IMPROVED MANAGEMENT OF DRINKING WATER QUALITY

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ABSTRACT

This paper discusses the methods and current practices for improving the management of drinking water quality by water authorities. These methods include risk assessment and the application of alternative principles of management, such as AS4360 (Risk Management), and Hazard Analysis and Critical Control Points (HACCP). HACCP principles have been widely adopted in the food industry and are currently being assessed by the World Health Organisation and the Australian water industry for relevance to drinking water quality management.

The paper outlines:

- the key management requirements for achieving an appropriate level of assurance of drinking water quality;
- the issues and considerations in the practical application of risk management and HACCP principles to drinking water quality management; and
- the process of risk identification and analysis that underpins the good management of drinking water supply systems.

1.0 INTRODUCTION

Following the events in Sydney in 1998, the Australian water industry has realised that mere compliance with numerical guidelines is not sufficient to avoid crises in public confidence in drinking water safety.

Because of this, alternative approaches to water quality management are being considered by the Australian water industry. This paper outlines the current approaches that are being explored by the major urban water authorities, and the issues involved in the practical application of an improved drinking water quality management system.

2.0 SHOULD WATER AUTHORITIES HAVE A DRINKING WATER QUALITY MANAGEMENT SYSTEM?

Water authorities already have a range of management systems in place. These can vary from a formally certified quality management system such as ISO9002, to informal systems with many of the elements of a quality management system, but which do not conform in all respects to the international standard and are not certified.

However, existing quality management systems are often "general purpose" in nature, and are not specifically targeted to address all of the issues that need to be considered for drinking water quality management. A quality management system may, for example, cover a large number of areas, such as financial management, design of treatment systems, maintenance of systems, environmental compliance, and so on.

Drinking water quality management requires consideration of a number of unique and difficult issues to be addressed that are not necessarily be dealt with in sufficient detail by a general purpose quality management system, even if the management system is certified.

The Sydney incident brought this into focus, and it has become apparent that simple compliance with the numerical requirements of the Australian Drinking Water Guidelines, for example, is not sufficient

to provide an assurance of safe water. Further, as analytical methods advance, the industry is moving into a situation where potential problem micro-organisms can be detected, but their significance is not yet able to be assessed. These factors can lead to the situation where the safety of the water is uncertain, and the water authority and its directors may be liable if they cannot readily confirm that the water is in fact safe, and that adequate due diligence can be demonstrated. Establishing and maintaining a comprehensive and verifiable quality management system provides a practical response to this need.

Implementing a drinking water quality management system presents several benefits to a water authority in that it:

- protects public health by assuring safer drinking water for consumers and increases trust and confidence by demonstrating commitment to quality management;
- provides for a systematic, in-depth and holistic evaluation of water supply systems; this in turn provides a better understanding of where water quality problems may potentially arise and where priorities should be placed; and
- places end-product testing in an appropriate quality assurance role while placing more emphasis on prevention rather than corrective action.

3.0 WHAT FORM SHOULD A DRINKING WATER QUALITY MANAGEMENT SYSTEM TAKE?

In order to answer this question it is useful to determine what management issues need to be addressed. The Cooperative Research Centre for Water Quality and Treatment (the CRC) currently has a project underway which has analysed the requirements of the water authorities for drinking water quality management. This work has concluded that the various elements listed in Table 1 are typical requirements, although they may vary depending on the particular situation and requirements of a water authority.

The requirements listed in Table 1 can be satisfied in a number of ways by a water authority:

- Expansion of an existing informal management system to include key elements necessary for water quality management, such as the adoption of risk management principles following AS/NZS 4360 or HACCP.
- Adoption of a formal quality management system based on ISO9001 (or ISO9002), with components specifically targeted to water quality management issues. This system may or may not be certified.
- Adoption of a formal quality management system based on ISO9001 and HACCP principles. This system may or may not be certified. If the HACCP component is to be certified, then development of an appropriate system in conjunction with a certification body will be required.
- Development of a formal quality management system specific to water quality in conjunction with an accreditation body, and adoption of this system. This system may or may not be certified, although if certification were required the system would need to be recognised by a certification body.

All of these options are being explored by the major urban water authorities, and are being considered by NHMRC and ARMCANZ in the revision of the Australian Drinking Water Quality Guidelines.

Table 1: ***Framework for Drinking Water Quality Management***

POLICY

REQUIREMENTS & OBJECTIVES
- Requirements
- Drinking Water Quality Objectives and Targets

ASSESSMENT
(Hazard Identification and Assessment)
- System Analysis
- Hazard Identification and Risk Assessment
- Water Quality Performance Assessment

DRINKING WATER QUALITY MANAGEMENT STRATEGIES
(Risk Management Strategies)
- Preventive Management Strategies
- Improvement Plan

DRINKING WATER QUALITY MANAGEMENT PROGRAMS
(Risk Management Programs)
- General Requirements
  - Operational Procedures and Control Measures
  - Implementation
- Catchment Management Program
- Reservoir Management Program
- Treatment Plant Operation Program
- Storage and Distribution System Program
- Maintenance Program

VERIFICATION
(Monitoring and Surveillance)
- Operational Monitoring (Verification)
- System Performance Monitoring (Validation)
- Investigation and Research Monitoring
- Customer Feedback
- Reliability of Data
  - Sampling Plan
  - Analytical Testing
  - Monitoring Equipment

INCIDENT & EMERGENCY RESPONSE
- Corrective Action
- Incident and Emergency Response

RESEARCH & DEVELOPMENT

EMPLOYEE AWARENESS & TRAINING

COMMUNITY INVOLVEMENT AND EDUCATION
- Community Consultation
- Communication and Reporting

GOVERNMENT LIAISON
- Communication and Reporting
- Regulatory Involvement
- Health Surveillance

PERFORMANCE EVALUATION & CONTINUAL IMPROVEMENT
- Drinking Water Quality Performance Evaluation
- Drinking Water Quality Management System Audit

4.0 SHOULD THE MANAGEMENT SYSTEM BE CERTIFIED?

Certification provides formal recognition that the management system in place in an authority complies with a particular standard. This provides a higher level of assurance that the management system elements necessary for good water quality management are in place, and that the quality of

the water conforms to particular requirements.

Whether a drinking water quality management system should be certified is matter of differing opinion within the industry. The Australian Drinking Water Quality Guidelines are "guidelines" and, as such, can be expected to provide generic guidance. Being only guidelines, they may outline management system requirements in a general way, but are unlikely to stipulate that a drinking water quality management system should be certified.

The larger water authorities that already have a certified quality management system (eg to ISO9001) are likely to be committed to formal quality systems, and are likely to see advantages in seeking a formally certified system.

Smaller water authorities in Australia generally have less formal management systems. The implementation of a formal quality management system and gaining its certification will involve significant effort for these authorities, and may be resisted because of the effort involved.

Because of these factors, it is probably unrealistic to think that the Australian water industry will agree to universal certification, although industry-wide commitments have been made in other industries, such as the Responsible Care initiative for the chemical industry.

Note that it is possible that under the proposed national Food Safety Standards, implementation and some form of external auditing of a water quality management system may be required.

5.0 WHAT WILL IMPLEMENTATION OF A DRINKING WATER QUALITY MANAGEMENT SYSTEM INVOLVE?

Based on our experience in the assessment of the management systems of major urban water authorities, the key requirements will be to:

- Assess the existing management systems against the requirements for good drinking water quality management, such as those outlined in Table 1, to identify gaps.
- Design and implement appropriate systems to fill these gaps.
- Because water authorities have generally focused on compliance with water quality guidelines, the assessment is likely to find that:
- The most important need will be to strengthen the processes of risk identification and management (ie the identification of how water quality problems may arise and then developing an appropriate method to provide control of these problems and assure water quality). This corresponds to the "aspects and impacts" assessment of an Environmental Management System, and can be achieved by implementing the principles of HACCP or a more generic risk management approach such as AS/NZS 4360.
- There are various other gaps where the existing systems can be strengthened and improved. These might include, for example, defining a policy with respect to water quality, defining and strengthening management and staff responsibilities and accountabilities, improving staff training and awareness, implementing an audit program, and so on.

In itself, the assessment and identification of gaps can be carried out quickly, and is unlikely to require a major effort. Filling in the gaps can require more effort, although in practice the work can be expected to be staged and directed towards the most important issues, and is likely to take place over an extended time period.

The important area of risk identification and management is central to water quality assurance, and in our experience is the area where immediate work is required. The process of systematically analysing the water supply systems to identify potential problem areas can be carried out relatively easily, although it can be more complex than it might at first appear. It is important to consider not only the issues that give rise to the water quality problem, but the significance of the water quality problem at the point of use after controls have been applied (such as down stream water treatment). Because a

single issue or event can involve a number of water quality parameters, such as taste and odour, appearance (colour and turbidity), as well as health related indicators, a carefully structured approach is required if confusion is to be avoided.

After identifying potential problem areas, then controls will need to be established. This will include preparing programs and procedures where these are not already in place (such as operating procedures for treatment plants and catchment management programs). Where these are not available this may simply require documentation of procedures that are already known to operators and staff. If the issues are new and have not been previously considered, then more work may be required to develop management strategies and documentation.

6.0 WHAT ARE SOME OF THE KEY ISSUES THAT NEED TO BE RESOLVED?

Providing objective evidence that the problems identified are under control is particularly important. It can be the most difficult aspect of implementing a drinking water quality management system.

The difficulty arises because the events that give rise to the issue are often inherently uncertain and not easily controlled (such as storms and bushfires), and the water quality excursions that arise are also not easily quantified.

In addition, as was the case in Sydney, the water quality parameters may not be easily measured, and criteria corresponding to acceptable water quality may not be specified. This is the case, for example, for the microbial pathogens such as *Cryptosporidium*, but also applies to other parameters such as algae (taste and odour, and toxins). Because of this, the approach taken is to rely on the performance of barriers (such as reservoir aeration, filtration or chlorination), and to use more easily measured parameters (such as aerator power and pressure, turbidity reduction, or chlorine residual) as evidence of control.

This approach can greatly reduce the reliance on treated water monitoring, and is an important aspect which makes the quality management approach attractive. However, even where alternative indicator parameters are used for control purposes, the relationship between the parameter of direct concern (such as the numbers of *Cryptosporidium* per litre in the treated water), the indicator parameter (such as the reduction in particle numbers), and the upstream water quality (eg numbers of *Cryptosporidium* per litre in the raw water) still needs to be established. Without this relationship and knowledge, it is difficult to provide objective evidence of drinking water safety.

This is an area that will take some effort to resolve, and is a key area that is being addressed in the current project in the CRC on drinking water quality management systems.

7.0 DIRECTIONS IN THE WATER INDUSTRY

Water authorities are commencing to examine their particular water supply systems with the objectives of determining where their existing management systems may not comply with the requirements for good drinking water quality management (such as those outlined in Table 1).

They are also determining the implications to the organisation if the principles of HACCP were to be adopted, carrying out a structured process to identify where potential water quality problems could arise, and identifying the requirements for avoiding and managing these problems.

It can be expected from this work that it will be found that most of the requirements for good water quality management will be in place, although it is likely to be found that there are particular areas where the hazard identification and risk management processes can be strengthened. A structured hazard identification program can be expected to indicate some areas where there are is potential for water quality problems to arise, although based on experience with the major urban water authorities in Australia, the water quality is known to be good and there is certainly no indication of illness in the

community. In practice, the main issues can be expected to be areas of uncertainty where it is difficult to formally prove that the water is safe, and uncertainty regarding the potential for particular events to occur which could give rise to unacceptable water quality and customer complaint. These conclusions can apply even where a formal quality management system is in place, as such management systems are not necessarily directed to providing assurance regarding the detail of water quality management.

The work can be expected to generally reinforce the need to adopt a more holistic management approach, from the catchment to tap, with improved single point accountability.

8.0 CONCLUSIONS

Water authorities have taken up the water quality challenge posed by the Sydney incident, and are exploring the application of a quality management approach to drinking water quality management. The approach being given most consideration is to adopt a quality management system based on ISO9001, and to ensure that this includes all of the key elements that are necessary for good water quality management.

The processes of risk identification and control require particular attention. ISO 9001 does not provide guidance on these aspects of water quality management, and it can be neglected in the normal application of the standard. Water authorities and NHMRC/ARMCANZ are considering the application of risk management principles (such as AS/NZS 4360) and HACCP principles, as these provide more guidance on how these issues can be addressed.

While these new approaches will rely more on monitoring of indicators of the performance of barriers to contamination (such as filtration and chlorination) than direct monitoring of treated water, the requirement to validate the performance of these barriers in producing acceptable quality treated water will always remain.

Water authorities are actively advancing this new approach, and it can be expected that this will lead to improvements in water quality management and, in particular, the ability of the water authorities in being able to provide a higher level of assurance of drinking water safety.