and Territory responsibility for the rigorous assessment of standards.

The NHMRC should continue to play an important role in providing scientific advice. However, the NHMRC guidelines would be just one, albeit important, input into the regulatory assessment process undertaken by State and Territory governments.

Regulatory authorities need to be adequately resourced to maintain their independence and have powers that enable them to obtain information.

Authorities have to be resourced adequately.

A greater commitment of expertise and resources is likely to be required. Overseas agencies appear to allocate significantly more resources than is currently the case in Australia. For example, Washington State, with a comparable population to NSW, has 80 to 90 people employed in the drinking water program. The water unit of NSW Health has a staff of 4.

There is a need to ensure that health risks from contaminants are addressed in the most effective and efficient way — across all possible sources, including those from hazards other than water.

An economywide focus is required.

Above all, there is a need for a well informed public debate about how safe drinking water should be and consultation on how much consumers are willing to pay for greater safety.

Public discussion is required on safety.

1 Introduction

There has been an international trend toward increasingly stringent regulation of drinking water quality. This trend can be expected to drive up water treatment costs, even if they are offset somewhat by technological improvements.

During the last decade, there has been a shift toward commercialisation and corporatisation of Australia's water suppliers (PC 1998). Suppliers have been required to develop a stronger commercial focus and among other things, reduce their operating costs.

In view of these developments, it was decided to review existing institutions and regulatory processes and to assess the effectiveness and efficiency of drinking water regulation in Australia.[1] This decision was based on the belief that good regulatory processes would deliver more effective and efficient outcomes.

Information from benchmarking can provide tangible insights into alternative regulatory approaches and their possible application in Australia.

1.1 Purpose

The purpose of this study is to compare Australia's approach to drinking water regulation with other countries and against generally accepted criteria for good regulatory practice.

The Australian urban water sector faces the prospect of having to make large investments in treatment works because of more stringent water guidelines. For example, Melbourne Water Corporation (MWC) has indicated that if it were to filter all water supplies to Melbourne, it would cost between $430 million to $510 million depending on the process selected (MWC pers. comm., 25 January 2000).

Information from the study will be particularly relevant to the consideration of whether:

[1] Regulation is effective when the objectives of the regulation are achieved — efficiency requires that an appropriate level of resources is allocated to that end.

- existing arrangements are amenable to the establishment of effective and efficient regulation;
- the implementation of existing regulation is consistent with its intended purpose; and
- the current approach to regulation in Australia will remain appropriate if the industry undergoes further restructuring and commercialisation.

At a more detailed level, the information presented is expected to facilitate the consideration of issues that are relevant to good regulatory practices. For example, the information should assist policy developers to:

- consider the impact of evolving scientific knowledge;
- assess the appropriate role of community awareness and consultation;
- assess current benefit–cost analysis of regulatory alternatives;
- explore the interactions and coordination issues between regulation of water quality and service delivery; and
- identify the type of information and analysis required for better public health policy choices.

1.2 Terminology

The Commonwealth Government coordinates the development of drinking water guidelines through a joint committee of the National Health and Medical Research Council (NHMRC) and the Agricultural and Resource Management Council of Australia and New Zealand (ARMCANZ). The *Australian Drinking Water Guidelines* are published jointly by both organisations, but for ease of exposition, they are hereafter referred to as either the NHMRC Guidelines, the Australian Guidelines or just the Guidelines.

The Commission believes that terminology is an important source of confusion and an impediment to constructive dialogue on changes in regulatory practice. The four terms ‘regulation’, ‘standard’, ‘guideline’ and ‘code of practice’ are commonly used, sometimes interchangeably, without regard for their precise meaning.

In particular, the distinction between a ‘standard’ and a ‘guideline’ is a source of much discussion within the industry. To avoid confusion, the Commission has sought to outline its interpretation of these terms (see box 1.1).

Box 1.1 **Interpretation of regulatory terms**

- In distinguishing between the terms 'regulation', 'standard', 'guideline' and 'code of practice', emphasis is sometimes placed on the administrative ease with which these instruments can be amended. However, the definitions proposed by the Commission below focus mainly on another important distinction — whether compliance is discretionary.
- *Regulation* — The legal form of a regulation is a rule that is subordinate to and made pursuant to a provision in an Act. A penalty for non-compliance with the rule normally applies.
- Sometimes the word 'regulation' is used loosely to encompass any of the terms 'standard', 'guideline', or 'code of practice'. This report uses the term *regulatory approach* as a catch all when referring non-specifically to any or all of these terms.
- *Standard* — In the drinking water context, the term 'standard' is sometimes used to distinguish it from a 'guideline'. The most important legal distinction between these two terms is that compliance with a standard is backed by a penalty, whereas there is no penalty for non-compliance with a guideline. It is this distinction which gives a standard the status of a regulation in the legal sense — in contrast with guidelines.
- Using 'standard' and 'guideline' interchangeably ignores the distinction made above.
- *Guideline* — A guideline has no legal status, in that non-compliance is not the subject of a penalty provision. If, however, an instrument of any kind is used to impose a penalty for non-compliance with a 'guideline', then the status of that 'guideline' has been elevated to that of a 'standard', and use of the term 'guideline' is no longer appropriate.
- For example, if compliance with a 'guideline' is a legal requirement for the continuance of an Operating Licence, then the 'guideline' has assumed the status of a 'standard'. Non-compliance incurs a penalty and therefore the so-called guideline fits within the above definition of a standard.
- *Code of Practice* — Codes can be purely advisory in nature, or there may be a penalty for non-compliance with the provisions of the Code. In the latter case, a Code has also assumed the status of a standard. Similarly, if a Code refers to a set of guidelines and the Code contains a penalty for non-compliance with the guidelines, then the Code has again assumed the status of a standard and is more correctly described as such.

Source: Productivity Commission.

1.3 Approach

The approach taken is to compare the regulatory arrangements for setting drinking water guideline values and standards in Australia and overseas. The differences in regulatory approach are highlighted, and their effectiveness and efficiency discussed in terms of the criteria generally considered to be consistent with good practice. The criteria used are presented in attachment 1A to this chapter.

These criteria refer to the institutional structures and processes involved in regulation making, rather than criteria for a particular regulatory model. As generally accepted criteria for good regulatory practice, they can be thought of as recommended principles for regulation making.

The main study tasks involved collecting information on the regulatory arrangements. This included information on the organisations, their responsibilities and accountabilities, as well as the processes in developing, adopting, monitoring and reporting on compliance with drinking water regulation.

At a more specific level, information was collected on the processes adopted in regulation-making, which included:

- problem identification and reasons for having a guideline or standard;
- specification of desired objectives;
- identification of options;
- consultation;
- assessment of impacts (benefits and costs) of each option; and
- consideration of implementation and review.

Information sources mainly comprised primary sources, publications and direct contact in the case of Australia. The Internet and e-mail communication were used to gather international information.

Consultation

The Commission consulted widely with government, industry and others during development of the study approach. Advice was obtained on regulatory issues and methodology. Representatives of the Water Services Association of Australia were particularly helpful at the commencement of the study.

A list of the organisations and individuals contacted by the Commission in the course of the study is provided in appendix A.

An invitation was also issued for those with an interest in the study to formally or informally comment and provide information that would assist the Commission. A study outline was posted on the Commission's web page as a guide.

Throughout the study, comment on the accuracy of factual information on regulatory arrangements was obtained from the National Health and Medical Research Council, the Australian industry and overseas regulatory authorities. Universally, those approached cooperated openly and constructively.

A workshop was held on 14 December 1999 to discuss the study methodology and present the study findings and their interpretation. A list of organisations and academics who were invited to attend the workshop is also provided in appendix A.

Refereeing

Drafts of the report chapters were refereed by Professor Don Bursill of the Co-operative Research Centre for Water Quality Treatment. Dr Murray Raff of the Melbourne University Law School and Associate Professor Jennifer McKay of the School of International Business, University of South Australia, refereed parts of the report dealing with legal issues.

1.4 Study scope

Regulatory arrangements for determining, implementing, monitoring and enforcing water quality guidelines and standards were benchmarked in Australia and overseas. All Australian States and Territories were included. These were compared with overseas arrangements in Canada, the European Union (EU), France, New Zealand, the United States of America (US) and the United Kingdom (UK).

In some cases, the benchmarking comparisons have led to findings that some arrangements are more consistent with the criteria or recommended principles in attachment 1A. However, these findings are too general to recommend their application in a particular jurisdiction.

Drinking water regulation is complex because there are many dimensions to water quality and local supply conditions and community values differ, which may necessitate different approaches. There is also scientific uncertainty about the links between particular aspects of water quality and public health outcomes.

Promulgation and enforcement of drinking water regulation depends on the institutional and legislative arrangements in place. Accordingly, promulgation and enforcement arrangements can differ widely between jurisdictions.

A preferred regulatory model is not just about processes that conform with best practice principles — it necessarily involves judgements about social and economic values. However, it is often not possible to take into account all of the local factors and community preferences that make one approach superior to another. How the elements of an approach interact, and the tradeoffs within individual jurisdictions between quality and affordability, for example, have not been fully articulated within the scope of the study. Accordingly, there is not sufficient basis on which to recommend particular regulatory models.

The study covered arrangements for setting all quality categories — microbiological, radiological, chemical and physical.

Microbiological guideline values and standards are given particular emphasis in this report because, among drinking water quality experts, concern about microbiological quality is the major driver of new capital expenditure on drinking water treatment facilities. However, consumers may be more concerned about the colour, taste and pH of water, sometimes referred to as physical or aesthetic guidelines.

The study was concerned with drinking water only. Possible links between the cost of meeting water quality guidelines and the cost of wastewater treatment were not examined.

The relationship between the regulation of drinking water quality and other components of the regulatory framework, for instance price regulation, is only covered to a limited extent in the study.

1.5 Report Outline

The regulatory and institutional arrangements for drinking water quality differ among Australian jurisdictions, and between Australia and the other benchmarked countries.

The urban water cycle, historical trends in treatment technology and guideline values and standards in Australia and the other countries selected for this study are described in chapter 2. Current water quality guidelines and standards are outlined. There is also a brief discussion of the industry's place within the general economy, the economics of the industry and the cost of current treatment processes. This

chapter is intended to provide the context to setting water quality guidelines and standards.

In chapter 3, the institutional settings and general approach to regulation are compared. The processes for establishing safe levels for each hazard are reviewed in chapter 4.

The promulgation and enforcement of standards in Australia and overseas is presented in chapter 5. Also included is a discussion of the approaches to monitoring.

Issues of systems management, cost recovery and risk communication are discussed in chapter 6. The issues examined include operator training and certification, cost recovery for investments made to achieve compliance with guidelines and standards and the benefits of effectively communicating risks.

Finally, the benchmarking findings and a number of overarching issues to be addressed in evaluating current and future effectiveness and efficiency of water quality guidelines and standards, are covered in chapter 7.

Attachment 1A Criteria used to assess the efficacy of arrangements

Criteria were developed as a basis for discussing the efficacy of current regulation making arrangements for drinking water. They are generic criteria that could also be applied to other areas of regulation making.

Institutional settings

The following criteria, consistent with effective governance, were used to discuss the strengths and weaknesses of current institutional settings.

Objectives

Clearly delineated responsibility and jurisdictional scope — responsibilities for outcomes are unambiguously defined and fall within jurisdictional function.

Non-conflicting objectives — ideally, objectives are not conflicting and allow the agency to take an economy-wide perspective to achieve the most effective and efficient outcomes for the community as a whole.

Accountability

Avoidance of shared responsibility — where responsibilities are shared, authority to act and accountability can become confused.

Effective review and appeals mechanisms — the agency is subject to the discipline of review and appeal.

Single-point accountability — ideally, the agency is accountable to a single higher authority.

Resource sufficiency — the agency is adequately resourced so that it cannot avoid accountability for performance deficiencies.

Requirement to report outcomes — requirement to report outcomes against statement of corporate intent and the achievement of objectives in the case of regulation.

Transparency

Clearly enunciated basis for decisions — where there are competing objectives, the tradeoffs made in program decisions should be published.

Open processes — decision-making processes should be open to participation and scrutiny.

Measurable performance — agency performance is readily measurable.

Responsiveness

Receptive to changing demands and needs — the agency actively assesses the need to review its regulation to ensure that it remains effective and efficient, given changes in need and preferences.

Regulatory process

The following elements of Regulatory Impact Statements were used in considering the current regulatory processes and their relative merit.

Identification of problems and issues — the nature of the problem is identified so that it is clear what the regulation is to address. In the case of water quality guidelines and standards, this involves a rigorous assessment of risks.

Objectives are transparent — the objectives of the proposed regulation are defined as desired outcomes and published.

Identification of options — all of the viable options are identified. This should include options outside water quality regulations.

In considering regulatory options and their codification, the following criteria were considered to be relevant.

Compliance flexibility — ideally, regulations focus on outcomes and maximise flexibility in the means by which these outcomes are achieved. However, output, input, or process forms of regulation may be specified in circumstances where their use is demonstrated to be the most cost-effective option.

Pro-competitive impacts — the regulation does not represent an impediment to neutral competition.

Impacts are assessed — a rigorous assessment of compliance costs and the impacts on consumers, business, government and the community is undertaken.

Consultation — consultation is undertaken throughout the regulation-making process.

Enforcement

The following criteria, consistent with effective enforcement, were used to discuss the strengths and weaknesses of current enforcement practice.

Legal instruments

Effectiveness — the instrument used provides the necessary force of law and accountabilities.

Transparency

Powers and sanctions — regulations clearly outline enforcement powers, appeal mechanisms and sanctions. Administrative procedures setting out the enforcement policy and strategies of the regulatory agency are published.

Industry consultation — mechanisms are in place to ensure that enforcement policy and procedures are understood, effective, and minimise the burden on industry of the proposed regulation.

Enforcement record — details of enforcement action and penalties are publicly available to provide information on how enforcement is being exercised and the outcomes for those not meeting standards.

Enforcement strategies

Legal action as a measure of last resort — enforcement strategies are consistent with minimising disputes and legal remedies.

Cost effectiveness — the benefits of better health outcomes from enforcement outweigh the cost of the enforcement effort and the compliance burden on industry.

Flexibility — the strategy is sufficiently flexible to accommodate new risks and changes to compliance response.

Penalties — penalties provide an effective disincentive to non-compliance.

Consistency — enforcement is consistently applied and is competitively neutral.

Monitoring

Indicators — the purpose of monitoring and the rationale for particular indicators is clear.

Cost effectiveness — the benefits of monitoring outweigh the cost burden on industry in providing information.

Acceptance — ideally, indicators are chosen after consultation with industry to ensure that they are widely used and there is agreement on their interpretation.

Implementation

The following criteria were used to assess compliance approaches.

Integrated approach — authorities have regard for the overall resource implications of meeting the guidelines or standards, taking a system-wide management approach as appropriate.

Productive efficiency — the most cost effective technology is used to meet the guidelines or standards.

Risk management — in identifying the best technical solution external risks are identified, assessed and managed.

Quality assurance — the systems in place to comply with guidelines or standards are quality assured to minimise systemic risks.

Evaluation and review — mechanisms are in place to evaluate and improve implementation.

2 The drinking water sector

Provision of safe drinking water in developed countries is seen as an essential requirement. This is because of the linkages between drinking water and health outcomes.

Drinking water quality depends on the quality of source water and the treatment processes undertaken prior to its consumption by the consumer. Its delivery is a significant economic activity.

2.1 Urban water cycle

Drinking water is one part of a complex physical system know as the urban water cycle (UWC). The UWC refers to the flow of water for consumption and other purposes, taken from and eventually returned to the environment (see figure 2.1).

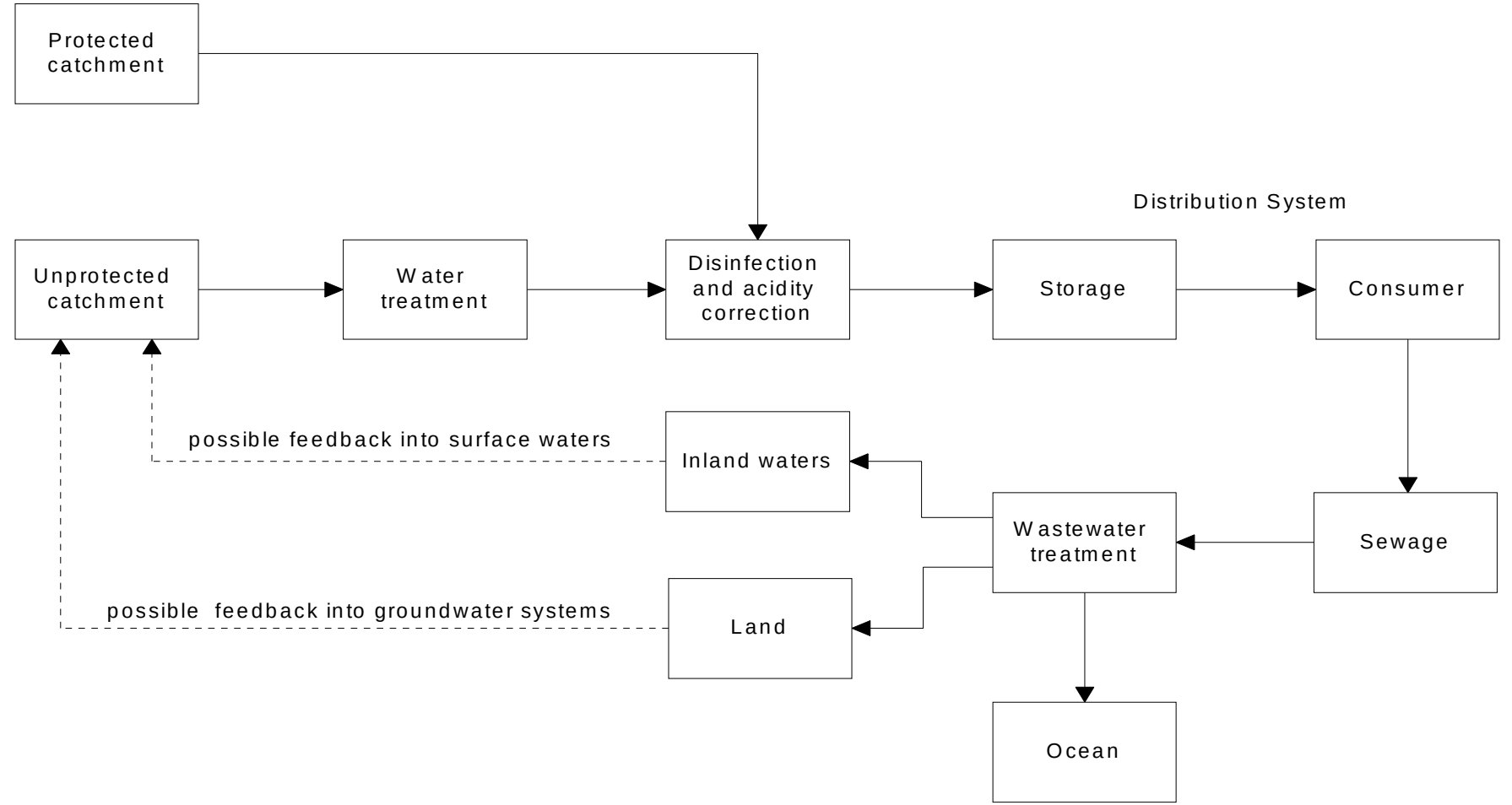
Water is harvested from rivers, streams, lakes and underground systems and stored in dams and reservoirs until needed. It is then transported to the population through a network of pipes and pumping stations.

Prior to, and during distribution, drinking water is treated to make it safe for human consumption. The level of treatment required is dependent on the quality of source water. Source water from a protected catchment is likely to be of a better quality because it is less likely to be subject to contamination.

Most properties in metropolitan areas are connected to a reticulated drinking water supply. The same reticulated supply is used to flush the sewerage system. Wastewater is returned to the environment through the sewerage system and its regulation is usually the responsibility of environment protection agencies. [1]

[1] The level of treatment of wastewater depends on whether it is to be re-used or disposed of on land or at sea.

Figure 2.1 **The urban water cycle**



2.2 Historical evolution of drinking water guidelines and standards

Water quality became an issue with the urbanisation that occurred during the Industrial Revolution. Cities were using the same water sources for both consumption purposes and waste disposal, causing the quality of drinking water and public health to deteriorate. This led to a series of developments in treatment processes aimed at improving drinking water quality (see box 2.1).

Setting guidelines and standards has had a significant effect on the drinking water treatment processes undertaken in developed countries. Filtration, together with chlorination, was a major breakthrough when introduced in the 1930s and reduced the risk of diseases such as typhoid and cholera.

Box 2.1 **Historical evolution of water treatment guidelines and standards over the past 200 years**

- In the 1820s, James Simpson pioneered the sand filter in the United Kingdom. It was the first treatment process used to clarify water supplies for consumption.
- It was not until 1852, when a law requiring all water to be filtered in London was introduced, that any standards or requirements concerning water quality were established.
- In the mid-1850s, the link between health and water quality was made. Dr. John Snow and William Farr released reports empirically linking cholera outbreaks to the quality of the water supplied at this time.
- In the 1880s, studies by Louis Pasteur on bacteriology, demonstrated the causal link between water quality and disease.
- In 1914, the first formal review of drinking water concerns occurred in the United States. Following this review, standards were established and it was agreed that they were to be re-evaluated on a regular basis.
- In the 1930s and 1940s chlorination was introduced almost universally throughout developed countries, when it became clear that filtration and disinfection with chlorine had a major impact on drinking water quality, preventing outbreaks of cholera and typhoid fever.

Source: AWWA (1990); Barty-King (1992).

Over the past fifty years, the World Health Organisation (WHO) and the United States Environmental Protection Agency (US EPA) have been the world leaders in setting guidelines and standards respectively (see section 1.2 for the distinction between guidelines and standards). Most developed nations, including Australia, have adopted or modified the WHO guidelines to suit local conditions.[2]

Despite the widespread development and acceptance of drinking water guidelines and standards over the last century, the processes by which standards are set, promulgated and enforced have been very different. These differences tend to reflect the history and unique characteristics of the countries in which the guidelines and standards have been developed.

Development of the US system of regulating drinking water started with a review of drinking water quality in 1914. Subsequently, drinking water guidelines were developed in 1925, 1942 and 1962 by the United States Public Health Services (USPHS).

The passing of the *Safe Drinking Water Act 1974* (SDWA) required the US EPA to set enforceable standards for health-related drinking water contaminants to apply to all drinking water systems (see appendix D3). The US EPA was established in 1970 out of the Federal Government's attempt to reduce cancer in the US by the regulatory control of carcinogens in the general environment (Albert 1994). The dissolution of the USPHS and other regulatory bodies saw Federal regulatory programs in air, water, radiation, pesticides, and drinking water reassembled under the US EPA.

The European Union (EU) first established standards for the quality of drinking water in 1980, with the Drinking Water Directive 80/778/EEC, applying to all water intended for human consumption. Revision of the Directive as part of the restructuring of European water policy, saw it replaced in 1998 by the Drinking Water Directive 98/83/EC (see appendix D1).

The current system that applies in Australia evolved in an *ad hoc* fragmented way through a series of historical developments. At the Commonwealth level, the National Health and Medical Research Council (NHMRC) is responsible for developing national drinking water guidelines and these are implemented at the State and Territory level. The first water quality guidelines for Australia were produced in 1972. They have subsequently been updated in 1980, 1987 and 1996.

2 The World Health Organisation (WHO) was created in 1948 as an agency of the United Nations with responsibility in international health matters and public health, including issues relating to safe drinking water supplies.

Australia's principal research and development body on drinking water quality is the Cooperative Research Centre for Water Quality and Treatment (CRCWQT). It was established in 1995 under the Australian Government's Cooperative Research Centres Program (see box 2.2).

Box 2.2 **The Cooperative Research Centre for Water Quality and Treatment (CRCWQT)**

- The CRCWQT's role is to look at issues relating to water quality management and health risk reduction, from catchment management to the distribution of drinking water to consumers' taps and to provide advice to the government regarding water supply policy and regulatory issues.
- The CRCWQT is funded through in-kind contributions made by participants who come from the Australian water industry, research organisations, universities and other relevant government organisations. External research grants are also important in supporting key projects.

Source: CRCWQT (1998, 1999a).

As drinking water standards have evolved, there have been ebbs and flows in the level of interest shown in particular contaminants. Water quality literature routinely contains assertions like the following:

> … water quality issues that concern developed countries have changed from a focus on infectious agents, which are largely under control, to a concern with chemical contaminants (Spear 1991).

This statement is only partly correct when viewed in the context of the full span of the twentieth century. In the early part of the century, diseases such as cholera and typhoid killed large numbers of people in developed countries, but these diseases have been largely brought under control.

In recent years guidelines and standards have been developed for radiological and chemical contaminants — largely in response to concerns about carcinogens — and the ability to detect them.

Despite the reduction of diseases through disinfection, concerns have arisen over the last twenty years about the by-products produced by disinfectants such as chlorine, chloramine and ozone.[3] In response to these concerns the US EPA promulgated a Total Trihalomethane Rule in 1979. Subsequently, a more

3 Chlorination and chloramination produce halogenated organics such as Trihalomethanes, chlorine dioxide produces chlorite and chlorate, while ozone produces bromate aldehydes, keytones and inorganic by-products.

comprehensive Disinfection By-products Rule was promulgated in 1998. This rule contains maximum contaminant level goals for four trihalomethanes and two haloacetic acids as well as a maximum residual disinfectant level goal for chlorine, chloramines and chlorine dioxide (US EPA 1998g).

In the 1970s and 1980s, there was considerable interest in chemical contaminants. At the same time, gastrointestinal diseases were regarded as less serious and not life threatening. However, experience in developed countries in the 1980s and 1990s has shown that some microbiological contaminants can have serious, and even life threatening consequences for more vulnerable sub-populations within the community.

Waterborne disease emerged as a major public health issue with outbreaks of illness from protozoa such as *Cryptosporidium parvum* and *Giardia lamblia*. In 1993, up to 100 people died and 400 000 were affected by an outbreak of *Cryptosporidium* in the US city of Milwaukee. In mid-1998 *Cryptosporidium* was detected in Sydney's water supplies. Although no illness of any kind was linked to the incident, 'boil water' alerts were issued over a period of three months.

Thus, a number of microbiological pathogens, some of whose properties are poorly understood, have assumed greater importance in the 1990s.

Escalation of guidelines and standards over time

Over the last twenty years, the scope and stringency of drinking water guidelines and standards in developed countries, including Australia, has increased. Developments in the science of detecting contaminants and the technology to remove them, as well as an increase in community awareness and demand for high quality water, have seen guidelines and standards become more comprehensive.

Australia and the benchmarked countries periodically adjust and update their guidelines and standards in an uncoordinated way. New rules, guideline and standard values are established at different times in different countries, such that they often supercede those existing elsewhere. However, countries often adopt or adapt the latest developments, even though they were conceived in another country. This creates a certain element of commonality in guidelines and standards for drinking water throughout developed countries.

In Australia, the number of contaminants for which values are listed in the *1996 Australian Drinking Water Guidelines* (referred to from here on as the Guidelines) has risen from 29 in 1980 to 125. This was most notably due to an increase in the

number of pesticides and other organic compounds included in the Guidelines (see table 2.1).

Table 2.1 **Comparison between 1980, 1987, 1996 Drinking Water Guidelines**

Guideline category	*1980*[a] *No. of Values*	*1987* *No. of Values*	*No. of values more stringent*	*No. of values less stringent*	*1996* *No. of Values*	*No. of values more stringent*	*No. of values less stringent*
Physical	4	4	3	0	8	2	0
Inorganic Chemicals	23	17	1	1	39	9	2
Organic Disinfection By-products	0	3	**na**	**na**	20	2	1
Other Organic Compounds	0	9	**na**	**na**	30	1	3
Pesticides	0	6[b]	**na**	**na**	21 (100)[c]	5	1
Radiological	2	2	1	0	7	0	1
Total	**29**	**41**	**5**	**1**	**125**	**19**	**8**

a The 1980 guidelines provide three different categories of values — 'desirable current criteria', 'long term objectives' and 'health investigation levels'. The desirable current criteria is used for the purpose of comparison with subsequent guideline values. **b** The 1987 Guidelines contain an appendix listing the values for pesticides that degrade rapidly in the environment and are therefore non-toxic. They are included only as a guide for situations where there is accidental direct contamination of drinking water. However, the non-toxic pesticides in this list are not included among these six pesticides. **c** The figure in parenthesis is the number of pesticides for which guideline values are listed in the 1996 Guidelines, but are not likely to be found in Australian water systems. **na** not applicable.

Source: NHMRC (1980, 1987 and 1996).

Increases in the number of organic compounds and pesticides included in the Guidelines are not a true reflection of the increase in the scope or stringency of the Guidelines. A number of these compounds are only included as a precautionary measure and do not require monitoring.[4]

The scope of the Guidelines may be extended further in the future to include pharmaceutical residuals such as hormones. Research, although still formative, has shown that minuscule concentrations of these residuals in water supplies may be enough to threaten reproductive health, posing an environmental health problem (Fisher 1999).

The stringency of drinking water guideline values is also increasing. This is evident in Australia, with the alteration of recommended concentration in guideline values,

4 Many of the pesticides, for example, are not currently used in Australia and are listed in case they are used at some time in the future.

where the number that have become more stringent outweighs the number of guideline values that have been relaxed (see table 2.1).

Monitoring regimes have also become more rigorous, with the required frequency of testing for some contaminants increasing (see table 2.2). Further, developments in science and technology have allowed the detection of contaminants that were previously unknown.

Table 2.2 **Comparison of monitoring frequency for microbiological quality**

Population serviced	*1987: Minimum number of samples*	*1996: Minimum number of samples*
Above 100 000	13 samples per month plus one sample per 10,000 people.	Six samples per week, plus one additional sample per month for each 10,000 above 100,000 people.

Source: NHMRC (1987 and 1996).

2.3 Current concerns

Current guidelines and standards have arisen in response to concerns about disease and the toxic impact of chemicals, pesticides and radiological compounds. The expansion in the number and stringency of guideline parameters over time is, in part, due to the development of new technology in detecting contaminants and from research linking contaminants with adverse health outcomes. As noted previously, water treatment, the establishment of guidelines and regulation arose in response to concerns about waterborne diseases.

Waterborne diseases

Waterborne diseases, such as cholera and dysentery, continue to be a major health problem in many developing countries. Between 1991 and 1993, a cholera epidemic spread from Peru north up the coast to Mexico — killing 7000 people and infecting over 800 000 (Putnam and Wiener 1995).

Cholera and dysentery occur only rarely in developed countries, with most waterborne disease outbreaks exhibiting as non life-threatening gastroenteritis of undefined cause. However, these disease outbreaks have the potential to spread and impose costs not just on those initially infected, but on other community members as well.

Many waterborne disease outbreaks come and go before the causal organism can be identified because of the difficulty in sampling and culturing organisms. Between

1971 and 1985, the causal organism was not identified in approximately half of the disease outbreaks recorded in the US over the period, despite improved sampling and analytical techniques (Tate and Arnold 1990).

In the US between 1971 and 1988, there were nearly 137 000 cases of waterborne disease reported. When unreported cases are included, it is believed that there may have been as many as 900 000 cases and 900 deaths (Putnam and Wiener 1995).

Waterborne diseases result from a variety of micro-organisms (see table 2.3).

While bacterial diseases such as cholera and typhoid have largely been brought under control in developed countries, other micro-organisms are constantly being identified and connected to waterborne illness.

In the US, the microbial agent most commonly identified in outbreaks of waterborne disease between 1971 and 1985 was the protozoan cyst *Giardia lamblia* (Tate and Arnold 1990). This observation is not surprising given that 26 to 43 per cent of US water supplies are said to be contaminated with *Giardia* cysts, ranging in concentration from 0.3 to 100 cysts per one hundred litres (Putnam and Wiener 1995).

In developed countries, the diseases listed in table 2.3 are not for the most part fatal for people with normal immune systems and their symptoms are usually reversible. However, these diseases can be a serious health threat to those whose immune systems are incapable of dealing with them. Further, diarrhoea and dehydration due to poor water quality kill millions of children each year in developing countries.

The treatment and disinfection of drinking water has dramatically lowered the incidence of waterborne disease outbreaks since the early part of this century. More recently, however, there is some evidence of an increase in the number of reported outbreaks from the US (Tate and Arnold 1990). This is presumed to be the result of increased public awareness and the associated increase in the reporting of disease outbreaks.

Epidemic and endemic disease

Disease can exhibit as an epidemic or it may be endemic. In the case of an epidemic, the disease is likely to be readily observed and it will usually be well documented. Alternatively, disease may be endemic in that it appears relatively frequently, but is confined to a smaller number of individuals on any one occasion. Because its occurrence is sporadic, it frequently goes undetected or unreported. Accordingly, its impact is not documented and the relevant authorities may not even be made aware of its existence, let alone its cause.

Table 2.3 **Waterborne diseases**

Waterborne disease[a]	*Causative organism*[b]	*Source of organism in water*	*Symptom*
Gastroenteritis	Multiple potentially causative organisms	Animal or human faeces	Acute diarrhoea and vomiting
Typhoid	*Salmonella typhosa* (bacterial)	Human faeces	Inflamed intestine, enlarged spleen, high temperature; can be fatal
Dysentery	*Shigella* (bacterial)	Human faeces	Diarrhoea; rarely fatal
Cholera	*Vibrio cholerae* (bacterial)	Human faeces	Vomiting, severe diarrhoea, rapid dehydration, mineral loss; often fatal
Infectious hepatitis	Virus	Human faeces, shellfish grown in polluted waters	Yellowed skin, enlarged liver, abdominal pain; lasts up to 4 months, seldom fatal
Amoebic dysentery	*Entamoeba histolytica* (protozoa)	Human faeces	Mild diarrhoea, chronic dysentery
Cryptosporidiosis	*C.parvum* (protozoa)	Animal or human faeces	Diarrhoea, abdominal discomfort, possibly fatal
Giardiosis	*Giardia lamblia* (protozoa)	Animal or human faeces	Diarrhoea, cramps, nausea and general weakness; lasts 1 week to 30 weeks, not fatal

a All of the diseases listed can also be transmitted by means other than water. **b** Not all of the organisms listed cause the associated waterborne disease.

Source: American Water Works Association, reproduced in Putnam and Wiener (1995) and US EPA (1993).

The contribution of waterborne micro-organisms is particularly unclear in the case of endemic disease. A pivotal Canadian study suggested that tap water was responsible for about 30 per cent of gastrointestinal illness, even though the water was free of *total coliforms* and was compliant with Canadian water quality guidelines (Payment et al 1991). However, the absence of 'double blind' methodology used in this Canadian study has been criticised, and further research effort attempted to establish whether drinking water that meets accepted microbiological guidelines, can still cause gastroenteritis.[5]

5 'Double blind' methodology is designed to prevent reporting bias which can occur if those being tested already know the status of the water they are being given in the study.

In Australia, the CRCWQT is undertaking a large epidemiological study similar to that undertaken in Canada. The study objective is to determine whether additional treatment of Melbourne's drinking water supply is required on public health grounds (see box 2.3).

Box 2.3 **Melbourne water quality study**

The Melbourne Water Quality Study (MWQS) is a large scale household study designed to investigate the level of endemic disease attributable to drinking water at its present level of quality. The MWQS has been designed as a 'double blind' study to overcome the methodological criticisms of a similar study conducted in Canada. The results are expected to be available in April 2000.

The study recorded illness among two population groups, each comprising approximately 300 households. One group consumed normal tap water and the other consumed water that was filtered and disinfected with ultraviolet radiation.

The study objective is to test whether the baseline group drinking normal tap water experience a higher level of gastrointestinal illness than the group drinking filtered water. If there is a difference, then it is anticipated that the difference can be used to estimate the public health benefit from further treating Melbourne's water supply. The cost of further treatment would depend on the organism(s) responsible for the difference.

If on the other hand there is no difference between the two groups, then the study will not necessarily mean that there is no endemic waterborne gastroenteritis. Rather, if it exists at all, it may be too small to measure. The study team has suggested that a randomised clinical trial like the MWQS is unable to rule out endemic waterborne gastroenteritis if it represents less than 15 per cent of all community gastroenteritis.

Source: Fairley and Sinclair (1999).

Chlorine resistant organisms

Disinfection is the major means of guaranteeing the microbiological quality of drinking water. However, *Cryptosporidium* is immune to chlorine at concentrations normally used for drinking water disinfection. This has prompted greater interest in advanced technologies capable of removing *Cryptosporidium*. About one per cent of the general population contracting *Cryptosporidiosis* require hospitalisation, but severely immuno-compromised individuals may suffer a mortality rate of 50 per cent because no effective drug treatment currently exists (Baudish and Merz 1999). Nevertheless, the links between *Cryptosporidium* and health outcomes are not clear.

Disinfection by-products

Disinfection by-products are the most commonly found organic contaminant in Australian drinking water supplies according to the Guidelines. Disinfection by-products result from the interaction between disinfectants, particularly chlorine, and naturally occurring organic material resulting from the decay of animal and vegetable matter. Of these disinfection by-products, the trihalomethanes (THMs) are produced in the highest concentrations.

THMs have been the source of international concern for some time. A difficult aspect to the regulation of THMs is the risk tradeoff between the use of disinfecting chemicals that result in their production, and the risk from minimising chemical use to the point where it jeopardises the effectiveness of disinfection. In this context, the Australian Guidelines contain the following caution:

> Action to reduce the concentration of disinfection by-products is encouraged, but disinfection itself must not be compromised: the risk posed by disinfection by-products is considerably smaller than the risk posed by the presence of pathogenic micro-organisms in water which has not been disinfected (NHMRC 1996, pp. 3–4).

2.4 Treatment technologies

Drinking water treatment processes encompass the management and protection of raw water sources, through to the protection of treated water in the distribution system before it reaches the consumer's tap. Water treatment is undergoing rapid change, driven by advances in technology, a greater understanding of the contaminants present in water and their health risks, as well as rising public expectations and the need to develop cost effective processes.

Effect of source water quality on treatment approaches

The level of risk of hazardous contamination in drinking water supplies is determined by source water quality and by catchment conditions. Both these factors affect the level of treatment required to satisfy quality standards and hence the technology required to remove hazardous contaminants.

Water collected from catchments that are isolated from human and agricultural contamination, is usually of better quality, and therefore may require less treatment for drinking purposes. These catchments may be protected catchments, where the

likelihood of human pathogens being transmitted is very low, particularly in terms of protozoa and viruses.[6]

Conventional and alternative treatment processes

Conventional treatment of drinking water is a combined process of screening, coagulation, sedimentation, filtration and disinfection (see figure 2.2 and box 2.4). Conventional treatment processes have been effective over the past century in eliminating outbreaks of waterborne disease such as cholera and typhoid in developed countries.

Currently in Australia, all major urban water suppliers (Water Services Association of Australia (WSAA) members) at least filter and disinfect most of their water supplies, with the exception of Melbourne Water which only filters a small proportion taken from sources outside their protected catchments.[7] A survey of non-metropolitan water suppliers found that 76 per cent filtered and disinfected and at least 97 per cent disinfected drinking water supplies (AFFA 1999).[8]

In most cases conventional treatment will provide safe drinking water. However, there are limits to the extent which conventional treatments can remove harmful organisms such as *Cryptosporidium*. Accordingly these deficiencies have renewed interest in the multiple barrier approach, involving processes other than disinfection, and the development of alternative treatment technologies (see box 2.5).

These technologies all have advantages and disadvantages and there is no single water treatment process that is at present regarded as superior in all circumstances.

The high capital cost of new technologies, high energy consumption and, in some cases, very large waste streams, can make their application uneconomic. Their use has been restricted to relatively small scale plants needed to deal with special situations, but larger scale plants are now appearing.

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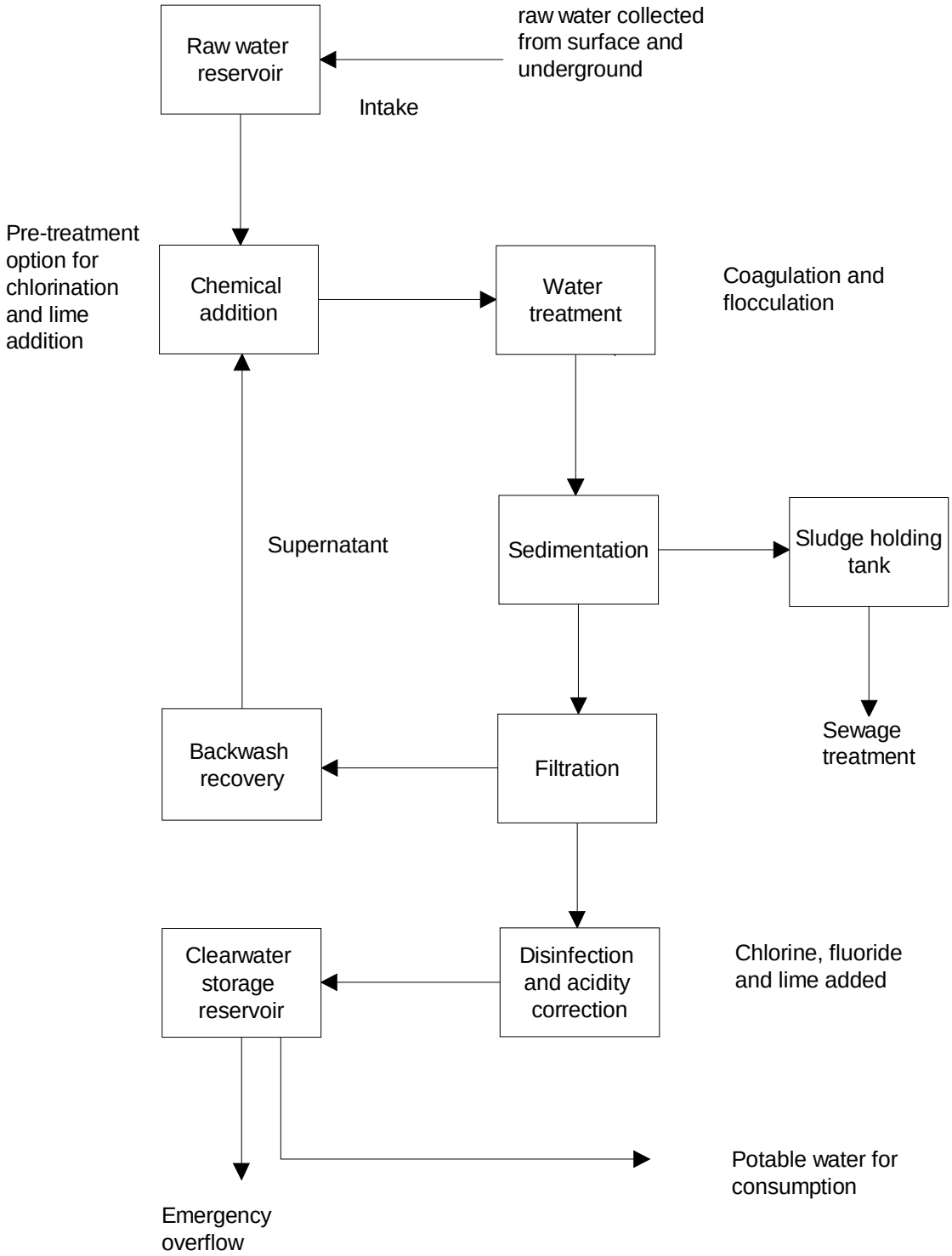
6 Despite the isolation of protected catchments, there is still some risk of contamination from birds and native animals (NHRMC 1999).

7 Currently, most of Melbourne's water supply does not undergo full treatment as around 90 per cent of its water is sourced from protected catchments (MWC 1999, p. 5).

8 A non-metropolitan water supplier is defined in *The Non-Major Water Utilities 1998 Performance Measurement Report* as a water utility in Australia supplying water to 10 000 – 50 000 properties.

Figure 2.2 **Conventional water treatment process**



Source: AWWA (1990).

Box 2.4 **Conventional treatment processes**

Intake is the process of taking water from its natural source and transferring it to a holding water reservoir in preparation for treatment. Screens are used to remove floating material and prevent large clumps of organic material from entering the holding reservoir.

Storage of water in open reservoirs reduces the number of pathogenic micro-organisms through a combination of settling, ultraviolet (UV) radiation and natural die off.

Water is often transferred from a reservoir to an enclosed tank, where acidity levels of the water may be adjusted before treatment. This prevents corrosion and enhances the effectiveness of disinfection.

Alum and iron salts or synthetic organic polymers (alone, or in combination with metal salts) are added to promote coagulation of fine organic matter and pathogenic organisms in the water into a 'floc'.

The water and floc then passes into clarifiers, where the floc settles to the bottom of the tanks. The clear water then flows into the filtration tanks and the sediment at the bottom of the clarifiers is removed.

Filters, made of layers of sand and gravel, remove remaining flocculated particles and micro-organisms, enhancing the effectiveness of subsequent disinfection. These filters rely on chemical pre-treatment of the incoming water to be effective in removing the remaining particles and micro-organisms.

Disinfection is the last stage in the treatment process. Chlorine (or some other disinfectant such as chloramine) is added to inactivate any remaining microbiological contaminants which have passed through the filters. The treated water is finally stored in a closed tank or reservoir, before being distributed to consumers. Residual amounts of chlorine are left in the water to prevent infection from bacterial regrowth and provide protection against contaminants in the distribution system.

After disinfection, water may have more chemicals added to make it suitable for drinking. For example, lime may be added to adjust the pH level. Some governments have legislated for fluoride to be added to drinking water supplies.

Source: AWWA (1990).

It has been claimed that water treatment plants in the future will use more sophisticated treatments, such as membrane filtration processes (Brignall and Bayley 1999). Improvements have been made in the past decade or so in the quality, robustness, longevity and operating requirements of membranes while their price has been reduced. Thus, membranes are expected to become more widely applied in the treatment of water:

> In the past five years, there has been a significant increase in the use of membrane filtration processes for the production of drinking water. At one time, membrane

processes were considered inappropriate or too costly for municipal water treatment … However, the recent commercialisation of back washable hollow fibre membrane systems (that is, microfiltration and ultrafiltration) has resulted in a fundamental change as to how utilities, engineers and regulatory agencies approach water treatment (Pirnie et al 1998, p. 705).

Box 2.5 **New and alternative treatment processes**

Raw water sources that are high risk, will generally require treatment other than by conventional means. Alternative water treatment processes include *Granular Activated Carbon (GAC),* disinfection with *Ozone* or *ultraviolet (uv) radiation*, and *membrane filtration.*

GAC removes residual tastes and odours, and reduces the concentration of dissolved organic material which cannot be removed by sand filters. It does this through an absorption process, causing compounds to stick to the surface of the GAC, protecting treated water from particle penetration. *Powder Activated Carbon* is also used for this purpose, but is generally not as effective in removing these contaminants.

Ozone used as a disinfectant in conjunction with *GAC,* is particularly effective in reducing tastes and odours. However, it is not effective in controlling biological contaminants in the distribution system, as residuals cannot be sustained long enough to keep the water free from re-infection before reaching the consumer's tap. Also, ozone is a very powerful oxidising agent, capable of generating carcinogenic by-products such as bromates and aldehydes. Current conventional and advanced water treatment processes do not remove either bromide or bromate.

Ultraviolet treatment usually requires the prior removal of particulate matter to allow the clear passage of UV radiation. Some bacteria have the ability to repair damage caused by UV irradiation, and thus may potentially 'reactivate'.

Membrane filtration, in the form of microfiltration and nanofiltration, is being used more frequently for treating drinking water. These technologies remove particles the size of *Cryptosporidium* and *Giardia* cysts. However, only nanofiltration removes viruses and colour.

Source: Baudish and Merz (1999); Brignall and Bayley (1999); AWWA (1990).

2.5 Economics of the industry and water quality regulation

Water supply in Australia is a significant activity, with an estimated gross value of output over $6 billion (AATSEIE 1999). It is estimated that 20 million megalitres of water was supplied for consumption and production uses in both rural and urban areas in 1995–96.

Metropolitan urban suppliers service approximately 70 per cent of Australia's population. In 1997–98, their total turnover was around $4.6 billion. Total operating costs were around $3 billion (WSAA 1998).

In 1997–98 WSAA members controlled fixed assets with a total written down value of approximately $20 billion (WSAA 1998).

Of the total amount of water used in Australia, 17.5 per cent is treated for urban uses, including residential, industrial and commercial (AATSEIE 1999). The average annual volume of water supplied per property in 1997–98 was 423 kilolitres, with residential users accounting for 59 per cent of urban water use (WSAA 1998).

Despite accounting for 17.5 per cent of total water use, urban water accounts for about 80 per cent of supply costs (AATSEIE 1999). This is mainly because of the treatment processes that urban water must undergo and the capital cost of the extensive reticulation systems used.

The percentage of treated water used for drinking purposes is estimated to be less than one per cent.[9] In contrast, garden use accounts for approximately 34 per cent of annual domestic use.

Demand characteristics

Water is a basic necessity with few substitutes (such as bottled water and fruit juices) available. The structure of the industry, with only one supplier for each property, makes it susceptible to monopoly pricing. This helps to explain the provision or regulatory supervision of water services by governments in many developed nations.

Preferences in a market are important in determining an efficient allocation of resources. Governments, in cooperation with the water industry, are trying to improve signals concerning community preferences in relation to the *quantity* of water supplied, through the introduction of user pays pricing.

When there are many customers in a network, one customer's unexpectedly high demand may be offset by another's low demand. Any residual volatility in aggregate demand can be addressed with less reserve capacity, where a network of inter-connected local storages can be drawn upon.

9 Based on average household consumption of six litres per day.

With only one supplier, consumers have no practical choice but to buy water from that supplier. It might be expected that demand for higher quality water would increase with income. However, there are information problems and no ready price mechanism to determine the effect of water *quality* on consumption.

Drinking water does not need to be treated to high quality levels for the majority of consumers. However, reducing current guidelines or standards could prove fatal for immuno-compromised people in a community.

Supply characteristics

The cost of establishing a metropolitan water treatment and distribution system is substantial. Once set up though, operating costs that vary with the level of output are relatively low. This is characteristic of a natural monopoly with economies of scale and scope (see box 2.6).

Box 2.6 **Economies of scale and scope**

The fixed costs of setting up a distribution system also result in economies of density in distribution — a special form of scale economy related to the throughput in a given geographical area. These economies arise because the costs of supplying water per litre decrease as more water is supplied through a given mains distribution system.

Suppliers of major urban areas in Australia have cost advantages compared with suppliers of smaller areas, as there can be almost twice as many 'customers per kilometre of main'. However, any such advantages may be offset to some extent by the high cost of replacement and repairs in high-density urban areas.

Economies of scope exist in supplying water for urban uses. This is because the same supply infrastructure is used to deliver water to residential and commercial properties. Economies of scope are also present in household consumption. Residents use water from the same pipes for many purposes such as cooking, bathing, washing clothes and watering gardens as well as drinking.

Source: Productivity Commission.

Water is supplied for many purposes that do not require high levels of treatment (see box 2.6). For example, water for garden purposes, does not need to be of high quality. The economies of supplying water are such that there is only one system of dual reticulation in Australia in which water of different standards is supplied.[10]

10 Dual reticulation is also used to refer to systems with a re-use component. This would involve the treatment of effluent to a non-potable standard for re-use.

The cost of duplicating reticulation in this way is generally considered to outweigh the cost of treating all water to the same high standard.

The New South Wales government is currently undertaking a project at Rouse Hill which is experimenting with the viability of dual reticulation, to test whether or not the costs do outweigh the benefits of such a system (see box 2.7). The Commonwealth Scientific and Industrial Research Organisation (CSIRO) is also undertaking research into alternatives for a coordinated approach to urban drinking water supply and effluent disposal.

Box 2.7 **Dual reticulation at Rouse Hill**

In the early 1990s, Rouse Hill was one of the areas designated to accommodate projected population growth in Sydney. A dual reticulation system was provided for at the planning stage.

Rouse Hill has its own Sewage Treatment Plant (STP), which was opened in May 1994 for the purpose of supplying water for non-potable uses after extensive treatment. To date only fresh water has been used in the Rouse Hill dual reticulation scheme supply, as initial sewerage treatment processes were unable to meet required guideline values. Additional treatment is being installed so that the dual water supply system can be used for a range of non-drinking purposes such as lawn watering, gardening and toilet flushing.

Rouse Hill is served by the first STP in Australia to be designed to produce effluent of a sufficiently high quality for use as a domestic non-potable water supply.

Source: EA (1999) and NSW Health (pers. comm., 17 February 2000).

Treatment costs

Treatment costs are just one component of total operating costs.

In 1997–98, capital expenditure for Melbourne Water Corporation (MWC) totalled $79.4 million. Water accounted for 16 per cent of this cost, compared with sewerage (48 per cent) and waterways and drainage (32 per cent). A majority of this 16 per cent was on supply infrastructure and not treatment technology (MWC 1998), which is to be expected given that Melbourne's water receives (and is said to require) relatively little treatment.[11]

It is the pipes in the ground that generally comprise the greater part of the cost in supplying drinking water. Nevertheless, the ongoing movement towards more

[11] There may be considerable year-to-year variation in the size and purpose of capital expenditure programs.

stringent guidelines may see treatment become an increasingly larger proportion of the overall cost base.

The average household expenditure on water services — water and sewerage — per week is 0.96 per cent of total household expenditure (ABS 1993). It can be assumed that water supply accounts for half of this expenditure, of which a fifth is attributable to treatment.[12] From this it can be estimated that total expenditure on water treatment processes in Australia is up to $400 million per annum.[13]

As water treatment costs increase as a proportion of the total, it will become more important for suppliers to separate their treatment costs from total operating costs. This will enable them to identify movements in their total cost structure, resulting from the implementation of increasing levels of treatment.

Operating costs for WSAA suppliers during 1997–98 ranged from approximately $190/ML to $560/ML (WSAA 1998). The Commission does not have a separate record of the treatment cost component for WSAA businesses.

A survey of non-metropolitan suppliers conducted in Australia, revealed that operating costs ranged from $156/ML in Fish River to $2271/ML in Kalgoorlie, averaging around $400/ML (AFFA 1999). Treatment costs that were available from the non-metropolitan suppliers surveyed, ranged from $6/ML in Ballina to $399/ML in Westernport, averaging around $50/ML, indicating that treatment costs make up approximately 10–20 per cent of total operating costs (AFFA 1999).

This information demonstrates that treatment costs vary greatly across individual suppliers — reflecting the quality of source water and hence the choice of treatment technologies and the size of water suppliers.

To illustrate the effect that more sophisticated technology and economies of scale have on treatment costs, a simulated costing exercise was conducted for various population sizes (see box 2.8).[14]

12 Melbourne Water's treatment costs average between 20-25 per cent of total operating costs as a bulk water supplier (MWC, pers. comm., 17 September 1999).

13 This is consistent with estimates of treatment costs averaging $50 per property, with approximately eight million properties in Australia.

14 Source water from protected catchments is normally of higher quality than that from semi-protected catchments and degraded rivers. As source water quality deteriorates, more sophisticated technologies are required to treat it to the required quality.

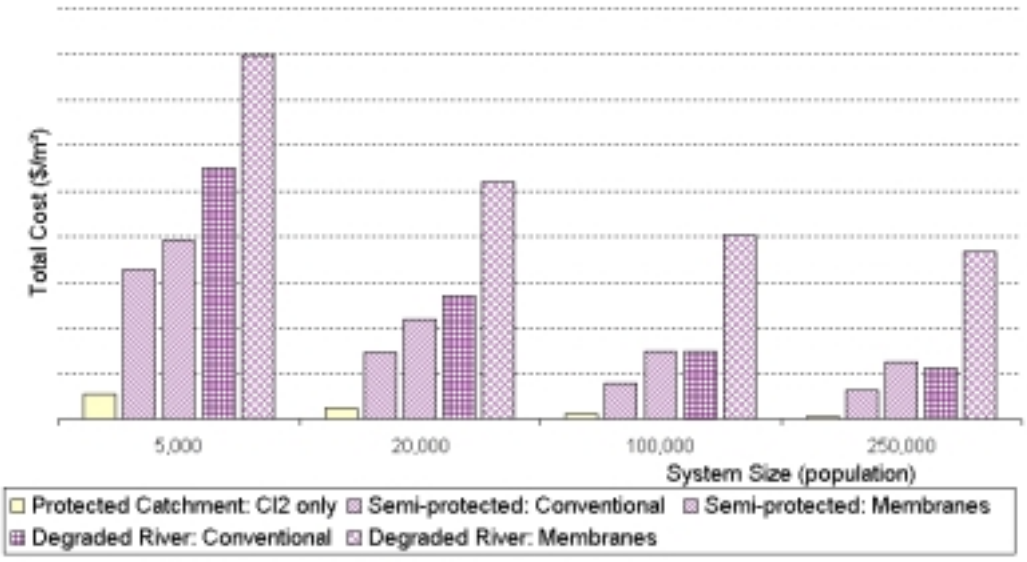
Box 2.8 **Water treatment plant costing exercise**

Water treatment costs (including sludge handling) for varying technologies and population sizes were simulated by Dr Nic Booker from CSIRO's Molecular Science Division to illustrate the cost differences between treating different quality source water and for different population sizes.

Plant sizes to cope with supplying water to 5000, 20 000, 100 000 and 250 000 people were used in the simulation.[a] The three different source water qualities and five alternative treatment technologies used in the simulations were as follows:

- *Protected catchment* with chlorination (Cl_2 only).
- *Semi-protected catchment* with chemical coagulation, sedimentation, filtration and chlorination (conventional).
- *Semi-protected catchment* with microfiltration and chlorination (membrane).
- *Degraded river system* with chemical coagulation, sedimentation, filtration, ozone/biological activated carbon and chlorination (conventional).
- *Degraded river system* with chemical coagulation, sedimentation, microfiltration, ozone/biological activated carbon and chlorination (membrane).

Water treatment costs (amortised capital and operating)



The results (expressed as $\$/m^3$) illustrate relative treatment (amortised capital and operational) costs only. They do not take into account catchment opportunity, management and reservoir costs, head works for the protected and semi-protected catchment cases, and transport. Consequently, they are not a comprehensive estimate of the total cost.

[a] Larger populations may have more than one plant per population area – this introduces more complicating factors into the analysis of treatment costs per ML for a given population.

Source: CSIRO Molecular Science, pers. comm., 20 January 2000.

The treatment costs shown in the figure in box 2.7 are illustrative of scale and technology effects — they do not reflect actual values.

The illustrative treatment costs of each scenario was derived by adding on the incremental cost of each additional stage used in the treatment process. It can be seen from the figure in box 2.7 that relative treatment costs decrease as the quality of the source water improves. In this particular simulation, the cost of treating water in all scenarios (source and type of treatment processes used) also declines as population and hence the volume of water treated increases — consistent with scale economies.

Economics of arriving at efficient standards

Government regulation and other rules are established to produce 'better' outcomes for the community. Consideration of the net gain to the community requires an assessment of the cost of administration, compliance and enforcement as well as any unintended consequences.

Why are standards set?

Market transactions may not result in an optimal level of water quality. This can occur because consumers are unable to signal the level of water quality they want — consumers are not well informed about water quality — and because disease can be transmitted beyond the area under immediate consideration.

Consumers cannot signal the level of quality that they want provided in their drinking water because a single supplier of a uniform product services them. In a normal market consumers can determine the quality of good they wish to purchase through choice and the price paid. With a natural monopoly, even if consumers could make informed judgements about the quality of water they would like to receive, they could not change to another service provider.

Information asymmetry exists in the provision of drinking water because consumers and suppliers do not have the same level of information. Consumers are unable to determine quality from direct inspection. Hence, they may receive water of different quality than if they were better informed or had greater choice.

Consumers may contract gastrointestinal illness as a direct consequence of drinking contaminated water or indirectly from someone who has.[15] The repercussions of illness in a community are potentially far reaching, in that disease can be transmitted from one person to another. Moreover, poor quality water can lead to deaths. However, it is difficult to prove the water was the cause of illness and thus that the water supplier was liable.

Guideline and standard values provide a measure against which the quality of water provided can be judged and give consumers confidence about the product they are receiving. Guidelines and standards may provide greater certainty that illness and fatalities will be prevented and they eliminate the difficulty and cost for individual consumers in seeking common law redress.

Determining an efficient standard

A structured benefit–cost approach to policy development is required to determine whether regulation meets the dual goals of 'effectiveness' and 'efficiency'. The relevant problem to be addressed and subsequent policy objective should be identified as a first step in the policy development process, followed by consideration of a range of options (including no action) for achieving the objective. The benefits of any regulation should outweigh the costs to the community (ORR 1998).

A benefit–cost assessment should take into account all benefits and costs, including the flow-on effects into other industries. For example, drinking water of a higher quality may require less treatment by the food manufacturing industry.

There are limitations with the benefit–cost assessment of water quality guidelines and standards — mainly because the causal links between water quality and health outcomes are uncertain and therefore the benefits are difficult to measure.

When identifying safe levels of contaminants in drinking water and efficient standards, the probability that exposure will occur, and the consequences of that exposure, are generally unknown. For example, in the case of pathogens such as *Cryptosporidium* and *Giardia*, there is uncertainty about what concentrations of pathogen can cause infection and it is often difficult to determine whether a micro-organism is viable.

15 Indirect effects are referred to as externalities. An externality exists when an action by either a producer or a consumer affects other producers or consumers, yet is not accounted for in the market price.

Box 2.9 **Decision making under uncertainty**

Where subjective probabilities can be assigned to outcomes

An approach to decision making under uncertainty is to assign subjective probabilities to outcomes. The approach is based on the maximisation of an individual's expected utility.

One of the limitations of this approach is that not all people have the same preferences. Also the behavioural assumptions underlying the theory do not always hold. Individuals show a preference for situations in which there is some certainty. Such behaviour has been called 'uncertainty aversion'. Behavioural studies have revealed that individuals have stronger aversions to events that are out of their control as compared to those in which they have control. Individuals generally prefer a lower level of risk when hazards are imposed through actions or events that are out of their control.

One alternative to maximising subjective utility is to base decisions on the 'maximin' approach. According to 'maximin', an action *b* should be preferred to another action *c* if and only if the worst possible consequence of *b* is better than the worst possible consequence of *c*.

Minimising the potential for the worst case still requires sufficient initial information to assign a 'worst case' value. However, even the 'worst case' is estimated with incomplete information, where the range and distribution of outcomes is unknown. It does not seem reasonable to behave in either way for non-repeatable problems or situations where there is little evidence on which to base estimates of probabilities.

Where subjective probabilities cannot be assigned

In the absence of quantifiable or subjective probabilities. the following principles have been formulated to guide decision making.

Reserved rationality: Describes the decision making process where the probability of outcomes is unknown, making it natural to proceed cautiously — to safeguard initially against the possibility of unexpectedly adverse welfare losses.

The following principles are subordinate principles.

Precautionary principle: A risk management approach that is exercised in a situation of scientific uncertainty where there is a need for action before the results of scientific research are available. For example, the UK has set a standard for the presence of *Cryptosporidium* despite the uncertainty concerning its infectivity and identification.

Burden of proof: In the absence of scientific certainty about the consequences of a decision, the body wishing to change the *status quo* is required to show that the possible risk is less than the likely benefits of the change. This principle applies also to those who wish to preserve the *status quo* — that is, not follow the precautionary principle. The 'double blind' study on the health outcomes of Melbourne's water compared to filtered water is an example of accepting the burden of proof. This study may influence whether Melbourne's water remains largely unfiltered.

Source: ECDG XXIV (1998); Kesley (1993 and 1994); Kesley and Quiggan (1992); Perrings (1991); Wills (1997); Woodward and Bishop (1997).

A consequence of the uncertain nature of the link between standards and health outcomes is that the techniques used for economic decision making under 'risk' cannot be applied. Probabilities of outcomes are measurable under risk, and decision can be made on the basis of probabilistic benefits and costs.[16] However, in the case of uncertainty, other decision making principles are followed (see box 2.9).

Governments are usually expected to make a judgement on behalf of the community — not to refuse to act because of that uncertainty. A government may choose to determine strict guidelines and standards that eliminate all risk to consumers, including those consumers that would be particularly affected by contaminated drinking water. Alternatively, governments may judge that such strict guidelines or standards are impracticable or not economically justified given the risk involved.

That said, there is a tradeoff between removing all likelihood of contamination and an 'after the event fix' approach. This tradeoff arises because compliance costs increase with the stringency of standards and the benefits at some level begin to decrease.

Consideration must also be given to the cost of enforcement. There is also a cost burden of meeting the monitoring requirements for enforcement. These monitoring and enforcement costs are additional to the cost of complying with standards.

2.6 In summary

Provision of safe drinking water is seen as an essential service in developed countries because of its importance to public health outcomes.

Over the last twenty years, the scope and stringency of quality requirements and monitoring regimes in developed countries, including Australia, has increased. This has been in response to increased awareness of the toxic impact of chemicals, pesticides and radiological compounds. Developments in the science of detecting contaminants and the technology to remove them may also have played a role.

Drinking water quality depends on the quality of the raw source water supply and the treatment processes that this raw water undergoes prior to human consumption. Both the type and level of contaminants in source water, drive the choice of treatment technologies and hence investment decisions. With the ongoing

16 A situation is said to involve *risk* if the randomness facing an economic agent can be expressed in terms of specific numerical probabilities (these probabilities may either be objectively specified, as with lottery tickets, or else reflect the individual's own subjective judgements). On the other hand, situations where the agent cannot (or does not) assign probabilities to the alternative possible occurrences, are said to involve *uncertainty* (Palgraves 1987).

movement towards higher water quality standards, the cost of treatment can be expected to increase.

Governments have responsibility for setting guidelines and standards that are practicable and economically justified, given the level of risk involved. In doing so, they should consider the cost of compliance, monitoring, and enforcement.

A benefit–cost assessment should ideally be undertaken to ensure that regulation meets the dual goals of 'effectiveness' and 'efficiency'. However, there are limitations with the benefit–cost assessment of water quality standards.

The benefits of applying a guideline or standard are uncertain because of incomplete knowledge about the links between water quality and health outcomes. Consequently, judgements are necessary — such as, whether it is appropriate to set high guidelines or standards to prevent sickness or set lower guidelines or standards and address some adverse health outcomes as they arise.

In making judgements about the level at which to set guidelines or standards, community preferences cannot be readily determined. Consumers are unable to express their preferences for a particular quality product through traditional market choice mechanisms — as they can, for example, through the purchase of fruit and vegetables.

There are also equity and public health issues to be resolved. High quality drinking water that protects all consumers, including immuno-compromised people, may not be affordable to the entire population and may require additional resources.

Given that the decisions in setting guidelines or standards involve difficult judgements, it is important that those responsible are accountable for their decisions. This can be done by ensuring that the institutional arrangements promote decision making that is in the public interest.

Institutional accountability depends on a high level of transparency and clearly defined and delineated responsibility and accountability arrangements. These attributes are discussed in the following chapter.

3 Regulatory practices and institutions

The institutions involved in developing drinking water guidelines and standards and their regulatory practices are discussed in this chapter. The arrangements vary significantly among Australian jurisdictions and the overseas countries included in this study.

The process for setting safe levels for individual contaminants is described in chapter 4. The regulatory instruments used and the enforcement and monitoring procedures in place are assessed in chapter 5.

3.1 Drinking water guidelines and standards

A regulatory approach to drinking water quality was first developed in the nineteenth century, in response to public concern about water quality (see chapter 2).

Guidelines and standards establish quantitative limits or values for individual drinking water contaminants (for the distinction between guidelines and standards see box 1.1). In the case of chemicals, these values generally represent the concentration of a contaminant that would not result in any significant risk to health if consumed over a lifetime.

Guidelines are non-enforceable with discretionary compliance. Standards have the force of law, must be complied with in a specified timeframe and are usually backed by penalties for non-compliance. Guidelines may be adopted as goals to be achieved over time.

Guidelines may differ from standards in the way they are established. There is no requirement for a Regulatory Impact Statement (RIS). However, good practice is to produce a RIS for standards.

Ideally, an assessment framework should be in place to determine whether the guidelines or standards are effective and efficient, that is, they meet the community's objectives. Such a framework would be capable of accommodating health, economic and social (including equity) objectives.

In Australia, there is no framework at the national, State or Territory level which ensures that all objectives are examined. The Commonwealth Government coordinates the development of drinking water guidelines through a joint committee of the NHMRC and ARMCANZ. However, only health objectives are considered in the process. Economic and social objectives are the responsibility of the State and Territory governments, but it is unclear to what extent they consider these objectives.

In contrast, the US Environmental Protection Agency (US EPA) is required by law to consider all these objectives. In particular, it must consider the ability of a supplier and its customers to support the cost of compliance in developing more stringent standards. Further, in recognition of the inequities between small and large suppliers, small suppliers benefit from measures to comply with higher standards.

In all of the benchmarked countries, guidelines or standards (in the absence of guidelines) are set at the national level. Many are derived from World Health Organisation (WHO) recommendations. However, it is unclear whether national guidelines or standards are designed to protect all members of the community, except in the US.

The US EPA is required by law to consider the risk to some groups such as infants, children, the elderly and those who are immuno-compromised. In the 1996 Australian Guidelines, there is no explicit reference to setting guidelines for these groups. However, the NHMRC indicate that the Guidelines may not be stringent enough for specialised purposes such as renal dialysis and some industrial uses.

A national regulatory approach is consistent with a universal right to good quality drinking water. However, national standards may not have regard for differences in local community preferences and the economic costs of compliance. In such circumstances, an approach that allows standards to be tailored to local circumstances may be warranted.

World Health Organisation

The WHO recommends drinking water guidelines for both the developed and developing world. These guidelines published, in 1984 and 1993, are based on the premise that water must be safe to drink and aesthetically acceptable.

The WHO health-based guidelines are for microbiological, chemical and radiological contaminants that may be detected in drinking water. These guidelines are based on an assessment of the risks these contaminants represent for human health.

The WHO also establishes guidelines for the physical or aesthetic characteristics of water such as colour and turbidity. In doing so, the WHO recognises that aesthetic characteristics even though they may not in themselves be of any direct consequence to health, affect consumers' acceptance of the water supply.

If the aesthetic quality of water is poor, consumers may use water from less safe sources. For example, the WHO notes that it can result in the use of bottled water and home treatment devices, some of which can have adverse effects on water quality (WHO 1993).

The WHO Guidelines are intended to be a basis for the development of national guidelines and standards. If properly implemented, they ensure the safety of drinking water supplies by eliminating or reducing the concentration of contaminants that are known to be hazardous to health (WHO 1993).

The WHO guidelines provide governments with the flexibility to undertake qualitative or quantitative assessments to establish standards to suit local conditions and economic priorities.

In establishing guidelines, the WHO has been able to draw upon the best scientific and human health advice in the world. For example, the preparation of the 1993 *Guidelines for Drinking-Water Quality* involved the participation of 200 leading scientists from nearly 40 developing and developed countries.

National Health and Medical Research Council

In Australia, the Commonwealth Government has no direct power to make laws relating to the management of water resources or the provision of drinking water, sewerage and drainage. This power rests with the State and Territory governments. However, the Commonwealth Government provides broad policy direction on drinking water quality.

Under the *National Health and Medical Research Council Act 1992* (NHMRC Act), the NHMRC is empowered by the Commonwealth Government, among other things, to foster the development of nationally consistent health standards. This includes the development of drinking water guidelines. However, the NHMRC is not required under its Act to prepare a RIS, that is, to assess the benefits and costs of proposed guidelines.

In the US, the requirement to prepare a RIS for new drinking water standards is specified in the *Safe Drinking Water Act 1974* (SDWA).

In 1997, the Australian Government endorsed *A Guide to Regulation*, which among other things, makes it mandatory for all Commonwealth departments, agencies, statutory authorities and boards making, reviewing and reforming regulations to undertake a RIS that includes a benefit–cost evaluation of regulatory alternatives (ORR 1997). This requirement does not apply to the NHMRC because water quality guidelines do not have regulatory status.

Nevertheless, during the development of the 1996 Guidelines, the NHMRC commissioned the University of Wollongong to undertake an assessment of the Guidelines (Morrison et al 1995). The assessment included consideration of the health, social, economic and environmental consequences of implementing the 1996 Guidelines. However, the assessment by Morrison et al was not as rigorous as assessments undertaken for a RIS.

The study by Morrison et al estimated the costs of implementation, but it was unable to estimate the size of the benefits in monetary terms of a life saved or an illness avoided. In contrast, such estimates are routinely included in similar studies mandated in the US under the SDWA. Without such estimates, it is impossible to determine if there are net benefits in setting particular guideline values.

Implementation of the Guidelines by the States and Territories is at the discretion of the State and Territory Health Departments, usually in consultation with water suppliers. In some jurisdictions, a range of quasi-regulatory instruments such as operating licences, incorporate the Guidelines as standards (see table 3.1). Although the 1996 Guidelines have been adopted by some suppliers, others are working to Guidelines issued in earlier years. Most suppliers aim to comply with the most recent Guidelines.

Where water supply operations have been contracted out, guideline values can be and often are more stringent than those specified in the Guidelines. For example, the contractual arrangements in place between the Sydney Water Corporation (SWC) and its water filtration plant operators go beyond the requirements specified in the 1996 Guidelines that the SWC has to meet.

The 1996 Guidelines are comprised of two elements — a description of good practice for overall systems management and sets of guideline values for contaminants in water (NHMRC 1996). The NHMRC indicate that these two elements represent an integrated package.

Table 3.1 **Regulatory practices in Australia**

State	*Water Suppliers*	*Guidelines*	*Standards*
NSW	SWC		Required by Operating Licence to comply with 1996 Guidelines
	HWC		Required by Operating Licence to comply with draft 1994 Guidelines
	Wyong Shire Council	Comply with 1996 Guidelines as set out in the Water Supply Business Plan	
	Gosford City Council	Comply with 1996 Guidelines	
	Non-metropolitan suppliers	Comply with 1987 & 1996 Guidelines	
Vic	MWC	Comply with 1987 Guidelines	
	CWW SEW YVW		Required by Operating Licence to comply with 1987 Guidelines
	Non-metropolitan suppliers	Comply with 1984 WHO Guidelines under MoU with DNRE	
SA	SA Water	Under performance agreement with SA Government, required to achieve compliance with health related 1996 Guidelines	
	United Water		Commercial contract with SA Water to comply with 1996 Guidelines
	Riverland Water		Water Treatment and Economic Development Agreement with SA Water to comply with 1996 Guidelines
WA	All water suppliers		Required by Operating Licence to comply with the 1987 Guidelines
Tas	Suppliers of potable water	Comply with the 1996 Guidelines	Required by the *Public Health Act 1997* to comply with the sampling regime for microbiological contaminants
Qld	SEQWB	Comply with 1996 Guidelines	
NT	Power and Water	Comply with 1987 Guidelines	
ACT	ACTEW	Comply with 1996 Guidelines[a]	

[a] In the ACT, it is envisaged that ACTEW will be required to comply with a Code of Practice that is enforceable and backed with substantial penalties.

Source: SWC (1998a); HWC (1995); WSC (1999); Gosford Council, NSW, pers. comm.,1999; DLWC, NSW, pers. comm., 1999; CWW (1998c); SEW (1998a); YVW (1998b); DNRE (1997); SA Water (1998); OWR (1998); *Public Health Act 1997* (Tasmania); Power and Water, NT, pers. comm., 1999.

Good practice is defined in the Guidelines to include:

- the use of effective barriers to prevent contamination of the water at source or within the distribution system;[1]
- regular inspections of catchment areas to identify the chemicals being used, and how they are applied;
- control of industrial, mining, forestry, agricultural and human activities within catchment boundaries;
- an effective maintenance program for plant and equipment used in the water supply system;
- use of appropriately skilled and trained personnel in the operation of water supply systems; and
- public awareness and education programs so that people know what is being done to protect their water supply.

The second element comprises recommended guideline values for physical, microbiological, chemical (including organic and inorganic chemicals and pesticides) and radiological contaminants which affect water quality. The guideline values are used in two separate but complementary ways — as the basis for assessing how well a water supply system is performing and as 'action levels', which trigger an incident management response when they are exceeded (see appendix B).

The incorporation of good management practices occurred for the first time in the 1996 Guidelines. Previous versions focussed on guideline values only.

In developing the current 1996 Guidelines, the NHMRC based the guideline values primarily on the recommendations of the 1993 WHO Guidelines. Specialist panels representing Australian and New Zealand suppliers, State and Commonwealth departments of health and water resources, the Commonwealth Scientific and Industrial Research Organisation (CSIRO), universities and private industry were consulted (NHMRC 1996).

1 These may include measures that protect the source water from contamination by human or animal faeces; the pre-treatment of water by detention in reservoirs for sufficient time to allow micro-organisms to die off; protection of water storages; coagulation, settling and filtration; disinfecting the water before it enters the distribution system; maintaining an adequate disinfectant residual throughout the distribution system; and securing the distribution system against possible re-contamination which involves ensuring the integrity of the pipe system, vermin-proofing water tanks and preventing backflow.

The NHMRC, like the WHO, also recommend guideline values for the aesthetic characteristics of water.[2] The guideline values are recommended minimum concentrations for these characteristics. In contrast, the WHO approach provides a greater degree of flexibility for developed and developing countries to adopt higher or lower values for their own aesthetic characteristics.

The NHMRC and ARMCANZ Ministers are committed to re-emphasising the need for suppliers to develop and implement drinking water quality management systems of the kind outlined in the 1996 Guidelines. However, many suppliers are still working to pre-1996 Guidelines (see table 3.1).

A framework providing guidance for establishing these systems is currently being developed through the ongoing review process associated with the Guidelines. The framework builds on the quality management actions already outlined in the Guidelines. In addition, it includes Hazard Analysis and Critical Control Points (HACCP) principles, similar to those currently being introduced in the food industry (see chapter 6).

The development of a water quality management system is designed to minimise the risk of contaminated water over the entire supply chain. This is also true of the proposed regulatory approach to food regulation in Australia, which addresses health outcomes by focussing on food handling practices (see box 3.2).

The proposed national food regulations require businesses to institute programs that identify hazards, assess risks and implement measures to minimise risk as far as practicable. Suppliers are required to take measures that ensure that the concentration of contaminants should not exceed guideline or standard values. Guidelines on good risk mitigation practice are recommended, but are not mandated as specific requirements.

The United States Environmental Protection Agency

In contrast to the WHO and the NHMRC, the US EPA is required under the SDWA to set National Primary Drinking Water Standards and Secondary Drinking Water Guidelines based on a comprehensive economic evaluation and risk assessment process.

Primary standards are enforceable standards for health-related drinking water contaminants and apply to all suppliers (except those households on private wells). Suppliers can be penalised for non-compliance.

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2 The aesthetic characteristics of water include colour, turbidity, hardness, total dissolved solids, pH, temperature, taste, odour and dissolved oxygen.

Box 3.2 **Proposed food regulation mechanisms**

In May 1999, the Australia New Zealand Food Authority issued an analysis of the regulatory impact of proposed national food safety reforms. The standards proposed under the reform cover:

- programs to identify hazards;
- practice (handling, cleaning, sanitising and personal hygiene), notification, food recalls and training; and
- design and construction parameters for food premises and the equipment used.

The proposed regime is intended to unify standards. The standard requirements are minimised to just those that are effective and necessary to achieve safe food, replacing overly prescriptive and inconsistent requirements. They require producers to systematically minimise food contamination by controlling microbiological, chemical and physical hazards using a Hazard Analysis and Critical Control Points (HACCP) approach.

The proposed safety standards are claimed to be outcome-based — that is, promoting health outcomes. In their formulation it was recognised that prescription is inappropriate because the desired outcomes can be achieved by particular businesses in a variety of ways.

General requirements that are generic to all food handling and processing are specified — for example, the temperatures at which food must be maintained.

Source: ANZFA (1999).

In setting primary standards, the US EPA must first establish a non-enforceable health-related Maximum Contaminant Level Goal (MCLG) for a contaminant (see appendix D3).[3] Once the MCLG is determined, the US EPA must concurrently set, either an enforceable Maximum Contaminant Level (MCL) or a treatment technique in lieu of establishing a MCL.[4]

MCLGs are based on public health considerations. For chemicals which are non-carcinogenic, the MCLG is based on the Reference Dose (RFD). A RFD is an estimate of the amount of a chemical that a person can be exposed to on a daily basis, that is not anticipated to cause adverse health effects over a person's lifetime. The US EPA's policy is to set MCLGs for carcinogenic and microbial contaminants

3 The US EPA conducts a risk assessment for each contaminant, which determines the level at which a MCLG will be set.

4 When it is not economically or technically feasible to set a MCL for a contaminant — for example, when the contaminant cannot be easily measured — the US EPA may set a treatment technique. This is an enforceable procedure or level of technological performance which water suppliers must follow to ensure control of a contaminant.

at zero. However, zero is often not measurable nor feasible using Best Available Technology (BAT), nor is it practicable when costs constraints are severe.

The SDWA defines a feasible level as that which may be achieved with the use of BAT, treatment techniques, and other means which the US EPA finds available, taking cost into consideration.

This explicit recognition of cost as a constraint is a distinguishing feature of the US arrangements. It effectively draws together both risk analysis and benefit–cost analysis in the setting of MCLG and MCL values.

Suppliers have three years to comply with new national primary drinking water standards from the date they are promulgated. However, if capital improvements are required, the US EPA, or the administering State, may allow this period to be extended by up to two years.

As drinking water regulations have become more stringent and complex, small suppliers have found it increasingly difficult to comply and provide safe water at affordable costs. To address this situation, small suppliers receive special consideration and funding support from the US EPA and their State governments (see appendix D3).

In addition to health-related enforceable standards, the SDWA requires the US EPA to set secondary or non-enforceable national guidelines for contaminants that may adversely affect the aesthetic quality of drinking water. The States are encouraged to adopt these secondary guidelines, but may establish higher or lower values depending on local conditions, provided that public health is not adversely affected.

The 1996 SDWA amendments require each supplier to adopt a multiple barrier approach which includes systems management procedures for drinking water protection. Each supplier must assess and protect drinking water sources, protect wells and collection systems, make sure water is treated by qualified operators, ensure the integrity of distribution systems, and make information available to the public on the quality of their drinking water (see appendix D3).

In recognition of some shortcomings in the regulatory approach to setting drinking water standards in the US, the Partnership for Safe Water was formed in 1995.[5] This Partnership is a voluntary initiative between the US EPA, the American Water Works Association and several national organisations.

5 The failure to provide safe drinking water to 12 per cent of the population in 1994 combined with an outbreak of *Cryptosporidosis* in 1993, was the catalyst for the formation of the Partnership for Safe Water.

The goal of this partnership is to provide a new measure of safety by implementing prevention programs. The preventative measures are based on optimising treatment plant performance and increasing protection against microbial contamination.

Among other things, such partnerships allow suppliers to provide safe water without regulatory coercion and to solve internal problems in a cost effective manner through the free exchange of information.

Other benchmarked countries

Unlike the US, the other benchmarked countries (Canada, New Zealand, the European Union (EU), United Kingdom (UK) and France) have adopted variants of the WHO Guidelines to suit local conditions and community preferences. In some cases, the status of these variants has been elevated from guidelines to that of standards (see table 3.2).

- In Canada and New Zealand, all suppliers comply with guidelines (except in three Canadian provinces where standards apply).[6]
- In the EU, guidelines developed by the WHO have been incorporated in the Drinking Water Directive 98/83/EC and are enforced as standards under national legislation by EU member countries. Although there is a requirement under the EC Treaty to assess the benefits and costs of new environmental proposals, a RIS was not undertaken. As with the US legislation, the EU Directive specifies a date that Member States must comply with new drinking water standards.
- In the UK, the Secretary of State is required by the *Water Industry Act 1991* to set drinking water regulations based on the standards specified in the EU Drinking Water Directive.[7] The standards may exceed but must not be below the levels set by the EU. The UK does not normally prepare a RIS on legislation put in place as a result of an EU Directive. However, if the UK develops legislation over and above EU requirements, a RIS is prepared — this occurred in 1999 with the establishment of a standard for *Cryptosporidium*.
- In France, drinking water standards are specified in the Decree 89.3 (1989) and are based largely on the EU Drinking Water Directive.[8] Like the UK, France does not prepare a RIS on legislation put in place as a result of an EU Directive.

6 Although the New Zealand guidelines are referred to as standards, they are non-enforceable and are therefore classified as guidelines for the purposes of this report (see appendix D5).

7 The UK drinking water regulations are currently being amended to incorporate most of the standards established in the EU Drinking Water Directive 98/83/EC. It is envisaged that this process will be completed by December 2003.

8 The French Health Ministry is currently amending Decree 89.3 following the introduction of the EU's Drinking Water Directive 98/83/EC.

Table 3.2 **Regulatory practices in overseas benchmarked countries**

Country	*Guidelines*	*Standards*
Canada	National Guidelines (except Alberta, Quebec and British Columbia where standards apply)	
European Union		Required by the Treaty of European Union (1992) and Drinking Water Directive 98/83/EC
France		Required by the Decree 89.3 (1989)
United Kingdom		Required by the *Water Industry Act 1991* and the *Water Supply (Water Quality) Regulations 1989*
New Zealand	National Guidelines	
United States	National Guidelines for Secondary Drinking Water Regulations (optional can be enforced at the state level)	Required by the *Safe Drinking Water Act 1974* and National Primary Drinking Water Regulations

Source: *Safe Drinking Water Act 1974;* MoH (1995); *Water Industry Act 1991* (UK); EU (1998).

Forms of regulation

The regulatory forms used by governments to provide safe drinking water may include output, input, process and outcome regulation (see box 3.3).

Governments sometimes use only one of these regulatory forms but more often use a combination to achieve the desired objective. What combination governments use depends on a number of factors such as the practicalities of implementation and the costs associated with enforcement.

In Australia and all the benchmarked countries, output regulation is the most commonly used regulatory form. Output regulation is an efficient way to regulate drinking water if a contaminant is measurable and it is supported by effective enforcement mechanisms. Although the Australian Guidelines rely mainly on an output-based approach, it is not always supported by effective enforcement mechanisms.

Box 3.3 **Forms of regulation**

To achieve regulatory objectives, governments may use output, input, process or outcome regulation.

Governments use *output regulation* where they require an industry's final product to be of a certain type or meet certain quality criteria. Output regulation is the most common form of regulation used in the water industry and comprises the numerical guideline values or standards that drinking water must meet.

Governments use *input regulation* to manage the type and quality of inputs used in a production process. Within the water industry, input regulation may constitute catchment management requirements, for example. This form of input regulation aims to influence the quality of the source water used in the water treatment process.

Process regulation refers to government management of the operation of a production process. In terms of water treatment, governments may require water suppliers to use certain processes or technologies within their water treatment and distribution systems. Governments may also lay down maintenance schedules or operator certification requirements to protect the integrity of the water supply systems and ensure their effective operation. The US EPA's Interim Enhanced Surface Water Treatment Rule, which specifies a treatment technique for the removal of *Cryptosporidium*, is an example of a process regulation.

Outcome regulation frames regulatory requirements in terms of meeting an objective, defined as a measurable improvement in a performance indicator — say an upper limit on the proportion of the population made sick through contaminated drinking water. Judgements about which contaminant causes such illness, or the levels to which such contaminants should be reduced, are left to those subject to the regulation.

This form of regulation maximises compliance flexibility, in that the means of achieving the regulated outcome are left to the water supplier. However, in doing so the supplier must address the scientific uncertainties involved in selecting a means of achieving the regulated outcome. In contrast, if output regulation is used and particular contaminant levels are specified, the scientific uncertainties are borne by the regulator.

Selection of output or outcome regulatory forms is likely to be influenced by the ease to which contaminant levels or sickness respectively, can be measured. It may also be influenced by the extent to which a regulator can be held accountable for compliance with either of these two forms of regulation.

Source: Productivity Commission.

Output regulation provides suppliers with the flexibility to achieve the required output by selecting the least costly means of compliance. However, one of the criticisms of output regulation when it is universally applied, is that it does not allow for flexibility to tailor standards to meet the particular characteristics of different water systems.

Output regulation is of dubious effectiveness in the prevention of microbiological contamination such as *Cryptosporidium*, because it is very difficult to measure. Accordingly, Australia and the US have not established a guideline or standard value for *Cryptosporidium* at present.[9]

Process regulation is seen by most regulators as a more appropriate alternative to reduce the risk of *Cryptosporidium* outbreaks. For example, the US EPA has specified a treatment technique for minimising levels of *Cryptosporidium*.

In Australia, the NHMRC propose to recommend that suppliers develop and implement a water quality management system based on the approach used in the food industry. This is seen as part of a multiple barrier approach that will address water quality in situations such as *Cryptosporidium* contamination.

Regulatory forms that prescribe particular inputs and processes may impose high compliance costs, stifle innovation, prevent the evolution of best practice and continuous improvement (IC 1995).

Outcome regulation is probably the least frequently used because it is the most difficult type of regulation to implement. Outcomes are difficult to measure because the precise relationships between water quality and health outcomes is often unknown.

Status of guidelines and standards

There have been four versions of the Australian Guidelines — 1972, 1980, 1987 and 1996. Although the State Health Departments encourage their respective suppliers to comply with the latest Guidelines, in reality there is no uniform adoption of the Guidelines by suppliers within and among States and Territories in Australia (see table 3.1).

The NHMRC emphasise that the Guidelines are not legally enforceable. However, consumer protection from the risk of contaminated drinking water can be achieved in a combination of ways — a common law duty of care, a statutory duty of care, drinking water regulations, or Commonwealth legislation pursuant to the *Trade Practices Act 1974* (TPA) and complementary State and Territory legislation (see box 3.4 and appendix E).

9 The UK has established a standard value for *Cryptosporidium* but many commentators believe it is impracticable to enforce.

Measures to protect consumers can take the form of both the recovery of compensation for contaminated drinking water, or statutory rules and regulations that prescribe potential criminal offences.

Box 3.4 **Consumer protection**

A common law duty of care requires a person to exercise reasonable care in the conduct of an activity. However, under common law, there must be some damage to a person or property before a person may bring an action alleging a breach of the duty (IC 1995). The harm can be physical, serious nervous shock or economic loss. The real burden for a plaintiff in a water pollution case is proving that there was a breach of duty and that the illness came from the water. In cases related to cancer this is difficult. For some illnesses it will be easier to prove the causal link.

Where a common law duty of care exists there are high transaction costs involved when seeking redress (compensation for breach of duty) through the legal system.

Generally, a statutory duty of care is expressed in similar terms to the common law duty of care and encourages a broader view of responsibilities than those imposed by detailed regulation. A statutory duty of care is put in place to make environments safer, and to codify and formalise good practice (Reynolds 1995).

Unlike common law duty of care, if a statutory duty appears to be breached, action can be taken to enforce the Act and make drinking water safe before illness occurs — for example, failure to install a cover on a storage tank. A breach of the statutory duty does not have to be associated with an accident or illness (IC 1995).

Drinking water regulations in most cases prescribe outputs rather than how they are to be achieved. Compliance is supported by effective enforcement mechanisms. This approach is aimed at preventing contamination before it occurs.

Drinking water regulations provide a mechanism to reduce the possibility of non-compliance, and avoids the cost burden on individuals seeking legal redress. However, the costs of effective enforcement can also be high. Further, the potential compliance burden and disincentives to use efficient technologies (where a process rather than an output is prescribed) may impact on efficient service delivery.

(Continued next page)

Box 3.4 (continued) **Consumer protection**

The *Trade Practices Act* (TPA) applies to conduct involving corporations, but under certain circumstances, it can also apply to individuals.[a]

The consumer protection provisions of the TPA which are most relevant to contaminated drinking water include Part V (s. 52, s. 71(1) and (2), s. 74B, s. 74D), Part VA and Part VI (s. 87B) (see appendix E).[b]

Under Part V provisions:

- s. 52 prohibits misleading and deceptive conduct.
- Under s. 71 there is an implied condition that goods supplied under contract are of merchantable quality[c], and fit for a purpose[d] communicated by the consumer to the manufacturer. The remedy for a breach of s. 71 is to sue for breach of the implied condition of the contract rather than to proceed for remedies such as damages under s. 82. Section 71 only allows the consumer to sue the retailer for breach of contract but not the manufacturer.
- Provisions under s. 74B and s. 74D are similar to s. 71. However, consumers' rights are extended to allow consumers to sue the manufacturer and other retailers further up the chain of distribution.

In addition to Part V, the TPA also includes provisions under Part VA which relates to the liability of manufacturers and importers of defective goods. A person who is injured, or whose property is damaged by a defective product, has a right to compensation by the manufacturer of the product. Individuals can bring actions, or the Australian Competition and Consumer Commission (ACCC) can bring representative actions on behalf of one or more persons.

Further, under Part VI (s. 87B) consumer protection can take the form of enforceable undertakings provided by a water supplier to the ACCC.

[a] For example, the Act may apply (in some circumstances) to individuals such as doctors, dentists, architects, engineers, accountants, chemists, teachers, solicitors and other professional persons who, in trade or commerce in any of the Territories, engage in misleading or deceptive conduct. [b] All States and Territories have enacted their own Fair Trading legislation (covering misleading and deceptive conduct) and Sale of Goods legislation (covering merchantable quality and fitness for purpose provisions) which complements Part V of the TPA. State and Territory legislation can protect a consumer when the seller of a good or service is not a corporation. [c] Saleable and fit for the market, sound and undamaged, such as is generally sold in the market. [d] 'Fit' in this context means suitable or appropriate.

Source: Miller (1999); IC (1990).

In Australia, a common law duty of care always exists, unless explicitly over-ridden by particular statutes. These statutes can include specific provisions established in the Commonwealth TPA or in State and Territory legislation.

Irrespective of whether a jurisdiction has adopted the Guidelines or elevated the status of the Guidelines to standards, suppliers have a common law duty of care to identify hazards, minimise the risks of harmful contamination and monitor the

performance of water quality. Further, they have a duty to investigate the cause and, if appropriate, take practical steps to eliminate or reduce risk.

The duty of care need not necessarily be limited to one person or entity, it may be apportioned. For example, a contamination incident may have been averted but for the incorrect readings from a science laboratory contracted by a water supplier to carry out testing. The science laboratory may have failed because of faulty equipment received from a supplier. It is conceivable that the water supplier, the science laboratory and the equipment supplier may all be found to owe a duty of care to the consumer.

The inclusion of a statutory duty of care in legislation can strengthen consumer protection if it formalises good practice. However, the existence of a right of action depends entirely on the interpretation of the particular statute or regulation in question. A supplier will not be liable unless the statute or regulation is couched in such terms as to impose liability on the supplier (Balkin and Davis 1996).

In Australia, statutory provisions may provide consumers with additional protection from contaminated drinking water. For example, under s. 73 of the Victorian *Water Industry Act 1994*, a licensee must cause as little damage and inconvenience as possible in the performance of its functions. It is specified that a licensee is liable to compensate any person who has sustained pecuniary losses or incurred any expense as a direct, natural and reasonable consequence of the licensee's functions. A limitation of this provision is that the Act only applies to the three Melbourne water suppliers.[10]

The use of national drinking water regulations in the EU, UK and the US is supported by strong enforcement procedures including the threat of criminal prosecutions and jail terms. This can act as an effective deterrent which provides consumers with greater certainty that their drinking water will not be contaminated.

In Australia, some governments have elevated the status of the Guidelines to standards for metropolitan suppliers. Where this has occurred, some consumers are also protected by an implied customer contract.[11]

Implied customer contracts provide rights and obligations to the supplier and consumer. If a supplier fails to meet its obligations under the implied customer

10 An earlier Victorian statute, the *Water Act 1989*, includes an indemnity provision for water suppliers which may negate protection from contaminated drinking water otherwise provided to consumers. However, the precise scope of this indemnity is unclear as it has not yet been judicially considered (see box E.1 and appendix E).

11 The contracts are 'implied' as they are deemed under an Act of Parliament rather than having been expressly made by the parties.

contract, consumers have legal redress for breach of an implied customer contract (see appendix E).[12]

The Sydney water incident in 1998 provides an insight into the legal obligations which have been and may be imposed on the SWC. Although consumers have been compensated under customer contracts, there are class action cases which have not been concluded (see box 3.5).

In response to this incident, the provision of water in the Sydney metropolitan area was vertically separated to create the Sydney Catchment Authority as a wholesale supplier of water to the SWC. While vertical separation may improve accountability and transparency, it can have an unintended effect of complicating legal responsibilities if contaminated drinking water is supplied to consumers in the future.[13]

Link between guidelines, standards and health outcomes

The primary objective of a guideline or standard is to minimise exposure to a drinking water contaminant that would result in a known or potential adverse effect on human health (Sidhu 1991). To achieve this objective, the link between guidelines or standards and health outcomes must be thoroughly understood.

Despite enhanced efforts to measure the health effects of drinking water, there is still a great deal of uncertainty about the causal relationship between guidelines or standards and health outcomes. This is largely because of insufficient scientific evidence and the imprecision of detection.

Although the NHMRC establish guidelines for chemical contaminants on scientifically demonstrated health effects, they indicate that values are promulgated in the face of great uncertainty. For example:

> A number of epidemiological studies have suggested an association between water chlorination by-products and various cancers. This association has been most consistent in relation to cancer of the bladder and rectum, but there are insufficient data to determine concentrations at which chlorination by-products might cause an increased risk to human health (NHMRC 1996, p. 3-3).

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12 In Australia this form of consumer protection is currently limited to the three Melbourne retail water suppliers, the SWC and the HWC.

13 This situation could equally apply in the Melbourne metropolitan area, where the Melbourne Water Corporation supplies bulk water at the wholesale level to the three retail water companies.

Box 3.5 **Sydney water incident**

In 1998, *Cryptosporidium* and *Giardia* were detected in Sydney's water supply. A number of boil water alerts were issued to consumers in the affected areas.

Despite Sydney water being declared unfit to drink, it still met the health requirements of the Australian Guidelines.

This is because *Cryptosporidium* and *Giardia* are difficult to measure and at present there is no requirement for routine monitoring. Nor is such routine monitoring recommended in the draft 1999 Guidelines on *Cryptosporidium* and *Giardia* released for public comment by the NHMRC after the Sydney water incident. Rather, the draft Guidelines rely on a multiple barrier approach to prevention, supplemented by investigative testing when contamination is suspected.

Under these circumstances, compliance with the Guidelines could be seen as all that was practicable and required of the SWC to discharge its responsibilities in 1998. However, consumers have a number of avenues to seek compensation from the SWC for failure to protect the public from the risk of contaminated drinking water.

The SWC is required by law to establish a customer contract. This contract provides for a rebate on the service availability charge and compensation if it can be demonstrated that the SWC failed to provide the services set out in the contract.

In response to the Sydney water incident, the Independent Pricing and Regulatory Tribunal of New South Wales determined that consumers should receive a A$15 rebate on their service availability charge. In addition, an increase in the water usage charge has been deferred until the relevant authorities are satisfied that the problem affecting delivery of filtered water has been satisfactorily resolved.

Consumers also have an option to seek redress through class action. First, consumers could claim a breach of contract if a supply authority agreed to supply householders and businesses with safe water and failed to do so. Second, it could be argued that the product was defective and that the SWC had engaged in misleading conduct when they implied that the product was safe under the *Trade Practices Act 1974*. Finally, it could be argued that the SWC was negligent under a common law duty of care (ABCRN 1998).

According to newspaper reports, about 9000 businesses have registered compensation claims under a class action scheme approved in December 1998 by the Federal Court. Payouts under this scheme are expected to amount to several million dollars, with claimants being mainly from the food and hospitality industries. These claims are in addition to settlements totalling about A$700 000 already paid to 3000 businesses and individuals by the SWC (CRCWQT 1999b).

Further, the International Agency for Research on Cancer has reviewed the available data and concluded:

> … that there is inadequate evidence to determine the carcinogenicity of chlorinated drinking water to humans (NHMRC 1996, p. 3-4).

Notwithstanding this uncertainty, the Australian Guidelines contain guideline values for chlorination by-products.

In Australia, guideline values for organic and inorganic compounds, including pesticides, are generally based on epidemiological or toxicological data. However, as noted in the Australian Guidelines:

> Interpreting these data and extrapolating from them to human populations can be difficult, as health effects vary with dose, route of exposure (that is ingestion, inhalation or skin absorption), frequency or duration of exposure, and the species, sex and age of the exposed population (NHMRC 1996, p. 3-6).

Historical data is normally available indicating the type of disease that results from consumption of a particular microbiological contaminant. However, there is often uncertainty about infectivity or the number of organisms required to cause disease.

Large numbers of bacteria are generally required to cause disease, but there is uncertainty about the infective dose of protozoan parasites such as *Giardia* and *Cryptosporidium*. For these micro-organisms, it is believed that small numbers of parasites may infect much of the population. However, there are many confounding factors, including immunity.

In relation to infectivity, the WHO has concluded that:

> The multifactorial natures of infection and immunity mean that experimental data from infectivity studies and epidemiology cannot be used to predict infective doses or risk precisely (WHO 1993).

In the context of such uncertainty, a judgement has to be made whether to err on the side of caution and set a guideline or standard with a higher factor of safety. However, this approach may lead to an inefficient use of resources. For example, a high level of capital expenditure may be required for no real reduction in risk.

The alternative is to set a guideline or standard with a low factor of safety, accepting that there is a possibility that some people may become ill, and adopting other health-based measures to address these problems if and when they occur.

3.2 Linkages between standards and monitoring and response

Monitoring programs and response protocols are a necessary part of implementing drinking water guidelines and standards. Monitoring programs are essential to provide the final check that guidelines and standards are being met — by ensuring that the various values are not exceeded at the time of sampling.

Operational and notification responses, such as increased chlorination or boil water alerts, depending on the nature of the problem, can be triggered if monitoring data indicate that values are exceeded.

A monitoring program should be assessed on the basis of its effectiveness and efficiency. An effective monitoring program should have clear linkages to a set of well defined objectives. The absence of a clear purpose can lead to monitoring data being collected without a definite use.[14] If a program is efficient, the benefits must outweigh the cost burden of monitoring — costs borne initially by suppliers are passed on to consumers.

A monitoring program may be undertaken for regulatory, public health and operational purposes.

- For regulatory reasons, monitoring is required to assess compliance with guideline or standard values or agreed levels of service.
- For public health reasons, monitoring is required to assess the ongoing effectiveness of catchment management and treatment processes in providing barriers to the risk of contamination in drinking water. The data generated can indicate if consumers' health is at risk and if so, be used to determine public health responses, including boil water alerts.
- For operational performance reasons, monitoring is used to check that all the key processes and equipment are working properly. The data can be used, if necessary, as a trigger for immediate short term corrective action but they are not used for assessing compliance with guidelines or standards or agreed levels of service.

Irrespective of whether monitoring is required by law or by cooperative arrangements, it typically covers nominated physical, microbiological, chemical and radiological contaminants. However, the nature of the monitoring (routine, continuous, investigative, random or event based) and its frequency (hourly, weekly, monthly, annually) varies according to the potential hazard and the probability of a system problem occurring.[15] Generally, the greater the hazard and the risk of it occurring, the higher the rate of monitoring required.

14 A situation commonly referred to as data rich but information poor.

15 Routine monitoring involves regular sampling at set sites with no specified time or termination. Continuous or real time monitoring uses instrumentation that allows continuous reading of certain values, rather than having to send samples away and wait for several days before laboratory results are available. Investigative or random monitoring has a specific information purpose related to a particular water quality problem and has a set timeframe.

Although routine monitoring may be recommended for chemical and microbiological contaminants, the frequency will vary. Brief periods of exposure at levels above established values, may be of limited public health concern in the case of chemical contaminants. This is because monitoring of chemical contaminants is set at frequency levels consistent with the objective of ensuring that a lifetime of consumption will not cause illness. Hence, frequent monitoring is generally not required.[16] There are exceptions, most notably chemicals modified by water treatment operations and which should be monitored frequently.

In contrast, even brief exposure to microbiological contaminants may be a serious public health concern and more frequent monitoring may be justified — in particular the effects of microbiological contaminants can be immediate, potentially fatal and widespread throughout the community.

Sampling protocols

Monitoring programs involve collecting water samples from identified locations throughout the water supply system, and analysing turbidity levels, chemical pollutants and microbiological indicator organisms to determine if they meet the required guideline or standard value.[17]

Sampling frequency, that is, the number of samples to be collected, is usually determined by factors such as population size, the source and quality of water, the treatment the water receives, the risks of contamination, the previous history of the supply and the knowledge of the water supply system's operation.

To be effective, the quality of the water sampled must be representative of that being delivered to the consumer. This requires identifying sampling locations that are representative of each part of the water supply system (see appendix B).

Sufficient samples must be collected over a representative period to enable the data for each contaminant to be statistically evaluated, significant trends identified, and performance against the guideline or standard value assessed. In framing the Guidelines on monitoring, the NHMRC recognised that sufficient data for statistical

16 There are few chemical contaminants that lead to acute and immediate health problems, except through massive accidental contamination of a water supply. The problems associated with chemical contaminants arise primarily from their ability to cause adverse health effects after prolonged periods of exposure — of particular concern are contaminants that have cumulative toxic properties, such as heavy metals, and substances that are carcinogenic (WHO 1993).

17 Output monitoring excludes operational monitoring to check that processes and equipment are working properly.

evaluation may take time to collect in small supplies and, therefore, reporting over a five year period (rather than annually) may be more appropriate.

Sampling frequencies for large and small suppliers tend to differ in practice. Small suppliers are less able to meet the costs of treatment and monitoring. Consequently, this often means that only untreated water can be supplied or sampling is infrequent or not conducted at all.[18]

Notwithstanding the constraints faced by small suppliers, the NHMRC emphasised that microbiological safety of drinking water should not be compromised. In such circumstances, the NHMRC recommended that small suppliers:

- undertake regular sanitary inspections of their water supply; and
- use the guideline values, and in particular the microbiological guidelines, as a goal for progressive improvement.

Limitations of monitoring for microbiological contaminants

It is impracticable to monitor for every possible microbiological contaminant such as bacteria, protozoa and viruses. Although it is now possible to detect the presence of these contaminants, the methods of isolation and enumeration are often complex, expensive, time-consuming and the laboratory results are frequently unreliable. Consequently, monitoring of microbiological quality has continued to rely on 'bacterial indicator organisms', namely *thermotolerant coliforms* (or alternatively *E. coli*) and *total coliforms,* as surrogate measures of overall microbiological water quality (see box 3.6).

As noted in the Guidelines, *total coliforms* can occur naturally in soil and vegetation and are therefore not always indicative of faecal contamination. For this reason, the guideline value for *total coliforms* was relaxed in the 1987 Guidelines for closed catchments. However, the values were subsequently restored in the 1996 Guidelines. Despite this amendment the Australian Guidelines indicate that:

> Where the health authority is satisfied that it has been demonstrated that the coliforms are not faecally derived, their persistence may be tolerated provided there is a level of microbiological monitoring sufficient to detect any change in the pattern of coliform occurrence (NHMRC 1996, p. 2-13).

At face value, some suppliers such as the Melbourne Water Corporation (MWC), appear to have difficulty in meeting the 1996 *total coliform* test and it has been estimated that the MWC might have to spend around A$500 million on filtration to comply with the 1996 Guidelines (see chapter 1). However, if the MWC can

[18] Small suppliers are defined here as those serving less than 1000 people.

demonstrate that these *total coliforms* are not faecally derived, then it seems that the Corporation would be deemed to have satisfied the 1996 Guidelines.

Box 3.6 **Bacterial indicator organisms**

- In developed countries, including all those in this study, the microbiological quality of drinking water has traditionally been measured by the concentration of two types of indicator bacteria. The indicator bacteria used are the concentration of *total coliforms* and the sub-class known as *thermotolerant coliforms*.
- *Total* and *thermotolerant coliforms* are used as indicators of faecal contamination and hence the possible presence of pathogens.
- A major output from monitoring indicator organisms is that it provides a measure of the effectiveness of disinfection, because all indicator organisms should be killed during the disinfection stage of drinking water treatment. If the indicator organisms have not been killed, then there is the possibility that other microbiological contaminants, also intended to be killed by disinfection, have passed into the distribution system. Alternatively, their detection at the consumers' tap may indicate regrowth within or penetration of the distribution system.
- In the 1996 Australian Guidelines, the NHMRC recommend that no sample should contain any *total coliforms* or *thermotolerant coliforms*. The Guidelines also contain a schedule prescribing minimum values for sampling frequency, that varies according to the population within the supply area. For assessing overall system performance during any preceding 12 month period, the Guidelines state that 95 per cent of samples tested during that period should be free of *total coliforms* and 98 per cent should be free of *thermotolerant coliforms.*
- The 1996 Australian Guidelines indicated that the system performance measure is set at 95 per cent for *total coliforms,* rather than 100 per cent, because they occur naturally in soil and vegetation and are sometimes present in the absence of faecal contamination. However, although the NHMRC conceded that *total coliforms* may occasionally be isolated from drinking water, they indicated that any persistence of *total coliforms*, even at low numbers, should trigger follow up action.
- The more stringent 98 per cent figure for *thermotolerant coliforms* reflects the greater specificity of this organism as an indicator of faecal contamination. It is also set at less than 100 per cent, to provide some allowance for sporadic contamination resulting from occasional lapses in laboratory testing procedures. However, the NHMRC also indicated that any detection of *thermotolerant coliforms* should trigger follow up action.

Source: NHMRC (1996).

The NHMRC recommend routine monitoring of the two indicator organisms as an effective means of identifying faecal contamination and where appropriate, alerting public health authorities to the possibility of disease outbreaks.

Although the presence of these indicator organisms usually confirms the breakdown of disinfection procedures, their absence does not guarantee the safety of drinking water. Research is demonstrating that *Cryptosporidium*, for example, will not be killed by doses of chlorine that can be used in drinking water, and therefore it may survive, even though indicator organisms are killed.

The risks from microbiological contaminants can never be entirely eliminated. Even with relatively frequent sampling, the passage of a brief surge in concentration of a harmful contaminant may not be detected. Therefore, monitoring traditional indicator organisms is increasingly being seen as an aid to confirming that drinking water quality is unlikely to be injurious to health.

Further, real time monitoring, which is designed to provide immediate testing results, may be technically impracticable. Monitoring is not regarded as a fully effective response to contamination by *Cryptosporidium* for example, and hence there is a greater interest in preventative measures.

In the event that it is not efficient to remove all contaminants from drinking water, it may be more cost effective to respond to health problems if and when they occur.

Cryptosporidium and *Giardia*

In contrast to the UK and the US, there have been no reported deaths from *Cryptosporidiosis* and *Giardiasis* in Australia.[19] More importantly, there have been no outbreaks of these two diseases associated with drinking water in Australia, although there have been outbreaks of *Cryptosporidiosis* attributed to swimming pool exposures.

Monitoring for specific levels of *Cryptosporidium* and *Giardia* is agreed by most scientific experts to be impracticable at present, principally because the particular organisms that are infectious to humans cannot be easily detected.

There is a trend in parts of Europe and the US toward developing more stringent measures to reduce *Cryptosporidium* oocysts to levels that can be regarded as safe, without necessarily trying to eliminate it completely.

In the UK, a number of experts have reportedly concluded that it is impossible to eradicate all risk of *Cryptosporidium* oocysts entering drinking water supplies — although technologically feasible with modern absolute barrier techniques, the costs would be prohibitive and unjustified by the magnitude of the risk (Attenborough and Campbell 1998).

19 *Cryptosporidiosis* and *Giardiasis* are the diseases that arise from *Cryptosporidium* and *Giardia*.

The UK Government has nonetheless established a standard value for *Cryptosporidium*. Legislation has also been introduced to impose compulsory monitoring for this contaminant in some water supplies, combined with heavy penalties for exceeding a standard value (see appendix D2).[20] However, with the present incomplete understanding of *Cryptosporidium*, there is some doubt about the rationale for implementing this regulation.

In contrast with the UK approach, the US EPA has established the Interim Enhanced Surface Water Treatment Rule (IESWTR) which specifies a treatment technique for *Cryptosporidium* based on a turbidity criterion,[21] which, if complied with, is expected to achieve a 2 log (99 per cent) removal of *Cryptosporidium* oocysts (US EPA 1998a).[22]

In the US, suppliers are deemed to comply with this level of *Cryptosporidium* removal, even if they are using conventional filtration methods, provided that such filtration systems satisfy strengthened rules concerning filter performance.[23] In promulgating this new rule, the US EPA has implicitly acknowledged that complete removal of *Cryptosporidium* is impracticable, even if it is technologically possible.

In Australia, a guideline value or treatment technique for *Cryptosporidium* has not been set. Also, routine monitoring for this contaminant has not been recommended 'due to the time and complexity of testing' (NHMRC 1996).

In July 1999, revised draft Guidelines for *Cryptosporidium* and *Giardia* were released for public comment. Guideline values or routine monitoring were not recommended. Rather, the draft Guidelines recommended implementation of a multiple barrier risk management strategy from catchment to tap (NHMRC 1999).

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20 The standard value must not exceed one oocyst per 10 litres of water.

21 The IESWTR specifies a turbidity level of one Nephelometric Turbidity Unit (NTU) for filtered water as a measure of process performance. In the Australian Guidelines, turbidity of less than one NTU is said to be 'desirable' for any water supply irrespective of treatment. This more relaxed Australian position is not related to *Cryptosporidium* or *Giardia per se*, but is discussed in terms of higher turbidity levels having potential to jeopardise the effectiveness of disinfection.

22 The IESWTR applies to all *Cryptosporidium* species, not only *C. parvum* (the species known to cause illness in humans), as it is recognised that detection techniques are not yet reliable enough to provide identification of particular oocyst species.

23 The US EPA observed that when the performance of traditional filtration systems is optimised to achieve compliance with the IESWTR turbidity levels, then 2 log removal of *Cryptosporidium* can be achieved. Thus, turbidity is in effect being used as a proxy measure of *Cryptosporidium* levels, because it is impracticable to routinely monitor for *Cryptosporidium* directly.

The NHMRC recommended that investigative testing should be used in response to events that increase the risks of contamination by *Cryptosporidium* and *Giardia*. Such events could include heavy rainfall leading to a marked increase in turbidity and numbers of *Cryptosporidium* and *Giardia* in source water or treatment plant failures (NHMRC 1999).[24]

The ability to effectively monitor for *Cryptosporidium* and *Giardia* in drinking water remains an unresolved issue. Consequently, routine monitoring of Australian drinking water supplies is generally confined to the traditional indicator organisms. In Australia, emphasis remains on preventing contamination and optimising water treatment operations, supported by investigative and event based testing if there are reasons to suspect contamination.

Preventing contamination

The limitations of monitoring for indicator organisms as a method of detecting and subsequently preventing certain forms of contamination, mean that other approaches assume greater importance.

A favoured approach in Australia and overseas toward preventing contamination, has been to adopt comprehensive risk management strategies. According to the WHO:

> Pathogen-free water is attainable by selection of high-quality uncontaminated sources of water, by efficient treatment and disinfection of water known to be contaminated with human or animal faeces, and by ensuring that such water remains free from contamination during distribution to the user. Such a policy creates multiple barriers to the transmission of infection (WHO 1993).

Preventing contamination as close as possible to the source water and prior to final stage disinfection is seen as a desirable strategy.

> The multiple barrier concept of water treatment requires that the removal of pathogens and of pollutants and biodegradable compounds should be as nearly complete as possible before terminal disinfection (WHO 1993, p. 21).

Source water protection and improvement can be achieved by active catchment management and by the control of human activities within catchment areas. Each stage of a water supply system is linked. For example, if a major improvement can be made in the quality of source water, less treatment may be required.

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[24] In response to the Sydney water incident in 1998, the SWC is required to undertake investigative testing for *Cryptosporidium* and *Giardia* until the NSW Health Department is convinced that there is no further threat of contamination to the public.

The MWC relies heavily on the relatively pristine state of its catchments to prevent contamination of its water supply (see appendix C2). It was not until 1978, that Melbourne's water was disinfected. This option would not have been available in other parts of Australia, or in most countries, because of the relatively poorer quality of their source water.

Preventing re-infection during distribution, and the suppression of re-growth bacteria by maintaining an effective disinfectant residual, are other common preventative strategies used in Australia and the other countries in this study.

3.3 Transparency, accountability and consultation

Drinking water objectives that are clearly and explicitly stated in legislation or regulation provide guideline or standard setters with certainty about their responsibilities.

Ideally, the process by which a drinking water guideline or standard is developed should be transparent and provide for public consultation. Specifically, a RIS which formalises the steps taken in developing a standard should be published.

A RIS helps to ensure that options to address a perceived public health risk are canvassed in a systematic, objective and transparent manner, with options ranked according to their net economic and social benefits (ORR 1998). By publishing a RIS with the rationale for a guideline or standard, and involving interested parties in the process, not only is there a more consultative and transparent process, but the quality of policy development and decision making is also likely to be improved.

Consultation allows for the injection of information on community preferences into economic decision making, as well as ensuring that proposed guidelines or standards are rigorously developed and scrutinised. In this way, it makes guideline or standard setting bodies more accountable to those affected by their decisions.

There should be clear delineation in the responsibilities of those agencies involved in the enforcement of guidelines or standards. It is clearly inappropriate to have one agency acting as both service provider and regulator. Such a dual role creates a potential conflict of interest between advancing the commercial interests of the agency and advancing wider public interests through the exercise of regulatory powers. Further, in a competitive environment, this might present opportunities for incumbents to misuse control over guidelines or standards to frustrate the actions of actual or potential competitors (Hilmer 1993).

Transparency

Decision making must be linked to clearly specified objectives and it must also be transparent for organisations to be held accountable for those decisions. In Australia, the process for setting guidelines is less transparent than in some of the benchmarked countries.

Best practice evaluation processes will help to prevent public money being wasted on the purchase of inappropriate or unnecessary water treatment technology. In the absence of a robust decision making framework, the effectiveness and efficiency of drinking water guidelines or standards cannot be adequately assessed. Further, it is more difficult to resist commercial and political pressures to adopt new treatment technologies that may not be cost effective and efficient.

Although the NHMRC is responsible for developing national drinking water guidelines, there are no clearly defined objectives in legislation concerning the quality of drinking water. The NHMRC Act only refers to generic health objectives and not drinking water quality specifically. Without nominated objectives, the effectiveness of the guidelines cannot be gauged.

Unlike Australia, in most of the benchmarked countries, drinking water objectives are clearly defined in legislation. In the case of the EU, they are defined in the Drinking Water Directive. The objective of the Directive is 'to protect human health from the adverse effects of any contamination of water intended for human consumption by ensuring that it is wholesome and clean'. Water is wholesome and clean if it:

- is free from any micro-organisms and parasites and from any substances which, in numbers or concentrations, constitute a potential danger to human health; and
- complies with the microbiological, chemical and indicator parameters and parametric values listed in the Directive (see appendix D1).

In the US, drinking water objectives are explicitly described and defined in the SDWA. The objectives outline the responsibilities of the US EPA in setting drinking water standards and regulations. In particular, the US EPA is authorised to set a MCLG and a National Primary Drinking Water Regulation for contaminants that may 'have an adverse effect on the health of persons,' that are 'known to occur or there is a substantial likelihood that the contaminant will occur in public water systems with a frequency and at levels of public health concern' (SDWA Section 1412(b)(1)(A)).

In addition, the US EPA is required to take into consideration the effects of contaminants on infants, children, pregnant women, the elderly and individuals with

a history of serious illness, and other relevant factors (SDWA Section 1412(b)(3)(C)).

Accountability

In Australia, accountability appears to be weaker than in some of the benchmarked countries. In part this reflects a failure to clearly delineate and define the roles and responsibilities of those involved in the development of drinking water guidelines.

Accountability is further weakened when standards are not specific concerning their requirements.

The NHMRC is only responsible for developing, not implementing the Guidelines. The development of drinking water guidelines involves rigorous scientific assessments and consultation with stakeholder groups. However, the NHMRC and the ARMCANZ have limited accountability for their decision making processes or for the compliance costs which the Guidelines potentially impose when subsequently adopted by the States as standards.

Any decision to recommend more stringent guidelines is not supported by a published assessment of the public health benefits and costs. Nor are they explicitly assessed in relation to their priority *vis-a-vis* other public health priorities.

At the State level, responsibilities are often shared between agencies implementing guidelines or standards. Although the Health Departments in most States and Territories are responsible for recommending new or more stringent drinking water guidelines or standards, there is often divided responsibility for implementation. For example, in Victoria, the Health Department, the Office of the Regulator General, the Water Agencies Branch and suppliers, all have a role in setting drinking water standards.[25]

In recommending new or more stringent guidelines or standards, there are benefits and costs of complying with them. However, it is not clear how or whether most Australian Health Departments undertake an evaluation of compliance costs. In these circumstances, Health Departments cannot be held accountable for the compliance costs which they impose. Nor is there evidence to suggest that State and Territory governments have prepared a RIS when promulgating quasi-regulatory instruments such as operating licences, which incorporate the Guidelines as

[25] The Water Agencies Branch is part of the Department of Natural Resources and Environment.

standards.[26] In bypassing a RIS, standards are not subject to a detailed and formal review to determine whether they are effective and efficient.

In the US, there are much stronger accountability mechanisms in place for the organisation responsible for imposing standards. In particular, in developing more stringent standards, the US EPA is required by the SDWA to consider the ability of a supplier and its customers to support the cost of compliance.

There are several steps in the US accountability mechanism. For example, the 1996 SDWA amendments directed the US EPA to conduct a survey of the infrastructure needs facing suppliers if they were to satisfy more stringent standards. The first survey, released in 1997, estimated that suppliers would need to invest US$138.4 billion over a 20 year period to ensure the provision of safe drinking water consistent with US EPA standards. However, only a portion of these funds are required for compliance with the SDWA (US EPA 1999a).[27]

In recognition of the compliance costs imposed by the US EPA's standards, there is a provision in the 1996 SDWA amendments for financial assistance. This is done through the Drinking Water State Revolving Fund (DWSRF) to assist suppliers to make improvements that allow them to comply with revised standards. Between 1994 and 2003, the SDWA authorises US$9.6 billion for the DWSRF program and related programs (see appendix D3).

Of the other benchmarked countries, stronger accountability has become an issue in the UK. The EU is not directly accountable for the cost implications of its recommendations. The OFWAT National Consumer Council (ONCC) is pressing for the full assessment of benefits and costs of the EU's proposals for higher standards, prior to their implementation. ONCC is pressing for the establishment of an affordable program and an assurance that customers' interests are taken into account, alongside those of environmental and other interest groups (ONCC 1998).

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26 The preparation of a RIS is mandatory for all reviews of existing regulation, proposed new or amended regulation and proposed treaties involving regulation which will directly affect business, have a significant indirect effect on business, or restrict competition (ORR 1998).

27 SDWA projects often include components that are not required for compliance but are undertaken at the same time to realise efficiencies in operation as well as savings in design and building costs. For example, a state-of-the-art computerised system for monitoring and control of operations in the entire system may be included in a project for a new filter system. Only the filter plant and the component of the computer system used for the filter plant is a SDWA need, but the Needs Survey is likely to have recorded the need for both as one SDWA project.

Consultation

Consultation improves decision making by gathering input from a range of interested parties. It also facilitates the gathering of information on community preferences and addresses the right of individuals affected by decisions to have a say in those decisions.

In Australia, there are some safeguards in the guideline setting process at the national and State level, that provide for public consultation. The process used by the NHMRC to develop the Guidelines involves public and ministerial consultation prior to finalising the Guidelines. Given that State and Territory jurisdictions have input to the process and translate these guidelines into their own requirements, it could be argued that the guideline values have also received scrutiny by State and Territory governments.

Section 12 of the NHMRC Act provides that, whenever the NHMRC proposes to develop guidelines or recommendations, it must publish a notice to that effect, seek submissions from the public and interested bodies on the matter, publish draft recommendations, and seek further submissions before issuing a definitive report.

Specification of consultative procedures in legislation can improve accountability for effective consultation, by ensuring procedures are followed. Legislative provisions for consultation safeguard 'due process'. However, if these provisions are not adhered to, court action is possible. For example, in 1996, the NHMRC was subjected to a Court challenge by the tobacco industry, claiming that the Council had not followed the procedures specified in its Act (see box 3.7).

Box 3.7 **Tobacco industry challenge**

In 1996, the Tobacco Institute of Australia (TIA) Ltd initiated court action against the NHMRC, claiming deficiencies in discharge of procedures specified in the NHMRC Act.

The court decided that the NHMRC Working Party on Passive Smoking had erred significantly in the consultative procedure it used. Early in its deliberations the Working Party had decided that, in responding to its terms of reference requiring it 'to review the relevant scientific evidence linking passive smoking to disease in adults and children', it would only consider evidence that had been published in the peer-reviewed scientific literature. The submission received from the TIA was not considered to be peer reviewed material.

Justice Finn ruled that the Working Party 'failed to have regard to the submission received' from the TIA, in that it was obliged to but failed 'to give positive consideration to their contents as a fundamental element in its decision making'. Justice Finn also found that the NHMRC Act did not provide for the Working Party to dismiss a submission on the basis that the material contained therein was not peer reviewed.

Source: Jamrozik et al (1997).

In contrast to Australia, the US has a more formalised consultative process (see box 3.8). One of the formal means by which the US EPA solicits the assistance of its stakeholders is the National Drinking Water Advisory Council (NDWAC). The NDWAC advises the US EPA's Administrator on all of the agency's activities relating to drinking water. The Science Advisory Board is also mandated by the SDWA to comment on drinking water regulations prior to promulgation.

The US EPA also encourages public input into its decision making process by seeking comments on the US EPA's proposed regulations and encouraging participation in public meetings. Proposed regulations are published in the *Federal Register* and can be accessed on the US EPA's web site.

Box 3.8 **US EPA consultative procedures**

Throughout the standard setting process the US EPA considers input from many diverse sources. These include:

- The National Drinking Water Advisory Council (NDWAC) created in 1974 by the SDWA. The 15 member committee comprises members of the general public, State and local agencies, and private organisations and groups (including two members who are associated with small rural suppliers).
- To receive more formal input from stakeholders, the US EPA has increased the scope of the Council. NDWAC working groups have been formed that will make recommendations to the full Council, which in turn will advise the US EPA on individual regulations, guidances and policy matters. These NDWAC working groups consist of approximately 20 members with a variety of viewpoints. All NDWAC working group meetings and full NDWAC meetings are open to the public.
- The Science Advisory Board (SAB) was mandated by the 1996 SDWA amendments. The SAB provides independent scientific and engineering advice to the US EPA's Administrator on the technical basis for US EPA regulations.
- The US EPA also consults with the Secretary of the Federal Department of Health and Human Services (DHHS). The US EPA may use information provided by the DHHS, or may ask for input from the DHHS when developing a regulation (or when an already final regulation comes into question).
- In addition to the NDWAC, SAB and DHHS, representatives from water suppliers, environmental groups, public interest groups, States, Indian tribes and the general public are all encouraged to take an active role in shaping the regulations, by participating in public meetings and commenting on proposed rules. Special meetings are also held to obtain input from minority and low-income communities, as well as representatives of small business.

Source: US EPA (1997a, 1998b).

3.4 Incident plans and response protocols

Incident plans and response protocols are both important elements of overall risk management. They are developed in recognition that the risks of supplying contaminated drinking water cannot be eliminated entirely, despite the measures put in place to protect public health (by monitoring and treatment) — that is, some residual risk has to be borne by the consumer.

Incident plans are developed by suppliers to address an incident or event, or a series of events, when the quality of water deteriorates. They may be as simple as setting out the procedures for notifying a health authority that the quality of water is, or is likely to become, a threat to public health. Alternatively, an incident plan may be a comprehensive document covering a range of management responsibilities including communication, coordination and emergency training protocols.

Response protocols are generally developed by government agencies and set out procedures for addressing a notifiable incident that has already occurred. These incidents may relate to a fault or breakdown in preventative measures such as catchment protection, filtration and disinfection, that could present a risk to the general population.

Incident plans

The NHMRC recommended in the 1996 Guidelines that suppliers develop incident plans for emergency situations, including procedures for notification when water quality poses a health risk. More specifically, they recommended that these plans should specify coordination responsibilities, communication and notification plans, and plans for providing emergency water supplies (NHMRC 1996).

In Australia, the development of incident plans by suppliers varies significantly across State and Territory jurisdictions. Tasmania, Victoria and South Australia are the only jurisdictions where incident plans are supported by legal obligations. In NSW, incident plans have been developed by the SWC and the HWC.

In Tasmania, suppliers are required by the *Public Health Act 1997* to:

- notify the Director of Health that the quality of water is, or is likely to become, a threat to public health;
- develop in consultation with the Director of Health, a protocol for advising the users of water under their control on water quality issues; and
- prepare an incident plan for public reticulated potable water as part of its management responsibility.

In Victoria, only the three retail suppliers are required by their respective operating licences to have in place a plan to effectively and efficiently respond to potential emergencies.

In South Australia, United Water and Riverland Water are required by their contracts to prepare emergency response and contingency plans for management of operational incidents, including water quality incidents.

In NSW, the SWC and the HWC have developed incident plans under the umbrella of a Memorandum of Understanding (MoU) with NSW Health.[28] The MoU, among other things, establishes the responsibilities of each party in dealing with events of public health significance.

The SWC's Drinking Water Quality Incident Management Plan contains procedures and protocols for the coordinated management of incidents, including the notification of public health advice to customers and media communication of public health information. The protocol requires the SWC to notify NSW Health immediately on the detection of contamination and provide information about the concentration and the likely affected areas.

In the benchmarked countries, particularly the UK and the US, incident procedures are set out in legislation.

UK suppliers are required by the *Water Industry Act 1991* to develop and implement incident management procedures. It is also mandatory for suppliers to notify the relevant authorities of events and incidents. This notification rule applies to any event that is likely to give rise to a significant risk to consumers, but also to events that may be of national significance, have attracted publicity, or may have caused significant concern to consumers (McClellan 1998).

In the US, the SDWA outlines public notification requirements relating to violations of the national primary drinking water regulations. Suppliers are required to inform consumers, the US EPA Administrator, or the head of the State agency that has primary enforcement responsibility for violations of drinking water standards.

28 With recent amendments to the *Public Health Act 1991*, NSW Health has the powers under its own legislation and the *Sydney Water Act 1994* to enforce the MoU obligations. The HWC is not required by law to enter into a MoU with NSW Health — this is a voluntary procedure and hence the contents may not be enforceable.

Response protocols

In Australia, health authorities in each State and Territory are responsible for addressing a notifiable incident. In doing so, they are usually guided by an established response protocol. In NSW, Victoria, Tasmania and South Australia, response protocols have been established in legislation and regulation.

A response protocol outlines action procedures which must be communicated to both the supplier and the community. These procedures may include issuing a boil water alert.

In some jurisdictions the responsibility for advising the community to boil water is delegated to the supplier. For example, in Victoria, if the health department is satisfied that the water supplied may be contaminated, and that there is a substantial risk to public health, it may:

- direct the supplier to issue a boil water alert; and
- direct the supplier to purify the water supply to a standard that is acceptable to the health department.

In South Australia, the government has endorsed a Water and Wastewater Incident Notification and Communication Protocol. The Protocol prescribes water quality criteria for notification (determined by the Health Aspects Water Quality Committee) and time frames for that notification by suppliers to the Department of Human Services (DHS(SA)).[29]

In addition, the Protocol describes duties of a Water Incident Coordinator (located in the DHS(SA)) who acts as a single point of contact for communication of all water and wastewater incidents and the duties of the Lead Minister (when required). The Lead Minister is responsible for managing communication of serious incidents to the public and the Government. In the event of incidents designated as having potential human health effects, the Lead Minister would be the Minister for Human Services.

In NSW, the Chief Health Officer (CHO) has the sole responsibility for determining whether a boil water notice should be issued in the case of the SWC and the HWC. However, in doing so, the CHO may direct the SWC or the HWC to issue the

[29] Type I incidents (serious incidents that could cause risk to human health) require immediate reporting to the DHS(SA) by telephone with a hard copy report to follow within 24 hours. Such incidents are also reported to concerned Ministers. Type II incidents (incidents that represent a low risk to human health) generally require reporting to DHS(SA) within one business day. Persistent minor operational problems in distribution systems are reported monthly to the DHS(SA).

notice. Recommendations have been given to non-metropolitan suppliers to contact their regional Public Health Unit (PHU) when a real or potential health risk exists. The PHU is required to advise the Water Unit of NSW Health to help determine the necessity for a boil water notice.

In the US, suppliers are responsible for issuing boil water alerts in consultation with the health authority when a drinking water regulation is violated. A boil water alert is announced through the media as well as details of the violation, the potential adverse effects on human health, and the steps the supplier is taking to correct the violation.

In NSW, Queensland, Victoria, South Australia and the ACT, the health departments have established response protocols to deal specifically with actual and potential outbreaks of *Cryptosporidium* and *Giardia* in drinking water. These protocols define responsibilities and include criteria to guide decisions on public health action. In particular, NSW and Queensland Health consider that any positive *Cryptosporidium* and *Giardia* result constitutes an incident and warrants further investigation.

3.5 Regulation review process

In Australia and most of the benchmarked countries, drinking water guidelines and standards are to be reviewed on a rolling basis rather than as one comprehensive review.

The EU is required to review drinking water parameters and parametric values, the monitoring of parameters, and specifications for the analysis of parameters at least every five years.

The UK and France do not undertake a rolling review of their standards but rely on the outcome of EU reviews and make the necessary amendments to existing legislation.

In the US, the EPA is required to review existing regulations every six years to determine if they are appropriate. In addition, the US EPA has a list of unregulated contaminants from which it must examine at least five contaminants every five years.

The advantage of a rolling review over a comprehensive review is that it is less resource intensive because it does not require all guideline or standard values to be reviewed at the same time. It also provides greater opportunity for a guideline or standard setter to act in a more timely and efficient manner. For example, a rolling

revision approach provides greater scope to respond to emerging contamination problems and to amend existing guideline and standard values as new scientific evidence emerges.

3.6 In summary

Guidelines and standards establish quantitative limits or values for individual drinking water contaminants. Their regulatory status depends on their legal form — standards have the force of law and are usually backed by penalties for non-compliance, whereas guidelines are discretionary and non-enforceable.

Internationally, there is great scientific uncertainty about the link between guideline or standard values and health outcomes. In particular, health benefits, although real, are difficult to substantiate and quantify.

In Australia, the NHMRC Guidelines comprise sets of guideline values and a description of good practice for overall systems management. Their content is largely drawn from the WHO Guidelines.

Most suppliers in Australia aim to meet the 1996 Guidelines or earlier versions. In some jurisdictions, a range of quasi-regulatory instruments have been used to upgrade the status of the Guidelines to that of standards without undertaking a regulatory impact assessment. The variety of instruments used means that there is a lack of consistency in implementation.

Guidelines are not always set independently of the suppliers. Where MoUs are used for example, the agreed implementation processes are established by mutual consent between the supplier and a regulatory agency.

In Australia, irrespective of whether a jurisdiction has adopted the Guidelines or elevated the status of the Guidelines to standards, suppliers have a common law duty of care to take practicable measures to identify hazards, minimise the risks of harmful contamination and monitor the performance of water quality.

In addition to a common law duty of care, consumers may also be protected from the risk of contaminated drinking water by a statutory duty of care, Commonwealth legislation pursuant to the *Trade Practices Act 1974* and complementary State and Territory legislation. Where the status of Guidelines have been elevated to standards, some consumers are also protected by an implied customer contract.

In contrast with Australia, suppliers in the US, EU, UK and France must comply with national drinking water regulations which are supported by strong enforcement

mechanisms. This approach provides consumers with more certainty that their drinking water will not be contaminated.

Provision of safe drinking water in the US is covered by specific safe drinking water legislation (SDWA). The SDWA provides a mechanism for explicitly linking health risk assessment and economic evaluation by providing for goals (MCLGs) as well as standards (MCLs). MCLGs are goal levels for what is ideal in public health terms, whereas MCLs are tempered by what is scientifically practicable and affordable. In Australia, risk assessment is undertaken. However, economic evaluation, if done at all, is at best implicit.

Water quality monitoring is a key risk management strategy and necessary to fulfil the duty of care and to operate systems properly.

Monitoring traditional indicator organisms is a form of output regulation that has limitations. Consequently, preventative measures involving risk management and quality assurance have assumed greater importance. These approaches necessitate the adoption of comprehensive catchment to tap strategies.

Cryptosporidium and *Giardia* are the two contaminants of greatest contemporary concern. *Cryptosporidium* in particular, has the potential to produce life-threatening illness in immuno-compromised persons. It is not possible to reliably monitor *Cryptosporidium* and knowledge of the organism is incomplete. Consequently, the policy response to its possible presence in drinking water supplies is still emerging. At issue, is whether it is practicable to eradicate all risk of *Cryptosporidium* and to do so at a cost that is justified by the magnitude of the risk.

There are differences between countries in whether a RIS is prepared and an associated benefit–cost analysis undertaken and hence the transparency with which drinking water regulations are developed. Without transparency, accountability is diminished and proper consultation is unlikely to occur.

Of the countries studied, the US seems to have the most transparent and robust regulation-making process. By comparison, there is less rigour in Australia. In particular, there is little evidence to suggest that State and Territory governments have prepared a RIS, despite a mandatory requirement to do so when proposing new or amending regulation. Further, there is no framework at the national, State or Territory level which requires a comprehensive assessment of health, economic and social (equity) objectives to ensure that the recommended guidelines are effective and efficient.

The process for reviewing and updating drinking water guidelines and standards varies between countries, with Australia adopting the practice of a rolling review to

take account of new scientific information as it becomes available. However, the NHMRC may have insufficient resources to undertake such reviews and this may jeopardise their ability to review standards independently of other countries. At the State and Territory level, there is no evidence of a formal regulatory review process to comprehensively assess the ongoing appropriateness of standards.

4 Setting parameter values

The development of guidelines and standards has already been discussed in chapter 3 in broad terms. At a more detailed level, quantitative limits are set for each hazard in terms of its maximum concentration in drinking water. The water is subsequently tested, with these limits or parameter values forming a set of reference points, against which to judge the safety of drinking water.

This chapter is concerned with the detailed process of arriving at these individual parameter values. The monitoring and enforcement of such values is discussed in chapter 5.

It is important to distinguish between sets of guidelines and standards collectively and their constituent parts. Guidelines and standards such as those developed by the World Health Organisation (WHO) and the United States Environmental Protection Agency (US EPA) respectively, are sometimes referred to as if they were a single entity. However, they are actually sets of guideline and standard values for numerous contaminants, which are compiled into a single resource document.

The date of a guideline or standard document is also an important distinguishing characteristic, because parameter values are updated from time to time. Although the substance covered may not change, revisions to parameter values can result in them becoming more or less stringent.

4.1 General approach

All the countries studied have taken the general approach of adopting either guidelines or standards in the pursuit of safe drinking water supplies.

The main objective of these guidelines is to describe harmful contaminants in drinking water and for each contaminant establish the maximum concentration deemed unlikely to produce an adverse health effect. A secondary objective is to identify and reduce the level of contaminants which jeopardise the aesthetic qualities of drinking water, such as taste and colour, but which have no public health significance.

The Guideline values are embodied in enforceable standards in some Australian jurisdictions (see chapter 3). In this context, the Council of Australian Governments (COAG) has endorsed a generic framework for achieving best practice in regulation-making (COAG 1994). It includes the preparation of a Regulatory Impact Statement (RIS) as a critical feature of the regulation-making process. Moreover, the COAG envisages that all RISs will include a benefit–cost analysis of regulatory alternatives.

A RIS is seen as an important step in policy formulation, because it ensures that options for addressing a perceived policy problem are addressed in a systematic and transparent manner (ORR 1998). However, the US is the only benchmarked country included in the study that legislates for a RIS procedure in making drinking water regulations.

Preparing a RIS involves identifying the problem, determining the objective(s) of any proposed regulatory action, and considering alternative regulatory options or means by which these objectives can be pursued.

Regulatory problems must be clearly identified before considering regulatory options. Failure to do so provides no basis for assessing the effectiveness of the regulation. For example, *Cryptosporidiosis* contracted from drinking water is but a subset of the *Cryptosporidiosis* problem, with most outbreaks arising not from drinking water but from contaminated swimming pools and person-to-person contact in child-care centres. Accordingly, a regulatory strategy targeting *Cryptosporidium* in drinking water addresses only part of the broader public health problem.

The regulatory options or instruments by which regulatory problems in general can be addressed are potentially numerous (see box 4.1).

In the case of drinking water, regulatory objectives are frequently pursued using an Operating Licence or a Memorandum of Understanding (see chapter 3). Another common strategy is to provide tied funds to assist small systems to upgrade their water quality. This approach has been used in some States of Australia and in the US (see chapter 3).

The purpose of all such measures is nonetheless the same — improved water quality — with the rationale being a link between poor water quality and adverse health outcomes. However, it is necessary to understand the nature and extent of this link, before setting parameter values targeted at ameliorating these adverse health effects.

For this purpose, it is desirable to undertake a structured risk assessment.

Box 4.1 **Regulatory options**

The following list illustrates the wide range of potential regulatory options available in a general sense, although only some will be relevant for a particular regulatory initiative:

- no specific action (ie, rely on the market in conjunction with existing general liability laws (negligence or no fault) and insurance laws);
- information and education campaigns (including product labelling or media campaigns);
- market-based instruments (including taxes, subsidies, tradeable permits, performance bonds);
- tradeable property rights;
- pre-market assessment schemes (such as listing, certification and licensing);
- standards (including voluntary and regulatory);
- self-regulation (service charters);
- quasi-regulation (codes of conduct and co-regulation); and
- other mechanisms, such as public information registers, mandatory audits and quality assurance schemes.

Source: ORR (1998).

4.2 Risk assessment

In all of the benchmarked countries, risk assessments are published for all of the contaminants for which water quality guidelines or standards are set — microbiological, physical, chemical, pesticide and radiological.

Risk assessment is predicated on the ability to demonstrate a link between cause and effect, in this case between drinking water quality and disease or other adverse health consequences. Assessing the magnitude and probability of these adverse consequences is often difficult and controversial because of insufficient evidence from human epidemiological or animal toxicity studies.[1] Difficulties also arise because of the number of confounding factors involved.[2]

1 Epidemiology is the study of the distribution of disease in the human population and the factors which determine that distribution.

2 Confounding factors are those which have a bearing on disease but are not related to exposure from drinking water.

Scientifically robust evidence can sometimes be obtained and used to prove causal relationships. In other situations, however, less robust but still compelling evidence may be used to support hypotheses or presumptions of a linkage between a proposed standard and an expected health outcome (see box 4.2).

Box 4.2 **Different quality of evidence**

In 1852, a law was passed in London requiring all waters to be filtered. This initiative was based on the observation and therefore the presumption that cholera and typhoid were linked to contaminated water. However, the causal relationship was not proven until the late 1880s by Louis Pasteur.

Nowadays, causal relationships between human exposure and disease are frequently hypothesised or inferred from the results of animal experiments, rather than demonstrated directly by using evidence from human epidemiological surveillance.

Source: Cotruvo and Vogt (1990).

The generic steps in a risk assessment procedure are often formally outlined under the headings contained in box 4.3. The National Health and Medical Research Council (NHMRC) go through a similar procedure to that outlined in box 4.3, when they are deriving guideline values for contaminants.

Each contaminant requires its own risk assessment, because the information requirements for each are different. For example, the exposure and dose-response assessment steps outlined in box 4.3 for short term exposure to a microbiological pathogen, differ from the cumulative effects of long term exposure to a toxic chemical.

A key part of the risk assessment procedure outlined in box 4.3 is the dose-response assessment. Typically, there is uncertainty about the dose-response relationship — which in most cases is derived from animal experiments — yet these data must be used to set guideline or standard values for humans. The data are used to estimate the probability of an adverse health effect or level of risk associated with a chosen guideline or standard value. This is done via the risk characterisation step outlined in box 4.3.

What is an acceptable risk?

A chemical guideline or standard value is often described as acceptable, because it is the concentration of a contaminant that is not expected to result in any significant risk to health over a lifetime of consumption.

Box 4.3 **Steps in a risk assessment**

A formal scientific risk assessment procedure, includes four recognised elements:

- *Hazard identification* —This step involves identifying hazards and where they might arise. A hazard is a source of potential harm — for example, from human activity or chemical use in catchments or a particular pathogen under consideration. A hazard is not the same thing as a risk. Hazard relates to the inherent properties of a substance, whereas risk relates to the probability of an event occurring.
- *Exposure assessment* — This step involves estimating the probability that exposure to a hazardous constituent will occur, as well as the number of people exposed. Water treatment is one obvious means of minimising exposure. However, in saying this, it should be remembered that a complete exposure assessment should take into account all potential exposure routes, including those from sources other than drinking water.
- *Dose-response assessment* — Having established the probability that exposure to a hazardous constituent will occur, the effect or consequences of that exposure must then be determined. The dose–response concept lies at the heart of toxicology and quantitative risk assessment. The assessment method involves animal toxicity experiments and, in some cases, gathering data from human epidemiological studies. Such studies often involve uncertainty in the accuracy and interpretation of data.
- *Risk characterisation* — Risk is the likelihood of harm occurring from exposure to a hazard. Having determined the probability of exposure, and of adverse effects occurring via the dose-response assessment, the final task of risk characterisation involves an overall assessment of the risk faced by a human population.

Source: US EPA (1998a) and Nadebaum et al (1997).

For carcinogenic compounds, the NHMRC have adopted a risk of one additional cancer per million people, compared with the figure of one in one hundred thousand used by the WHO. The NHMRC offer the following comment on this difference:

> Whether the assumed risk should be one in one hundred thousand or one in a million is a value judgement; however the greater degree of protection afforded by a risk of one in a million is generally consistent with calculations based on a threshold approach, and is in line with the high expectations of Australian consumers. (NHMRC–ARMCANZ 1996, p. 3-9)

Lifetime exposure is a useful concept for chemical carcinogens, but not for microbiological pathogens that can cause illness in the short term. Moreover, even for single events, there may be no safe level or concentration of pathogens below which there is little or no risk of disease. This is especially so for immuno-compromised individuals, for whom the exposure to a single micro-organism can have fatal consequences.

What is an acceptable risk, depends on the cost of eliminating or reducing that risk. The cost of risk reduction may differ between drinking water contaminants and between particular water supply systems.

Incorporating cost considerations is not explicitly part of the NHMRC–ARMCANZ brief when setting guideline levels. The NHMRC–ARMCANZ mechanism may include some implicit recognition of cost but, if so, the process is not transparent.

Cost aside, a commonly used target risk level for carcinogenic hazards, is an excess lifetime tumor incidence of 10^{-6} or one in a million. It has been suggested that this probability level has been selected by some regulatory authorities for no better reason than that it has a 'nice ring to it' (Albert 1994). The same author has pointed to the more substantive issue that the 10^{-6} level, or any other figure for that matter, should not be adopted without regard for cost. It is for this reason that the US EPA does not adopt a single fixed risk level in setting standards. However, the US EPA generally sets Maximum Contaminant Limits (MCLs) that limit an individual's lifetime risk of cancer from a contaminant so that it lies in the range 10^{-4} to 10^{-6} or between 1 in 10 000 and 1 in a million (US EPA 1997b).

Defining an 'acceptable risk' not only involves cost considerations, but community preferences concerning risk bearing. In this context, self-imposed risks are qualitatively different from those involuntarily imposed on individuals by the actions of governments and suppliers. In general, the tendency is for individuals to prefer a lower level of risk when hazards are imposed involuntarily.

Not all individuals have the same risk preferences and some attempt at determining these preferences is a necessary part of rigorous decision making. In the final analysis, a judgement has to be made about the level of resources the community is prepared to commit to risk reduction. For this judgement to be representative of informed preferences, a high level of community consultation and input is required (see chapter 3).

Community consultation designed to determine community risk preference, presumes that numerical risk levels can be attached to a range of adverse outcomes, and therefore that the preferred risk level can be selected with certainty. A common situation is that there is uncertainty about risks and, as a consequence, risk preferences are unquantifiable. Therefore, policy decisions have to be based to some extent on the personal judgement of the decision maker(s).

The precautionary principle, normally applied in the context of environmental hazards, can be of assistance to decision makers in situations of uncertainty. There is no internationally recognised definition of the precautionary principle, although there is general agreement on its main feature. Broadly, the principle is that

knowledge about risks may be imperfect and in the face of a potentially serious risk, action should be taken to minimise risks, without waiting until further information becomes available (see box 4.4 for the approach articulated by the European Commission and box 2.8 for other principles advocated to assist decision making under uncertainty).

Box 4.4 **The precautionary principle as articulated by the European Commission**

The precautionary principle is a risk management approach to be exercised in circumstances of scientific uncertainty, requiring action to avoid damage without awaiting the results of scientific research. It is based on six guidelines.

- Implementation of an approach based on the precautionary principle should start with an objective risk assessment, identifying at each stage the degree of scientific uncertainty.
- All the stakeholders should be involved in the decision to study the various management options that may be envisaged once the results of the risk assessment are available and the procedure should be as transparent as possible.
- Measures based on the precautionary principle must be proportionate to the risk which is to be limited or eliminated.
- Measures based on the precautionary principle must include a benefit–cost assessment (advantages and disadvantages) with an eye to reducing the risk to a level that is acceptable to all the stakeholders.
- Measures based on the precautionary principle must be able to establish responsibility as to who must furnish the scientific proof needed for a full risk assessment.
- Measures based on the precautionary principle must always be of a provisional nature, pending the results of scientific research performed to furnish the missing data and perform a more objective risk assessment.

Source: ECDG XXIV (1998).

In the context of drinking water, a key issue is the uncertainty about the links between standards and health benefits. However, this uncertainty should not prevent a benefit–cost study from being undertaken. In general, decision making and judgement will be assisted if there is explicit acknowledgement of these uncertainties. This acknowledgement of uncertainty is a feature of the recent draft guidelines on *Giardia* and *Cryptosporidium* released by the NHMRC.

Microbiological guidelines and standards

Microbiological contaminants present the most common health risk and the category where causality is more likely to be established, because the effects of waterborne disease are immediate, recognisable and usually well documented. For some pathogens, however, it is difficult to determine a guideline or standard value because of insufficient information about infectivity, or because the organism is difficult to identify. These situations create considerable analytical challenges.

Understanding the effects of human microbiological pathogens

Before establishing a microbiological guideline or standard, waterborne microbes must be isolated, identified and studied to assess their risk level and specific effects on humans. Large numbers of bacterial pathogens are generally required to cause disease, but there is considerable uncertainty about the infective dose of protozoan parasites such as *Giardia* and *Cryptosporidium*. For these pathogens, it is believed that a more modest number of micro-organisms could infect much of the population.

In relation to the infectivity of human microbiological pathogens, the WHO has concluded that:

> The multifactorial natures of infection and immunity mean that experimental data from infectivity studies and epidemiology cannot be used to predict infective doses or risk precisely (WHO 1993).

Peculiarities relating to microbiological pathogens

Microbial pathogens exhibit several properties that distinguish them from chemical contaminants (see box 4.5). These distinguishing characteristics have a bearing on the methods used for their scientific analysis, and in turn, on risk assessment and the selection of water treatment strategies. For example, the adherence of microbial pathogens to suspended solids, makes the removal or minimisation of these solids prior to disinfection an important priority in the selection and operation of treatment plants.

Box 4.5 **Characteristics of microbiological pathogens**

- Microbiological pathogens are discrete and not in solution. They are often clumped or they adhere to suspended solids, so that the likelihood of acquiring an infective dose cannot be predicted from their average concentration in water.
- Adherence to or embedding within suspended solids, provides microbial pathogens with partial protection from the effects of disinfection.
- The likelihood of infection depends upon the virulence of the pathogen and the immunity of the individual.
- Unlike many chemical agents, the dose-response is not cumulative. Microbiological pathogens can multiply quickly within the body so that infection can result from a single, short-term exposure.
- This exposure characteristic is in sharp contrast with the ingestion of chemical contaminants for example, where exposure and gradual accumulation over many years eventually causes acute toxicity.[a]

[a] This delayed response makes it virtually impossible to confirm chemical cause and effect relationships using traditional epidemiological methods, because toxicity may have resulted from sources other than drinking water and may reflect a variety of unknown causal factors during the lifetime of an individual.

Source: WHO (1993).

Testing for human pathogenicity

Human pathogenicity can only be demonstrated by reproducing the disease in a human host. However, the infective dose is difficult to estimate because it is highly variable between individuals, depending on such factors as age, health and immune status. Unlike chemical contaminants, tests that involve exposing test animals to human pathogens are of little direct relevance when assessing pathogenic risk in human populations.

Tests designed to purposefully expose humans to human pathogenic organisms present ethical problems. Studies of *Cryptosporidium* have been designed in which healthy humans are fed live *Cryptosporidium* oocysts in increasing concentrations, to try and estimate human infective dose levels. However, such studies raise serious ethical issues, even when healthy target individuals are used. Such techniques cannot be used to determine infective doses for the more vulnerable groups that are of most interest because of the risk that the testing could be fatal.

Rather than epidemiological experimentation, human risk assessment must generally rely upon historical epidemiological data, where there is often uncertainty about the causal agent. If, for example, food is contaminated by water containing pathogens, or if susceptible persons become infected by water and subsequently

infect others by person-to-person contact, the involvement of contaminated water may be overlooked.

Further, the infective dose level that caused the disease and led to its detection in epidemiological studies is almost impossible to determine (in the absence of reliable epidemiological experimentation conducted on healthy volunteers). All that can be said in many cases is that a relatively large number of pathogenic bacteria are required to cause bacterial disease, whereas it is believed that fewer organisms are required to constitute an infective dose of protozoan and viral diseases.

According to the WHO:

> It is not possible to set guideline values for pathogenic protozoa, helminths, and free-living organisms, other than that these agents should not be present in drinking water, because one or very few organisms can produce infection in humans (WHO 1993).

Cryptosporidium

The latest US Rule relating to *Cryptosporidium*, cites a study which suggests that some individuals may contract *Cryptosporidiosis* by ingesting a single viable oocyst (US EPA 1998a). Such a result would suggest that there is no tolerable lower limit for such microbiological pathogens in drinking water. However, the US EPA did not seek complete elimination of *Cryptosporidium* in its December 1998 ruling, but said instead that it would continue to assess additional information on *Cryptosporidium* as it becomes available, and 'consider such data in subsequent regulations' (US EPA 1998a).

A *Cryptosporidium in Water Consensus Conference*, held in Melbourne in October 1998, provided an overview of the current scientific knowledge on *Cryptosporidium*, and an opportunity for the 280 Australian and international participants to discuss research needs and rational public health and water supply management strategies.[3] It was agreed at the Conference that *Cryptosporidium* is potentially life threatening among immuno-compromised people.

The only documented outbreak of *Cryptosporidiosis* related to drinking water in Australia to date, occurred as a result of gross sewage contamination of a small private water supply (Sinclair and Langford 1999). There were no cases of *Cryptosporidiosis* attributed to the 1998 Sydney Water incident.

In contrast, a number of *Cryptosporidiosis* outbreaks have been attributed to drinking water in the US and the UK and new monitoring arrangements for

3 Interest in the meeting was heightened by the water contamination incidents in Sydney, beginning in July 1998, but the conference had been planned prior to these events.

Cryptosporidium have recently been implemented in those two countries (see chapter 3). In Australia, the NHMRC has also responded to concerns about *Cryptosporidium* by releasing a draft revised guideline (see chapter 3).

Chemical guidelines

As with microbiological pathogens, the general approach with chemical guidelines and standards is that any excursion beyond an established guideline or standard value should trigger further investigation and possible notification to the relevant health authority.

Chemical guidelines and standards are categorised into inorganic chemicals, organic chemicals and pesticides.

Inorganic chemicals

A number of inorganic chemicals occur naturally in food and water and are known to be important for good human nutrition when consumed in appropriate quantities. Others, including heavy metals such as cadmium, have been implicated in adverse health effects when consumed at relatively low levels.

Organic chemicals

In the Australian Guidelines, organic chemicals are divided into disinfection by-products (see chapter 2) and other organic compounds.

The other organic compounds category includes naturally occurring organic compounds that are not generally of human health concern, with the exception of algal toxins. Organic contaminants resulting from human activity are not normally detected in Australian drinking water, but as noted in the Guidelines, they have been detected in Europe and North America, usually following an accidental spill or, on rare occasions, from air-borne contamination of rain. Accordingly, fact sheets and guideline values are included in case similar incidents should occur in Australia.

Pesticides

In Australia, the National Registration Authority for Agricultural and Veterinary Chemicals (NRA) is responsible for pesticide registration and for formulating guideline values for pesticides in drinking water. Pesticides may or may not be approved by the NRA for use in water catchment areas. If a pesticide is detected at

above the guideline value, the Guidelines recommend that advice be sought from the relevant health authority.

Chemical health risk assessment

The fact that chemical contaminants are not normally associated with acute or short term effects, sets them apart from microbial contaminants, for which the effects are usually short term, acute and widespread.

There are few chemical constituents of water that can lead to acute health problems except through massive accidental contamination of a supply. Moreover, such incidents are often self-limiting because the water becomes undrinkable due to unacceptable taste, odour or colour.

Chemical guideline values and standards are set because of concerns about their cumulative toxic effects or their cancer-causing properties. The clinical effects of such chemicals may not be recorded until several decades after exposure. This time delay has major ramifications for the way that the health effects of chemical exposure are evaluated.

First, it is impracticable to wait perhaps 20 years to try and observe whether elevations in cancer rates, for example, can be linked to exposure to a particular chemical. Second, the small elevations in cancer rates, particularly when set against the relatively high background level of some cancers, as well as the 'noise' from all of the other confounding factors, present significant methodological difficulties in establishing causal relationships.

Epidemiology relies on cases of disease being present to study the factors that appear to be determining the distribution of disease in a population. Unfortunately, because of the long time periods involved, the small elevations in incidence and the 'noise' from confounding causal factors, epidemiological methods are not very useful in the study of chemical contaminants.

The current approach to studying the health effects of chemical contamination is to gather the necessary health evidence via chemical-by-chemical animal health analysis or toxicology experiments, and then attempt to infer human health risk from this secondary evidence.

Rather than relying on traditional epidemiological surveillance methods, these inferential methods are predictive and fraught with uncertainty. They often rely on extrapolating from animal data relating to the toxic effects from much higher levels of contaminants than normally found in drinking water, and using these results to

predict the effects of the same contaminants (at lower concentrations) on human populations.

These inferential, quantitative risk assessment methods have become increasingly sophisticated. However, the reliability of the inferences drawn from such studies can be seriously compromised by the uncertainty surrounding the type of data that is used (Thomas and Hrudey 1997). Nevertheless, animal-based toxicity studies remain the principal basis for establishing chemical guideline values and standards for drinking water around the world.

Derivation of chemical guideline values and standards

The method used to derive chemical guideline and standard values is broadly uniform among the countries in this study, although there are matters of detail where differences occur.

Some chemicals are assumed to be safe, unless a certain threshold dose is reached. Other chemicals are assumed not to be safe at any level.

Chemicals with a safe threshold

For some chemicals, no adverse response is detected until a threshold level of exposure is reached. This threshold level or concentration of exposure is known as the No Observed Adverse Effects Level (NOAEL). A related measure is the Lowest Observed Adverse Effects Level (LOAEL).

Unless appropriate human data are available, drinking water parameter values are derived using animal experiments to (indirectly) establish human threshold levels. The following formula is used, where 'animal dose' refers to their NOAEL level expressed on a body weight basis (mg/kg) for the test animal.

$$Guideline = \frac{animal\ dose \times human\ weight \times proportion\ of\ intake\ from\ water}{volume\ of\ water\ consumed \times safety\ factor}$$

The general form of this equation is used by all countries in the study, although the values assumed for some of the terms in the equation differ slightly. For example, in deriving values for humans, the Australian Guidelines assume a human body weight of 70 kg, whereas the WHO assumes 60 kg.

The assumptions used in the equation are conservative and err on the side of safety. The preceding equation makes explicit provision for safety factors to account for the uncertainty in extrapolating from animal experiments to human populations (see

box 4.6).[4] Safety factors can be thought of as translating observed NOAEL levels for experimental animals, into presumed NOAEL levels for humans, taking into account the uncertainties involved.

Each safety factor is multiplied together to give an overall safety factor. An overall figure of 100 to 1000 is common and results in a presumed NOAEL level for humans of one hundredth and one thousandth respectively, of the NOAEL level for experimental animals. Higher values (up to a limit of 10 000) may be used on occasions.

Box 4.6 **Safety factors**

Safety factors generally applied are multiplicative. Four types are used:

- a factor of 10 for variations between animals — some animals within a species may be more sensitive to the effects of a chemical than the group tested;
- a factor of 10 for variations between species — the animal species tested may be less sensitive than humans, and in many cases human sensitivity is unknown;
- a factor of 10 if data from a sub-chronic study are used in the absence of reliable data from chronic studies — this factor can be less if chronic studies are available and indicate that no other effects occur, or that other effects are mild; and
- a factor of up to 10 if adverse effects have been observed at the lowest doses — usually the data are based on the highest dose at which no adverse effects are seen.

Source: NHMRC–ARMCANZ (1996).

Although the use of safety factors is common among all countries in this study, again there are some differences of detail in their application. Because safety factors have an effect on the parameter values that are set, they also have an effect on any benefit–cost calculations that are undertaken.

Tolerable daily intake approach

A number of countries, and the WHO, derive guideline values using a Tolerable Daily Intake (TDI) approach (see box 4.7). The TDI approach is closely related to that described above for calculating Australian Guideline values. TDI is only calculated for those compounds that are assumed to have a safe threshold dose.

4 Safety factors are referred to as uncertainty factors by the WHO.

Box 4.7 **Tolerable daily intake and WHO guideline calculation method**

Tolerable Daily Intake (TDI) is an estimate of the amount of a substance in food or drinking water that can be ingested daily over a lifetime without appreciable health risk.

TDI can be derived as follows:

$$TDI = \frac{NOAEL \text{ or } LOAEL}{UF}$$

where *NOAEL* = *No Observed Adverse Effect Level;*

LOAEL = *Lowest Observed Adverse Effect Level; and*

UF = *the overall uncertainty factor for humans.*

The guideline value (GV) is then derived from the TDI as follows:

$$GV = \frac{TDI \times bw \times P}{C}$$

where *TDI is expressed on a body weight basis (mg/kg);*

bw = *human body weight (60 kg for adults);*

P = *fraction of TDI allocated to drinking water); and*

C = *daily intake (2 litres for adults).*

Source: WHO (1993).

The term acceptable daily intake (ADI) has a similar meaning to TDI, but is usually applied to food additives or pesticide residues. For chemical contaminants with no intended function in drinking water, the term 'tolerable daily intake' is preferred by the NHMRC because it signifies permissibility rather than acceptability.

Chemicals with no safe level

Some chemicals such as carcinogens, are assumed not to be safe at any level, however small.

Based on long term animal studies, the International Agency for Research on Cancer (IARC) categorises chemical substances according to their potential carcinogenicity. The categories range from Group 1 substances, which are presumed to be carcinogenic, to Group 4 substances, which are classified as 'probably not carcinogenic to humans'. These categories are used by the NHMRC when setting guideline values.

Carcinogens are also classified as genotoxic or non-genotoxic.[5] Genotoxic carcinogens are presumed not to be safe at any level.

The 'no safe level' premise is controversial because, unlike a conventional scientific hypothesis, it cannot be tested or falsified. It was originally adopted as a science policy decision and was meant to be provisional, but it has since gained widespread acceptance even though opposition to its use remains (Hrudey 1998).

Health goals (and sometimes guidelines and standards) tend to be set at zero for contaminants presumed not to have any safe level of exposure. However, this practice presents a dilemma for policy making in terms of the practicability of defining zero, that is further compounded by advances in analytical chemistry (see box 4.8).

Box 4.8 **The 'no safe dose' assumption**

Much of the early focus on controlling carcinogens was aimed at the total elimination of exposure. For example, in 1958, the US Food and Drug Administration prohibited the use of any food additives which had been determined to cause cancer.

Such prohibitions were at least conceptually feasible for substances which were intentionally added to food, but they posed a dilemma for substances which may be present as unintentional residues.

In most cases, analytical detection limits for trace substances were poor enough that inability to detect a substance was common and could be casually treated as complete absence.

However, since the 1960s, the analytical limits of detectability have improved by over 10 000 fold, presenting enormous scope for finding carcinogens in water previously thought to be carcinogen-free. Therefore, any zero tolerance policy relying on prescribed analytical detection limits, could be subject to revision.

Source: Hrudey (1998).

With compounds for which no safe level can be assumed, risk assessment models are used to estimate the probability of harm resulting from exposure to very low concentrations. Because these probability estimates are derived from dose–response relationships observed at much higher doses, there is an element of uncertainty in their estimation. In this context, the Australian Guidelines contain the following observation:

5 Genotoxicity refers to the causal mechanism believed to underlie particular cancers and in the case of genotoxic compounds, their presumed ability to initiate cancers by disrupting the genetic material or DNA within a cell.

> While a number of uncertainties are involved, the calculations used tend to over-estimate rather than under-estimate the risk, and so provide a greater margin of safety: it is possible that the actual risk from exposure to low concentrations may, in fact, be lower than the estimated values by more than an order of magnitude (NHMRC–ARMCANZ 1996, p. 3-8).

These methods of risk assessment and extrapolation are also used by the WHO and the other countries in the study, and provide the basis for the values in the Australian Guidelines.

Differences between Australian and WHO guideline values

As noted previously, for compounds with a safe threshold, differences can occur between the Australian and the WHO Guidelines because of the different (70 kg) weight assumption, for example.

With substances for which no safe threshold is assumed, such as genotoxins, differences between Australia and the WHO can arise because, as explained in the Australian Guidelines, values for these types of compounds are based on a *balancing* of three different approaches outlined below:

- the limit of determination — based on the most common analytical method;[6]
- the concentration, based on the WHO risk assessment model, that could give rise to one additional cancer per million people, if water containing that compound were consumed over a lifetime; and
- the value derived using a safe threshold level calculation of the kind referred to previously, to which an additional safety factor is added for potential carcinogenicity.

The Australian Guidelines indicate that the balancing between these three approaches is done as follows:

> Provided the limit of determination gives an adequate degree of protection (ie, is within a factor of 10 of those values determined from health considerations), then this has been used as a guideline value. If the limit of determination is much lower than the values determined from health considerations, then the lower of the two calculated values has been used. If conversely, the calculated value is much lower than the limit of determination, then the calculated value is used as the guideline, but with a note that it is lower than the practical limit of determination. Improved limits of determination are required for such compounds (NHMRC–ARMCANZ 1996, p. 3-9).

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6 The limit of determination refers to the range of concentration over which a change in contaminant concentration is readily measurable. It is a numerically larger value than the limit of detection, which is the lowest level or concentration at which a contaminant is first detected.

The Australian Guidelines for acrylamide and benzene provide examples of how the balancing of these three approaches is done (see box 4.9).

Box 4.9 **Guideline setting principles as applied to chemicals in Australia**

Acrylamide is classified by the IARC as a Group 2A substance in that it is 'probably carcinogenic to humans.'

In relation to balancing the three considerations referred to previously, selecting a health-based calculation would yield a guideline value of 0.0007 mg/L.

Using the WHO risk model yields 0.00005 mg/L based on a zero safe level assumption and the NHMRC figure for acceptable risk of one additional cancer per million.

The limit of determination for acrylamide is 0.0002 mg/L.

The Australian Guideline value for acrylamide is set at the limit of determination, 'because it is within the values derived from health considerations, and provides an adequate degree of protection.' It also satisfies the decision rules above taken from page 3-9 of the Guidelines.

Benzene is classified as a Group 1 carcinogen by the IARC. It is genotoxic, with no safe concentration.

Using epidemiological data and a mathematical risk model, the WHO has calculated that a concentration of 0.001 mg/L would involve a lifetime risk of one extra case of leukaemia per million people.

Accordingly, the Australian Guidelines indicate that no safe level can be confidently set, but that for practical purposes the concentration should not exceed 0.001 mg/L, which is the limit of determination.

This approach also satisfies the decision rules on page 3-9 of the Guidelines..

Source: NHMRC–ARMCANZ (1996).

Neither acrylamide nor benzene have been found in Australian drinking water and the Australian Guidelines indicate that they are included because they have been occasionally detected in drinking water supplies overseas.

Different terminology is used in determining maximum contaminant levels (MCL) in the US, although the approach is similar (see appendix D3). A major difference is perhaps the more explicit recognition that a Maximum Contaminant Level Goal (MCLG), assumed to be zero for chemicals with no safe level of exposure, is rarely practicable or economically feasible. Accordingly, a somewhat higher concentration or MCL is set in regulation.

The MCL is subject to a benefit–cost test in the form of a RIS process. Within the limits of practicability and economic constraints, the US EPA strives to set the MCL as close as possible to the MCLG.

Comparison of threshold and non-threshold approaches

It has been claimed that the safe threshold approach outlined above has a number of attributes that make it more easily understood by the general public (Sim and McNeil, 1999). Unlike the no safe threshold approach, it is not based on a numerical estimate of cancer risk, but a guideline value that is regarded as acceptable, because it is below the dose considered likely to cause any measurable excess cancer risk, taking into account a series of safety factors to account for uncertainty. Sim and McNeil comment on the favourable attributes of the threshold approach as follows:

> The approach acknowledges scientific uncertainty, is more easily understood by the public, does not rely on an absolute measure of acceptable risk, and does not require explanation of the relevance of extremely small numerical excesses of cancer (often less than 1 in 10^5) which may be derived by modelling (Sim and McNeil 1999).

Physical standards

The characteristics by which consumers judge water quality include colour, taste and odour, which are sometimes collectively referred to as aesthetic characteristics. Although these characteristics are of less public health significance than microbiological parameters, for example, their importance in gaining consumer acceptance has been emphasised by the WHO (see chapter 3).

The countries in the study do not generally set health-related guidelines for physical or aesthetic qualities, either because they are judged not to be necessary, or because there is insufficient data to set a guideline based on health considerations. The US EPA distinguishes between primary drinking water standards, which are mandatory health related standards, and secondary guidelines, which are based on aesthetics and are not mandatory.

Turbidity is not in itself a health hazard, although it can reduce the effectiveness of disinfection. Accordingly, under the Australian Guidelines, turbidity at a level of less than 1 NTU is 'desirable'.[7] This advice applies to all supplies, both filtered and unfiltered.

[7] Turbidity can be thought of as a measure of 'cloudiness' in water and is measured in Nephelometric Turbidity Units (NTU).

In other countries, more restrictive turbidity standards are in place, in part because there is a link to health outcomes, albeit a somewhat indirect one. In the US, for example, turbidity standards are applied to filtered supplies as a measure of process efficacy and as a proxy measure for the possible presence of *Cryptosporidium*.

Turbidity standards are an indicator of filtration plant performance in removing small particles. This is important because some organisms can survive disinfection through the shielding effects of those particles.[8]

The NHMRC recognises that physical characteristics are an important component of good drinking water from the consumer perspective. However, it is stressed that consumer preferences for particular physical characteristics should not be allowed to deflect attention from public health as the main objective of drinking water regulation.

Radiological parameters

There is some radiological risk associated with radionuclides in the environment. However, the contribution of drinking water to total ambient exposure is small under normal circumstances.

Guideline values or standards for drinking water should not to be confused with those applying during an emergency, following an accidental release of radioactive substances to the environment.

The level of radionuclides can be elevated to levels of public health concern in drinking water by human activities associated with mining, nuclear power generation, or as a result of medical or other uses of radioactive materials. Some groundwater sources can be contaminated by mineral deposits, which impart radioactive contaminants to the aquifer.

Radiation from these sources is normally limited by regulatory control of these same sources or practices, and it would be through these regulatory mechanisms that contamination of drinking water would normally be addressed. Nevertheless, the NHMRC recommend initial screening to assess the radiological quality of drinking water using measures of gross alpha and gross beta emissions.

These screening measures are based on advice concerning acceptable dose rates from the International Commission on Radiological Protection (ICRP), that provides advice on which all countries in the study base their guideline values or

8 The presence of organic material can also affect the effectiveness of disinfection.

standards. The NHMRC recommend that if these indicator measures are exceeded during initial screening, then specific radionuclides should be identified and their emission characteristics compared to the values listed in the Guidelines.

The Australian Guideline values are based on WHO values and advice from the ICRP. They reflect dose levels equal to about 5 per cent of the radiation received from natural sources.

4.3 Evaluating public health costs

Over recent decades, governments around the world have placed increasing emphasis on quantifying the compliance cost of regulations. In many countries, formal benefit–cost evaluations are required as part of the regulation-making process and are routinely included in a RIS accompanying each regulatory proposal.

In Australia, an attempt was made to estimate the cost of upgrading from the 1987 Guidelines to what are now known as the 1996 Australian Drinking Water Guidelines (Morrison, R.J. et al 1995). The cost estimates produced by Morrison et al were part of a broader consultation exercise completed as a project for the NHMRC and the Commonwealth Department of Health.[9] The authors estimated that the new Guidelines would result in annual costs (operating plus annualised capital costs) increasing by 3 per cent.

The US EPA undertakes formal benefit–cost analysis as part of the process in establishing new drinking water regulations.

There appears to be little in the way of benefit–cost evaluation of EU Directives on water quality (see appendix D1). This has caused the OFWAT National Consumer Council to seek better costing of European Commission proposals (ONCC 1998). At the same time, the Better Regulation Task Force (BRTF) in the UK has been urging the application of benefit–cost analysis to all new national regulations based on EU Directives, particularly where the EU proposals exceed the requirements under existing UK regulations.

Notwithstanding the intentions of OFWAT and the BRTF outlined above, benefit–cost evaluation does not seem to be soundly practised in the UK. A RIS was prepared in the UK in 1998 for the regulatory amendments specifying new

9 Section 12 of the *National Health and Medical Research Council Act 1992*, provides for consultative mechanisms in the development of new guidelines or recommendations.

monitoring and control measures for *Cryptosporidium* in that country.[10,11] However, compared with similar assessments by the US EPA, the UK analysis is less comprehensive.

4.4 Evaluating public health benefits

There are a number of reasons why the public health benefits of more stringent drinking water guidelines and standards are not evaluated well, if at all. The most important reason is uncertainty in the data to support quantification of the public health benefits.

As noted previously, the link between guidelines or standards and public health outcomes is often not well established. Because of this uncertainty, the benefits are harder to estimate than the costs, where the link with guidelines or standards is much clearer.

Although benefits are real, it may not be known how big they are, as suggested below in the context of a proposed upgrading of the Australian Guidelines:

> Estimating the dollar value of the benefits of moving from the 1987 Guidelines to the 1995 [Draft] Guidelines is impossible given the limited data available on the anticipated health gains. This, however, does not mean that the potential benefits are not real. Lives may be saved or extended and health care and other resources may be saved. Nevertheless, our current state of knowledge makes it impossible to make a quantitative estimate of the benefits either in real or monetary terms (Morrison, R. J. et al, 1995).

In estimating the size of benefits, it is necessary to put a monetary value on a life saved or an illness avoided. This type of valuation is done routinely for insurance and compensation purposes for example. In the drinking water context, it is used routinely in the US when assessing the benefits of drinking water regulations.

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10 In the RIS, capital expenditures are assumed to be negligible on the grounds that the proposed *Cryptosporidium* levels can be achieved by improved operation of existing filtration plants, without the need for investment in new technologies to achieve the levels proposed. The new US EPA Rule on *Cryptosporidium* does not assume that such levels as envisaged in the UK can be achieved with traditional filtration technologies, even if they are operated optimally.

11 Expert commentators have questioned whether the monitoring and target levels in the new UK Rule are practicable, given the current incomplete state of knowledge concerning *Cryptosporidium.* Moreover, these concerns have been expressed against a backdrop in which the new Rules incorporate substantial monetary and even criminal penalties for non-compliance.

The US EPA provides the best example of a comprehensive process for estimating benefits as part of an overall benefit–cost evaluation of new drinking water Rules. The RIS prepared by the US EPA for the recent Interim Enhanced Surface Water Treatment Rule provides detailed monetary estimates of expected health damage avoided and lives saved as a result of implementing the proposed regulations (US EPA 1998a). Moreover, these calculations are promulgated publicly by means of the US *Federal Register*.

An important methodological issue in estimating benefits is to establish the baseline from which one is measuring. Estimates are rarely prepared where there is no baseline for drinking water guidelines or standards at all. It is important to recognise that it is incremental benefits that should be measured, not total benefits measured against a zero baseline.

4.5 In summary

The objective of drinking water quality guidelines or standards should be to reduce the quantity of contaminants in drinking water to a level that is effective and efficient in protecting public health. The effective level is largely a matter for scientific or technical assessment, but the efficient level is a matter requiring economic or benefit–cost assessment to determine the level of resources that should be allocated to meeting public health objectives.

Guideline values or standards are set for all categories of contaminant — microbiological, physical, chemical, pesticide and radiological. Each category has its own unique properties as outlined in the chapter. Values or standards in all of the benchmarked countries include a structured risk assessment undertaken for individual contaminants or hazards.

These risk assessments should take account of the properties of each hazard under consideration, and the available scientific evidence concerning the link between its possible concentration in drinking water and resulting adverse health outcomes. However, for many hazards or contaminants, the nature and extent of this link is uncertain because of gaps in the scientific knowledge about their effects.

Judgement has to be exercised in addressing this uncertainty, usually by adopting conservative safety factors in the setting of parameter values or concentrations. Judgement is also required concerning acceptable risk, taking into account among other things the cost of achieving a particular level of risk reduction.

An economic focus can be brought to the setting of parameter levels through a benefit–cost analysis and RIS. In some jurisdictions, a RIS is mandated for all

regulation of water quality. In Australia, there is little evidence that drinking water guidelines are being determined within a comprehensive benefit–cost framework.

Costs of complying with guidelines or standards are easier to estimate than the resulting benefits from improved public health. However, notwithstanding the methodological difficulties in benefit estimation, the US EPA provides an example of the analysis of benefits and costs being undertaken.

5 Monitoring and enforcement

The approaches used to put drinking water guidelines and standards into effect, in Australian jurisdictions and in the benchmarked countries, are compared in this Chapter.

An assessment is made of the regulatory instruments used to commit a water supplier to established quality guidelines or standards. This is followed by an assessment of the monitoring and enforcement procedures in place to ensure compliance with the requirements of the regulatory instrument. Finally, the compliance record and enforcement costs are examined.

Information on the regulatory approach to setting drinking water guidelines or standards can be found in chapters 3 and 4.

5.1 Regulatory instruments

Regulatory instruments are the tools governments use to give effect to their regulatory objectives. They include legislation or regulation, operating licences, memoranda of understanding (MoU), codes of practice, or some combination of these.

To be effective and efficient an instrument should ideally possess certain characteristics. These include flexibility, transparency, accountability and, in some cases, the force of law.

An instrument is flexible if it can be easily amended to reflect changes in drinking water guidelines or standards. This ensures that the instrument remains effective in achieving health objectives as new information becomes available on the link between guidelines or standards and health outcomes. Flexibility also reduces the administrative cost associated with amendments and therefore improves cost-effectiveness.

The regulatory instrument may also need to be flexible to accommodate regional differences. An instrument that uniformly applies drinking water guidelines or standards may be inappropriate because of cost and other differences.

Although flexibility is important, the process of establishing or amending the instrument should be transparent, maintain accountability and ensure that the established water standards are effective and efficient.

The obligations that the instrument places upon the water supplier should be clearly specified in order to provide the supplier with certainty about its obligations and accountability for meeting them. Such obligations should also constitute the minimum required to achieve the intended health objectives and should avoid over-prescribing technical requirements.

Force of law is required if it is necessary to rely on sanctions to ensure that suppliers comply with their obligations. The guidelines or standards against which compliance is measured should be measurable. Force of law also requires that the instrument give the enforcement agency sufficient powers and sanctions to enforce obligations.

These features are not mutually exclusive and invariably some tradeoff is required. A flexible instrument that minimises administrative costs may also result in reduced transparency and accountability. For example, codes of practice may be flexible, as they are more easily amended and tailored to industry operations. However, because of the resulting discretion, accountability can be reduced because there may be no compulsion upon suppliers to abide by the code. Transparency will also be reduced because codes do not require a Regulatory Impact Statement.

On the other hand, an instrument that provides for greater transparency and accountability, such as legislation, can be less flexible and impose higher administrative costs when amendments are required.

Comparisons

Australian State and Territory governments have taken diverse approaches to committing water suppliers in their jurisdictions to the NHMRC and ARMCANZ *Australian Drinking Water Guidelines* (hereafter referred to as the Guidelines) (see table 5.1). In most cases, Australian governments have used quasi-regulation such as operating licences, charters, MoUs and customer contracts.

Table 5.1 **Regulating water quality requirements in Australia**[a]

Supplier(s)	*Instrument*	*Requirements*	*Amended by*	*Publicly available*
SWC (NSW)	Operating licence	Abide by requirements of MoU	Governor	Yes
	MoU	1996 Guidelines	SWC & NSW Health	Yes
	Customer contract	Defines obligations to customers	SWC with approval of Governor	Yes
HWC (NSW)	Operating licence	Draft 1994 Guidelines	Governor	Yes
	MoU	1996 Guidelines	HWC & NSW Health	Yes
	Customer contract	Defines obligations to customers	HWC with approval of Governor	Yes
Wyong City Council (NSW)	Water supply business plan	1996 Guidelines & NSW Health Guidelines	Wyong City Council	Yes
Gosford City Council (NSW)	City Management Plan	1996 Guidelines	Gosford City Council	Yes
Non-metropolitan suppliers (NSW)	None	—	—	—
City West Water South East Water Yarra Valley Water (Vic)	Operating licence	1987 Guidelines microbiological values only	Governor-in-Council	Yes
	Health (Quality of Drinking Water) Regulations 1991	Establishes monitoring arrangements only	Governor-in-Council	Yes
	Customer contract	Provide consumers with water that complies with 1987 Guidelines	Approved by ORG	Yes
MWC (Vic)	MoU[b]	1987 Guidelines	MWC & Department of Human Services	
Non-metropolitan urbans (Vic)	MoU	1984 WHO Guidelines	NMUs & DNRE	No
SA Water (SA)	Charter	Australian water quality guidelines	SA Water's Minister & Treasurer	Yes
	Performance agreement with SA Government	Health-related parameters of 1996 Guidelines	Discussion and agreement within the Health-Aspects Water Quality Committee	
United Water Riverland Water (SA)	Commercial contract	Equal to or more stringent than 1996 Guidelines	Negotiation between SA Water and contractors	No

(Continued on next page)

Table 5.1(continued) **Regulating water quality requirements in Australia**[a]

WAWC (WA)	Operating licence	Directive of Health Minister — currently the 1987 Guidelines	Coordinator of Water Services	Yes
Tasmanian water suppliers	Public Health Act 1997 — Guidelines for Water Quality	Four legislated health outcomes	Director of Public Health	Yes

a Queensland, the ACT and the NT have no regulatory arrangements in place. **b** This MoU has expired and, as of late 1999, has not been renewed (DHS(Vic), pers. comm., 10 March 2000).

Source: s. 21 of *Sydney Water Act 1994*; SWC (1996); NSW Health (1998a&b); s.13 of *Hunter Water Act 1991*; HWC (1995); CWW (1998a&b); SEW (1998a&b); YVW (1998a&b); DNRE (1997); Queensland Government (1999); SA Water (1998); OWR (1998); s. 128 *Public Health Act 1997* (Tasmania).

The instruments employed vary not only between States and Territories, but also within State boundaries in some jurisdictions. Often some combination of these instruments is employed. One jurisdiction (South Australia) has commercial contracts with the private sector in place, while three other jurisdictions — Queensland, the ACT and the NT — place no regulatory requirements upon their water suppliers.

In the benchmarked countries, the most common type of regulatory instrument used is a regulation or rule backed by an Act and with penalties for non-compliance (see table 5.2). The US, UK and France all have national standards with statutory backing.

Canada and New Zealand are similar to Australia in that they have developed a set of drinking water guidelines at the national level. These guidelines may be adopted by State or local government and, in some cases, they are given statutory force.

There are a variety of reasons why countries have employed different instruments. The differences in instruments used by governments in Australia and in the other benchmarked countries, may be partly due to differences in the underlying industry structure. Greater levels of private sector ownership in the UK, France and US may warrant greater use of regulation.

Differences in the instrument used may also reflect historical or political circumstances. For example, the EU requires that its Member States transpose the Drinking Water Directives (and all other Directives) in the form of binding national legislation (EP 1997, s. 1.2.1). Consequently, countries such as the UK and France, which are members of the EU, had little discretion over the type of regulatory instrument they would employ.

Table 5.2 Regulating water quality requirements in benchmarked countries

Country	*Instrument*	*Drinking water quality requirements*	*Amended by*	*Publicly available*
Canada	National non-enforceable guidelines but with regulatory status in three Provinces	Establish guideline values for various contaminants	A joint Federal-Provincial Subcommittee on Drinking Water	Yes
EU Member States	Drinking Water Directive 98/83/EC	Protect public health by ensuring water is wholesome and clean as defined in Directive	European Parliament & European Council	Yes
France	French Decree [a]	Establishes maximum concentration levels and monitoring requirements	Assemble Nationale	Yes
NZ	Drinking Water Standards	Established guideline maximum acceptable values for contaminants	Expert committee on drinking water quality	Yes
UK	Water Industry Act 1991[a]	Water supplied must be wholesome	UK Parliament	Yes
	Water Supply (Water Quality) Regulations 1989, with amendments[a]	Defines 'wholesome'	UK Parliament	Yes
US	*Safe Drinking Water Act 1974*	Establishes regulation setting framework	US Congress	Yes
	National Primary Drinking Water Regulations	Maximum contaminant levels (MCLs); treatment techniques	US EPA	Yes
	Total Coliform Rule	95% of samples must be coliform free	US EPA	Yes
	Surface Water Treatment Rule	Filter and disinfect water to provide minimum 99.9% removal of *Giardia* & 99.99% removal of viruses	US EPA	Yes
	Lead &Copper Rule	If the level reaches 10%, treatment steps must be undertaken	US EPA	Yes
	Information Collection Rule	Suppliers with >100 000 customers to report on disinfection by-products & pathogens	US EPA	Yes
	Interim Enhanced Surface Water Treatment Rule	Suppliers with >10 000 customers must achieve 99% removal of *Cryptosporidium*	US EPA	Yes
	Stage 1 Disinfection Byproducts Rule	Achieve specified levels	US EPA	Yes

[a] Requirements must at least match those specified in the EU's Drinking Water Directive.

Source: EU 1998; Section 68 *Water Industry Act 1991* (UK); Section 300g *Safe Drinking Water Act 1974* (US).

In the US, national regulation was thought necessary to reduce the disparities in the quality of drinking water between jurisdictions by requiring a minimum standard. The main concern was chemical contamination of US source water and the link to cancer.[1] The US and other Governments have also been committed to supporting communities that had difficulty in meeting the cost of higher imposed standards.

Flexibility

Australian State and Territory governments have adopted more flexible regulatory instruments than those used in most of the benchmarked countries. These instruments include operating licences, charters, MoUs and customer contracts. These instruments are often more easily amended to accommodate changes to requirements than statutory regulation, which is the more common type of instrument used in the other countries.

Amendments to instruments such as operating licences are not so flexible as they generally require Ministerial or parliamentary approval. For example, the *Sydney Water Corporation Act 1994* states that:

> … a proposed amendment to an operating licence will not take affect until written notice of the proposed amendment, accompanied by a copy of the proposed amendment, is laid before each House of Parliament and either:
>
> (a) 15 sitting days of each House of Parliament has passed after the proposed amendment was tabled and notice of a motion to disallow the proposed amendment has not been given; or
>
> (b) if notice of a motion to disallow the proposed amendment has been given, the motion has lapsed or has been withdrawn or defeated (s. 16(2), *Sydney Water Corporation Act 1994*).

In NSW, Victoria and SA, where use is made of licences and charters, supplementing the licence with some other form of instrument has improved flexibility by facilitating the ease with which provisions can be amended. For example, the *Sydney Water Corporation Act 1994* requires the Sydney Water Corporation (SWC) to enter into an MoU with NSW Health. This states that:

> This Memorandum can be amended at any time upon agreement between the parties and in accordance with [amendment procedures specified in] the Act. Where agreement is not reached, the view of the Department is to prevail … (NSW Health 1998b, p. 4).

The MoU forms the basis for a cooperative relationship between the SWC and NSW Health and defines the SWC's responsibilities.

[1] Specific standards have been set to minimise the risk of developing cancer after ingesting chemical contaminants in drinking water over a lifetime (see chapter 4).

> In particular, the memorandum with the Department of Health is to recognise the Department's role in providing advice to Government in relation to drinking water quality standards and to commit Sydney Water to supplying water which is safe to drink having regard to the health of the public (SWC 1996, s. 5.2).

SA Water operates according to a charter that requires it to strive to meet the Australian Guidelines. It is not specified in the Charter which version of the Guidelines is pertinent — rather, this is negotiated between SA Water and the Department of Human Services (DHS(SA)).

Instruments like MoUs, or arrangements like those in SA, shorten the time frame required to amend drinking water guidelines or standards because amendments do not require parliamentary approval. Instead, the supplier and agency establishing the standards must come to an agreement.

The greater flexibility of instruments such as MoUs, reduces administrative costs. Such instruments also allow tailoring requirements to the needs and circumstances of regions within the jurisdiction. Regulations established at the national level may not provide the scope to achieve the flexibility to accommodate differences in regional circumstances and preferences. For example, UK regulations apply uniformly across England and Wales and have resulted in significant cost impositions upon lower income communities (ONCC 1998).

An alternative approach used to increase the flexibility of operating licences has been to delegate the authority to amend to a regulatory agency. In WA, the authority to amend the Western Australia Water Corporation's (WAWC's) licence has been delegated to the Licence Regulator (the Coordinator of Water Services). An amendment to the WAWC's licence merely requires agreement between the Coordinator and WAWC.

Contracting out water supply to the private sector potentially lessens the scope for regulatory flexibility. Contractors prefer to have their future requirements tightly specified at the start of the contract period. However, providing the private sector operator with certainty is often not possible where future upgrades to drinking water guidelines or standards are unknown. Higher quality guidelines or standards may require new processes and new capital equipment. Consequently, capital investment plans designed to meet the guidelines or standards in place at the start of the contract period, may prove insufficient further into the contract period if the guidelines or standards change.

With these tensions in mind, Quiggin has argued that:

> … government should bear risk related to changes in regulatory policy and risk related to capital intensive project(s), while risk specific to the operation of particular activities should be contracted out as far as possible (Quiggin quoted in IC 1996, p. 334).

In contracting out Adelaide's water supply services, SA Water (government-owned) has taken an approach that is consistent with that advocated by Quiggin. United Water (privately-owned) is responsible for the operation and management of the water supply system, while SA Water remains in control of capital investment decisions.

In the event of changes to the 1996 Guidelines, United Water and SA Water would negotiate changes in water quality targets and subsequent changes in operating procedures and contract costs. If capital investment was required, United Water would submit capital investment proposals following consultation with SA Water. If accepted by SA Water, they would be submitted for Board and Government approval (SA Water, pers. comm., 22 October 1999).

A similar contractual approach has been taken in France, where lease contracts provide for the private water company to operate and manage assets leased from the local municipality. Under these contracts, the private water company retains operational risks but the local municipality, as owner of the assets, assumes the capital investment risk.

In those benchmarked countries where the use of statutory regulation predominates, long timeframes can sometimes be required to establish new or amend existing regulation. For example, negotiations between the European Parliament, the European Council and the European Commission took almost four years before the Drinking Water Directive 98/83/EC could be finalised. In the US, the regulation making process can take several years. This delay is due to the policy appraisal process that the United States Environmental Protection Agency (US EPA) must undertake prior to establishing or amending regulation (see chapter 3).[2]

Transparency

The cooperative approach to specifying drinking water guidelines or standards, as used by Australian State and Territory health departments and water suppliers, may

[2] The realisation in the US that legislation might take years to implement led to the formation in 1995 of the Partnership for Safe Water. The goal of this partnership is to provide a new measure of safety by implementing prevention programs where legislation or regulation does not exist. The preventative measures are based on optimising treatment plant performance and increasing protection against microbial contamination in America's drinking water supply.

provide a greater degree of flexibility. However, the process of negotiation and amendment and the greater administrative discretion allowed may be less transparent than the processes used by the benchmarked countries.

Agreements negotiated between a water supplier and the relevant authority decrease the level of public or parliamentary scrutiny prior to arrangements being finalised. By embodying guidelines or standards in instruments such as MoUs, quasi-regulation is being established without parliamentary scrutiny. This lack of transparency may be exacerbated where there is no formal requirement upon either the water supplier or the authorities to provide for public consultation.

There have been attempts to improve the transparency of the process used to amend instruments such as MoUs. For example, consultation with a customer feedback forum is required prior to amending the customer contracts of the three Melbourne retailers:

> The licensee must develop and implement procedures to consult with customers about the content of the implied customer contract and must by 30 September in each year or such date as agreed by the Office and licensee submit to the Office proposed revisions to that contract arising as a result of its consultation with customers (CWW 1998b).

Similarly, copies of SWC's MoU must be made publicly available and NSW Health must consider public submissions.

Proposals to amend drinking water guidelines or standards in most of the benchmarked countries receive a high level of public and parliamentary scrutiny. This is due to the statutory nature of the regulatory instruments used, and at least some level of benefit–cost evaluation. In the EU, UK and France, amending existing regulations requires the approval of the relevant legislature. In the US, the US EPA has been delegated the authority to make and amend regulations, but is required to engage in a public and detailed policy appraisal process prior to finalising any proposed regulation (see chapter 3).

Accountability

The regulatory instruments used by Australian State and Territory governments may be less specific about the obligations they place upon water suppliers than the approaches used by most of the benchmarked countries. This can weaken the accountability of the supplier and the regulator.

In Australian States and Territories, regulatory instruments define obligations in regard to drinking water by cross-referencing to the Guidelines. For example, Tasmanian water suppliers are required to comply with the microbiological sampling regime specified in sections 2.8.1 and 6.2.6 of the 1996 Guidelines.

Similarly, under its MoU, the SWC is required to meet the health-related parameters of the 1996 Guidelines.

In some instances, the Guidelines are not specific in their requirements because they are only intended to serve as a guide regarding what and where to measure. For example, the Guidelines recommend that suppliers should identify key characteristics and work out their own monitoring needs.

> The testing frequencies are suggested minimums only; local knowledge and experience based on variability of different characteristics and the size of the water supply scheme may dictate different frequencies. Individual water suppliers need to work out their own monitoring needs … (NHMRC 1996, p. 6-6).

Requiring a supplier to comply with the Guidelines, without specifying how it is to meet them, does not unambiguously define its obligations. It also leaves the supplier with a degree of discretion as to how it interprets and implements the Guidelines. In the event of litigation however, the onus would be upon the supplier to demonstrate that careful consideration was given to issues addressed in the Guidelines.

In the UK and the US, water suppliers face clearly defined obligations and have little discretion as to how they interpret those obligations. Statutes spell out in detail what is required of the supplier. In doing so, these statutes establish a strong accountability framework.

Regulations are only as effective as the implementation processes, including those used to ensure compliance. Suppliers may be reluctant to maintain compliance with regulatory requirements where they impose large administrative costs or where surveillance for compliance is ineffective.

Force of law

The regulatory instruments used by some Australian State and Territory governments and by the US, UK, France and EU have the force of law. In Australia, operating licences or charters are generally a requirement of a governing regulatory statute.[3] In the US, UK, France and EU, the use of statutory regulation makes specified requirements enforceable by law.

The key difference is that in the US, UK, France and EU, the water supplier's obligations are specified in the regulatory instrument itself. In Australia, obligations are defined by cross-referencing to the Guidelines.

[3] The governing statute normally defines what is to be included in the licence and the operating area of the licencee. It may also specify a range of penalties that apply should the licensee contravene any of its licence requirements.

It is unclear whether cross-referencing to the Guidelines provides sufficient force of law, particularly where the Guidelines themselves are not specific in their requirements. The Guidelines allow a water supplier the discretion to tailor its obligations to its own particular situation. For example, as noted above, the Guidelines permit suppliers to identify key characteristics and work out their own monitoring needs after consideration of local conditions.

On the other hand, the public expects to be provided with safe drinking water. Given this, and because water is considered an essential service, a supplier could be held to be negligent if it had not considered guidelines or standards regarded as 'best-practice' and worked out regimes to monitor and test the water supplied. Duty of care and the provision of safe drinking water are discussed in more detail in chapter 3 and appendix E.

There has been some attempt in Australia to strengthen the legal obligation upon suppliers through the use of customer contracts. For example, the SWC's Customer Contract extends the rights of its customers and is legally enforceable. It outlines the rights and responsibilities of the SWC and its customers and provides for customer redress — a rebate on the service availability charge and compensation in the event that the SWC fails to provide services at agreed standards.

Under the *Sydney Water Act 1994*, the customer contract provides an effective and efficient mechanism to compensate consumers in the event that the SWC fails to provide water at the agreed standards — in contrast to the time that would be taken for individuals to pursue compensation through legal channels for example.

5.2 Enforcement agencies and procedures

The role of enforcement is related to the regulatory instruments that are already in place. For example, a broad approach to enforcement will already have been defined to some extent, where the force of law is used to back standards and therefore makes provision for prosecuting non-compliance.

Nevertheless, there are two broad approaches to enforcement. It may be deterrent-based, where compliance is coerced through maximising the probability of detection and sanctioning violations. Alternatively, enforcement may be cooperative-based. A cooperative strategy emphasises flexible or elective enforcement that takes into consideration the particular circumstances of an observed violation. The degree to which enforcement is required will depend on how clearly obligations can be defined and the willingness to cooperate with the regulated entity.

Deterrent-based strategies may be preferred where obligations can be clearly defined and the enforcement agency is dealing with suppliers who might not otherwise engage in the prescribed activity cooperatively. Coercion will be required where the behaviour of the supplier departs substantially from the norms expected.

Cooperative based strategies may be more appropriate where the regulated entity is willing to cooperate and:

> … the complexity of compliance situations makes it impossible to specify in unambiguous legal rules the behaviour required to achieve intended policy purposes (Scholz 1984, p. 183).

Complexity and ambiguity create dilemmas for enforcement if, as noted previously, the Guidelines are not specific in their requirements, but allow instead, discretion for a water supplier to tailor its obligations to its own particular situation.

Regardless of the type of enforcement strategy employed, enforcement should be effective and efficient. Enforcement is efficient if it minimises administrative costs of enforcement and the compliance burden placed on the industry. The enforcement strategy should ensure that monitoring costs and the resources employed by the enforcement agency are minimised, subject to achieving desired outcomes (ORR 1998).

A cost-effective enforcement strategy requires that the benefits of achieving greater compliance through enforcement, outweigh the cost of the enforcement activity and the compliance burden placed upon industry. To this end, the enforcement strategy should accommodate sufficient flexibility to avoid penalties for minor violations if the cost involved in detection and prosecution outweighs the benefits that compliance may have brought.

Sanctions, such as fines, act as a deterrent by imposing an expected cost upon an offender before a violation has occurred or been detected. In other words, they are aimed at preventing the occurrence of breaches. Instruments such as improvement notices, are designed to achieve compliance without using sanctions once a violation has been detected.

There are often large costs involved in bringing a successful prosecution against an offender. Consequently, the enforcement agency should be allowed to scale its response to the seriousness of the breach — a graduated response. This may involve allowing the enforcement agency to issue an improvement notice or warn an offender for a small or initial breach, but impose fines or undertake prosecution for serious breaches or continued non-compliance. Enforcement may also involve reporting upon the performance of water suppliers as adverse publicity often substitutes as an effective deterrent.

The enforcement effort should be applied consistently across regulated entities to ensure that enforcement is competitively neutral and is effective in achieving the health objective. A regulator's enforcement effort should not discriminate solely on the basis of whether water is supplied by a government-owned authority or by the private sector.

Consistency is desirable to encourage cooperation from the regulated entity. Differential treatment may weaken the firm's resolve to cooperate with an enforcement agency, if an organisation believes it is being treated unfairly.

The regulator should be clearly separated from the ownership of the supplier. Otherwise, the enforcement effort may be compromised and appropriate sanctions not applied.

Transparency ensures that the enforcement agency can be held accountable for its performance. It also demonstrates and reinforces the independence of the enforcement agency, as political interference is more observable.

To be transparent, the powers and sanctions of the enforcement agency must be publicly available, along with the reasons for the decisions that the agency makes. Also, the administrative procedures that set out the enforcement policy and strategies of the enforcement agency should be published.

Designing an efficient and effective enforcement strategy necessitates tradeoffs and may result in compromise. A flexible approach that provides scope for the enforcement agency to cooperate with the regulated entity may reduce transparency, because it reduces the ability of the public to scrutinise the enforcement process. On the other hand, a less flexible approach increases the compliance burden on the industry and the cost of enforcement, and may thus reduce cost-effectiveness.

Comparisons

In Australia, enforcement agencies assess compliance with the Guidelines based on self-reporting by the water supplier. Performance is assessed over a period of time — usually 12 months — rather than on an ongoing basis. However, suppliers are generally required to notify the health authority where monitoring indicates there may be a risk to public health.

Although the general approach to enforcement in Australia is similar across the jurisdictions, the procedures used to assess compliance vary (see table 5.3). Operational audits of performance are undertaken in those States where the water supplier operates under a licence — namely, NSW, Victoria and WA — but are not used in other jurisdictions.

Table 5.3 **Enforcement agencies and procedures in Australia**[a]

Supplier(s)	*Enforcement agency*	*Health department*	*Treatment of violations*	*Available sanctions*
NSW SWC HWC	Assesses compliance with licence requirements on annual basis through operational audit	Assesses system performance against requirements of MoU quarterly and annually based on reports received from the SWC and the HWC	Health Department may advise: • on corrective action; and • Licence Regulator of breach of licence requirements. Licence Regulator may prosecute for breach of licence. Unclear what action is taken for breach of MoU requirements.	A$1 million fine Cancellation of licence where licence requirements are breached. No formal sanctions for breach of MoU conditions
Wyong and Gosford Councils	n.a.	n.a.	n.a.	n.a.
Vic CWW SEW YVW	12 month rolling average assessment of licence compliance with operational audit	Monthly reporting of microbial results to DHS(Vic)	DHS(Vic) may investigate incidents and oversight incident rectification plans.	Financial penalties
Non-metropolitan urbans	DNRE records information on compliance with MoU	DHS(Vic) is notified if laboratory results indicate contamination	DHS(Vic) may investigate incidents and oversight incident rectification plans.	No legislated penalties
WA	Assessment of licence compliance through operational audit undertaken not less than once every 24 months		OWR may serve a letter of reprimand and cause the contravention to be rectified to the satisfaction of the Minister.	Monetary penalty of A$100 000 Cancellation of licence by Govenor
SA	Annual report on operating results of SA Water forwarded to government	Receives monthly monitoring report from SA Water	Investigation by SA Water and DHS(SA) and rectification plans developed. Water Incident Coordinator acts as single point of contact in the event of an incident. Lead Minister responsible for managing communication of serious incidents to public and government.[b] Financial penalties imposed on the two contractors where they fail to comply with specified quality requirements.	Financial penalties

(continued on next page)

Table 5.3(continued) **Enforcement agencies and procedures in Australia**[a]

Tas.	n.a.	Reports annually on the performance of suppliers based on information received from suppliers	DHHS(Tas) has a number of powers under *Public Health Act 1997*, including closing water supplies. However, response is likely to constitute advice on corrective action, or issuance of a permanent boiled water alert	A$2500 fine for failure to notify Director of Public Health where Guideline values are exceeded

a Queensland, ACT and the NT have no arrangements in place. **b** In the event of incidents designated as having potential human health effects the Lead Minister would be the Minister for Human Services. n.a. Not applicable.

Source: Appendixes.

The magnitude of sanctions available to the enforcement agency also varies. For example, if the SWC or the HWC fail to comply with their licence obligations, the Governor may direct that the following is to apply:

- a letter of reprimand by the Minister is to be served on the corporation;
- the corporation is to pay a monetary penalty (not exceeding A$1 million in the case of the SWC or A$150 000 in the case of the HWC) in any amount to be determined by the Governor; and
- the Operating Licence is cancelled.[4]

In some instances, enforcement procedures also vary within a jurisdiction. For example, in NSW, both the SWC and the HWC are subject to certain sampling, testing and reporting requirements as specified in their Operating Licences or their MoUs with NSW Health. They are also subject to annual operational audits conducted by an independent auditor. However, Wyong and Gosford Councils are not required to hold an operating licence, customer contract, or MoU with NSW Health, and nor are they subject to annual operational audits.

Enforcement is generally undertaken by an agency separate from the authority responsible for setting the standards — namely, the health authorities. For example, in Victoria and WA, where metropolitan water suppliers operate under a licence, the Office of the Regulator-General and the Licence Regulator respectively are the primary enforcement agencies.

[4] It is not clear how this sanction would operate in practice.

Table 5.4 Enforcement agencies and practices in the benchmarked countries

Country	*Enforcement agency*	*Treatment of violations*	*Available sanctions*
Canada	Health Canada	Corrective action may be required.	No formal sanctions.
EU Member States	European Commission has an oversighting responsibility but it does not directly monitor compliance with the Directive. It only reacts to non-compliance where a complaint is received.	Institute legal proceedings in the European Court of Justice to induce Member State to take necessary steps to comply.	There are no formal sanctions such as fines or imprisonment.
France	Prefet[a]	All violations of standards must be addressed, recorded and filed by the water supplier. Usually, this is undertaken in coordination with the Departmental Authority for Health and Social Services and the municipality in the case where it has outsourced its water services.	Sanctions are not pre-defined but a set of precedents from past cases exists.
NZ	Ministry of Health (MoH)	MoH can issue boil water alerts.	No formal sanctions.
UK	DWI assesses compliance with regulated standards on an ongoing basis based upon information received from suppliers. Conducts interim checks on particular aspects of compliance.	DWI may: • overlook trivial breaches; • receive an undertaking from supplier to correct violation; • issue an enforcement order;[b] • prosecute.	Fines Criminal prosecution (including jail term of two years) of Chief Executive Officer.
US	US EPA or States with primacy assess compliance with MCLs and monitoring requirements on an ongoing basis. US EPA may enter any establishment, facility or other property of supplier to determine compliance with regulations.[c]	US EPA or State with primacy may: • undertake informal assistance measures; • enter into compliance agreements.	Citations; Administrative orders; Criminal complaints with penalties; Civil referrals to State Attorneys General or to the Department of Justice (civil penalties can range from US$5000 to US$25 000); Emergency orders (the US EPA has the authority to impose a penalty of US$15 000 per day for violating an emergency order) Criminal cases; Fines or administrative penalties.

[a] The Prefet is a local representative of the central government [b] Enforcement orders place a duty upon the water supplier to comply with its obligations and allows a person who has sustained a loss or damage from breach of this duty, to take action against the supplier. [c] The US EPA is not authorized to enter an establishment if the facility is located in a State with primacy, unless the US EPA consults with the State first.

Source: Appendixes.

In the US, UK and France, the enforcement agency assesses compliance with regulatory standards on an ongoing basis (see table 5.4). Water suppliers forward the results of their monitoring to the enforcement agency as it is conducted.

Checks are made of the information and monitoring procedures used by water suppliers. For example, in the UK, the Drinking Water Inspectorate (DWI) carries out inspections of individual suppliers on the information provided, the quality of water supplied, compliance with sampling and other statutory requirements, and the progress made on improvement programs. It also checks that the sampling and analysis carried out by suppliers is accurate and that it provides a reliable measure of drinking water quality. Interim checks on particular aspects of compliance may also be carried out on information provided by the suppliers (DWI 1999a).

In the UK and US, enforcement procedures are undertaken consistently within each country because enforcement arrangements are established at a national level. For example, all UK suppliers of drinking water for human consumption must comply with the regulated standards and monitoring procedures specified in the *Water Supply (Water Quality) Regulations 1989*, with amendments.

Separation of the enforcement role

In the US, the degree of separation between the standard setter and the enforcer varies between the States. Enforcement is undertaken by State jurisdictions where a State has primacy,[5] or by the US EPA.

It is unclear to what extent enforcement is separated from standard setting within the UK. A specialist regulator, the DWI, undertakes the enforcement of all drinking water standards, whether established by the EU or the Department of the Environment, Transport and the Regions (DETR).[6] However, it is unclear how independent it is as the DWI sits within, and is funded by, the DETR.

A specialist regulator may carry out its functions more effectively than a more generalist regulator. Using a specialist regulator concentrates expertise in the field being regulated and results in the development of a knowledge base that may reduce the information asymmetry between the regulator and those being regulated.

Employing a specialist regulator may also enhance transparency and accountability. It may be easier to ascertain how effectively the enforcement agency is carrying out

[5] Primacy is given where States meet certain enforcement criteria (see appendix D3).

[6] The EU is responsible for setting most of the environmental and drinking water quality standards for the UK. However, the DETR may establish drinking water (or environmental) standards over and above those set by the EU (see appendix D2).

its tasks because its tasks are more clearly discernible. Also, a single line of responsibility for enforcement is created.

However, a specialist regulator may break the nexus between the regulation making process and how regulations are implemented and function in practice. The experiences and knowledge acquired through interacting with the industry may not be fed back to the agency responsible for setting guidelines or standards. This may result in regulations being created that, in practice, are ineffective in meeting their stated objectives.

Cost-effectiveness

Enforcement in Australia may be more cost-effective than the approaches used in countries such as the US and UK. In Australia, compliance is assessed over a period of time whereas in the UK and US, compliance is assessed on an ongoing basis. Consequently, enforcement costs may be lower than those in the US and UK because compliance is assessed less frequently. Also, trivial breaches that do not threaten the public health are not reported until the end of the assessment period and are unlikely to result in any action from either the enforcement agency or the health authority.

In the case of a more serious breach that threatens public health, suppliers are required to notify health authorities. Although health authorities have a number of responses available, including in some instances the closure of the water supply, serious breaches will generally elicit cooperative responses. The health authorities may coordinate an improvement program or merely offer advice on the actions that might be taken.

The cooperative approach to enforcement used in Australia may be well suited to addressing drinking water quality, where there is a high level of uncertainty, variation in source water quality and hence great difficulty in being very specific about the Guideline requirements. In these circumstances, enforcement may need to be flexible.

In the US and UK, all breaches, whether trivial or not, are reported to the enforcement agency and, at least in the UK, a trivial breach may precipitate investigation by the DWI to verify that the breach was indeed trivial.

The investigation of trivial breaches could also occur in Australia. However, it is more likely in the UK and US because of the more pervasive regulatory approach in these countries.

Notwithstanding this rigorous approach to investigations, enforcement agencies in the UK and US may adopt more flexible approaches once breaches are detected. Enforcement agencies in both the UK and US may overlook trivial breaches and, in the case of more serious breaches, work with the water supplier to get it back into compliance before resorting to sanctions. For example, formal enforcement actions in the US may be delayed while State governments take advantage of a range of assistance measures designed to help get the water supplier back into compliance. This approach is adopted unless there is a health risk necessitating immediate action.

Similarly, UK water suppliers may be exempt from prosecution where the DWI is satisfied that the breach is of a trivial nature (s. 19(1), *Water Industry Act 1991*). Water suppliers may also be exempt where they have given, and are complying with, an undertaking to correct the contravention.

Sanctions

The magnitude of available legal sanctions may affect the willingness of a water supplier to comply with its requirements. As sanctions increase in their severity, the expected cost of non-compliance may increase and the greater is the benefit to the supplier from complying. For example, a supplier may be more compliant when faced with criminal prosecution, than a monetary fine that is small in relation to turnover. Indeed, public exposure can be a more effective sanction than monetary penalties.

There is a significant difference between the size of penalties in Australia and those that may be incurred in countries such as the US and UK. In Australia, sanctions include fines and the cancellation of licences. In the UK and US, penalties include not only fines and cancellation of licences, but criminal prosecution and jail terms.

It is questionable how much of a credible threat the imposition of fines or even the possibility of licence cancellation is where the water supplier is providing an essential service and is government-owned. In fact, even where financial sanctions are used upon a government-owned entity, the cost can be passed onto the customer if there is inadequate economic regulation. However, the imposition of a penalty on a service provider, should not result in the customer being penalised twice.

A possible alternative to financial sanctions is to report upon the performance of water suppliers, highlighting where violations have occurred. Where water suppliers are concerned over a loss of reputation, adverse publicity can often be as effective an deterrent as traditional economic sanctions.

The Tasmanian Government has adopted such an approach. Suppliers are not required to comply with the values set out in the Guidelines, but they must abide by the monitoring regime specified and report the results to the DHHS(Tas). These results are collated into an annual publication by the DHHS(Tas) which identifies those suppliers that have met the guideline values and those that have not.

This annual water quality publication introduces transparency into the industry and provides a reference for drinking water quality information for communities throughout Tasmania. It also allows them to compare their water quality with other regions of the State and over time.

This discussion suggests that a regulator should have at its disposal a range of options available for the imposition of sanctions. Financial sanctions could be seen as a last resort option, only applied when there has been a significant breakdown in service.

Transparency

Australian State and Territory governments provide some degree of transparency in enforcement procedures. Most of the regulatory instruments used, such as operating licences and MoUs, specify the role, responsibilities and powers of the enforcement agency and the potential sanctions that may be incurred for non-compliance.

However, the self-reporting style of enforcement operating in Australia may not provide the same degree of transparency as is provided for by the enforcement practices in the UK and US. The key difference is that, unlike these countries, few Australian governments undertake independent assessments of the information provided by water suppliers and whether they are complying with sampling and testing requirements.

In the US, the US EPA may enter an establishment or facility to determine whether a supplier is complying with regulations and it may access any records, reports or information necessary to determine such compliance.[7] Similarly, the DWI in the UK carries out a number of checks of individual companies including checks on the information provided, the quality of water supplied, compliance with sampling and the progress made on improvement programs.

The public health Acts in some Australian jurisdictions provide the health authorities with the power to enter the premises of water suppliers and carry out inspections. For example, in response to the Sydney Water Inquiry in 1998, changes

[7] However, it is not permitted to carry out such inspections without the approval of the State, if that State has primacy.

to the *Public Health Act 1991* extended the powers of the Director-General of NSW Health. These included powers to enter the premises of any supplier to inspect, test, sample and obtain necessary information relating to the quality and testing of specific water supplies.

There is little evidence, however, that the powers to inspect sampling and testing results are exercised. Victoria, WA and Tasmania appear to be the only States that carry out checks of monitoring practices. The operational audits of water suppliers in Victoria and WA include the procedures and processes used to collect the data on water quality measures. In Tasmania, the Environmental Health Officers in each Council are responsible for ensuring compliance with monitoring requirements.

Enforcement agencies in Australia do not have prescribed formal enforcement policies.[8] It appears, however, that enforcement agencies in the benchmarked countries also do not have formal enforcement policies in place. The one exception is the UK, where the DWI has issued a Code for Enforcement that sets out what the water suppliers and the public may expect from the DWI. The following are set out in the Code:

- the role of the DWI;
- the standards to which it will operate;
- the principles it will follow in providing information and advice to the water companies and how it will consult and communicate with the industry;
- how it will deal with complaints by consumers;
- how it will approach complaints about the DWI itself;
- its aim to provide value for money; and
- its relations with water suppliers and the public (DWI 1999a).

5.3 Monitoring practice

Monitoring involves taking water samples at set times from identified locations and testing them for contaminants and physical characteristics. It is undertaken for a variety of purposes including regulatory, health and operational reasons.

Monitoring undertaken for regulatory and health reasons is generally termed system performance monitoring. This involves a wide-ranging assessment of the quality of water in the distribution system and as supplied to the consumer (NHMRC 1996).

[8] An enforcement policy sets out the objectives and operating principles of the enforcement agency and may outline the basis for consultation with the industry and public.

System performance monitoring provides a check that the water supplied is suitable for human consumption, a trigger for corrective action to improve water quality, as well as data to assess a water supplier's performance against agreed levels of service.

Operational monitoring is used to check the integrity of the processes and equipment used in the provision of drinking water (NHMRC 1996). Results are used to identify where purification processes are not functioning correctly and as a trigger for corrective action to improve water quality. This type of monitoring is generally not used for compliance purposes.

Both system performance monitoring and operational monitoring are undertaken on a routine basis to ascertain that treatment and distribution comply with given objectives and regulations.

Routine monitoring may be accompanied or complemented by baseline monitoring and investigative testing, or replaced by continuous monitoring.[9] Baseline monitoring is used to test the quality of raw water. In establishing a new supply of source water, baseline monitoring is often used to determine those characteristics that will need to be routinely monitored. It will also indicate likely treatment technology required, and identify water quality problems more broadly.

Investigative testing is most commonly used where routine monitoring indicates that guideline or standard values have been exceeded. It is a targeted approach, used to verify initial monitoring results and determine or confirm the source and type of contamination.

In determining the amount of resources to be used in monitoring, consideration should be given to the benefits and costs. The more frequently water is monitored, the higher is the associated cost of monitoring but the more likely it is that contamination will be detected.

Comparisons

Monitoring practice in Australia does not differ markedly from that undertaken in the benchmarked countries. In Australia and in the other benchmarked countries, the frequency of monitoring is a function of the quality of raw water and the size of population served.

[9] Routine monitoring involves regular sampling at set sites with no specified time or termination. Continuous or real time monitoring uses instrumentation that allows continuous reading of certain values, rather than having to send samples away and wait for several days before laboratory results are available.

Most systems incorporate a routine monitoring schedule for certain parameters including microbiological indicator organisms, turbidity, colour, pH, certain metals, disinfection by-products and some inorganic chemicals. Other contaminants such as pesticides, radiological material and other organic and inorganic chemicals are monitored on a less frequent basis.

In the UK, monitoring requirements recently incorporated a requirement to sample for *Cryptosporidium* on a continuous basis, where a risk of contamination by this organism exists. The UK is the only country studied that mandates direct monitoring for *Cryptosporidium* and there is some doubt about its efficacy (see chapter 3).

The US EPA has established a treatment rule for *Cryptosporidium*. The treatment rule establishes certain filtration requirements designed to achieve a 2 log (99 per cent) removal of *Cryptosporidium*. These treatment processes will be deemed effective if suppliers comply with the established turbidity requirement.[10] A similar approach has been adopted in New Zealand where *Cryptosporidium* will be deemed to be absent from water supplies where the turbidity criterion has been met. In the US, turbidity sampling must occur every four hours, while in NZ it is continuous for populations greater than 100 000 and twice daily for populations between 20 000 and 100 000.

Except in the case of the SWC and the HWC, there is no requirement for suppliers in Australia to routinely monitor for *Cryptosporidium* or *Giardia*. The SWC tests for both in accordance with a monitoring program developed in consultation with NSW Health.

Australian monitoring regimes and those in the benchmarked countries are similar in that suppliers are required to sample for microbiological indicator organisms more frequently than for physical and chemical contaminants.

The emphasis placed upon monitoring for microbiological contaminants relative to chemical contaminants, may be justified because of the different exposure characteristics of microbiological and chemical contaminants (see chapter 4).

Monitoring practices are also similar among the benchmarked countries in that microbiological sampling frequency varies with population size. However, within a particular population range, a higher *rate* of coliform sampling is undertaken in the US than the SWC in Australia, for example (see table 5.5).

[10] Water suppliers are required to monitor turbidity continuously from individual filters.

Generally, the performance of Australian water suppliers is assessed at the point furthest from the point of treatment (at the consumer's tap).[11] A similar method of assessment is used in the UK, although monitoring for microbiological contaminants is also carried out at the treatment plant and service reservoir. In the US, system compliance is assessed at a point of entry to the distribution system just after treatment.

Table 5.5 **Coliform sampling frequencies for community water systems in the US and the SWC in NSW**

US		*SWC*		
Population size	*No. of samples*	*Water Delivery Systems*	*Estimated population June 1996*	*No. of samples*
	(Per month)		(No.)	(Per month)
4 901 - 5 800	6	Greaves Creek	5 300	8
41 001 - 50 000	50	North Richmond	45 900	12
220 001- 320 000	150	Illawarra	245 900	43
450 001 - 600 000	210	Ryde	598 400	89
970 001 - 1 230 000	300	Potts Hill	1 155 800	142

Sources: Based on s. 141.21(2) National Primary Drinking Water Regulations (US) & SWC(1998b), p. 13.

The extent to which the results of compliance monitoring are publicly reported varies between Australian jurisdictions and between countries (see tables 5.6 and 5.7 respectively). US legislation requires that water suppliers prepare and mail to customers a consumer confidence report detailing the quality of the drinking water that was supplied to them over the previous year. In addition, States must publish summaries of the compliance reports forwarded to the US EPA and the US EPA must produce an annual report summarising and evaluating compliance reports.

In NZ, a *Register of Community Drinking-Water Supplies* provides the public with information on each community's water supply, the source of the water, the plants where water is treated and the distribution zones. It also grades water supplies according to the degree to which water suppliers can show that the drinking water at the tap, and in their treatment systems, is safe from a public health point of view. The Register also contains lists of the contaminants of public health concern known to be present (see appendix D5).

In Australia, reporting upon the compliance record of the major water suppliers in metropolitan areas is common, although the comprehensiveness of these reports

[11] The Guidelines recommend sampling at a number of locations, including as water leaves the treatment plant.

varies. However, water quality in rural and regional areas is less frequently reported publicly.

Table 5.6 **Publication of monitoring results in Australia**[a]

Suppliers	*Compliance reporting*
NSW	
SWC	Annual report comparing monitoring results against requirement of the NHMRC Guidelines. Publishes quarterly Consumer Confidence Report on water quality. Daily water testing updates for *Cyrptosporidium* and *Giardia* on web site. Results of operational audit against licence requirement published.
HWC	Results of operational audit against licence requirement published.
Gosford and Wyong Councils	Monitoring results are published by IPART in a final price determination report and made available to the public. Published results are not comprehensive — there are no details on individual water quality parameters, nor are they consistently reported for each Council.
Vic	
CWW SEW YVW	Required by their Licence to publish the results of monitoring on an annual basis. The ORG publishes an annual comparative report including performance against the Guidelines.
Non-metropolitan urbans	An annual report on the bacteriological quality of their drinking water is produced by DNRE, together with a bi-annual report of the physical and chemical quality. The reports on NMU drinking water quality are not widely circulated but are available to the general public.
WA	
WAWC	Results of operational audit against licence requirement published.
SA	
SA Water United Water Riverland Water	Non-comprehensive reporting of results in SA Water's Annual Report. Tri-monthly report provided to HAWQ Committee but not publicly available.
Tas	Department of Health publishes an annual report on compliance by all water suppliers.
NT PAWA	Monitoring results are not publicly reported but are available on request.

a Queensland, the ACT and the NT have no arrangements in place.

Source: Appendixes.

Cost-effectiveness

The relative cost-effectiveness of the monitoring regimes used in Australia and those used in the benchmarked countries could not be assessed. However, the benefits of monitoring for specific microbial contaminants, as occurs in the UK, may be questionable given that the analytical methods involved in their detection are expensive and time-consuming (WHO 1993, p. 23). Morgan and Thompson (1998, p. 21) stated that available diagnostics on *Cryptosporidium* are of limited

value due to insensitivity, poor reproducibility, problems with interpretation and cost. Deere (1998, p. 33) noted that reported monitoring results on *Cryptosporidium* cannot be directly interpreted as actual pathogen densities.

Table 5.7 **Publication of monitoring results in benchmarked countries**

Country	*Compliance reporting*
Canada	No requirement to publish the results of monitoring.
EU	Requires Member States to take measures necessary to ensure that adequate and up-to-date information on the quality of water is available to consumers.
France	Monitoring results are available to the public through the town hall where a summary, particularly of health-related results, is on display. An annual report is issued by the municipality and is available to the public on request and a summary report is mailed to each water subscriber annually. A national report on the performance of water suppliers is issued annually by the Ministry of Health and made available on its web site.
NZ	The *Register of Community Drinking-Water Supplies* provides consumers with information about each community's water supply, including provisional public health gradings and known contaminants present in the water.
UK	DWI annually publishes a summary of the compliance record of each water supplier. Water suppliers must prepare an annual report on quality.
US	*Safe Drinking Water Act 1974* requires: • State to publish and distribute summaries of compliance report forwarded to US EPA and make it available for public view. • US EPA produces annual report summarising and evaluating compliance reports. • Suppliers required to prepare a Consumer Confidence Report to be mailed to each customer at least annually.

Source: Appendixes.

A consultation paper prepared by the DETR (1998a) prior to the introduction of the *Cryptosporidium* requirement, estimated the annual recurrent cost of compliance (presumably reflecting monitoring costs) at around £7 million (A$21 million) or £1.23 per Ml/yr (A$3.73 per Ml/yr).[12]

In the UK, it appears that suppliers may face prosecution even where there is no evidence of illness associated with a breach of the prescribed standard. Since suppliers face criminal prosecution for non-compliance with the prescribed standard, there are strong incentives to introduce additional water treatment processes.

5.4 Compliance record and enforcement costs

It is difficult to make any definitive statements about whether a cooperative approach to enforcement, as opposed to a deterrent-based approach, leads to better

[12] Based on 5 694 000 Ml/yr and a currency conversion rate of A$1 = £0.33.

health outcomes. This is principally because it is difficult to establish a clear link between drinking water quality and the state of public health (see chapter 4).

The link between the type of enforcement approach used and the level of compliance achieved by the industry is more direct. However, making conclusions about this nexus is difficult. In Australia, compliance records are not always comprehensive. Factors such as the degree of private ownership or government funding programs may obscure the picture of how effective the enforcement effort itself has been. For example, improved compliance by a small regionally-based supplier may be due to the success of the regulator and enforcement mechanisms, or it could be due to government funding which has allowed the supplier to upgrade its water treatment facilities.

Australian suppliers generally have a good record of compliance with water quality requirements in so far as it is recorded. In 1997-98, the majority of suppliers reporting on compliance met their quality requirements (see table 5.8). However, there is some evidence that smaller systems were not performing as well as large metropolitan systems.

In the UK, the DWI reported that 99.78 per cent of around three million tests carried out met the relevant standards (see table 5.9). Although the percentage of samples exceeding prescribed values has declined over the last three years (see table 5.9), the level of enforcement action undertaken does not appear to have tapered off (see table 5.10).

In 1997, 88 per cent of the population served by community water systems in the US received drinking water with no reported violations of any health-based standard (US EPA 1999b). There were more violations of significant monitoring and reporting requirements (17 per cent of systems) than of health-based standards (8.5 per cent of systems). Small water systems were the major cause of violations of monitoring and reporting requirements because these systems tend to have fewer resources or lack trained staff to ensure compliance.

Data on enforcement costs in Australia is not generally available because enforcement activity is subsumed within either a health department or a regulatory agency that has responsibilities not only for the water industry, but also for other industries. However, it appears that the resources devoted to this activity are relatively minor.

The resources provided to auditing and enforcement are much greater in the US and UK. For example, the US State of California had the equivalent of 150 full-time staff employed on drinking water and wastewater issues, while Washington State (which has a similar population to NSW) had 80–90 people employed in the

Drinking Water Program. The water unit of NSW Health has a staff of four (NSW Health, pers. comm., 17 February 2000).

Table 5.8 **Compliance record in Australia, 1997-98**

Supplier(s)	*Record of compliance with drinking water quality requirements*
NSW	
SWC	1998 operational audit found that monitoring and reporting of water quality results indicated that the SWC complied with the health-related requirements of both the 1980 and 1996 Guidelines. An independent assessment reported that performance met the health aspects detailed in the 1980 Guidelines as well as the health related aspects of the 1996 Guidelines for the period 1 July 1998 to 31 December 1998.
HWC	The 1997-98 operational audit indicated that Licence requirements for micro-biological and all key and non-key chemical and physical parameters (based on 1996 Guidelines) were met.
Wyong and Gosford Councils	Published results not comprehensive. No details on individual water quality parameters.
Non metropolitan water supply authorities	Not subject to an operational audit by the Licence Regulator.
Vic	
CWW SEW YVW	All three water retailers complied with requirements.
Non-metropolitan urbans	40 per cent did not meet microbiological requirements.
SA	
SA Water	No record of non-compliance.
United Water	Metropolitan water supplies fully complied with 1996 Guidelines.
Riverland Water	Only four plants had become operational and these had been functioning only for a short time.
Tas	All three bulk water suppliers were in compliance. Eleven water suppliers in smaller rural areas did not meet requirements.[a]
NT PAWA	Compliance record is not formally assessed by Territory Health Services. PAWA advise that water supplies for Darwin and Alice springs meet the 1996 Guidelines and other supported water supplies meet the 1987 Guidelines.

[a] Failure to comply with requirements was due to an inability to afford adequate treatment systems (Jacobs, M. quoted in The Mercury, 17 September 1999).

Source: Licence Regulator (NSW) (1998b); ORG 1999; VAGO (1999); DHS(SA), 18 May 1999, pers. comm.; SA Water (1998); DHHS(Tas) (1999); Territory Health Services; NT; pers. comm.; 9 March 2000.

The US EPA undertakes a range of activities, of which enforcing drinking water standards is only one part. Moreover, enforcement activity is in some cases undertaken by States with primacy. For these reasons, it is not possible to separately identify the cost of enforcing drinking water requirements in the US.

Based on appropriations for two programs — the Safe Drinking Water Program and the Enforcement Tools to Reduce Non-Compliance Program — the cost of

enforcing drinking water standards in the US could be anywhere up to US$1.2 billion (A$2 billion).[13] However, this amount would include drinking water-related activities undertaken by the US EPA unrelated to enforcement, and may include activities undertaken by the US EPA for other non-drinking water related enforcement.

In 1998-99, the DWI's budget totalled £2.1 million or A$6.4 million (DETR 1999).[14] On a per megalitre basis, the cost of the DWI's activities ranges between A$1.12 per Ml per year and A$1.38 per Ml per year.[15,16]

Table 5.9 **Water quality testing in the UK, 1996-1998**

Testing and results	*1996*	*1997*	*1998*
Total number of analyses conducted for a particular parameter	3 055 050	2 980 737	2 807 280
Number exceeding prescribed concentration or value	9 107	7 434	6 245
Per cent exceeding prescribed concentration or value	0.30	0.25	0.22

Source: DWI (1999b).

Table 5.10 **Enforcement action in the UK, 1994-1998**

	1994	*1995*	*1996*	*1997*	*1998*
Points of non-compliance:	No.	No.	No.	No.	No.
In supply zones	101	96	102	141	115
Leaving treatment works					
- coliforms	15	10	18	16	18
- faecal coliforms	4	1	4	4	2
In service reservoirs					
- coliforms	9	17	11	12	9
- faecal coliforms	12	11	2	6	3
Total	**141**	**135**	**137**	**179**	**147**

Source: DWI (1999b).

13 Conversion rate used is A$1= US$0.60.

14 Converted at an exchange rate of A$1 = £0.33.

15 Obtaining a single figure for enforcement costs on a per megalitre basis is difficult because, in the UK, water is not metered and there is a significant quantity of leakage. The DWI (1999b) estimates water supplied at 15 600 Ml/day (5 694 000 Ml/yr) while OFWAT (1998a) places water supplied at 12 674 Ml/day (4 626 000 Ml/yr).

16 These are only indicative figures. However, they suggest that compliance costs imposed on suppliers are much greater than the regulator's enforcement costs. For example, it was estimated in section 5.3 that *Cryptosporidium* monitoring alone might cost around $3.73 per Ml.

5.5 In summary

The approaches used to monitor and enforce compliance with drinking water guidelines or standards appear to be distinguished by whether or not they are incorporated in legislation and whether they have the force of law (see chapter 3).

Australian governments have employed more flexible regulatory instruments than those used in most of the benchmarked countries. Flexibility can lower the administrative costs associated with amending such instruments and provides scope to set guidelines or standards according to the circumstances in a particular jurisdiction.

However, these advantages should be weighed up against a possible lack of accountability and rigour that may not be conducive to effective and efficient guideline or standard setting.

Transparency and accountability may not be as strong as when standards are promulgated through legislation. By embodying guidelines or standards in instruments such as MoUs, quasi-regulation is being established in Australia without parliamentary scrutiny and without the benefit of a proper benefit-cost assessment included as part of a RIS. This is in contrast with the US, where benefit–cost assessment is mandated in dedicated drinking water legislation.

It is uncertain how much legal force Australia's regulatory instruments have where obligations are defined by cross-referencing to the Guidelines.

Australia's enforcement arrangements are often characterised by cooperative and 'light-handed' supervision. Enforcement agencies rely on self-reporting by the suppliers, with only a few States subjecting the information provided to independent checking. Although similar approaches to reporting are used in the UK and US, authorities in these countries tend to scrutinise the information provided to a greater degree.

In the event of guidelines or standards being breached in Australia, the health authorities' general response is to cooperate with the supplier to identify the cause of the incident and to advise on corrective action. This approach may reflect:

- the uncertainties associated with pinpointing drinking water quality as the cause of a gastroenteritis outbreak, for example;
- the uncertainties inherent in the quality of source water and detection of contaminants that make it difficult to be very specific about water quality requirements in the Guidelines; and
- government ownership of suppliers.

The US and UK, which use more deterrent-based approaches to enforcement, have also recognised that there are uncertainties inherent in the provision of drinking water. Enforcement agencies in these countries may overlook trivial breaches and cooperate with a non-complying supplier in order to bring the supplier back into compliance before resorting to the use of sanctions.

There may be a tradeoff between the costs of enforcement and the level at which guidelines or standards are set (and the associated costs of treatment). Where guidelines or standards are set higher than necessary to achieve public health outcomes, regulators may not need to scrutinise a supplier's performance as closely because a margin for error has been built into the guidelines or standards. This can reduce the cost of enforcement but can impose large compliance costs (in the form of treatment costs) on the supplier.

Monitoring for specific microbial contaminants, such as *Cryptosporidium*, may not be cost-effective because the analytical methods involved are time-consuming, expensive and often inconclusive.

Australian suppliers generally have a good record of compliance where it is reported. However, current arrangements may be untenable with public demands for greater government accountability.

6 Systems management, cost recovery and risk communication

There is increasing use of quality management systems within the Australian water industry. This reflects an increasing recognition in the industry that reliance on monitoring alone has limitations.

Quality management systems can assist suppliers to keep their systems in compliance with existing drinking water quality standards. However, faced with meeting more stringent standards, suppliers are likely to be confronted with the need to undertake capital investment to bring their systems into compliance. Recovering these costs is essential to the continued viability of suppliers.

Risk communication strategies are important if suppliers are to inform their consumers how they are addressing the risks associated with supplying safe water and build consumer confidence.

Quality management systems, recovering the cost of capital investment, and the use of risk communication strategies are discussed in this chapter.

6.1 Quality management systems

Quality management systems embody holistic approaches to managing water systems and incorporate quality assurance principles with an emphasis on prevention rather than reaction (CRCWQT 1999c). Within the water industry, they involve appropriately managing and effectively operating each stage of the water supply system, including:

- source water protection;
- storage management;
- treatment efficiency and reliability;
- disinfection; and
- management of the distribution system.

The NHMRC, with assistance from the Cooperative Research Centre for Water Quality and Treatment (CRCWQT), is currently developing a Framework for Drinking Water Quality Management Systems that will be incorporated into future versions of the Guidelines.

The 1996 version of the Guidelines included a list of the activities that comprise such systems (see box 6.1). However, how these activities should be undertaken is not documented.

Box 6.1 **Quality management systems in the 1996 Australian Drinking Water Guidelines**

The 1996 version of the *Australian Drinking Water Guidelines* stated that quality systems offer an effective and efficient way of managing a water supply system. This involves establishing a regime whereby each step of system management and performance assessment is reliably carried out, thus guaranteeing the end result — in this case, good quality water.

According to the Guidelines, a quality system should include:

- an agreed level of service;
- effective treatment processes, including disinfection;
- regular inspection and maintenance of the system;
- practices that identify likely external sources of contamination;
- ongoing evaluation and refinement of the overall operation of the system;
- monitoring programs which assess water quality throughout the system, and which can identify the location and nature of any water quality problem within the system;
- validation procedures for sampling and laboratory testing programs;
- the use of monitoring information both to facilitate day-to-day management of the supply, and to assess its performance over time;
- appropriate procedures for immediate correction of any serious water contamination and resolution of longer term water quality problems which might be costly to address;
- defined lines of responsibility for remedial action;
- use of appropriately skilled and trained personnel;
- transparent auditing procedures; and
- reporting to consumers.

Source: NHMRC 1996, pp. 5-4–5-5.

To date, it has been common for suppliers and other interested parties, including the general public, to focus upon guideline values, to the exclusion of all the other

information included. The Guidelines need to be considered as a whole, with consideration given to the additional information included in the Guidelines, including the guidance provided on monitoring and systems management.

The impetus for developing a more comprehensive quality management framework comes from the recognition that the most effective means of managing drinking water quality for the protection of public health is through the adoption of a preventive management approach that encompasses all steps in water production (CRCWQT 1999d). It is also recognised that monitoring is limited in that it leads to a reactive rather than preventative management approach as corrective action is initiated only after monitoring reveals that guideline values have been exceeded.

The Framework is intended to provide guidance on a comprehensive preventive strategy for drinking water quality management from catchment to tap. It comprises an integrated system of approaches and procedures to fully address the range of drinking water quality issues that can arise. The key features of the Framework are:

- the identification of hazards;
- the assessment of risks and the specific measures to control and to verify control of hazards, emphasising elements that can be monitored in real time; and
- the documentation to demonstrate that the critical activities are working and are effective (CRCWQT 1999d).

A number of suppliers — the Sydney Water Corporation (SWC), the Melbourne Water Corporation (MWC), the Victorian non-metropolitan urban suppliers — are using or are intending to implement quality management systems to manage water quality (SWC 1998a, MWC 1997, and Department of Natural Resources and Environment, Victoria, pers. comm., 21 June 1999).

A Victorian metropolitan water retailer, South East Water, introduced a Hazard Analysis and Critical Control Point (HACCP) system in 1999. HACCP is commonly used in the processed food industry and focuses upon prevention through process control. It uses tools to assess hazards and to understand how a product can become unsafe and allows control systems to be developed that focus on preventing health-related problems before they occur (see box 6.2).

Under South East Water's system, staff involved in managing and operating the water supply system are trained to identify risks to consumers. Staff are required to understand how to prevent exposure to any significant public health risk through proper operational practice (SEW 1999).

Box 6.2 **Hazard and Critical Control Point Systems**

The intent of HACCP is to focus controls at the key points in an operation or process (Critical Control Points (CCPs)) where potential hazards may occur. At control points, critical limits are specified that define what is acceptable and what is not. Monitoring is then scheduled to measure or observe the process at its CCPs relative to set critical limits. Where monitoring indicates that a process has exceeded its critical limit, corrective action is initiated. Verification that the CCPs are controlling hazards and that the HACCP is performing as planned is usually confirmed by third party audits.

HACCP integrates with other (ISO) quality management systems and is essentially conducted according to seven steps:

- conduct a hazard analysis;
- determine the CCPs;
- establish critical limits;
- establish a system to monitor control of the CCP;
- establish corrective action to be taken if monitoring indicates that a particular CCP is not under control;
- establish procedures to verify that the HACCP system is working effectively; and
- establish documentation concerning all procedures and records appropriate to these principles and their application.

Source: CAC (1997).

In the US, the Partnership for Safe Water Program has been developed as a cooperative initiative between the US EPA, the American Water Works Association (AWWA), several national organisations representing drinking water suppliers and 225 surface water suppliers directed at improving risk management and water quality. The Program is expected to provide a new level of safety by implementing prevention programs where legislation or regulation does not exist. The preventative measures are based on optimising treatment plant performance and increasing protection against microbial contamination.

Operator training and certification

Adequate training of operators is essential to the safe and reliable operation of supply systems. In addition, monitoring and sampling procedures carried out by a trained operator are more likely to produce accurate results and be correctly interpreted.

The provision of adequate training is more likely to be of concern in smaller systems in regional areas. Smaller operators often do not have the resources available to provide effective training programs.

The Australian Guidelines do not address the issue of what training should be provided to operators. However, the National Utilities and Electrotechnology Industry Training Advisory Body (NUEITAB) is recognised nationally by the Australian National Training Authority (ANTA) as the body responsible for training in the water industry.[1] The NUEITAB provides training in source water management, treatment and distribution and offers apprenticeships and traineeships that enable employers to select and train people specifically for the water industry.

The Commission is not aware that there is any requirement upon water suppliers to provide such training to staff or to have operators formally certified.

Formal operator certification schemes are used throughout the US. The US EPA, in partnership with the States, suppliers and the public, has developed guidelines specifying minimum standards for the certification and re-certification of operators (see box 6.3). The guidelines aim to ensure that:

- customers of any supplier must be provided with an adequate supply of safe, potable drinking water;
- consumers are confident that their water is safe to drink; and
- water supply operators are trained and certified and have knowledge and understanding of the public health reasons for drinking water standards (US EPA 1999c).

States are required to implement the guidelines, or have an equivalent State program certified by the US EPA, or risk a reduction of 20 per cent in their Drinking Water State Revolving Fund allocation. Systems serving 3300 persons or less receive reimbursement for the costs incurred in training and certification.

6.2 Cost recovery

Water suppliers may not be concerned with more stringent standards *per se*, as with their ability to recover additional treatment costs required to achieve those standards.

1 ANTA was established out of an agreement by Heads of Government in 1992 to develop a national system of vocational education and training in cooperation with state and territory governments, the Commonwealth government and industry.

Box 6.3 **Summary of the US EPA operator certification guidelines**

Each State operator certification program must include as a minimum, the essential elements of the nine baseline standards as follows:

- *Authorisation* — States must have the legal authority to implement the program.
- *Classification of systems, facilities and operators* — States must classify all community and non-transient non-community water suppliers based on indicators of potential health risk. They must develop specific operator certification and renewal requirements for each level of classification.

  All operating personnel making process control and/or system integrity decisions about water quality or quantity must be certified. There must be a certified operator available for each shift.
- *Operator qualifications* — To become certified an operator must take and pass an exam that demonstrates the operator has the necessary skills, knowledge, ability and judgement as appropriate for the classification of the facility he or she will operate. The operator must have a high school diploma or a general equivalency diploma and have the defined minimum amount of on-the-job experience for each appropriate level of certification.
- *Enforcement* — States must have appropriate enforcement capabilities and the ability to revoke operator certifications. States must also have the ability to suspend operator certifications or take other appropriate enforcement action for operator misconduct.
- *Certification renewal* — States must establish training requirements for renewal and must require all operators to acquire necessary amount and types of State approved training. Renewal must occur every three years.
- *Resources needed to implement the program* — States must provide sufficient resources to adequately fund and sustain the operator certification program.
- *Re-certification* — States must have a process for re-certification of individuals whose certification has expired for a period exceeding two years. This program must include a review of the individual's experience and training, and re-examination.
- *Stakeholder involvement* — States must include ongoing stakeholder involvement in the revision and operation of State operator certification programs.
- *Program Review* — States must perform reviews of their operator certification programs.

Source: US EPA (1999c).

Comprehensive information on what Australian suppliers have had to invest to meet the 1996 Guidelines is unavailable. However, there is some evidence to suggest that the capital expenditure incurred in upgrading to the 1996 Guidelines has not been large by international standards. To bring drinking water quality into line with the

1996 Guidelines, SA Water augmented its metropolitan treatment plants through the introduction of enhanced treatment processes. Introducing these processes is estimated to cost around A$5 million (the project has not been completed) with an associated additional annual operating cost of approximately A$3.5 million (SA Water, SA, pers. comm., 22 October 1999).

MWC has indicated that if it were to filter all water supplies to Melbourne, it would cost between $430 million to $510 million depending on the process selected (see chapter 1).

Suppliers in the UK have undertaken extensive capital investment works over the last 10 years to meet more stringent drinking water quality requirements. Between 1990 and 1995, suppliers in the UK invested between £5 billion (A$15 billion) and £17.5 billion (A$53 billion) to bring their systems into line with the requirements of the EU Directives (Booker 1997).[2] Complying with the EU's second Drinking Water Directive is estimated to cost between £850 million (A$2.6 billion) and £2.3 billion (A$7 billion) in the five years between 2000 and 2005 (OFWAT 1998b).

The most significant potential cost driver in the UK is compliance with the EU's lead standard. Complying with this standard will require replacing all the lead piping in the distribution system at a cost estimated at over £3 billion (A$9 billion) between 2000 and 2015 — £1 billion (A$3 billion) between 2000 and 2005 (OFWAT 1998b).

The US EPA estimated that the cost to comply with the 1996 amendments to the *Safe Drinking Water Act 1974* amendments will be around US$138 billion (A$209 billion) over 20 years. It is suggested that the majority of this cost will be directed at meeting microbiological standards and associated drinking water rules (US EPA 1997c).[3]

While capital expenditure costs to date have not been large in Australia, they still represent a significant cost burden for smaller regional suppliers that do not have the advantage of scale economies. Consequently, Australian state governments have provided financial assistance to smaller regional suppliers in order to bring them into line with the Guidelines. For example, the NSW Government made a commitment to provide A$855 million to assist non-metropolitan suppliers

2 These figures include capital investment undertaken to meet environmental quality standards under the EU sewerage-related Directives.

3 This may over-estimate the cost as cost estimates include infrastructure components that are not required for compliance but are undertaken at the same time to realise savings in design and building costs.

overcome problems with existing water supply and sewerage systems, and to provide initial infrastructure to presently unserviced towns. This commitment included an allowance of A$125 million for the provision of new water treatment facilities (DLWC, NSW, pers. comm., 14 October 1999).

Australian state governments have also made increasing use of Build-Own-Operate-Transfer (BOOT) schemes to fund the construction of upgraded treatment facilities in regional areas. Under these schemes, private sector operators are contracted to build, own and operate treatment plants and related assets for a number of years, after which the assets are transferred back to the government.

As an example, Grampians Water in western Victoria contracted AquaTower Pty Ltd under a 25 year BOOT scheme to construct four water treatment plants and associated works to bring water quality up to the 1984 World Health Organisation (WHO) Guidelines. Under the contract, AquaTower will treat water supplied by Grampians Water for a fee and Grampians Water will reticulate the treated water to consumers (*The Age*, 11 October 1999, p. 5).

The capital investment required to bring a water system into compliance is a significant cost driver in the water industry. Economic regulators must allow suppliers to recover the costs associated with capital expenditure in order for them to remain viable. However, the economic regulator must ensure that the capital expenditure cost claims made by suppliers, are reasonable in light of the standards they are required to meet.

Complicating this picture is uncertainty about future drinking water guidelines and standards. Prices set to recover the cost of investment undertaken to meet current standards, may prove insufficient in the future if guidelines or standards increase.

6.3 Risk communication

Community consultation is one of the criteria identified for best practice regulation making (see chapter 1, attachment 1A). In this case, where public health is the principal objective of the regulatory process, consumers will want to know how guidelines or standards are affecting their exposure to health risks and how these risks are being managed.

Informing consumers of risks and advising them on what is being done to control them is an essential part of risk management:

> It enables people to participate in deciding how risks should be managed. Communication is also a vital part of implementing decisions — whether explaining mandatory regulations, informing and advising people about risks they can control

themselves, or dissuading people from risky, antisocial behaviour (Inter-Departmental Liaison Group on Risk Assessment (ILGRA 1998, p. 1).

Risk communication is an accountability issue. Incentives for good decision and policy making are diminished if those responsible are not accountable for their actions. Transparency, a prerequisite of accountability, is therefore crucial.

There are different levels of risk communication. These depend on the type of information disclosed to consumers about their water quality, and the linkages to health outcomes.

Risk communication can be defined broadly or narrowly. A broad definition may include informing consumers of the statistical probability of adverse health consequences related to consumption of an individual contaminant, at a particular concentration. Examples of this can be found for carcinogenic compounds in the Australian Guidelines, the WHO Guidelines, and the US EPA Federal Register.

Narrowly defined risk communication could involve reporting the level of contaminants in water supplies and how these levels measure up against guideline or standard levels, but without the extra step of trying to interpret what it means for the actual risk level involved.

In the past, very little information has been provided. The focus had been on informing consumers about aspects of service provision, such as connection times and service disruptions.

In recent years, suppliers have tried to provide more information to consumers on the quality of their water. The SWC has an extensive web site. It contains, along with copies of water quality reports, daily updates of water quality testing for *Cryptosporidium* and *Giardia,* with a link to NSW Health. Most large Australian suppliers have information on water quality on their web sites. The three Melbourne retail companies are required to publish water quality performance information, and are subject to an independent assessment of their performance by the Victorian Office of the Regulator General.

Suppliers and the agencies involved in setting guidelines or standards have an important role to play in informing consumers, who are not in a position to assess or make informed choices about water quality. However, they have a right to know the quality of water being consumed and the risks they are exposed to.

Communicating the risks involved in the provision of drinking water is also necessary if community preferences are to be gauged and taken into account. This potentially reduces the likelihood of wasted investment in inappropriate or unnecessary water treatment technology.

By excluding the public from decision making and overlooking the need for proper evaluation of decisions, there may be investment in expensive new treatment processes that produce little in the way of health benefits. If consumers are not informed of the decisions taken and the reasons for them, they may be more susceptible to 'scare campaigns' that drive governments and suppliers to make costly and unwarranted capital investments.

Incentives for communicating risks

A formal risk communication policy has the benefit of requiring suppliers to estimate the risks involved in consuming drinking water and informing consumers of these risks. However, information about complex risks is difficult to communicate and this may explain why it is not often undertaken within Australia. In addition, suppliers may be reluctant to advise their customers if they are not currently complying with guidelines or standards.

Regulators may also decline to implement a risk communication policy where they perceive that doing so is difficult and resource-intensive. However, the US EPA has successfully implemented policies that provide consumers with a broad range of information, from general reporting on quality issues to public involvement in regulatory impact assessments.

Effective communication

Engaging the community requires an investment of resources and expertise in presenting the information to the public. Of the benchmarked countries, the UK Government appears to be the only one that has established a formal risk communication policy (see box 6.4). Under this policy, the UK Government posits two fundamental principles for integrating communication into the regulation making process — 'listen to stakeholders' and 'tailor the message'.

In communicating the risks that are associated with drinking water, the information provided must be readily accessible and understandable. Consumers do not have the resources or the expertise in the field to understand and interpret technical water quality reports. New Zealand's Ministry of Health produces an annual publication called the *Register of Community Drinking-Water Supplies in New Zealand*. The aim of this document is to provide easily accessible information about community water supplies in a format and language that is easy to follow.

Healthy consumers may have been drinking water of a sub-standard quality but have built up a resistance to the contaminants present in their local supply.

However, there is a higher risk of adverse health outcomes for immuno-compromised groups and people visiting towns with sub-standard water quality. These groups need to have their views and preferences incorporated into policy decisions on the regulation of water quality.

Awareness programs should be targeted at effectively informing the public when major guidelines or standards and policy reviews are undertaken. There is also a strong case for providing performance information on an ongoing basis.

Comparisons

There is no evidence to suggest that Australian suppliers, the NHMRC, or State health departments have instituted formal risk communication policies. The information arrangements that Australian suppliers have in place are educational, but do not constitute a risk communication policy. Monitoring and testing results are published (see chapter 5) and most major suppliers have educational programs in schools and informative pieces in the media.

Communications have been improved, at least in Sydney, since the Sydney water crisis. The SWC makes extensive information available to consumers on water quality, both through the mail and over the Internet.

Australia has an established standard on risk communication. In AS/NZS 4360:1999 *Risk Management* it is argued that communication and consultation are an important consideration at each step of the risk management process:

> It is important to develop a communication plan for both internal and external stakeholders at the earliest stage of the process. This plan should address issues relating to both the risk itself and the process to manage it.
>
> Communication and consultation involve a two way dialogue between stakeholders with efforts focused on consultation rather than one way flow of information from the decision maker to other stakeholders. Effective internal and external communication is important to ensure that those responsible for implementing risk management, and those with a vested interest understand the basis on which decisions are made and why particular actions are required (AS/NZS 1999, p. 20).

There is no evidence of a formal risk communication policy in New Zealand. However, unlike Australia, the health-risk status of all community drinking water supplies is reported through the one central register — the *Register of Community Drinking-Water Supplies in New Zealand*. There is a user's guide at the beginning of the *Register* which explains how to use it.

Box 6.4 **Principles developed by the Inter-Departmental Liaison Group on Risk Assessment (UK) in communicating risks**

An Inter-departmental Risk Communication Benchmark Study was completed which developed and tested a set of benchmark principles to improve risk communication, which were then used in the guide, *Risk Communication – A Guide to Regulatory Practice*. This was endorsed by the Inter-Departmental Liaison Group on Risk Assessment (ILGRA) and released in August 1998. These principles provide a framework integrating communication into the regulatory process and ways of developing good practice on the following supporting principles:

Integration of risk communication and risk regulation

Engagement and dialogue with those interested in and affected by risk issues is vital. It should be an integral part of every process for the management and/or regulation of risks. Communication should neither be treated as a 'bolt-on' extra, nor approached solely in the context of one-way provision of public information. The aims of risk communication should be:

- to enable the effective participation or representation of all interested and affected parties in making decisions about how to manage risks; and
- to support the most effective possible implementation of risk management decisions.

Listen to stakeholders

Regulatory bodies should identify and engage with all those interested in and affected by each risk issue. They should seek to understand their attitudes to risks and risk control measures. Their views and preferences should be incorporated into policy and practice. Where practical and appropriate, those affected should be involved in or empowered to take decisions about risks and their control.

Tailor the message

Government messages and communications about risk should be tailored to their audience and purpose. Particular attention should be paid to:

- engaging and demonstrating empathy with the audience;
- displaying openness and responsiveness to audience emotions, fears and concerns;
- demonstrating credibility, competence and commitment; and
- articulating the benefits of proposed or alternative options for the audience.

Manage the process of risk communication

Risk communication is always important for policy success. Thus, clear and well-defined risk communication management processes and procedures are needed. These should cover setting goals, allocating responsibilities, planning, implementing, monitoring and evaluation.

Source: Inter-Departmental Liaison Group on Risk Assessment (1998).

The *Register* is easily accessible, and it contains the following information for each supply system:

- the name of the community;
- the components of the supply system, namely sources, treatment plants and distribution zones;
- who owns and operates the supply; and
- how many people use the supply.

If more than 500 people are served, the *Register* also records:

- the public health grading for the supply; and
- any substances of public health significance requiring monitoring in the supply.

Unique codes are used to distinguish between quality at source and in the distribution system. This is an important distinction and a measure of water quality both before and after treatment, thus identifying which component of the water system is failing in delivering safe drinking water.

In the US, all suppliers are required by the 1996 SDWA amendments to provide their customers with an annual consumer confidence report. These reports provide consumers with information on results of monitoring that the supplier performed during the year and information on health concerns associated with violations that occurred during the year. The Consumer Confidence Report Rule which was promulgated in August 1998, will affect 55 000 water suppliers and the information in the report will be distributed to around 248 million people nationwide.

In the UK, risk communication is being used in reviewing existing regulation. However, it is unclear to what extent this encompasses drinking water standards, as legislation necessary to comply with EU Directives is exempt from these reviews.

In Australia, a more explicit recognition of the need for risk communication may occur if greater use were made of Regulatory Impact Statements in the decision to adopt more stringent drinking water guidelines or standards.

6.4 In summary

Quality management systems embody holistic approaches to managing water systems and incorporate quality assurance principles with an emphasis on prevention rather than reaction. Currently, a number of Australian suppliers are using or are intending to implement quality management systems to manage water quality. This trend should be encouraged by the intention of the NHMRC and

ARMCANZ to incorporate a more comprehensive quality management framework into the Guidelines.

A good quality management system should ensure that operators of water systems are given adequate training. While the provision of adequate training is more likely to be of concern in smaller regional areas, the Commission is not aware that there is any requirement upon water suppliers to provide training to their staff or to have operators formally certified.

This contrasts with the US which has a formal national operator certification scheme. This scheme specifies minimum standards for the certification and re-certification of operators and aims to ensure that consumers are confident that their water is safe to drink.

The capital investment required to bring a water system into compliance with more stringent drinking water standards is a significant cost driver in the water industry. It is important for the continued economic viability of water suppliers that economic regulators allow suppliers to recover these costs. However, economic regulators must also ensure that capital expenditure is undertaken at minimum cost.

To date, the capital expenditure undertaken to meet revised versions of the Guidelines has not been large in comparison to the costs incurred in the benchmarked countries. However, this may not remain the case in future if new treatment technologies, such as micro-filtration, are introduced to meet more stringent standards.

Any increase in standards represents a significant imposition upon smaller regional suppliers and Australian State governments have attempted to relieve these cost pressures through the provision of direct funding contributions.

Risk communication has an important role in the development of guidelines and standards. Communicating the risks involved in the provision of drinking water is essential for ascertaining the preferences of consumers. As such, it improves transparency and accountability for good decision and policy making.

There is no evidence that Australian suppliers have formal risk communication strategies. However, it has been effectively undertaken in the US, where all suppliers are required by the right-to-know provisions of the 1996 SDWA amendments to provide their customers with an annual consumer confidence report.

Informing consumers of the nature of the risks involved in supplying safe drinking water may sometimes negate the need for undertaking large scale capital investment. If consumers do not have an understanding of the risks, they may be

more susceptible to ‘scare campaigns’ which drive governments and suppliers to more costly capital investments without significant public health benefits.

7 Overarching issues

In this chapter, principles of good institutional design are used to describe the features of best practice institutional structures for standard setting and enforcement.[1] Structures with these features could be expected to produce efficient and effective regulation.

The issues that would have to be resolved to arrive at best practice standards, regulatory instruments and enforcement strategies, are also identified and discussed to alert policy developers of what reform might entail. This discussion is based on general principles of good regulatory process established by the Office of Regulation Review and others.

At the workshop held in December 1999 to discuss a draft of this report, a number of participants asked the Commission to establish a best practice model. However, this was not possible. Best practice institutional structures are dependent on the nature of the regulation and the legislative framework in each jurisdiction. The best form of regulation can only be decided on after a thorough assessment of regulatory options.

7.1 Standard setting

Institutional arrangements are the key to effective and efficient regulation making.

Institutional issues

The threshold institutional issue in Australia is the respective roles and responsibilities of the NHMRC and the State and Territory standard setting bodies.

Among other things, the NHMRC recommended maximum safe levels for contaminants in the 1996 Guidelines. These Guidelines are based on scientific assessment, with limited consideration of their economic consequences.

1 These principles, listed in chapter 1, are widely accepted by Australian governments.

Some jurisdictions have promulgated the Guidelines as standards. As far as can be ascertained, this has been done without published assessments of their effectiveness and efficiency and consideration of regulatory alternatives. Rather, State and Territory governments have viewed the Guidelines as goals — to be adopted as standards when this is financially feasible.

Responsibility for drinking water regulation is effectively shared between the NHMRC and the States and Territories, when NHMRC guidelines are adopted as standards without formal regulatory assessment. Shared responsibility makes it difficult to apportion responsibility for poor outcomes.

The NHMRC should continue to play an important role in providing scientific advice. However, the NHMRC recommendations should be just one input into the regulatory assessment process undertaken by State and Territory governments.

The NHMRC's role should complement the State and Territory responsibility for setting water quality standards and administering public health. Specifically, one of the NHMRC's objectives in developing the Australian Guidelines should be to reinforce State and Territory responsibility for the rigorous assessment of standards.

The NHMRC role in providing advice on risk management and quality assurance is less clear. Further, guidelines are not necessarily the appropriate vehicle for promulgating this information. It is also outside the NHMRC's real strength of scientific risk assessment.

Industry representative bodies should be able to furnish guidance to their members based on practical experience of risk management and quality assurance. If this expertise lies outside the industry, there is a systemic problem in the Australian drinking water supply industry. Indeed, it would be evidence of existing water quality regulation providing inappropriate incentives for good risk management and quality assured outcomes. It would also suggest the need for risk management plans to be drawn up and possibly regulation requiring quality assured systems to be in place.

In Australia, most State and Territory governments have made standard setting and promulgation the responsibility of health departments. However, health departments may not be the appropriate body.

The response management and advisory roles of health departments potentially conflict with independent, impartial standard setting. For example, when a body is responsible for setting regulation as well as enforcement, regulations may be

formulated to suit the interests of the enforcement arm rather than the public interest.[2]

Further, health departments may not have the expertise or the resources to undertake, for example, economic assessment of standards. Also, health departments reputedly do not place a high priority on drinking water quality, given the many competing public health issues they face.

Accountability and transparency

The current arrangements are not transparent because of the absence of Regulatory Impact Statements (RISs). Governments do not have to justify to consumers the levels at which standards are set and why standards vary, or sometimes fall below the recommendations contained in the current version of the Australian Guidelines.

This lack of transparency in setting water quality standards is unlikely to be sustainable. The public expects ever higher standards of accountability, for which greater transparency is necessary. Moreover, a lack of transparency provides opportunities for misunderstanding and even scare campaigns about the safety of water supplies.

Australian governments have agreed that their agencies and businesses should have clear non-conflicting objectives so that they can be held accountable for their performance. Yet the objectives of the NHMRC in regard to drinking water are not unambiguously clear. For example, are they to provide input to State regulatory assessment, or is the objective to establish a 'standard' to be adopted by State and Territory governments as a goal to be achieved over time?

Risk bearing

Significant uncertainty exists about the links between standards and health outcomes. There is also variability in the quality of source water, the reliability of testing and effectiveness of treatment processes.

Overall costs are often affected by who bears risk, as well as by how well it is managed. Risk also affects preferences, hence it has a direct influence on economic efficiency.

[2] That said, there should be links between the regulation setting and enforcement agencies to channel feedback on the enforceability of the regulation and the level of compliance.

A core issue for governments when considering regulatory options is who is best able to bear risk — consumers, the public through government ownership, or suppliers.

Under the Australian approach, there is an implicit judgement that the public should bear some non life-threatening risk. Health departments are given the power to intervene after a health problem occurs, rather than ensure that risk is eliminated altogether. Moreover, governments assume some responsibility for scientific risk in setting standards.

The principle that normally guides the approach to regulation of risky activities is that those that are best able to identify and control risk should do so. An associated principle is that risk should be carried by those who are best able to bear the consequences. Further, the incentives for good risk management should be considered when formulating regulation.[3] In this regard, the choice of regulatory instruments is critical. For example, statutory penalties may provide for greater incentive to meet standards than general consumer protection legislation.

Regulatory options

The efficacy of current regulatory arrangements does not appear to have been tested adequately. It is unclear that all the regulatory options have been identified and assessed, which is possibly a significant omission given the range of options used among countries.

One important issue is the appropriate balance between numerical standards and risk management. The desired outcome in the case of setting water quality standards is to improve public health. Numerical standards — a form of output regulation — require judgements about the link between outputs and outcomes. Risk management requires a supplier to identify hazards, assess risks and mitigate those risks in a way that is efficient.

Some industry representatives at the Commission's workshop claimed that, on equity grounds, there should be a set of minimum national standards. Moreover, it was suggested that there should be a simplification of the current requirements, containing fewer standard values and with greater emphasis placed on quality assurance.

National numerical standards are unlikely to be efficient in all circumstances because of disparate treatment costs (see box 2.8). This issue has been addressed

3 Overall, it is important that the regulation encourages efficient management of complex systems under uncertainty.

partially in the US, for example, by subsidising suppliers that are faced with untenable costs of implementing uniform standards.

A minimum set of national standards may be justified on equity grounds. However, the principle should be to aim for equitable outcomes, not uniform standards *per se*. Where local circumstances and preferences vary, uniform standards may not be equitable. That said, minimum standards may be justified when wider public health benefits outweigh local costs. Once again, only a comprehensive RIS would reveal whether this is the case.

The form of regulation should always be considered in regulatory assessments. This requires choosing among outcome, output, input and process regulation, or some combination of these (see box 3.3).

Outcome regulation is usually preferred because it leaves the choice of operating and investment decisions to suppliers, who generally have superior knowledge about the best way of meeting regulatory requirements. However, outcomes cannot always be measured. This is possibly the reason why regulatory requirements mainly take the form of output standards in the countries studied — that is, values for maximum safe levels of contaminants.

Input and process regulation may be appropriate in some cases where outputs cannot be reliably specified or measured and where these regulatory forms do not constrain technical innovation. For example, input and process forms of regulation may be better than output regulation in dealing with a low probability (rare) catastrophic event. If these approaches are to be formalised, they should be subjected to rigorous assessment.

In particular, a greater role for process regulation in the future is envisaged — principally in response to contaminants such as *Cryptosporidium* that cannot be readily detected. The Water Services Association of Australia (WSAA) is emphasising the need for risk management and quality assurance. Others are advocating the Hazard Analysis and Critical Control Point (HACCP) approach (see box 6.2).

Compliance is another important regulatory design issue. In Australia a cooperative approach — based on self-reporting — is used to achieve compliance. Enforcement by the use of sanctions is seen as a last resort. Although this approach appears to have served the community well, there are other options, and these should be explicitly considered. For example, greater emphasis is placed on independent monitoring and testing in the US.

Aesthetics are important to the community and consumer confidence. Consequently, standards must address not only pathogens that are a threat to public health, but aesthetic quality. However, if aesthetic quality standards are set, they should stand up to rigorous assessment like all standards.

Regulatory assessment

There is no evidence of rigorous regulatory assessment of current standards, which is contrary to best practice. With all regulation, best practice processes are based around a requirement to prepare and publish a RIS. This involves consultation with all stakeholders and the publication of a draft statement for public consultation.

Without such rigour, standard setting bodies will not be accountable for their performance. This may in turn lead to inefficient standards and unwarranted investment in treatment and reticulation works.

The absence of rigorous regulatory assessment may prevent consumers' economic preferences from being given adequate weight in the development of drinking water standards. Instead, technological considerations may dominate. For example, as the technology develops to detect and treat waterborne pathogens, there may be pressures to introduce new monitoring requirements or treatment technologies.

A related advantage of rigorous regulatory assessment is that the process prevents reactive policy making. This safeguards against pressures to respond hastily to new perceived threats or to respond publicly to reduce concerns when unusual events occur such as the Sydney water scare in 1998.

In undertaking a RIS, the benefits and costs should be quantified (to the extent that this is possible) and made available at an early stage of the standards development process to facilitate consultation and informed comment. This requires adequate consultation with suppliers to obtain realistic estimates of the capital and operating costs associated with any proposed change to standards.

One challenge will be to identify and quantify the public health and consumer satisfaction benefits of changes to drinking water standards (see chapter 4). Another is dealing with uncertain hazards and public health benefits. Failure to address uncertainty appropriately will compromise the usefulness and acceptance of any regulatory assessment.

In order to gain some indication of consumer satisfaction, current and future risks must be adequately communicated. This requires mechanisms by which the public can provide feedback on their preferences and willingness to pay for better quality water.

Only after risk communication can public preferences be gauged to assess the efficiency of regulatory options. Preferences are important as they can vary markedly. For example, residents of the Tasmanian township of Lilydale decided not to disinfect their water supply and instead to issue permanent boil water alerts. On the other hand, risk communication is also required to ensure that those in the community who resist improvements to the quality of water supplied, because of their cost, are aware of the risks that they currently face.

The evidence produced in this study suggests that the level of risk communication is poor in all countries. Only the UK has a published risk communication strategy (see box 6.4).

7.2 Standards promulgation

In a number of Australian jurisdictions, the Guidelines are promulgated as standards by means of quasi-regulatory instruments such as operating licences and memoranda of understanding (see chapter 3). These instruments do not always establish clear legal responsibilities.

Generally, regulation within Australia is predicated on cooperation between health departments and government-owned water suppliers. There are few effective legal sanctions for non-compliance and considerable flexibility in implementation to accommodate local circumstances. Overseas, there is a greater reliance on statutory requirements backed by the force of law, with stronger enforcement measures (see chapter 5).

Regulatory arrangements backed by the force of law and strong enforcement are intended to ensure compliance leads to better health outcomes. This law must coexist with, and ideally complement, general consumer protection law (see chapter 3).

An important issue is the 'right' balance between specific regulation and general consumer protection law. This issue is best resolved by assessing regulatory options to determine which arrangements provide the greatest incentive for the achievement of effective and efficient public health outcomes.

The incentives for protecting public health by means of general consumer protection law may be weak, because of the difficulty and high cost of pursuing a compensation claim (in other than a class action). For example, consumers must establish that negligence has occurred and that there is a case for compensation.

With standards promulgated under legislation, the process is likely to be more transparent because the responsible Minister and the government are accountable to Parliament. Public consultation would assist in determining the level of transparency expected by the community. Where standards are promulgated as quasi-regulation, such as memoranda of understanding, the process may be less transparent. However, the promulgation and amendment costs are likely to be lower.

Decisions about which instruments to use should be resolved as part of the regulatory assessment process. If best practice is followed, the choice and design of instruments should be examined when considering regulatory options.

7.3 Enforcement

Governments have a supervisory role to play in enforcing compliance with health-related standards, ensuring customer satisfaction with aesthetic water quality and supply integrity. Institutional arrangements are critical to effective supervision.

Institutional arrangements

It is widely accepted that standard setting and enforcement should be undertaken by separate agencies. This is generally the case overseas, but not always so in Australia.

Best practice in other industries suggests that a body responsible for enforcement should remain at arm's length from the industry. If the enforcement agency works closely with the industry — for example, by providing advice — it will inevitably accept some responsibility for outcomes. This is particularly so in water supply because uncertainty and incomplete information or informational asymmetries exist, and the nature of risks changes over time.[4]

Some countries, for example the UK, have industry-specific regulators that undertake supervision. Others rely on general regulators, or invest this function with health departments. However, the arrangements in each country are similar in that the regulator relies on industry self-reporting and the supervisory agency monitors or audits the information reported.

4 Informational asymmetries exist when one agent in a market has information not held by other market participants or a regulator.

Enforcement approach

The general approach to enforcement is a key issue in any review of regulatory arrangements. To some extent, the approach to enforcement defines the effectiveness of the regulation because of its role in influencing health outcomes through compliance.

Compliance in Australia is achieved largely through cooperative agreements between regulatory authorities and water suppliers. This approach assumes that supplier incentives for achieving the best possible outcomes are generally compatible with those of the regulator and, hence, the public interest. However, this may not always be the case because of the risk attached to hazards and uncertainty about health outcomes.

An advantage of a cooperative approach is that it provides for greater flexibility than the alternative — stringent regulatory enforcement. The approach also recognises that some contaminants are difficult to monitor and the effectiveness of treatment can be variable. A disadvantage is that enforcement is less transparent than in other countries.

Coercive enforcement measures are typically embodied in legislation or in regulations. Consequently, there is greater transparency and reduced opportunity for administrative discretion, than is the case with cooperative arrangements. Greater transparency can strengthen accountability for enforcement as well as standard setting.

In Australia, a 'light handed' self-reporting approach has been adopted. Authorities tend to assess compliance against guidelines or standards over a period of time (usually 12 months) whereas in the UK and US, compliance is assessed on an ongoing basis. While all countries rely on self-reporting, monitoring results are more rigorously checked overseas than they are in Australia. Moreover, UK, EU and US regulatory bodies also have the power to impose substantial penalties for non-compliance.

It is unclear why there are large differences in enforcement approaches. However, the greater risk posed by inferior quality source water in other countries may be one explanation. Another factor may be the greater level of private participation in the industry overseas and the shift in incentives this is perceived to introduce.

A prime consideration in the development of the general approach to enforcement should be whether compliance is measurable. Effective enforcement and sanctions are compromised by regulatory requirements that cannot be reliably measured and monitored.

Enforcement agencies should be accountable to the community and the industry by making their enforcement policies and strategies open to scrutiny. This is particularly necessary if cooperative arrangements are in place and where graduated response strategies are used.[5] If self-reporting is to continue, an issue to be addressed is whether existing levels of scrutiny and independent third party testing are appropriate.

Feedback on the level of compliance is a necessary input into regulatory design and assessment. If standard setting and enforcement are undertaken by independent agencies, it is necessary to set objectives that require these agencies to provide and receive feedback.

The same level of compliance should be demanded from both public and private suppliers or operators to ensure competitive neutrality. However, this may not mean equal enforcement effort when the incentives for compliance are not the same.

7.4 Coordination with economic and other regulation

A necessary role of government is to ensure that regulation is consistent with broader objectives. Primarily, this requires all regulation to complement economic efficiency and other social goals.

Resources should be used efficiently overall when addressing threats to public health. The benefits and costs of increasing water quality standards should be assessed against alternative health measures to ensure that resources are being used efficiently to address the problem. As argued by the WSAA (pers. comm., 24 February 2000) an economywide approach is required, with governments considering the most efficient way of improving public health.

Water quality regulation must coexist with other regulation without unnecessarily creating conflicting incentives or unnecessary compliance costs. In setting water quality standards, governments should therefore ensure that the objectives are consistent with related general public health, environmental and economic objectives.

A rigorous RIS would have regard for these wider objectives. A necessary step in the process is to identify clearly the objectives of the regulation. One way of achieving this would be to require that these other broader objectives are taken into account when assessing the benefits and costs of proposed regulation.

5 An enforcement strategy which in the first instance may be advice, then graduating up through improvement notices and fines to revocation of licences to conduct business.

In conducting a regulatory assessment, all options must be considered, including the regulation of other possible sources of contamination that may offer more effective and efficient outcomes. Threats to public health should be addressed in the most cost effective way. Often this will require considering the regulation of other sources of risk, for example the use of pesticides, as well as setting water quality standards.

Economic regulation

In most Australian and overseas jurisdictions, enforcement of water quality standards and the economic regulation of suppliers are separated. This is generally regarded to be appropriate in other industries because a dual role can lead to incompatible incentives. The objective of an economic regulator is to ensure that prices are as low as possible, consistent with a fair return on investment and given standards which suppliers have to achieve. The objective of an enforcement agency is to ensure compliance, irrespective of the consequences for prices and profitability.

An institutional issue that would have to be addressed is whether a single agency should be involved in the enforcement of customer service standards as well as health-related standards. Enforcement of health-related standards and customer service standards are combined in some models and separated in others. The choice boils down to administrative efficiency and compatibility with the legislative framework within the jurisdiction.

Another issue is whether an industry-specific regulator, such as OFWAT in the UK, is required. The main justification for this appears to be the specialised expertise required to assess performance, capital expenditure plans and costs generally. However, even industry-specific regulators are not always well placed to determine whether claims made by suppliers in pricing reviews are reasonable.

Drinking water quality standards should be compatible with effective and efficient economic regulation (when this is considered appropriate). The economic regulator's role is to ensure that compliance is achieved efficiently, and that costs are passed on equitably (as defined by government) and efficiently to consumers. This requires that the objectives of standards are clear and the linkages between standards and health outcomes are adequately understood.

The process of coordinating regulation should ideally be the responsibility of a single agency. This does not necessarily imply that the same agency has to be responsible for both regulatory assessment and coordination.

The coordination process should include consultation with industry, in order to avoid unnecessary compliance costs. Consultation is central to considering regulatory options and assessing their costs in a regulatory assessment. Consequently, mechanisms have to be established to ensure that it takes place and that it is effective.

7.5 Implementing reform

An overhaul of regulatory structures would be required to produce best practice regulation in Australia, such as preparing a RIS.

The NHMRC's role should be compatible with and complement the State and Territory responsibility for setting water quality standards and administering public health. Specifically, the NHMRC's objectives should reinforce State responsibility to rigorously assess standards.

The NHMRC could only identify regulatory options in a general sense. The legal and institutional frameworks vary among jurisdictions and are likely to affect the choice of the most efficient and effective instrument. Moreover, it would be difficult to assess regulatory options because of the broad range of consumer preferences and local circumstances affecting treatment costs. Indeed, these considerations, could even preclude regulatory assessment at a national level.

At the State and Territory level, the key requirement of any reform is to establish effective institutional structures and appropriate institutional objectives. This would involve ensuring a clear delineation of responsibilities and setting unambiguous objectives that are measurable.

Regulatory authorities should be adequately resourced to maintain their independence and be given powers to obtain information. The disparity between the resources directed at the development of drinking water standards in Australia and other countries suggests that there may be insufficient resources devoted to the activity in Australia.

The resourcing required for enforcement is appropriately a matter for consideration in any regulatory assessment. If stronger enforcement is deemed necessary, additional resources will be required.

Industry representatives at the Commission's workshop indicated that there is a significant gap between the technical competence required to meet standards and the competence of operators, especially in non-metropolitan areas. Yet operator

competency is an important implementation issue that has the potential to affect the extent of compliance and public health outcomes.

If there are operator deficiencies, the situation suggests that current regulatory arrangements may have provided insufficient incentives for training to manage treatment works and catchments appropriately. Alternatively, current standards may be considered to be unnecessarily high by management and staff — a possible manifestation of inadequate consultation and regulatory assessment.

In implementing any new regulatory arrangements, ongoing review of regulation should be considered because there are always emerging issues that challenge the appropriateness of existing regulation.

A policy issue for government is the scope of monitoring and public access to monitoring test results. Monitoring has an important role to play in increasing public awareness and risk communication that is essential to determining community preferences.

Once the appropriate level of monitoring and reporting is decided, there are institutional issues to be resolved concerning responsibility for oversighting accountability mechanisms and risk communication. However, if governments decide to give regulatory force to monitoring and publication of test results for public awareness purposes, the underpinning regulation should also be subjected to rigorous assessment.

7.6 In summary

The Commission examined the efficacy of Australian and overseas institutional structures and regulatory processes for the setting, promulgation and enforcement of drinking water standards. The aim was to compare these arrangements against principles of best practice in order to identify areas that might be improved.

The overall findings from these comparisons suggest that changes to institutional structures and regulatory processes are possible and necessary as Australia pursues the goal of international best regulatory practice.

The Commission, however, neither sought, nor was in a position, to undertake the work needed to develop a particular Australian model that would suit all jurisdictions and circumstances within each jurisdiction. In the absence of rigorous regulatory assessment, it is not possible to judge whether the general approach to regulation in Australian is better than those adopted overseas. For example, it could

not be determined whether the cooperative approach followed in Australia, is superior to the more compliance based approaches used overseas.

That said, it is clear that one model is unlikely to fit all circumstances. Consequently, it would be inappropriate to import and replicate an overseas model — no matter how well it seems to work in the context in which it was developed.

The Commission has set out the attributes of best practice institutional structures and regulatory assessment. A number of structures could be developed, each meeting these attributes, but designed to fit the circumstances of each jurisdiction. All would be expected to lead to good standard setting, and better regulatory outcomes could be expected to emerge.

The *status quo* may be untenable. Pressures for reform are likely to arise from public demands for greater government accountability, participation in decision making, and other changes brought about by increasing private sector involvement in the industry. For example, consumers are bearing an increasing proportion of the cost of more stringent standards under recent reforms that require full cost recovery.

This report provides information that should promote and facilitate the necessary public debate required before reform can take place. However, governments will have to act to bring about reform.

A sharper distinction of responsibilities between the NHMRC and the States and Territories, which have prime responsibility for safe drinking water, could be achieved through inter-governmental cooperation. Further, cooperation is required to ensure that health risks from contaminants are addressed in the most effective and efficient way — across all possible sources, including water. This would require assessing the public health concerns in relation to drinking water quality standards relative to other health priorities at a national level.

Ultimately, responsibility for water quality rests with the States and Territories. Governments would have to bring together a number of portfolios to progress reform.

In undertaking reform, it should be recognised that a greater commitment of expertise and resources is likely to be required. Overseas agencies appear to allocate significantly more resources than currently devoted to the activity in Australia (see chapter 5).

As this study has clearly shown, the key requirement of any reform undertaken at the State and Territory level, is to establish effective institutional structures and appropriate institutional objectives.

A Participants

Organisations and individuals contacted by the Commission in the course of the study are listed below.

Agriculture, Fisheries and Forestry - Australia

Australian Council for Infrastructure Development Ltd

Australian Water & Wastewater Association

Department of Health Services, California

CSIRO Land and Water

Cooperative Research Centre for Water Quality and Treatment

Department of Health & Community Care, Australian Capital Territory

Department of Health & Human Services, Tasmania

Department of Human Services, South Australia

Department of Human Services, Victoria

Department of Natural Resources and Environment, Victoria

Department of Natural Resources, Queensland

Department of Treasury & Finance, Victoria

Drinking Water Inspectorate, United Kingdom

European Commission

Gosford City Council, New South Wales

Health Canada

Health Department of Western Australia

Hunter Water Corporation, New South Wales

Independent Pricing and Regulatory Tribunal, New South Wales

Institute of Environment Science and Research, New Zealand

Melbourne Water Corporation, Victoria

Ministry of Health, New Zealand

NSW Department of Land and Water Conservation

NSW Health

NSW Licence Regulator

NT Department of Natural Resources, Land Planning and Environment

National Health and Medical Research Council and Agricultural and Resource Management Council of Australia and New Zealand

Office of the Regulator-General, Victoria

Office of Water Regulation, Western Australia

Queensland Health

South East Water, Victoria

Sydney Water Corporation, New South Wales

Territory Health Services, Northern Territory

United States Environmental Protection Agency

Victorian Water Industry Association Inc.

Water Services Association of Australia

Wyong Shire Council, New South Wales

Yarra Valley Water, Victoria

A workshop was held on 14 December 1999 to provide a forum for the discussion of the study methodology, the presentation of results and their interpretations. Drafts of report chapters were circulated prior to the workshop on a 'confidential work in progress' basis.

The organisations who were represented are listed below.

Agriculture, Fisheries and Forestry - Australia

Australian Council for Infrastructure Development Ltd

Australian Water & Wastewater Association

City West Water

Cooperative Research Centre for Water Quality and Treatment

Department of Health & Community Care, Australian Capital Territory

Department of Health & Human Services, Tasmania

Department of Human Services, South Australia

Department of Human Services, Victoria

Department of Natural Resources & Environment, Victoria

Department of Natural Resources, Queensland

Environment Management Industry Association of Australia

Hunter Water Corporation. New South Wales

Melbourne Water Corporation, Victoria

National Health and Medical Research Council

NSW Health

Office of the Regulator-General, Victoria

Queensland Health

Sydney Water Corporation, New South Wales

Victorian Water Industry Association Inc.

Water Services Association of Australia

B Australian Drinking Water Guidelines

There have been three versions of the *Australian Drinking Water Guidelines* — 1980, 1987 and 1996.[1] The 1996 Guidelines were a significant expansion on the 1987 and the 1980 Guidelines.

In this appendix, the current guidelines are described and the changes to the scope and stringency of their recommendations are compared.

B.1 Australian Drinking Water Guidelines 1996

The Commonwealth Government coordinates the development of drinking water guidelines through a joint committee of the National Health and Medical Research Council (NHMRC) and the Agricultural and Resource Management Council of Australia and New Zealand (ARMCANZ). The *Australian Drinking Water Guidelines* are published jointly by both organisations, but for ease of exposition, they are hereafter referred to as either the NHMRC Guidelines, the Australian Guidelines or just the Guidelines.

The 1996 Guidelines were prepared by a joint NHMRC–ARMCANZ Coordinating Committee that oversaw several specialist panels. The specialist panels produced reports on micro-organisms, physical quality, inorganic chemicals, organic chemicals (including pesticides) and radiological contaminants. These panels and the joint committee included representatives from the NHMRC, water authorities, private industry, universities and departments of health.

The 1996 Guidelines are based on the 1993 World Health Organisation (WHO) *Guidelines for Drinking Water Quality* but are adapted to the Australian context. Differences between the Australian guidelines and the WHO guidelines are identified.

1 In 1972, a set of guidelines which focussed on drinking water quality issues in Australian capital cities was issued. These closely followed the WHO's 1963 Guidelines on drinking water quality.

Unlike the US and UK, where drinking water standards are mandatory, the 1996 Guidelines are not legally binding. Rather, they provide a framework for identifying acceptable drinking water quality, emphasising flexibility and community consultation. It is envisaged that the Guidelines will be subject to ongoing review and updating.

The primary aim in developing the Guidelines was to ensure that drinking water should provide no risk to public health, including the transfer of disease through micro-organisms. A secondary aim was to ensure the aesthetic quality of water, by addressing factors such as colour, odour and taste.

The Guidelines contain quantitative measures, referred to as guideline values, for compounds and characteristics that determine water quality. These characteristics include:

- physical;
- microbiological;
- chemical, including inorganic and organic chemicals; and
- radiological.

The Guideline values are meant to apply to any water at the point of use that is intended primarily for human consumption, including that used in food processing. The Guidelines do not cover bottled water and packaged water.

The health-related guideline values are the maximum recommended concentration of a contaminant parameter that, based on present knowledge, does not present any significant health risk over a lifetime of consumption. Aesthetic guideline values are the concentration of parameters associated with physical characteristics, but take a lower priority than health-related parameters.

For most water quality parameters there is a grey area between what is clearly safe and clearly unsafe. Often the latter can not be clearly demonstrated. Health-related values are very conservative and always err on the side of safety, particularly where scientific data is inconclusive or where data is only available from animal studies. Therefore, it follows that, for most health-related parameters, occasional excursions above the guideline values do not necessarily present a threat to public health.

NHMRC recommend that suppliers employ an integrated management systems approach to ensure safe water supplies and use the guideline values as a check that systems are operating correctly.

Integrated management systems should include:

- the use of effective barriers to prevent contamination of the water supply system; and
- regular inspections of catchment areas to identify the chemicals being used and methods for protecting source water.

NHMRC stress the importance of community consultation in water suppliers' decision making processes. Under the Guideline framework for community consultation, the possibility of tradeoffs between improvements in water quality and other priorities in the supply of drinking water are recognised. For example, expenditure to marginally improve the quality of water supplies may not be financially viable.

Microbiological guideline values

Pathogenic (disease causing) organisms that are of public health concern include bacteria, viruses and protozoa. Generally, waterborne pathogens originate from the gut of humans or other animals.

Bacteria and algae that produce toxins that affect humans are also addressed in the Guidelines. These toxins can remain in the water supply long after the organisms that produce them are removed. Also, 'nuisance organisms' that affect taste, odour or colour and may promote deposition and corrosion problems in the distribution network are included in the Guidelines.

The major waterborne pathogens are:

- bacterial pathogens;
- protozoa;
- enteric protozoa;
- free living protozoa;
- viruses;
- helminths; and
- cyanobacteria (also known as blue–green algae).

Water is only one of several means by which many infectious agents can be transmitted. However, contaminated water represents a significant source for the transmission of infectious diseases through a community. The incidence of waterborne infections occurring in a community will depend on factors such as:

- the concentration of pathogens in the water;
- virulence of the strain;
- *per capita* intake of contaminated water;
- infectious dose of a particular pathogen;
- susceptibility of individuals; and
- the level of acquired immunity (a tolerance to particular pathogens can be built up over time).

NHMRC recommend that when infection occurs within a community, the source of the infection should be confirmed by epidemiological investigation.

Protective barriers

Emphasis is given to preventing disease-carrying organisms from entering or being transmitted in the water system. NHMRC recommend that barriers should be in place at every stage of the collection and distribution system. This ensures that pathogens are dealt with early in the water cycle and do not re-enter the distribution system.

Under the Guidelines, barriers must be part of a comprehensive management system. A wide ranging program of catchment protection, treatment and monitoring, with barriers to the entry and transmission of pathogens throughout the system is advocated.

The Guidelines include a number of measures that could be used as barriers in the water system, and recommend that suppliers include most of the following:

- water sources should be protected from contamination by human or animal faeces and an active catchment protection program maintained;
- water should be pre-treated;
- water storage should be protected;
- coagulation, settling and filtration should be carried out;
- the water should be disinfected before it enters the distribution system (the Guidelines highlight this measure as a priority);
- an adequate disinfectant residual should be carried through the distribution system (this is to minimise risks of re-contamination); and
- the distribution system, including pipes and tanks, should be secured against re-contamination.

According to the Guidelines, protecting the catchment area requires the development of a catchment management plan to minimise the potential risk from human and animal activity contaminating the water supply. It is recommended that this be achieved through community consultation in concert with the use of modern water treatment technology.

Pre-treatment involves storing water for three to four weeks, which brings about significant die-off of pathogens in the water supply. Protecting water storage, after pre-treatment or after treatment, reduces the risk that the supply may become re-contaminated.

Treatments such as coagulation, settling and filtration can significantly reduce the number of waterborne micro-organisms present and provides an additional barrier to pathogens entering the distribution system. Treatment processes can be expected to reduce coliform counts by a further 99 per cent, and produce water of high microbiological quality.

Disinfection usually involves treating water with chlorine or hypochlorite, although chloramines, chlorine dioxide, ozone and ultraviolet radiation may also be used.[2]

NHMRC recommend that a disinfection residue should exist to minimise the effects of accidental contamination or re-contamination in the distribution system. However, it is noted in the Guidelines that it is extremely difficult in practice to achieve a residual at all points in a complex water system. Therefore, it is recommended that suppliers ensure that the delivery of water is as free as possible of infectious micro-organisms.

The Guidelines recommend that water distribution systems should be fully enclosed to prevent re-contamination. An enclosed distribution system will also assist in maintaining a disinfection residual. Small storages of water or tanks should be enclosed and there should be effective procedures for repair and local disinfection of water mains following main bursts.

Under the Guidelines, the focus of monitoring for biological quality is on testing for the effectiveness of the barriers. Monitoring is not a substitute for any of the barriers.

Indicator organisms

Human pathogens are known to be present in human and animal faeces. Faecal contamination therefore represents *prima facie* evidence of a health hazard.

2 It is noted in the Guidelines that cyanobacterial toxins and harmful protozoa such as *Cryptosporidium*, are immune to chlorine disinfection.

Consequently, NHMRC advocate the use of microbial *indicator organisms* as a test for faecal contamination, and to infer the presence of pathogenic organisms in drinking water.

Two indicator organisms are used — the coliform group of bacteria as a whole and the sub-group of coliforms known as *thermotolerant coliforms*. The most common *thermotolerant coliform* is *E.coli*.

The coliform group of organisms is widely accepted as an indicator of faecal contamination. Although as a group they may not be exclusively of faecal origin, they are present in very high numbers in the faeces of warm-blooded animals. According to the Guidelines, water recently contaminated with faeces will always contain coliforms. However, some coliforms also occur naturally in soil and vegetation, so that coliforms may be present in water in the absence of faecal contamination. Therefore, the presence of coliforms is suggestive, but not conclusive evidence of faecal contamination.

Non-thermotolerant coliforms are usually easier to detect because they outnumber *thermotolerant coliforms*. However, *thermotolerant coliforms* are the more specific indicator as their detection unambiguously confirms that faecal contamination has occurred.

The presence of *thermotolerant coliforms* also indicates that faecal contamination has been recent because *thermotolerant coliforms* are less robust than *non-thermotolerant coliforms*. *Non-thermotolerant coliforms* can survive longer in natural water than *thermotolerant coliforms*, so that they may indicate less recent or more remote incidents of faecal contamination.

According to the Guidelines, the lower specificity of *non-thermotolerant coliforms* as a test organism dictate that some allowance is made for their occasional presence in drinking water. Hence, it is recommended that 95 per cent of samples be free of coliforms (compared with 98 per cent for *thermotolerant coliforms*).

Notwithstanding the less stringent system performance level for *non-thermotolerant coliforms*, regular occurrence of coliforms of any kind is a matter for concern according to the Guidelines. Any persistence of coliforms, even at low numbers, after appropriate investigation and follow-up action has been carried out, requires consultation with the relevant health authority. NHMRC recommend that such an investigation should focus on ascertaining the origin of the coliforms and their identification to species level. For example, the identification of *E.Coli* would confirm the presence of faecal contamination.

Under the Guidelines, if a health authority is satisfied that coliforms are not faecally derived, their persistence may be tolerated. However, the level of microbiological monitoring should be sufficient to detect any change in the pattern of coliform occurrence.

NHMRC note that coliforms other than those of faecal origin can be present in drinking water as a result of:

- the presence of biofilms on pipes and fixtures; or
- contact with soil as a result of leaks, fractures or repair works.

However, coliforms are most likely to be present in reticulated supplies when the water is not treated or disinfected, or when treatment has been inadequate.

Disinfection is regarded as the paramount barrier, and if initiated for the correct amount of time, will eliminate up to 100 per cent of indicator organisms.

Tests for specific pathogens

It is known that, occasionally, disease can occur in the absence of the two indicator organisms. This is because some enteric pathogens can occur in the presence of few, if any, indicator organisms. For example, *Giardia* and *Cryptosporidium* are resistant to chlorine disinfection, and may survive, even though the indicator organisms are killed.[3] This underlines the importance of maintaining effective barriers to prevent faecal material from entering the water supply.

Although under the Guidelines the two indicator tests are viewed as valuable for assessing source water protection, treatment and the effectiveness of the barriers, tests for specific pathogens may sometimes also be necessary. Tests for specific pathogens including viruses, *Giardia* and *Cryptosporidium* are appropriate for special investigations — following waterborne disease outbreaks for example. However, compared with the indicator organisms, testing for specific bacterial, viral and protozoan pathogens is complex, expensive and time consuming. More significantly, the tests available are unreliable, often failing to detect the presence of these organisms. Therefore, NHMRC do not recommend these tests for routine monitoring of water supplies for these specific pathogenic organisms.

NHMRC recommend testing for the existence of nuisance organisms. Nuisance organisms comprise a diverse range of microbes that mainly affect the aesthetics of drinking water, in particular taste, turbidity, colour and odour. Nuisance organisms are usually dependent on certain conditions in the water systems. Raw water does

3 *Giardia* is less resistant to chlorine disinfection than *Cryptosporidium*.

not usually contain sufficient numbers of nuisance organisms to create problems. However, water treatment processes may increase their growth.

Systems performance and monitoring philosophy

Monitoring is recommended to examine the effectiveness of barriers in preventing the transmission of disease through the water supply. Monitoring the integrity of these barriers entails:

- analysing an adequate number of samples for bacteriological quality, based on the population served;
- using a minimum of two indicator organisms to indicate the possible presence of pathogens;
- ensuring that immediate action is taken to rectify the situation and advise the relevant health authority if faecal contamination is detected or suspected — this action should not be delayed while laboratory tests are being carried out;
- inspecting the water supply regularly to reduce the risk of barriers failing without warning; and
- evaluating the performance of a system over time, to determine the need for further improvements in the barriers.

The performance of the system is assessed by the number of times over a 12 month period, that *total coliforms* and *thermotolerant coliforms* are detected in routine samples that are representative of the water supplied to consumers.

Satisfactory performance under the Guidelines requires ensuring that over a 12 month period:

- at least the set minimum number of routine samples have been tested for indicator organisms;
- at least 95 per cent of scheduled samples return a zero value for *total coliforms*; and
- at least 98 per cent of scheduled samples contain no *thermotolerant coliforms* or *E.coli*.

Physical guideline values

Measures of physical water quality are largely subjective because they concern appearance, taste and odour. Nevertheless, the Guidelines contain a number of measurable parameters of physical water quality, including:

- true colour;
- turbidity (the cloudiness caused by suspended matter in the water);
- hardness;
- total dissolved solids;
- pH;
- temperature;
- taste and odour; and
- dissolved oxygen.

It is acknowledged in the Guidelines that the physical characteristics of water are not directly related to public health concerns. Rather, physical characteristics affect the aesthetic quality of water, which often determines the willingness of consumers to drink it.

The physical quality guideline values are intended to ensure that drinking water is aesthetically pleasing, safe and can be used without detriment to fixtures and fittings. In determining these values the following criteria were considered:

- taste and odour thresholds, that is, the smallest concentration or amount that would be detected by a group of experts;
- the concentration or amount that would produce noticeable stains on laundry or corrosion and encrustation on pipes and fittings; and
- the concentration or amount that would be just noticeable in a glass of water, and lead to a perception that the water is not of good quality.

NHMRC emphasise in the Guidelines that the physical measures of water are generally not absolute and depend on value judgements. Therefore, the values should be set through a process of community consultation for which the guideline values provide a starting point.

Chemical guideline values

In the Guidelines, the chemical quality of water is addressed in terms of the public health and aesthetic effects of organic and inorganic chemicals, such as pesticides.

The presence of inorganic chemicals in the drinking water supply may occur because of a range of factors, including:

- natural leaching into source waters from mineral deposits;
- catchment land use activities, leading to the exacerbation of natural processes;
- addition of chemicals such as fluoride and chlorine;
- carry over of small amounts of treatment chemicals; and
- from corrosion and leaching of pipes and fittings.

Guideline values are set at the total amount of substance present, regardless of its form — whether in solution or attached to suspended matter. Chemical parameters are divided into two groups — disinfection by-products and other organic compounds

By-products of disinfection are the most commonly found organic contaminants in Australian drinking water supplies. Chlorine is the most widely used disinfectant. However, most disinfectants will produce by-products. In the chlorination process, chlorine reacts with naturally occurring organic matter to produce a complex mixture of by-products.

Epidemiological studies suggest an association between water chlorination by-products and various cancers. However, there has been insufficient data to determine the concentrations at which chlorination by-products might cause an increased risk to human health. Indeed, the International Agency for Research on Cancer has reviewed the available data and concluded that there is inadequate evidence to determine the carcinogenicity of chlorinated drinking water.

NHMRC recommend that action to reduce the concentration of disinfection by-products is important but should not be taken at the expense of the effectiveness of disinfection.[4] This is because the risk posed by disinfection by-products is significantly smaller than the risk posed by the presence of pathogenic organisms in water that has not been properly disinfected.

NHMRC has found that naturally occurring organic compounds are not generally a concern for human health, except for certain specific toxins.

4 The lower the concentration of chlorine used in disinfection, the lower the production of disinfection by-product. However, the effectiveness of disinfection in killing waterborne disease can be jeopardised if chlorine concentration is reduced too much.

Pesticides

The National Registration Authority for Agricultural and Veterinary Chemicals is responsible for assessing insecticides, herbicides, nematicides, rodenticides and miticides, prior to registration for sale and use in Australia. When a pesticide is registered, a safe level of exposure, conditions for use, and maximum levels of residues for water are determined. These are recommended in the Guidelines to ensure that the levels of pesticides in drinking water are safe.

NHMRC emphasise that pesticides should only be authorised for use in water catchment areas where necessary. It is recommended that unauthorised pesticides should not be present in drinking water.

Health-related values for pesticides are presented in the Guidelines. They are intended for use by regulatory authorities for surveillance and enforcement purposes, and to provide a mechanism to measure compliance with approved label directions. In cases under which aesthetic considerations require a more stringent guideline than is required for health-related reasons, both values are presented in the Guidelines.

For pesticides not approved for use in water catchment areas, the guideline value is set at a level as low as can be detected, and this applies regardless of any demonstrated health effects. For pesticides approved for use in water catchment areas, the guideline values are set at a level which is consistent with good water management practice.

It is intended that health authorities use the health-related values in the Guidelines to manage the health risks associated with inadvertent exposure, resulting from a spill or misuse of a pesticide.

Chemicals

Under the Guidelines, two categories of chemicals are considered:

- those where the effects are observed only above a certain threshold dose, with no effects observed at doses below this threshold; and
- those that do not appear to have a threshold and are assumed to have an effect at any dose, however small.

Chemicals with a threshold dose

Epidemiological data are used, where available, as the primary means of determining guideline values for chemicals. In the absence of human epidemiological data, data from experiments on laboratory animals are used to infer the effects of exposure to chemical agents. NHMRC recognise the problems of this approach.

The guideline value, in the absence of human epidemiological data, must be based on toxicological data on the highest dose that causes no adverse effects in long term experiments on laboratory animals. The formula used to derive this value is:

$$\text{Guideline value} = \frac{\text{animal dose x human weight x proportion of intake from water}}{\text{volume of water consumed x safety factor}}$$

The use of this formula requires assumptions about the amount of water consumed per day, average body weight, and the proportion of total intake of a particular substance that can be attributed to water. A safety factor is also attached to the equation. The safety factor is applied because of the uncertainty inherent in extrapolating data from animal studies to human populations.

The guideline values are dependent on the assumptions made in using the formula. The assumptions made in calculating guideline values are very conservative. For example, the animal dose is usually the *no effect level* — the highest amount of compound that does not cause observable adverse effects in repeat dose studies on experimental animals. If this information is unavailable, the dose often used is the *lowest effect level* — the lowest amount of the compound that does not have any observable effects on experimental animals.

Chemicals with no threshold dose

The derivation of guideline values for substances where no threshold dose has been demonstrated, and any dose, however small, is assumed to have an effect, assumes that as the level of exposure increases the resultant hazard increases. According to the Guidelines, a number of uncertainties are involved. However, the calculations used tend to over- rather than under-estimate the risk, therefore providing a greater margin for safety. The WHO also adopts this approach.

The Australian Guidelines take the WHO Guidelines as a reference point. Where the Australian Guideline values for chemicals differ from the WHO values, it is usually because of differences in the assumption about average adult weight — Australia uses 70 kilograms consistent with most developed countries, whereas the WHO uses 60 kilograms to cater for lower body weights.

For genotoxic carcinogenic compounds (those disrupting cell structure), the WHO uses a risk assessment approach, with the guideline value set at the concentration that would give rise to one additional cancer per hundred thousand people. The Guidelines for these types of compounds are based on considerations of:

- the limit of determination (the point at which measurements become quantitatively meaningful) based on the most common analytical method;
- the concentration calculated by the WHO using a risk assessment model, that would give rise to one additional cancer per million people, if water containing the compound at the concentration is consumed over a lifetime; and
- a value based on a threshold effect calculation, with an additional safety factor for potential carcinogenicity.

The Australian approach is generally in line with most developed countries. The guideline values for some chemicals are set at the limit of determination.

Systems management

The Guidelines contain a chapter on systems management. It highlights the emphasis placed on management of the whole water supply system. The term *system* is used to refer to all parts of water supply infrastructure from the point of collection to the consumers' tap, including:

- streams and rivers in the catchment;
- storage and service reservoirs;
- treatment and disinfection facilities;
- trunk and service mains; and
- consumers' plumbing and appliances.

Each one of these points can affect water quality, but they are all inter-related. Therefore, a whole-of-system management system is appropriate.

NHMRC recommend the use of a quality assurance approach in managing the water supply system. This involves establishing a regime in which each step of system management and performance assessment is reliably carried out.

The following steps are listed in the Guidelines:

- an agreed level of service;
- effective treatment processes, including disinfection;
- regular inspection and maintenance of the system;

- practices that identify likely external sources of contamination;
- ongoing evaluation and refinement of the overall operation of the system;
- validation procedures for sampling and laboratory testing programs;
- the use of monitoring information both to facilitate day-to-day management of the supply and to assess its performance over time;
- appropriate procedures for immediate correction of any serious water contamination and resolution of longer term water quality problems which might be costly to address;
- defined lines of responsibility for remedial action;
- use of appropriately skilled and trained personnel;
- transparent auditing procedures; and
- reporting to consumers.

These steps are outlined as principles, without detailed articulation.

Desirable disinfection properties

Under the section on Systems Management, the Guidelines include a sub-section on the disinfection of drinking water which should be read in conjunction with the material in the Microbiological Quality section of the Guidelines. The criteria cited for ideal disinfection are that it:

- is effective in removing pathogens over a range of physical and chemical conditions;
- produces a disinfectant residual which is stable and easily measured;
- produces no undesirable by-products;
- is easily generated, safe to handle, and suitable for widespread use; and
- is cost effective.

Choosing the most appropriate form of disinfection will depend on local conditions and will involve compromises regarding quality and cost. This depends on:

- the nature and concentration of the disinfectant;
- the type of micro-organisms present;
- contact time (the length of time the disinfectant is in contact with the water being disinfected);
- satisfactory mixing of disinfectant and target micro-organisms; and

- the degree to which micro-organisms are protected by:
  - adsorption to, or inclusion in, solid particles;
  - attachment to surfaces of pipes or fittings;
  - the level of competing inorganic and organic reactants; and
  - temperature and pH.

To assess the relative effectiveness of disinfectants, the NHMRC recommend the use of C.t values. This concept takes the concentration of disinfectant (C) (in mg/L) and multiplies it by the contact time (t) (in minutes) to obtain a constant.

NHMRC recommends that several disinfection experiments be used to determine the time required to achieve a 99 per cent kill of a test micro-organism, using different concentrations of the disinfectant under specific conditions.

The C.t concept can be mathematically expressed as:

$$K = C^n.t$$

Where:
C = disinfectant concentration,
n = constant also called the coefficient of dilution,
t = contact time required for a fixed per cent of inactivation, and
K = constant for a specific micro-organism exposed under set conditions.

A low C.t value indicates a strong primary disinfectant.

In the equation for C.t values, the term n generally approximates to 1 and therefore the equation is simplified to K = C.t. The Guidelines include a table showing the comparative efficiencies of different disinfectants, based on C.t values. The table shows the high susceptibility of micro-organisms to ozone, chlorine dioxide and chlorine and monochloramine as the least effective disinfectant.

Systems performance

In the section of the Guidelines on systems performance, processes by which good quality drinking water is supplied are outlined. Performance of a system is viewed in terms of quality assurance, having regard for the ability of existing infrastructure to deliver a superior water supply service.

Consumer satisfaction is determined by a number of factors including:

- the consumers' own assessment of water quality based on taste, odour and appearance;
- information provided by suppliers and health authorities; and
- confidence in the existing processes for providing information and dealing with water quality issues.

Monitoring

NHMRC recommend that monitoring should be regarded as a final check on the effectiveness of barriers and treatment processes. They identify two components of a monitoring program — systems performance monitoring and operational monitoring. They stress that when, how and to whom the results of testing are reported, will determine the effectiveness of monitoring in allaying public concerns over water quality matters.

Systems performance monitoring is a wide-ranging assessment of the quality of water in the distribution system. Operational monitoring provides information to ascertain whether processes and equipment put in place to improve water quality are working. The information can also be used as a trigger for immediate corrective action.

NHMRC posit that baseline monitoring of all new and potential water supplies is necessary to gauge the quality of source waters and to determine what treatment is required to make it suitable for human consumption. In the absence of other data or information, it is recommended that baseline monitoring be carried out for all health-related characteristics listed in the Guidelines. However, NHMRC warns that the baseline will change as land usage changes and therefore, follow up sampling regimes are required to assess significant changes in water quality.

NHMRC recognise that it is neither economically nor physically feasible to test on an ongoing basis, for all substances or organisms that may be present in water. Therefore, it is recommended that monitoring effort and resources should be directed at significant or key characteristics that require frequent monitoring.

The key characteristics identified in the Guidelines related to health include:

- microbiological indicator organisms;
- any chemicals used in treatment processes and any by-products that may result from their use;
- any characteristic that can reasonably be expected to exceed its guideline value, even if only occasionally;

- potential contaminants identified in catchment surveys; and
- pollutants likely to be present but not listed in the Guidelines.

NHMRC recommend the use of surrogates for characteristics that are less common, or for which testing is more difficult and expensive. For example, trihalomethanes, which are the most common of the disinfection by-products and occur in the greatest concentrations, serve effectively as a surrogate for a range of other related by-products.

The Guidelines set out some general principles on the sampling of key characteristics. These principles include how often, when and where to sample. The variability of a characteristic and whether it is of aesthetic or health significance determines sampling frequency.

For both an initial baseline survey and ongoing monitoring, sufficient samples must be collected over a representative period. These enables the data for each characteristic to be statistically evaluated, significant trends identified and performance against the guideline values assessed. NHMRC recognise that sufficient data for statistical evaluation may take time to collate in small systems, and therefore reporting over a five-year period (rather than annually) may be more appropriate.

The Guidelines include tables on the recommended minimum testing frequencies. However, there is flexibility for local authorities to alter frequencies, depending on local conditions and the different characteristics and size of water systems.

With respect to sampling locations, NHMRC stress the importance of choosing points that are truly representative of each part of the water system. It is recommended that samples are taken from:

- the raw (source) water;
- the treatment plant;
- the treated water;
- the headworks of the distribution system;
- service reservoirs;
- representative sample points within the distribution system;
- points representative of the quality of water supplied to consumers;
- consumers' taps for specific investigations; and
- points where previous samples have revealed unsatisfactory water quality.

The Guidelines include recommendations for the long term evaluation of results. The purpose of these recommendations is to provide suppliers with a means of using the results of a planned monitoring program to assess the performance of all parts of the water supply system over a given period of time (typically the preceding 12 months).

The assessment of water quality over the preceding 12 months is to include the following:

- data for key characteristics displayed in control chart format;5
- for health-related characteristics, a reasonable objective is to have a high degree of confidence that 95 per cent of results over the preceding 12 months are less than the guideline value;
- non-health-related characteristics should be the subject of community service agreements; and
- the minimum sampling frequency should be determined from a statistical assessment of the data.

Currently, there is no guidance on monitoring consumers' overall impression or perception of physical water quality. This is because consumer satisfaction has a regional or local context and therefore, it is recommended that this should be negotiated at this level.

It is recognised that no single physical characteristic really measures consumer quality perceptions. Consequently, the NHMRC suggest the use of direct indicators of consumer acceptance in agreeing to standards of service — for example, complaint rates for taste, odour and appearance.

Reporting

NHMRC suggest that reporting on water quality must be open and comprehensive if the public is to have confidence in the supplier. Therefore, it is recommended that the responsibilities of all parties involved in reporting should be documented and publicly available.

Event reporting is recommended in cases in which significant system failures pose a health risk, or could adversely affect water quality for an extended period. Reports should be made immediately to the relevant health authorities and to the public, and actions should be taken to resolve any problem.

5 A control chart displays monitoring data for a given characteristic against time or sample sequence number.

NHMRC recommend that suppliers report a summary of their performance against the guideline values and agreed levels of service on an annual basis. Further, the annual report should include a statement that monitoring has been carried out in accordance with the Guidelines and according to the requirements of the agreed levels of service. Finally, a more comprehensive summary of water quality information should be available to the public.

The timing and frequency for public notifications is not specified in the Guidelines. However, NHMRC consider that it is good practice for water suppliers to notify the public when:

- supply is interrupted;
- water quality does not meet the guideline values, and there is a possible health risk;
- treatment fails or a reticulation system is compromised;
- monitoring is not carried out at the recommended frequency;
- monitoring is not carried out using recommended testing procedures; and
- adopted levels of service are not met.

Small water suppliers

The Guidelines contain a chapter on small water suppliers — defined as those serving less than around 1000 people. NHMRC recognise that the costs involved for small suppliers in meeting all of the recommendations may not be affordable.

Variations to the general recommendations are provided, with the intention of maintaining confidence that safe water is being supplied, but ensuring that guideline values are suited to small systems. The basic principles of systems management still apply.

Economic constraints often mean that for small systems, only untreated water can be supplied, or treatment may be limited. NHMRC stress the importance of sanitary assessment and the use of clean and unpolluted source water in such cases. They recommend small communities:

- carry out regular sanitary inspections of their water supply; and
- use the guideline values — in particular the microbiological guidelines — as a goal for progressive improvement.

Where problems are identified, the options for a small community may then be to:

- seek an alternative source of water;

- upgrade substantially the barriers to contamination, in order to achieve the guideline values; or
- declare the water supply non-potable and recommend alternatives (such as boiling the water).

B.2 Comparison of versions

With each version of the *Australian Drinking Water Guidelines*, the number of parameters covered has increased and, in some cases, the guideline values have become more stringent.

Desirable Quality for Drinking Water in Australia 1980 included three different values for each guideline parameter. The first indicated the basic level regarded as acceptable under Australian conditions — termed Desirable Current Criteria.

The second value set out the long term goals toward which suppliers could aim if they chose. These long term goals generally established more stringent levels which could be aspired to and which, if achieved, would result in drinking water of excellent quality. These long term goals were based on the World Health Organisation's *International Standards for Drinking Water 1971*. The third level established guideline parameter values that were potentially harmful to health.

In the 1987 version of the Guidelines, the multiple classification of guideline parameters was replaced by a single guideline value for each parameter. The number of parameters included in the 1987 Guidelines increased (see table B.1).

Values for pesticides were included. Also, a number of parameter values (excluding pesticides) were more stringent than those included in the 1980 version.

The 1996 Guidelines include both health and aesthetic guideline values and acknowledge the constraints faced by smaller water systems by varying the Guideline recommendations to suit smaller communities. Under the 1987 version, the difficulty that a smaller system may have had in complying with the guideline values was recognised. However, the 1987 Guidelines recommended that small systems seek the assistance of health and other appropriate authorities in developing their own levels of service (NHMRC 1987).

Table B.1 **Comparison between the 1980 and 1987 Australian Drinking Water Guidelines**

Category	*No. of parameters*		*No. of values more stringent*	*No. of values less stringent*
	1980	*1987*		
Microbiological	2	2	2	0
Physical	4	4	3[a]	0
Inorganic chemicals	24	19	7[b]	1
Organic chemical (ex. pesticides)	0	10	10	0
Pesticides	0	6	6	0
Radiological	5	2	1	0
All	**35**	**43**	**29**	**1**

[a] In the 1980 version, although the desirable parameter values for colour and turbidity were less stringent, the long term objectives were more stringent than the parameter values in the 1987 version. [b] For three of these values, although the desirable parameter values set by the 1980 guidelines were less stringent than that established by the 1987 version, the long term objective set by the 1980 version were more stringent.

Source: Commonwealth Department of Health (1980) and NHMRC (1987).

A greater number of parameters were covered by the 1996 Guidelines. However, much of this increase was attributable to the inclusion of a number contaminants that were not recommended for routine monitoring (see table B.2). For example, guideline parameters are included for a number of pesticides that are unlikely to be found in Australian water systems and therefore would not be monitored, except in cases where accidental contamination occurs. There was also an increase in the number of values that were more stringent than in the 1987 Guidelines.

The 1996 Guidelines also contain parameters for organic and inorganic chemicals that are unlikely to be found in most Australian water systems. Baseline monitoring of new water systems was recommended in order to identify the potential presence of these chemicals. However, after chemical contaminants are determined, monitoring should only occur annually, if it is required at all.

Table B.2 **Comparison of the 1987 and 1996 Australian Drinking Water Guidelines**

Category	*No. of parameters*		*No. of values more stringent*	*No. of values less stringent*
	1987	*1996*		
Microbiological	2	2 [a]	0 [b]	0
Physical	4	8 [c]	0	0
Inorganic chemicals	19	32 (38) [d]	9	1
Organic chemicals (ex. pesticides)	10	35 (50) [e]	1	8
Pesticides	6	63 (141) [f]	6	0
Radiological	2	2 (7) [g]	0	1
All	**43**	**142 (246)**	**16**	**10**

[a] Most individual micro-organisms are not subject to regular monitoring. They do not have guideline values because there is insufficient knowledge about them, but they should be reported to health authorities if detected. [b] Although the guideline value set for *thermotolerant coliforms* under the 1987 version (none present) is more stringent than that under the 1996 version (98 per cent), in assessing long term compliance, the 1987 guideline value was less stringent (<95 per cent). [c] Hardness and total dissolved colours were included under inorganic chemicals in the 1987 version. [d] There are another six inorganic chemical parameters listed, but health-based guidelines values were not set either because it was considered unnecessary or there were insufficient data. [e] There are another 15 organic chemical parameters listed, but there were insufficient data to set a guidelines value based on health considerations. [f] All pesticides listed have a health value but only 63 have a guideline value. Routine monitoring is not required for pesticides unless the potential exists for contamination of water supplies. [g] Guideline values for five specific radionuclides are specified but these need only be tested for where either of the guideline values for gross alpha and gross beta are exceeded.

Source: NHMRC (1987 and 1996).

Table B.3 **Comparison of microbiological guideline values**

1987	*1996*
Thermotolerant coliforms	
No scheduled sample should contain any *thermotolerant coliforms* in 100 millilitres.	At least 98 per cent of scheduled samples contain no *thermotolerant coliforms*
For long term assessment of non-compliance with *thermotolerant coliforms* guideline value:	
Annual number of samples / *Maximum number of failures*	
12–16 / 3 (75–81 per cent compliance)	
17–25 / 4 (76–84 per cent compliance)	
26–99 / 5 (81–95 per cent compliance)	
100 or more / At least 95 per cent compliance	
Total coliforms	
95 per cent of scheduled samples should not contain any coliform organisms in 100 millilitres.[a] Up to 10 coliform organisms may be occasionally accepted	At least 95 per cent of scheduled samples contain no coliforms[b]

[a] The 1987 guidelines allowed 90 per cent of scheduled samples for systems with protected catchments. [b] A higher level of coliform contamination might be tolerated in a particular area under certain conditions specified in 1996 Guidelines.

Source: NHMRC (1987 and 1996).

Unlike previous versions, the 1996 Guidelines included a list of individual micro-organisms that, if explicitly sought and detected, should be reported to health authorities (see table B.4). Routine monitoring for these organisms was not recommended because of the time involved and complexity of testing.

Suppliers are monitoring some of the micro-organisms in table B.4 on a regular basis, particularly since the Sydney water crisis. Any inclusion of a micro-organism in the Guidelines may lead suppliers to monitor and report on it as part of a risk management strategy.

The Guidelines include a note on the potential for technological developments in monitoring and investigation of water supplies to enhance the detection of pathogens.

> Promising new techniques based on amplifying and identifying specific genes or gene fragments may revolutionise the monitoring and investigation of drinking water supplies. … however the technology has not yet been developed sufficiently for it to replace traditional methods (NHMRC 1996, p. 2–15).

Table B.4 **Individual micro-organisms not subject to regular monitoring**

Micro organisms which should be not be detected in water if explicitly sought. If detected, advice should be sought from the relevant health authority

Bacteria	**Viruses**
Campylobacter	Adenovirus
Klebisella	Enterovirus
Salmonella	Hepatitis viruses
Shigella	Norwalk virus
Vibrio	Rotavirus, para-rotaviruses & reovirus
Yersinia	
Aeromonas	**Protozoa**
Legionella	Acanthamoeba
Mycobacterium	Cryptosporidium
Pseudomonas-aeruginosa	Giardia
	Naegleria fowleri
Toxic Algae	
Cyanobacteria (blue-green algae)	

Source: NHMRC (1996).

Monitoring frequencies were broadly similar between the 1987 and 1996 versions of the Guidelines, although the recommended frequency of sampling for population centres greater than 100 000 people increased in the 1996 Guidelines (see table B.5). The 1996 Guidelines include allowances for the differential treatment of smaller systems. For example, where water systems are servicing under 5000 people, the minimum number of samples has been set at one per week as opposed to six per week for populations greater than 100 000.

Table B.5 **Sampling frequencies for populations over 100 000[a]**

1987	*1996*
13 samples per month plus 1 additional sample per 10 000 population	6 samples per week, plus 1 additional sample per month for each 10 000 above 100 000

a Sample rates are minimums.

Source: NHMRC (1987 and 1996).

Physical characteristics

The physical characteristics included in the Guidelines either influence the appearance and taste of water or suggest whether corrosion or encrustation are likely to be significant problems in pipes or fittings.

There has been little change to the physical parameter values between successive versions of the Guidelines (see table B.6). The Guidelines contain references to possible health effects from physical characteristics, but they do not provide health-

based guideline values. Health-based guideline values are either deemed unnecessary or the data available are insufficient for determining a value.

Table B.6 **Comparison of the guideline values for physical characteristics**

	Aesthetic value	
	1987	*1996*
Dissolved oxygen	–	>85 per cent
Hardness	500 milligrams per litre	200 milligrams per litre
pH	6.5 to 8.5	6.5 to 8.5
Taste and odour	Not objectionable to most customers	Acceptable to most people
Temperature	–	No value set
Total dissolved solids	1000 milligrams per litre	500 milligrams per litre
True colour	15 TCU	15 HU[a]
Turbidity	5 NTU	5 NTU

a Hazen units.

Source: NHMRC (1987 and 1996).

Turbidity is an important physical characteristic as suspended particles may shield micro-organisms that cause disease in humans. Turbidity is used in the US and NZ as an indicator for the possible presence of microbial pathogens, such as *Cryptosporidium*.

Chemical quality

A number of chemicals, both organic and inorganic, are of concern in drinking water because some are toxic to humans and others are suspected carcinogens. Between 1987 and 1996 there have been a number of changes in the scope and stringency of the guideline values for inorganic chemicals (see table B.7).

Some chemicals affect the aesthetic quality of water. As a consequence, the 1996 Guidelines include a health-related value and an aesthetic value or both (see table B.7).

Table B.7 **Comparison of guideline values for inorganic chemicals**

	1987	*1996*	
	Guideline value	*Health value*	*Aesthetic value*
	(mg/L)	(mg/L)	(mg/L)
Aluminium	0.2	*	0.2
Ammonia	-	*	0.5
Antimony	-	0.003	
Arsenic	0.05	0.007	
Asbestos	-	*	
Barium	-	0.7	
Beryllium	-	*	
Boron	-	0.3	
Bromate	-	0.02	
Cadmium	0.005	0.002	
Chlorate	-	*	
Chloride	400	**a**	250
Chlorine	-	5	0.6
Chlorine dioxide	-	1	0.4
Chlorite	-	0.3	
Chromium	0.05	0.05	
Copper	1	2	1
Cyanide	0.1	0.08	
Fluoride	0.5 to 1.7	1.5	
Hydrogen sulfide	-	*	0.05
Iodide	-	0.1	
Iodine	-	*	
Iron	0.3	*	0.3
Lead	0.05	0.01	
Manganese	0.1	0.5	0.1
Mercury	0.001	0.001	
Molybdenum	-	0.05	
Monochloramine	-	3	0.5
Nickel	-	0.02	
Nitrate	10	50	
Nitrite	-	3	
Selenium	0.01	0.01	
Silver	-	0.1	
Sodium	300	**a**	180
Sulphate	400	500	250
Tin	-	**a**	
Zinc	5	*	3

Note Aesthetic values are not listed if the compound does not cause aesthetic problems, or if the value determined from health considerations is the same or lower. **a** No health based guideline is necessary. ‑ No reference is made to this chemical in that year's Guidelines. * Insufficient data to set a guideline value based on health considerations.

Source: NHMRC (1987 and 1996).

Table B.8 **Comparison of guideline values for organic disinfection by-products**

	1987	*1996*	
	Guideline value	*Health value*	*Aesthetic value*[a]
	(mg/L)	(mg/L)	(mg/L)
2,4,6-Trichlorophenol	0.01	0.02	0.002
Chloreketones	–	*	
Chlorinated furanones (MX)	–	*	
Chloroacetic acids	–	0.15	
Chloropicrin	–	*	
Cyanogen chloride	–	0.08	
Dichloroacetic acid	–	0.1	
Dichlorophenol	–	0.2	0.0003
Formaldehyde	–	0.5	
Haloacetonitriles	–	*	
Pentachlorophenol	0.01	–	–
Trichloroacetaldehyde	–	0.02	
Trihalomethanes (THMs)	0.2	0.25	

[a] Aesthetic values are not listed if the compound does not cause aesthetic problems, or if the value determined from health considerations is the same or lower. ⁻ No reference is made to this chemical in that year's Guidelines. * Insufficient data to set a value based on health considerations.

Source: NHMRC (1987 and 1996).

Organic chemicals can be naturally occurring, but in Australia, are most likely to occur as disinfection by-products (NHMRC 1996). Hence, organic compounds are divided into two sections — disinfection by-products and other organic compounds.

The 1996 Guidelines included a larger list of disinfection by-products than the 1987 Guidelines (see table B.8). The recommendation is that, as a minimum, trihalomethanes (THMs) should be monitored. The guideline value for trihalomethanes is less stringent in the 1996 Guidelines by 0.05 mg/L.

There have also been changes in the scope and stringency of the other organic compounds category (see table B.9).

Table B.9 **Comparison of guideline values for other organic compounds**

	1987	*1996*	
	Guideline value	*Health Value*	*Aesthetic value*
	(mg/L)	(mg/L)	(mg/L)
1,1-dichlorethene	0.003	0.03	
1,1,1–Trichlorethane	–	*	
1,2-dichloroethene	0.01	0.06	
1,2-dichlorobenzene	–	1.5	0.001
1,3-dichlorobenzene	–	*	0.02
1,4-dichlorobenzene	–	0.04	0.0003
2,4,6-Trichlorophenol	0.001	–	–
Acrylamide	–	0.0002	
Benzene	0.01	0.001	
Benzo-(a)-pyrene	0.00001	0.00001	
Carbon tetrachloride	0.003	0.003	
Chlorobenzene	–	0.3	0.01
Di(2-ethylhexl phthalate)	–	0.01	
Dialkyltins	–	*	
1,1-dichloroethane	–	*	
1,2-dichloroethane	–	0.003	
Dichloromethane	–	0.004	
Epichlorohydrin	–	0.0005	
Ethylbenzene	–	0.3	0.003
Ethylenediamine tertraacetic acid (EDTA)	–	0.25	
Hexachlorobutadiene	–	0.0007	
Nitrotriacetic acid	–	0.2	
Pentachlorophenol	0.001	–	–
Styrene	–	0.03	0.004
Tetrachloroethene	0.001	0.05	
Toluene	–	0.8	0.025
Tributylin oxide	–	0.001	
Trichlorobenzenes (total)	–	0.03	0.005
Trichloroethylene	–	*	
Vinyl chloride	–	0.0003	
Xylene	–	0.6	0.02

– No reference is made to this chemical in that year's Guidelines. * Insufficient data to set a guidelines value based on health considerations.

Source: NHMRC (1987 and 1996).

Pesticides are a category of organic chemicals for which the scope and stringency has also changed (see table B.10). For all the pesticides listed, the guideline values have become more stringent in the 1996 version of the Guidelines.

Table B.10 **Comparison of guideline values for pesticides**[a]

	1987	*1996*	
	Guideline value	*Guideline value*	*Health value*
Aldrin and Dieldrin	0.001	0.00001	0.0003
Chlordane	0.006	0.00001	0.001
DDT	0.003	0.00006	0.02
Heptachlor and Heptachlor epoxide (total)	0.003	0.00005	0.0003
Lidane (HCH)	0.1	0.00005	0.02
Dichlorophenoxyacetic acid (2,4-D)	0.1	0.0001	0.03

a Table only compares pesticides included in the 1987 Guidelines. Another 135 pesticides were included in the 1996 Guidelines.

Source: NHMRC (1987 and 1996).

Radiological quality

The 1996 radiological guidelines continue the method used in the previous versions, using alpha and beta emitters as indicators of radiological activity in the water supply. Screening for gross alpha and gross beta emitters is used to determine whether more complete analysis for specific radionuclides is warranted.

The 1996 guideline value for gross beta activity of 0.5 Becquerel per litre is less stringent than the 1987 guideline value of 0.1 Becquerel per litre (see table B.11). However the value continues to be more stringent than the current WHO guideline value of 1 Becquerel per litre.

Table B.11 **Comparison of guideline values for radiological quality**

	1987 Guideline value	*1996 Guideline value*
	Becquerel/litre	Becquerel/litre
Gross alpha activity	0.1	0.1
Gross beta activity	0.1	0.5

Source: NHMRC (1987 and 1996).

C1 New South Wales

There are four metropolitan water suppliers in NSW — Sydney Water Corporation, Hunter Water Corporation, Gosford City Council and Wyong Shire Council. The two Corporations combined supply drinking water to more than 65 per cent of the State's population. In addition, there are 126 non-metropolitan water suppliers responsible for supplying drinking water to around 30 per cent of the State's population living in NSW rural towns.

C1.1 Metropolitan suppliers

Sydney Water Corporation

The Sydney Water Corporation (SWC) is Australia's largest water supplier providing services to more than 3.75 million residential customers and 73 000 businesses. It is responsible for water supply, sewerage services and wastewater disposal within Sydney, Illawarra and the Blue Mountains.

Sydney's bulk drinking water supply is largely drawn from catchments on four main river systems. All potable water supplied by the SWC is filtered, disinfected and fluoridated at one of the eleven water filtration plants. The SWC contracts the operation of four of its eleven water treatment plants to private companies.

The SWC became a State Owned Corporation in 1995 under the *Sydney Water Board (Corporatisation) Act 1994*.[1] The SWC is required by the Act to pursue commercial, as well as environmental and public health objectives, with each given equal importance.[2] To achieve these objectives, s. 21 of the Act requires the SWC to:

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1 As part of the *Water Legislation Amendment (Drinking Water and Corporate Structure) Act 1998*, the *Sydney Water Board (Corporatisation) Act 1994* was renamed the *Sydney Water Act 1994*.

2 In contrast, the statutes of corporatised water authorities in Victoria, Western Australia and England, are used to fulfil commercial aims and objectives only — in particular, pricing, customer service, efficiency and competition (Licence Regulator 1998a).

- be a successful business and, to this end operate at least as efficiently as any comparable business, to maximise the net worth of the State's investment in the Corporation, and to exhibit a sense of social responsibility by having regard to the interests of the community in which it operates;
- protect the environment by conducting its operations in compliance with the principles of ecologically sustainable development contained in s. 6(2) of the *Protection of the Environment Administration Act 1991*; and
- protect public health by supplying safe drinking water to its customers and other members of the public in compliance with the requirements of any operating licence.

The *Sydney Water Act 1994* also specifies a number of regulatory arrangements to control the operations of the SWC (see box C1.1).

In response to the Sydney water crisis in 1998, the NSW Government made significant changes to the operation of the SWC.

First, it moved to bring the SWC under closer Ministerial supervision by enacting the *Water Legislation Amendment* (*Drinking Water and Corporate Structure) Act 1998*. The SWC was changed from a company to a statutory State Owned Corporation. As a result of this change the SWC is now more accountable to its responsible Minister and through this, the Minister is more accountable to the Parliament and people for the actions of the Corporation (SWC 1999a).

The Act also provides the Minister with greater powers to access information and to direct the Corporation on the grounds of urgency, public health or safety.

Second, the NSW Government enacted the *Sydney Water Catchment Management Act 1998* in response to the recommendations of the Sydney Water Inquiry. The Inquiry found that the Sydney water catchments were seriously compromised by many possible sources of contamination and that the SWC did not have sufficient regulatory control of the catchments to guarantee safe drinking water (SCA 1999). A new approach to the problems of managing catchments, including the establishment of the Sydney Catchment Authority (SCA) has been recommended to address this problem (see box C1.2).

Box C1.1 **SWC regulatory arrangements**

Regulatory instruments include:

- An *Operating Licence* which incorporates a provision for price regulation by the Independent Pricing and Regulatory Tribunal of New South Wales (IPART). The Operating Licence is granted by the Governor under s. 12 of the *Sydney Water Act 1994.* The Licence sets out the operating and customer standards to be met by the Corporation in running its business, including drinking water quality standards. It defines the terms and conditions under which the Corporation will operate and establishes mechanisms for customer participation. Further, it defines the guiding principles for relationships with its regulators.
- A *Customer Contract*. The terms and conditions that must be included in the Customer Contract are set out in the Operating Licence, in accordance with s. 54(1) of the *Sydney Water Act 1994*. The Customer Contract outlines customer's rights to the supply of water, sewerage and drainage services, consultation, information and assistance, notice of interruption to supply and customer redress. The Customer Contract is legally enforceable.
- *Memorandums of Understanding* (MoUs) which, under s. 35 of the *Sydney Water Act 1994*, must be reached separately with NSW Health, the Environmental Protection Authority (EPA) and the Water Administration Ministerial Corporation (WAMC) which reports to the Department of Land and Water Conservation (DLWC).[a] The MoUs are designed to clarify roles and responsibilities and facilitate cooperative relationships between the signatories, including agreed areas of study and data exchange.[b]

A new Licence Regulator was established to conduct an annual operational audit to assess compliance with the conditions of the Operating Licence.

[a] The WAMC managers the State water resources and is responsible for issuing licences to all metropolitan and non-metropolitan suppliers to extract water from dams, river systems and manmade channels. [b] With recent amendments to the *Public Health Act 1991*, NSW Health has the powers under its own legislation and the *Sydney Water Act 1994* to enforce the MoU obligations.

Source: Sydney Water Act 1994.

Box C1.2 **Sydney Catchment Authority**

In response to the Sydney Water Inquiry, the Sydney Catchment Authority (SCA) was established under the *Sydney Water Catchment Management Act 1998 (SWCM* Act*)* and commenced operations on 2 July 1999. Its principal functions are:

- supplying water to the SWC, and to other suppliers, local councils and county councils;
- managing and protecting the catchment areas (both inner and outer and special areas to which access by the public is strictly limited) and catchment infrastructure works;[a]
- protecting and enhancing the quality of water harvested in its catchments;[b]
- undertaking research on catchments generally, and in particular, on the health of its own catchments;[c] and
- undertaking an educative role within the community on water management and pollution control.

[a] In the Warragamba system, most of the inner catchment is vested in the Crown and zoned as national park. These inner catchments will be jointly managed by the SCA and the NSW National Parks and Wildlife Service. In the Upper Nepean system, the inner catchment lands will be transferred to the SCA. The Special Areas Strategic Plan of Management is a blueprint for managing Sydney's water supply catchment areas. It has been developed jointly by the SCA, the SWC and the NSW National Parks and Wildlife Service. It aims to protect the ecological values of the Special Areas and to ensure clean water for Sydney well into the twenty-first century. The Plan redefines best practice for catchment management and is to be placed on public exhibition. [b] An enhanced monitoring program is required to assess the likely occurrence of contaminants in the raw water entering the water treatment plants. [c] The SCA is required to set up a catchment audit within five months of the Act coming into effect. The SCA will compile indicators, and undertake research on the ecological health of the catchments. It is particularly interested in the protection of vegetation cover, riparian zones and water quality. In these tasks the SCA will build on the databases held by government agencies, local councils, community and environmental groups that have knowledge of the catchments.

Source: Sydney Water Catchment Management Act 1998.

The SWCM Act requires the SCA to enter into arrangements with the SWC. These arrangements include water quality standards to be supplied, continuity of water supply, maintenance of adequate reserves of water by the SCA and the price of the water supplied to the SWC.

Under the legislation, the SCA is also required to have an Operating Licence, to be audited by the Licence Regulator and to enter into MoUs with the EPA, NSW Health and the WAMC.

The IPART is currently reviewing the Operating Licences of both the SWC and the SCA, addressing demarcation of responsibilities, water quality and public health issues. The Tribunal called for submissions in July 1999 and has released an issues paper.

Hunter Water Corporation

The Hunter Water Corporation (HWC) provides water and sewerage services to almost 185 000 properties or around half a million people from five local government areas including Newcastle, Lake Macquarie, Maitland, Cessnock and Port Stephens.

The HWC became a State Owned Corporation in 1992 under the *Hunter Water Board Corporatisation Act 1991*.[3] Like the SWC, the HWC is required to have an Operating Licence under the Act. The Licence prescribes standards of drinking water quality, water supply continuity, water pressure, wastewater treatment, wastewater transportation and drought security. The HWC is also subject to price regulation by the IPART.

A Customer Contract was established as an appendix to the Operating Licence and other components of the HWC's regulatory framework. The Contract outlines the HWC's service delivery objectives, intentions regarding the reinstatement of interrupted services and the sanctions for not reinstating interrupted services within established timeframes.

As part of the HWC's Operating Licence, an independent operational audit must be performed annually. The Licence Regulator is required by the State government to perform this task.

Although the Act does not require them, HWC has entered into a MoU with NSW Health, the EPA and is negotiating one with the WAMC. The WAMC have issued a Water Management Licence to the HWC.

Wyong Shire and Gosford City Councils

Wyong Shire Council supplies drinking water to approximately 129 000 people including 53 000 residential and 2000 industrial properties. Raw water is supplied from an unprotected catchment (443 square kilometres) comprising a mixture of agricultural activities and native forest. All reticulated water is filtered and disinfected (Wyong Council, NSW, pers. comm., June 1999).

Gosford City Council is responsible for supplying water to around 141 000 people including 62 000 properties of which 3000 are non-residential (WSAA 1998).

3 As part of the *Water Legislation Amendment (Drinking Water and Corporate Structure) Act 1998*, the *Hunter Water Board Corporatisation Act 1991* was renamed the *Hunter Water Act 1991*.

Drinking water is supplied from a protected catchment and all reticulated water is filtered and disinfected (Gosford Council, NSW, pers. comm., June 1999).

Gosford and Wyong Councils operate as water supply authorities under the *Water Supply Authorities Act 1987*. Under the Act, these authorities must:

- ensure that the water and related resources are allocated and used in ways which are consistent with environmental requirements and provide the maximum long term benefit for the area and the State; and
- provide water and related services to meet the needs of users in a commercial manner consistent with the overall policies of the government. There are no provisions within the Act that establish regulatory arrangements governing the operations of these suppliers. For example, they are not required by the Act to hold an Operating Licence, Customer Contract, a MoU with NSW Health, the EPA or the WAMC, and nor are they subject to annual operational audits.

The authorities are subject to price regulation by the IPART and they must obtain a Licence to extract water where applicable.[4]

The Wyong Shire Council has developed a Water Supply Business Plan which sets out the Council's water supply functions and responsibilities. Similarly, Gosford Council has a City Management Plan, which among other things, establishes the Council's objectives in relation to water and sewerage.

C1.2 Non-metropolitan suppliers

The provision of water supply and sewerage services to country towns in NSW is the responsibility of Local Government under the *Local Government Act 1993*. The majority of non-metropolitan suppliers are constituted under this Act.

Like Wyong and Gosford Councils, the non-metropolitan suppliers are subject to price regulation — the IPART sets bulk water prices, and the WAMC issues a licence to extract water where applicable.

Unlike the metropolitan suppliers, no MoUs have been developed between the non-metropolitan suppliers and NSW Health, the EPA and the WAMC.

4 Wyong Council is licenced by the WAMC to extract water for town water supply purposes. Gosford Council has been issued with nine licences by the WAMC to extract water.

C1.3 Regulation

The responsibility for implementing the NHMRC Guidelines is at the discretion of NSW Health, usually in consultation with the suppliers.[5] However, in implementing the Guidelines NSW Health does not undertake an economic evaluation of the benefits and costs of higher drinking water standards (NSW Health, pers. comm., 1999).

In NSW, all metropolitan suppliers comply with the 1996 Guidelines. However, the Guidelines adhered to by the non-metropolitan suppliers vary substantially — some monitor and assess against the 1987 Guidelines, some have adopted the 1996 Guidelines and some currently comply with two versions of the Guidelines. For example, some monitor against the 1987 Guidelines and comply with the health-related parameter values specified in the 1996 Guidelines. However, NSW Health is in the process of resolving these anomalies.

In implementing the Guidelines, there are no legal requirements for Wyong and Gosford Councils, or the non-metropolitan suppliers to meet a particular version of the Guidelines. However, under the *Sydney Water Act 1994* and the *Hunter Water Act 1991*, the SWC and HWC Operating Licences, among other things, specify the Guidelines that must be met. Under the Operating Licence, the Guidelines have assumed the status of enforceable standards.

Operating Licences are issued by the NSW Government for a five year period and can only be amended by ministerial or parliamentary approval. As a consequence, they cannot be altered rapidly to reflect amendments to the Guidelines as they occur. As a result, the current Operating Licences may not reflect the version of the Guidelines actually being adhered to by these Corporations.[6]

The MoUs between the SWC and HWC and NSW Health also specify the Guidelines that will be met. Although the MoUs cover the period of the Operating Licence, they are a more flexible instrument than an Operating Licence because as cooperative agreements they are more easily amended to accommodate changes to requirements.

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5 In addition to the Guidelines, the Minister for Health has emergency powers to respond to public health risks.

6 In the current Operating Licence, HWC must comply with the health-related parameters of the Draft 1994 Guidelines. In July 1999, the SWC's Operating Licence was amended and now specifies that the SWC is required to meet any updates of the 1996 Guidelines.

In December 1998, under the Proposed Amendments to the MoU between NSW Health and the SWC, it was agreed that the SWC would meet the 1996 Guidelines. As stated in the MoU:

> This will include all amendments, updates and supplements of those Guidelines which may be made from time to time. Compliance with the Guidelines shall be in a manner agreed between the Corporation and the Department of Health provided that, where such agreement cannot be reached, the view of the Department of Health shall prevail (NSW Health 1998b, p. 5).

The MoU also outlines procedures to facilitate effective interaction between the two parties. These procedures include the establishment of two consultative groups, namely:

- a Strategic Liaison Group comprising of the Director-General of NSW Health and the Managing Director of the SWC, and senior officers nominated by them to discuss the broad principles, directions and policies underlying the roles and responsibilities of the parties under the MoU; and
- a Joint Operational Group to coordinate implementation of the MoU. This group also establishes data sharing programs, programs of investigations, feasibility studies and economic analyses to be undertaken by the SWC to meet changing health objectives in relation to drinking water.

The MoU between NSW Health and the HWC is similar in structure and content to the MoU which exists between NSW Health and the SWC.[7] The consultative process occurs at the regional level with the establishment of the Strategic Liaison Committee (see box C1.3). Membership includes the Director of the Public Health Unit/Medical Officer of Health (Hunter Region) and a Senior Environmental Health Officer.

[7] The HWC is not required by law to enter into a MoU with NSW Health — this is a voluntary procedure.

Box C1.3 **Functions of the Strategic Liaison Committee**

The Strategic Liaison Committee is responsible for:

- annually reviewing progress on the implementation of the MoU;
- considering long term strategic issues and policies and defining and implementing processes for the interchange of strategic planning information;
- establishing data sharing programs;
- establishing programs of investigation, feasibility studies and economic analyses to be undertaken by the Corporation to meet changing public health objectives in relation to drinking water;
- making recommendations to the Director-General of Health and the Managing Director of the Corporation regarding the updating of the MoU;
- rectifying and investigating drinking water and wastewater problems;
- responding to emerging public health issues;
- preparing a plan for contingency, emergency and disaster response; and
- providing oversight of the viral monitoring program in the Hunter River.

Source: NSW Health (1998a).

For the first time, the current MoU includes a provision which gives the HWC the opportunity to quantify the costs of compliance with future monitoring and guideline level requirements. As stated in the MoU:

> The Department has a role in providing advice to the Government on standards in relation to drinking water quality. In this context, the Corporation also has a role in providing advice to Government on costs associated with varying drinking water quality standards (NSW Health 1998a, Clause C, p. 1).

Although the Wyong Council is not subject to an Operating Licence or MoU with NSW Health, it has established a Water Supply Business Plan that specifies the Guidelines to be met.

To conform with the Plan, Wyong Council must supply water which meets the 1996 Guidelines and NSW Health Guidelines 100 per cent of the time (WSC 1999). Under this Plan, the Council undertakes to:

> …. ensure the cost effective provision of water supply services that meet customer service standards, conform with health and environmental requirements and are provided in a timely manner consistent with development needs (WSC 1999, p. 2).

Gosford Council is also required by its City Management Plan to meet the 1996 Guidelines. Under this Plan, the Council must:

> Meet the community's needs by providing a high quality water supply complying with recognised drinking water standards through the planning and development of water supply schemes and the operation and maintenance of existing installations.

The Plan defines the performance indicators and workload measures, which include compliance with the Guidelines.

For the non-metropolitan suppliers, NSW Health relies on 17 Public Health Units, who are responsible for regional and local public health issues, to encourage these suppliers to comply with the monitoring requirements of the 1996 Guidelines.

NSW Health is mindful of the costs to meet these requirements, particularly as the sampling frequency for some parameters has increased from once a month to once a week. Although NSW Health does provide a free water testing service for non-metropolitan suppliers, the problem for some suppliers relates to the resources needed to cover problems associated with distance in remote areas (NSW Health, pers. comm., 1999).

The Department of Land and Water Conservation (DLWC) also keeps the non-metropolitan suppliers informed of any significant changes to the Guidelines which may impact on their water supply. However, for the non-health-related parameters, the decision on the level of service is a matter to be decided by each supplier and its community (DWLC, NSW, pers. comm., October 1999).

C1.4 Monitoring and enforcement

NSW Health is responsible for assessing whether suppliers comply with the monitoring requirements specified in the Guidelines.

Although each supplier has similar monitoring practices, the extent to which the results of compliance monitoring are publicly reported varies. Reporting of the compliance record of the major suppliers in metropolitan areas is common. However, in rural and regional areas water quality information is less frequently reported publicly.[8]

In NSW, all suppliers are subject to the enforcement provisions set out in the *Public Health Act 1991*.

8 NSW Health is taking measures to improve monitoring and reporting of drinking water quality in rural and regional areas.

Monitoring

The SWC and HWC are committed by their Operating Licences to monitor water quality. Monitoring requirements are also specified in the MoUs with NSW Health.

SWC water quality monitoring procedures

Under Clause 7.5 of the MoU with NSW Health, the SWC must prepare an annual Water Quality Monitoring Plan for review and approval by NSW Health.

The SWC ensures that drinking water is of good quality and that the Guidelines are met by testing and monitoring water quality at every stage in the supply system. Samples are taken in the catchments and storages, after water is treated and in the distribution pipes close to consumer taps. The test results are reviewed by NSW Health.

Water supplied by the SWC is tested for more than 70 different health-related and aesthetic parameters. The health-related parameters include microbiological, physical, chemical and radiological. The aesthetic features are those such as appearance, taste and odour.

In addition to system performance monitoring (for compliance purposes), the SWC also undertakes operational monitoring. This involves testing water quality to measure the performance of the water supply system from catchment to tap. This is intended to reveal whether the processes and equipment that are in place to protect water quality are working properly and to allow the SWC to respond immediately to any malfunctions in a particular part of the system.

Although the 1996 Guidelines do not recommend routine testing or set guideline values for *Cryptosporidium* and *Giardia*, the SWC tests for both as a precautionary measure.[9] It does so in accordance with a monitoring program developed in consultation with NSW Health. The monitoring program provides for the testing of raw water entering the water filtration plants and includes a strict protocol to ensure a consistent and reliable response to the detection of *Cryptosporidium* and *Giardia*.

If *Cryptosporidium* and *Giardia* are detected, immediate testing of filtered water at the affected water filtration plant is required in accordance with a SWC response protocol. In addition, a NSW Health Department protocol vests sole responsibility for issuing a 'boil water' notice with NSW Health's Chief Health Officer and lists

9 The SWC has been forced to conduct intensive monitoring on a daily basis since the *Cryptosporidium* incident in 1998.

factors in addition to *Cryptosporidium* and *Giardia* levels to be considered in deciding to issue or lift the notice.

Reporting requirements

The MoU between the SWC and NSW Health specifies that the SWC must prepare an annual report on all routine water quality testing conducted and results obtained in its area of operation. This report is part of an integrated strategy by the SWC to provide consumers with more information about the quality of drinking water.

In addition to producing this report, the SWC is required under s. 101(3) of the *Sydney Water Act 1994*, to publish on its web site a quarterly consumer confidence report on water quality (see box C1.4). The first quarterly report was released on 30 April 1999.[10] A summary pamphlet is also forwarded to all consumers with their quarterly water account.

Box C1.4 **Consumer confidence reports**

The consumer confidence report must include, in summary form, the following:

- details of the quality and quantity of water in the Corporation's catchment areas;
- an evaluation of the effectiveness of the Corporation's treatment of water from its catchment areas during and immediately preceding three months;
- a review of developments in the literature concerning issues relating to the quality of drinking water, being issues faced by authorities world wide who are responsible for the quality of any drinking water;
- an overview of issues relating to catchment management that were current during the immediately preceding three months; and
- such other matters as the regulations may prescribe.

Source: Sydney Water Act 1994, s. 101(5).

In recognition that *Cryptosporidium* and *Giardia* are still a matter of concern with consumers, the SWC provides daily water testing updates for *Cryptosporidium* and *Giardia* on its web site.

10 The SWC estimated that the cost to publish consumer confidence reports is around A$314 000 per annum (SWC 1999b).

Incident management and emergency response

Under the terms of the MoU with NSW Health, the SWC must develop a comprehensive Drinking Water Quality Incident Management Plan covering the Corporation's drinking water supply systems, wastewater reclamation and reuse. The aim is to minimise the impacts of disruption of services.

The parties to the Plan must nominate a 24 hour incident management contact point for the coordination of responses to any event of public health significance. The Plan must also contain procedures and protocols for the coordinated management of incidents including the notification of public health advice to customers and media communication of public health information.

Under the Plan, the SWC on detecting contamination of the water supply would notify NSW Health and provide information about the concentration of the contaminant and the likely affected areas. NSW Health has responsibility for assessing the public health implications of the event, based on the testing results provided by the SWC, and if necessary to exercise the authority to issue a 'boil water' notice to the community. The SWC would carry out further testing to ensure that the filtration systems were working and that there was not a major breakthrough of contamination into the filtered water supply. Only NSW Health can lift the 'boil water' notice once the safety and quality of the water supply has been confirmed.

SWC and NSW Health personnel must be trained to respond to and execute the Incident Management Plan and appropriate training exercises must be jointly developed and conducted.

HWC water quality monitoring procedures

The monitoring procedures for the HWC are specified in detail in the MoU with NSW Health. Clause 3 of the MoU states that:

> Sampling will be conducted by the Corporation in accordance with the 1996 NHMRC and ARMCANZ Guidelines for Drinking Water Quality in Australia and as qualified in the Operating Licence [(see box C1.5)]. Additional sampling and testing may be carried out if reasonably required (NSW Health 1998a, Clause 3, p. 2).

Box C1.5 **Monitoring requirements specified in the Operating Licence**

The Operating Licence makes the following qualifications with respect to monitoring.

- Where the Guidelines have suggested a sampling frequency of annually if at all, the Corporation will sample once within the Licence period.
- For disinfection by-products, as allowed within the Guidelines, monitoring will be carried out as a minimum for trihalomethanes. If concentrations exceed the guideline value then other by-products will be analysed specifically.
- As the Corporation's sources are well protected, sampling for pesticides will be taken quarterly for all sources. However, Grahamstown must take additional samples after a major transfer of water (greater than 10 per cent total storage) from the Williams River.
- Radiological quality will be measured every two years for ground water supplies and five years for surface supplies.
- For compliance purposes, chlorine will be assessed against the health parameter listed in the Guidelines, not the aesthetic parameter. This is required to ensure the Corporation maintains an effective disinfectant residual.
- For compliance purposes pH will be assessed in the range 6.5 to 9.2 in accordance with the provision for extending the range where cement mortar lined pipes are used.
- Where the Guidelines recommend monitoring at a consumer's tap, the Corporation will monitor at the boundary to the property from a service pipeline directly off a main selected to represent the quality of water supplied to a consumer.

Source: HWC (1995), Schedule 3.

Since 1 July 1997, the HWC has been routinely testing both its raw water and treatment plant output for *Cryptosporidium* and *Giardia*. In addition, samples have been taken from the distribution (pipe network) system as a check on water delivered to consumers.

The 1997-98 operational audit conducted by Hyder Consulting, noted that the HWC had increased the frequency of its sampling to average 13 tests per month (in raw water, treated water and the distribution system).[11] During 1997-98, the testing regime had been spread over seven to ten days each month with around 100 tests taken for *Cryptosporidium* and *Giardia* in the treated water supplies. Over this time the HWC did not detect a positive result in either the treated water or distribution samples (Hyder Consulting 1998).

11 Hyder Consulting performed the 1997-98 operational audit on behalf of the Licence Regulator.

Reporting requirements

Copies of monthly Board reports on Licence compliance are provided to the Hunter Public Health Unit which reports to NSW Health (NSW Health 1998a). Monthly reports are also provided to the media and public libraries in the Corporation's area of operations (HWC, NSW, pers. comm., November 1999). Further, the operational audit of the HWC, after acceptance by the regulating Minister, must be made available to NSW Health each year. The HWC is also required to make public the outcome of this report under the conditions of the Licence (HWC 1995).

Emergency response

Under the MoU with NSW Health, the HWC must report to NSW Health, any event within its water supply systems that may have significant implications for public health. NSW Health will provide a 24 hour point of contact for the reporting of any such event in order to facilitate coordination of responses to any event of public health significance.

Wyong and Gosford Councils and non- metropolitan suppliers water quality monitoring procedures

In the absence of a formal mechanism such as an Operating Licence or MoU to commit a supplier to monitor water quality, Wyong and Gosford Councils and the non-metropolitan suppliers, monitor water quality according to the Guideline recommendations.

Wyong Council has in place a Water Quality Monitoring Plan which complies with the 1996 Guidelines. The Council also reviews sampling and monitoring programs at least annually (Wyong Council, NSW, pers. comm., June 1999).

Similarly, Gosford Council undertakes sampling and analyses under the Council's Health Program in accordance with monitoring requirements specified in the 1996 Guidelines (Gosford Council, NSW, pers. comm., June 1999).

To assist non-metropolitan suppliers to manage the risk of *Cryptosporidium* and *Giardia* in their water supplies, the DLWC has recently published a document entitled '*The Management of Giardia and Cryptosporidium in Town Water Supplies — Protocols for Local Government Councils'*. This document provides advice on how to manage catchments and water supply systems through risk evaluation, critical point analysis and a multiple barrier approach.

Reporting requirements

Compliance information for Wyong and Gosford Councils and the non-metropolitan suppliers is not reported publicly by NSW Health or by the suppliers. However, limited compliance information is published by other agencies. For example, Gosford Council supplies compliance data to the Water Services Association of Australia (WSAA) which is publicly available from WSAA (WSAA 1998).

The IPART publishes Wyong and Gosford Council's monitoring results, albeit limited in scope, in its final price determination report.[12] However, because the reporting requirements of a price regulator are quite different to those of a Health Department or supplier, the published results are not comprehensive — there are no details on individual water quality parameters, nor are they consistently reported for each Council.

Enforcement

The Minister for Health and the Director-General of the Department of Health have certain responsibilities in relation to the protection of public health under the *Public Health Act 1991*.[13]

Specific provisions for the safety of drinking water are contained in Part 2A of the *Public Health Act 1991*. In particular, the Minister for Health has emergency powers to take such action, or give such directions, as he or she considers to be necessary in order to restrict or prevent the use of water which is unfit for drinking or domestic purposes, or which is suspected to be a risk to public health.

In response to the Sydney Water Inquiry in 1998, the regulatory powers of the Director-General of NSW Health have been strengthened (see box C1.6). The proposed changes to the *Public Health Act 1991*, give the Director-General of NSW Health greater powers to enter the premises of any supplier of drinking water to inspect, test, sample and obtain necessary information relating to the quality and testing of specific water supplies. It also specifies that the Chief Health Officer has

12 Gosford and Wyong Councils are required to demonstrate to the IPART that they are complying with the Guidelines. Monitoring results are one indicator of compliance in the absence of conducting an operational audit.

13 The *Public Health Act 1991* (Part 2A Safety of Drinking Water) covers the SWC, the HWC, a water supply authority within the meaning of the *Water Supply Authorities Act 1987* (includes Wyong and Gosford Councils), a local council (includes non-metropolitan suppliers) or a county council exercising water supply functions under Division 2 of Part 3 of Chapter 6 of the *Local Government Act 1993*, and the Lord Howe Island Board.

exclusive responsibility for issuing 'boil water' advice to the public, in the case of the SWC and the HWC.

Box C1.6 **Financial penalties for non-compliance**

Significant financial penalties have been introduced for suppliers who fail to correctly advise the public on the safety of drinking water. For example, under the *Public Health Act 1991* (Part 2A Safety of Drinking Water) if:

- a supplier of drinking water fails to issue an advice to the public provided to it by the Chief Health Officer, the maximum penalty which may be imposed is 10 000 penalty units (in the case of a Corporation) or 2500 penalty units (in any other case);
- a supplier of drinking water fails to comply with a direction to correct misleading information in relation to the safety of the supplier's drinking water, the maximum penalty which may be imposed is 10 000 penalty units (in the case of a Corporation) or 2500 penalty units (in any other case);
- a supplier of drinking water wilfully intimidates, obstructs or hinders a person authorised by the Director-General to enter and inspect the premises of a water supplier, the maximum penalty which may be imposed is 2500 penalty units (in the case of a Corporation) or 400 penalty units (in any other case);
- a supplier of drinking water fails to test drinking water pursuant to a request by the Director-General, the maximum penalty which may be imposed is 2500 penalty units (in the case of a Corporation) or 400 penalty units (in any other case);
- a supplier of drinking water fails to provide information as directed by the Director-General, the maximum penalty which may be imposed is 2500 penalty units (in the case of a Corporation) or 400 penalty units (in any other case).

Source: Public Health Act 1991.

The SWC and HWC are also subject to enforcement action if they contravene their Operating Licence or fail to meet their service obligations set out in their Customer Contract.

Under the *Sydney Water Act 1994* and the *Hunter Water Act 1991* if, in the opinion of the Minister, the SWC or HWC have contravened their Operating Licences, the Minister may cause a notice to be served on the Corporation requiring it to rectify the contravention within a specified period.[14]

If either Corporation contravenes its Operating Licence, the Governor may direct that the following is to apply:

14 Contravention includes failure to comply with the Guidelines set out in the Operating Licence.

- a letter of reprimand by the Minister is to be served on the Corporation; or
- the Corporation is to pay a monetary penalty (not exceeding A$1 million in the case of the SWC or A$150 000 in the case of HWC) in any amount to be determined by the Governor.

Further, the Operating Licence may be cancelled under s. 20 of the *Sydney Water Act 1994* and s. 18 of the *Hunter Water Act 1991*.

The cancellation of the SWC's Operating Licence was described in the Sydney Water Inquiry Report as:

> … a purely hypothetical penalty in view of the essential nature of water supply services and the lack of an alternative provider. It does not constitute a meaningful sanction (McClellan 1998, p. 225).

If the SWC does not meet its obligations under its Customer Contract, a customer has rights of redress. For example, if water or sewerage service continuity does not conform with the Operating Licence standards, the customer may be entitled to a rebate on the service availability charge. In addition, the SWC voluntarily has a policy to provide a rebate for instances of dirty water, poor pressure or sewer discharge.

In recognition of the contamination of Sydney's water supply by *Cryptosporidium* and *Giardia* in 1998, the Premier of NSW asked the IPART to consider and make recommendations on the issue of rebates (SWC 1998a). The IPART recommended a A$15 rebate for customers affected, and also recommended that its previous determination to increase the price of water (usage charge) from 80 to 85 cents per kilolitre would be deferred from the quarter commencing 1 July 1998 until the relevant authorities are satisfied that the problem affecting the delivery of filtered water supply has been satisfactorily resolved (SWC 1998a). Documents tabled in the NSW Parliament show that it has cost the SWC A$20 million in consumer rebates and a further A$17 million in deferring a scheduled increase in water rates (Nason et al 1999).

According to newspaper reports, about 9000 businesses have registered compensation claims under a class action scheme approved in December 1998 by the Federal Court. Payouts under this scheme are expected to amount to several million dollars, with claimants being mainly from the food and hospitality industries. These claims are in addition to settlements totalling about A$700 000 already paid to 3000 businesses and individuals by the SWC (CRCWQT 1999b).

The HWC's Customer Contract also includes a provision to pay rebates to customers if specified service standards are not met. The rebate of the annual service charge applies to contract events including low pressure, sewer overflows or

water discontinuity where they are due to either a failure of the HWC's system or under-capacity problems. Customers do not have to apply for a rebate, it is automatic (HWC 1998).

Record of compliance

The Licence Regulator is a statutory body corporate established by the *Sydney Water Board (Corporatisation) Act 1994*. The principal function of the Licence Regulator is to manage the independent operational audits that are carried out annually to assess the SWC's and the HWC's compliance with their Operating Licences (including compliance with the Guidelines specified in the Licence).[15]

Wyong and Gosford Councils and the non-metropolitan suppliers are not subject to an operational audit by the Licence Regulator.

The NSW Government has adopted the principle of separating regulation from service delivery, and in doing so, funding of the audit is provided by a budget allocation.[16]

The Licence Regulator has five part-time members appointed by the Minister. Membership includes representation from environmental, consumer, water industry and business interests, in addition to a nominee of the Minister administering the *Water Administration Act 1986*.

The SWC and the HWC require similar, but not identical, processes to audit their Operating Licences (Licence Regulator 1998a).

For the SWC, the Licence Regulator is required to:

- monitor compliance with the SWC's Operating Licence conditions;
- inform the Operating Licence Minister about any failure of the Corporation to meet operational standards or any other Operating Licence requirements; and
- commission an independent annual audit of the Corporation against the Operating Licence requirements.

The Minister for Urban Affairs and Planning is required to table the audit in Parliament and decide on any actions resulting from the independent audit and

15 Operational audits are performed on a calender year basis for the SWC and on a financial year basis for the HWC.

16 n contrast, the Western Australian statute requires the supplier to commission and pay for audits every two years, reporting on the effectiveness of its asset management system and initiatives to comply with its licence (Licence Regulator 1998a).

advice from the Licence Regulator. The Licence Regulator is required to advise the Minister of penalties or remedial action required for not meeting the Operating Licence conditions.

In its 1998 Operating Licence audit of the SWC, the Licence Regulator found that the SWC had achieved high compliance with the health-related requirements of both the 1980 and 1996 Guidelines. Monitoring and reporting of water quality results during 1998 found no breaches of the chemical or radiological criteria, and that against the 1996 Guidelines, all 14 water delivery systems had greater than 97.1 per cent compliance for *total coliforms* and greater than 99.6 per cent compliance for *thermotolerant coliforms* (Licence Regulator 1999).

The SWC on behalf of NSW Health, also arranged for an independent assessment of their performance and adequacy of monitoring procedures. This assessment revealed that their performance met the health-related aspects detailed in the 1980 Guidelines, as well as the health-related aspects of the 1996 Guidelines for the period 1 January 1998 to 31 December 1998.

The 1997-98 operational audit of the HWC activities indicate that the Corporation met the Licence requirements for microbiological and all key and non-key chemical and physical parameters based on the 1996 Guidelines.[17] For example, 98.7 per cent of samples tested for *total coliforms* (licence target 95 per cent) and 99.6 per cent of samples tested for *faecal coliforms* (licence target 98 per cent) were within the guideline values (Hyder Consulting 1998).

C1.5 Industry response

In implementing more stringent drinking water standards, the cost of compliance can be significant — particularly if suppliers are required to upgrade their facilities. These upgrades may be funded by capital grants or by increased water prices.

In NSW, the Government subsidises the capital works necessary to upgrade small systems on equity and public health grounds. The IPART, is given the responsibility of setting prices to recover the cost of investment undertaken to meet current drinking water standards.

[17] Monitoring of *faecal coliforms* and *total coliforms* are used as the indicator organism for microbiological parameters. The key chemical and physical parameters monitored include copper, chlorine, fluoride, manganese, lead and trihalomethanes. The non-key parameters include ammonia, dissolved oxygen, hydrogen sulphide, nitrates and nitrites, herbicides and pesticides.

Action to implement drinking water guidelines

In NSW successive State governments have provided technical and financial assistance to the large number of relatively small non-metropolitan suppliers (DWLC, NSW, pers. comm., October 1999).

The Minister for Land and Water Conservation provides technical, management and financial assistance through the Country Towns Water Supply and Sewerage Program. The DLWC administers this Program and advises on appropriate policies, legislation and State-wide priorities for assistance to the non-metropolitan suppliers.

As part of the Program, DLWC provides advice on appropriate water treatment infrastructure to ensure the quality of drinking water in country towns meets the Guidelines.

Cost of implementation

In 1996 the NSW Government made a commitment to provide A$855 million to assist non-metropolitan suppliers overcome problems with existing water supply and sewerage systems and to provide initial infrastructure to presently unserviced towns. This commitment included an allowance of A$125 million of government funds for the provision of new water treatment facilities (DWLC, NSW, pers. comm., October 1999).

This financial assistance is limited to backlog capital works only and provided on a dollar-for-dollar basis. No subsidy is provided for operation, maintenance and renewal.

The DLWC manages the grants allocation process and is involved at every stage of a project. A project manager ensures the scope and details of the project and the procurement method have the endorsement of the non-metropolitan supplier and the DLWC.

For other suppliers such as Wyong and Gosford Councils, there were no capital costs incurred in moving from the 1987 to the 1996 Guidelines. The only costs related to the sampling and monitoring frequency and were considered to be insignificant in relation to total costs (Wyong and Gosford Councils, NSW, pers. comm., June and December 1999).

Cost recovery

The IPART was established in July 1992 under the *Independent and Regulatory Tribunal Act 1992* (IART Act). The IPART is empowered to determine maximum prices and periodically review pricing policies for declared government monopoly services (IPART 1999).

There are provisions within the IART Act which allow the government to set prices below, but not above those recommended by the IPART.

The SWC, the HWC, Gosford and Wyong Councils are all declared monopolies which are regulated by the IPART.[18]

Under s. 15 of the IART Act, the IPART must have regard for a number of factors in making its determinations and recommendations. These factors include consumer protection, economic efficiency, financial viability, environmental issues and standards.

Although one of the objectives of the IPART's determinations is to improve the efficiency levels of water suppliers, this must not occur at the expense of lowering service standards below acceptable levels. The IPART consults with the Licence Regulator to ensure that the SWC and the HWC have fully met their obligations for quality, reliability and safety. The IPART relies on Wyong and Gosford Council's Annual Information Returns, which indicate compliance or otherwise with quality standards, as well as WSAA *facts*, to make an assessment.

In January 1996, the IPART was required to take account of standards of quality, reliability and safety of the services concerned (whether those standards are specified by legislation, agreement or otherwise) for the first time in making its price determinations and recommendations.

Compliance with the IPART's determinations is required under s. 18 of the IART Act. Suppliers are required to indicate how they have implemented a determination in their annual reports. Information must also be provided on whether the IPART recommendations made in pricing policy reviews have been implemented and reasons must be given for any failure to do so (IPART 1998).

The IPART follows transparent public processes which include advertisement of all investigations, public submissions which are available for public inspection, at least one public hearing for each investigation, public seminars and workshops and the

18 In addition, the IPART is required by s. 12(1) of the IART Act to regulate bulk water services for the non-metropolitan suppliers, irrigation areas and districts and direct water users including private irrigators on rivers, groundwater users and industrial users.

submission of a public report to the Premier. The IPART's Secretariat liaises extensively with interested parties and the agencies concerned during the process.

C2 Victoria

The administration of drinking water service provision in Victoria is split between the Melbourne Metropolitan Area (MMA) and regional Victoria.

In 1995, water supply to the MMA was 'disaggregated' by splitting the Melbourne Water Corporation (MWC) into four separate corporations. MWC now supplies bulk water at the wholesale level to three water retail companies — City West Water, South East Water and Yarra Valley Water.[1] MWC have Bulk Water Supply Agreements (BWSAs) with the three retailers. These Agreements include provisions concerning the quality of bulk water and management of risks and catchments.

Currently, most of Melbourne's water supply does not undergo filtration as around 90 per cent of its water is sourced from protected catchments (MWC 1999).[2] This water undergoes disinfection, fluoridation and pH correction, before being distributed to the population.

During the 1990s, the drinking water sector in Victoria underwent review and reform. Part of this process included the establishment of operating licences for the three metropolitan retail companies. The Office of the Regulator-General (ORG) administers these licences.

The MWC does not hold a licence or Memorandum of Understanding (MoU) with the ORG, Department of Human Services (DHS(Vic)), or the Department of Natural Resources and Environment (DNRE). MWC has no formal role in the regulation of drinking water quality. However, like most water suppliers, it is understood to make representation to the NHMRC concerning drinking water quality.

Fifteen Non-Metropolitan Urban water authorities (NMUs) supply regional Victoria's drinking water. Unlike Melbourne, water is mainly sourced from unprotected catchment areas and undergoes extensive treatment in some

1 As State-owned enterprises, these metropolitan water retailers make tax-equivalent payments and also pay dividends to the Victorian government.

2 The 10 per cent of water obtained from other sources undergoes filtration mainly at the Winneke Treatment Plant.

communities (using dissolved air flotation, biological activated carbon and ozone in Edenhope for example).[3]

The State government, through the DNRE, has established MoUs with the NMUs. These MoUs cover, among other things, the quality of drinking water.

Source water for regional supplies is harvested from catchment lands, managed by various agencies such as the Forests Service, Parks Victoria, water authorities, the DNRE, municipal councils and private landowners. Strategic catchment management is a role of Catchment Management Authorities (CMAs). Regionally based CMAs were formed in 1997, to provide for sustainable land and water management in their regions under the DNRE Catchment Management and Sustainable Agriculture Program. The policies of the CMAs and other catchment land managers therefore affect raw water quality prior to its treatment by the NMUs.

C2.1 Regulation

The DHS(Vic) is the lead Government agency with respect to drinking water quality incidents. The Department's Environmental Health Unit is responsible for monitoring compliance with the relevant health legislation as it applies to water suppliers in Victoria. It is understood that future options for water sector regulation (including the setting of standards for drinking water quality) for the Victorian water industry are at present being investigated by DNRE and the DHS(Vic) (DNRE, Melbourne, pers. comm., 30 November 1999).

Department of Human Services

The responsibilities of the DHS(Vic) in relation to drinking water are formally defined in the *Health Act 1958*. Section 80 of the *Health Act 1958* gives the DHS(Vic) power to take action if a water supply presents a threat or potential threat to public health, including the power to close a water supply.

Under s. 81 of the *Health Act 1958*, regulations can be made for a wide range of purposes associated with water supplies. Despite having this power, the DHS(Vic) has not made any regulations that directly specify the standard of drinking water quality to be adhered to by the State's suppliers. However, at the time this report was written, the DHS(Vic) and the DNRE were addressing the extent to which the

[3] A number of supplies, particularly in northern Victoria, are sourced from the systems of the four Rural Water Authorities.

Australian Drinking Water Guidelines 1996 should be applied as enforceable standards, in place of the current standards which are based on the *Guidelines for Drinking Water Quality in Australia 1987* (ORG 2000).

Regulations currently applying to drinking water supplies are as follows:

- *Health (Quality of Drinking Water) Regulations 1991*; and
- *Health (Infectious Diseases) Regulations 1990.*

The *Health (Quality of Drinking Water) Regulations 1991* require each water authority in Victoria to 'take reasonable precautions to ensure its water supply system and catchments are protected from contamination' where the water is intended for human consumption. The Regulations also place obligations on water suppliers with regard to frequency of catchment inspections and sampling of water for faecal and total coliforms using accredited laboratories.

Samples are tested and the results are notified to the DHS(Vic). Laboratories are obliged under the *Health (Infectious Diseases) Regulations 1990* to notify the DHS(Vic) if human pathogenic organisms (including *Giardia* cysts or *Cryptosporidium* oocysts) are detected in a water quality sample. The DHS(Vic) has powers to intervene with the supply of water in the event that an outbreak of infectious disease may, or has occurred.

DHS(Vic) also has responsibility for the administration of the *Health (Fluoridation) Act 1973*, which regulates the fluoridation of specified drinking water supplies.

Metropolitan retail water suppliers

The regulatory framework applying to the Melbourne metropolitan water industry has been described as 'light handed' (ORG 1996). The Minister for Agriculture and Resources is responsible for the *Water Industry Act 1994*, under which operating licences have been issued to the three metropolitan retail water companies.

Established under the *Office of the Regulator-General Act 1994*, the ORG has the power to regulate selected industries within Victoria, including the restructured metropolitan water industry. The Regulator-General is independent of the Government, and of the industries regulated by the Office.

The objectives of the Office in relation to regulating the metropolitan water industry as described under the *Water Industry Act 1994* are to:

- ensure the maintenance of an efficient and economic water industry;

- protect the interests of customers with respect to water industry charges and terms and conditions of water industry services;
- protect the interests of customers with respect to the reliability and quality of water industry services; and
- facilitate the maintenance of a financially viable water industry.

Although the DHS(Vic) has primary responsibility for regulating and maintaining health related aspects of water quality, the ORG also regulates some aspects of water quality for the metropolitan water retailers. This creates a partial overlap of responsibilities. The ORG monitors operating licence conditions for the metropolitan retailers. The operating licences mainly cover customer service obligations, but they also deal with water quality standards and monitoring programs (ORG 1999). The licences contain:

- two performance standards for microbiological water quality (faecal and total coliforms); and
- an obligation that the licensee conduct a water quality monitoring program in accordance with the *Health (Quality of Drinking Water) Regulations 1991* and the *Guidelines for Drinking Water Quality in Australia 1987* issued by the NHMRC, as well as delivering water clear and free from objectionable taste and odour.

MMA water retailers are required to supply the ORG with quarterly reports showing compliance with their operating licence conditions. An annual water quality report is also required to be produced and made publicly available as part of the operating licence conditions. This report includes information on areas such as monitoring programs, operation of systems, improvement programs and customer complaints, as well as how they are complying with their licence conditions.

The ORG was envisaged as the economic regulator of the water industry. At present, it does not perform this function.

Non-metropolitan urban water authorities

NMUs were established under the *Water Act 1989* and are responsible to the Minister for Agriculture and Resources. No specific requirements for drinking water quality supplied by the NMUs are specified under the *Water Act 1989*. However, it is expected that these water authorities will supply water that is safe to drink. This is 'checked' through the Business Plan that the NMUs are required to submit to the DNRE each year. In these plans, the NMUs must specify water quality performance targets for microbiological parameters (DNRE, Melbourne, pers. comm., 30 November 1999).

As a part of its $1.3 billion water reform package announced in October 1997, the Victorian Government decided to provide for the acceleration of capital works in non-metropolitan regions. Non-metropolitan urban and rural water suppliers were to be provided with $410 million, part of which was to be applied in the upgrading of drinking water quality (Office of the Premier 1997).

As a consequence of the October 1997 water reform package, the NMUs entered into MoUs with the Minister to achieve the health-related parameters of the *1984 World Health Organisation Guidelines* (WHO) (see box C2.1).[4] These MoUs between the Government and the NMUs are not enforceable.

Capital investment by NMUs under MoUs between the suppliers and the Minister for Agriculture and Resources is occurring across country Victoria to bring drinking water systems up to compliance with the 1984 WHO Guidelines. Public consultation by the NMUs is a key activity during the planning of upgrades to treatment systems because of the costs that communities can incur, and the need to explain the reasons for the proposed works.

NMUs are required to provide a Performance Report, as part of the Report of Operations in their Annual Report. The Performance Report contains service delivery performance indicators of:

- bacteriological quality; and
- physio-chemical quality.

NMUs are required to report in their Business Plan the planned target for each performance indicator. They are also required to report their actual performance achieved, and the variance in percentage terms between the target and the outcome. Where the Performance Report identifies significant unfavourable variances between planned and actual performance, authorities must provide a Variance Report stating the reasons for the differences.[5]

4 The requirements for drinking water quality are set out in Schedule C of the MoU and are based on the 1984 WHO Drinking Water Guidelines.

5 In the case of Bacteriological Quality of Potable Water Supplied to Customers and Physio-Chemical Quality of Water Supplied to Customers, a significant variation has been defined as more than five per cent.

Box C2.1 **Memoranda of Understanding between the State and NMUs**

The Memoranda with the NMUs cover issues such as tariff reduction, government capital contributions toward water quality improvement projects, drinking water quality, environmental and dam improvement projects. The provisions relating to drinking water quality supplied by each NMU are outlined below:

DRINKING WATER QUALITY

(a) The Authority shall provide by 31 December 1999 drinking water supplies that meet the health-related standards listed in Schedule C ('the Standards') for all systems, in towns and zones currently or, from time to time under its control, except:

(i) the towns and zones listed in Part 1 of Schedule D for which the specified parameters will not be met;

(ii) the remote towns listed in Part 2 of Schedule D with less than 200 people, being towns where reticulated water is not used for drinking purposes and it is not cost effective for the water supply to meet the health-related standards;

(iii) the towns and systems listed in Part 3 of Schedule D being for rural water supplies; and

(iv) individual supplies by agreement.

(b) In order to meet the requirements of clause (a), the Authority has identified the projects listed in Part 4 of Schedule D which are to be completed by 31 December 1999.

(c) Commencing in January 2000, the Authority shall take samples at quarterly intervals for a 12 month period of drinking water supplies for those systems, towns and zones which must meet the Standards and those which are listed in Part 1 of Schedule D. The Authority shall ensure that the samples are analysed by an Approved Laboratory for each of the parameters listed in Schedule C and shall forward a copy of the results to the Minister by 31 January 2001.

Source: DNRE (1997).

C2.2 Monitoring and enforcement

Compliance of all water suppliers is monitored using samples collected in accordance with the schedule outlined in the *Health (Quality of Drinking Water) Regulations 1991* (see box C2.2).

Box C2.2 **Health (Quality of Drinking Water) Regulations 1991**

The *Health (Quality of Drinking Water) Regulations 1991* set out the requirements for the reporting of waterborne illness, inspections and sampling of drinking water. Inspecting and sampling are outlined in s. 7:

7. (1) A water supply authority must —

(a) take samples from its water supply systems in accordance with the Schedule; and

(b) cause the samples to be bacteriologically examined for faecal coliforms and total coliforms at a laboratory approved by the Chief General Manager.

In monitoring and sampling their drinking water, the water authorities across the State must comply with the following schedule:

SCHEDULE

Maximum intervals between successive samples of water from water supply systems and minimum number of samples to be taken and analysed for faecal coliforms and total coliforms.

PART 1 — SAMPLING IN DISTRIBUTION SYSTEMS

Population served in each distribution system	*Maximum interval between successive samples in each distribution system*	*Minimum number of samples each month from each distribution system*
Up to 2 000	1 month	1 sample
2 001 – 10 000	1 month	1 per 2 000 population
10 001 – 20 000	1 month	3 plus 1 per 5 000 population
20 001 – 50 000	2 weeks	3 plus 1 per 5 000 population
50 001 – 100 000	4 days	3 plus 1 per 5 000 population
More than 100 000	1 working day	13 plus 1 per 10 000 population

Note Sampling should be rotated throughout all parts of the distribution system. Samples should be taken from each point where water enters a distribution system.

PART 2 — SAMPLING OF SOURCE WATER

If water is received from several sources, the water from each source must be sampled monthly.

The regulations include a sampling regime, with the frequency of sampling linked to population. This is in keeping with the principle that the level of monitoring should be linked to the number of people at risk. There is a minimum monitoring requirement to provide some protection for very small communities.

Suppliers must test the samples they take from various points in the distribution system with a laboratory accredited by the DHS(Vic). These laboratories examine the samples according to the bacteriological guidelines for thermotolerant and total coliforms. In certain circumstances, DHS(Vic) may direct a water authority to do additional testing under the *Health (Infectious Diseases) Regulations 1990*.

The Melbourne water retailers and the NMUs pass on these results to the DHS(Vic) under s. 7 of the *Health (Quality of Drinking Water) Regulations 1991*. However, the test results are assessed against the 1984 WHO Guidelines in the case of NMUs and the 1987 NHMRC Guidelines in the case of the three Melbourne retailers.

Internal and external audits are undertaken on the test results for the three metropolitan retail suppliers. The three retailers are also required to produce an annual report and an annual water quality report that is to be made publicly available, as part of the conditions in their operating licence. The ORG specifies the minimum content of these reports. However, the ORG believes rather than coordinating the regulation of water quality amongst various agencies, that a single body, such as the Drinking Water Inspectorate that regulates the UK water industry, could better implement the oversight of water quality obligations:

> The Office considers that best practice water quality regulation is based on primary responsibility being consolidated within a single body which pro-actively monitors water quality against an appropriate and comprehensive range of standards and ensures a holistic catchment to customer tap approach is followed in preventing water contamination (ORG 2000, p. 9).

The ORG produces an annual performance report on Melbourne's retail water and sewerage companies. The primary purpose of this report is to enable comparison of compliance with the standards and procedures undertaken by the three retailers.

The DNRE produces reports annually on the bacteriological quality of drinking water supplied by NMUs, and biannually on the physical and chemical quality for the whole of the State. AWT Water Eco Science compiles these reports from their own data and from DHS(Vic) records.[6] The reports on the NMUs' drinking water quality are not widely circulated, but are available to the general public.

The NMUs provide details of their water quality compliance with the 1984 WHO Guidelines in their annual reports.

6 AWT Eco Science is just one of the DHS(Vic) approved laboratories which monitors drinking water quality in Victoria.

Cost of compliance

At face value, some suppliers such as the MWC, appear to have difficulty in meeting the 1996 *total coliform* test. However, the 1996 Guidelines make it clear that if a water supplier can demonstrate that these total coliforms are not faecally derived, then the supplier (in this case MWC) would be deemed to have satisfied the 1996 Guidelines.

MWC has reported that it would cost between $430 and $510 million, depending on the process selected, for it to meet the 1996 Guidelines by filtering all of the water it supplies to the MMA (MWC pers. comm., 25 January 2000).

The Auditor-General's report on Ministerial Portfolios 1999 recognised that to ensure high water quality, a comprehensive program of water quality management is required. This includes catchment protection and management, effective water treatment, maintenance of distribution systems, comprehensive water quality standards and appropriate benefit–cost analysis of additional water treatment processes. The response provided by the Secretary, DNRE, to the Auditor-General's 1999 *Report on Ministerial Portfolios* and the comments concerning the MWC were as follows:

> As indicated earlier in audit's Report, the microbiological quality of water in the Melbourne metropolitan area is of a high standard and the benefits of incurring costs in the order of $500 million to further improve it to ADWG 1996 standards are not clearly established. Other options, including a number not requiring extensive capital works which would satisfy key requirements of ADWG 1996, need to be examined and evaluated (VAGO 1999 p. 236).

Enforcement

The DHS(Vic) is responsible for handling non-compliance with the sampling requirements of the *Health (Quality of Drinking Water) Regulations 1991*. The Regulations specify a sampling regime but do not refer to the Guidelines.

If contamination is found, the DHS(Vic) can direct the supplier to treat the water to a standard determined by the DHS(Vic) under s. 9 of the *Health (Quality of Drinking Water) Regulations 1991*:

> If the Chief General Manager [DHS(Vic)] is satisfied that the water supplied by a water supply authority is, or may be, contaminated and that there is a substantial risk to the public health because of the contamination, the Chief General Manager may, after consulting with the water supply authority, do either or both of the following:
>
> (a) direct the authority to notify all affected services that water should be boiled before drinking; and

(b) direct the authority to purify the water supply to a standard determined by the Chief General Manager.

Any breach of the operating licences for the metropolitan retailers is dealt with by the ORG. Enforcement orders for licence compliance are outlined in the *Office of the Regulator-General Act 1994*:

35. *Enforcement orders*

(1) This section applies if a person is contravening, or is in the opinion of the Office is likely to contravene—

(a) a determination; or

(b) if the Office is under the relevant legislation or by virtue of an Order in Council under section 3(2) responsible for licensing, the conditions of a licence—

and the Office considers that the contravention or likely contravention is not of a trivial nature.

(2) The Office may serve a provisional order or a final order on the person requiring the person to comply with the determination or licence condition.

Thus, both DHS(Vic) and the ORG have a role with respect to metropolitan drinking water quality.

In the case of water supplied by the NMUs, both DHS(Vic) and DNRE have a role.

There has been no information collected in Victoria on the effect of non-compliance on public health (VAGO 1999 para 3.5.42). The *Water Industry Act 1994* gives DNRE inspectors extensive powers to verify whether licensees are complying with water quality standards. However, no inspectors have been appointed (DNRE, Melbourne, pers. comm., 30 November 1999).

In the event of non-compliance with the customer contract overseen by the ORG, customers who suffer illness or loss may be able to take action for damages under the Commonwealth *Trade Practices Act 1974*. In addition, water supply authorities may also have general duties under common law (see chapter 3).

Sanctions

Under s. 35(8) of the *Office of the Regulator-General Act 1994*, if a person breaches their licence conditions and fails to comply with a provisional or final order given by the ORG, they are subject to a significant penalty. This penalty is currently set at an initial $100 000 fine and $10 000 per day for a continuing breach (ORG 1999).

These penalties are imposed by the Supreme Court under s. 36 of the *Office of the Regulator-General Act 1994*, and can only be sought if a person has failed to comply with orders first given by the ORG as a result of a breach of licence conditions.

Under s. 10(2) of the *Health (Quality of Drinking Water) Regulations 1991*, the penalty for non-compliance with the specified monitoring and sampling requirements is a maximum of fifty penalty units.[7] There has been no recorded incidents of any water supplier being prosecuted for non-compliance with the *Health (Quality of Drinking Water) Regulations 1991* (DHS(Vic) pers. comm., Melbourne, 17 November 1999).

7 Under s.110 of the *Sentencing Act 1991* (Vic), one penalty unit is equal to one hundred dollars.

C3 Queensland

In Queensland, the provision of urban drinking water is essentially a local government function. The State's 125 local governments operate 430 urban water supply schemes, supplying 90 per cent of Queensland's population of 3.4 million.

The Queensland Health Department is the regulatory agency responsible for public health and has powers to deal with health-related matters arising from contaminated drinking water.

C3.1 Institutions

By far the largest water authority in Queensland is the South East Queensland Water Board. The Board supplies bulk water to half of Queensland's population. It stores and provides bulk water to its 17 member local governments, including Brisbane City Council.

The water service assets of Queensland local governments are said to be worth in excess of $18 billion (Queensland Government 1999).

Local government urban water providers are generally formed by regulation under powers conferred by the *Local Government Act 1993*. In addition, there are three urban water Boards established under separate legislation:

- *South East Queensland Water Board Act 1979*;
- *Townsville-Thuringowa Water Supply Board Act 1987* (the Board stores, treats and delivers bulk water to the reservoirs of member local governments — Townsville and Thuringowa); and
- *Gladstone Area Water Board Act 1984* (supplies bulk water to Gladstone and Calliope local governments.

A number of small urban water supply systems are operated for indigenous communities and there are a number of privately-operated schemes serving isolated mining towns and tourist resorts.

Under the *Water Resources Act 1989*, the Minister is responsible for statewide rural water development, scheme operations and water resources management.

From 1 July 1997, responsibility for rural water supply was transferred to State Water Projects (SWP), a newly established and discrete commercial entity within the Department of Natural Resources. SWP is primarily responsible for the supply of irrigation water and water for livestock. However, SWP also acts as a bulk water supplier to some local governments, who subsequently treat and reticulate the water for urban use.

C3.2 Regulation

The *Health Act 1937* gives the Minister for Health extensive powers in the event of a public health emergency. In addition, the Act provides for standards to be prescribed (by regulation) for water for human consumption, including measures to protect and purify such water. However, there is no formal requirement to comply with quality standards for drinking water in Queensland.

Water service providers are encouraged by the Queensland Health Department to meet the *Australian Drinking Water Guidelines 1996*. The Health Department is responsible for issuing advice to the public regarding measures to minimise disease risk, including water borne disease. At an operational level however, responsibility rests with the drinking water providers — generally local governments. These providers are encouraged to adopt a multiple barrier approach to risk minimisation outlined in the Guidelines (see appendix B). Also, Queensland Health provides a support service for drinking water providers by offering free of charge, water sampling and testing for compliance with the *Australian Drinking Water Guidelines 1996*.

An Expert Group on Water Quality has been established by Queensland Health to provide the State Manager of Public Health Services, with advice for making decisions regarding the public health aspects of water use in Queensland. The Expert Group has issued an interim protocol which outlines the process for dealing with situations where *Giardia* or *Cryptosporidium* have been detected in drinking water (Queensland Health 1998). The protocol also includes a checklist for good systems management. It is to be reviewed when the NHMRC Guidelines on these two organisms are updated.

In a recent policy discussion paper, the Queensland Water Reform Unit has raised the option of issuing operating licences to water providers (Queensland Government 1999). The discussion paper envisages that the licences could cover a range of issues, but there is no discussion of whether compliance with drinking water standards might be included as a licence condition. However, the paper suggests that, were the regulator to determine that a service provider had complied with its

licensing responsibilities, such determination should not imply that the government had provided any sort of guarantee or assumed any of the liability or risk associated with the provision of the relevant service.

> Regulatory requirements outlined in this framework would be aimed at ensuring that basic requirements for water service provision are met, and consequently would not be intended to mitigate or transfer any liability, risk or responsibility which currently lies with the water service provider. It therefore needs to be emphasised that where the regulator determined that a water service provider has complied with its licensing responsibilities, such determination would not imply that the government had provided any sort of guarantee or assumed any of the liability or risk associated with the provision of the relevant services (Queensland Government 1999, p. 29).

Draft legislation is currently under development in Queensland to revise the overall regulatory framework for water service providers. However, no decision has yet been taken on whether to include drinking water quality within this revised framework and the existing informal arrangements for drinking water quality are continuing to operate in the meantime.

C4 Western Australia

The Western Australian drinking water industry serves 1.7 million customers in over 300 towns and communities across the State (OWR 1999). Drinking water in Perth is sourced from protected catchments and from freshwater underground reserves.[1] In 1998, groundwater accounted for 50 per cent of Perth's total drinking water supply (WRC, pers. comm., 1 March 2000).

Western Australia's Water Corporation is the main supplier, although not the sole provider, of drinking water. Local government, water boards and private enterprise also supply water services to regional areas.

Three separate bodies regulate water supply in Western Australia (see table C4.1). The Office of Water Regulation (OWR) licences service providers in the water industry, the Water and Rivers Commission (WRC) regulates sources of water and the Health Department regulates drinking water quality. This framework was established in 1995 when the Water Authority of Western Australia was split into the Water Corporation, the WRC, and the OWR.

Since 1949, local governments have had the power to make local health laws regarding the provision of adequate supplies of potable water. This power includes specifying the method of reticulation, connection and pressure where the supply is from an established water source (HDWA pers. comm., 13 March 2000).

Each local government is deemed to be a health district and is responsible for the efficient execution of the *Health Act 1911* and associated legislation.

1 Freshwater from underground reserves may be treated by aeration or filtration, depending upon location, before being distributed.

Table C4.1 **Western Australian water industry**

Focus	*Organisation*	*Role*	*Minister*
Water Industry Advice and Regulation	Office of Water Regulation	Regulating and licensing service and infrastructure provision; Promotion of competition; Issue of technical standards; Promotion of customer service charters; Water industry policy and planning; Advise Minister on pricing policies for water and water services.	Minister for Water Resources
Resource Management and Protection	Water and Rivers Commission	Allocation of surface and groundwater; Resource protection.	Minister for Water Resources
Water Quality	Health Department	Monitoring drinking water quality.	Minister for Health

Source: OWR (1999).

The Office of Water Regulation

Water supply service providers are required to supply drinking water that is safe for human consumption and to comply with directions made by the Minister for Health. This is specified in the operating licence that suppliers are required to hold with the OWR.

The OWR does not regulate 'water quality' as such. The Health Department of Western Australia (HDWA) is the primary regulator for drinking water quality.

The OWR administers the *Water Services Coordination Act 1995* (WSCA) and is accountable to the Minister for Water Resources. Under this Act, the OWR has the authority to:

- regulate and license the provision of water services;
- coordinate and advise on water services policy; and
- perform functions under laws relating to the provision of water services.

The OWR has the power to specify the areas — known as Operating Areas — within which water service providers can operate. All organisations providing water services in a controlled area must hold an operating licence (see box C4.1).[2]

Box C4.1 **Regulatory arrangements in Western Australia for water supply service operating licences**

An operating licence established under the *Water Service Coordination Act 1995* includes the terms and conditions of the licence.

Consumer interests and concerns are incorporated into the operating licence with provisions for:

- customer complaints (Schedule 2);
- a customer charter (Schedule 3); and
- consumer committees, (Schedule 4), for the purpose of obtaining consumer opinions on the providers' prices and service standards.

Standards and requirements of the water service provider are set out in the operating licence and cover areas such as:

- asset management (Clause 4);
- operational audit (Clause 4);
- technical standards (Clause 4);
- prescribed individual standards of performance (Clause 4);
- standards for the provision of water services (Schedule 7); and
- performance indicators and reporting requirements (Schedule 8).

Source: OWR 2000.

Changes to operating licences do not have to be passed by Parliament. The OWR has flexibility to amend an operating licence during its term under s. 31 of the WSCA. Any amendment requires notice to be published in the Government Gazette indicating the nature of the amendment.

The OWR has a key policy development role and is a prime source of advice to the Minister for Water Resources regarding price levels and structures and the future development of the industry (see box C4.2).

2 If a water service is being provided outside of a controlled area it is not necessary for the service provider to hold an operating licence. However, the Act makes it an offence to provide water service without first notifying the Coordinator of Water Services to gazette a new controlled area if it is thought necessary to licence the service (OWR 1998).

Box C4.2 **Pricing processes for drinking water in Western Australia**

The OWR provides advice to the Minister for Water Resources on prices and pricing policy for the Water Corporation, Aqwest (Bunbury Water Board) and the Bussellton Water Board. The respective Acts under which these agencies were established — the *Water Corporation Act 1995* and the *Water Boards Act 1904* vests responsibility for prices in the Minister. Local governments who provide water services are responsible for setting their own charges under the *Local Government Act 1995*. The OWR has responsibility for monitoring these charges. The OWR also has responsibility for approving prices for a number of small water service providers.

Each year the Water Corporation, after consultation with the Minister, prepares a submission to Cabinet detailing the level of rates and charges required to achieve the Corporation's business goals in the forthcoming financial year. The Minister presents the submission to the Premier for final approval. Once approval is given, the Water Corporation's subsidiary legislation is amended to reflect the new prices.

Source: OWR (2000).

Water and Rivers Commission

Established in 1995, the WRC is a State government agency. Set up under the WSCA, it is responsible to the Minister for Water Resources.

WRC's responsibilities include:

- allocating water resources between competing interests to ensure sustainable use and conservation through mechanisms including licensing;
- protecting source water quality;
- conserving and managing the State's rivers and waterways through maintaining or enhancing their public amenity;
- investigating the longer term quantity and quality trends in ground water resources;
- measuring water flow and quality; and
- investigating, measuring and assessing the State's water resources.

All users of water resources in a proclaimed area must have a licence with the WRC to do so. Although the OWR licenses service providers, these licensees are required to approach the WRC in order to obtain the allocation of water required delivering their services. Proclaimed areas cover the major water resources of the State and WRC licensing is active in most areas.

The WRC implements its water allocation decisions and regulates the use of water through the powers assigned to it under the *Rights in Water and Irrigation Act 1914*.

Other Acts administered by the WRC under the WSCA cover the protection of ground and surface water sources and include:

- *Country Areas Water Supply Act 1947* (CAWS);
- *Metropolitan Water Supply, Sewerage and Drainage Act 1909* (MWSS&D);
- *Water Agencies (Powers) Act 1984*; and
- *Environmental Protection Act 1986*.

The WRC delegates regional offices, community-based waterways management authorities, and community groups, the task of implementing management, protection and works programs for water sources, catchments and waterways. It also coordinates land use planning with the Ministry for Planning, Department of Environmental Protection and local government to protect water resources.

The WRC is able to declare Underground Water Pollution Control Areas, Water Reserves or Catchment Areas under the MWSS&D, CAWS and the *Water Agencies (Powers) Act 1984* to protect existing and future drinking water sources. These protection areas are collectively referred to as Public Drinking Water Source Areas (PDWSAs).

Water Source Protection Plans (WSPP) are developed by the WRC to establish the level of protection required within PDWSAs. The plans identify development pressures, assess the vulnerability of a water source to contamination, establish Priority Protection Areas and set out programs to protect the resource.

The preparation of WSPPs is not governed by any specific requirement under any legislation. However, it does relate to the general functions of the WRC under s. 10(2) of the *Water and Rivers Commission Act 1995*:

> (e) undertaking, coordinating, managing and providing practical and financial assistance to, activities and projects for the conservation, management or use of water resources;
>
> (h) publishing information and material relating to water resources.

The Water Quality Protection Branch of the WRC are responsible for the preparation of WSPPs. The Infrastructure Planning Branch of the Water Corporation also prepare WSPPs under delegation from the WRC (WRC pers. comm., 16 March 2000).

C4.1 Water quality regulation

In WA there are no regulations that specify the standard that drinking water is to be treated to, reporting of waterborne illnesses, inspection and sampling of water supply.

The Public Health Division of the HDWA is responsible for drinking water quality issues. The aim of the program is:

> To protect public health by ensuring provision of adequate environmental health services to all population centres and communities, the safety of public buildings and the safety of drinking and recreational water (HDWA 1999).

The *Health Act 1911* specifies under s. 129:

> Any person who —
>
> (a) defiles, or pollutes any water supply, or the catchment area thereof; or
>
> (b) permits or suffers any water supply or catchment to become defiled or polluted, commits an offence.
>
> This can be applied to any river, stream, watercourse, creek, swamp, water hole, well, tank, lake, or reservoir containing water intended or available for human consumption.

The quality of water can be regulated through the *Health (Food Hygiene) Regulations 1993* where food is prepared or produced for human consumption, and by the reporting of waterborne illness and the actions taken upon detection through Part IX – Infectious Diseases of the *Health Act 1911*.

The term 'water', is defined in the *Health (Food Hygiene) Regulations 1993* as:

> Potable water as described in the 'Guidelines for drinking water quality in Australia' prepared by the National Health and Medical Research Council and the Australian Water Resources Council, and published by the Australian Government Publishing Service.

Part IX Infectious Diseases of the *Health Act 1911* provides a wide range of powers commensurate with the potential risk to public health.

Inspection and sampling protocols to ensure compliance with the NHMRC 1987 Guidelines are specifically dealt with by a combination of a Memorandum of Understanding and licensing arrangements through the OWR.

Advisory Committee for the Purity of Water

The State Advisory Committee for the Purity of Water (ACPW) is a non-statutory inter-departmental committee that provides advice to the Ministers for Health and

Water Resources on drinking water quality.[3] The main role of the ACPW is to identify trends that may adversely effect water quality.

The ACPW was originally established to address water quality issues in 1925 and to provide a link between the water supplier and the health department. Empowered to communicate directly to the Minister for Works, it was composed of senior officers from each department.

The ACPW has evolved and following the recent water industry reform in WA the Chair and Secretariat have changed to the Health Department. The terms of reference for the Committee set out its role (see box C4.3). The ACPW membership is also included in the terms of reference and is comprised of:

- The Executive Director Public Health or delegate, Health Department of Western Australia (Chair);
- Chemistry Centre of WA;
- Agriculture Western Australia;
- Department of Conservation and Land Management;
- Office of Water Regulation;
- Water Corporation; and
- Western Australian Municipal Association.

The ACPW advises the Minister for Health and Water Resources in accordance with its terms of reference. One such aspect is the adoption of national guidelines and standards. In this, the ACPW decides water quality compliance requirements across the State. The Minister for Health has the lead responsibility with respect to issues of health. However, it is customary for both Ministers to jointly accept the recommendations of the ACPW.

[3] The Advisory Committee for the Purity of Water remains a non-statutory inter-departmental committee, although the *Draft Public Health Bill* proposes to alter this position.

Box C4.3 **Terms of Reference for the State Advisory Committee for the Purity of Water**

The Terms of Reference for the Advisory Committee for the Purity of Water as endorsed by the Minister for Health on 15 April 1998 are as follows:

- To advise the Hon Minister for Health and the Executive Director Public Health on matters relating to the regulation of drinking water quality (health criteria).
- To advise the Ministers for Health and Water Resources on any matter affecting the quality of drinking water that is referred to the Committee by either Minister or initiated by the Committee.
- To report to the Ministers from time to time on any matter arising out of these Terms of Reference that the Committee considers should be brought to their attention.
- To recommend alternative quality criteria or guideline values for drinking water in various parts of the State, where those recommended by the National body may be inappropriate.
- To regularly review the results of the routine and any special tests carried out by any water provider, the Health Department of Western Australia and local governments on drinking water supplies available to the public from both public and private sources.
- To review and advise on arrangements and procedures adopted for monitoring the quality of drinking water.
- To keep under review trends or practices that might adversely affect the quality of catchment run-off or ground water used or available for use.
- To consider and advise on proposed developments or practices that might affect the quality of catchment run-off or ground water used or available for use for drinking water supplies.
- To advise on special studies or surveys relating to the quality of drinking water to receive reports on such studies or surveys, and recommend any action considered necessary.
- To foster inter-departmental cooperation for the efficient carrying out of action taken under the above Terms of Reference.
- To seek advice and Committee input as required and from specialist organisations to accomplish the above Terms of Reference.

Source: HDWA (pers. comm., 13 March 2000).

Standard setting

Operating licences specify that water supplied must be safe for human consumption as defined in directions made by the Minister for Health. Directions are made by the Minister for Health, under recommendation from the ACPW, and specify the standards to which drinking water must comply (see box C4.4).

Box C4.4 **Drinking water health directions**

In July 1988, the Hon Ministers for Water Resources and Health jointly accepted a recommendation from the State Committee for the Purity of Water that the 1987 publication of the NHMRC and the ARMCANZ *Guidelines for Drinking Water Quality in Australia* (the Guidelines) as follows:

(a) Adoption of the Guidelines for use in Western Australia in the assessment of the quality of drinking water supplied by public water supply agencies to their customers.

(b) That all suppliers of potable water available to the public shall aim to comply with the Guidelines for 'health related' characteristics as set out in the 1987 document by the year 2000. The Health Department should be able to approve departures from the Guidelines for individual supplies as it may judge appropriate, in light of public health considerations.

(c) That all public water supply agencies should aim to comply, as far as practicable, with the Guidelines for 'not directly health related' characteristics as set out in the document. However, bearing in mind the high levels of public expenditure which would be required to achieve full compliance in respect of some small water supplies, it is accepted that achievement of this aim may take many years.

Source: OWR (2000).

The ACPW is currently working through the 1996 Guidelines and following consultation with water suppliers, it proposes to recommend their adoption in operating licences and their implementation between 2000 and 2004 (HDWA pers. comm., 13 March 2000).

C4.2 Monitoring and enforcement

Monitoring of drinking water sampling activity throughout the State is the responsibility of the HDWA.

Water sampling for microbiological determinants is conducted in accordance with procedures outlined in the HDWA's *Standard Drinking Water Sampling Technique* document. Under this regime, water must be sampled and analysed in accordance with the draft document *Guidelines for Water, Effluent, and Soil Assessment – Microbiological* (formally known as the *Water Examination Test Guidelines*

Manual). This draft document has been circulated to all microbiological laboratories to ensure uniform sampling methodologies are adopted.

The *Standard Water Sampling Technique*, as endorsed by the Executive Director Public Health, provides uniform sampling procedures for use by all personnel involved in drinking water sampling activities throughout the State. This document is available to the public.

Environmental Health Officers (EHOs) monitor small water suppliers — roadhouses, caravan parks, tearooms, farm stays etc — and are also contracted to sample water for the Bunbury Water Corporation AQWEST. The HDWA employs EHOs who have statewide powers to ensure universal application of health legislation, to investigate complaints and to monitor statewide issues (such as water supply).

Each local government employs EHOs. Upon appointment and satisfactory qualification review by the Executive Director Public Health, they are gazetted for the district in which they are employed. Thus an EHO has responsibilities to both his employer for his health district and to the Executive Director Public Health to ensure uniformity and compliance.

Only water samples analysed by a NATA registered laboratory are recognised by the HDWA. However, responsibility for collection varies. For example, the Water Corporation employees sample Water Corporation supplies. Busselton Water Board employs a private contractor. Aboriginal remote localities are sampled by regional service providers who encourage supplementary sampling by aboriginal environmental health workers. Small supplies and packaged water providers are sampled by EHOs.

A licensee is required to provide quarterly reports to the OWR to confirm that the service is operating efficiently and is meeting all statutory and customer requirements. Compliance with operating licences, including meeting the 1987 Guidelines for drinking water quality, is monitored by the OWR through these reports. Compliance with operating licences, including meeting the 1987 Guidelines for drinking water quality, is monitored by the OWR through these reports. Licensees are also required to develop a customer service charter and asset management plan. Smaller operators are not subject to these requirements, reducing the impact of regulatory compliance on them (OWR pers. comm., 29 March 2000).

All operating licences issued by the OWR require an operational audit to be undertaken, which reviews the compliance and efficiency of services provided with respect to conditions of the operating licence and the WSCA (see box C4.5).

Box C4.5 **Operational audits of water supply licensees**

Operational audits require external examination of the recording and reporting processes, and of information provided to the OWR. An external audit team approved by the OWR undertakes the audits during the term of a licence.

The conditions under which the audits are to be undertaken are stated in s. 37 of the *Water Services Coordination Act 1995* as follows:

(1) It is a condition of every licence that the licensee is to, not less than once in every period of 24 months (or such longer period as the Coordinator allows) calculated from the commencement of this section, provide the Coordinator with an operational audit conducted by an independent expert acceptable to the Coordinator.

(2) An operational audit is an audit of the effectiveness of measures taken by the licensee to maintain any quality and performance standards referred to in the licence.

(3) The Coordinator is to present to the Minister a report on each operational audit within one month after his or her receipt of the audit.

Source: OWR (1999).

Upon receipt of the audit document the OWR provides a report to the Minister, together with an audit action plan outlining the implementation strategies the service provider intends to introduce.

These operational audit documents are published and available to the public.

Sanctions

The Minister for Health has the power under s. 41 of the WSCA to call for the rectification of any licence contravention without serving notice on the licensee, if in his or her opinion, the health or safety of members of the public is or may be at risk.

Section 39 of the WSCA sets out that:

(1) If, in the opinion of the Minister, a licensee contravenes an operating licence, the Minister may cause a notice to be served on the licensee requiring the licensee to rectify the contravention within a specified period.

(2) If, in the opinion of the Minister, a licensee has failed to comply with a notice under subsection (1) the Minister may, subject to s. 40, do one or more of the following —

(a) serve a letter of reprimand on the licensee;

(b) order the licensee to pay a monetary penalty fixed by the Minister, but not exceeding $100 000;

(c) cause the contravention to be rectified to the satisfaction of the Minister.

The Governor of Western Australia has the power, under s. 42 of the WSCA, to cancel a licence if they are satisfied that the licensee has failed to comply with a term or condition of the licence.

C5 South Australia

South Australia Water Corporation (SA Water) is responsible for supplying the majority of South Australians with water.[1] SA Water was established in 1994 by the *South Australian Water Corporation Act 1994* (SAWCA 1994). Under the SAWCA 1994, SA Water has:

> … the principal responsibility of providing water and sewerage services for the benefit of the people and economy of the State (s.3, SAWCA 1994).

In December 1995, SA Water contracted out the operation, maintenance and management of Adelaide's water supply system, including six metropolitan water treatment plants, to United Water International. Operations under the contract commenced in January 1996 for a term of 15 years with requirements for significant improvements in efficiency and service with cost savings (SA Water 1995).[2]

In 1996, SA Water entered into the Water Treatment and Economic Development Agreement (WTEDA) with Riverland Water Pty Ltd. Under this Agreement, Riverland Water was contracted to finance, design, construct, operate and maintain 10 water filtration plants for a minimum of 25 years.[3] The aim of the project is to extend the availability of filtered water to fringe metropolitan and country areas (SA Water 1995). Previously, these communities had been receiving unfiltered water from the River Murray (SA Water 1997).

On average, around 60 per cent of bulk water supplies are sourced from local catchments with the remainder pumped from the River Murray. The quantities taken from the Murray vary significantly with rainfall variations. For example, in 1997-98, below average rainfall resulted in the Murray supplying much higher levels of water than normal (SA Water 1998).

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1 Local councils and others supply some areas of the State.

2 The contract also specifies that United Water lead the development of a world class water industry in South Australia, including the generation of substantial exports. For the three year period to the end of calender year 1998, the target of $64.8 million for net exports was exceeded with an export result of $105 million being achieved.

3 These plants are located at Balhannah, Swan Reach, Waikerie, Barmera, Mannum, Berri, Tailem Bend, Renmark, Murray Bridge and Loxton. The final plant at Murray Bridge was completed in September 1999.

Bulk water supplies are managed by the Bulk Water Division, which was created by SA Water in 1997-98. The Bulk Water Division operates as a separate business unit and is responsible for harvesting, storing and transferring bulk water supplies. The Division also manages SA Water's interests in the River Murray and in other areas under the Catchment Water Management Boards (CWMBs) (see box C5.1).

Box C5.1 Catchment Water Management Boards and the Water Resources Council

Catchment Water Management Boards (CWMBs) are established under the *Water Resources Act 1997* and are responsible for the management of water resources within catchments; each CWMB is responsible for a particular catchment. The functions of a CWMB are to:

- prepare and implement a Catchment Water Management Plan;
- provide advice to the Minister and the constituent councils for the CWMB's area in relation to the management of water resources;
- promote public awareness of the importance of the proper management of water resources and of the sustainable use of those resources; and
- carry out any other functions required under the Act (s. 61, *Water Resources Act 1997*).

Catchment Water Management Plans, among other things, set out the CWMB's goals in relation to management of water resources and how these goals will be achieved. Plans must be consistent with the State Water Plan and must be developed following consultation with each of the constituent councils, owner(s) of the land, SA Water, the public and any other person prescribed by regulation (s. 94, *Water Resource Act 1997*).

The extent to which a CWMB has succeeded in implementing its Catchment Water Management Plan is examined and assessed by the Water Resources Council. The Water Resources Council is established by the *Water Resources Act 1997* and comprises five members appointed by the Governor on nomination from the Minister. The Council is required to prepare a written report for the Minister in relation to these matters.

CWMBs fund catchment improvement works through Catchment Environment Levies. Local councils collect the levy from ratepayers on behalf of CWMBs. The Levy is spent only in accordance with the approved catchment water management plan and only in the local area. The Parliamentary Economics and Finance Committee must approve proposed levies. If that Committee rejects them, then they must go before State Parliament.

Source: Water Resources Act 1997.

While most CWMBs are still in the process of developing their Catchment Water Management Plan, there are some examples as to how SA Water interests are being incorporated. The North Adelaide and Barossa CWMB (NABCWMB's) stated that one of its goals is to enhance social wellbeing through protecting public water supplies. The Board aims to achieve this through:

- integrating principles of land management and water resources management to help protect public water supplies; and
- integrating, as far as practicable, the planning functions of the Environmental Protection Authority (EPA(SA)), SA Water and the Board (NABCWMB 1998).

Torrens CWMB suggested that improving the quality of raw water in upper catchment areas through appropriate management practices could result in a possible saving to the community in water treatment costs (Torrens CWMB 1997).

Raw source water is of relatively poor quality in South Australia. This is due to the reliance placed upon the River Murray and the high levels of activity taking place in the catchment areas. Lower catchment areas are densely urbanised and there is intensive horticultural and agricultural use in the upper rural catchments.

A large amount of expenditure on improving water quality has been directed towards dealing with the poor physical quality of raw source water. Robust water treatment plants have been constructed which generally provide water with a high microbiological quality (DHS(SA), pers. comm., 28 May 1999).

C5.1 Regulation

There is no legal requirement for SA Water to meet the NHMRC's Guidelines. However, SA Water holds a Performance Agreement with the SA Government which requires it to achieve compliance with the health-related parameters of the 1996 Guidelines for filtered metropolitan supplies. SA Water has a longer term goal of complying with the health-related drinking water guidelines for the majority of the population of South Australia.

Drinking water requirements are determined by the Government Committee on Health Aspects of Water Quality (HAWQ Committee) (see box C5.2). The HAWQ Committee is a cooperative body with membership from the Department of Human Services (DHS(SA)), the EPA(SA) (part of the Department for the Environment, Heritage and Aboriginal Affairs), SA Water and the Local Government Association.

HAWQ Committee members may propose that new health-related standards be adopted. SA Water initiated the move to the 1996 Guidelines following a review of metropolitan operations that indicated that water quality did not comply with the health-related aspects of the 1996 Guidelines (SA Water 1995).

Box C5.2 **Health Aspects Water Quality Committee**

Several members of the Committee have been or are currently involved in the preparation and review of the *Australian Drinking Water Guidelines* and also contribute to the development of World Health Organisation Guidelines. As such, the Committee maintains an awareness of new developments.

The Committee meets every three months and is responsible to the relevant Ministers for health, the water supply and the environment, through the respective Chief Executives for advice on any of the following matters:

- government policies on health-related aspects of quality for water supplies in South Australia including acceptable criteria and objectives, taking into consideration the need for the protection and enhancement of the aquatic environment;
- the health-related aspects of water quality in South Australia in relation to recommendations by authorities, such as the National Health and Medical Research Council and the World Health Organisation;
- the establishment and maintenance of appropriate programs for the monitoring, assessment and reporting of water quality;
- procedures for coordination and communication between water, environmental and health authorities and Local Government in South Australia in relation to water quality matters;
- appropriate action on any specific health-related aspect of water quality including monitoring, water treatment, and public awareness programs; and
- the need for research on health-related aspects of water quality.

The HAWQ Committee currently monitors the performance of SA Water according to agreed Levels of Service and the 1996 Guidelines. It also administers a set of incident criteria. These criteria require SA Water to notify the Department of Human Services immediately should a particular 'incident', such as detection exceedence of agreed levels of faecal coliforms or turbidity, occur.

Source: DHS(SA), pers. comm., 18 and 28 May 1999.

The Committee may develop criteria outside the scope of the Guidelines. Where it does this, the Committee may ask a subcommittee to examine the issue. Subcommittees would normally include representatives from both SA Water and DHS(SA). Risk assessment procedures may be followed in developing a response to these issues.

The HAWQ Committee is comprised of specialists in the various aspects of water supply and health-related impacts. Membership includes water engineers and water treatment experts, toxicologists, water microbiologists and a representative from communicable disease control. Specific advisers are invited to attend meetings as required.

Decisions taken by the HAWQ Committee are reached through discussion and agreement. There is no formal voting procedure, however, if agreement cannot be reached, there is scope for out-of-session discussions between agencies. To date, there has not been a situation where these have been required.

Under the Committee's terms of reference (see box C5.2), the DHS(SA), SA Water and EPA advise their respective Ministers on, among other things, decisions taken in relation to recommendations by authorities such as the NHMRC and the World Health Organisation (WHO).

SA Water is responsible for ensuring that quality requirements established by the HAWQ Committee are met by its two contractors. United Water is also required to comply with targets for water quality set down in the contract. All are equal to or more stringent than those in the 1996 Guidelines. Where no specific contract target is set, the Guideline values for health and non-health related parameters apply.

The WTEDA with Riverland Water contains a treated water specification. The parameters included in this specification are aluminium, colour, turbidity, chlorine residual (free or combined), coliforms, faecal coliforms, fluoride, iron, manganese, pH (chlorinated or chloraminated) and trihalomethane (total). Geosmin/MIB levels, taste and odour are measured but do not form part of the performance specification.[4]

The values of parameters contained in the treated water specification for performance measurement are generally of a higher standard than those contained in the Guidelines.

C5.2 Monitoring and enforcement

SA Water monitors United Water's and Riverland Water's performance against their contractual requirements. United Water's monitoring program was determined by a joint SA Water/United Water team (including specialist staff from the

4 Geosmin and MIB (methyl isoborneol) are by-products of the biological activity of algae and can cause odours.

Australian Water Quality Centre) based on the philosophy and recommendations of the Guidelines.

United Water is required to report monthly to SA Water on its performance including water quality compliance. The monthly reports are forwarded to the DHS(SA) which uses them for checking compliance.

There is a SA Government Water/Wastewater Incident Notification and Communication Protocol in place for reporting adverse water quality results to the DHS(SA). Trigger levels for reporting are determined by the HAWQ Committee. Type I incidents (serious incidents that could cause risk to human health) require immediate reporting to the DHS(SA) by telephone with a hard copy report to follow within 24 hours. Such incidents are also reported to concerned Ministers.

Type II incidents (incidents that represent a low risk to human health) generally require reporting to DHS(SA) within one business day. Persistent minor operational problems in distribution systems are reported monthly to the DHS(SA).

The protocol describes the duties of the Water Incident Coordinator (placed within the DHS(SA)) who acts as a single point of contact for communication of all water and wastewater incidents. It also describes the duties of the Lead Minister who is responsible for managing communication of serious incidents to the public and the Government. In the event of an incident designated as having potential human health effects the Lead Minister would be the Minister for Human Services.

Under the WTEDA, Riverland Water is required to undertake monitoring and reporting of water quality in both raw and treated waters in accordance with specified monitoring programs. The results of all monitoring and analyses are reported to SA Water on a weekly basis and in summary form at each month for all the 10 plants. SA Water also has continuous access to all on-line measurements and analyses via telemetry.

There are financial penalties imposed upon United Water for failure to comply with specified water quality parameters. Single serious failures attract high financial penalties which are deducted as they arise. Deductions for general performance failures (that is, failures to meet performance targets assessed over a financial year) are made at the end of each financial year as part of contract payment adjustments. The size of penalties depends on how critical the failures are. They are escalated for repeated failures.

WTEDA specifies penalties for non-conformance to treated water specification parameters. These vary in accordance with the extent of non-conformance and the

potential impact of the quality of the water supplied. Penalties also exist for loss of plant capacity.

SA Water publishes the monitoring results in its Annual Report. This covers microbiological quality, turbidity and colour. According to the 1998 Report, metropolitan water supplies fully complied with the microbiological requirements of the 1996 Guidelines and the turbidity and colour requirements required under United Water's contract (SA Water 1998).

Microbiological control in the metropolitan water network improved in the 1996-97 and 1997-98 financial years. Improved performance came as a result of the introduction of enhanced treatment processes to remove a higher proportion of natural organic matter from the water and improved disinfection processes at the Barossa, Little Para, Anstey Hill, Hope Valley and Happy Valley water treatment plants (SA Water 1998).

The introduction of enhanced treatment processes also led to a reduction in the chlorine levels in consumer's water. In 1997-98, around 98 per cent of water samples taken from customer sampling points contained chlorine levels below detectable taste and odour levels. In 1995-96, around 90 per cent of samples contained undetectable chlorine levels (SA Water 1998).

C5.3 Industry response

Under the terms of its contract, United Water must develop a Detailed Asset Management Plan, setting out its proposed operational maintenance and capital expenditure plans over a five-year period. A joint SA Water/United Water team oversees the development of each plan.

The Asset Management Plan establishes a program for operational maintenance and capital expenditure, intended to minimise SA Water's costs in managing water and wastewater infrastructure. SA Water retains responsibility for deciding which capital works will proceed and oversees the development of infrastructure specified in the plans. United Water manages the capital works programs.

The first Plan was completed in 1997-98. Particular emphasis was given to water quality improvement. This Plan was included in SA Water's five-year capital works plan.

Enhanced treatment processes were introduced at each of the metropolitan treatment plants to bring drinking water quality into line with the 1996 Guidelines. Developed by the Australian Water Quality Centre, these treatment processes remove higher

proportions of natural organic matter from water. The processes also improve the disinfection process by increasing the persistence of residual chlorine in the distribution network while, at the same time, reducing general chlorine levels.

The total capital investment required to implement the enhanced treatment processes is around $5 million, although the project has not been completed. The associated annual operating costs is estimated to be around $3.5 million.

In the event of changes to the Guidelines, United Water and SA Water may negotiate changes in water quality targets and subsequent changes in operating procedures and contract costs. If capital investment was required to achieve higher standards, United Water would submit cost proposals for approval following consultation with SA Water staff.

As the body responsible for overseeing the development of infrastructure, SA Water would bear the cost of any infrastructure development. This could be recouped by SA Water through customer charges.

Riverland Water's contract to construct and operate ten water treatment plants is designed to bring drinking water quality for certain communities into line with the 1996 Guidelines. These plants provide chemical treatment, sedimentation, filtration and disinfection where previously only disinfection was provided. The capital cost of this contract is estimated at $115 million.

An ancillary capital works program is supporting Riverland Water's project. SA Water has invested $30 million in infrastructure and operating costs to assist in distributing the treated water. The most significant aspect of this project is the construction of a pipeline connecting Strathalbyn and Milang to the Summit Storage Filtration Plant at Balhannah.

Riverland Water receives payment from SA Water through a daily availability charge per plant, which varies according to the size of the plant. It also receives a usage charge which is based on the quantity of water treated ($/ML treated). The WTEDA specifies both the availability and usage charges applicable.

The WTEDA contains similar provisions to the contract with United Water in the event of changes to the Guidelines. Where improvements in water quality can be achieved by operational and/or process changes, the WTEDA contains provisions to vary operating cost (usage charges) subject to agreement by SA Water.

Where capital investment is required, Riverland Water would submit priced proposals to SA Water for approval. This would include changes to availability and usage charges.

Improvements in water treatment are also being made in other regional areas under the Country Water Quality Improvement Program. This program aims to improve the microbiological quality of country water supplies through the installation of additional disinfection facilities. Techniques, such as ultraviolet light and electrolytic chlorination, are being used to meet special requirements and to provide cost-effective alternatives for smaller communities.

C6 Tasmania

Over seventy-four per cent of drinking water in Tasmania is provided by three bulk water authorities and 15 per cent by local councils. The bulk water authorities — Hobart Water, Esk Water and North West Water — sell bulk drinking water to the local councils within their respective operating zones who then reticulate the water to households and businesses.

There are 69 local government water supply systems operating in the State. Not all Councils are involved in drinking water service provision, however all Councils are involved in water regulation under the *Public Health Act 1997*. The remaining nine per cent of Tasmanian drinking water is supplied by private water systems, such as tank water, river water and dam water.

Each of the bulk water suppliers is a joint authority comprising the local councils situated within their respective operating zones. Hence, the member councils are the shareholders of the bulk water suppliers and determine the bulk water suppliers' strategic direction.

In 1997, the assets, property, rights and liabilities of Hobart Water and Esk Water were transferred from State Government ownership to the current joint authorities. North West Water was transferred to a council joint authority in 1999.[1]

C6.1 Regulation

Under s. 128(1) of the *Public Health Act 1997*, water suppliers have a general obligation to manage the water in a manner that does not pose a threat to public health. Where water suppliers become aware that the quality of the water is, or is likely to become, a threat to public health, the water supplier must notify the Director of Public Health (see box C6.1) in accordance with *Public Health Act 1997 — Guidelines for Water Quality* (Water Quality Guidelines).

The Water Quality Guidelines specify four legal procedural requirements (termed 'outcomes'). Subsequent detail contained within the Guidelines provide a guide to

1 A council joint authority comprises the councils to which the bulk water supplier supplies water.

how the requirements might be achieved. If a water supplier can effectively meet the required outcome in some alternative way then often there may be no need to strictly follow the procedures.

Box C6.1 **Functions of the Director of Public Health**

The *Public Health Act 1997* creates the position of Director of Public Health (the Director). The person appointed as the Director must be a registered medical practitioner and have qualifications in the area of public health.

Under the *Public Health Act 1997*, the Director's functions are to:

- develop and implement strategies to promote and improve public health;
- ensure provisions of the *Public Health Act 1997* are complied with;
- advise the Minister on any changes to the *Public Health Act 1997* that may be necessary or appropriate; and
- carry out any other function for the purpose of the *Public Health Act 1997* the Minister determines.

The Director must submit to the Minister a report on the status of public health in the State at five-yearly intervals.

Source: Public Health Act 1997.

According to the Tasmanian Department of Health and Human Services (DHHS), using Guidelines rather than regulations is designed to provide for administrative flexibility to accomodate minor variations in law without the need to access Parliament. This flexibility enables new threats to public health to be dealt with quickly, effectively and efficiently (DHHS, pers. comm., 1999).

The procedures specified in the Water Quality Guidelines are as follows:

- That the Director of Public Health be notified in a timely manner that the quality of water is, or is likely to become, a threat to public health and that public health is protected.

- That a Council takes action to protect public health if it receives a report from an Environmental Health Officer indicating that the quality of water under its control is, or is likely to become, a threat to public health and that the Director is notified in a timely manner.

- That all potable water supplies and recreational waters are monitored and that all monitoring is conducted in accordance with the current relevant guidelines as published by the National Health and Medical Research Council (NHMRC).

- That health evaluations are conducted by suitably qualified persons when required by the Director of Public Health and that the information supplied is accurate.

These outcomes are legally enforceable under s. 184(5) of the *Public Health Act 1997* and non-compliance incurs a fine of 25 penalty units. The penalty unit is presently $100.

The Guidelines indicate that the microbiological sampling regimes specified in section 2.8.1 of the NHMRC's *Australian Drinking Water Guidelines*, as amended, should be followed. Chemical and physical testing is required where potential contaminants are identified in catchment surveys. Currently, water suppliers are required to test for harmful chemicals on a risk management basis using a recognised methodology such as the Australian/New Zealand Standard 4360:1999 — Risk Management.

When the relevant parameters specified in the NHMRC's Guidelines are exceeded, the controlling authority must notify the Director of Public Health under the established procedures and suppliers must take action to prevent or minimise the threat to public health. In the case where the microbiological values are exceeded, the water supplier must issue a boiled water alert to inform the consumers.

The DHHS desires that water suppliers operate to the NHMRC's guideline microbiological values but they are under no legal obligation to do so. Only the sampling regimes specified in guidelines are legally enforceable.

Where a supplier does not meet with the microbiological values, they may still supply water as long as consumers are aware (through a boil water alert) that the quality of the water supplied may not match the guidelines microbiological values and may therefore be unsafe. This process is intended to involve the community and induce compliance by allowing consumers to become aware that the water supplier is not meeting industry best practice.

However, there is flexibility as the residents of the township of Lilydale and the Launceston City Council have decided not to disinfect the Lilydale town water supply. As a result, the Launceston City Council has issued a permanent boil water alert for the town and placed notices on every public tap (DHHS 1999).

According to the Director of Public Health in the Annual Water Report:

> This legislative process will protect public health and enable industry to operate in a cost-effective manner while informing consumers that sometimes their drinking water supply is substandard, when compared to desired national water industry standards (DHHS 1999, p. 2).

This legisative process is also designed to inform the public on drinking water quality issues so they can participate in local policy making decisions on water supply issues and make informed decisions about their consumption of drinking water (DHHS 1999).

Public Health Act 1997

Consultations on the *Public Health Act 1997* commenced in 1993. A discussion paper was issued, three community consultation phases undertaken and a working group of stakeholders established. The working group comprised:

- Tasmanian Chamber of Commerce and Industry;
- Local Government Association of Tasmania;
- Australian Medical Association;
- Public Health Association;
- Royal Australian College of General Practitioners;
- Australian Institute of Environmental Health;
- Department of Geography and Environmental Studies at the University of Tasmania;
- Department of Environment and Land Management;
- Environmental Groups;
- three Regional Health Boards; and
- Department of Primary Industry and Fisheries.

The working group was charged with developing the Act, undertaking a regulatory impact assessment in accordance with National Competition Policy and issuing two draft versions of the Act for public comment.

The Working Group identified the objectives of the Act and analysed the costs and benefits of the Public Health Bill and assessed the possibility of using alternatives to legislation. The working Group found that public health legislation was in the public interest, that the benefits outweighed the costs and that the objectives of the legislation could only be achieved by some limited restrictions on business (DHHS 1997).

The Group's assessment was approved by the Tasmanian Department of Treasury and Finance. It was released for public discussion with notification provided by an advertisement in daily newspapers.

C6.2 Monitoring and enforcement

Councils are responsible for ensuring that water suppliers comply with the monitoring requirements specified in the Water Quality Guidelines. A controlling authority must notify the Director of Public Health of a potential threat to public health where the microbiological values specified in the NHMRC's guidelines are exceeded. Local Government Environmental Health Officers (EHOs) are empowered to investigate incidents and manage the subsequent threat to public health.

Where a Council receives a report from an EHO that the quality of water is, or is likely to become, a threat to public health, the council must take action to prevent or minimise the threat. Such action may include:

- restricting or preventing the use of the water;
- restricting of preventing the use of any food product in which the water has been used;
- rendering the water safe; or
- giving warnings and information to the public about the safe use of the water or risk of using the water (s. 128(3), *Public Health Act 1997*).

The *Public Health Act 1997* also makes provision for the Director of Public Health or the Council, if satisfied that the quality of water is, or is likely to become, a threat to public health, to make one or more of the following orders:

- an order closing the supply of the water;
- an order restricting or preventing the use of the water;
- an order restricting or preventing the use of any food products in which the water has been used;
- an order restricting or preventing the taking, harvesting or public supply of fish or shellfish from the water or which have been in the water;
- an order requiring the water to be brought to an approved standard;

- an order requiring the relevant agency, public authority or person to provide a temporary alternative supply of water (s. 129(1), *Public Health Act 1997*).

Failure to comply with all or any of these orders carries a fine of 100 penalty units.

Under the Water Quality Guidelines, all water suppliers must submit a report on their previous financial year health performance to the Director of Public Health by 30 September each year. This report must include details of all water quality sampling conducted in relation to the water supply system and details of the overall management of the water supply system.

The Director of Public Health each year publishes an annual consolidated report on the quality of Tasmania's drinking water and details the performance of all reticulated water suppliers in meeting the requirements of the legislation. This report is then made available to the public upon request.

C7 Northern Territory

The Power and Water Authority (PAWA) is responsible for supplying drinking water to urban centres in the Northern Territory. It is also responsible through a Community Service Obligation (CSO) for the provision of essential services, including water and sewerage, to rural and major remote Aboriginal communities.[1]

The PAWA is not responsible for the supply and quality of water supplied to mining towns such as Nhulunbuy and Jabiru, national parks and Aboriginal outstations. In relation to Aboriginal outstations, the Commonwealth government retained responsibility for all essential services, including the quality of water supplied to outstations, when the Northern Territory was granted self-government in 1978.

The PAWA was established in 1987 by the *Power and Water Authority Act 1987* as a result of the amalgamation of the Northern Territory Electricity Commission and the Northern Territory Water Authority. The PAWA reports to the government through the Minister for Essential Services.

Under s. 14 of the Act, the PAWA is required in relation to water and sewerage services to:

- fulfil those functions and duties and exercise those discretions expected of it by the *Water Supply and Sewerage Act 1996*;
- assess, manage and develop water resources in or outside of the Territory;
- advise the Minister on all matters concerning water and the provision of sewerage services; and
- consult with the Commonwealth or any State or any instrumentality, body, corporation or person on any matters relating to water and sewerage.

In the Northern Territory around 58 per cent of drinking water is sourced from surface water and 42 per cent from ground water. The PAWA is responsible for managing catchments under its control. However, on community-owned land the Department of Lands, Planning and Environment is responsible for the protection of

1 There are 85 rural and remote communities with reticulated power and water supplies, and 50 have sewerage systems. The size of these communities range from 75 to more than 2000 people.

water quality under the *Water Act 1992*. The Department works with all stakeholders to minimise the risk of pollution to current and potential future water supplies.

C7.1 Water quality regulation

Territory Health Services (THS), a department of the Northern Territory Government, is responsible for providing public health support and information to the PAWA. In particular, THS and the PAWA work collaboratively to address water quality issues using the NHMRC–ARMCANZ *Australian Drinking Water Guidelines* as a reference for safe water.

Northern Territory legislation does not specify any particular quality for drinking water supplies. The Northern Territory is in the process of reviewing legislation pertaining to the supply of water under the requirements of the National Competition Council. The review is expected to be completed in July 2000. The *Utilities Commission Act 2000*, establishes an independent regulator with responsibilities for a number of industries including water supply.

PAWA water supplies generally comply with the 1987 Guidelines. However, logistics of sampling in remote locations sometimes results in samples not being forwarded to the testing laboratory for analysis. PAWA is addressing this issue and aims to conform by 2002 with the 1996 Guidelines for monitoring in all communities. The major urban water supplies of Darwin and Alice Springs already comply with the 1996 Guidelines (THS, NT, pers. comm., March 2000).

In implementing the 1996 Guidelines, the PAWA and the Northern Territory Potable Water Quality Committee have expressed concerns over the relevance of the Guidelines to small rural water supplies particularly in relation to treatment, monitoring and aesthetic parameters that are non-health related.[2]

Where water supplies do not conform to aesthetic guideline values, the PAWA and the Potable Water Quality Committee have developed a consultative process with respective communities to address the issues.

In the Northern Territory, surface water supplies are disinfected with chlorine for safe consumption. The majority of rural water supplies (greater than 98 per cent) are sourced from ground water. These ground waters are mostly of very good quality

2 The Potable Water Quality Committee had the responsibility for developing appropriate water quality policy for the consideration of the Northern Territory Cabinet. Alternative arrangements are being considered in light of the requirements of Northern Territory 'Utilities' legislation.

and PAWA ensures that the good quality ground water is not contaminated between extraction and delivery to the customer. Ground waters are chlorinated where there is historical evidence of bacteriological contamination at the source (THS, NT, pers. comm., March 2000).

The water supply to Yulara has an electrodialysis reversal plant to reduce natural bore water salinity to levels in accordance with the 1987 Guidelines (PAWA 1999a).

In addition to the Guidelines, the PAWA has been developing and implementing a water quality management strategy to maintain and improve the quality of water supply (PAWA 1999b). This strategy incorporates the Hazard Analysis and Critical Control Point (HACCP) principles (see chapter 6).

The strategy is directed in the first instance at protecting water supply catchments. This is seen as an important barrier to ensure that water supplies are safe. In particular, the protection of the Darwin River Dam catchment, the principle water supply for Darwin, the McMinns Borefield, and future water storage catchments and sources is an important focus for the PAWA.

C7.2 Monitoring and enforcement

The analysis of drinking water supplies for microbiological parameters in urban and remote communities is undertaken by government water testing laboratories in Darwin and Alice Springs.

Copies of the reports of all samples examined in the laboratories are monitored by the THS operational Environmental Health Officers for issues of public health concern and appropriate action taken where problems are identified. In the first instance, the action is normally to make contact with PAWA to ensure that they are aware of the laboratory results and to ascertain the nature of PAWA's response.

In the case of remote communities, monitoring results are normally returned to the community council, which operates as an agent of the PAWA in monitoring. In all communities monitoring results are available on request.

Where samples fail to meet the appropriate guideline values for microbiological parameters, the testing laboratory makes immediate contact with the PAWA staff to enable them to take appropriate action. It is also normal for the testing laboratory to notify THS. If a chemical parameter level is found to be of concern both PAWA and THS work in collaboration to determine an appropriate health outcome.

There are no statutory penalties for non-compliance. However, there are provisions within the PAWA Essential Service Contracts with remote communities, for the PAWA to withhold a proportion of the service payment, where communities fail to participate in the water quality monitoring program.

In the event that drinking water is contaminated and is a risk to public health, boil water alerts are issued by THS, after consultation with the PAWA, the Local Government Council and other stakeholders. Within THS, the Disease Control Unit is developing an Outbreak Control Strategy that will include triggers for boil water alerts.

There is also provision for boil water alerts in the public Health Counter Disaster Sub-Plan that is implemented in response to major disasters such as cyclones or floods.

Record of compliance

There is no provision in legislation for independent audits of the PAWA's compliance with the Guidelines. The implementation of the 1996 Guidelines primarily concentrates on the provision of more effective monitoring programs. The THS monitor laboratory results for compliance with the Guidelines as the results become available.

However, a 1998 draft PAWA report entitled, *Managing Drinking Water Quality in the NT — The Issues and Strategies*, identified the regional water quality issues as, microbiological compliance, nitrates, dissolved solids, fluoride and monitoring. In recognition of these and other issues, the PAWA is reviewing its monitoring program to improve its data reliability and is developing strategic water supply management plans for individual communities. These plans will include sanitary monitoring and not rely solely on guideline values as a tool for the delivery of safe water.

C8 Australian Capital Territory

There are presently no formal drinking water compliance requirements imposed on the ACT water supply authority (ACTEW Corporation), although the Minister has powers to respond to public health incidents generally under the *ACT Public Health Act 1997*. However, developments are currently underway to introduce a new utilities regulatory regime in the ACT.

ACTEW is the sole supplier of reticulated drinking water in the ACT. At present, the ACTEW Corporation works to comply with the *Australian Drinking Water Guidelines 1996* in accordance with a decision by its Board, but it is under no legal obligation to do so.

ACTEW produces an annual water quality report and provides a more detailed monthly report on its web site. In these more detailed reports, information is provided on compliance with the Guidelines on *total coliforms* and *thermotolerant coliforms*. The monthly reports also include monitoring data on aesthetic parameters and the performance of Canberra's two water treatment plants.

All of Canberra's water is chlorinated. It is tested for microbiological and other quality parameters and the results are published in a monthly report that is posted on ACTEW's web site.

ACTEW operates its Water Quality and Supply System under a NATA Certified ISO 9001 Quality System and ISO 14001 Environment Management System. ACTEW has indicated in its Annual Report that under these systems, there is an emergency procedure in place for drinking water contamination.

The ACT *Public Health Act 1997* has provision to declare an activity that may result in the transmission of disease to be a public health risk activity. Under the Act, the Minister may also determine Codes of Practice setting out minimum guidelines or standards relating to such activities. Although these powers are not currently being used to set out drinking water quality requirements, consideration is being given to introducing a Code of Practice under the Act, that would draw heavily on the existing 1996 Guidelines.

D1 European Union

Drinking water quality policy forms a part of the European Union's (EU) environmental policy. Initially, the EU had no formal mandate to regulate in the area. Consequently, the involvement of the EU had:

> … to be legitimised through a liberal interpretation of certain general provisions of the Treaty of Rome (such as the preamble which refers to the goal of improving living and working conditions) (Jones 1996, p. 218).

It was not until the enactment of the *Single European Act 1985* (SEA) that the EU explicitly adopted environmental objectives. One of these objectives required the EU 'to contribute towards protecting human health'. Environmental concerns were then incorporated into The Treaty of the European Union (Maastricht 1992) and the Treaty of Amsterdam (1997).

Under the European treaties, the power to initiate new European policy lies with the European Commission (see box D1.1). Within the Commission, water policy is developed by the Directorate-General of the Environment, Nuclear Safety and Protection (DGXI). Its areas of responsibility include:

- bathing water quality of rivers, lakes, and coastal water (Council Directive 76/160/EEC);
- wastewater pollution coming from households and industry (Urban Waste Water Treatment Directive 91/271/EEC and the IPC Directive (98(C6)05 of 10/1/98));
- water pollution caused by agricultural activities (Nitrates Directive 91/676/EEC);
- the new European Water Policy (proposal for a Water Framework Directive);
- drinking water quality (Council Directives 80/778/EEC and 98/83/EC); and
- the environment and agriculture.

DGXI operates according to the objectives for environment policy written into the Treaty of the European Economic Community (1957) by the Treaty of European Union (1992). The Treaty of European Union states that Community policy on the environment should contribute to the pursuit of:

- preserving, protecting and improving the quality of the environment;
- protecting human health;

- ensuring a prudent and rational utilization of natural resources; and
- promoting measures at the international level to deal with regional or worldwide environmental problems.

Box D1.1 **The European Commission**

The European Commission is comprised of 20 Commissioners and is the executive arm of the Community. It consists of 23 Directorates-General (DGs), plus another 15 or so specialised services. They are each headed by a Director-General, who is equivalent in rank to the top civil servant in a government ministry. The Directors-General report to a particular Commissioner who has the political and operational responsibility for one or more DGs.

The Commission's main tasks relate to supervision, initiative and implementation. In its supervisory role, the Commission ensures that the provisions of the Treaties and the decisions of the Community are applied correctly. It can institute legal proceedings in the European Court of Justice against those Member States who fail to implement Community law. It can also allow temporary waivers or derogations from Community rules for Member States.

Under its power of initiative, the Commission has the exclusive right to develop new legislative proposals. It does this on the basis of what it considers is best for the EU and its citizens as a whole, rather than on behalf of sectoral interests or individual countries. The scope of these activities are laid down in the Treaty.

Once Community policy is formulated, the Commission is responsible for ensuring that policy is implemented by the Member States.

Source: European Communities (1995-1999) and EP (1997).

The EU's first Drinking Water Directive 80/778/EEC was designed to safeguard human health by establishing strict standards for the quality of drinking water (EC 1998b). It applied to all water intended for human consumption, except natural mineral waters and waters which are medicinal products.

This Directive was replaced in 1998 by the Drinking Water Directive 98/83/EC. The European Union considered it:

> … necessary to adapt Council Directive 80/778/EEC … to scientific and technological progress; … experience gained from implementing that Directive shows that it is necessary to create an appropriately flexible and transparent legal framework for Member States to address failures to meet the standards; … furthermore, that Directive should be re-examined in the light of the Treaty of European Union and in particular the principle of subsidiarity (Subsection 1, Council Directive 98/83/EC).

Revising the original Directive also aimed to simplify and consolidate the Directive. This was achieved through reducing the number of parameters so that it restricted

compliance to only essential quality and health parameters. It would then be the responsibility of Member States to add new parameters if this is necessary for reasons of human health protection. Revising the Directive also aimed to increase transparency and flexibility and simplify monitoring obligations (EC, pers. comm., 13 November 1999).

Revision of Directive 80/778/EEC coincided with a review of European water policy and the development of the Water Framework Directive. The Water Framework Directive aimed to improve the quality of the environment and assist water utilities in meeting drinking water quality standards by keeping surface and groundwater clean through appropriate water-protection measures (Subsection 8, Council Directive 98/83/EC).

D1.1 Regulation

The standards specified in Drinking Water Directive 98/83/EC are generally based on the World Health Organisation's (WHO's) Guidelines for Drinking Water Quality and the opinion of the European Commission's Scientific Advisory Committee. Only those parameters for which WHO did not have a health-based guideline value were excluded. The new Directive has 50 parameters which include 4 microbiological parameters (Annex I, part A), 26 chemical parameters (Annex I, part B) and 20 indicator parameters (Annex I, part C) (see table D1.1).

The objective of the Directive is 'to protect human health from the adverse effects of any contamination of water intended for human consumption by ensuring that it is wholesome and clean' (Article 1, Council Directive 98/83/EC). Water is wholesome and clean if it:

- is free from any micro-organisms and parasites and from any substances which, in numbers or concentrations, constitute a potential danger to human health; and
- complies with the microbiological, chemical and indicator parameters (Table D1.1) and parametric values listed in the Directive (Article 4, Council Directive 98/83/EC).

The parametric values used are based on available scientific knowledge and apply the precautionary principle in that they aim to ensure that water intended for human consumption can be consumed safely on a life-long basis (Subsection 13, Council Directive 98/83/EC). The parameters and their values must be reviewed at least every five years in light of scientific and technical progress (Article 11(1), Council Directive 98/83/EC).

The Directive aims to strike a balance between the need for chlorine as a disinfectant and the chemical risks associated with chlorine by-products. The EU has set parametric values for disinfection/oxidisation by-products, but requires that, where possible, Member States strive for a lower value without compromising disinfection (Annex I, Part B Notes 2 and 10, Council Directive 98/83/EC).

Table D1.1 **Parameters in the Drinking Water Directive 98/83/EC**

Microbiological	*Chemical*	*Indicator*
E.coli	Acrylamide	Aluminium
Enterococci	Antimony	Ammonium
Where water is offered for	Arsenic	Chloride
sale in bottles or containers	Benzene	Clostridium perfringens
E.coli	Benzo(a)pyrene	Colour
Enterococci	Boron	Conductivity
Pseudomonas aeruginosa	Bromate	Hydrogen ion concentration
Colony count 22^0c	Cadmium	Iron
Colony count 37^0c	Chromium	Manganese
	Copper	Odour
	Cyanide	Oxidisability
	1,2-dichloroethane	Sulphate
	Epichlorohydrin	Sodium
	Fluoride	Taste
	Lead	Colony count 22^0c
	Mercury	Coliform bacteria
	Nickel	Total organic carbon
	Nitrate	Turbidity
	Nitrite	**Radioactivity:**
	Pesticides	- Tritium
	Polycyclic aromatic hydrocarbons	- Total indicative dose
	Selenium	
	Tetrachloroethene and Trichloroethene	
	Trihalomethanes	
	Vinyl chloride	

Source: Council Directive 98/83/EC.

The Directive provides for Member States to allow exemptions from particular parametric values where this is required, provided:

- the exemption does not constitute a human health hazard;
- there is no other reasonable means of maintaining the distribution of drinking water in the area concerned;

- the exemption must be as restricted in time as possible and not exceed three years, although the exemption may be renewed for a further two three-year periods.

Where an exemption is granted, a Member State must inform the population affected. It must also inform the European Commission if the exemption covers the distribution of more than 1000 cubic metres per day on average or supplies more than 5000 persons.

The parametric values specified by Directive 98/83/EC must be complied with:

(a) in the case of water supplied from a distribution network, at the point, within premises or an establishment, at which it emerges from the taps that are normally used for human consumption;

(b) in the case of water supplied from a tanker, at the point at which it emerges from the tanker;

(c) in the case of water put into bottles or containers intended for sale, at the point at which the water is put into bottles or containers;

(d) in the case of water used in a food-production undertaking, at the point where the water is used in the undertaking (Article 6(1), Council Directive 98/83/EC).

Member States are required to bring into force of law, regulations and adminstrative provisions necessary to comply with the Directive by 2000. They must take the measures necessary to ensure the quality of water intended for human consumption complies with the Directive within five years of its entry into force.[1]

Under the Treaty of European Union, the Commission, and therefore the DGXI, must take account of the following aspects when developing environmental policy:

- Available scientific and technical data.
- Environmental conditions in the various regions of the Community.
- The potential benefits and costs of action or lack of action.
- The economic and social development of the Community as a whole and the balanced development of its regions.

1 They must take the measures necessary to ensure the quality of water intended for human consumption complies with the bromate and trihalomethane standard by 2008 and with the lead standard by 2013.

The first Drinking Water Directive 80/778/EEC pre-dates the requirements of the Treaty of European Union and thus the Commission did not undertake a systematic benefit-cost appraisal of the standards included in the original Directive.

Pearce (1998) reported that some of the technical studies for the new Drinking Water Directive attempted to appraise benefits in qualitative terms and costs in money terms. Indeed, Directive 98/83/EC states an intention to strike a balance between microbiological and chemical risks and, to that end, to establish parametric values based on public health considerations and risk assessments:

> Whereas a balance should be struck to prevent both microbiological and chemical risks; whereas, to that end, and in the light of a future review of the parametric values, the establishment of parametric values applicable to water intended for human consumption should be based on public health considerations and on a method of assessing risk (Subsection 14, Council Directive 98/83/EC).

In developing the second Drinking Water Directive, the EC consulted with interested parties, the industry, non-government organisations and the scientific community. A conference of all interested parties was held in September 1993 to gather views on the need for a revision of the initial Directive.

A period of analysis and further consultation with scientific specialists followed with a formal proposal for a new Directive published in early 1995. After almost four years of negotiations between the European Council, Parliament and European Commission, the European Council adopted the Directive in November 1998.

D1.2 Monitoring and enforcement

Article 4 of the Drinking Water Directive 98/83/EC requires Member States to take the measures necessary to ensure that water intended for human consumption is wholesome and clean. To this end, they must set values for drinking water quality standards no less stringent than those specified in the Directive (Article 5, Council Directive 98/83/EC). Member States may set values that are more stringent or include additional parameters but they must notify the European Commission of those standards (Subsection 19, Council Directive 98/83/EC).

Member States must ensure that regular monitoring of drinking water is carried out in order to check that water quality meets the requirements under the Directive (Article 7, Council Directive 98/83/EC).

Member States may set their own monitoring programs provided the minimum monitoring requirements set out in Annex II of the Directive are met. Annex II

specifies the parameters that must be monitored and the minimum frequency of sampling and analyses of drinking water.

It requires that Member States carry out both check monitoring and audit monitoring. Check monitoring provides regular information on the organoleptic and microbiological quality of drinking water as well as information on the effectiveness of drinking water treatment. Audit monitoring provides the information necessary to determine whether or not all of the Directive's parametric values are being complied with.

When analysing samples, Member States must comply with the specifications set out in Annex III of Directive 98/83/EC. Annex III requires each Member State to:

> … ensure that any laboratory at which samples are analysed has a system of quality control that is subject from time to time to checking by a person who is not under the control of the laboratory and who is approved by the competent authority for that purpose (Annex III, Council Directive 98/83/EC).

The European Commission has responsibility for ensuring that the provisions of Directive 98/83/EC are implemented by the Member States. Where Member States fail to comply, the Commission may institute legal proceedings in the European Court of Justice.

Reports on the quality of drinking water must be published every three years by each of the Member States. Based on these reports, the European Commission is required to draw up a summary report on the quality of water in the European Community every three years.

D1.3 Implementation

Implementation of Directives requires each Member State to enact legislation. Thus Member States have a degree of discretion over how the Directive is implemented. Artis and Lee have argued that:

> The delayed and incomplete implementation of EU-level actions is, in effect, one of the important mechanisms by which EU-level and individual Member State interests are reconciled. Such mechanisms need to be taken into consideration when assessing the actual costs and benefits to individual Member States which result from EU-level actions (Artis and Lee 1997, p. 238).

Assessing how the Member States have implemented Drinking Water Directive 98/83/EC is premature given its comparative newness. In addition, an assessment of how Member States implemented the Drinking Water Directive 80/778/EEC is hampered by a lack of reporting requirements under that Directive.

Pearce (1998) noted that, by the end of 1993, no Member State had fully complied with the Drinking Water Directive 80/778/EEC. Several Member States (including the United Kingdom) had been taken to the European Court of Justice because of alleged breaches of the Directive (Jones 1996).

Non-compliance centred on the chemical parameters specified in the original Directive. Member States found it difficult to comply with the standards set for nitrates, pesticides and heavy metals:

> Wide spread opinion suggested that some of the standards – eg, for nitrates and pesticides – were unnecessarily restrictive. The EC limit for individual pesticides (0.1 micrograms per litre) and for total pesticides (0.5 micrograms per litre), for example, does not correspond to WHO standards which are generally less stringent, are health-related, and are specific to particular pesticides (Pearce 1998, p. 494).

Bosanquet has also argued that some of the requirements of the Directive were extreme:

> The scientific and technological basis of some Maximum Admissible Concentrations (MACs) is questionable, to say the least. For example, the cost of full compliance with the EC MAC on pesticides is estimated at £1 billion in [the UK] alone. The familiar search through an Olympic swimming pool for an aspirin tablet … arises because the 1980 pesticides limit was not based on scientific evidence on toxicity, but on the 'precautionary principle', (essentially; if in doubt, ban it!). The pesticides MAC is a surrogate for zero; the lowest concentration technologically detectable when the Directive was drawn up. Yet this blanket figure applies to 400 different chemicals, making up 3153 individual pesticides of vastly different toxicity (Bosanquet 1993, p. 1).

Bosanquet pointed out that in the case of the standard for nitrate:

> … epidemiological study does not clearly link adverse health effects and nitrate at the levels which are causing such expense to remedy. … no adverse health effects have been linked to nitrate levels below 50mg/l, and [the European Union of National Water Suppliers] therefore recommends that the EC guidelines value of 25mg/l should be abolished (Bosanquet 1993, p. 5).

Meeting the microbiological requirements of the Directive was more successful:

> All Member States have implemented the mandatory standards for microbiological parameters, colour and oxidisability. Many Member States have gone much further than required by the Directive by implementing requirements for disinfection and maintenance of disinfectant residuals and by setting standards for disinfectant by-products (Hyde 1998, p. 18).

D2 England and Wales

Ten water service companies and 17 water only companies supply drinking water services in England and Wales.[1] The water service companies were privatised in 1989.

Each of the ten water and wastewater companies operate in a specific geographical area (figure D2.1) and are responsible for the abstraction, treatment and distribution of water and the collection, treatment and disposal of wastewater. The 17 water only companies operate in localised areas of England and Wales not supplied by the water and wastewater companies.

Figure D2.1 **Operating areas of the water and wastewater companies and water only companies**

Data source: Water UK (1999).

1 Scotland and Northern Ireland drinking water standards are administered through separate local arrangements.

Two thirds of the water supplied for drinking in England and Wales comes from surface water and one third from groundwater. About half the surface water is abstracted from upland reservoirs, which drain partially protected catchments. The remaining surface water is abstracted from lowland rivers which drain unprotected catchments and often receive agricultural and urban run off and effluent discharges upstream of a water treatment works abstraction point.

All water intended for human consumption undergoes some form of treatment. Generally, conventional filtration and disinfection treatment processes are used, although more advanced treatment processes are becoming more common. For example, Thames Water now employs ozonisation technology in its water treatment process (see box D2.1).

Box D2.1 **Thames Water water treatment process**

- Storage reservoirs — water is stored in reservoirs. This ensures that larger solid particles sink to the bottom, and the large surface area allows oxygen in the air to work on other impurities.
- Pre-ozone — a small dose of ozone is added to start to clean the water.
- Primary sand filters — Grains of sand trap particles such as vegetation and micro-organisms which naturally occur in river water.
- Main ozone — A dose of ozone gas breaks down chemicals, such as pesticides, and helps to disinfect the water.
- Granular Activated Carbon (GAC) and secondary sand filters — A layer of GAC is sandwiched between secondary sand filters. This removes the last remaining dissolved substances and improves the taste and appearance of drinking water.
- Disinfection — A small dose of disinfectant is added, normally in the form of chlorine.
- Service reservoir — Some water is pumped straight into distribution, but most is stored in service reservoirs. These reservoirs are covered to keep the water clean and are usually on high ground to enable water to flow by gravity into the mains.

Source: Thames Water (1999).

D2.1 Regulation

The *Water Industry Act 1991* (WIA) places an obligation on the water utilities to ensure that the water they supply is wholesome, namely:

> It shall be the duty of a water [utility]:

(a) when supplying water to any premises for domestic or food production purposes to supply only water which is wholesome at the time of supply; and

(b) so far as reasonably practicable, to ensure, in relation to each source or combination of sources from which that [utility] supplies water to premises for domestic or food production purposes, that there is, in general, no deterioration in the quality of the water which is supplied from time to time from that source or combination of sources (s. 68(1), WIA).

The Secretary of State has primary responsibility for setting water quality requirements. Section 67 of the WIA provides for the Secretary of State to make regulations in regard to the wholesomeness of water supplies.[2]

> The Secretary of State may by regulation make provision that water that is supplied to any premises is or is not to be regarded as wholesome … if it satisfies or, as the case may be, fails to satisfy such requirements as may be prescribed (s. 67(1), WIA).

The quality of drinking water supplies are regulated under *The Water Supply (Water Quality) Regulations 1989* (WS(WQ)R). Water is regarded as wholesome if water supplied for human consumption meets the following requirements:

- The water does not contain any element, organism or substance (other than a parameter listed in table D2.1) at a concentration or value which would be detrimental to public health.
- The water does not contain any element, organism or substance (whether or not a parameter) at a concentration or value which in conjunction with any other element, organism or substance it contains (whether or not a parameter) would be detrimental to public health.
- The water does not contain concentrations or values of the parameters listed in A to C (see table D2.1) in excess of the prescribed concentrations or values.
- The average concentrations or values of parameters listed in D (see table D2.1) taken from water samples over the preceeding 12 months did not exceed the concentrations or values specified.
- Over the three preceeding months, the average concentrations of trihalomenthanes did not exceed 100µg/l.
- The hardness and alkalinity of water supplied for consumption is not below the minimum specified (ss. 3(3)&3(4), WS(WQ)R).[3]

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2 The powers under the WIA are exercised jointly by the National Assembly of Wales and, in England, the Secretary of State for the Environment, Transport and the Regions.

3 Minimum hardness and alkalinity values specified only apply to (artificially) softened and desalinated water.

Table D2.1 **Prescribed parameters**

A	*B*	*C*	*D*
Colour	Arsenic	Total coliforms	Conductivity
Turbidity	Cadmium	Faecel coliforms	Chloride
Odour	Cyanide	Faecal streptococci	Calcium
Taste	Chromium	Sulphite-reducing	Substances extractable
Temperature	Mercury	clostridia	in choloform
Hydrogen ion	Nickel	Colony counts	Boron
Sulphate	Lead		Barium
Magnesium	Antimony		Benzo 3,4 pyrene
Sodium	Slenium		Tetrachloromethane
Potassium	Pesticides and related		Trichloroethene
Dry residues	products		Tetrachloroethene
Nitrate	Polycyclic Aromatic		
Nitrite	hydrocarbons		
Ammonium			
Kjeldahl nitrogen			
Oxidizability			
Total organic carbon			
Dissolved or emulsified hydrocarbons			
Phenols			
Surfactants			
Aluminium			
Iron			
Manganese			
Copper			
Zinc			
Phosphorus			
Fluoride			
Silver			

Source: Schedule 2, *The Water Supply (Water Quality) Regulations 1989*.

Under the WS(WQ)R, the Secretary of State[4] may authorise a relaxation of drinking water quality requirements if the Secretary is satisfied that the authorisation is:

- necessary, as an emergency measure, to maintain a supply of water for human consumption;
- called for by reason of exceptional meteorological conditions; or
- called for by reason of the nature and structure of the ground in the area from which the supply emanates (s. 4(1), WS(WQ)R).

4 Secretary of State for the Environment, Transport and the Regions in England and the National Assembly of Wales.

An authorisation granted under s. 4(1) must specify the date on which the authorisation ceases to have effect and the extent to which the prescribed concentrations and values may be relaxed. An authorisation must not relax the prescribed concentrations and values so far as to give rise to a public health risk which the Secretary considers unacceptable.

The WS(WQ)R also require that raw water be treated to a minimum level prior to supplying it to consumers:

> … a [water supplier] shall not supply water from any source which consists in or includes raw water unless the water has been disinfected and, in the case of surface water, subjected to at least such further treatment as is … required to secure compliance with Council Directive 75/440/EEC (quality required of surface water intended for the abstraction of drinking water) (ss. 23(1) and 23(2), WS(WQ)R).

Further, suppliers must treat water in such a way as to eliminate or reduce any risk of contamination by copper, lead or zinc from household and business pipes. Such treatment is not required where:

- the treatment is unlikely to achieve a significant reduction in the concentration of copper, lead or zinc;
- the prescribed risk relates only to water supplied in an insignificant part of the water supply zone; or
- treatment is not reasonably practicable (s. 24, WS(WQ)R).

Amendments to the WS(WQ)R introduced in 1999 established a treatment standard for *Cryptosporidium*. The amendments require that treated water must contain on average less than one oocyst in 10 litres of water. Where there is a significant risk that the organism will be present in the treated water, sampling for *Cryptosporidium* must be carried out on a continuous basis. The sample collection device is removed once each day and analysed at an approved laboratory within three days, or in specified circumstances, within one day.

The Department of Environment, Transport and the Regions (DETR) claimed that the regulations were:

> … necessary to provide a more secure basis for protecting public health and to reduce the possibility of an outbreak of *Cryptosporidiosis* arising from the failure of a water company to exercise due diligence in the operation of its treatment processes. The need for these Regulations arises from the failure of the criminal prosecution of South West Water for supply of water unfit for human consumption (DETR 1998b, p. 1).

The regulation of drinking water quality has largely encompassed the translation of European Union requirements, as specified in its Drinking Water Directives, into UK legislation.

The WS(WQ)R gave effect to the first Drinking Water Directive (80/778/EEC) issued in 1980. In some instances, the WS(WQ)R were more stringent than those required by the Drinking Water Directive. For example, the requirement for lead was more stringent and a standard for trihalomethanes was set (OFWAT 1997a).

The European Union's new Directive, Drinking Water Directive 98/83/EC, is due for transposition into legislation by 25 December 2000. New regulations are currently under preparation to effect transposition and to apply most of the standards from 25 December 2003.[5]

Where the requirements of these new regulations go beyond those necessary for compliance with the new Directive, the policy appraisal process outlined in the UK Government's Better Regulation Guide must be applied. The Better Regulation Guide was developed by the Better Regulation Task Force (BRTF) which is independent of Government and supported by the Cabinet Office Better Regulation Unit, now the Regulatory Impact Unit (RIU). The BRTF's terms of reference are:

> To advise the Government on action which improves the effectiveness and credibility of government regulation by ensuring that it is necessary, fair and affordable, and simple to understand and administer, taking particular account of the needs of small businesses and ordinary people (BRTF 1998a).

More detail on the BRTF and its work is in box D2.2.

The policy appraisal process outlined in the Better Regulation Guide aims to ensure that regulations are necessary, effective in securing the desired benefits and that the costs are justified (BRTF 1998b).

> … no regulatory proposal which has an impact on business, charities and voluntary bodies should be considered by the Government without a thorough assessment of the risks, costs and benefits, a clear analysis of who will be affected and an explanation of why non-regulatory action would be insufficient. This requirement applies whenever Ministers or their officials are seeking to clear a new proposal for primary or secondary legislation or a negotiation line that will result in such legislation (Blair reported in BRTF 1998b).

5 Some standards come into effect later. For example, the final lead standard of 10 µg/l is 25 December 2013.

Box D2.2 **Better Regulation Task Force**

Besides the Better Regulation Guide, the Better Regulation Task Force (BRTF) has developed documents on the Principles of Good Regulation and Enforcement.

In its Principles of Good Regulation, the BRTF argued that good regulation and its enforcement should be measured against five principles — transparency; accountability; targetting; consistency; and proportionality (BRTF 1998c). The BRTF is currently applying these principles to assess the quality of existing and proposed legislation. It does not appear to have reviewed existing water regulation as yet.

Within its document on Enforcement, the BRTF recommended ways to promote consistency and best practice in enforcement and ensure that arrangements are clear and user-friendly to businesses, consumers and citizens.

The BRTF also works with the Interdepartmental Liaison Group on Risk Assessment (ILGRA) which sits under the Directorate of Science and Technology. The ILGRA meets regularly to share views on and experiences of risk assessment matters.

At the direction of the BRTF, the ILGRA recently undertook a study to improve risk communication activities. The resulting guidelines, 'Risk Communications – A Guide to Regulatory Practice', aim to enable Departments to review the way they develop and implement risk policy so that risk communication can be incorporated more fully into mainstream policy development, implementation and evaluation.

Source: BTRF (1999).

The appraisal process involves undertaking appropriate risk assessment strategies and regulatory impact assessments to assess the net benefit of the proposal. It describes good practice at all stages of regulating and provides general guidance to policy makers on how to prepare a Regulatory Impact Assessment (RIA).

The Guide proposes that a RIA should include:

1. Title;
2. Purpose and intended effect of the measure:
   - identify the issue and objective; and
   - risk assessment;[6]
3. Options;
4. Benefits;
5. Compliance costs for business, charity and voluntary organisations;

6 Risk assessment involves identifying the hazard or situation which leads to harm or detriment, and estimating the probability that the detriment or harm occurs (BRTF 1998c).

6. Consultation with small business;
7. Identify any other costs;
8. Consultation results;
9. Summary and recommendations; and
10. Enforcement, sanctions, monitoring and review.

The RIU in the DETR is responsible for ensuring that all new regulation proposed by the Department undergoes a RIA. Copies of all final RIAs must be sent to the Cabinet Office RIU.

D2.2 Monitoring and enforcement

The duties of a water utility in the WIA and the WS(WQ)R to supply wholesome water and meet other requirements are enforceable by the Secretary of State (s. 68(5), WIA). The Secretary of State may, by a final enforcement order, make such provision for the purpose of securing compliance (s. 18(1), WIA). An enforcement order places a duty upon the water utility to comply with its obligations and allows a person who has sustained a loss or damage from breach of this duty to take action against the utility (s. 22(1)(2), WIA). Failure to comply with an enforcement order could lead to the water utilities' licence being revoked and awarded to another supplier.

The Secretary of State need not issue an enforcement order if the Secretary is satisfied that:

- the contravention was of a trivial nature; or
- the company has given, and is complying with, an undertaking to correct the contravention; or
- such an order would conflict with the Secretary's duties under the Act (s. 19(1), WIA).

The WIA creates an offence of supplying water unfit for human consumption. Water utilities found guilty of this offence can incur a fine and an individual of the utility could be imprisoned as well as fined. A water utility may have a due diligence defence.

The Drinking Water Inspectorate (DWI), which is part of the DETR, monitors supplier compliance with their obligations under the WIA and WS(WQ)R. Its functions also include:

- taking enforcement action to ensure compliance with legal requirements;
- investigating incidents which adversely affect the quality of drinking water;
- assessing consumer complaints;
- providing technical advice to government on drinking water policy issues; and
- advising the Secretary on prosecution if a company has supplied water unfit for human consumption.

The DWI's assessment of whether a utility is complying with requirements is based on information received from the water utilities. However, the DWI carries out inspections to ensure that the results are reliable and to give an accurate picture of the quality of the water supplied.

The WS(WQ)R require the water utilities to conduct their own monitoring:

> For the purpose of determining whether water [supplied for the purposes of drinking, washing or cooking] satisfies the provisions [in regard to wholesomeness] …, a water [utility] shall take and analyse or cause to be analysed such number of samples of the water within each of its water supply zones as is so specified (s. 10, WS(WQ)R).

Sampling points and frequencies are specified in the WS(WQ)R.[7] According to these regulations, water utilities determine the number and location of all sampling points to produce data that is 'representative of the quality of the water supplied' in each supply zone (s. 11(1), WS(WQ)R). There is a proviso that sampling points for copper, lead, zinc and at least 50 per cent of the sampling points for *total coliforms*, *faecal coliforms* and colony counts are selected at random.

In taking, handling, transporting, storing and analysing a sample, a water utility must ensure that the sample is:

- representative of the quality of the water at the time of sampling;
- not contaminated when being taken;
- kept at such temperature and in such conditions as will ensure no material alteration of the concentration or value;
- analysed as soon as may be after it has been taken:
  - by or under the supervision of a person who is competent to perform that task;
  - with the use of such equipment as is suitable; and

7 Section 69 of the WIA empowers the Secretary of State to make regulations in regard to monitoring.

- by applying such analytical systems and methods as are capable of establishing whether the sample contains concentrations or values that contravene prescribed requirements; and

- analysed at a laboratory that has a system of analytical quality control in place that is subject to checking by a person not under the control of either the laboratory or the water utility and is approved by the Secretary of State (s. 21(2), WS(WQ)R).

Under the *Water Undertakers (Information) Direction 1998*, a water supply company is required to notify the Secretary of State if there is the occurrence of any event that is likely to cause a significant health risk. The water supplier must also notify the DWI and, within 72 hours, provide an initial report detailing the incident and the action the utility proposes to take.

Where an incident occurs, the DWI will investigate the cause of the incident and make recommendations regarding corrective action. A follow-up audit would normally be conducted to ensure that their recommendations have been implemented.

D2.3 Industry response

The standards demanded by the WS(WQ)R required the water companies to increase capital expenditure from £1 billion to £3.5 billion a year between 1989 and 1995.[8] Higher capital expenditures translated into higher consumer water bills, which increased over the period by an average of 25 per cent (Booker 1997). Booker claimed that:

> Increasingly, over the period 1990 to 1995, there was customer unrest, high levels of complaints about charges, a great deal of complaining to Members of Parliament with the ensuing political fallout, particularly in those areas which were hit worse than average and which also happened unfortunately to be relatively low income areas. By 1995, affordability had become a real issue for a significant number of low income customers … (Booker 1997, p. 69).

Although there is still considerable uncertainty about how the obligations under the Drinking Water Directive 98/83/EC will be interpreted by the UK Government, initial company estimates of the cost of complying with the new requirements approximated £1.7 billion. These estimates were challenged by the Office of Water Services (OFWAT) which argued that the cost would be around £850 million (OFWAT 1998b).

8 This expenditure covered maintaining, renewing and building new assets.

The most significant cost is the new lead standard as compliance as it requires the replacement of lead communications pipes. Suppliers have estimated that this process alone will cost over £1 billion over the period 2000-2001 to 2004-2005 (OFWAT 1998b).

Despite this cost, Pearce (1998) stated that the human health benefits from replacing lead piping are likely to be small since lead intake via drinking water represents only a fraction of total lead intake by humans.

The price regulator, the Director-General of Water Services (DGWS) (see box D2.3), is in the process of reviewing pricing arrangements for the period 2000 to 2005. The DGWS has indicated that he wishes to see an initial price cut followed by four years of generally stable prices (Booker 1997).

Box D2.3 **The Director-General of Water Services**

The Director-General of Water Services (DGWS) is appointed (and may be removed) by the Secretary and is assisted by the Office of Water Services (OFWAT). The DGWS can only be removed for incapacity or misbehaviour.

The DGWS's duties are spelt out in s. 2 of the *Water Industry Act 1991*. The DGWS's primary duties are to ensure that:

- the functions of water and sewerage companies are properly carried out in every area of England and Wales; and
- the companies are able to finance these functions, in particular by securing reasonable returns to their capital.

The DGWS's secondary duties include:

- protecting consumers by ensuring there is no undue discrimination in the way companies fix and recover charges, that rural customers are protected and other consumer aspects, such as quality of service, are protected;
- promoting economy and efficiency on the part of the appointed companies;
- facilitating competition between suppliers and potential suppliers and ensuring that a framework exists in which competition can develop; and
- further the conservation and enhancement of flora, fauna and geological or physiographical features of special interest.

The DGWS fulfills its duties by ensuring that companies comply with their operating licences. Licences are concerned with the economic regulation of the industry and deal with such issues as price controls, ensuring that supply and quality of service are maintained and protecting the interests of consumers.

The DGWS can amend Licences with the company's agreement or following reference to the Monopolies and Merger Commission on public interest grounds. When a company is in breach of the terms of its Licence, the DGWS has the power to secure compliance by means of an Enforcement Order and, ultimately, it may ask the High Court to appoint a special administrator until a new company can take over. However, disagreements are normally settled through consultation and negotiation.

Source: OFWAT (1997b).

D3 United States

There are around 170 000 water suppliers in the United States that are regulated under the *Safe Drinking Water Act 1974*.[1] These suppliers provide drinking water to 250 million Americans or around 90 per cent of the population. The remaining population is served by private wells not subject to regulation.

Drinking water sources vary even within communities. In the United States, approximately 53 per cent of all drinking water comes from ground water sources (wells), with the remaining 47 per cent coming from surface water (rivers, lakes and reservoirs) (US EPA 1997b).

There are three types of suppliers:

- community suppliers which provide water to cities, towns, villages and mobile home parks and serve the same people all year-round;[2]
- non-transient non-community suppliers which provide water to places such as factories, schools and day care centres and serve at least 25 of the same people for at least six months of the year; and
- transient non-community suppliers which provide water to places such as restaurants, rest stops, camp grounds and parks and serve transient populations.

In general, community and non-transient suppliers must comply with most regulations. Transient suppliers do not have to comply with the regulations for contaminants causing chronic health effects, because users are not exposed to the contaminants long enough for adverse health effects to occur (OECA 1998).

A summary of the drinking water regulations which apply to each category of supplier is provided in table D3.1.

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1 Water suppliers are commonly referred to as Public Water Systems (PWS) in the US. A PWS may be publicly or privately owned and is defined by the Environmental Protection Agency (EPA) as a system that has at least 15 service connections or serves at least 25 people for at least sixty days per year.

2 There are around 50 000 community suppliers in the US, of which 33 per cent are privately owned.

Table D3.1 **Summary of drinking water regulations for water suppliers - 1998**

Contaminant/Rule	*Community Suppliers*	*Non-transient non-community suppliers*	*Transient non-community suppliers*
Organic Contaminants	All	All	Some (only epichlorohydrin and acrylamide)
Total Trihalomethanes	Some (Only suppliers serving more than 10 000)	None	None
Inorganic Contaminants	All	Some (all except arsenic and fluoride)	None
Nitrate and Nitrite	All	All	All
Radionuclides	All	None	None
Total Coliform Rule	All	All	All
Surface Water Treatment Rule	Some (Only suppliers using surface water or ground water sources under the direct influence of surface water)	Some (Only suppliers using surface water or ground water sources under the direct influence of surface water)	Some (Only suppliers using surface water or ground water sources under the direct influence of surface water)
Lead and Copper Rule	All	All	None
Stage 1 Disinfection ByProducts Rule	Some (Only those that treat water with a chemical disinfectant for either primary or residual treatment)	Some (Only those that treat water with a chemical disinfectant for either primary or residual treatment)	None

Sources: US EPA (1998g and 1999b).

Suppliers are also categorised according to the size of the population they serve (see table D3.2). Some regulations only apply to suppliers of a particular size. For example, the Information Collection Rule applies to large surface water suppliers serving at least 100 000 people and ground water suppliers serving at least 50 000 people, and the Interim Enhanced Surface Water Treatment Rule applies to large suppliers serving more than 10 000 people.[3]

3 These rules are discussed in section D3.4.

Table D3.2 **Water suppliers by size, 1997**

Size	*Number of suppliers (thousands)*	*Population served (million)*
Small (serving 25 –3300 persons)	162.5	25.0
Medium (serving 3301 – 10 000 persons)	4.3	25.1
Large (serving more than 10 000 persons)	3.6	202.4

Source: US EPA (1999b).

D3.1 Evolution of drinking water standards

Congress enacted the *Interstate Quarantine Act 1893* which among other things, empowered the US Public Health Service (PHS) to establish standards for drinking water suppliers (Cotruvo et al 1990). But it was not until 1914 that the first federal drinking water standard for bacteriological quality was promulgated. This standard applied to water used on common carriers only — railroads, vessels and other interstate carriers. Each State of the US established its own standards for intra-State waters (Kawata 1986).

Between 1914 and 1974, standards were established for physical and chemical parameters such as lead, arsenic, fluoride and selenium — many standards were set for aesthetic reasons. In 1962, water quality criteria based on scientific information were used for the first time to determine standards for nitrates, radioactivity, synthetic detergents, barium, cadmium, cyanide and silver. These standards applied to drinking water used by carriers and others subject to federal quarantine regulations. They only applied to intra-state supplies when the States adopted the federal standards as their own.

In the 1970s, public attention focussed on chemical contamination of drinking water sources. Over 12 000 chemical compounds were known to be in use, many of which contaminated ground and surface water and had toxic and/or carcinogenic characteristics.

At the same time, there was inconsistent (and frequently ineffective) State supervision of drinking water suppliers. Based in part on data collected in the 1969 Community Water Supply Survey, monitoring of drinking water quality, particularly in small communities, was determined to be seldom practiced and compliance with the PHS standards (which were non-enforceable guidelines) for drinking water were minimal. Except for the bacteriological standard established

under the *Interstate Quarantine Act 1893*, drinking water standards were not legally binding until the passage of the *Safe Drinking Water Act 1974* (Cotruvo et al 1990).

In response to these concerns, the *Safe Drinking Water Act 1974* (SDWA) was enacted by Congress (Clark 1995). The SDWA led to the creation of the first set of uniform national minimum standards for drinking water and gave greater power to the Federal Government to regulate drinking water supplies. Initially, 22 contaminants were regulated under the Act (ten inorganic chemicals, six organic chemicals, turbidity, coliform, radium-226, radium-228, gross alpha activity and manmade radionuclides). By 1989, the number of regulated contaminants had increased to 83.

By the 1990s, microbial contaminants (bacteria, protozoa and viruses) were considered the greatest remaining public health risk to drinking water supplies. Between 1986 and 1992, the Centres for Disease Control and Prevention reported a total of 102 drinking water disease outbreaks linked directly or indirectly to microscopic bacteria, viruses or parasites affecting 34 155 people in 35 States. However, in 1993 a single outbreak of *Cryptosporidiosis* in Milwaukee affected over 400 000 people and caused up to 100 deaths (Innes et al 1998).[4] This was the catalyst for the development of the Interim Enhanced Surface Water Treatment Rule which was promulgated in February 1999.

D3.2 Institutions

In the United States, the focus for the development, compliance and enforcement of drinking water standards to protect public health rests with the Federal Government.

Federal government departments

In the United States, the Environmental Protection Agency (US EPA) is the principal (federal) agency responsible for setting national standards for drinking water contaminants.

More than a dozen major laws form the legal basis for the diverse environmental programs of the US EPA (US EPA 1999d). However, of most relevance to drinking water are the SDWA and the *Clean Water Act 1977* (CWA*)*.

Within the US EPA, there are a number of Offices directly responsible for regulation, enforcement and compliance, research and development, and peer-

4 *Cryptosporidiosis* is the disease that arises from *Cryptosporidium*.

reviewed science associated with setting national standards for drinking water contaminants (US EPA 1999e).

The Office of Water is responsible for implementing the CWA and the SDWA. Within this Office, the Office of Ground Water and Drinking Water (OGWDW) is responsible for the following activities:

- development of regulatory tools to address drinking water treatment technologies, analytical methods, benefit–cost analysis, contaminant identification and occurrence, and the development of regulations for individual chemical contaminants in drinking water such as radon, arsenic and emerging new contaminants;
- provision of technical and scientific support to the development and implementation of drinking water regulations, the Information Collection Rule and drinking water laboratory certification program;
- development of drinking water regulations for microbial contaminants and disinfection by-products, including modelling, data collection, assessment and policy development;
- responsibility for the Drinking Water State Revolving Fund, operator certification, small suppliers, chemical monitoring, the Tribal program,[5] training and technical assistance, implementation of the Public Water Supply System Program Rules and the Underground Injection Control Program;
- protection of source water, state ground water and wellhead areas;[6] and
- maintaining information on drinking water through computer databases and the Internet, and promoting consumer awareness of safe drinking water issues.

The Office of Enforcement and Compliance Assurance (OECA) is responsible for ensuring the compliance of the regulated community with Federal environmental statutes.

The Office of Research and Development (ORD) provides the scientific foundation for US EPA's mission of protecting public health and the environment. The ORD's responsibilities are to:

- conduct research and development to identify, understand and solve current and future environmental problems;
- provide responsive technical support to the US EPA's programs and regions;

5 Tribal program refers to the drinking water program for all water suppliers on Indian reservations.

6 Wellhead protection refers to the area surrounding a drinking water well or well field, which is protected to prevent contamination of ground water by surface contaminants.

- collaborate with scientific partners in academia and other agencies, State and Tribal governments, private sector organisations and nations; and
- exercise leadership in addressing emerging environmental issues and advancing the science and technology of risk assessment and risk management.

Within the Office of the Administrator, the Science Advisory Board (SAB) is mandated by the 1996 SDWA amendments to comment on drinking water regulations prior to their promulgation. The expert Drinking Water Committee (DWC) carries out this mandate on behalf of the Board by reviewing various scientific and technical documents associated with the Office of Water's SDWA regulatory activities. The DWC also reviews various drinking water research plans and projects for the US EPA's Office of Research and Development.

Other federal government departments

The Department of Health and Human Services (DHHS) is responsible for protecting the health of all Americans. The DHHS is not directly involved in developing drinking water regulations, however, it has input into standard setting.

The Department's programs are administered by eleven Health and Human Services operating divisions. Of relevance to this study are the Food and Drug Administration (FDA) and the Centres for Disease Control and Prevention (CDC).

The FDA is responsible for the safety of foods, which includes bottled water. The CDC provides a system of health surveillance to monitor and prevent outbreak of diseases, and maintains national health statistics.

Legislation

The SDWA is the primary statute for protecting the quality of drinking water in the US. It empowers the US EPA to establish regulations to ensure safe drinking water.

The SDWA was significantly amended in 1996. The amendments include, among other things, changes to the regulatory program, improving consumer information, funding for states and local water suppliers and measures aimed at new prevention approaches (US EPA 1996). More specifically:

- The new law replaced the requirement that the US EPA set 25 new standards every three years with a new process for selecting and regulating contaminants. Current regulations remain in place and are not subject to the new standard setting provisions.

- The US EPA is required to base national primary drinking water regulations on risk assessment and benefit–cost considerations and on minimising overall risks.[7]
- Community suppliers are required to provide customers with annual consumer confidence reports describing the source and quality of water they provide.
- States are required to establish a Drinking Water State Revolving Fund (DWSRF) program. The program is to be funded largely by 'capitalisation' grants from the Federal Government. The primary purpose is to assist suppliers upgrade or install drinking water treatment facilities that will allow them to comply with the national primary drinking water regulations.[8]
- States are required to develop and implement a Source Water Assessment and Protection (SWAP) program. This program is designed to prevent contamination through source water protection and enhanced water system management. Funding for this program is available through the DWSRF.

The CWA is concerned with water as a natural resource rather than as a source of drinking water. It is the principle law governing pollution control and the water quality of US waterways (US EPA 1999f). The Act:

- requires major industries to meet performance standards to ensure pollution control;
- charges states and Indian Tribes with setting specific water quality criteria appropriate for their waters and developing pollution control programs to meet them;
- provides funding to states and communities to help them meet their clean water infrastructure needs; and
- protects valuable wetlands and other aquatic habitats through a permit process that ensures development and other activities are conducted in an environmentally-sound manner.

The CWA gives the US EPA the authority to set effluent standards on an industry basis (technology-based) and to set water quality standards for all contaminants in surface waters.

The CWA makes it unlawful for any person to discharge any pollutant from a point source into navigable waters unless a permit (national pollutant discharge

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7 There are both primary and secondary drinking water regulations. The latter are non-enforceable.

8 The DWSRF is similar in design to the Wastewater State Revolving Fund which was established in 1987 under the *Clean Water Act 1977*.

elimination system) is obtained under the Act. These permits are available from the US EPA or from any State that has a US EPA approved permit program.

D3.3 Standards setting process

The primary objective of standards is to minimise exposure to a contaminant in drinking water that would result in a known or potential adverse health affect on human health.

Identification of potential contaminants to regulate

The 1996 SDWA amendments required the US EPA to publish, no later than February 1998 a drinking water Contaminant Candidate List (CCL). The CCL is a list of currently unregulated contaminants that are known or anticipated to occur in water supplies (predominantly pesticides and microbes) (US EPA 1998b).

In developing the list, the US EPA must consult with the scientific community, including the US EPA's SAB and provide notice and opportunity for public comment (Pontius 1997).

To support the identification and selection of contaminants for future regulation, the 1996 SDWA amendments direct the US EPA to establish a National Contaminant Occurrence Database (NCOD) by August 1999.

The NCOD will be a collection of data on regulated and unregulated chemical, radiological, microbial and physical contaminants likely to occur in source water and treated water (US EPA 1998b).

To obtain data on unregulated contaminants for inclusion in the NCOD, the US EPA is required to select up to 30 unregulated contaminants from the CCL for monitoring by a representative sample of water suppliers serving fewer than 10 000 people (to ensure an understanding of contaminant occurrence in different size supplies).

The US EPA has not determined whether or not data collected under the Information Collection Rule will be included in the NCOD, or remain in its own database (US EPA, pers. comm., 1999).

Determination to regulate a contaminant

The US EPA must have reviewed and published a decision on whether to regulate at least five contaminants within three and a half years of the first CCL being finalised (by August 2001). The decision to regulate must be based on the best available public health information, including information obtained from the NCOD (Pontius 1997).

To regulate a contaminant, the US EPA must find that:

- the contaminant adversely affects human health (does not have to be proven conclusively prior to regulation);
- it is known or substantially likely to occur in water supplies with a frequency and at levels of public health concern; and
- regulation of the contaminant presents a meaningful opportunity to reduce health risks for those served by water suppliers.

Risk assessment

For each drinking water contaminant regulated, the US EPA must first establish a Maximum Contaminant Level Goal (MCLG), which is a non-enforceable public health goal. MCLGs are set at a level at which 'no known or anticipated adverse effect on the health of a person occurs' and that 'allows an adequate margin of safety'.

To establish a MCLG for a contaminant of concern, the US EPA conducts a risk assessment which provides information on health risk effects (US EPA 1998f).[9] The components of the risk assessment cover:

- Hazard identification — Involves gathering and evaluating data on types of health injury or disease that may be produced by a chemical and on the conditions of exposure under which injury or disease is produced. Hazard identification is not risk assessment. It determines if it is scientifically correct to infer that toxic effects observed in one setting will occur in other settings (that is, whether substances found to be carcinogenic or teratogenic in experimental animals are likely to have similar results in humans).
- Dose-response assessment — Involves determining the quantitative relationship between the amount of exposure to a substance and the extent of toxic injury or disease. There may be many different dose-response relationships for a

9 Risk assessment is defined as the characterisation of the potential adverse health effects of human exposures to environmental hazards.

substance if it produces different toxic effects under different conditions of exposure. The risks of a substance cannot be ascertained with any degree of confidence unless dose-response relations are quantified, even if the substance is known to be toxic.

- Exposure assessment — Involves describing the nature and size of the population exposed to a substance and the magnitude and duration of their exposure. The evaluation could concern past or current exposures, or exposures anticipated in the future.
- Risk characterisation — Having determined the probable exposure and likelihood of an adverse effect, the risk characterisation involves a description of the risk assessment results, underlying assumptions, uncertainties and some judgement about whether this is an acceptable situation.

The level at which a MCLG is set varies according to the type of contaminant (US EPA 1998b). For non-carcinogenic chemicals, the MCLG is based on the Reference Dose (RFD). A RFD is an estimate of the amount of a chemical that a person can be exposed to on a daily basis, without any anticipated adverse health effects over a lifetime of consumption.

Calculations are based on human life expectancy of 70 years, average human adult body weight (70kg), average child body weight (10kg), average daily water consumption by an adult (2 litres), average daily water consumption by a child (1 litre), to provide a Drinking Water Equivalent Level (DWEL). The DWEL is multiplied by a percentage of the total daily exposure contributed by drinking water (assumed to be 20 per cent) to determine the MCLG.

For carcinogenic chemicals, the MCLG is set at zero because there is no dose below which the chemical is safe. If a chemical is carcinogenic but a safe dose can be determined, then the MCLG is set at a level above zero that can be demonstrated to be safe.

For certain microbial contaminants that present a public health risk, the MCLG is set at zero because ingesting one protozoa, virus or bacterium may cause an adverse health effect. The US EPA is conducting studies to determine whether there is a safe level above zero for some microbial contaminants. So far, these levels have not been established.

Standards and regulation development

In addition to the MCLG, the US EPA must set a Maximum Contaminant Level (MCL). MCLGs are based on public health considerations using a risk assessment

approach. The US EPA's policy is to set MCLGs for carcinogenic and microbial contaminants at zero. However, zero is often not measurable nor feasible using Best Available Technology (BAT), and nor is it practicable when cost constraints are severe. Consequently, the MCLs for these contaminants are usually set at a concentration detectable by certified laboratories under routine operating conditions.

When it is not economically or technically feasible to set a MCL for a contaminant — for example, when the contaminant cannot be easily measured — the US EPA may prescribe a treatment technique. This is an enforceable procedure or level of technological performance which water suppliers must follow to ensure control of a contaminant (US EPA 1998b).

In most cases, the standard set is a MCL, the maximum permissible level of a contaminant in water which is delivered to any user.

The SDWA requires a MCL to be set as close to the respective MCLG as feasible, except when the US EPA determines that the costs of a standard at that level are not justified by the benefits, or when certain 'risk-risk' considerations apply (US EPA 1998b).[10]

The SDWA defines feasible as the level that may be achieved with the use of BAT, treatment techniques, and other means which the US EPA finds are available (after examination for efficiency under field conditions and not solely under laboratory conditions), taking cost into consideration.

Benefit–cost analysis

The 1996 SDWA amendments require the US EPA to take account of the benefits and costs of setting drinking water standards. At the time the US EPA proposes a MCL or treatment technique based on affordable technology for large suppliers, it must publish a determination (based on health risk reduction and cost analysis), incorporating a statement on whether the benefits of the standard justify the costs.

If the benefits of the standard do not justify the costs, the law allows the US EPA to adjust the MCL for a particular class or group of suppliers to a level that would provide the maximum reduction in health risk at a cost justified by the benefits (US EPA 1998b).

10 Risk-risk considerations take account of the potential for a feasible MCL to increase the concentration of other contaminants in drinking water and compromise other primary drinking water regulations.

In support of each proposed regulation, the US EPA is required by the SDWA to:

- Use the 'best available, peer-reviewed science and supporting studies' in carrying out actions within the standard setting process 'to the degree that US EPA action is based on science'.
- Ensure that information presented on the health effects of the contaminant is comprehensive, informative, and understandable and make available to the public a document that specifies:
  - the population addressed by the regulation;
  - the central, upper and lower estimates of risk;
  - significant uncertainty identified in the process of the assessment of public health effects and studies that would assist in resolving the uncertainty; and
  - peer-reviewed studies that support, are directly related to, or fail to support any estimate of public health effects and the methodology used to reconcile inconsistencies in the scientific data.
- For proposed regulations that include a MCL or a treatment technique, the US EPA must undertake and seek public comment on an analysis of quantifiable and non-quantifiable risk reduction benefits and costs for each MCL or treatment technique and health risks the regulated contaminant poses to immuno-compromised individuals. More specifically, the benefit–cost analysis must include:
  - the health risk reduction benefits likely to occur;
  - the costs likely to occur;
  - the incremental costs and benefits associated with each alternative MCL considered;
  - the effects of the contaminant on the general population and on immuno-compromised individuals;
  - any increased health risk that may occur as the result of compliance; and
  - other relevant factors, including uncertainties in the analysis and the nature of the risk.

Consultation

Before proposing any MCLG or national primary drinking water regulation, the US EPA requests comments from the SAB, which can respond any time before its promulgation.

The SAB was established by Congress to provide independent scientific and engineering advice to the US EPA Administrator on the technical basis for US EPA regulations.

The SAB deals with risk assessment issues (hazard identification, dose-response assessment and risk characterisation) and only that portion of risk management that deals strictly with the technical issues associated with various control options. Issues of US EPA policy are generally beyond the scope of SAB's mandate.

Generally the SAB functions as a technical peer-review panel. It conducts its review openly drawing on public input for its deliberations. These reviews subject the US EPA to critical examination by leading experts in the field. The SAB also serves as a council of peers to evaluate the soundness of the technical basis of the science policy position adopted by the US EPA. In doing so, the SAB recognises that the US EPA is sometimes forced to take action to avert an emerging environmental risk before all of the rigours of scientific proof are met. In such cases, the US EPA makes certain assumptions and extrapolations from what is known in order to reach a rational science policy position regarding the need (or lack thereof) for regulatory action (US EPA 1999g).

The US EPA Administrator consults with the Secretary of the DHHS. The US EPA may use information provided by the DHHS, or may ask for input from the DHHS when developing a regulation (or when an already final regulation comes into question).

One example of this consultation occurred in the case of fluoride (see box D3.1).

Box D3.1 **Regulation of fluoride**

The US EPA has passed a final regulation for fluoride which establishes two standards — a primary standard to protect against skeletal fluorosis, and a secondary, non-enforceable standard to protect against dental fluorosis. The US EPA made this secondary standard non-enforceable on the basis that dental fluorosis is a 'cosmetic' effect and not a major health concern.

There was controversy about this issue and the US EPA has requested that the DHHS address whether dental fluorosis should be considered an adverse health effect or a cosmetic effect. The US EPA has also asked DHHS to explore ways to reduce fluoride exposure when it exceeds beneficial levels.

Source: US EPA, pers. comm., 25 September 1999.

The National Drinking Water Advisory Council (NDWAC) is also consulted regarding proposed and final rules. The NDWAC was created by the SDWA in 1974 and comprises 15 members including a chairperson, appointed by the Deputy Administrator after consultation with the Secretary of the DHHS. The committee includes five members of the general public, five representatives of State and local agencies concerned with water hygiene and supply, and five representatives of private organisations and groups demonstrating an active interest in water hygiene and public water supply, including two members who are associated with small rural suppliers (US EPA 1997a).

The NDWAC is authorised to form subcommittees and working groups for any purpose consistent with their charter to consider specific matters and report back to the full Council.

The NDWAC provides practical and independent advice to the US EPA on matters and policies related to drinking water quality and hygiene, and maintains an awareness of developing issues and problems in the drinking water area and advises the US EPA on emerging issues. Its functions are to:

- review and advise the Administrator on regulations and guidance that are required by the SDWA;
- make recommendations concerning necessary special studies and research;
- recommend policies with respect to the promulgation of drinking water standards;
- assist in identifying emerging environmental or health problems related to potentially hazardous constituents in drinking water; and
- proposes actions to encourage cooperation and communication between the US EPA and other government agencies, interested parties, the general public, and technical associations and organisations on drinking water quality.

In addition to the NDWAC, representatives from water utilities, environmental groups, public interest groups, states, Indian Tribes and the general public are encouraged to take an active role in shaping the regulations, by participating in public meetings and commenting on proposed rules. Special meetings are also held to obtain input from minority and low income communities, as well as representatives of small businesses.

Time frames

Under the 1996 SDWA amendments, the US EPA must propose a MCLG and a national primary drinking regulation within two years of determination to regulate a

contaminant (by August 2003). The US EPA must publish a MCLG and a final national primary drinking water regulation no more than 18 months thereafter (by February 2005), with a nine month extension allowed (until November 2005) (Pontius 1998).

Every five years, the US EPA is required to repeat the cycle of revising the CCL, making regulatory determinations for five contaminants and identifying 30 contaminants from the CCL for unregulated monitoring. In addition, every six years, the US EPA is to re-evaluate existing regulations to determine if modifications are necessary.

Rules and regulations are published in the Federal Register which specifies the effective date of regulation. Water suppliers have three years to comply with new national primary drinking water regulations from publication, unless the US EPA determines that an earlier date is practicable. However, if capital improvements are required, US EPA's Administrator, or a State, may allow this period to be extended by up to two additional years (OECA 1998).

D3.4 National drinking water regulations, monitoring and enforcement

Drinking water regulations

The US EPA develops two categories of drinking water regulations (US EPA 1998b). These are:

- A National Primary Drinking Water Regulation (NPDWR or primary standard) which is legally enforceable and applies to all suppliers. Primary standards are based on toxic characteristics of the contaminant. They are designed to protect drinking water quality by limiting the levels of specific contaminants that can adversely affect public health and are known or anticipated to occur in water.
- A National Secondary Drinking Water Regulation (NSDWR or secondary standard) which is a non-enforceable guideline based on contaminants that may cause cosmetic effects (such as skin or tooth discolouration) or aesthetic effects (such as taste, odour or colour) in drinking water. The US EPA recommends secondary standards for suppliers but does not require suppliers to comply. However, states may choose to adopt them as enforceable standards.

Drinking water rules

In addition to setting MCLs for around 83 drinking water contaminants between 1974 and 1998, the US EPA have also established a number of drinking water rules which are legally enforceable regulations. These rules include:

- The Total Coliform Rule — Promulgated in June 1989 and effective 31 December 1990. There are a variety of bacteria, parasites and viruses in drinking water which can cause immediate health problems when humans ingest them. Testing water for each of these is difficult and expensive. Hence, coliform bacteria are used as an indicator organism to monitor the microbiological safety of drinking water. The presence of any coliforms in drinking water suggests that there may be disease-causing agents in the water. The US EPA has set a legal limit on *total coliforms* in drinking water. Suppliers must not find coliforms in more than five per cent of the samples they take each month to meet US EPA's standards.
- The Surface Water Treatment Rule (SWTR) — Promulgated in June 1989 and effective 31 December 1990. This rule was developed to prevent waterborne diseases caused by viruses, *Legionella* and *Giardia*. Since measuring these disease-causing microbes was not considered feasible, the US EPA incorporated a treatment technique in this rule to reduce the occurrence of unsafe levels of these microbes. The rule requires that all water suppliers filter and disinfect water from surface water sources to provide a minimum of 99.9 per cent combined removal and inactivation of *Giardia* and 99.99 per cent removal of viruses.[11]
- The Lead and Copper Rule — Promulgated in June 1991 and effective 7 December 1992. Unlike other rules which require suppliers to treat water so that when it leaves their facilities, it is clean and safe to drink, this rule regulates two contaminants that nearly always taint drinking water after it has left the treatment plant. The US EPA set so-called action levels for lead and copper. When the level of lead or copper reaches the action level in 10 per cent of tap water samples, the supplier must begin certain water treatment steps. For example, at a minimum, suppliers must maintain optimal corrosion control and assess its source water. The rule also requires suppliers that exceed the lead action level to educate the affected public about reducing its lead intake.

11 Surface water is defined as water which is open to the atmosphere such as rivers, lakes and reservoirs and subject to surface runoff. Surface water is particularly susceptible to microbial contamination from sewerage treatment plant discharges and runoff from storm water and snow melt. These sources often contain high levels of faecal microbes that originate in livestock wastes or septic systems.

- The Information Collection Rule (ICR) — Promulgated in May 1996, this rule applies to large surface water suppliers serving populations of at least 100 000 people and ground water suppliers serving at least 50 000 people to collect and report data on the occurrence of disinfection by-products and pathogens (including bacteria, viruses, *Giardia* and *Cryptosporidium*) in drinking water over an 18 month period. About 300 suppliers operating 500 treatment plants are involved with the extensive ICR data collection. The information collected under this rule will be used to support future regulation of microbial contaminants, disinfectants and disinfection by-products. The rule is intended to provide the US EPA with information on: chemical by-products that form when disinfectants used for microbial control react with substances already present in source water (disinfection by-products); disease-causing micro-organisms (pathogens), including *Cryptosporidium*; and engineering data to control these contaminants.
- The Interim Enhanced Surface Water Treatment Rule (IESWTR) — Promulgated in February 1999, this rule builds on the treatment requirements of the SWTR. It includes a treatment technique for the removal of *Cryptosporidium* from drinking water in lieu of measuring oocysts in water. The purpose of the rule is twofold: to improve control of microbial pathogens, more specifically *Cryptosporidium*, and to guard against significant increases in microbial risk that might otherwise occur when suppliers implement the Stage 1 Disinfection ByProducts Rule.[12] The IESWTR applies to suppliers that use surface water (or ground water under the direct influence of surface water) and serve 10 000 or more people. Water treatment plants covered by the rule are required to achieve a 2 log (99 per cent) removal of *Cryptosporidium* oocysts. To achieve this, turbidity requirements have been tightened by reducing the average monthly turbidity level of a supplier's combined filtered water at each plant from 0.5 NTU to 0.3 NTU. The maximum permissible turbidity level has also been reduced from 5 NTU to 1 NTU. For both requirements, compliance is determined based on measurement of the combined filter effluent at four hour intervals. The rule applies to all *Cryptosporidium* species, not only *C. parvum* (the species known to cause illness in people), as it is recognised that detection techniques are not yet reliable enough to provide identification of oocyst species. The rule also requires states to conduct sanitary surveys of suppliers that use surface water (or ground water under the direct influence of surface water) irrespective of size.

12 The Stage 1 Disinfection ByProduct Rule is predicated on its own merits but it also creates incentives to minimise the use of disinfectants, which can if not managed properly jeopardise disinfection effectiveness.

- Stage 1 Disinfection ByProducts Rule — Promulgated in February 1999, the purpose of this rule is to protect public health from exposure to potentially harmful disinfection by-products (DBPs). The rule contains MCLGs for four trihalomethanes and two haloacetic acids as well as a maximum residual disinfectant level goal for chlorine, chloramines and chlorine dioxide. This rule applies to community and non-transient suppliers that treat water with a chemical disinfectant for either primary or residual treatment. There are over 200 million people in the US who are served by suppliers that apply a disinfectant to water in order to provide protection against microbial contaminants. However, these disinfectants react with natural organic and inorganic matter in the water to form DBPs, some of which may pose health risks. One of the most complex questions facing water supply professionals is how to minimise the risk from DBPs and still maintain adequate disinfection control over microbial contaminants.

Monitoring

All suppliers that are regulated under the SDWA are required to monitor drinking water contaminants. Monitoring provides information on the quality of the water delivered to consumers, indicates if consumers' health is at risk and if so allows the US EPA, states and Indian Tribes to take appropriate steps to safeguard public health.

The US EPA is empowered to collect information to determine compliance with drinking water standards. The US EPA also uses monitoring information to assist it in developing standards, evaluating health risk or advising the public of potential health risks (US EPA 1996).

Suppliers are required to collect water samples, take them to a certified laboratory for analysis and provide the monitoring results to the primary enforcement authority. States or the US EPA analyse the monitoring results, determine compliance and report violations to the US EPA on a quarterly basis.

Monitoring and sampling requirements

The SDWA requires that suppliers test their water on a routine basis for the presence of contaminants. In addition, the law requires that when necessary**,** suppliers treat their water continuously to remove or reduce specific contaminants to levels that will not adversely affect human health.

The US EPA has established contaminant-specific monitoring schedules for suppliers (see table D3.3). This particular table highlights the major groups of

contaminants and the minimum frequency that suppliers must monitor. The US EPA sets different monitoring schedules for specific contaminants, depending on the routes by which each contaminant enters the water supply. In general, surface water suppliers must take samples more frequently than ground water suppliers because their water is subject to more external influences (US EPA 1998d).

Table D3.3 **Sample monitoring schedule**

Contaminant	*Minimum monitoring frequency*
Acute Contaminants	
Bacteria	Monthly or quarterly, depending on supplier size and type
Protozoa and viruses	Continuous monitoring for turbidity, monthly for *total coliforms*, as indicators
Nitrate	Annually
Chronic Contaminants	
Volatile organics (eg benzene)	Ground water suppliers, annually for 2 consecutive years; surface water suppliers annually
Synthetic organics (eg pesticides)	Larger suppliers, twice in 3 years; smaller suppliers, once in 3 years
Inorganics/metals	Ground water suppliers, once every 3 years; surface water suppliers annually
Lead and copper	Annually
Radionuclides	Once every 4 years

Note General requirements may differ slightly based on the size or type of drinking water supplier.

Source: US EPA 1997b.

For specific contaminants such as asbestos, a supplier which has never detected asbestos must monitor only once in nine years. However, for nitrates and pesticides the level of contamination can vary depending on rainfall and farmers' utilisation rates. For these contaminants suppliers in areas prone to nitrate problems monitor quarterly to track the seasonal variations (US EPA 1998d).

Although a supplier may monitor a contaminant on a monthly or quarterly basis, the sampling frequency may vary for microbiological, physical and chemical contaminants. In particular, microbiological sampling frequency varies with population size.

For example, *total coliforms* are used as indicators of the presence of microbiological contaminants. The number of coliform samples a supplier must take depends on the number of customers it serves. Suppliers serving fewer than 1000 people may sample once a month or less frequently, while suppliers with 50 000 customers may sample 60 times per month and those with 2.5 million customers may sample at least 420 times per month. These are minimum schedules, and many suppliers sample more frequently (US EPA 1998d).

Suppliers that are able to demonstrate over several years that their raw water is not susceptible to contamination can usually get State permission to reduce the frequency of monitoring.

For example, states may grant 'interim monitoring relief' to suppliers serving 10 000 or fewer persons for any regulated or unregulated contaminant (except for microbial contaminants, disinfection and corrosion by-products) so that no further quarterly monitoring is required if initial monitoring fails to detect the presence of the contaminant, and the State determines that the contaminant is unlikely to be detected by further monitoring. Interim monitoring relief can be granted for three years until permanent relief is adopted, whichever is sooner (US EPA 1996).

States also have the flexibility to adopt permanent alternative monitoring arrangements for certain contaminants (except microbials, microbial indicators, disinfectants, disinfection and corrosion by-products). However, to do so states must have an approved source water assessment program and alternative requirements must comply with US EPA guidelines and ensure compliance with US EPA applicable regulations (US EPA 1996).

Testing procedures for water quality

The US EPA is responsible for coordinating and developing an analytical method for each regulated and unregulated drinking water contaminant (includes monitoring of organic, inorganic, radionuclide and microbiological contaminants).

An analytical method is a procedure used to analyse a sample in order to determine the identity and concentration of a specific sample component. Analytical methods generally include information on the collection, transport, and storage of samples; define procedures to concentrate, separate, identify and quantify components contained in samples; specify quality control criteria the analytical data must meet; and designate how to report the results of the analyses (US EPA 1999h).

Only approved methods can be used for compliance monitoring of drinking water contaminants. Prior to using these methods to analyse drinking water compliance samples, laboratories must be certified by the US EPA or the State. Once certified, laboratories must analyse performance evaluation samples, use approved methods and undergo periodic on-site State audits.

In developing these methods the US EPA is required to seek public comment. In response to adverse comments, the US EPA has been known to publish a notice of withdrawal of the proposed rule in the Federal Register.

Enforcement

The SDWA requires each State and the US EPA to publish annual compliance reports. States with primary enforcement responsibility (primacy) must prepare and submit to the US EPA an annual report on suppliers' violations (US EPA 1999b).

These reports must address both health-related and monitoring violations. Health-related violations are those that put public health at risk by providing water containing levels of specific contaminants above the US EPA's national primary drinking water standards, or fail to comply with required treatments. These reports only focus on significant monitoring requirements, or those where the supplier has failed to take a significant number of the required samples. States are also required to publish and distribute summaries of their reports and indicate where the full report is available for review.

The US EPA must summarise and evaluate the states' reports in an annual national report. In this report the US EPA must make recommendations concerning the resources needed to improve compliance with the SDWA. The report must also address supplier compliance on Indian reservations, enforcement activities undertaken and financial assistance provided by the US EPA to Indian reservations.

In 1997, 88 per cent of the population served by community suppliers received drinking water with no reported violations of any health-related standard. Of the people affected by a violation of a health-related standard, most received water from a supplier that violated the standard that protects against viruses and *Giardia*. This standard applies to suppliers that draw from a surface water source (such as a river or lake), and usually requires the supplier to filter and disinfect its water. Many major urban suppliers rely on surface water sources, and the failure of several of these suppliers to filter their water accounts for the large number of people affected by this violation. The other health-related standard that was frequently violated in 1997 was the coliform bacteria standard (US EPA 1999i).

There were more violations of significant monitoring and reporting requirements than of standards in 1997, (17 per cent and 8.5 per cent of suppliers respectively). However, fewer people (7 per cent and 12 per cent respectively) are served by suppliers with these violations. Most of the monitoring violators are small suppliers that do not have the resources and trained staff to ensure compliance with monitoring requirements (US EPA 1999h).

State enforcement and compliance assistance programs

States engage in a variety of activities, including formal enforcement actions, informal actions, and technical assistance to help suppliers remain in, and return to, compliance (US EPA 1999b).

State enforcement and compliance assistance efforts may include:

- conducting on-site visits and sanitary surveys at suppliers premises (ie, an on-site review of the water sources, facilities, equipment, operations, and maintenance of a water supply to evaluate the adequacy of these elements for producing and distributing safe drinking water);
- assisting suppliers invest in preventive measures;
- providing financial assistance for improvements through the DWSRF and other State funding programs;
- reviewing supplier plans and specifications;
- conducting training sessions;
- holding public information meetings;
- loaning specialised monitoring equipment; and
- publishing information bulletins and newsletters on training events.

Unless there is an health risk necessitating immediate action, formal enforcement actions may be initiated several months after the violation is detected and reported. The reason for this delay is that, when appropriate, states commonly undertake a variety of informal actions and compliance assistance measures to try to get suppliers back into compliance as quickly as possible. Informal actions may include the following activities:

- compliance reminder letters or notices of violations;
- field visits; and
- telephone calls.

Formal enforcement actions may include the following activities:

- bilateral compliance agreements;
- citations;[13]
- administrative orders (maximum penalty for violating an administrative order is US$25 000);

13 Written advice or summons to appear in court.

- criminal complaints with penalties;
- civil referrals to State Attorneys General or to the Department of Justice (civil penalties can range from US$5000 to US$25 000);
- emergency orders (the US EPA has the authority to impose a penalty of US$15 000 per day for violating an emergency order);
- criminal cases;
- fines or administrative penalties (states have the authority to impose administrative penalties on suppliers serving a population greater than 10 000 an amount that is not less that US$1000 per day per violation. For suppliers serving a population of 10 000 individuals or less, states have the authority to impose an administrative penalty that is 'adequate to ensure compliance'); and
- other sanctions such as denying permission for supplier expansion.

In the 1997 financial year, states issued a total of 913 formal enforcement actions, including 632 administrative orders without penalty, 220 administrative orders with penalty, 60 civil referrals and one criminal referral. During the same period, the US EPA issued 266 notices of violation, 392 Federal administrative orders, 12 complaints for penalty, and 4 referrals for civil judicial action.

In the event that there is a violation of a US EPA standard, the public must be notified. Suppliers have 24 hours to inform their customers of violations that have the potential to have serious adverse effects on human health as a result of short term exposure. If such a violation occurs, the supplier will announce it through the media and provide information on:

- the potential adverse effects on human health;
- the steps that the supplier is taking to correct the violation; and
- the need to use alternative water supplies (such as boiled water or bottled water) until the problem is corrected.

For violations of less immediate concern, the supplier will inform customers in the first water bill sent out after the violation, in an annual report, or by mail within a year.

D3.5 Implementation

The US EPA is directly accountable to Congress for implementation of the SDWA. However, in most cases, the US EPA delegates responsibility for implementing drinking water standards to states and Indian Tribes.

Box D3.2 **Primacy**

Under the SDWA, the US EPA may grant primacy providing a State, territory or Indian Tribe subject to the following requirements:

- the State must adopt regulations that are at least as stringent as the US EPA regulations for national primary drinking water standards. However, states have the flexibility to:
  - choose a more stringent standard for a water contaminant;
  - regulate additional contaminants for which the US EPA has set no standards; and
  - adopt national secondary, non-enforceable drinking water guidelines.
- the State must have adopted and be implementing procedures for the enforcement of State regulations;
- the State must maintain an inventory of suppliers in the state;
- the State must have a program to conduct sanitary surveys of the water supply in the State;
- the State must have a program to certify laboratories that will analyse samples required by the regulations;
- the State must have a laboratory that will serve as the State's 'principal' lab, that is certified by the US EPA;
- the State must have a program to ensure that new or modified supplies will be capable of complying with State primary drinking water regulations;
- the State must have adequate enforcement authority to compel suppliers to comply with NPDWRs, including the :
  - authority to sue in court;
  - right to enter and inspect supplier facilities;
  - authority to require suppliers to keep records and release them to the states;
  - authority to require suppliers to notify the public of any violation of the State requirements; and
  - authority to assess civil or criminal penalties for violations of the State primary drinking water regulations and public notification requirements.
- the State must have adequate record keeping and reporting requirements;
- the State must have adequate variance and exemption requirements as stringent as the US EPAs, if the State chooses to allow variances or exemptions;
- the State must have an adequate plan to provide for safe drinking water in emergencies like a natural disaster; and
- the State must have adopted authority to assess administrative penalties for violations of their approved primacy program.

Source: US EPA (1998e).

In order for a State, territory or Indian Tribe to implement national drinking water standards, they must obtain primary enforcement responsibility (primacy) to run a drinking water program (see box D3.2).

States with primacy are those which have the responsibility and authority to administer US EPA's drinking water regulations within their borders. Of the 56 eligible states (defined to include Commonwealths, Territories and the District of Columbia), all but Wyoming and the District of Columbia have primacy. The US EPA Regional Offices administer the drinking water program within these two jurisdictions and on all Tribal lands (US EPA 1999b).

Assistance to small suppliers

Although the majority of the US population is served by large suppliers, around 95 per cent of all suppliers are small and serve fewer than 3300 persons.

As drinking water regulations have become more complex, small suppliers have found it increasingly difficult to comply with higher standards and to provide safe water at affordable rates. To address this situation, small suppliers receive special consideration from the US EPA and the states.

In particular, the 1996 SDWA amendments enable states to grant technology and treatment variances, with US EPA approval, based on cost and health risk reduction considerations. This explicitly recognises that optimal treatment levels must vary with the size of the customer population.

A summary of the relevant amendments is as follows:

- *List of small supplier compliance technologies* — In August 1998, the US EPA published a list of alternative technologies that small suppliers may use to remove or treat regulated contaminants. These alternative technologies give small suppliers more flexibility in choosing the most cost-effective methods to meet drinking water standards.
- *Variances and exemptions* — In August 1998, the US EPA revised its variance and exemption rule, which provides a framework to help small suppliers comply with drinking water standards. Variances allow a small supplier to comply with less stringent, but still protective standards, based on a US EPA approved variance technology. States are authorised to grant variances for suppliers serving up to 3300 people, but must seek approval from the US EPA if they wish to grant variances to suppliers serving 3301 to 10 000 people. The SDWA does not allow small suppliers to have variances from microbial contaminants. Exemptions may be granted, to allow a water supplier extra time to obtain

financial assistance, develop an alternative source of water or engage in management or restructuring changes. An exemption is limited to three years, with renewals limited in total to six years.

- *Technical assistance* — The US EPA is now supporting a total of eight technology assistance centres, based at universities, to help small suppliers with training, technical assistance and technology demonstrations. With grant support from the US EPA, university-based Environmental Finance Centres are assisting states to develop and implement innovative programs to help small suppliers build their capacity. In addition, the SDWA requires that at least 15 per cent of the DWSRF be made available to small suppliers (US EPA 1999b).

Quality management

Compliance with drinking water standards is one component of the SDWA's multiple barrier approach to drinking water protection. This approach also includes assessing and protecting drinking water sources, protecting wells and collection systems, making sure water is treated by qualified operators, ensuring the integrity of distribution systems, and making information available to the public on the quality of their drinking water (US EPA 1998b).

The 1996 SDWA amendments established a number of new provisions designed to assist States and suppliers to improve the quality of drinking water by preventing problems before they occur.

Source water protection and enhanced systems management

Prior to the 1996 SDWA amendments, the only options available to suppliers finding contaminants in their drinking water supply were treatment, or the development of new water supplies. Accordingly, the 1996 amendments included provisions for suppliers to address problems or emerging problems of contamination through the SWAP program provisions (US EPA, pers. comm., 1999).

Under the new source water protection provisions, the US EPA must publish guidelines for states to establish SWAP programs. This program requires each State to identify potential contamination threats and to determine the susceptibility of drinking water sources such as wells or reservoirs to activities that may harm the source water. The assessments will provide the information necessary for states and localities to protect source water from contamination. States are not required to establish such programs, but they forfeit a portion of funding available through the DWSRF if they fail to do so.

States must involve or consult with the public about key decisions on their SWAP programs, including how they will work with suppliers to improve their operations, which specific drinking water improvement projects they will fund, and on the level of funding they plan to use for the SWAP program (US EPA 1997b).

Operator certification

The operator certification provision of the SDWA is seen as critical to the protection of public health and the maintenance of safe, effective and reliable water treatment plants and distribution lines. Each State must carry out an operator certification program including training and certification for individuals responsible for operating drinking water treatment plants. Most states required operator certification before it was mandated by federal law.

This provision does not require that every supplier be certified. That is not always necessary for proper system operation, nor is it a flexible or efficient approach. Rather, the objective of the program is to ensure every supplier has (directly, under contract, or in conjunction with other suppliers) an operator to perform certain key compliance functions, who is trained and certified to the right level that each State determines is appropriate to the functions, facilities and operations of that system.

Capacity development programs

States must also develop capacity development programs to ensure that all water suppliers, especially small suppliers, have sufficient technical, financial and managerial capacity to meet drinking water standards.

Public participation

All suppliers are required by the right-to-know provisions of the 1996 SDWA amendments to provide their customers with an annual consumer confidence report.

The Consumer Confidence Report Rule which was promulgated in August 1998 will affect 55 000 suppliers and the information in the report will be distributed to around 248 million people nationwide.[14]

[14] The US EPA estimated the annual cost to delivering a report to every customer served by all community suppliers (except for California, which already requires notices similar to the consumer confidence reports in this rule) is US$21 million. The US EPA estimates that the average cost per supplier is US$442 (US EPA 1998h).

As with other drinking water rules, states may set their own regulations for the reports within their borders. However, the rule includes baseline standards to ensure that all consumers receive reports that are comparable and include the same type and amount of basic information. Both the US EPA and the states can take enforcement action to ensure that consumers' right-to-know is respected by all suppliers (US EPA 1998h).

As stated in the Federal Register:

> The information contained in the reports is expected to raise consumer awareness of where water comes from, help them understand the process by which safe drinking water is delivered to their homes and educate them about the importance of preventative measures, such as source water protection, that ensure a safe drinking water supply.
>
> These reports can promote dialogue between consumers and their suppliers and can encourage consumers to become more involved in decisions which may affect their health. The information in the reports can be used by consumers, particularly those with special health needs, to make informed decisions regarding their drinking water (US EPA 1998h, p.44512).

At a minimum, the US EPA requires the reports to provide consumers with the following information:

- the source of their drinking water, ie rivers, lakes or underground acquifers;
- results of monitoring that the supplier performed during the year; and
- information on health concerns associated with violations that occurred during the year.

Partnership programs

In 1994, the US EPA released a report which detailed violations of drinking water standards. Its findings showed that some 30 million people — about 12 per cent of the US population — were served by drinking water suppliers that violated one or more public health standards during one or more reporting periods (AWWA 1998).

These findings combined with the 1993 outbreak of *Cryptosporidosis* and subsequent boil water alerts in Washington DC and New York City, were interpreted as supporting the need for additional safer drinking water standards.

In particular, the realisation that appropriate legislation might take years to implement, led to the formation in 1995 of the Partnership for Safe Water.

This Partnership is a voluntary initiative between the US EPA, the American Water Works Association (AWWA), several national organisations representing drinking

water suppliers and 225 surface water suppliers that serve more than 90 million people as of April 1999.

The goal of this partnership is to provide a new measure of safety by implementing prevention programs where legislation or regulation does not exist. The preventative measures are based on optimising treatment plant performance and increasing protection against microbial contamination.

The benefits of such Partnerships, among other things, allow suppliers to provide safe water without further regulatory control and solve internal problems in a cost effective manner through the free exchange of information between suppliers.

Benefits and costs of implementation

The implementation of new regulations has both benefits and costs. The benefits of regulating contaminants is often expressed in terms of prevented illness or reduced exposure to illness. However, the benefits of prevented illness do not come without compliance costs.

For example, the benefits of the lead and copper rule is expected to reduce the exposure of 156 million people to lead. Compliance costs are estimated to be US$490 million annually to undertake additional monitoring and treatment (Auerbach 1994 and US EPA 1998d).

Similarly the benefits of the SWTR is expected to prevent 80 000 to 90 000 cases of acute gastroenteritis annually, that would otherwise have resulted from microbial contamination of water supplies. Compliance is estimated to cost around US$534 million annually for testing and upgrading treatment systems. Most of this cost is spread among the 10 200 water suppliers (serving 48 million people) which would need significant plant upgrades (Auerbach 1994 and US EPA 1998d).

The US EPA estimate that the IESWTR will reduce the likelihood of endemic illness from *Cryptosporidium* by 110 000 to 463 000 cases annually. Based on this estimate, the mean estimated annual benefits of reducing the illnesses range from US$0.263 billion to US$1.240 billion per year. This calculation is based on a valuation of US$2000 per incident of *Cryptosporidiosis* prevented (US EPA 1998a).

The Regulatory Impact Assessment (RIA) also indicated that the rule could result in a mean reduction of 14 to 64 fatalities per year. Using a mean value of US$5.6 million per life saved, reducing these fatalities could produce benefits in the range of US$0.085 billion to US$0.363 billion.

The IESWTR will result in increased costs to suppliers for turbidity treatment, monitoring, disinfection benchmarking and covering new finished water reservoirs, as well as State implementation costs. The aggregate annualised costs to State, local and tribal governments and the private sector is approximately US$307 million (annualised at 7 per cent).

Under the IESWTR, 92 per cent of households (60 million) will incur less then a US$1 per month, and 7 per cent of households (5 million) will face an increase in cost of between US$1 and US$5 per month. The highest cost faced by 23 000 households is approximately US$100 per year (US$8 per month).

The US EPA is required by the SDWA to consider the ability of a supplier and its customers to support the cost of compliance in developing more stringent standards or promulgating new standards.

As part of this requirement, the 1996 SDWA amendments directed the US EPA to conduct a survey of the infrastructure needs of suppliers if they are to satisfy more stringent standards. The first survey, released in 1997 estimated that suppliers would have to invest US$138.4 billion over a 20 year period to ensure the provision of safe drinking water consistent with US EPA standards. Only a small proportion of this amount — US$12.1 billion — is needed immediately for compliance with the 1996 SDWA amendments (Beecher et al 1998).

To complement the Infrastructure Needs Survey, there is provision in the 1996 SDWA amendments to provide financial assistance. This assistance is financed from the DWSRF to suppliers that cannot afford to make improvements that would allow them to comply with revised regulatory standards. Between 1994 and 2003, the SDWA authorises US$9.6 billion for the DWSRF program and related programs (US EPA 1998c).

D4 Canada

Canadian drinking water guidelines have been developed for a variety of microbiological, chemical, physical and radiological parameters.

The Canadian Constitution does not address which level of government is responsible for drinking water. However, the Provinces have almost total authority over water resources within their boundaries. Thus, although the Canadian drinking water guidelines are developed as national guidelines, implementation is a provincial responsibility.

The national guidelines are developed by a joint Federal-Provincial Subcommittee on Drinking Water (FPS) and published by the Canadian Department of Health. The FPS has been developing drinking water guidelines since its establishment in 1986.

The guidelines are now in their sixth edition — published in September 1996.[1] They are recognised as the standard for drinking water throughout Canada. The guidelines are intended to apply to all drinking water supplies, public and private. They constitute a national reference point, but in common with the Australian Guidelines, they contain the facility for local variations to be adopted that take account of local circumstances.

D4.1 Institutions

The FPS includes Federal and Provincial representatives and is the principal body responsible for developing drinking water guidelines in Canada. It is comprised of representatives from all provinces, the Yukon, Northwest Territories, and two federal government departments, Health Canada and Environment Canada.

Health Canada acts as Secretariat to the FPS. As such it prepares the technical documents that are reviewed by FPS members.

1 The 1996 Guidelines indicate that the first comprehensive Canadian compilation of recommended limits for substances and conditions that affect drinking water was published in 1968.

In Canada, most drinking water systems are owned and operated by municipalities, although some treatment plants are owned and operated by the provincial governments. Private water systems are less common.

Responsibility for implementing the guidelines within the Provinces differs, with health departments having prime responsibility in some provinces and Environment Protection Agencies (EPAs) responsible in others. However, when drinking water problems arise, most jurisdictions involve both health and environment departments to work with the utility to resolve the issue.

A co-operative approach

In the 1996 Canadian Guidelines, it is emphasised that the Guidelines should not be regarded as legally enforceable standards unless promulgated as such by the appropriate provincial, territorial or federal agency.

Like Australia, it is State or Provincial governments that are responsible for the implementation of the Canadian Guidelines, and like Australia, there is considerable variation between jurisdictions. In Canada, the Provinces of British Columbia, Alberta and Quebec have incorporated different aspects of the Guidelines into regulatory standards, and each province has taken a different approach to enforcement.

Notwithstanding their status as guidelines, lacking statutory force in most provinces, it has been suggested that the Canadian Guidelines are considered by the public, the media, and the environmental community to be minimum water quality standards (Decker and Long, 1992). Nevertheless, in reviewing implementation across the various Canadian provinces, the same authors emphasise that the approach is one of pursuing cooperative abatement strategies. This approach tries to help water suppliers achieve compliance with the guidelines, rather than focusing on enforcement.

The FPS is said to have expanded its consultation activities since beginning operation and has actively involved industry organisations such as the Canadian Water and Wastewater Association (CWWA) and the Canadian Public Health Association (Decker and Long 1992). Consultation has focused on, among other things, feasibility and cost of implementation, with both issues explicitly recognised in the guidelines themselves.

D4.2 Regulation

The steps in developing Canada's drinking water guidelines are well documented and readily available to the public. Health Canada maintains a bank of information on its web site *(http://www.hc-sc.gc.ca/english/)*, outlining the processes for developing the guidelines and mechanisms for commenting on draft guidelines. The site also provides general information to inform the public.

More detailed published documents, some of which are also available on the Health Canada web site, describe the steps involved in deriving guideline values for individual contaminants.

The FPS is responsible for developing a priority list of parameters scheduled for review. The primary concern of FPS in developing drinking water guidelines is the protection of human health.

In common with the trend elsewhere, the latest edition of the Canadian guidelines notes that some of the parameters contained therein are more restrictive than those in the previous edition. In commenting on this trend toward ever more restrictive guidelines, the document contains the following observation:

> It is recognised that not all drinking water systems will be able to meet these more restrictive guidelines immediately and that priority given to meeting these new limits may be based on factors such as cost and the degree to which the drinking water systems exceed the guideline values. However, it is recommended that all public and private drinking water supplies aim to reduce concentrations of these substances to below the specified values as soon as practicable (Health Canada 1996).

Scientific basis for establishing Canadian guideline values

The guideline document emphasises that individual guideline values are developed on a sound scientific basis.

Scientists begin by examining available data to determine the relationship between dose and response, and to establish a level of exposure at which no adverse health effects are observed in human or animal studies (termed the No Observed Adverse Effect Level or NOAEL).

Based on this NOAEL, a maximum daily exposure level to a contaminant (expressed as a tolerable daily intake or TDI) is calculated, taking into account the differences in response between animals and humans, variability between individuals or groups in the human population, and the reliability of the data.

Using the TDI level, scientists calculate a maximum acceptable concentration (MAC), adjusting for average body weight and drinking water consumption. The methods used to develop the guidelines ensure that MACs are far below (i.e. 10 to 10,000 times) exposure levels at which any adverse health effects have been observed.

The calculation of an MAC is a way of expressing a contaminant as a concentration in water (MAC), rather than as a quantity (TDI). Adjusting for body weight and the average daily volume of water consumed, is designed to take account of the proportion of an individual's TDI attributable to drinking water intake. Because drinking water is rarely the principal source of exposure to a contaminant, an allowance is made for exposure from other sources such as food, air and soil, as well as the use of water for bathing and other domestic purposes. This allowance for other sources is large, usually accounting for 80 to 95 per cent of the calculated total daily exposure.

The guideline values are normally based on long term chronic or lifetime studies, as well as special studies on reproductive hazards, genetic damage, and potential to cause cancer. Other considerations may result in slight modification of the MAC. For example, the existence of a method to measure the chemical accurately at a very low concentration, and the availability of treatment or removal techniques are two factors taken into consideration. Aesthetic characteristics such as taste, odour, staining action, corrosiveness, turbidity and colour are also considered.

Exposure to water at the MAC level is expected to have no impact on health, assuming lifelong consumption of drinking water containing the substance at that concentration. Accordingly, ingestion of water containing concentrations above the MAC for a short period is not necessarily presumed to be hazardous to health.

Use of indicator organisms

Like the Australian Guidelines, the Canadian Guidelines acknowledge that it is not practical or technically feasible to monitor for all pathogens in drinking water and the microbiological guidelines rely on monitoring the traditional coliform indicator bacteria. In Canada, the MAC for coliforms is as follows:

- No sample should contain more than 10 total coliforms per 100 mL, none of which should be faecal or *thermotolerant coliforms*. (If up to 10 total coliforms are detected, the water should be resampled).
- No consecutive sample from the same site should show the presence of coliforms.

- Not more than one sample from a set of samples taken from a given community on a given day should show the presence of coliform organisms. Further, not more than 10 per cent of the samples, based on a minimum of 10 samples, should show the presence of coliform organisms.

The Guidelines recommend that if any of the above criteria are exceeded, corrective action should be taken immediately, in consultation with the local authority responsible for drinking water supplies. They also recommend that the confirmed presence of *E.Coli* in drinking water should trigger an immediate boil water alert.

In Canada, the attitude toward the trade off between disinfection by-products (DBPs) and the use of chlorine for disinfection seems to be weighted heavily in favour of chlorination. In a survey of water quality managers, many expressed their strong concern that in avoiding or minimising DBPs, chlorine use should not be adjusted in a way that caused the effectiveness of disinfection to be compromised (Decker and Long 1992). This is consistent with the approach taken in the Australian Guidelines.

In common with the risk management approach taken elsewhere, the Canadian Guidelines recommend a sampling frequency that varies according to the size of the population served.

Institutional mechanisms in developing the guidelines

Health Canada outline the following steps in developing the guidelines: (i) identification, (ii) assessment, (iii) evaluation, (iv) approval and (v) announcement of the guidelines. This is said to be a flexible process, with provision to modify the steps to accommodate the diverse needs of the various jurisdictions.

Health Canada is responsible for preparing the risk assessments on the ingestion of specific parameters in drinking water and recommending guideline values to the FPS. However, in a Health Canada document titled 'Approach to the Derivation of Drinking Water Guidelines', it is suggested that as the provincial governments are responsible for the provision of safe drinking water, it is the FPS that is accountable for the evaluation and approval steps of the guidelines development process. The document goes on to say:

> Each guideline value and its accompanying health risk assessment are evaluated for their practicality and impacts. Consultations are recommended by the Subcommittee [FPS] and may be carried out by the provinces and territories and/or the Subcommittee's secretariat. Through this consensus-based development process, a guideline is established, and the associated health risk assessment is modified to create

> a criteria summary that reflects the risk management decisions involved in the guideline's development (Health Canada 1995).

According to Health Canada, for some waterborne pathogens (for example, certain viruses and protozoa), one infectious unit may be sufficient to yield an illness (Health Canada 1996). To protect sensitive subpopulations, therefore, it is generally assumed in risk assessment that infection will result in illness. Taking this approach, there is no tolerable lower limit for the concentration of microbiological pathogens in drinking water. This essentially means that the recommended MAC is zero (the adoption of a zero MAC value is similar to the approach used for chemicals in drinking water that are deemed to be carcinogenic).

The consensus-based development approach outlined above, recognises that although the desired goal in terms of public health may be zero risk of illness, this desired goal is rarely technically and economically feasible. In recognition of this reality, the Canadian documentation on guidelines development notes that instead of the goal of zero risk, 'acceptable' microbial risks are derived and used in risk assessment. For example, the US EPA's Surface Water Treatment Rule (SWTR) is cited, which has set a risk of one infection per 10 000 people per year (a risk of 10^{-4}) as a health goal for exposure to *Giardia* in drinking water.

Guidelines based on treatment and the absence of indicator organisms

Although the absence of indicator organisms is a good indicator of the absence of pathogenic bacteria, it is no guarantee that enteric viruses and parasitic cysts are also absent. Viruses, for example, survive longer in water, are more resistant to disinfection and are more infective than most bacteria. Thus, the use of indicator organisms is only one means of guarding against the presence of waterborne pathogens. Adequate treatment is often the primary method of ensuring the absence or inactivation of pathogens in drinking water.

The 1996 Canadian Guidelines do not contain guideline values for viruses and protozoa, although both pathogens are scheduled for review. However, Health Canada refer to the US EPA's SWTR and note that it requires all systems to disinfect as well as provide filtration unless certain site-specific conditions are met (Health Canada 1996). The 1996 Canadian guidelines do not explicitly recommend filtration, although they include in Section 3.5 the comment:

> Alone, disinfection is not always sufficient to produce a supply of adequately treated water. Other treatments may be necessary, depending upon the water source, to ensure the effectiveness of the disinfection process and to satisfy other criteria for good-quality drinking water (Health Canada 1996).

In relation to the US EPA's SWTR, Health Canada note that treatment must achieve at least 99.9 per cent and 99.99 per cent removal or inactivation of *Giardia* and viruses respectively.[2] These required performance levels are based on treatment method, rather than the number of pathogens measured in water, thereby avoiding all problems associated with analytical methods in counting pathogenic micro-organisms. Health Canada suggest that this US approach is also the basic position of the FPS on drinking water (Health Canada 1995). This statement is made in spite of the fact that, unlike the US, the 1996 Canadian guidelines contain no quantitative guidelines for microbiological pathogens and no prescription of particular treatment methods, except that the Guidelines comment as outlined above, that disinfection may not remove all pathogens.

In practice, the Canadian provinces have adopted a variety of approaches ranging from chlorination as the only treatment undertaken, to extensive filtration, ozonation and ultraviolet treatments for example.

The Canadian Guidelines emphasise the importance of chlorination. In this context, comparisons with US EPA drinking water practice seem to be important. The Canadian Guidelines on trihalomethanes (THMs), a by-product of chlorination, have generally been less stringent than those applying in the US.[3] Nevertheless, interviews with a cross section of Canadian water sector managers indicated their very strong concern about possible pressure to lower the Canadian THM guideline value (Decker and Long 1992). In particular, they were worried that lowering the THM value might result in reduced chlorine dosage, in such a way as to compromise the effectiveness of chlorination — widely regarded as the single most effective weapon against microbiological pathogens.

2 From 1999, the US EPA also prescribed treatment methods to achieve defined levels of protozoa removal or inactivation (see appendix D3 for details).

3 The US EPA standard was revised in 1999 (see appendix D3 for details).

D5 New Zealand

Around 85 per cent of the population in New Zealand obtain their water from Community Drinking Water Supplies (MoE 1997).[1] About half of New Zealand's drinking water is pumped from the ground, with the remainder coming from surface sources (MoH 1999).

Local, regional and national levels of government have responsibilities for safe drinking water in New Zealand through:

- 12 regional councils;[2] and,
- 74 territorial local authorities (TLAs), including 15 city councils, 58 district councils, and the Chatham Islands Council.

Typically, water services are provided using facilities owned by a TLA. The TLAs charge for water services through property rates. The Auckland TLA is an exception, because it charges on a user pays basis.

There is no independent economic regulator for the provision of water services in New Zealand.

At the national level, the Ministry of Health (MoH) oversees drinking water quality and is accountable to the Minister for Health. At the regional level, Public Health Service Providers (PHSPs) oversee the TLAs in their area, and report the results of sampling to the MoH.

Every health district in New Zealand has a Medical Officer of Health. They are representatives of the MoH, ensuring that TLAs maintain appropriate water quality, and have the power under s. 44 of the *Health Act 1956* to order a water supply to close if they believe there is a serious health risk situation. Medical Officers of Health generally work with water suppliers to achieve safe drinking water, and closure would be a last option.

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1 Community Drinking Water Supplies are defined as systems serving 25 or more people for more than 60 days a year. This includes many schools, permanent camp sites and marae (MoH 1999).

2 Regional Councils are responsible for the management of source water. They can therefore have an effect on the quality of drinking water prior to its treatment.

D5.1 Regulation

Ministry of Health

The *Health Act 1956*, is the principal Act relating to the safety of drinking water in New Zealand.

The *Water Supply Protection Regulations 1961* were made pursuant to the *Health Act 1956* and deal specifically with drinking water quality. Under these regulations it is an offence to supply water that is not 'wholesome' to a 'public main'. Wholesome water has been defined in the Regulations to be water '… coming from a source undergoing treatment and distribution to the satisfaction of the Medical Officer of Health'.

Despite there being no legislation requiring the Central government to do so, it has undertaken the following responsibilities:

- producing water quality guidelines (Ministries of Health and Environment)[3]; and
- monitoring drinking water supplies (Ministry of Health).

The latest guidelines are the *Drinking-Water Standards for New Zealand 1995*.[4] They are used as one input into a water quality grading system operated by the MoH.

The former Board of Health began grading New Zealand drinking water supplies in 1960. This grading system was developed to compare and identify water supplies that may not be delivering good quality water or supplies at risk — with no barriers to protect them despite being of good quality.

During the early 1990s, the first test results for *Giardia* showed it to be widespread in New Zealand waters (Ampofo et al 1991). Cysts were found in 33 per cent of water samples taken in 1990. The extent of *Cryptosporidium* distribution in source waters and in drinking water supplies is unknown. In 1991, 1992 and 1993, a quarter of the supplies surveyed (supplying approximately 5 per cent of the population), failed to meet the MoH's microbiological standards. As a consequence, several small communities were advised to boil water because of microbiological contamination.

3 The Ministry for the Environment is responsible for the quality of water from an environmental perspective.

4 Although called *Drinking-Water Standards for New Zealand 1995*, the values given in this document are not enforceable, thus they may be considered as guideline values.

In response to this state of affairs, the MoH has commenced and in some cases completed the following activities:

- reviewed management procedures and legislation relating to the public health aspects of drinking water;
- revised the public health grading procedures for Community Drinking Water Supplies;
- developed the *Drinking Water Standards for New Zealand 1995*;
- developed an accessible national drinking water quality database and published *Guidelines for Drinking-Water Quality Management 1995*; and
- published the *Register of Community Drinking Water Supplies in New Zealand*.

The results of the National Drinking-Water Surveillance Program are published in the annual *Register of Community Drinking-Water Supplies in New Zealand.* The Register contains information available to the MoH about each community's water supply, the source of the water, the plants where water is treated and the distribution zones, together with any provisional public health gradings which have been given and the contaminants of public health concern known to be present (MoH 1999).

The grading system is designed to increase transparency and consumer awareness. Community water supplies are graded according to the degree to which they can show that both their drinking water at the tap, and in their treatment systems, are safe from a public health point of view (see box D5.1). The MoH gradings relate to the adequacy of the entire supply system, not just the quality of drinking water at the tap.[5]

Informing the public about the grading system, and the implications of the grades received, is considered essential to the effectiveness of the grading system as a means of improving drinking water quality. Local authorities are required to:

> '…ensure information is made available to the public on the implications of the grades on supply management. The Minister of Health should consider ways in which the provision of information on the grading system and the implications of the systems are more 'user friendly' for the public' (ONZPCE 1996).

The results of the MoH gradings are published four times a year in the *Register of Community Drinking Water Supplies in New Zealand*, which is available at public libraries.

5 The MoH grades water supplies by assessing the quality of the original water source and the ability of the treatment system and water pipes to prevent contamination.

Box D5.1 **New Zealand's water supply grading program**

New Zealand water quality is graded by the Ministry of Health for the purpose of:

- assessing whether a particular drinking water supply consistently delivers a safe wholesome product; and
- ensuring that communities are provided with reliable information about the quality of their water supply.

The grading system assesses separately the source and treatment part of the water supply system, as well as the distribution system. A two letter grading is designated, such as Aa, Cb, Ed. The capital letter (A1, A, B, C, D or E) represents the grade of the water coming into the zone (source quality and treatment) while the lower-case letter (a, b, c, d, or e) indicates the quality of the water received at the consumer's tap.

Both gradings are presented in the *Register of Community Drinking-Water Supplies in New Zealand*, which is accessible through public libraries.

The description of the grades for source and treatment is as follows:

A1 Completely satisfactory, negligible level of risk, demonstrably high quality

A Completely satisfactory, very low level of risk

B Satisfactory – low level of risk

C Marginal – moderate level of risk

D Unsatisfactory – high level of risk

E Completely unsatisfactory – very high level of risk

The evaluation of the distribution system uses a system of demerit marks for factors in the distribution of the water supply which adversely affect, or put at risk, the quality of the distributed water.

The description of the distribution grading is similar to the source and treatment description and uses letters a to e, with the smallest number of demerit marks receiving an 'a' grade.

Source: ONZPCE (1996).

Complex calculations are used to determine gradings. The gradings are based on 33 aspects of source and treatment, plus 22 factors for the distribution system and final water quality, including compliance with standards (MoH 1999). However, by using terms such as 'satisfactory' or 'unsatisfactory' to summarise this information, the grading system may be providing more meaningful information to consumers than the reporting of individual contaminant levels.

The latest grading of drinking water quality by the MoH shows almost 20 per cent of supplies have an unsatisfactorily high risk of contamination (serving approximately 17 per cent of the population). Water supplies serving some 8 per cent of the population have not been graded because they serve communities

of less than 500 people (MoE 1997). These suppliers may still be supplying safe drinking water despite not having been graded (MoH, Wellington, pers. comm., 17 November 1999).

The MoH states that the purpose of the Register is 'to provide easily accessible information about community water supplies.' The Register is the MoH's main instrument for disseminating information on the quality of drinking water. Making this information available to the public, allows the MoH to test whether there is community pressure for change (although it is local government that would need to implement such change). This is explained thus:

> If your water supply is good, you can appreciate this public notification of its quality. Otherwise, as a consumer, you can either accept the situation or make it clear locally that good drinking-water is important to you (MoH,1999, p. 4).

In 1996, the Office of the New Zealand Parliamentary Commissioner for the Environment (ONZPCE) stated that the outcome of self-regulation of the water supply industry between 1980 and 1993, indicated that external assessment of drinking water quality was required in order for quality standards to be maintained (ONZPCE 1996). It recommended that the MoH continue its external assessment process of drinking water quality delivered by the TLAs.

Current drinking water standards

The *Drinking Water Standards for New Zealand 1995* replaced the 1984 *Drinking Water Standards for New Zealand*.[6] They were developed with the assistance of an expert technical committee. Extensive use was made of the WHO *Guidelines for Drinking Water Quality 1993*, *Drinking Water Standards for New Zealand 1984* and the *Draft Australian Drinking Water Guidelines 1993*.[7] The process included public consultation.

The *Drinking Water Standards for New Zealand 1995* outline the maximum concentrations of contaminants acceptable for public health in drinking water and include microbiological, chemical and radiological parameters. They were adopted as the national guidelines to be applied to all drinking water supplies.

In the 1995 version of the New Zealand Standards, Maximum Acceptable Value (MAV) was used to replace the guideline values in the previous 1984 New Zealand Standards.

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6 Since 1984, the range of substances covered increased as a result of additional scientific knowledge (MoH 1995).

7 The *Drinking Water Standards for New Zealand 1984* were not enforceable.

MAVs for micro-organisms are based on the number of organisms detected in a given volume of water (see table D5.1). Derivation of the MAV for individual determinands covered in the 1995 Standards, depends on the way in which the particular determinand presents a health risk (see box D5.2).[8]

Box D5.2 **Characteristics of Maximum Acceptable Values**

The MAV of a determinand in drinking water represents the concentration of a substance which, on the basis of present knowledge, is not considered to cause any significant risk to the health of the consumer over a lifetime of consumption.

The MAVs set in the Standards define water suitable for human consumption and hygiene. Water of higher quality may be required for special purposes, such as renal dialysis or certain industrial processes. The Standards do not address these issues.

Short term excursions above the MAV do not necessarily mean the water is unsuitable for consumption. Most MAVs have been derived on the basis of a lifetime exposure. The amount and the duration by which any MAV can be exceeded, without affecting public health, depends on the characteristics of the determinand.

Source: Drinking Water Standards for New Zealand 1995.

In some instances, adaptation to suit New Zealand conditions has resulted in a minor difference between the guideline value recommended by WHO and the MAV in the *New Zealand Drinking Water Standards 1995*.[9] Also, some chemical determinants not covered by the WHO Guidelines have been added to the standards because their public health significance is peculiar to New Zealand circumstances.[10]

8 Determinands are chemical substances, microbiological organisms, or some other characteristic of the water that can be measured.

9 MAVs from the 1995 Standards differ from previous guideline levels as they were based on the WHO intake for a person of 60 kilograms average weight. The 1995 MAVs are based on the average New Zealander's weight which is 70 kilograms (MoH, Wellington, pers. comm., 17 November 1999).

10 Such as the use of fluoro-acetic acid, commonly known as 1080 poison, used for culling the possum population.

Table D5.1 **MAVS for micro-organisms of health significance**

Micro-organism	*MAV*
Faecal coliforms	Must not be detectable in 100mL of sample
Viruses	No enteric viruses shall be detectable in 100L of sample
Protozoa (pathogenic)	Not detectable in 100L sample
Helminths (pathogenic)	Not detectable in 100L sample
Algae	No toxic algae present in 10mL of sample

Source: Drinking Water Standards for New Zealand 1995.

Determination of compliance with standards

In New Zealand's Drinking-Water Register, determinands are divided into four priority classes. Only determinands classed as Priority 1 and 2 require monitoring (see box D5.3) (MoH 1999). The MoH personally advise water suppliers if they have an obligation to monitor for priority 2 determinands.

Compliance is determined by comparing the results of monitoring programs against the specified grading criteria on a running annual basis.[11]

Monitoring of Priority 3 and 4 determinands is at the discretion of the supplier, unless otherwise required by the Medical Officer of Health.

[11] Records must be kept for at least 10 years to enable trends to be detected and to establish the statistical significance of the results.

Box D5.3 **Priority classes for drinking water determinands**

Priority 1

Are the determinands of health significance for all drinking water supplies in New Zealand and include:

- *Faecal coliforms*
- *Giardia*
- *Cryptosporidium*

Priority 2[a]

These determinands include:

A Chemical and radiological determinands which could be introduced into the drinking water supply by water treatment chemicals, at levels potentially significant to public health (usually greater than 50 per cent MAV).

B Chemical and radiological determinands of health significance where there is good reason to suspect they may be in the drinking water supply at levels potentially significant to public health (usually greater than 50 per cent MAV).

C Micro-organisms of health significance where there is good reason to suspect they may be present in the drinking water supply.

Priority 3[b]

These determinands include:

A Chemical and radiological determinands of health significance arising from treatment processes in amounts known not to exceed 50 per cent MAV.

B Chemical and radiological determinands of health significance which are not known to occur in the drinking water supply at greater than 50 per cent MAV.

C Micro-organisms of health significance where there is no reason to suspect that they are present.

D Determinands of aesthetic significance known to occur in the drinking water supply.

Priority 4

These determinands include:

A Chemical and radiological determinands of health significance which are known not to be likely to occur in the drinking-water supply.

B Micro-organisms of health significance which are known not to be likely to be present.

C Determinands of aesthetic significance not known to occur.

[a] A priority 2 determinand may be relegated to Priority 3 or 4 with the consent of the Ministry when twelve successive monthly samples show concentrations below 50 per cent MAV. [b] Priority 3 includes those health significant determinands for which there is insufficient information about their occurrence in a specific drinking water supply, but which may occur at health-significant concentrations.

Source: Drinking Water Standards for New Zealand 1995.

D5.2 Monitoring and enforcement

Most regional councils have water quality monitoring programs for both surface water and groundwater (including geothermal water where applicable). Monitoring is applied to drinking water when it leaves the treatment plant (see table D5.2) and in the distribution zone (see table D5.3). If continuous free available chlorine

concentration is being monitored, no monitoring of faecal coliforms is required because the chlorine is presumed to kill these micro-organisms (see table D5.3).

Laboratories acceptable to the MoH and the Public Health Commission must be used for all analyses. These laboratories are expected to hold laboratory accreditation to *ISO/IEC Guide 25:1990* (general requirements for the competence of calibration and testing laboratories) or equivalent, and to use quality control systems which provide evidence of competency in testing.

Table D5.2 **Minimum recommended sampling frequency for faecal coliforms in drinking-water leaving a treatment plant**

Supply Type	*Faecal coliform minimum monitoring frequency*[a]
All surface and non-secure groundwater supplies serving more than 100 000 people.	None required if continuous free available chlorine concentration is being monitored; and is not less than 0.2 mg/L after a contact time of not less than 30 min. At a pH less than 8.0 and turbidity less than 0.5 NTU. Otherwise daily.
Chlorinated surface and non-secure groundwater supplies serving 500 – 100 000 people.	None required if continuous free available chlorine concentration is being monitored; and it is not less than 0.2 mg/L at a pH less than 8.0 and turbidity is less than 0.5 NTU after a contact time of no less than 30 min. Otherwise weekly.
All non-chlorinated surface and non-secure groundwater supplies serving 500 – 100 000 people	Twice weekly
All surface supplies and non-secure groundwater serving fewer than 500 people[b]	Weekly
Secure groundwater [b,c,d] (regardless of population)	Monthly This may be reduced to every second month after 12 successive samples have shown zero faecal coliforms

[a] Monitoring additional to that required for compliance monitoring should be carried out after installation of new mains or following repairs. [b] For supplies serving fewer than 500 people, samples prescribed to be taken from drinking-water leaving the treatment plant may be taken from the distribution zone instead, if this is more convenient, provided that sampling is done at the frequency specified and that no faecal coliforms are found.[c] Secure groundwater is defined as water contained beneath the land surface which is abstracted via a secure well-head or similarly proven structure. It must be not under the direct influence of surface water or demonstrate any significant and rapid shifts in characteristics such as turbidity, temperature, conductivity or pH which closely correlate to any climatological, surface water conditions or land use practices. There must also be no insects or other macro-organisms such as algae, organic debris or large diameter pathogens. Compliance with these requirements must have been reliably demonstrated. If any doubt remains that the groundwater is secure, a check should be made that the water has been in the aquifer for more than 1 year. (see the *Guidelines for Drinking-Water Management for New Zealand*, 1995 for details).[d] The frequency of faecal coliform monitoring of drinking-water derived from secure groundwater must be increased from monthly to at least weekly when the source water quality may have changed, for example at peak abstraction during dry spells, following flooding of the recharge area, or when chemical or physical water quality changes have occurred.

Source: Drinking-Water Standards for New Zealand 1995.

Table D5.3 **Minimum recommended sampling frequency for faecal coliforms in drinking water in a distribution zone**

Population serviced[a]	*Minimum number of samples to be collected*[b]
Less than 500	1 per month
500 – 5 000	1 per week
5 000 – 100 000	1 per week + 1 per month for each additional 5 000 above 5 000
100 000 +	6 per week + 1 per month for each additional 10 000 above 100 000

a This must take seasonal fluctuations into account. **b** Testing is to be carried out on different days throughout the week and must give a representative geographical coverage of the distribution zone.

Source: Drinking Water Standards for New Zealand 1995.

Enforcement of standards

The *Drinking Water Standards for New Zealand 1995* are not legally enforceable. However, the Medical Officer of Health can declare drinking water to be 'unwholesome' if it does not comply with the standards, and suspend supply in an emergency or where there is a major health risk from contamination.

Some regional councils have introduced the 1995 Standards into their by-laws, giving them regulatory status. However, this has not been widespread across the country (McClellan 1998).

Under the *Water Supply Protection Regulations 1961*, the Medical Officer of Health has the power to prosecute a TLA for a breach of the regulations. However, prosecution does not occur due to the costs involved, both to the government and the community that the TLA delivers water to (MoH, Wellington, pers. comm., 17 November 1999).

Future proposals

Consideration is currently being given to making compliance with the 1995 Standards mandatory through a revision of the *Water Supply Protection Regulations 1961*. The proposed revised regulations would require risk assessment procedures, auditing, grading, and keeping of records and public disclosure of information (MoH 1999).

D5.3 Industry response

The development of a core set of water quality indicators and an agreed methodology and program for monitoring and updating data, is currently being undertaken by the Institute of Environment and Science Research (ESR) called Water Information New Zealand (WINZ) (see box D5.4). The MoH has contracted this work out to the Water Group of ESR. The rationale is that water monitoring and management becomes easier as information systems become standardised.

Box D5.4 **WINZ program**

Water Information New Zealand, or WINZ, is a system of integrated databases for improving and maintaining the quality of community drinking water in New Zealand.

It is developed on behalf of the MoH by ESR Water Quality. The program is for user organisations to help them protect public health by optimising water quality.

WINZ works by collecting information from 1760 consistently defined and registered supplies. The supplies are registered by source, treatment plant and distribution zone.

WINZ serves local and national needs, servicing Government, local bodies, public health organisations and the general public.

The databases operate at three levels – local, for water suppliers, regional, for public health, and national, for ESR and Government organisations such as the MoH.

WINZ automatically evaluates compliance with the Standards based on supply characteristics and analytical results entered at local level.

Detailed information is in the hands of local health service providers and water supply managers, empowering local action, while also providing a national perspective.

Source: ESR (1999).

The information presented in the *Register of Community Drinking Water Supplies in New Zealand* is just a part of the WINZ database on water quality information. The database is a vast source of information that may contribute in other ways — for example, in risk management strategies by water suppliers.

Most local authorities have commissioned capital works to improve the quality of water supplies, and are conducting continuous monitoring. This has been in response to the 1993 grading results. By making these changes, local authorities hope to demonstrate compliance with the standards, even though there is no statutory imperative to do so (ESR 1999).

Cost of implementation

The renewed emphasis on the grading system and on monitoring, which some local authorities may not have done in the past, has meant that some councils are facing significant new costs to demonstrate compliance with the 1995 Standards.

The adoption of systems to treat water is dependent on the funding available to the TLAs. Lack of funding explains why smaller community water suppliers are failing to meet the 1995 Standards relative to their city counterparts. In general, the implementation of new systems has been slower across the South Island (disregarding economic factors) due to the higher quality of source water (MoH 1999).

D6 France

In France, local municipalities are responsible for providing public services, including the collection and distribution of drinking water. Municipalities are free to delegate the provision of public services to the private sector and this has been achieved in the drinking water sector through the use of binding contracts.

Private sector provision of water services increased in popularity in the early 1980s after growing recognition that the public monopolies that had operated up to that point were inefficient and often provided water that was not safe to drink. In addition, the higher quality standards transcending from the EU through its Directives were financially and technically difficult for the municipalities to meet (Elnaboulsi 1997).

In the late 1980s, there were six private companies operating in the water sector. By 1997, only three remained — Compagnie Générale des Eaux; Lyonnaise des Eaux; and Societe d'Amenagement Urbain et Rural. Each of these companies provide services under the oversight of the local municipality.[1]

Lease contracts (or 'affermage') are the most common contractual arrangement.[2] Under a lease contract, the private sector company rents the facilities from the municipality for a period of time and is responsible for the operation, maintenance and management of the service. The municipality, which retains ownership of the assets, is responsible for capital investments, debt servicing and tariff and cost-recovery policies.

The leaseholder pays the municipality a rental fee (known as a 'surtaxe') for use of the assets. Rental income is used by the municipality for debt servicing and finances a large part of the investment program.

The private sector company obtains its revenue from the water bills paid by consumers. This effectively transfers the risk of divergence between revenue and operating costs from the water authority to the private sector lessee.

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1 A number of small, independent companies may be setting up. However, even if this is the case, the three big operators still effectively dominate the market.

2 The other forms are concessions, management contracts and commissioner management contracts.

Public or private suppliers have an obligation to ensure that services are continuous, dependable, flexible and equitable. They must also ensure that the interests of users are protected with respect to both prices and quality and that there is no undue discrimination (Elnaboulsi 1997).

In 1964, France was divided into six large water resources management regions (called Catchment Agencies), with five containing one each of the major French rivers.[3] These Catchment Agencies have subsequently been renamed Water Agencies and are responsible for managing and protecting water resources within the catchment.

D6.1 Water quality regulation

The Ministry of Health is responsible for setting national drinking water standards. Currently, French drinking water standards are specified in the *French Decree* (1989) (Decree 89.3) and are based largely on the European Union's Drinking Water Directive 80/778/EEC (see appendix D1). Some quality criteria (notably lead) included in the Decree were not included in the EU's initial Directive and some parametric values were more stringent than those required by the EU's Directive (for example, pesticides).

The French Health Ministry is currently amending Decree 89.3 following the introduction of the EU's new Drinking Water Directive 98/83/EC. The amended decree will be stricter than required by the new EU Directive.

While the decree is still under review, it is likely that the following parameters will be included in the amended decree even though their analysis is not required by the EU's Directive:

- Colony count 37°C (variation <1 log);
- Chlorine (if a chlorine odour or taste is detected, research has to be done to determine the cause);
- Temperature (no parametric value);
- TH and TAC (TH and TAC >8°F with TH/TAC=1);
- Carbonates (no parametric value);
- Hydrogenocarbonates (no parametric value);
- Dry residue (no parametric value);
- Calcium (no parametric value);

3 The five major rivers are the Rhône, the Rhine, the Loire, the Seine and the Garonne.

- Magnesium (no parametric value);
- Potassium (no parametric value);
- Silica (10 mg/l if treatment with silica);
- Dissolved iron (no parametric value);
- Phosphorus (5 mg/l), Kjeldhal nitrogen (no parametric value);
- Dissolved oxygen (no parametric value);
- Hydrogen sulfide (no parametric value);
- COD (no parametric value);
- BOD (no parametric value);
- Suspended solids (no parametric value);
- Barium (no parametric value);
- Zinc (5 mg/l if treatment with Zn).

There are also a number of parameters included in the EU's Directive that will be included in the amended decree but will have a more stringent parametric value (see table D6.1).

Table D6.1 **Parameters with a higher parametric level under the Decree**

Parameters	*French Decree*	*EU Directive*
Colony count 22°C	variation < 1 log	no parametric value
Sulfite-reducing clostridia	0/20 ml	Clostridium Perfringens: 0/100ml
Colour	15 mg/l Pt	acceptable to consumers and no abnormal change
Taste	dilution yield: 3 at 25	acceptable to consumers and no abnormal change
Turbidity	0.5 NTU (treatment works exit) - 2 NTU to the tap	acceptable to consumers and no abnormal change (for surface water treatment : 1 NTU in the water ex treatment works)
pH	6.5 <pH<9	6.5<pH<9.5
Conductivity	1000µS/cm at 20 °C	2500µS/cm at 20 °C
Ammonium	1000µS/cm at 20 °C	2500µS/cm at 20 °C
Ammonium	0.1 mg/l (0.5 mg/l for ground water if NH4 is from natural origin)	0.5 mg/l
Boron	1 mg/l (analyses frequency increases if >0.5 mg/l)	
Fluoride	1.5 mg/l (analyses frequency increases if >1mg/l)	1.5 mg/l

Source: Katalyst 21 and Vivendi Water; pers. comm.; 14 February 2000.

There is no formal review and amendment process. The Ministry of Health amends regulation or legislation on the advice of its committee of nominated scientific experts, 'Le Conseil Superieur d'Hygiene Publique' (or High Council of Public Health). The duties of this council are to be transferred to a newly created body called 'L'Agence Française de Sécurité Sanitaire des Aliments' (or The French Agency for the Hygienic Safety of Foodstuffs).

The High Council of Public Health does not have any specific benefit-cost or external consultation process. It makes recommendations based only on scientific assessments. The Ministry of Health considers these recommendations and consults stakeholders before modifying the law, however, no formal pre-defined processes are in place. The Ministry obtains an idea of cost implications through consultation with the water industry but there are no community consultation processes.

D6.2 Monitoring and enforcement

The Direction Départementale de l'Action Sanitaire et Sociale[4] (DASS) is responsible for monitoring drinking water quality. DASS requests water suppliers (public and private) to comply with an Analytical Control Program that is based on the monitoring requirements specified in the Decree.

Monitoring requirements are usually more demanding than those specified by the EU, particularly for small communities. In the EU Directive, analyses have to be undertaken on water at the consumer's tap whereas, in French legislation, analyses also have to be undertaken on the raw water source, at the treatment works and in the distribution network. Also, French legislation requires a higher rate of sampling than is required by the EU Directive (see table D6.2 for an example).

Table D6.2 **Analysis frequencies for monitoring parameters**

Volume of water distributed or produced within each supply zone	*Proposed French regulations*	*EU Directive*
m^3 per day	No. of samples per year	No. of samples per year
4 000 – 5 000	50	19
30 000 – 40 000	280	112

a Parameters include aluminium, ammonium, colour, conductivity, clostridium perfringens (only for surface water), E. coli, pH, iron (when used as a flocculant), nitrite (if chloramination used as disinfectant), odour, taste, coliform bacteria and turbidity.

Source: Katalyst 21 and Vivendi Water; pers. comm.; 14 February 2000.

4 Departmental Authority for Health and Social Services.

Water samples are analysed by independent laboratories certified by the Ministry of Health. Analysis costs are invoiced directly to the water supplier.

Monitoring results are forwarded to the local representative of the central government — the Prefet — who is responsible for the enforcement of drinking water standards. All violations of standards must be addressed, recorded and filed by the water supplier. Usually, this is undertaken in coordination with the DASS and the municipality in the case where it has outsourced its water services. Sanctions are not pre-defined but a set of precedents from past cases exists.

Incident response protocols aim to clarify the multi-layer administrative structure that could hinder efficient and timely decision making. They define the role and responsibilities of the supplier — primarily as a provider of information and as an executor of decisions — and the responsibilities of the various local and national government agencies and how they should communicate, cooperate and make decisions.

Suppliers work under protocols developed with the local health authorities on how to respond to contamination incidents. Such incidents are dealt with on a case-by-case basis.

Monitoring results are available to the public through the town hall where a summary, particularly of health-related results, are displayed. An annual report is issued by the municipality and is available to the public on request and a summary report is mailed to each water subscriber annually.

A national report on the performance of water suppliers is issued annually by the Ministry of Health and made available on its web site (http://www.sante.gouv.fr/).

E Legal responsibilities

Legal responsibilities in supplying safe drinking water were examined.[1] The main focus was the different methods available to a consumer for obtaining compensation if contaminated drinking water is provided.

Compensation can be provided under the tort of negligence and the *Trade Practices Act 1974* (TPA), although some water suppliers may also be liable under implied customer contracts and State water law.[2] In addition, a water supplier can be criminally liable for providing contaminated drinking water under a number of State laws.

The case of *Ryan v Great Lakes Council*[3] was used to illustrate some of the methods of legal redress that could be available to a consumer in a case involving contaminated drinking water. In *Ryan*, oysters were grown in a contaminated lake and over four hundred cases of hepatitis A resulted from their consumption. The case was not used as a binding case authority for a case regarding contaminated drinking water, due to the different facts and circumstances that would be involved. However, *Ryan* is sufficiently analogous to provide a practical example of some of the methods of legal redress that could be available for contaminated drinking water. The legal reasoning of Ryan may be potentially important for a case involving contaminated drinking water because of the doctrine of precedent.

In Australia, concurrent liability is allowed and therefore in a civil action, a water supplier can be liable under different methods of legal recourse for providing contaminated drinking water. A plaintiff can plead several methods of legal redress at the same time and choose the recourse that is most advantageous in view of the loss suffered.

If there is an inconsistency between a Commonwealth and State law, the Commonwealth law prevails and the State law is invalid to the extent of the inconsistency. If there is an explicit inconsistency between two State statutes or between two Commonwealth statutes, the later statute is presumed to prevail. A

1 This appendix is based on all materials available up to 2 February 2000.

2 A tort is a civil wrong that involves a breach of a duty. The normal remedy for a tort action is damages where the primary aim is to compensate the plaintiff for the loss suffered.

3 [1999] FCA 177.

Statute prevails over an inconsistent executive act of government such as a regulation. Further, although it is a common law presumption that legislation does not alter common law principles, legislation overrides any inconsistent judge-made law.

An outline of potential legal recourse for a case regarding contaminated drinking water, as discussed in the appendix, is presented in table E.1.

Table E.1 **Taxonomy of law potentially applying to a case of contaminated drinking water**

Potential applicable law	*Description*
Negligence	Applicable to all States and Territories. A common law redress, established under the law of torts.
***Trade Practices Act 1974* (Cth)**	Applicable to all States and Territories.
s. 52	Prohibition of misleading and deceptive conduct.
s. 71	Merchantable quality and fitness for purpose provision.
s. 74B, s. 74D	Merchantable quality and fitness for purpose provisions.
Part VA	Different statutory rights for loss caused by defective goods.
Implied Customer Contracts	Applying between particular water suppliers and their customers. A common law redress if there is breach of contract.
Deemed under the *Sydney Water Act 1994* (NSW)	Contract between Sydney Water and customers.
Deemed under the *Hunter Water Act 1991* (NSW)	Contract between Hunter Water and customers.
Deemed under the *Water Industry Act (1994)* (Vic)	Separate contracts between each of the Melbourne water suppliers and their customers.
Consumer Protection under State Law	Potential criminal offences if statutory or regulatory requirements are contravened.
	Possible statutory redress for consumers if contaminated drinking water is provided.

Source: Productivity Commission.

E.1 Negligence

Negligence is a tort derived from judge-made law, its modern origins descending from Lord Atkin's judgment in the House of Lords decision *Donoghue* v *Stevenson*.[4] It consists of three elements, which must be established by a plaintiff on the balance of probabilities to succeed on the action. These criteria, which were examined in turn, are:

- the defendant owed to the plaintiff a duty of care at the time of the negligent act;
- the defendant failed to observe that duty; and
- as a consequence, the defendant caused the plaintiff to suffer damage.

The provision of indemnities in State water legislation as a possible defence to alleged negligence in the supply of drinking water is presented in box E.1.

A case example of the duty to supply potable water and right to discontinue supply when there is contamination is presented in box E.2.

Establishing a duty of care

The duty of care is used as a 'control device' to limit circumstances when a defendant can be considered liable for negligent conduct. From *Donoghue*, it is owed when the plaintiff is a person who is so closely and directly affected by the defendant's actions, that as a consequence, the defendant reasonably ought to have the plaintiff in contemplation as being so affected at the time of engaging in the alleged negligent act.[5]

However, *Donoghue* left open exactly how the principle should be implemented. An important issue, which has not been resolved, is how the principle should be implemented when there is a lack of case authority establishing a duty of care category for the factual circumstances being considered. This is particularly significant for cases dealing with alleged negligence causing financial loss, which is a developing area and described as the 'most controversial area of our law of tort.'[6] Courts have traditionally been more reluctant to establish a duty of care for alleged negligence causing financial loss as compared to alleged negligence resulting in personal injury or injury to property.

4 [1932] AC 562.

5 [1932] AC 562 at 580.

6 *Perre* v *Apand Pty Ltd* [1999] HCA 36 [par 230], Kirby J quoting Lord Steyn.

Box E.1 **The provision of indemnities in State water legislation**

A possible complication for recovery of compensation for contaminated drinking water may be the different indemnity provisions for water suppliers in State legislation. For example, in Victoria under s. 166 of the *Water Act 1989* (Vic) it is specified:

> An Authority or any member or person acting on behalf of an Authority is not liable for any action taken in connection with the treatment of water (including disinfection or fluoridation) in accordance with this or any other Act.

The precise scope of this section is unclear since it has not yet been judicially considered.

In the High Court case of *Punotiero* v *Water Administration Ministerial Corporation*[a], a Corporation was successfully sued for negligence after providing contaminated irrigated water, which damaged a farmer's crops. The Corporation was unsuccessful in relying on an indemnity provision found under s. 19 of the *Water Administration Act 1986 (NSW).*

A majority of the High Court interpreted the indemnity provision narrowly. The Court held that the immunity does not apply to loss occurring from a *failure* to exercise a Corporation's functions [Par 14, 18, 122]. It was found by a jury that there was a failure to warn that the water was contaminated and there was also a failure to test the water supply for chemicals likely to damage crops. Under s. 19, the Corporation would not have been liable if the loss suffered was a consequence of any positive acts of its functions.

The High Court interpreted the indemnity provision in context and this included considering the *Water Administration Act (1986)* as a whole and other relevant legislation. Further, it was held that based on previous case authority, the immunity required a 'jealous' (strict) interpretation [Par 4, 34].

[a] [1999] HCA 45

In *Donoghue*, Lord Atkin used two terms, which would give rise to a duty of care and these were 'proximity' and 'reasonable foreseeability'.

The High Court of Australia adopted the view that 'proximity' and 'reasonable foreseeability' have different meanings with proximity being the harder test for a duty of care to be established. 'Reasonable foresight' involves not what the defendant could have foreseen but rather, what a reasonable person in the position of the defendant would have foreseen. By contrast, 'proximity' means 'nearness' in some sense, although this does not have to be physical or temporal. Proximity is more concerned with factors including the nature of the injury inflicted, the nature of the plaintiff's interest and the circumstances in which the injury occurred (Trindade and Cane 1996, pp 329-330).

Box E.2 **The duty to supply water and Timor Water Action Group Inc. v Coonabarabran Shire Council**

In the NSW case of *Timor*, the issue was whether there could be disconnection of water supplied from the Timor gravity main because of algal blooms that were occurring in the Timor dam. The Coonabarabran Shire Council relied on cl 31 of the *Water Sewerage and Drainage Regulation 1993* in its resolution to disconnect consumers from water supplied by the Timor gravity main. Under cl 31 disconnection was permitted because of 'unusual drought or other unavoidable cause or any accident'.

It was held that the clause was valid and that the Council could rely on it to disconnect the water supply because of an unavoidable cause.

The Court found that based on past authority, a duty to *supply* potable water did exist. However, there is no breach of the duty if supply is disconnected because of potential circumstances of limited duration as outlined by cl 31. This includes disconnection because of public health and safety concerns. In such a case, it is not relevant to reflect upon what the council may have done before the water contamination. Rather, it was held that the relevant time to examine the position is when the decision to disconnect supply was made.

Nonetheless, it was also decided that the Council resolution was made without due regard to the processes of natural justice. The resolution had a prejudicial effect on an individual's rights since water is an essential commodity needed for life. There was no opportunity given to consumers to put their case against the resolution when it was made and the opportunities for discussion were insufficient after the date of the resolution. As a state of emergency did not exist to exclude the rules of natural justice, relief was granted to the plaintiffs in the form of a declaration reflecting the Court's finding. The parties to the case were given the opportunity to negotiate between themselves as to the final orders, reflecting the Court's finding.

Source: [1997] NSWLEC 62.

In Australia, it was strongly arguable that even if there was reasonable foreseeability of negligence, there will not have been a duty of care if there was not a sufficiently proximate relationship between the parties.[7] The requirement of proximity corresponded with the view of Deane J in *Jaensch* v *Coffey*,[8] which was endorsed by a majority of the High Court in subsequent cases.[9]

7 In cases dealing with physical injury, compensation is usually recoverable if there is reasonable foreseeability. In such circumstances, the requirement of proximity is normally satisfied by reasonable foreseeability (Trindade and Cane 1996, p. 336).

8 (1984) 155 CLR 549 at 579.

9 See Balkin, R. and Davis, J. 1996, p 206-207 and Kirby's J. judgments in *Pyrenees Shire Council* v *Day* (1998) 151 ALR 147 [Par 237] and *Perre* v *Apand Pty Ltd* [1999] HCA 36 [Par 279].

Nonetheless, it is currently clear that proximity is no longer regarded as the necessary criterion for establishing a duty of care. In *Pyrenees Shire Council* v *Day*,[10] after noting recent High Court criticism of proximity as lacking precise definition, Kirby J concluded that:

> … it is tolerably clear that proximity's reign in this Court, at least as a *universal* identifier of the existence of a duty of care at common law, has come to an end.[11]

In *Perre* v *Apand Pty Ltd*,[12] a negligence case involving purely economic loss, the High Court unilaterally reaffirmed that proximity was no longer the essential criterion for establishing a duty of care.

However, no agreement was reached in *Perre* as to how a duty of care should be established for negligence resulting in economic loss. An approach adopted by Kirby J involves a three stage test. First, to reasonable foreseeability, then to proximity and then to whether it is fair, just and reasonable for imposing a duty of care in the circumstances. By contrast, McHugh J argued that the most satisfactory approach to economic loss is through an incremental extension of existing duty categories. If this is not possible, then the general principles of economic loss should be considered. For instance, if there is indeterminacy, so that 'liability can not be realistically calculated'[13], the existence of a duty of care may be denied.[14]

In *Tepko Pty Ltd* v *Water Board*,[15] the New South Wales Court of Appeal did not follow any particular approach in *Perre*, highlighting the lack of consensus that emerged in that case. However it was pointed out how several of the justices:

> … emphasised the relevance of the plaintiff's known vulnerability because of the defendant's exclusive control of the situation as a significant factor in establishing a duty of care… Most of the justices also emphasised the defendant's foresight of the likelihood of harm occurring to the plaintiffs.[16]

10 (1998) 151 ALR 147.

11 (1998) 151 ALR 147 [Par 238].

Kirby J came to this conclusion by noting the effect of various criticism and the limitations of proximity recognised by the High Court majority in *Hill v Van Erp* (1997) 188 CLR 159.

12 [1999] HCA 36.

13 [1999] HCA 36 [Par 107].

14 Different approaches by other Justices for establishing a duty of care regarding economic loss were also advocated. An overview of the different approaches can be found in *McMullin* v *ICI Australia Operations [1999]* FCA 1814 [Par 21-29].

15 [1999] NSWCA 40.

16 [1999] NSWCA 40 [Par 25].

In *McMullin v ICI Australia Operations*,[17] it was pointed out that *Perre* was the latest example of an increasingly liberal approach taken by the High Court for negligence resulting in pure economic loss. Nonetheless, it was also highlighted how all members of the High Court confined the scope of a duty not to cause economic loss.[18]

Overall, until a High Court majority concludes how a duty of care should be established, particularly for cases dealing with alleged negligence resulting in economic loss, this area of the law will remain uncertain.

Establishing a duty of care in Ryan v Great Lakes Council

In *Ryan*, contaminated oysters grown in Wallis Lake were consumed and resulted in over four hundred cases of hepatitis A. The virus, which can survive for prolonged periods in fresh or salt waters, is excreted in human faeces and is then contracted when contaminated material is ingested. Oysters, being filter feeders, can retain the virus from contaminated water.

The plaintiff, who contracted the virus after buying oysters from Graham Barclay Distributors Pty Ltd, successfully sued for negligence against the Great Lakes Council, the State of New South Wales and the Barclay Companies. Further, Barclay Oysters Pty Ltd was also found guilty of breaching various provisions of the TPA. Graham Barclay Oysters Pty Ltd ('Barclay Oysters') was the largest oyster grower at Wallis Lake and Graham Barclay Distributors Pty Ltd ('Barclay Distributors') was its distributor.

The relief granted to the plaintiff consisted of damages in the sum of $30,000 with the defendants assigned to pay an equal apportionment of the damages. It was held irrelevant for calculating the burden of damages that the Barclay Companies were negligent and had breached provisions of the TPA, whilst the other defendants were only negligent. The critical issue was the relative culpability of the defendants and since it was found they were equally culpable, the burden to pay the damages was shared equally.

An important implication of *Ryan*, which would be relevant for contaminated drinking water, is that the case provides an example that a duty of care can be owed by more than one person or entity.

17 [1999] FCA 1814.

18 [1999] FCA 1814 [Par 33].

Great Lakes Council and its duty of care

It was held by Wilcox J that in light of all the facts, Great Lakes Council owed a duty of care towards oyster consumers. The Council was not under an absolute duty to prevent pollution of the lake since prevention could not be guaranteed. Nonetheless, it was held that there was a duty to take those steps reasonably open to the Council in order to minimise human faecal contamination of the lake.[19]

Wilcox J, following Priestly J in *Avenhouse* v *Hornsby Shire Council*,[20] adopted a pragmatic approach to proximity, which involved answering whether a duty existed 'in light of the Court's own experience-based judgment.'[21] The important facts known to the Council, which gave rise to a duty of care being established included:

- Wallis Lake being used for the growing of oysters for human consumption.
- Within the lake catchment area, there were facilities which constituted potential sources of human faecal contamination. These facilities included septic tanks, pumping stations, watercraft and pit toilets.
- The Council had extensive statutory powers to control pollution from the facilities.
- No depuration[22] or testing procedure is available to prevent Hepatitis A Virus (HAV) contaminated oysters being consumed by consumers.
- A HAV contaminated oyster might cause serious illness.

It was held that a water testing program would not have imposed a major burden in terms of cost, having regard to the health of residents and visitors as well as other factors such as the importance of the Wallis Lake oyster industry to the economy of the shire. Hence the Council was held to have a duty of care towards oyster consumers.

19 [1999] FCA 177 [Par 292].

20 (1998) 44 NSWLR 1.

21 [1999] FCA 177 [Par 290].

22 In Ryan, [par 27], Wilcox J quoted Mr Murphy for the definition of depuration:

> Depuration is a process where oysters are placed in tanks of clean and disinfected water. The water is disinfected by ultra-violet radiation or ozone treatment…All depuration facilities in use at Wallis Lake use ultra-violet light as a disinfectant. Ultraviolet light, given correct conditions, will destroy all viruses and bacteria it comes into contact with. It will not destroy bacteria [and viruses] with which it does not come into contact.

The State and its duty of care

The State was held to have a duty of care to take reasonable steps to minimise the risk to consumers of contracting a viral infection from oysters. This was because the State's involvement:

> … was so extensive and significant to warrant the conclusion that it gave rise to a duty of care to oyster consumers.[23]

The State had a direct financial interest in the industry as the lessor of oyster leases as well as other indirect financial interests and social and political concerns. The involvement included the:

- Department of Fisheries in determining the areas to be leased to oyster growers and the supervision of their use;
- Health Department in supervising the depuration process;
- EPA in inspecting premises in the Wallis Lake catchment area; and
- participation of a number of agencies in the Wallis Lake Estuary Management Committee.

Further, since the State, through the Minister for Fisheries, could prohibit the taking of oysters from the lake, a finding of a duty of care was held to be justified.

The Barclay Companies and their duty of care

The Barclay Companies acknowledged they owed a duty of care to consumers of their oysters. It was held the duty was to take reasonable steps to obtain a virus-free growing environment and if this was not possible, to refrain from selling oysters for human consumption, except perhaps with a warning about the risk of their consumption.[24]

Breach of a duty of care

The second element for a finding of negligence is concerned with the standard of care that is required by the defendant. It is required that a defendant is found careless under an objective 'reasonable person' test, whereby the behaviour of a reasonable person is placed in the circumstances of the defendant at the time of the alleged negligent act. The defendant's conduct is judged in the light of that standard

23 [1999] FCA 177 [Par 336].

24 [1999] FCA 177 [Par 351].

and so is found careless if an act was either done or not done, which differed from a reasonable person and as a consequence, was likely to cause injury to the plaintiff.

The law requires a high degree of foresight and perspicacity by the defendant. In *Wyong Shire Council* v *Shirt,*[25] the High Court of Australia considered the behaviour of the 'reasonable person'. It held that defendants were not only required to foresee risks which were 'real' or 'not unlikely to occur', but also risks which were unlikely, unless they were far-fetched or fanciful.

Nonetheless, this is qualified by Mason J in *Shirt*, with the standard of care judged according to all the circumstances of the case:

> [It] calls for a consideration of the magnitude of the risk and the degree of probability of its occurrence, along with the expense, difficulty and inconvenience of taking alleviating action and any other conflicting responsibilities which the defendant may have.[26]

The analysis of all the circumstances therefore means a consideration of what has been termed the 'calculus of negligence' of a particular case (Trindade and Cane 1996, p 414). A complication is that the factors comprising the negligence calculus may contradict each other and a court will then have to weigh the circumstances that are involved. Nonetheless, one of the factors may be determinative in any given situation.

Under the calculus of negligence, the more serious the likely injury to the plaintiff if the risk materialises, the greater the standard of care that is required by the defendant.

Second, the lower the probability of an accident occurring, the less likely a defendant will be found liable.

Third, consideration is given to the expense of precautions which a plaintiff alleges ought to have been taken, the difficulty of taking the precautions and also the inconvenience which they would cause. There is case authority where a court has not imposed liability if it meant the cessation of a particular activity undertaken by the defendant. [27] However, if the danger to be guarded against is significant and the precautions easy to take, then there is also authority for a finding of negligence even if it would result in putting the defendant out of business.[28]

25 (1980) 146 CLR 40.

26 Trindade and Cane 1996, p 412.

27 *Bolton* v *Stone* [1951] A.C.850.

28 *Arnold* v *Teno* (1978) 83 DLR (3d) 609.

The final aspect of the negligence calculus involves the examination of conflicting responsibilities which the defendant may have. Mason J held in *Shirt* that in analysing the precautions the defendant ought to have taken towards the plaintiff, consideration is also required as to whether the precautions were compatible with the defendant's responsibilities to other people and to the community at large.[29]

Another important consideration in determining whether a breach has occurred is the effect of a statutory rule or regulation upon a common law action for negligence. The basic rule, from *Sibley* v *Kais,*[30] is that compliance or non-compliance with a statute or regulation is relevant but not conclusive for a finding of common law negligence. For example, if there is no other evidence of negligence other than a breach of a regulation, then a court may find negligence on the basis of the breach. Nonetheless, it is important to avoid classifying a failure to comply with a regulation as necessarily negligence *per se*, since this would effectively transform the action from one of negligence into one of breach of statutory duty.

Further, a separate concept — known as *res ipsa loquitur* — may be important regarding the standard of proof required for a finding of negligence. The concept means the *accident itself* will provide the necessary evidence of negligence provided that certain conditions are met.

The first condition is that the rule is dependent on the absence of an explanation, so that if there is evidence of how the accident occurred, the doctrine does not apply. However, despite some ambiguity of when exactly the doctrine should not be applied, it is clear that only a 'precise' or 'exact' explanation will have the effect of unequivocally ousting the application of the rule (Balkin and Davis 1996, p 289). Case authority suggests some scope for the rule when an exact cause is not fully revealed.

The second condition is that the harm must be of a kind that does not ordinarily happen if proper care is being taken. First, this means that the likely cause of the accident must be within the knowledge of the ordinary person. If the question of negligence turns on expert evidence, the principle has generally been held not to apply, although there has been authority contradicting this (Trindade and Cane 1996, p. 443). Second, the accident must be of a type which more often than not is caused by negligence.

The third condition is that the defendant must have been in exclusive control of the situation or facility which caused the accident. However, the meaning and

29 The most common application of this factor has been in emergency situations, which can involve speeding ambulances or fire engines.

30 (1967) 118 CLR 424.

application of 'exclusive control' has not been resolved since it is clear from recent authority that complete control of all the circumstances is no longer required (Balkin and Davis 1996, p. 292). The particular context and the perception of the court as to who is in control would therefore be important.

The breach of a duty of care in Ryan v Great Lakes Council

As noted previously three separate parties were found to have breached their duty of care in *Ryan v Great Lakes Council*.

Great Lakes Council and the breach of its duty of care

It was held that the Council had breached its standard of care.[31] Particular circumstances leading to the breach included that the Council knew that serious sewerage effluent problems existed in villages draining to the Lake's tributaries. It was therefore held that anybody would have realised there was a possibility that viruses in that effluent might reach the Lake and contaminate the oysters. Further, it was held there were numerous contributors or potential contributors to estuarine pollution, which the Council knew or chose not to investigate. It also did not respond to complaints, which the Court found to be an irrational policy.

The Council's argument that regular inspections would be expensive was rejected for lack of evidence provided by the Council. In any event, the available evidence suggested that an upgraded water testing program would not have been an unreasonable burden on the Council's resources.

The State and the breach of its duty of care

The State was also found to have breached its duty of care.[32] It was held that the stage had long been reached for the State, as the ultimate manager of the fishery, to have ensured the making of a comprehensive sanitary survey or to have closed the fishery. The failure to do either of those things constituted a breach of its duty of care.

An initial shoreline survey and regular subsequent sanitary surveys is important since depuration cannot be relied on to remove viruses from shellfish. It was held that depending on the circumstances, a point would arise after which it is not reasonable for a management authority to have failed to conduct a sanitary survey

31 [1999] FCA 177 [Par 299].

32 [1999] FCA 177 [Par 337].

or alternatively to terminate production. The expert evidence in this case was against allowing any harvesting of oysters until the completion of a sanitary survey.

The State argued that the standards existing in New South Wales regarding the quality of meat testing exceeded those applying elsewhere. However, this did not constitute a defence since meat testing prior to sale is not a sufficient guarantee of non-contamination. It was pointed out that all international models agreed on the need for regular sanitary surveys.

The Barclay Companies and the breach of their duty of care

The Barclay Companies were also found to have breached their duty of care.[33] It was conceded that Mr Barclay was aware of the existence of potential sources of viral pollution, that depuration was inadequate to remove viruses and that *E. coli* oyster meat testing would not necessarily show viruses. In such circumstances, it was held a prudent oyster grower needed to do more than depurate and rely on *E. coli* flesh tests.

It was noted that neither the Barclay Companies nor any of the committees with which they were associated, attempted to procure governmental or local governmental involvement for a sanitary survey. Given they actually produced the product putting consumers at risk, it was held the Barclay Companies could not escape responsibility for the lack of a sanitary survey.

Thus, it was decided that in selling the oysters without a warning that they were grown in waters known to be subject to possible viral contamination, the Barclay Companies breached their duty of care.

Causation and remoteness of damage

The final requirement for a finding of negligence is for the plaintiff to prove that on the balance of probabilities, the defendant caused or materially contributed to the injury suffered. The causation requirement has two aspects, which must be satisfied:

- factual causation; and
- attributive (legal) causation.

A further requirement separate to the causation question is that the damage is not too remote.

33 [1999] FCA 177 [Par 354].

Factual causation

In law, a plaintiff's loss is considered to comprise a number of causal conditions, which when combined together, produce the particular loss of the plaintiff.[34] A defendant's act is considered a factual cause of the plaintiff's loss if it was a *necessary* condition of that loss (Trindade and Cane 1996, p 448). This requirement is commonly called the *'but for'* test, which involves whether the plaintiff's loss would have occurred but for the defendant's negligence. If the plaintiff's loss would not have occurred but for the defendant's negligence, then the factual causation requirement will be satisfied.

An implication of the *'but for'* test and that each event comprises a number of causal factors is that the defendant can be liable for loss even though the tortious act operated in combination with other causal factors. This is provided that the loss would not have occurred but for the causal contribution of the defendant's tort. If there are two or more contributory tortious causal factors, each tortfeasor will be liable to contribute to the plaintiff's damages.

Nonetheless, whilst a defendant's tort may be a factual cause of the plaintiff's loss, it is only after the attributive causation requirement is satisfied that a defendant will be considered legally liable for causing the loss.

Attributive causation

The legal causation criterion involves the question of what was the *real* or *effective* cause of the plaintiff's loss (Trindade and Cane 1996, p 456). Nonetheless, at the same time, the causation requirement is not ultimately reduced to one philosophical formula, but rather is also resolved as a matter of common sense and experience, which necessarily involves policy and value judgments (Balkin and Davis 1996, p. 306).

The aim of establishing legal causation is to meet the deficiencies and incompleteness of the *'but for'* test which is indiscriminate and may be either under or over-inclusive. There are three areas where the *'but for'* test is inadequate, therefore making the legal causation requirement necessary.

First, legal causation is used to choose for which among the necessary conditions a defendant should be liable, since it is considered impracticable that a tortfeasor should be held liable for all consequences of a negligent act. For example, whilst

[34] As an example, when a trespasser drops a match in a field, the causal factors include the lighting and throwing of the match, the combustible material in the field, the oxygen in the air and the wind which fans the flames [Balkin and Davis 1996, p 304].

defects in road construction may often be a necessary condition of road accidents, they are rarely picked as the legal cause. The most popular approach to considering legal causation involves using commonsense notions, which an ordinary person would consider appropriate.

Second, it is important, to deal with cases involving '*multiple sufficient causes*', where a defendant's tort was a *sufficient* but not a *necessary* condition of the plaintiff's loss because the loss probably would have occurred even if the tort was not committed. An example in this category is where a defendant causes the death of a person who probably would have died anyway as a result of a pre-existing illness or condition.

Third, the High Court has also pointed to the inadequacy of the *'but for'* test in *novus actus interveniens* cases (Balkin and Davis 1996, p. 305). In such cases, a superseding cause is held to exist which breaks the chain of causation, so that the earlier wrongful act, although regarded as a necessary condition, is not considered as the 'true cause'.

Remoteness of damage

A defendant's liability for negligence, which has been the factual and legal cause of the plaintiff's damage, is limited to those consequences which are held not too remote.

In *The Wagon Mound (No 1)*[35], the foreseeability test was established to address remoteness, so that 'it is the foresight of the reasonable man which alone can determine responsibility'.[36] Whether consequences are foreseeable is a question usually left to juries. However, in general terms, consequences are considered foreseeable if a reasonable person considers the risk of an injury occurring is real rather than far-fetched. The test requires the broad type of injury to be foreseeable rather than its exact extent or precise manner of occurrence.

Nonetheless, courts have regarded as 'reasonably foreseeable' even the most unlikely events, whilst in other cases, even common occurring results have been excluded from consideration. Therefore, it is only in a qualified sense that foreseeability is the test of remoteness of damage. Policy considerations are ultimately important in deciding whether the defendant should be responsible for the consequences arising from the negligence.

35 [1961] A.C.388.

36 Quoted from Balkin and Davis 1996, p 307.

Causation and remoteness in Ryan v Great Lakes Council

In practice, once it is held that a defendant had a duty of care and that this was subsequently breached, the Court will then decide the matter in favour of the plaintiff unless the defendant raises the issue of causation. The ultimate onus of proof rests on the plaintiff although it is for the defendant to first raise and argue the requirement of causation.

In Ryan, the Great Lakes Council and the State did not raise the issue of causation and so were therefore found guilty of negligence.

The Barclay Companies argued that they did not cause the HAV infection suffered by the plaintiff and relevant group members. However, it was held that a clear causal connection existed between the breach and the damage since the illness of the plaintiff and other relevant group members arose from the contamination of the Lake.[37] As a result, the Barclay Companies were also found guilty of negligence.

E.2 Consumer protection under the *Trade Practices Act 1974* (Cth)

The consumer protection provisions of the TPA are found in Parts IVA, V and VA. The sections most relevant for contaminated drinking water are different provisions in Parts V and VA, prohibiting misleading and deceptive conduct, requiring that goods be of merchantable quality and fit for their purpose, and providing compensation for defective goods. A different form of consumer protection through enforceable undertakings to the ACCC, is provided under s. 87B Part VI.

The TPA relies for its validity on specific heads of power granted under the Constitution. The Act, relying on the corporations power, applies to conduct involving corporations. However, it can also be enforceable against individuals and this includes when circumstances exist which are 'reasonably incidental'[38] to the corporations power. Further, under s. 5 and s. 6, the Act has an extended operation where other heads of commonwealth legislative power are relied upon. Thus for example, any trader, whether incorporated or not, may be caught by the Act regarding conduct occurring in inter-state trade or commerce.

Each State and Territory also has consumer protection legislation which operates concurrently with the TPA. State legislation further protects a consumer when the

37 [1999] FCA 177 [Par 354].

38 See *Fencott v Muller* (1983) 152 CLR 570, [Par 9].

seller of the good or service is not a corporation. The State Fair Trading legislation provides protection from a *person* engaging in misleading and deceptive conduct, while Sale of Goods legislation contains merchantable quality and fitness for purpose provisions.

The prohibition of misleading or deceptive conduct

In Part V of the TPA, it is stated under s. 52(1) that:

> A corporation shall not in trade or commerce engage in conduct that is misleading or deceptive or is likely to mislead or deceive.

Misleading or deceptive conduct means a misrepresentation is made, generally comprising a false statement made either expressly or by implication. A necessary condition for liability under s. 52 is that the misleading or deceptive conduct occurs in trade or commerce.

A finding of misleading or deceptive conduct involves an objective test, which is determined in the context of the surrounding circumstances of the case. An implication of having an objective test is that it is irrelevant whether the corporation had any intention to mislead or deceive for the purposes of s. 52. Attempts to absolve or limit liability under s. 52 by using disclaimer or exclusion clauses will also be ineffective except under very special circumstances.[39] This is partly because of the public interest nature of the provision.

It is not expressly stated in s. 52 who should be considered as the possible victims for the purpose of objectively deciding whether the conduct was misleading or deceptive. The objective test developed under case law is less stringent than a reasonable person test, which would have considered the effect of the conduct alleged to be misleading on a reasonable person. Rather, the weight of authority favours the likely effect of the conduct:

> … on a person who is not particularly intelligent or well informed but perhaps of somewhat less than average intelligence and background knowledge, although the test is not the effect on a person who is for example, unusually stupid.[40]

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39 *Keen Mar Corporation Pty Ltd* v *Labrador Park Shopping Centre Pty Ltd* (1989) ATPR 46-048 provides one example, where there was no liability under s. 52. In that case, prospective tenants were required under a clause to specify in a deed what representations they relied upon. They were informed of the clause and had also received legal advice. It was held that upon leaving the clause blank, there was no misleading and deceptive conduct.

40 *Annand & Thompson* v *Trade Practices Commission* (1979) 25 ALR 91 quoted from Carter and Harland 1996, p 394.

Additionally, there is also much support for a second approach, which makes the test wider in scope by considering everyone who comes within the relevant section of the public including:

> … the astute and the gullible, the intelligent and the not so intelligent, the well educated as well as the poorly educated. [41]

The second approach is particularly significant in cases involving mass media advertising or other conduct directed at the public at large (Carter and Harland 1996, p. 395). It probably has less impact regarding one-to-one negotiations, except that it does emphasise that in every case, the audience to which the conduct is directed must be considered.

The type of misrepresentations which can be misleading or deceptive

The prohibition against misleading or deceptive conduct applies to representations of past or existing facts.

Additionally, s. 52 can apply to future predictions. The Courts have often held that a future statement may contain an implied representation as to present or past fact. If the implied representation is considered misleading, s. 52 will be contravened. It is also stated under s. 51A that a representation will be taken to be misleading for a future statement unless the corporation can prove that it had reasonable grounds for making that representation.

The Courts have recently taken a more expansive interpretation of s. 52, so that there may be less need to find an implied representation or to rely on s. 51A to successfully argue for a misleading future representation. In *Wheeler Grace & Pierucci Pty Ltd v Wright*[42] it was held that an unqualified prediction may be misleading if the circumstances indicated the need for some qualification or possibility of non-fulfilment. This was also accepted in *Bowler* v *Hilda Pty Ltd*.[43]

Liability under s. 52 can also apply under certain circumstances to statements of opinion. One example is where an opinion by an expert conveys a representation that the opinion is honestly held on rational grounds comprising an application of relevant expertise.[44] If this is not in fact the case, then the conduct can be held misleading and deceptive, breaching s. 52.

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41 *Taco Co of Australia Inc* v *Taco Bell Pty Ltd* (1982) 42 ALR 177 quoted from Carter and Harland 1996, pp 394-395.

42 (1989) ATPR 40-940.

43 (1998) ATPR 41-625.

44 *Bateman* v *Slatyer* (1987) 71 ALR 553, cited in Miller 1999, p 305.

Further, a statement may be held misleading or deceptive although literally true. Ambiguities and 'half-truths' can contravene s. 52 depending on the overall impression created by the conduct. Nonetheless mere exaggeration may be a defence to misleading and deceptive conduct since:

> In the ordinary course of commercial dealings, a certain degree of puffing or exaggeration is to be expected. Indeed puffery is part of the ordinary stuff of commerce.[45]

However, the more specific and precise a statement is, the more likely that the defence of 'puffery' will be unsuccessful (Carter and Harland 1996, p. 396). The defence is also less likely to succeed under s. 52 than under the common law for misrepresentation.

Finally, silence can also constitute misleading and deceptive conduct. At common law, silence is permissible except under limited circumstances when there is a duty of disclosure. Under s. 52, the Courts are not restrained by these common law principles and have adopted a more expansive approach when silence can be misleading. In *Demagogue Pty Ltd* v *Ramensky*,[46] it was held that the essential question was whether in light of all the circumstances constituted by acts, omissions, statements or silence, there was conduct likely to mislead or deceive. Further, if there is a reasonable expectation that if some relevant fact existed, it would be disclosed, then the conduct may be held misleading.

Damages for contravening s. 52

Part VI of the TPA contains a number of statutory remedies for breaching s. 52 and this includes damages, which can be awarded under s. 82 of the Act. Under s. 79, a breach of s. 52 can not be a criminal offence.

It was established in *Gates* v *CML Life Assurance Society*[47] that damages are to be awarded as under tort law, where the object is to place the plaintiff in the position as if the tort had not occurred. A necessary requirement for recovering damages is that loss or damage was actually suffered and this can include pure economic loss, mental distress and damages for injury to business reputation.

A desirable feature of s. 82 is that as well as allowing recovery against the party that contravened s. 52, it also extends liability to any 'person involved in the

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45 *General Newspapers Pty Ltd* v *Telstra Corporation* (1993) ATPR 41-274 quoted from Miller 1999, p 296.

46 (1992) 39 FCR 31.

47 (1986) 160 CLR 1.

contravention'. This is defined in s. 75B, which includes a person who was 'directly or indirectly, knowingly concerned in, or party to, the contravention'. An example of the effect of s. 75B is that a director of a company can be personally liable as well as the actual company itself. The person involved in the contravention must have had knowledge of the essential elements comprising the contravention. However, this evidential burden has frequently not prevented applications recovering damages against such a person (Carter and Harland 1996, p. 402).[48]

Ryan v Great Lakes Council and the allegation of misleading or deceptive conduct

In *Ryan*, the plaintiff argued that the Barclay Companies had breached various provisions of the TPA. There were no claims made against the Council or the State of New South Wales regarding the TPA.

The plaintiff contended that although no express representation was made by Barclay Companies concerning the quality of oysters, there was an implied representation resulting in a breach of s. 52 of the TPA. This was because the sale of oysters without any warning of possible viral contamination constituted an implied representation that they were uncontaminated.

However, this aspect of the claim was rejected by Wilcox J.[49] It was accepted that silence can constitute misleading and deceptive conduct but it was held that courts should be wary about treating *mere* silence as a breach of s. 52 of the Act in relation to the quality of goods. Silence would only constitute misleading conduct if something had occurred between the parties, which made it necessary for one party to supply further information so that the other party would not be misled. In the circumstances, the argument of misleading and deceptive conduct failed.

The merchantable quality and fitness for purpose provisions

The TPA contains provisions which specify that goods must be of merchantable quality and fit for their purpose.[50] The relevant sections are:

- s. 71 under Division 2, Part V.

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48 The State Fair Trading legislation often applies to make directors and agents of a corporation liable as primary contravenors. This further reduces the significance of the knowledge requirement under s. 75B of the TPA.

49 [1999] FCA 177 [par 378].

50 The Act also contains consumer protection provisions other than those relevant to this report. These include warranty as to title, a condition that goods supplied by description will meet that description and a condition that goods supplied by reference to a sample will correspond with the sample in quality. Further, there are warranties with regard to services.

- s. 74B, s. 74D under Division 2A, Part V.

Protection under s. 71, Division 2, Part V

Section 71 does not prescribe a norm of conduct but rather, operates by importing into all consumer contracts conditions of merchantable quality and fitness for purpose when that purpose is expressly or impliedly made known. The remedy for a breach of s. 71 is to sue for breach of the implied condition and not for damages under s. 82 (Miller 1999, p. 409).

A merchantable quality provision is found in s. 71(1) of the Act. It is stated that where a corporation supplies goods to a consumer in the course of a business, there is an implied condition that the goods supplied under the contract are of merchantable quality. The condition does not apply for auction sales, for defects specifically drawn to the consumer's attention before the contract was made or if the consumer examined the goods before the contract was made and the defects ought to have been revealed by the examination.

In s. 66(2) of the Act it is stated that goods are of merchantable quality if they are:

> … fit for the purpose or purposes for which goods of that kind are commonly bought as it is reasonable to expect having regard to any description applied to them, the price (if relevant) and all the other relevant circumstances.

In s. 4B, the term 'consumer' is defined for the purposes of the Act. It is stated in relation to goods, that a person is a consumer if the good is priced at below $40,000 or if this is not the case, the good was a kind ordinarily acquired for personal, domestic or household use or consumption.[51] Further it is necessary that the goods were not purchased for resale or for using or transforming them in:

> … trade or commerce, in the course of a process of production or manufacture or of repairing or treating other goods or fixtures on land.

A fitness for purpose provision is found in s. 71(2) of the Act. It is stated that where a consumer expressly or by implication makes known to the corporation any particular purpose for which the goods are being acquired, there is an implied condition that the goods supplied under the contract are reasonably fit for that purpose. It is irrelevant if the purpose is not one for which the goods are commonly supplied, except where there are circumstances that show the consumer did not rely or that it was unreasonable for him or her to rely on the judgment of the corporation.

51 The section also states that a purchaser is a consumer if a commercial road vehicle is bought.

The implied conditions can not be rendered ineffective by a contractual term made by the parties. Under s. 68(1) of the Act, any contractual term that purports or has the effect of excluding or restricting any of the provisions of the Division is void. This does not affect s. 68A, which provides that under certain circumstances, a contractual term may limit the liability of the corporation for a breach of the implied conditions. Section 68A does not apply to cases involving contaminated water since it does not apply to goods of a 'kind ordinarily acquired for personal, domestic or household use or consumption'.

A limitation of s. 71 is that it only applies to contracts for the supply of goods and therefore for the implied conditions to be effective, it is necessary for a consumer to be a party to the contract. The section will not protect a consumer who has acquired a good from a purchaser that contracted with the final seller of the product. A common example of this problem is where friends or family members of a person who purchased the product are injured by it.

An additional implication of the requirement to be an actual contracting party is that a consumer can sue the immediate seller but will not possess any rights against dealers that are further up the chain of distribution or against the manufacturer. Therefore where there has been vertical separation of the water industry into a wholesaler and retailer, the wholesaler can not be liable under s. 71. The requirement to be an actual contracting party can cause two further difficulties:

- The party with whom the consumer contracted may have less financial resources than the manufacturer or some other intermediate supplier.
- If the consumer successfully sues the immediate seller, this will mean the seller will normally have a contractual right to sue its supplier. This can continue further up the chain of distribution to the actual manufacturer. This is a cumbersome and expensive process for making the manufacturer liable and the process can break down (Trindade and Cane 1996, p. 572).

Ryan v Great Lakes Council and s. 71

In *Ryan*, it was contended by the plaintiff that Barclay Distributors had contravened the implied conditions of s. 71 of the TPA.

However, this argument was not accepted by the Court.[52] It was held that although Barclay Distributors had supplied oysters to a consumer, the plaintiff was not the actual party that contracted with Barclay Distributors. Rather it was the plaintiff's father and brother who bought the oysters from the oyster distributor.

52 [1999] FCA 177 [Par 380].

It was argued that the requirement to be a contracting party was not necessary since this was not the case in *Trident General Insurance Co Limited v McNiece Bros Proprietary Limited*.[53] However, it was held that the case dealt with parties contracting on the basis of benefiting third parties and thus was not sufficiently analogous to permit recovery. Therefore the argument failed.

Protection under s. 74B, s. 74D, Division 2A, Part V

The limitations of s. 71, regarding its scope, are addressed by Part V, Division 2A of the Act. It provides that a consumer can take action directly against a 'manufacturer' if the goods are unfit for their stated purpose or are of unmerchantable quality. Further, any person who acquires the goods or derives title from a consumer can also take action against the manufacturer. However, under s. 74A(2aa) this does not include a person acquiring goods for the purpose of re-supply. It is also necessary under s. 74A(2a) that goods are of a kind ordinarily acquired for personal, domestic or household use or consumption.

In *Zaravinos* v *Dairy Farmers Co-operative Ltd*,[54] it was held that:

> Division 2A does not apply where there is a contract between a manufacturer and a consumer. Rather, it applies when a manufacturer supplies goods to another person, usually a retailer or distributor, who acquires the goods for the purpose of re-supply.[55]

A definition of 'manufactured' is contained in s. 74A(1) and it is stated that this 'includes grown, extracted, produced, processed and assembled'. There are five circumstances provided under s. 74A when a corporation will be regarded as the 'manufacturer' of goods for the purposes of Division 2A, namely if the corporation:

- actually manufactures the goods,
- holds itself out to the public as the manufacturer,
- uses its own brand name in relation to the goods,
- permits another person to promote the goods as goods manufactured by the corporation, and
- not being the actual manufacturer, imports the goods in Australia and the actual manufacturer has no place of business in Australia.

The fitness for purpose provision of Division 2A is found in s. 74B of the Act. As with s. 71(2), it applies when goods are acquired by a consumer for a particular

53 (1988) 165 CLR 107.

54 (1985) 7 FCR 195.

55 Quoted from Miller 1999, p 417.

purpose expressly or by implication made known to the corporation. If the goods are not reasonably fit for that purpose and there is subsequent loss or damage to the consumer or other person acquiring or deriving title to the goods from the consumer, the corporation is liable to compensate the consumer or other person.

The merchantable quality provision of Division 2A is found in s. 74D of the Act. Under this provision, if goods supplied to a consumer are not of merchantable quality and there is subsequent loss or damage to the consumer or other person acquiring or deriving title to the goods from the consumer, the corporation is liable to compensate the consumer or other person. The definition of merchantable quality for the section is provided under s. 74D(3) and this is identical to the definition given earlier for s. 71 of the Act. In *Rasell* v *Cavalier Marketing (Aust) Pty Ltd*,[56] it was decided that it is unnecessary to consider the common law meaning of merchantable quality except under exceptional circumstances.

There are limited circumstances provided under s. 74B and s. 74D when a corporation will not be liable if the good is unfit for its purpose or is of unmerchantable quality. First, it is stated in s. 74B that a corporation can escape liability if the good is not reasonably fit for its purpose if there was an act or default by any person not being the corporation or a servant or agent of the corporation. Second, there is also no liability under s. 74B if there was a 'cause independent of human control'. However, both these exceptions are limited in scope because they only apply 'after the goods have left the control of the corporation.' These limited exceptions also apply under s. 74D with respect to merchantable quality.

An exception specific to s. 74B is where there are circumstances which show that the consumer did not rely or that it was unreasonable for the consumer to rely on the corporation's skill or judgment. Specific exceptions to s. 74D are where defects are specifically drawn to the consumer's attention before the contract is made or where the consumer has examined the goods before the contract is made and the examination ought to have revealed the defects.

As with s. 71, the fitness for purpose and merchantable quality provisions of Division 2A can not be rendered ineffective by a contractual term made by the parties. Under s. 74K(1) of the Act, any contractual term that purports or has the effect of excluding or restricting any of the provisions of Division 2A is void.

56 [1991] 2 Qld R 323.

Ryan v Great Lakes Council and liability under s. 74B and s. 74D

In *Ryan*, it was successfully argued that the oyster manufacturer, Barclay Oysters, was liable to compensate the plaintiff under s. 74B and s. 74D of the TPA.

It was held that the oysters were not fit for their purpose, rendering Barclay Oysters liable under s. 74B.[57] It was implicit in the series of transactions that the purpose was for human consumption, which was not met because the oysters were contaminated. Further, in contrast to s. 71, it did not matter that the plaintiff was not a contracting party for the purchase of the oysters.

It was unsuccessfully argued by Barclay Oysters that the consumer did not rely on the skill or judgment of Barclay Oysters or alternatively that it was unreasonable for him to have done so.

It was held that the consumer did indeed rely on Barclay Oysters because in the absence of an obvious defect or special circumstance, fitness will be assumed.

Further, it was not unreasonable to rely on Barclay Oysters since in the absence of a warning about the possibility of viral contamination, the consumer was entitled to rely on the skill and judgment of the grower. The issue is the reasonableness of the consumer's reliance rather than the reasonableness of the manufacturer's behaviour. It therefore did not matter that it was not possible to ensure than an oyster was free from viral contamination or if the particular oysters eaten could not have been tested because that would have involved destruction of the shell.

Wilcox J also held that the oysters were not of merchantable quality, rendering Barclay Oysters liable under s. 74D.[58] It was not accepted that the oysters met the merchantable quality definition on the ground that it is impossible to guarantee the absence of a virus. This is because, as with s. 74B:

> … the issue posed by s. 74D is not whether it was possible for the grower to ensure the oysters were free of viruses, but whether a *purchaser* would act reasonably in expecting they were [Par 374].

An objective test, having regard to all the circumstances, was used to examine if the goods were of merchantable quality. In the circumstances, which included the absence of a warning for possible viral contamination, the oysters were not of a standard that was reasonable to expect by a purchaser.

57 [1999] FCA 177 [Par 368].

58 [1999] FCA 177 [Par 375].

Part VA and protection from defective goods

The aim of Part VA is to provide a number of statutory rights against a 'manufacturer', based neither in tort nor contract, for loss caused by defective goods. Under s. 75AP, these rights can not be excluded or modified by a contractual term made between the parties. The definition of 'manufacturer', from s. 75AA and s. 75AB, is equivalent to that applying for Division 2A, Part V of the Act. In s. 75AC(1), it is stated that for Part VA:

> … goods have a defect if their safety is not such as persons generally are entitled to expect.

The standard adopted to determine if a good has a defect consistent with s. 75AC(1) is an objective test, based on what the community is entitled to expect. However, this does not mean that goods must be absolutely free from risk (Miller 1999, pp. 436-437).

Circumstances relevant in considering whether a good has a defect are provided under s. 75AC(2) and this includes whether any warnings were provided. Under s. 75AC(3), it is irrelevant that the manufacturer later supplies safer goods. Further, under s. 75AC(4), no inference is drawn that a good has a defect simply because the goods complied with a mandatory standard and that standard was not the safest possible standard having regard to the latest state of scientific or technical knowledge.

The first statutory right is provided under s. 75AD. A corporation that manufactures a defective good is required to compensate any individual if, because of the defect, the individual suffers physical injuries. The corporation will be liable to compensate the individual for the amount of loss suffered.

A further statutory right is specified in s. 75AE. Under this section, a corporation that manufactures a defective good is required to compensate an individual who suffers loss because another person has suffered death or injuries from the defect. A limitation of the section is that it excludes loss arising from a business or professional relationship between the injured person and the person suffering the loss.

There is an additional right in s. 75AF of the Act. The section imposes liability on a corporation that manufactures a defective good if, because of the defect, other goods are destroyed or damaged and a person who so used or intended to use the goods suffers loss or damage as a result. In such cases, the manufacturer is required to compensate the person for the amount of the loss. A limitation of the section is that the goods destroyed or damaged must be 'of a kind ordinarily acquired for personal, domestic or household use'.

There are defences available under s. 75AK which may preclude compensation arising from the statutory rights. It is a defence if the defect did not exist when the goods were supplied. It is also a defence if the defect could not have been discovered given the state of scientific or technical knowledge when the manufacturer supplied the goods. Another example is if the defect occurred because there was compliance with a Commonwealth mandatory standard and in such circumstances under s. 75AL, the Commonwealth becomes a defendant to the action. If the defence is proved, the Commonwealth is liable to compensate the plaintiff for the loss caused by the defect.

Ryan v Great Lakes Council and the alleged contravention of Part VA

In *Ryan*, it was unsuccessfully argued that Barclay Oysters should compensate the plaintiff for injury suffered as provided under s. 75AD.

It was decided that Barclay Oysters could rely on s. 75AK that it is a defence if the state of scientific or technical knowledge at the time the goods were supplied was not such to enable the defect to be discovered. It was held that whilst the defence is unavailable if the goods were supplied and it was possible to discover the defect in those goods, the defence would be successful if the goods were supplied and it was not possible to detect the defect. In this case, the testing would have destroyed the actual goods and therefore because supply and discovery were mutually exclusive, the s. 75AD claim failed [Par 377].

In a case involving contaminated drinking water, a different result to *Ryan* may occur if the testing does not destroy the good.

Enforceable undertakings to the ACCC under s. 87B

An alternative form of consumer protection involves an administrative approach that may be adopted by the ACCC. Under s. 87B, Part VI of the TPA, the ACCC may accept a written undertaking from a person regarding any matter for which the ACCC has a power or function under the Act (see box E.3). The ACCC has no power or function in respect of the supply of contaminated water under Divisions 2 and 2A of Part V. However, it does have a role in respect of misleading conduct under s. 52. The undertakings can only be subsequently varied or withdrawn with the consent of the ACCC.

If the ACCC considers that undertakings have been breached, it can apply to the Court which may make an order listed under s. 87B and this includes any other order it considers appropriate. There has not yet been a court application to enforce a s. 87B undertaking. However, an example of a Court order under s. 87B would be

a direction to pay the Commonwealth an amount up to the financial benefit attained. Additionally, the contravening party could be required to compensate any person who suffered loss or damage as a result of the breached undertakings.

The ACCC seeks to choose an administrative solution over litigation if it considers it would produce the best results in terms of lasting legal compliance and redress for injured parties (ACCC 1999, p. 3). An administrative solution of enforceable undertakings can be more expeditious and less costly than court processes.

That said, legal proceedings may be preferred to punish unlawful conduct and to deter by way of penalty and resultant publicity. The ACCC also does not have the power to demand a s. 87B undertaking. The decision of the ACCC between litigation and an administrative resolution also involves a consideration of factors including the nature of the alleged breach and the history of complaints against the business (ACCC 1999, p. 4).

Box E.3 The City West Water undertakings for 'blue-green water' problems

In January 1995, it became known that one hundred customers of City West Water were affected by a phenomenon known as blue-green water. This water quality problem occurs from the corrosion of customer copper pipes resulting in increased copper levels in the water. A number of factors in the water are believed to lead to the corrosion of the copper pipes although the precise cause of the phenomenon has not been discovered. The increased copper levels can have adverse health implications as well as turning water into a blue-green colour.

As a result of blue-green water problems, City West provided undertakings under s. 87B of the Act that were accepted by the ACCC. The undertakings included the provision of written material to residents in areas known to be affected by blue-green water and also general information of the blue-green water problem to all City West customers. City West were required to conduct random sampling of tap water within customer premises and report research results by the CSIRO to the Office of the Regulator-General and the ACCC indicating the causes of blue-green water. There was also a commitment by City West for further study of the issue in association with the Water Services Association of Australia.

However, it can not be assumed that the undertakings are valid under s. 87B and are enforceable by the Court. The merchantable quality and fitness for purpose provisions and Part VA of the Act give rights to sue for compensation. The ACCC does not have any power or function with regard to those provisions. The undertakings can only be enforced if they were given with regard to correcting a possible contravention of s. 52 and preventing any re-occurrences of a possible s. 52 contravention. The undertakings may be invalid if they went beyond correcting a possible contravention of s. 52.

Source: ORG (1999) and Productivity Commission.

E.3 Consumer protection under implied customer contracts

An additional form of legal redress available to a consumer is for breach of an implied customer contract that may apply between the customer and the water supplier. An implied customer contract provides rights and obligations to customers and their water supplier. This includes provisions relating to water quality and customer service. The water suppliers which currently have implied customer contracts are:

- Sydney Water Corporation (NSW);
- Hunter Water Corporation (NSW); and
- The Melbourne Retail Companies (City West Water, South East Water, Yarra Valley Water).

This consumer legal redress for contaminated water only applies when water suppliers are subject to a customer contract. The contracts are 'implied' as they are deemed under an Act of Parliament rather than having being expressly made by the parties. Nonetheless, the redress constitutes a common law cause of action if there is a breach of contract.[59]

The Sydney Water Corporation customer contract

The basis for the Sydney Water Corporation (SWC) customer contract is found under s. 55(1) of the *Sydney Water Act 1994* (NSW). It is specified that:

> An owner of land that is connected to a water main or sewer main owned by the Corporation is taken to have entered into a customer contract with the Corporation, on the terms and conditions set out in the relevant operating licence …

The initial customer contract is found in Schedule 1 of the Operating Licence, which was granted under s. 12 of the *Sydney Water Act 1994*. Under clause 4.7 of the Licence, any rights created by the customer contract are in addition to any rights conferred by the Licence and the *Sydney Water Act 1994*. Further, an interpretation or amendment of a provision in the customer contract can not override the rights and obligations conferred by the Licence and the Act.

In clause 5.4.1.1 of the Operating Licence, it is stated that the SWC must meet the requirements of clause 7.2(b) of the Memorandum of Understanding between the SWC and NSW Health. Under clause 7.2(b), the Corporation must meet the 1996

59 *Coles Myer Ltd v City West Water Ltd* [1998] VSC 63.

Guidelines from 1 July 1997 including any amendments that may be made to those Guidelines. These clauses override any inconsistency of clause 1.3 of the initial customer contract, which required the SWC to meet the 1980 Guidelines and the 1987 Guidelines according to a timetable agreed between the Corporation and the NSW Health Department.

Customer redress is provided in the customer contract under clauses 6.3 and 6.4. This includes rebates or payments to consumers if it is shown that the SWC's activities caused damage or disruption because of effects such as dirty water.

It is also provided under s. 58 of the *Sydney Water Act 1994* that the jurisdiction of a consumer claims tribunal extends to the hearing and determination of a consumer claim relating to a service supplied by the Corporation under a customer contract. Further, under s. 103 of the Act, any person may bring proceedings in the Supreme Court for an order to restrain a breach of a customer contract. The Court can make any orders it thinks fit to restrain the breach of contract.

The Hunter Water Corporation customer contract

The basis for the Hunter Water Corporation (HWC) customer contract is found under s. 36(1) of the *Hunter Water Act 1991* (NSW). It deems that an owner of land, connected to a water main or sewerage main owned by the Corporation, has a customer contract with the Corporation. Under s. 35(1), the initial terms and conditions of the customer contract are set out in the Operating Licence.

Clause 6.1 of the customer contract requires the Corporation to meet water quality standards as established in the Operating Licence. Under clause 4.1 of the Licence, the HWC must meet the standards of Schedule 3, which references the draft 1994 Guidelines.

In the December 1999 Memorandum of Understanding between the Corporation and the NSW Health Department, the Corporation's roles and responsibilities are dealt with under clause 6. It is specified under clause 6.2 that the Operating Licence requires the Corporation to meet the health related aspects of the 1996 Guidelines from the commencement of the Licence.

The implied customer contracts of the Melbourne retail companies

The basis for a customer contract existing between the Melbourne retail companies and their customers is found under s. 19 of the *Water Industry Act 1994* (Vic). It is stated that:

> … an owner of a serviced property connected to a retail licensee's works… or an occupier of any such property who is liable to pay a usage charge is deemed to have entered into a customer contract with the licensee on the terms and conditions set out in the licence…

The customer contracts for each of the water suppliers are found under Schedule 1 of their Operating Licenses, which are issued by the *Governor-in-Council* pursuant to s. 17 of the *Water Industry Act 1994.*

Under clause 7.3 of the Operating Licence, the licensee must consult with its customers about the content of the implied customer contract and submit annual proposed revisions to the Office of Regulator-General arising from its customer consultations. It is provided under clause 7.4 that the Office may approve the proposed revisions by a notice in writing to the licensee, which thereby has the effect of amending the implied customer contract.

Under clause 4.4.1 of each of the customer contracts, the water suppliers must meet three conditions relating to water quality. It is necessary that water is clear and free from objectionable odour and taste. Second, the water suppliers must comply with the health-related parameters of the *Guidelines for Drinking Water Quality in Australia 1987* or any other requirement set by the Department of Human Services. There are limited temporary exceptions to this condition in favour of water quality zones,[60] which have been nominated for water quality improvement works. The third requirement is that the quality of water must be at least of equal quality to that provided by the Melbourne Water Corporation before 1 January 1995.

A general right to compensation for breach of a customer contract is ensured under clauses 16.2.1 and 16.2.2 for each of the customer contracts. For example, with regard to the City West Water[61] customer contract it is stated that:

> If City West Water breaches this contract or otherwise fails to perform its functions adequately and a customer has suffered any financial loss as a result, then the customer may have a right to claim for compensation or seek rectification from City West Water [cl 16.2.1]. In such cases, the customer's right to compensation may arise under this contract [cl 16.2.2] …

60 A water quality zone is an area throughout which water supplied to consumers could reasonably be expected to be of similar quality (Office of the Regulator-General 1999, p 15).

61 Clauses 16.2.1 and 16.2.2 are identical for all the Melbourne water suppliers.

E.4 Consumer protection under State legislation

Consumers may also obtain compensation under State water law for contaminated drinking water on grounds other than for breaches of implied customer contracts as discussed in the previous section. There may be statutory provisions that provide a statutory cause of action if contaminated drinking water is provided.[62]

In Victoria, under s. 73 of the *Water Industry Act 1994*, a licensee must cause as little damage and inconvenience as possible in the performance of its functions. It is specified that a licensee is liable to compensate any person who has sustained a pecuniary loss or incurred any expense as a direct, natural and reasonable consequence of the licensee's functions. A limitation of this provision is that the *Water Industry Act 1994*only applies to the three Melbourne retail water suppliers.

A major emphasis of all States and Territories is the provision of potential criminal penalties if requirements relating to drinking water are contravened. The legal framework, which may involve criminal penalties on a water supplier, includes:

- State and Territory Public Health Acts;
- Legislation dealing with a particular water supplier or number of water suppliers; and
- Regulations made pursuant to the Public Health Acts.

An example of potential criminal offences under a State Public Health Act is the *Public Health Act 1991* (NSW). The provisions concerning safe drinking water are contained in Part 2A of the Act. A supplier of drinking water is defined in s. 10A and has the effect that all NSW water suppliers are liable under Part 2A.

Under the *Public Health Act 1991*, there are three Divisions containing provisions under which a NSW water supplier can be criminally liable. There are prescribed functions given to the Chief Health Officer in relation to drinking water, specified functions of the Director-General regarding drinking water and other 'general' provisions that are contained in the last Division. An example of an offence is provided under s. 10C, where a water supplier does not correct misleading information after it has been directed to do so by the Chief Health Officer.

An example of legislation dealing with a particular water supplier is the *Sydney Water Act 1994*, which is effective against the SWC. Under s. 19(2b) of the Act, the

62 This is to be contrasted with an implied customer contract which is a common law cause of action. In *Coles Myer Ltd*, a case where an underground water pipe ruptured and flooded the Myer City Store in Melbourne, the common law causes of action were held to have been overridden by s. 17 of the *Water Act 1989*.

Corporation is liable to pay a monetary penalty not exceeding $1 million if it contravenes its Operating Licence. Further, the Operating Licence may be cancelled by the Governor under s. 20 of the Act. For example, if the Corporation has been convicted on more than three occasions within 12 months of criminal offences punishable by a fine of at least $10,000, the Operating Licence may be cancelled.

In Western Australia, under s. 39(1b) of the *Water Services Coordination Act 1995* (WA), a licensee that contravenes an Operating Licence may be subject to a monetary penalty not exceeding $100,000. An example is the Operating Licence for the Water Corporation, where under clause 3.1, the Corporation must meet the *Guidelines for Drinking Water Quality in Australia 1987*. Under s. 42 of the *Water Services Coordination Act 1995*, the Governor may cancel a Licence if prescribed circumstances are met.

An example of Regulations made pursuant to a Public Health Act is the *Victorian Health (Quality of Drinking Water) Regulations 1991*. The Regulations are made under s. 81, s. 390, and s. 391 of the *Health Act 1958* (Vic).

Under the *Victorian Health (Quality of Drinking Water) Regulations 1991*, a water supplier must meet requirements involving the inspection and sampling of its water and also notify the Chief General Manager if the water may be the cause of an illness. Further, a water supplier must comply with any direction given by the Chief General Manager regarding its inspections and sampling of water. There must also be compliance with any direction given by the Chief General Manager to notify all affected services that water should be boiled before drinking. Under r. 10, a failure to comply with these requirements is an offence that is punishable by not more than fifty penalty units.[63]

63 Under s. 110 of the *Sentencing Act 1991* (Vic), one penalty unit is equal to one hundred dollars.

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