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SURVEILLANCE OF RURAL DRINKING WATER QUALITY IN NSW

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INTRODUCTION

The sampling and analysis of our drinking water supplies is fundamental to safeguarding public health. In rural NSW, water supply authorities – Local or County Councils, or the Public Works Department (PWD) – are responsible for the provision of drinking water which meets agreed microbiological, chemical and physical criteria.

Compliance with National Health and Medical Research Council (NHMRC) water quality guidelines should protect the public from waterborne illness. However, it is not uncommon for these recommended criteria to be exceeded in rural NSW, and some supplies are tested irregularly.

This review has two aims:

- to evaluate the current system of water quality surveillance in NSW; and
- to gauge the public health significance of these results.

BACKGROUND

Legal situation

There is no statutory requirement for any authority to monitor drinking water quality. However, legislation allows for closure of a drinking water supply if it is suspected to be unfit for drinking (Public Health Act, 1991)[1]; creates offences relating to the discharge of prohibited matter into sewers and drains, unauthorised drainage work, wasting or misusing water, and polluting a public water supply (Local Government Act, 1993)[2]; and confers powers to classify waters, inspect and impose standards and direct action in relation to pollution of a waterway (Clean Waters Act, 1970)[3]; as well as dealing with the mechanics of water supply and commercial standards for use.

To safeguard public health, the NHMRC and the Australian Water Resources Council (AWRC) have developed guidelines[4] for the microbiological, physical, chemical and radiological characteristics of drinking water in Australia. The guideline values are not standards, but achievement of the guidelines should ensure that drinking water will not present a significant health risk to the public. The NSW Health Department, the PWD and local councils have adopted these guidelines as a basis for assessing water quality in NSW. The guidelines, adopted in 1987, are being revised[5] and propose:

- more stringent values for some parameters;
- more frequent microbiological sampling; and
- a framework for the evaluation of a supply's water quality.

The draft guidelines[5] advocate that water authorities provide event reports and annual reports of water quality to health authorities and the public. Although having no legislative status, the guidelines imply there is a duty of care on the water supply and health authorities to ensure safe drinking water is provided to the public. The draft guidelines state that they provide a "needed reference to ensure the accountability both of water authorities, as managers, and of state health authorities, as auditors of water supplies" [5].

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Water supply authorities

In NSW the following government authorities are responsible for drinking water supplies:

- Water Boards (consisting of the Sydney, Hunter and Broken Hill water boards);
- NSW Public Works Department; and
- Local and County Councils which service most of the rural areas.

The PWD, through the Country Towns Water Supply and Sewerage Subsidy Program (CTWSSP), has delegated responsibility for the provision of water services to rural councils[6]. The program includes areas not covered by the Sydney and the Hunter Water Board and incorporates 128 councils and 200 water supply schemes[7].

In rural NSW towns about 82 per cent of the water supply comes from surface sources while the remainder originates from groundwater sources which include deep bores and shallow wells[6]. Almost all the supplies in rural towns use chlorination for disinfection, with chloramination being used in only two supplies where long disinfection residual times are required. A small number of councils has decided not to disinfect water supplies[6].

Costs

The 1987 water quality guidelines state that to achieve compliance with all water quality guidelines throughout Australia would cost around $2,000 million in 1984 dollars[4]. Although small towns have a limited capacity to meet these costs, the goal of the PWD is to improve the quality of all water supplies in rural towns to meet the 1987 guidelines as a minimum[6].

The Division of Analytical Laboratories (DAL) carries out microbiological, physical, chemical and pesticide analysis of drinking water samples for rural NSW supplies. The water samples are submitted by the water supply authorities and are analysed free of charge. Results are fed back to councils and the Public Health Units (PHUs).

Some councils use alternative laboratories for the analysis of water samples. Councils in the South West Region and two councils in the South East Region send samples to Wagga Wagga Base Hospital for microbiological analysis only, and a few councils in the New England Region carry out analysis in their own laboratories or send samples elsewhere.

The cost incurred by DAL for microbiological, chemical and physical analysis of both public and private drinking water samples for the period 1988-89 was $528,400 (excluding pesticide analysis)[8], and $664,630 for 1989-1990 (including pesticide analysis)[9]. These figures incorporate costs for salaries, maintenance, working expenses, laboratory equipment and equipment replacement. Councils also incur significant costs in the collection of samples.

Sampling and analysis of drinking water supplies in rural NSW

The NHMRC[1] states that local conditions and a knowledge of the water supply system will help to determine where and how frequently monitoring should be carried out. Nevertheless, the guidelines also define a minimum frequency for water sampling and state that the samples must be representative of the water supply. The guideline values relate to quality of the water which is delivered to the consumer. The guidelines stress that exceeding the standards occasionally is not necessarily a public health threat, but that authorities should consider the degree and duration when taking remedial action.

In addition to monitoring the treated drinking water supply, some authorities also test raw water sources and storages to assemble information on the quality of the water before treatment.

- *Microbiological sampling and analysis*
  It is not feasible to test for all materials or organisms which may be present in water. Instead, the coliform group of organisms, and in particular *E coli*, are used as indicator bacteria of faecal contamination. The NSW Health Department, including DAL, has adopted the sampling frequency for microbiological analysis as recommended in the guidelines. The major determinant of sampling frequency is population size[4] – for example, a minimum of one sample a month for the smallest supplies, and weekly sampling in supplies servicing areas with large seasonal increases in population such as holiday resorts.
  When faecal contamination occurs, the water and health authorities should take appropriate remedial action and where necessary issue a public warning. This action has been carried out by the Regional PHUs and Local Councils. In the event of a gastroenteritis outbreak, a full microbiological investigation is conducted, although no tests for the presence of viruses are done.
  The draft guidelines present a framework for the annual assessment and reporting of non-compliance with water quality standards. At present this is not often conducted.
- *Chemical, physical and pesticides analysis*
  The NHMRC guidelines[4] stipulate that supplies serving more than 50,000 people be sampled monthly, and those serving smaller populations be sampled twice annually. In addition, the pattern and types of pesticides used in the area should be considered.
  DAL has developed a water sampling program in which supply authorities are requested to submit two samples a year for chemical and physical analyses. Submission of water samples for pesticide analysis usually occurs at this time.

METHODS

The results of water quality surveillance were obtained from the following available DAL reports: bimonthly microbiological reports, record sheets for annual chemical and physical results by Region, annual pesticide results by Region, and the 1988-1989 and 1990 annual reports. The results presented in this review are for treated water samples only.

The PWD has been receiving water quality data from DAL for more than 20 years, and has computerised the information up to 1990. In addition, the PWD recruits councils on a voluntary basis to report annually on the performance of their water and sewerage systems. In the 1991 NSW Water Supply and Sewerage Performance Comparisons[10], water quality results have been compiled

from information collected on 86 water supply schemes (100 councils). A table from this report summarises the compliance of a sample of rural water supply authorities with current guidelines.

DAL results of water testing and compliance with current water quality guidelines are presented in terms of locations tested, supplies tested or total samples tested. A water supply scheme may serve one or more locations, and locations can be towns, villages or any other settlements.

RESULTS

Microbiological analysis

Between July 1991 and June 1992 DAL received specimens from 352 (73 per cent) of the 481 water supplies throughout NSW[11] (Table 1). Some of the 27 per cent of supplies not tested serve populations greater than 15,000 people.

In addition, many samples failed microbiological standards. In Table 2 the water samples submitted to DAL between 1988-90 and in 1992-93 are summarised by type of analysis and failure rate.

A total of 753 samples (10 per cent) from 313 locations failed during 1992-1993[12]. Of these locations, 195 failed at least once throughout the year; 65 failed twice and 53 failed three or more times. Similar information is not available for 1988-90, due to incompletion of record cards by the submitting water authorities.

Chemical and physical analysis

The proportion of locations tested for chemical and physical analysis has increased from 58 per cent in 1988-89 to 89 per cent in 1992[8,9,13]. During 1992, 39 per cent of samples submitted for chemical/physical analysis failed on at least one parameter[13]. The most common parameters for which samples failed were colour, turbidity, iron, manganese, pH and conductivity. During 1989-90 and 1988-89, the failure rates for chemical and physical analysis were 38 per cent and 51 per cent respectively (Table 2).

Pesticides analysis

The number of locations sampled for pesticide residues and the detection rates are shown in Table 3[14]. In addition to the routine pesticide samples submitted, some PHUs and councils have carried out specific surveys. These survey results are not included in this table.

PWD surveillance

The results obtained from the NSW Water Supply and Sewerage Performance Comparisons[10] from the PWD are presented in Table 4.

DISCUSSION

Microbiology

The results of this review clearly illustrate that a significant number of water supply authorities in rural NSW do not regularly submit samples for water analysis, and that a number of locations fail existing health criteria on a continual basis.

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TABLE 1

LOCATIONS FROM WHICH NO SAMPLES WERE SUBMITTED FOR MICROBIOLOGICAL ANALYSIS, JULY 1991-JUNE 1992

Areas or Regions	Total Number of Locations[a]	Number of Locations not tested (%)
Central Coast Region	32	6 (19%)
Hunter Area	11	4 (36%)
Illawarra Area	34	4 (12%)
Central West Region	70	20 (29%)
South East Region[b]	100	12 (12%)
North Coast Region	80	21 (26%)
New England Region[c]	68	13 (19%)
Orana and Far West Region	86	49 (57%)
Total	481	129 (27%)

Source: DAL, microbiology results.
a. Locations known to DAL.
b. Two councils from the South East Region send water samples to Wagga Wagga Base Hospital for microbiological analysis.
c. Several councils in the New England Region have alternative arrangements for analysis of water samples.

TABLE 2

FAILURE RATE OF SAMPLES SUBMITTED TO DAL 1988-1989 AND 1989-1990[a]

Type of sample		1988-89[b]		1989-90[b]		1992-1993[c]	
		No. of samples tested	Failure rate	No. of samples tested	Failure rate	No. of samples tested	Failure rate
Microbiological (coliforms, faecal coliforms and E. coli)	Public supplies	5,476	31% of samples	5,780	12% of samples	7,440	10% of samples
	Private supplies	324	41% of samples	421	43% of samples	502	44% of samples
	Food processing (TPC, coliforms and E. coli)	374	47%	296	52%	74	41%
Chemical analysis	Public supplies	2,499	51%	2,231	38%		
	Private	453	67%	388	48%		

Sources: Annual reports: 1988-1989; 1990. DAL
a. Failure is defined by DAL as: > 10 coliforms/100 ml of water or any faecal coliforms/100 ml of water.
b. Results obtained from DAL annual reports.
c. Results obtained from bimonthly microbiological reports.

TABLE 3

PESTICIDE MONITORING IN NSW 1990-1992

	1990	1991	1992
Total number of locations[1]	538	542	533
Locations for which samples were not submitted according to the Pesticides Program	40% (215)	28.4% (154)	34.7% (185)
Locations tested twice during the 12-month period	2.8.% (15)	2.8% (15)	8.1% (43)
Locations in which pesticides were detected	1 location Found in trace amounts	1.1% (6) All below guidelines	2.2% (12) Below guidelines or found in trace amounts

Source: DAL Pesticides laboratory
1. Locations may vary due to water supplies becoming operational/non-operational.

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The PWD and DAL use different reporting periods and criteria and so the information is not directly comparable. The PWD program relies on self-reporting of supplies by local councils which may introduce bias. For instance, the PWD compiled data on 55 schemes from the 200 in NSW for 1988.

Failure to comply with microbiological standards for drinking water may have important implications for public health. In the US more waterborne disease outbreaks were reported for the period 1971-1985 than in any 15-year period since 1920, although the incidence of waterborne disease has declined from eight cases per 100,000 during 1920-40 to four cases per 100,000 during 1971-85[16]. The US Centers for Disease Control and Prevention estimates that in the US 900,000 people become sick each year from drinking contaminated water[16].

Despite improvements in epidemiological and microbiological methods, an aetiological agent has not been identified in about half the recent US outbreaks[17]. Since 1971, outbreaks in surface water systems occurred primarily because of inadequate disinfection (13 per cent) or interrupted disinfection (14 per cent), especially in systems that provide disinfection as the only treatment[15]. However, a recent Canadian study showed that even with drinking water which met current guidelines, the rates of gastrointestinal symptoms in people drinking the unfiltered compared with filtered tap water were significantly higher[18]. The supply of water was sourced from sewage-contaminated surface waters. The authors concluded that there is a "non-trivial endemic level of unreported gastrointestinal disease due to the consumption of tap water"[18]. This may be due to the presence of viruses and cysts of pathogenic protozoa such as *Cryptosporidium* and *Giardia* which can survive conventional water treatment. Although protozoan organisms or viruses have been advanced as alternative or additional indicators[19], they are either not available or are too costly to be a practical alternative to the measurement of faecal coliforms.

Despite these problems it is reasonable to assume that the health risk of gastro-intestinal disease is related to how often and by how much the microbiological guidelines are exceeded. Knowledge of the quality of the water source and the treatment methods used may modify these concerns.

TABLE 4

NSW PERFORMANCE INDICATORS FOR 82 WATER SUPPLY SCHEMES

Water quality and treatment % of supplies complying	1988*	1989	1990	1991
Microbiological water quality	85%	85%	90%	90%
Physical water quality	70%	75%	80%	90%
Chemical water quality	70%	80%	80%	85%

* 1988 figures include information from 55 rural water supply schemes[6]
Source: 1991 NSW Water Supply and Sewerage Performance Comparisons

Chemical and physical agents

For chemical analysis, excesses of iron and manganese, and for physical criteria, excesses of colour, turbidity, pH and conductivity, were the most common reasons for failure. These characteristics are generally not a public health risk but do affect the aesthetic quality of water and may cause people to seek drinking water from alternative sources, which may not be as safe.

Manganese and iron contamination stain clothes, and low pH causes corrosion and encrustation to pipework and plumbing fixtures[4,5]. Turbidity, due to particulate matter in the water, can protect microorganisms from disinfection and promote bacterial growth.

Pesticides

The almost complete absence of pesticide residues in tested water should be viewed with some caution. The monitoring program, which tests only once or twice a year, is not specifically tailored to the timing or the type of pesticide used in each area[20].

Furthermore, this evidence stands in contrast to a NSW Water Resources study which found pesticide contamination at all sites tested in the Barwon, Gwydir, Namoi and Macquarie valleys, albeit at extremely low levels[21]. The DAL pesticides laboratory does not have the technology or the resources to screen for all pesticides in use in NSW, but efforts are being made to widen this range.

RECOMMENDATIONS

The following recommendations are proposed in response to the issues presented in this review:

- The establishment of a formal avenue for annual reporting of water quality in NSW by the Health

Department. This is not intended to replace annual reporting conducted by the water authorities. It is recommended that summarised results be published in the *Public Health Bulletin* each year, in a method agreed to by DAL, the Epidemiology Branch and the Public Health Units.

- That computerisation of data by DAL be given high priority.
- A Health Department circular be distributed to water supply authorities, outlining their responsibility to conduct periodic water sampling as a basic public health preventive measure. Emphasis be placed on proper completion of the water sample record cards to ensure all relevant data are collected.
- Water supply authorities be required to assess the long-term performance of their water supplies. This should be conducted on an annual basis in accordance with the guidelines, and the information should be provided to the PHUs.
- Non-compliance of water supplies either on a short-term or long-term basis, requires follow-up investigation by the PHUs.
- Consideration be given by the Public Health Network to the need for gastrointestinal symptom surveys in areas with supplies which regularly fail current microbiological criteria for water quality.
- Enhance communication between DAL, the PHUs and the Public Health Section of the NSW Health Department. PHUs, local councils, PWD and the Department of Agriculture should be requested to provide DAL with an annually updated list of:
  - supplies in each Region, and the number of locations requiring sampling. This will aid DAL in the programming of samples;
  - pesticides used in each Area/Region, giving priority to those most widely used and of greatest toxicity; and
  - annual patterns of pesticide use.
- The pesticide monitoring program be structured to suit patterns of Statewide pesticide use. Another suggestion is to concentrate on Regions supporting the most intense agriculture and to sample these areas more frequently.
- That Environmental Health Officers and/or Food Surveyors investigate the high degree of microbiological non-compliance of water used by food processing manufacturers.
- Review of the water monitoring program take place when the new guidelines are adopted.

1. Public Health Act, 1991. NSW Government. Government Printing Service.
2. Local Government Act, 1993. NSW Government. Government Printing Service.
3. Clean Waters Act, 1970. NSW Government Printing Service.
4. Guidelines for Drinking Water Quality in Australia. 1987 National Health and Medical Research Council, Australian Water Resources Council. Australian Government Publishing Service, Canberra 1987.
5. (Draft) Australian Drinking Water Guidelines. National Health and Medical Research Council, Agricultural and Resource Management Council of Australia and New Zealand. August 1993.
6. Fisher IH, Ho WK, Jenkins TB. NSW State Position Paper on Drinking Water Quality. 1991 *AWWA*.
7. 1991-92 Annual Report. Public Works Department.
8. Annual Report 1988-89. Division of Analytical Laboratories (DAL).
9. Annual Report 1990. Division of Analytical Laboratories.
10. 1991 NSW Water Supply and Sewerage Performance Comparisons. Public Works Department. November 1992.
11. DAL. Report on Water Sample Submissions for Microbiological Monitoring of Public Drinking Water Supplies in Rural NSW during the period July 1991 to June 1992.
12. DAL. Two-Monthly Reports: Microbiological Data.
13. DAL. Chemical and physical data.
14. DAL. Pesticide data.
15. Craun GF. Surface Water Supplies and Health. *AWWA*; Feb 1988.
16. NRDC Report finds Dangerous Leaks in Drinking Water System. *The Nation's Health*. November 1993.
17. Sobsey MD et al. Using a Conceptual Framework for Assessing Risks to Health from Microbes in Drinking Water. *AWWA*, March 1993.
18. Payment P et al. A Randomised Trial to Evaluate the Risk of Gastrointestinal Disease due to Consumption of Drinking Water Meeting Current Microbiological Standards. *Am J of Public Health*, 1991; 81:703-708.
19. Ashbolt NJ and Veal DA. Is the Indicator Dead? Water Microbiology for the 21st Century. September 21-22, 1993, Macquarie University. Australian Environmental Flow Cytometry Group, Macquarie University Centre for Analytical Biotechnology and AWT, Science and Environment.
20. Human Health and Pesticides in Agriculture in NSW: Issues, Programs and Future Directions for Health Workers. Louise Faulkner, Australian Agricultural Health Unit. June 1993.
21. Central and North West Regions Water Quality Program, Report on Pilot Program 1990-91. Department of Water Resources. In Human Health and Pesticides in Agriculture in NSW: Issues, Programs and Future Directions for Health Workers. Louise Faulkner, Australian Agricultural Health Unit. June 1993; p36.