

**Guidelines for  
Implementing Total Management Planning**

**Asset Management**

**DRINKING WATER QUALITY MANAGEMENT  
Implementation Guide**



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## LIST OF ACRONYMS

ADWG	Australian Drinking Water Guidelines (1996)
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
CCP	critical control point
DLGP	Department Local Government and Planning, Queensland
DNR	Department of Natural Resources, Queensland (now Department of Natural Resources and Mines (NR&M))
DWQMP	Drinking Water Quality Management Plan
EPA	Queensland Environment Protection Agency
KPI	key performance indicator
NHMRC	National Health and Medical Research Council
NR&M	Department of Natural Resources and Mines, Queensland
QH	Queensland Department of Health
TMP	Total Management Plan
WSP	Water Service Provider

## 1 PURPOSE

This guide is intended to provide guidance for water service provider (WSP) practitioners and their consultants on the processes involved in establishing and implementing effective drinking quality management strategies and procedures and developing associated documentation.

## 2 OUTCOMES

An effective water quality management strategy will ensure:

- the protection of public health by assuring a safer water supply;
- improved consumer confidence in water quality and trust of the water service provider;
- improved communication with consumers and employees;
- better-informed consumers and employees;
- demonstrated commitment by the WSP to a quality management system, to demonstrate due diligence; and
- clearly defined levels of service and performance indicators.

## 3 OUTPUTS

Outputs from the water quality management process include:

- Drinking Water Quality Management Plan (TMP sub-plan);
- documented risk assessment based analysis of the water supply system;
- detailed, documented supporting procedures for:
  - operation and management;
  - data recording and analysis systems; and
  - monitoring protocols.

## 4 BACKGROUND

Currently in Queensland there is no specific statutory requirement for WSPs to provide drinking water of a prescribed quality. However, WSPs should be aware of their potential liability under common law in the event of the water they supply causing harm or illness. Consumers are increasingly demanding more accountability and improved levels of service with respect to the quality and safety of their water supply.

A rigorously developed and implemented Drinking Water Quality Management Plan (DWQMP) will make it possible for a WSP to demonstrate due diligence, and more confidently meet the required levels of service relating to drinking water quality. This will result in improved consumer confidence in the WSP.

Monitoring of water for compliance against guideline values is not sufficient to guarantee the quality and safety of water if no corrective action is taken until guideline values are exceeded. Neither is it an effective response to contaminants for which there are no guideline values (e.g. *Cryptosporidium*, algal toxins). The industry trend is towards a preventive 'catchment to tap' risk-based management approach as the primary means of protecting public health. In this context monitoring is an important component of system management; it provides verification that the systems and processes are effective and reliable and that the quality of water provided meets defined levels of service.

The Australian Drinking Water Guidelines of 1996 (ADWG) are currently being revised. As part of this rolling revision a risk management-based Framework for Management of Drinking Water Quality is being developed; a public consultation document was released in May 2001 by the NHMRC/ARMCANZ coordinating group.

## 5 THE DRINKING WATER QUALITY MANAGEMENT PLAN

The following section highlights the key issues that should be considered when developing a DWQMP. The document, *Framework for Management of Drinking Water Quality*, should be consulted for more detailed discussion and guidance on the process (see References).

The key elements that should be considered for inclusion in a DWQMP are:

- drinking water quality policy;
- system management plans;
- system monitoring;
- contingency plans;
- documentation and reporting;
- performance evaluation, review and continual improvement; and
- community involvement and awareness.

While the key elements are discussed separately, they should form an integrated plan with links to other sub-plans developed under the TMP process (i.e. Water Source Management, Operations Management, Maintenance Management, Service Standards, Performance Management and Risk Management). The proposed process should not be seen as exhaustive or prescriptive. The components of a plan and the level of detail will vary according to the size and complexity of a water supply system (Table A). Some WSPs may develop a stand-alone DWQMP, while others may integrate it with an existing management system. Some WSPs already practise many of the principles and elements discussed. All they may need to do is review, formalise and document their practices.

A commitment to gaining the cooperation of employees and the community is essential. The knowledge, skills and motivation of employees and contractors ultimately determine how well the water supply system operates. Community consultation, involvement and awareness can have a major impact on public confidence in the water supply and a WSP's reputation. Several aspects of drinking water quality management require commitment from and involvement with other stakeholders (e.g. QH, NR&M, EPA, other local governments, catchment management groups, landholders).

A DWQMP should cover all components of the water supply system where quality can be affected, from source to consumer including:

- catchments, including groundwater systems;
- source water;
- storage reservoirs, intakes and bulk transport;
- treatment systems;
- service reservoirs and distribution system; and
- consumer components (plumbing, water demand, type) .

### 5.1 Drinking water quality policy

The policy should clearly define the commitment of the WSP in relation to drinking water quality management and should address issues such as:

- the quality of water to be provided to consumers (level of service), how this was determined and how it is to be achieved;
- level of compliance with relevant drinking water criteria (e.g. ADWG, including updates, or alternative criteria that might be used);
- liaison with relevant agencies and other stakeholders (e.g. Queensland Health (QH), NR&M, EPA, other local governments, catchment management groups, landholders);
- consultation and communication with the community (e.g. domestic and industry consumers, plumbers);
- communication with and involvement of employees;
- intention to adopt best practice management and multiple barriers; and
- continual improvement in the management of drinking water quality.

The water quality goals should be realistic in terms of the source water quality (including degree of catchment protection), level of treatment, history of the distribution system, identified significant hazards and cost. Where a supply cannot meet the health criteria of the ADWG, consultation with Queensland Health is essential.

## **5.2 Water supply system assessment**

It is vital to have a thorough understanding of the existing system from source to consumer, and of factors that influence the reliability of the system and water quality. Without this understanding it is impossible to effectively identify hazards, assess risks or develop preventive management strategies, improvement plans, monitoring plans and contingency plans.

Key aspects of the assessment are:

- system analysis, including water quality review; and
- hazard identification and risk assessment.

### **System analysis**

The purpose of system analysis is to describe the existing system and understand how it works. Issues to address include:

- identification of factors likely to affect water quality for each component of the system;
- a detailed water quality review (historical data, existing data) to assess:
  - source water characteristics (physical, chemical, microbiological, radiological) including seasonal and event-related effects on quality (e.g. high rainfall, drought, flood);
  - effectiveness of existing management and treatment barriers at preventing contaminants reaching the consumer; and
- baseline/investigative monitoring program to provide missing information if required.

This is not a one-off exercise but should be undertaken periodically to take account of changes such as catchment activities, treatment processes, organisational changes or legislation.

### **Hazard identification and risk assessment**

This process normally includes the involvement of key stakeholders and experts, and a number of workshops. Steps involved in the process include:

- determining the key stakeholders;
- determining the methodology to identify hazards and quantify risk (tools, techniques);
- defining the scope of the analysis with respect to the nature of risks being considered (human health impacts, aesthetics, customer service and public image, due diligence);
- identifying and documenting all potential hazards (agents, events, scenarios) likely to affect water quality for each component of the system from source to tap, including those not under the direct control of the WSP;
- estimating the level of risk for each hazard; and
- ranking the risks to determine priorities for risk management action.

## **5.3 System management plans**

The identification and implementation of preventive strategies that eliminate hazards or reduce their impact to acceptable levels is an essential component of effective drinking water quality management. Preventive strategies should be based on the concept of using multiple barriers to reduce exposure to hazards applied at critical control points. The strategies should wherever possible address prevention at the source (or as close to the source as possible) rather than relying on downstream control.

Traditional barriers include:

- catchment management and water quality protection at the water source;
- detention in protected storages;
- extraction management;
- treatment processes;
- disinfection, including maintaining adequate disinfectant residual in distribution systems; and
- maintenance of the distribution system and protective measures against water contamination.

Critical control points (CCPs) are those activities and processes that are essential for the control of water quality. These are operational control points at which a potential hazard can be prevented or reduced to an acceptable level. CCPs are characterised by the following:

- They can be monitored either by cost-effective procedures or by adherence to operational procedures and inspections.
- They verify performance and trigger immediate corrective actions.
- There is effective control to change or modify the activity or process.

Detailed and documented management plans should be developed for each component of the system and should address:

- strategies to prevent or minimise the risk from each of the identified significant hazards;
- specific operational procedures;
- control measures;
- monitoring protocols, particularly at CCPs (see Section 5.4, 'System monitoring');
- data and records management;
- corrective action procedures triggered by sub-optimal performance;
- maintenance programs;
- resource requirements (financial, human, expertise, physical);
- clearly defined responsibilities and chains of command;
- communication and internal/external reporting requirements;
- procedures for review of plans;
- liaison with other stakeholders (e.g. QH, NR&M, EPA, DLGP, other local governments, land use planners); and
- skills and training of operations staff;

## 5.4 System monitoring

Monitoring provides information on system performance and verification of the quality of water supplied to consumers. It includes analytical testing and observational monitoring such as inspections.

A monitoring plan should address the following:

- **Operational monitoring:** confirms status of operational processes and activities and serves as a trigger for corrective action.
- **Verification monitoring:** assessment of water quality within distribution system as final check that barriers and preventive measures are working effectively; can also serve as a trigger for short-term corrective action (e.g. if high bacterial counts are recorded).
- **Consumer satisfaction.**
- **Resources and responsibilities:**
  - what and where to monitor (consider the need for monitoring zones in large complex systems);
  - when and how often;
  - methods to be used (continuous on-line, laboratory);
  - what is done with results — recording, reporting, triggers for corrective action;
  - who is responsible for the various activities.

- **Reliability of data:** data must be representative, reliable and valid. The following should be considered:
  - monitoring equipment and on-line analysers — accuracy in required reporting range, calibration and inspection procedures, who is responsible;
  - sampling:
    - training of all personnel involved;
    - use of approved sampling methods and techniques including suitable equipment; and
    - quality assurance and validation of procedures; and
  - analytical testing:
    - qualifications and training of personnel;
    - approved test methods and laboratories;
    - quality assurance and validation procedures; and
    - external accreditation (e.g. testing facility registered with Nation Association of Testing Authorities Australia).

## 5.5 Contingency plans

Contingency plans cover the more extreme incidents or emergencies such as:

- major equipment breakdown and mechanical failure, prolonged power outages (minor operational failures would be addressed under system management plans);
- extreme weather events and natural disasters (e.g. cyclones, fire, flooding, earthquake);
- vandalism and sabotage; and
- accidental contamination events (e.g. chemical spills in catchment or water source, significant treatment failure).

Documented plans should be developed in advance, in liaison with relevant agencies (e.g. Emergency Services, Queensland Health) and address:

- responsibilities and authorities, both internal and for external agencies;
- notification procedures;
- response actions;
- emergency water supply options;
- communication protocols (agencies, media, public); and
- requirements for increased health surveillance and monitoring.

Emergency response training should be undertaken. Plans should be evaluated and updated following any real emergency situation.

## 5.6 Documentation and reporting

Documentation and reporting is fundamental to a quality management system. Appropriate rigorous documentation may be used to demonstrate accountability and establish due diligence and credibility. It serves as a reference for the development and implementation of the DWQMP, enables evaluation and provides a basis for negotiation and communication with stakeholders.

Requirements include:

- documented system management plans, operational procedures, procedures for information collection and assessment, management, monitoring and reporting and communication;
- systems to record results of all operational and compliance monitoring and other relevant information, allowing for easy access, review and analysis of data; and

- reporting procedures for:
  - internal purposes:
    - operational
    - performance;
  - external purposes:
    - consumers (e.g. annual report on performance against water quality goals and significant operational issues);
    - Government (e.g. health-related event or exception reports to Queensland Health); and
    - Compliance with regulatory requirements.

## 5.7 Evaluation and improvement plan

Long-term evaluation is required to ensure that preventive strategies are appropriate and effective. Ongoing commitment and improvement are critical to the operation of a quality system. Evaluation should cover the following:

- **Drinking water quality:** This should be evaluated on a long-term basis (normally 12 months) to assess overall performance against water quality goals, identify emerging problems and trends and determine priorities for water quality improvement.
- **DWQMP:** Should be reviewed to validate the appropriateness of the plan with respect to possible changes in significant hazards and operational environments, customer expectations and changing regulatory requirements. A schedule and process for review should be defined, and it should include significant occurrences likely to trigger the need for a review outside the defined schedule.
- **Audit:** WSPs should also seek to establish an independent external auditing procedure for their DWQMP. This provides added rigour for demonstration of due diligence.
- **Improvement plan:** This should outline the proposed time schedule and methodology for addressing improvements identified by the management planning process. Some improvements will require staged implementation (e.g. upgrading treatment plant and processes). Issues should be prioritised, and potential limiting factors identified (e.g. resources, cost).

## 5.8 Community involvement and awareness

Community awareness, and involvement of the community in the development of the DWQMP, can be very beneficial in terms of people's confidence in water quality and trust in the water service provider. Awareness and education programs need to be developed to allow for meaningful consultation with a well-informed community.

Community and industry sector involvement should be sought during decision-making processes, particularly those related to levels of service, existing water quality problems, costs, improvement programs and the timeframe for achieving them. The community must understand the options in terms of risk and cost, and appreciate that they will need to meet the cost of water supplied at a particular level of quality and reliability.

Management of public communication is particularly critical in the event of an emergency.

Processes for active two-way communication with consumers should be developed.

Refer to the *Framework for Management of Drinking Water Quality* (see Section 5) and the Service Standards Implementation Guide, Section 7, 'Consulting customers', for further guidance.

## 6 RISK ISSUES

A detailed list of potential hazards for all components of the water supply system is given in the *Framework for Management of Drinking Water Quality* (see Section 5).

Potential risk issues associated with drinking water quality management include:

- public health risks;
- non-compliance with water quality goals (service standards);
- customer complaints;
- inadequate commitment to drinking water quality management;
- lack of public confidence in water supply and WSP;
- sub-optimal operational practices;
- inadequate customer/community consultation;
- inadequate resources (financial and physical);
- inadequate emergency response;
- inadequate expertise and experience; and
- inability to demonstrate credibility and due diligence.

## 7 TMP REQUIREMENTS

Each WSP's Total Management Plan (TMP) should include an outline of key issues and identified strategies addressing these issues for the WSP's services in respect of drinking water quality management. Appendix A provides indicative content and appropriate TMP development level for this sub-plan.

A hierarchy has been established to define the level to which a WSP should develop its plan under total management planning. This is discussed in more detail in the TMP Development Guide. The development level depends on the size of the WSP (in terms of the replacement cost of its assets).

## REFERENCES AND FURTHER READING

*Australian Drinking Water Guidelines*, National Health and Medical Research Council and Agricultural and Resource Management Council of Australia and New Zealand, Canberra, 1996.

*Cryptosporidium and Giardia in Drinking Water. Interim Management and Response Protocol*, Queensland Health, Brisbane, 1998.

*Framework for Management of Drinking Water Quality: a Preventative Strategy from Catchment to Consumer*, (Public consultation document), National Health and Medical Research Council and Agricultural and Resource Management Council of Australia and New Zealand, Canberra, May 2001.

*Guidelines for Planning and Design of Urban Water Supply Schemes*, Queensland Water Resources, Brisbane, 1989 (DNR TB No 3/1997), Department of Natural Resources, Brisbane, 1997.

## APPENDIX A: Content and development level of sub-plan

TABLE 1: Indicative sub-plan content

Sub-plan features	Drinking Water Quality Management Plan content
Issues covered in sub-plan	<ul style="list-style-type: none"> <li>▪ Drinking water quality policy.</li> <li>▪ Water supply system assessment.</li> <li>▪ System management.</li> <li>▪ System and water quality monitoring.</li> <li>▪ Contingency plans.</li> <li>▪ Documentation and reporting.</li> <li>▪ Evaluation and improvement plan .</li> <li>▪ Community involvement and awareness.</li> </ul>
Purpose of plan	<ul style="list-style-type: none"> <li>▪ To provide an overview of the current practices in managing drinking water quality.</li> <li>▪ To outline the future objectives and initiatives for ensuring drinking water quality.</li> </ul>
Policies that may be required	<ul style="list-style-type: none"> <li>▪ Drinking water quality.</li> <li>▪ Customer and community consultation.</li> </ul>
Other Total Management Plan elements that are intimately linked to this sub-plan	<ul style="list-style-type: none"> <li>▪ Service Standards Plan: defined water quality levels of service and performance indicators.</li> <li>▪ Risk Management Plan: identifies critical activities and processes and acceptable levels of control for a preventive approach to water quality management.</li> <li>▪ Water Source Management Plan: minimises water quality deterioration at source.</li> <li>▪ Operations Management Plan: ensures system management will facilitate compliance with water quality goals.</li> <li>▪ Maintenance Management Plan: reliable assets in good condition essential to meeting water quality goals.</li> <li>▪ Performance Management Plan: ongoing evaluation and improvement.</li> </ul>
External issues contributing to the current operating environment that need to be considered	<ul style="list-style-type: none"> <li>▪ Development of risk-based framework for drinking water quality management, since Australian Drinking Water Guidelines recommend preventive risk-based system management approach.</li> <li>▪ Best-practice system management and monitoring. Regular public health incidents involving microbial contamination highlight the importance of such an approach.</li> <li>▪ Preventive ‘catchment to tap’ risk-based management approach as primary means of protecting public health.</li> <li>▪ There is potential liability under common law should water supplied cause harm or illness.</li> </ul>
Issues that need to be considered in summarising the status of current operations	<ul style="list-style-type: none"> <li>▪ Description of water supply system ‘catchment to tap’.</li> <li>▪ Status of system and water quality monitoring programs.</li> <li>▪ Compliance with service standards on drinking water quality and with Australian Drinking Water Guidelines.</li> <li>▪ Status of operational plans.</li> <li>▪ Status of system management for preventing contamination (sanitary surveys; backflow prevention, contingency plans); cross-referencing to Risk Management Plan.</li> <li>▪ History of water quality-related complaints.</li> <li>▪ Hazard identification and risk analysis.</li> </ul>

Sub-plan features	Drinking Water Quality Management Plan content
Strategic basis of the plan	<p>The strategic elements forming the basis of the plan should include:</p> <ul style="list-style-type: none"> <li>▪ goal for water quality;</li> <li>▪ objective(s) for drinking water quality management;</li> <li>▪ adopted KPIs; and</li> <li>▪ management strategies and performance targets.</li> </ul> <p>The management strategies developed will be based on the identified key strategic issues and risk assessment in respect of drinking water quality management, and on the required TMP development level.</p> <p>Many WSPs are likely to require strategies for establishing/reviewing appropriate water quality monitoring programs; developing systematic operational and management plans for critical procedures; establishing standing audit protocols; and maintaining contingency plans.</p> <p>The strategies should be supported by detailed action plans covering a period of up to 3 years.</p>
Suggested performance measures	<p><b>Outcome:</b> Compliance with defined water quality goals.</p> <p><b>Output:</b> Percentage of samples that meet defined water quality criteria.</p> <p>Number of water quality complaints.</p> <p>Number of significant water quality incidents.</p>
Supporting documentation	<p>This will depend on the WSP, but typically would include:</p> <ul style="list-style-type: none"> <li>▪ drinking water quality policy;</li> <li>▪ water quality/system review reports (internal, external);</li> <li>▪ risk assessment of system with respect to water quality;</li> <li>▪ system management and operational plans;</li> <li>▪ monitoring and data handling protocols;</li> <li>▪ current contingency plan(s);</li> <li>▪ evaluation and audit protocols; and</li> <li>▪ improvement plan.</li> </ul>

TABLE 2: Required sub-plan development level

Development level <sup>1</sup>	Target management mechanisms of Drinking Water Quality Management Plan
3	<ul style="list-style-type: none"> <li>▪ Defined water quality policy, including water quality goals and levels of service</li> <li>▪ System management plan (preventive strategies and control measures, operational and maintenance programs) for all components of the system ‘from catchment to tap’.</li> <li>▪ System monitoring protocols (operational and performance) included in the management plan.</li> <li>▪ Contingency plan (corrective action plans, incident and emergency plans).</li> <li>▪ Appropriate methods for performance assessment and reporting included in the plan.</li> <li>▪ Appropriate improvement plan.</li> </ul>
2	<ul style="list-style-type: none"> <li>▪ Defined water quality policy, including water quality goals and levels of service,</li> <li>▪ System management plan (preventive strategies and control measures, operational and maintenance programs) for all components of the system ‘from catchment to tap’.</li> <li>▪ System monitoring protocols (operational and performance) included in the management plan.</li> <li>▪ Contingency plan (corrective action plans, incident and emergency plans).</li> <li>▪ Appropriate methods for performance assessment and reporting included in the plan.</li> <li>▪ Appropriate improvement plan.</li> </ul>
1	<ul style="list-style-type: none"> <li>▪ Defined water quality goals.</li> <li>▪ Documented ‘catchment to tap’ system management protocols (inspections, maintenance).</li> <li>▪ Appropriate monitoring program.</li> <li>▪ Appropriate contingency plan.</li> <li>▪ Appropriate methods for performance assessment and reporting.</li> <li>▪ Appropriate improvement plan.</li> </ul>

<sup>1</sup> Defined in Section 4.2 of TMP Development Guide.