SUBMISSION TO ESSENTIAL SERVICES COMMISSION REVIEW OF WATER PERFORMANCE REPORT INDICATORS

While security of water supply is important, protection of public health is paramount. Extensive waterborne illnesses have occurred in Western countries e.g. Milwaukee 1993, Gideon 1993, Walkerton 2000; more recently Nokia 2007, Pitsford 2008, and most recently in Ostersund 2010. There have also been near misses in Australia, notably Sydney 1998 and Port Douglas 2008.

Professor Don Bursill, long time Chairman of the NHMRC WQAC and Head of the CRC for Water Quality and Treatment for many years, in his foreword to the series of books on water treatment published by the Water Industry Operators Association of Australia (WIOA) wrote:

> *The provision of water services to communities in developed countries has been the single most important development in improving public health at the population level. It has been much more significant than any other factor, notwithstanding the improvements in medical science over the past 100 years. It is also true that lapses in the operation and maintenance of water and waste water treatment facilities and the associated distribution networks have resulted in illness and deaths in affluent societies. If one looks at significant water quality incidents that occur in developed countries, the problems are usually due to the lack of adequate professionalism on the part of management, regulators and/or operational staff, rather than any basic inadequacy of the infrastructure involved.*

Hrudey and Hrudey (2004) and others have shown that pathogens are the major hazard in water treatment (including the distribution of water), and that all water treatment (in the broadest sense) should focus on the management of pathogens. Pathogens can gain entry to a water supply primarily through the raw water. They can also gain entry through the tanks and pipes that make up the distribution system. Studies abound to show the importance of media filtration in managing the risk of protozoan pathogens at the Water Treatment Plant (WTP). Nygard et al (2007) have shown that the public can become ill from maintenance activities carried out in the distribution system. Therefore, specific preventive measures are required in the operation of the distribution system. Such studies support the statements made by other public health organisations, such as the US Centre for Disease Control (CDC), who have noted that up to 30% of waterborne illness is derived from the distribution system, and, importantly, that distribution system-derived waterborne illness is under identified and therefore, under reported.

The Australian Drinking Water Guidelines (ADWG) Framework for the Management of Drinking Water Quality focuses on safe drinking water and the management of pathogens. Indeed, Chapters 9 and 10 provide substantial risk management background to this.

Victoria's *Safe Drinking Water Act 2003* and Safe Drinking Water Regulations 2005 have been in place for almost ten years now. The objective of this Act, as evidenced by its name, is the provision of safe drinking water. It is our belief that the ESC performance indicators should clearly support, and where appropriate extend, the essential requirement to protect public health and provide evidence that that is the case.

In contrast, the ESC document circulated for consideration contains no reference to "safe drinking water" or "pathogens", although colour and turbidity are emphasised as contaminants for removal. Colour and turbidity have never alone caused illness. Pathogens are what must be managed, not turbidity. Turbidity is simply a convenient everyday measure of the potential level of removal of pathogens in a water treatment process, but other equipment such as particle counters can also be used. Further, the ESC document contains no reference to *Cryptosporidium* or *Giardia* which are undoubtedly the most important waterborne pathogens requiring control at this time.

In support of the pathogen issue, we draw reference to a more detailed document relating to the management of pathogens in Appendix 1 below "*Information Sheet x.xx: Management of Protozoan Risk*". This document was developed in response to industry concerns relating to the management of *Cryptosporidium*, and came out of a meeting of water utility operations managers from around the country that was held in Adelaide in 2009. This document was developed and submitted to the NHMRC based on a consensus view from that meeting. The complete context of pathogen management is detailed in the document, however your attention is drawn to the parts that relate to the distribution system entitled **Distribution system management of mains breaks.**

Specific Proposal for Amendment to ESC Indicators

The current wording of REW3 is vague and open to interpretation.

REW 3	*Time taken to rectify bursts and leaks*	*Priority 1*	*Regional and Metropolitan*	*Average hours taken to fully repair and rectify bursts and leaks*	*The total job duration, including time from receiving first notification, responding to, and rectifying the fault to the required level of service.*
Priority 2 *Priority 3*					*Follow-up rectification works, such as reinstatement of nature strips are not included.*

In particular, the statement of "rectifying the fault to the required level of service" is vague and in our experience, problematic. We are aware through WIOA training initiatives, that "corners are being cut" particularly in Victoria with respect to the management of mains breaks to "get the water back on as quickly as possible to keep the ESC performance indicators on target". The statement that "we haven't got time" to undertake a range of sensible measures designed to guarantee the safety of the water supplied to consumers is all too common at our workshops.

It is our submission that the wording be changed to:

The total job duration, from the time of receiving first notification, responding to and rectifying the fault to the time that safe drinking water is reconnected.

We further draw your attention to Appendix 2 that provides an event log of a mains repair event in Gippsland in 2010. This is not an isolated event in Gippsland and indeed Victoria and may present a considerable risk to consumers.

WTP Performance Indicators

Whilst this submission relates specifically to REW3, we also consider that the performance indicators selected for monitoring WTP performance are deficient and need to reflect modern practices for the management of pathogens. Appendix 1 below provides a number of suggestions in that area as well.

We note in particular that DWQ 1 "Standards for Drinking Water Quality" with the associated Performance Measures of:

- % population receiving water meeting standards
- Number of zones meeting *E coli* standards.

Sadly, we suggest that this Indicator reflects a lack of understanding of pathogens and barriers. It also enshrines the long held indicator relating to *E coli* developed before the identification of protozoans as the major pathogens of concern.

The fact is that water supplied can be 100% compliant with requirements based on *E coli* and yet, a substantial proportion of consumers supplied with the water can become ill with giardiasis or cryptosporidiosis. Severe debilitating illness and possible death in the old and the young is a common consequence of giardiasis or cryptosporidiosis. Put simply, *E coli* is one of the easiest pathogens to kill with chlorine, however, *Cryptosporidium* is not. The emphasis on *E coli* as the sole measure of drinking water quality must be replaced by other measures reflecting the current knowledge of water microbiology and water treatment barriers. Again, the attached document provides specific guidance in these areas.

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APPENDIX 1

Information Sheet x.xx: Management of Protozoan Risk

When the source water for a drinking water supply is drawn from multi-use, surface water catchments there is a high probability that protozoan pathogens, such as *Cryptosporidium* and *Giardia*, will be present in the untreated source water. Depending on the types of activities that occur in the catchment, the densities and species of *Cryptosporidium* and *Giardia* will vary spatially and temporally.

Analytical techniques for the isolation and identification of *Cryptosporidium* and *Giardia* in untreated and treated water have improved markedly over recent years, but the identification of human infectious *Cryptosporidium* oocysts in water remains a technically demanding and relatively expensive process.

The management of protozoan risk is centred primarily on the operation and maintenance of catchment and treatment barriers.

Consistent with the ADWG Framework for the Management of Drinking Water Quality, the first barrier to the management of protozoan pathogens is source protection. Water destined for drinking should be drawn from the best available source. The best available source would be a catchment area that is undisturbed and free of point sources of contamination (for example, septic tanks, stormwater, livestock particularly cattle and sheep).

The reality is that many drinking water supplies are sourced from multi-use catchments that present multiple potential sources of protozoan pathogens. One of the primary goals for catchment managers is therefore to decrease the risk of pathogens entering the water courses in the catchment. A key management strategy is to work with landholders, natural resource management agencies, and other stakeholders to manage and reduce potential sources of microbial (and other) contamination.

Even with effective catchment management, there still exists a probability that protozoan pathogens will be periodically present in the source water, either after a storm event, or as the result of some incident or accident at one of the point sources. This probability is heightened where reservoir short circuiting occurs.

After source water protection, the operation and maintenance of robust water treatment processes is the most effective management tool for preventing protozoan pathogens entering drinking water supplies. Given that *Cryptosporidium* and *Giardia* cannot yet be continuously monitored in either raw or treated water, there needs to be commitment to manipulation of variable offtakes where these are present and to operating and maintaining the treatment processes at the highest possible level.

Chlorine disinfection does not inactivate *Cryptosporidium* and has limited success with *Giardia* due to the large Contact Time (Ct) required. Therefore chlorine disinfection cannot be used as a sole treatment barrier where the source water for a drinking water supply is drawn from multi-use, surface water catchment where sources of protozoan pathogens are known to exist.

Filtration can be a very effective treatment barrier to *Cryptosporidium* and *Giardia.* Filtration preceded by effective coagulation and flocculation physically removes protozoan pathogens, but the effectiveness of this process is highly dependent on how well the filters are operated and maintained.

As detailed in the Turbidity Fact Sheet (ADWG 2010), based on the need to remove waterborne pathogens, where filtration is used as part of the water treatment process, the turbidity of water leaving filters, under the normal operating conditions, should not exceed 0.1 NTU, unless validation data indicate that water of higher turbidity is microbiologically safe.

Depending on the level of risk posed by protozoan pathogens, an additional treatment barrier of ultraviolet (UV) light should be installed, particularly in the case where the assessed residual risk is still high or very high (based on a qualitative risk assessment).

As with filtration, the effectiveness of UV light at inactivating protozoa is highly dependent on how well the units are operated and maintained. The use of validated units is considered essential.

Once treated, water is distributed to the consumer. Recontamination can occur in the distribution system. The most common causes of recontamination are backflow, cross connections and water main repair and installation activities. Low-pressure events in the mains increase the likelihood of such contamination via these routes. Contamination also occurs in treated water storages as a result of birds and vermin gaining access through poorly maintained tank and roof structures. Once recontamination occurs in the distribution system, the chlorine residuals are insufficient to manage any but a minor bacterial contamination. Therefore recontamination must be prevented. The risk of recontamination can be minimised by ensuring the integrity of storage structures, use of high quality and, where appropriate, testable back flow prevention devices and thorough disinfection after repair work to mains particularly where dewatering of the main has been necessary to effect repair. After a mains break, water should not be returned to consumers until it is safe to do so.

Table x.xx details recommended source water protection barriers, water treatment processes and operational limits based on catchment type and level of protozoan risk. Recommendations for the management of mains breaks is also included. The table can be used as a guide to designing and operating water treatment processes to manage protozoan risk.

Table x.xx Recommended water treatment processes and operational limits based on catchment type and level of protozoan risk

Catchment Type	Fully protected	Moderate Impact	High Impact
Description of Catchment	Native bushland catchment. No human settlement or agriculture. Human access only for essential maintenance.	No point source inputs. Land use characterised by unimproved pasture, forest and rural residential No dairies or STPs or septic tank run off or use of manure on pastures	Intensive inputs. Land used characterised by intensive animal farming (in particular cattle and sheep) with irrigated grazing, dairies. Crop growth with irrigation and use of manure. Urban development (sewered or unsewered). STPs present Wastewater or manure may be discharged into the catchment without treatment.
Average Cryptosporidium Concentration (Note 1)	Cryptosporidium oocysts may be sporadically present. Typically 0.001/L. (Maximum concentrations may be 10 to 100 fold higher.)	Cryptosporidium is occasionally present. Typically 0.1/L. (Maximum concentrations may be 10 to 100 fold higher.)	Cryptosporidium is generally present. Typically 10-100/L. (Maximum concentrations may be 10 to 100 fold higher.)
Raw Water Intake	Not under direct influence of wastewater discharges	Not under direct influence of wastewater discharges, but some diffuse rural land use discharges.	May be under the direct influence of wastewater or point and diffuse manure discharges. Reservoirs with potential short circuiting and without variable off takes.
Source Barriers	No specific requirement	Effective catchment management program including annual auditing of all septic tanks in *critical* source areas, tertiary treatment on any small STPs present and no direct access by calves to streams, and no intensive calf or lamb facilities.	Effective catchment management program including annual auditing of all septic tanks in *critical* source areas, tertiary treatment on any small STPs present and programs to eliminate direct access by calves to streams, and no intensive calf or lamb facilities. Identification of and removal of point sources. Annual reviews of routine and event based monitoring to provide evidence of effectiveness of the catchment management program and improvements over time.

Catchment Type	Fully protected	Moderate Impact	High Impact
Treatment Barriers Required	No specific requirement	One Cryptosporidium barrier IF there is an active and effective catchment management program (see above) Otherwise, two Cryptosporidium barriers required.	Two Cryptosporidium barriers required.
Barriers	Chlorine disinfection	At least media filtration and chlorine disinfection. In catchments with a very small number of stock or humans, filtration may not be necessary but full quantitative microbial risk assessment (QMRA) required to establish adequacy.	Media filtration and validated UV or ozone, or media filtration and ultrafiltration membranes.
Treatment			
Clarification		Clarified water target <2 NTU critical limit 3 NTU	Clarified water target <1 NTU critical limit 3 NTU
Filtration (Note 3)	Generally not applicable	Individual filtered water turbidity <0.15 NTU 95th%ile, <0.5 NTU 98th %ile, max 1.0 NTU Ripening period <0.3 NTU, <15 minutes	Individual filtered water turbidity <0.15 NTU 95th%ile, <0.2 NTU 98th %ile, max 0.3 NTU Filter to waste capability should be included in new plants and retrofitted to existing plants if possible. Ripening period filtered to waste where filter to waste capability is present. Otherwise ripening period <0.3 NTU, <15 minutes 2-15um counts target <20/mL, critical <100/mL
Catchment Type	**Fully protected**	**Moderate Impact**	**High Impact**

Plant Operation		Any supernatant return should be continuous and < 10% inflow Continuous plant operation if possible Plant operation should be slowed during turbidity events Continuous on line monitoring of individual filters and chlorine residual Continuous on line analysis of at least one critical limit parameter for both filtration and disinfection, linked to alarms and automated plant shut down.	Untreated supernatant must not be returned to the head of the plant. Supernatant can be returned if media filtration, UV or ozone disinfection is applied to the supernatant. Plant operation should be continuous Increases in plant inflow should be <10% per hour???? During turbidity events plant should be taken offline or slowed significantly Continuous online raw water turbidity monitoring at the raw water source strongly recommended Continuous online clarified water turbidity monitoring strongly recommended Individual turbidity meters for individual filters Continuous on line analysis of at least one critical limit parameter for both filtration and disinfection, linked to alarms and automated plant shut down.
Treatment Disinfection (Note 4)	Chlorine only disinfection generally satisfactory. Turbidity <1 NTU at point of disinfection or proof that disinfection is occurring Ct>15 mg/L.min	Chlorine disinfection. Turbidity <1 NTU at point of disinfection Ct>30 mg/L.min	Ultrafiltration or validated UV disinfection >40 mJ/cm2
Catchment Type	**Fully protected**	**Moderate Impact**	**High Impact**

Monitoring	Monitoring of *Cryptosporidium* not recommended	Event monitoring of *Cryptosporidium* in raw water recommended If contamination is suspected, testing of treated water is recommended. Contamination could occur in association with a major rainfall event which could lead to a marked increase in numbers of Cryptosporidium, suboptimal operation of treatment processes or a breakdown in treatment plant operations	Routine and event monitoring of *Cryptosporidium* in raw water recommended. Testing of treated water is not generally required where a validated UV disinfection system is in place and operational process monitoring demonstrates adequate performance of barriers namely individual filter outlet turbidity, clarifier outlet turbidity, UV dose and transmissivity. Where there is doubt, treated water should be tested. Treated water should be collected using composite samplers to obtain representative samples.
Reporting	Annual reporting of Ct performance	Monthly reporting of individual filter turbidity performance Monthly reporting of Ct performance	Monthly reporting of individual filter turbidity performance. Monthly reporting of UV performance.
Distribution system management of mains breaks	Ensure all clothes and equipment free from contamination with contaminated soil. Repair under pressure where possible. Disinfect all fittings with 1% hypo for 10 minutes. If dewatering necessary, disinfect complete main to Ct 300. If risk of contamination with faecal material, disinfect to Ct 300 and implement boil water notice downstream of break.	Ensure all clothes and equipment free from contamination with contaminated soil. Repair under pressure where possible. Disinfect all fittings with 1% hypo for 10 minutes If dewatering necessary, disinfect complete main to Ct 300. If risk of contamination with faecal material, disinfect to Ct 300 and implement boil water notice downstream of break	Ensure all clothes and equipment free from contamination with contaminated soil. Repair under pressure where possible. Disinfect all fittings with 1% hypo for 10 minutes. If dewatering necessary, disinfect complete main to Ct 300. If risk of contamination with faecal material, disinfect to Ct 300 and implement boil water notice downstream of break

Catchment Type	Fully protected	Moderate Impact	High Impact
Operator Competency and Experience (based on Vic DH COP for Water treatment Operator Competencies)	Certificate II in Water Operations (NWP07/NWP01)	Certificate III in Water Operations (NWP07/NWP01). 3 years experience including 2 years assisting in the operation of a Level 3 facility.	Certificate IV (technical) in Water Operations (NWP07/NWP01). 5 years experience including 2 years responsibility for Level 3 facility
Refresher training		Yes	Yes
Operator Certification			Yes

Notes

1. The values of *Cryptosporidium* provided are for guidance only and are not necessarily prescriptive. They may be useful for utilities that have little (or no) monitoring data and are unsure how to interpret the data. However the description of the catchment type is probably a better system of classification of the catchment type and therefore the barriers necessary. The values are taken from WHO (2009).
2. Targets for ripening period from AWWA (2001). Targets for clarifier function are recommended to help achieve the filtration targets
3. Recommended UV energy based on German standard

References

AWWA 2001. Self assessment for treatment plant optimisation. American Water Works Association

WHO, 2009 Risk assessment of Cryptosporidium in Drinking. Water World Health Organisation

APPENDIX 2

Case Study: August 2011 Gippsland

- Late evening, water stopped and power went out
- Water utility contacted to report loss of water and householder went to bed
- Early morning householder woke and tested taps, water was back on but the water was very brown
- Householder flushed the house system from back to front but water still highly coloured
- Two showers taken water had a slight odour and was still “dirty” throughout the duration of the showers
- At start of business (9am) the householder contacted the water utility and asked if the water needed to be boiled.
- The employee on the phone stated
    - There was no need to boil the water and when pressed on this issue was told “it is up to the individual to decide whether or not to boil the water” and that the householder should reflush the house
    - The householder objected to the advice and suggested that the water utility needed to flush their mains ASAP. The operator responded by saying they would action a request for the mains to be flushed.
- At 1 pm a water utility operator rang to say the lines had been flushed and a “slug of dirty water” removed via a hydrant.
- The householder flushed the house and confirmed clean water.