Rationalising the Water Quality Monitoring Program for WSPs

Introduction

WSPs have had drinking water quality management plans (DWQMP) in place for many years with most having completed at least one round of reviews and audits. Under these plans, a WSP will conduct both an operational and verification monitoring program, with outcomes reported annually to DNRME. However, there may be situations in which the approved monitoring programs may be overly cautious when compared with the risk to public health, and anecdotally, consultants responsible for the original plans may have developed programs based on a standard list rather than a true analysis of catchment characteristics, networks and related risks, with some potential identified issues as follows:

- The risk assessment process has been inconsistent across the state.
- Some DWQMP were prepared in house by councils, some by consultants.
- Adjacent WSPs may have different reporting requirements.
- Some may be spending too much on analysis to manage essentially no risk.

The process for undertaking a risk assessment of a DWQMP has been described in several documents, including the recently updated Good Practice Guide to the Operation of Drinking Water Supply Systems[1] and the 2018 update to the Australian Drinking Water Guidelines (ADWG) National Water Quality Management Strategy[2].

These documents highlight a wholistic approach to the management of drinking water quality that is best described as a "catchment-to-consumer risk-based approach" to the production of safe drinking water.

The ADWG provides a Framework for the management of drinking water quality that includes a comprehensive outline of the process of water supply system analysis[3]. In summary:

> *The drinking water supply system is defined as everything from the point of collection of water to the consumer and can include:*
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> *• catchments, including groundwater systems;*
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> *• source waters;*
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> *• storage reservoirs and intakes;*
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> *• treatment systems;*
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> *• service reservoirs and distribution systems;*
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> *• consumers.*

[1] Water Research Australia Limited (2020) Good Practice Guide to the Operation of Drinking Water Supply Systems for the Management of Microbial Risk, Second Edition Final Report Project 1117 ISBN 978-1-921732-55-3

[2] NHMRC, NRMMC (2011) Australian Drinking Water Guidelines Paper 6 National Water Quality Management Strategy Version 3.5 Updated August 2018. National Health and Medical Research Council, National Resource Management Ministerial Council, Commonwealth of Australia, Canberra.

[3] Chapter 3.2 of NHMRC, NRMMC (2011) Australian Drinking Water Guidelines Paper 6 National Water Quality Management Strategy

One important component of the water supply system analysis is that it is periodically reviewed. This is a recognition that drinking water supply systems are dynamic, and that there may be both long- and short-term changes to a drinking water supply system that may impact the effectiveness of the management strategy and monitoring regime. A review would assess the existing (DWQMP) identified hazards for the catchment to ensure that no additional hazards can be identified, including potential changes to land use in the existing water source catchments (including shallow groundwater, if relevant), and similarly, review the existing (DWQMP) identification of potential water quality impacts associated with hazardous events to ensure that no additional hazards can be identified. Changes to water supply catchments in particular are generally beyond the direct control of the WSP, and as such should be reviewed regularly.

Changes to the catchment can be varied and may including the following, along with their potential WQ impacts:

Drought[4]

- May result in loss (or reversal) of stream flows.
- Elevated water temperatures resulting in higher biological activity and increased chlorine demand.
- Alternative water sources may be called into service (e.g. new bores, carted water).
- Higher temperatures may result in higher nutrient concentrations, leading to algae and cyanobacteria blooms.
- Decreased reservoir volume can lead to higher salinity, higher DOC, higher turbidity, increased animal and bird activity around reservoirs resulting in higher erosion, E.coli, pathogens.
- Decreased reservoir volume also leads to greater relative proportions from WWTP effluents in water sources, increased relative trace chemicals, possible temperature stratification and anoxic conditions.
- Lower groundwater recharge coupled with increased abstraction of groundwater sources.

Flood[4]

- Will result in erosion leading to higher sediment loads and TOC.
- Damaged pumps and potentially submerged WWTPs will have impacts on source waters, potentially increased turbidity and colour (organic and inorganic), increased pathogens, nutrients, DOC.

Bushfire[4]

- Loss of vegetation in catchment results in higher erosion leading to sediment, OC and nutrient (P) mobilisation.
- Damage to soils may result in slow recovery of vegetation and long-term impacts on source waters.
- Ash and silt runoff leads to increased DOC, colour, turbidity, nutrients, metals: increased aerobic metabolic activity leads to lower DO.
- Pathogens from dead animals in catchment runoff.
- Fire retardants applied to catchments.

Land clearing within the catchment

- Loss of vegetation in catchment results in higher erosion leading to sediment, OC and nutrient (P) mobilisation.
- Increased runoff may lead to reduced groundwater replenishment.
- Removal of trees causes disruption of aquitards to shallow groundwater aquifers (refer Case Study 1).

Changes in land use

- Development of previously undeveloped land areas increased runoff, and potential for contaminants entering the waterway (hydrocarbons, metals).

[4] Stuart Khan, Ben Stanford, Ben Wright, Jan Routt & Jean Debroux (2011) Water Quality Impacts of Extreme Weather Events. https://www.lgnsw.org.au/files/imce-uploads/48/1_Stuart_Khan_24July_11.40am.pdf

- Unlicensed landfills may have been added to the catchment resulting in contaminants entering the waterways/groundwater (hydrocarbons, heavy metals, pathogens).
- Land has been cleared for farming, which may result in runoff containing pesticides, herbicides and hydrocarbons.

Changes to abstraction rates (for groundwater)

- Increased abstraction rates due to increased or new demands (drought/urban development) can expand the cone of depression of local groundwater, drawing water from more distant sources that have untested groundwater quality.
- Increase abstraction rates may exceed the yield of certain aquifers accessed by a groundwater bore, resulting in reduced dilution of other water sources (refer Case Study 2).

If it has been confirmed that none of these changes have taken place, it is reasonable to assume that the existing DWQMP is adequately managing the catchment risk of the drinking water system.

Case study 1: Havelock North campylobacteriosis outbreak[5]:

In August 2016 a waterborne disease outbreak of gastroenteritis occurred in the town of Havelock North in the Hawkes Bay region of the North Island of New Zealand. Of the town's 14,000 residents 5500 were estimated to have become ill with campylobacteriosis, and 45 subsequently hospitalised. It is possible that the outbreak contributed to four deaths, and a number continue to suffer health complications.

Contaminated drinking water was the source of the outbreak with sheep faeces the likely source of the campylobacter. The root cause is likely to be heavy rain that inundated paddocks and caused contaminated water to flow into a pond about 90 metres from a supply bore. This water entered the aquifer from which the bore abstracts, and the well pump conveyed the contamination into the reticulation. Subsequent analysis of the catchment for the bore suggested that the clearing of trees in the vicinity of the pond disrupted the impermeable barrier at the top of the aquifer, permitting the free flow of contaminated water into the shallow aquifer. The land clearing had taken place several years prior to the event, but the unusually heavy rainfall caused the flushing of contaminated runoff water into pond and from there into the water system.

Case study 2: Reduced yield from a groundwater bore

The water service provider for *Rural Regional Council* has a bore that supplies a remote urban development. The bore is screened at multiple depths to intercept a combination of shallow and deeper aquifers. The historical data for the bore has never provided radionuclide detections. The ADWG suggest that the frequency of radiological screening of drinking water is quarterly for the first year and then every 2 years subsequently for groundwater. The last test conducted 18 months ago was below the detection limit.

The region has experienced a period of below average rainfall that has resulted in the reduction of recharge to some aquifers, coupled with an increase in total abstraction of water for residential use due to the local dry conditions. At the same time the yield of the bore has decreased.

[5] Taken from https://watersource.awa.asn.au/community/public-health/lessons-from-nzs-2016-havelock-north-water-supply-outbreak/

In response to the declining yield the water manager directed a comprehensive analysis of the raw bore water which shows that radionuclides along with other manganese and sulfide have been detected in the source water and have exceeded the guideline values.

Further testing of the bore indicates that one of the shallow aquifers intercepted by the bore has dried up, and a deeper aquifer is now supplying the bulk of the water to the bore, and the lack of dilution with the shallow aquifer water has resulted in the detection of radionuclides sourced from the deeper aquifer.

Rationalising the WQ testing program

Once an assessment of the catchment risk has been undertaken, it is reasonable to assume that the approved DWQMP was based on a robust and rigorous review of the water supply system.

Where there is a good history of water quality analyses with high level of data integrity for a catchment or a water source, a case can be made for rationalising the monitoring program without increasing the risk to health.

Dr Peter Mosse conducted an analysis of two particular WSPs in Western Queensland, and in doing so, provided the following argument for a rationalised approach to water quality monitoring (based on a 2016 WHO workshop paper):

- There are only a few (chemical) substances that have been proven to cause adverse effects through drinking water.
- These almost invariably require long term exposure to high levels to cause health effects.
- Monitoring requires significant resources, and thus is it is important to wisely use available resources to prioritise the parameters for health.
- In choosing which parameters to measure, there is a need to consider:
    - What are the important parameters from the catchment (source water), treatment and distribution?
    - If there is only periodic or intermittent presence of substances of concern, then sampling should be targeted to when they are present.
- There is no point monitoring substances if they are not there, or only at very low concentrations well below standards (<50%).

In Mosse's analysis the rationale for including an inorganic chemical for future ongoing monitoring in the raw water was made using two criteria[6]..

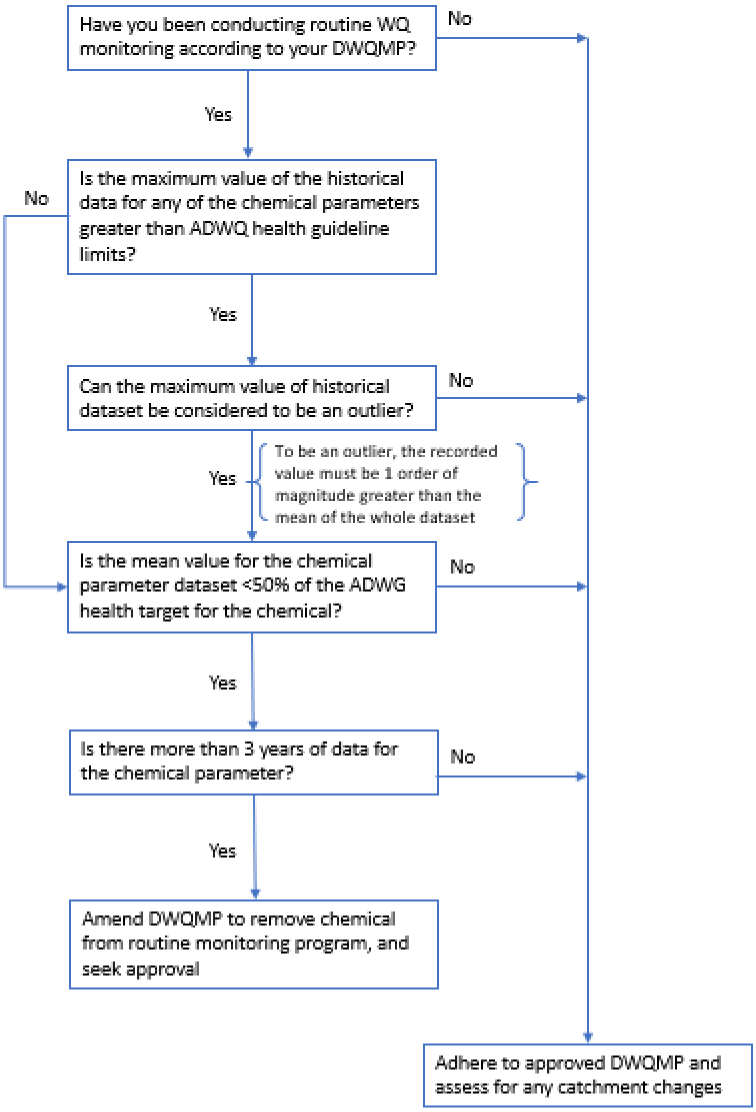
1. A full list of inorganic chemicals with health limits were extracted from the ADWG. Maximum values for each of the chemicals in the historic monitoring data from the water were compared with the health limits. If the maximum value was considered to be a possible outlier (1 order of magnitude greater than the mean) the mean value was used for the comparison. Where the maximum value for the particular chemical was >50% of the ADWG health target the chemical was flagged for ongoing monitoring.
2. If the compared value was <50% of the ADWG health limit and there was annual data for 3 separate years, that chemical was removed from the monitoring suite. While the WHO document provides no guidance on the amount of data required to make such a decision, the requirement for 3 years data was based on a simple principle used in experimental science and experimental design that requires a bare minimum of 3 replicates for any experiment.

[6] Peter Mosse (2016) Rationalised Chemical Monitoring Program, Diamantina Shire Council.

While Mosse's review was targeted specifically at the inorganic water quality analytes, a similar argument could be made for other parameters that typically require quarterly or annual monitoring[7], such as pesticides and organic toxicants and radionuclides.

A flowchart of the decision-making process is provided in Figure 1.

Figure 1: Decision tree for rationalising monitoring of inorganics, pesticides and organic toxicants and radionuclides.



[7] ADWG (2011) Version 3.5 Chapter 9, Table 9.5