IMPROVING DRINKING WATER QUALITY – A NEW ZEALAND PERSPECTIVE

Paper Presented by:

Dr Jason Colton

Author:

Dr Jason Colton, *Principal Process Engineer,*

h2ope (New Zealand)

74th Annual Water Industry Engineers and Operators' Conference
Bendigo Exhibition Centre
6 to 8 September, 2011

IMPROVING DRINKING WATER QUALITY – A NEW ZEALAND PERSPECTIVE

Dr Jason Colton, *Principal Process Engineer*, $h_2$ope (New Zealand)

ABSTRACT

There are key differences between the approach taking to managing drinking water supplies in New Zealand and Australia. In New Zealand water suppliers are required by law to comply with the drinking water standards. The standards themselves are arguably the toughest in the world and require compliance to be demonstrated continuously by on-line monitoring. The performance results of all plants are published and are available to the public. This approach is working in New Zealand since there has been a demonstrable improvement in drinking water quality since this approach was adopted.

1.0 REGULATORY TIMELINE IN NEW ZEALAND

The regulatory timeline associated with drinking water quality in New Zealand is summarised in Table 1.

Table 1: ***Regulatory Timeline in New Zealand***

Year	Publication	Key Features
1995	Drinking Water Standards introduced. DWSNZ 1995.	Grading of public water supplies introduced.
2000	New Revision of Drinking Water Standards. DWSNZ2000.	On-line instrumentation used to demonstrate compliance.
2003	Grading criteria revised.	
2005	New revision of Drinking Water Standards. DWSNZ2005.	Introduction of USEPA Log Removal concept for protozoa. Requirement for public health risk management plans.
2007	Health (Drinking Water) Amendment Act.	
2008	New revision of Drinking Water Standards. DWS2005(2008)	Minor amendments, no policy changes.

The health (Drinking Water) Amendment Act in 2007 marked a milestone in NZ. For the first time, all water suppliers had a duty to ensure their water is safe to drink. They are required by law to take all practicable steps to comply with the drinking water standards - DWS2005(2008).

2.0 GRADING OF PUBLIC WATER SUPPLIES

The concept of grading was first introduced in New Zealand in 1995. The grading criteria were revised in 2003 to reflect the requirements of DWSNZ2000. The grading is carried out by a drinking water assessor (DWA). DWA are public health professionals employed by regional health authorities who have undertaken specialist training. The grading criteria cover on-line compliance, chemical compliance and other non-water quality related parameters such as QA/QC, staff training and supervisor qualifications.

Table 2 shows grades assigned to public water supplies. The Ministry of Health has made efforts to demonstrate a link between these grades and public health (Ball, 2007).

Figure 1 shows a plot of incidences of Cryptosporidiosis against the grade assigned to the water supply and plant. This data clearly shows that the incidence of water borne disease increases as the plant grade decreases, with ungraded supplies showing the highest incidence.

Table 2: ***Source and Treatment Grades***

Grade	Description
A1	Completely satisfactory, negligible level of risk, demonstrably low level of risk
A	Completely satisfactory, extremely level of risk
B	Satisfactory, very low level of risk
C	Marginally satisfactory, low level of microbiological risk when water leaves the plant but may not be satisfactory chemically
D	Unsatisfactory level of risk
E	Unacceptable level of risk
U	Ungraded

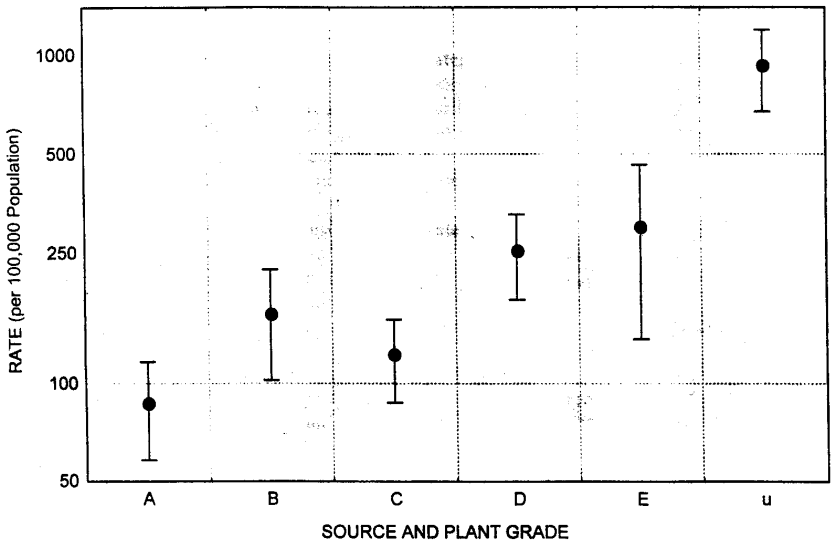

Fig. 1. Rates of notified cryptosporidiosis per 100,000 population in New Zealand June 1996–August 1998 by source and plant component of the public health grading of community drinking water supply where A = very satisfactory, B = satisfactory, C = marginal, D = unsatisfactory, E = very unsatisfactory and u = ungraded. Log scale on Y axis. Error bars indicate standard error. Data source NZ Ministry of Health.

Figure 1: ***Incidence of Cryptosporidiosis (reproduced from Ball 2007)***

2.1 Publishing Results of Grading

All grading results are available to the public via the Water Information for New Zealand (WINZ) database managed by the Institute of Environmental Science and Research Limited. The website address is drinkingwater.co.nz. Anybody can use the website to see what grade has been assigned to the water treatment plant supplying their community.

3.0 REQUIREMENTS OF CURRENT DRINKING WATER STANDARDS

The drinking water standards that apply in New Zealand are DWSNZ2005(2008). They are arguably the most onerous drinking water standards in the world. The document is organised into compliance categories. The three main ones are Chemical Compliance – which is similar in approach to the Australian Drinking Water Standards (ADWS); Protozoal Compliance and Bacteriological Compliance. The last two are very different to the ADWS.

3.1 Protozoal Compliance

The protozoal compliance criteria are based on the USEPA Log removal concept. Where the level of treatment required is linked to the protozoal risk in the source water. Protozoal risk is quantified by measuring *Cryptosporidium* oocyst concentration in the source water over one year, or for smaller suppliers (<5000 population) by a catchment risk survey. The lowest level of treatment required is 3 Log removal and the highest is 5 Log removal. Treatment processes are assigned a certain Log removal value provided they meet certain criteria. Processes can be combined to achieve a cumulative Log removal value matching the source requirements.

The protozoal compliance criteria have to be measured continuously (every minute) using on-line instrumentation. The compliance reporting period is monthly.

3.2 Bacteriological Compliance

The bacteriological compliance criteria are based on using the Free Available Chlorine Equivalent (FACE) concept. This takes into account the effect of pH on the efficacy of chlorine. Where at higher pH proportionally more chlorine is required to get the same disinfecting power.

The bacteriological compliance criteria have to be measured continuously (every minute) using on line instrumentation. The compliance reporting period is daily.

4.0 DEMONSTRATION OF PLANT PERFORMANCE

Two plants have been selected to demonstrate compliance with the Protozoal and Bacteriological requirements of DWSNZ2005(2008). The first is the Te Marua WTP in Wellington, operated by Greater Wellington Regional Council. The plant is a 140ML/d conventional clarification and filtration plant. The plant has always had an A1 grading. The second is the Te Aroha WTP, operated by Matamata Piako District Council. The plant is a 5ML/d conventional clarification and filtration plant. The plant was an E grade plant but following a recent $100K refurbishment is now producing A1 grade water.

Figure 2: ***Te Marua WTP and Te Aroha WTP***

4.1 Protozoa Compliance

Both plants have to provide 4 Log of protozoal treatment. In order to provide 4 Log treatment with conventional clarification and filtration the Enhanced Individual Filter Turbidity rule must be used.

The performance that must be met to achieve compliance for this criteria are as follows:

- Turbidity must be measured every minute on each filter;
- Turbidity must be <0.1NTU for not less than 95% of the month;
- Turbidity must be <0.3NTU for not less than 99% of the month;
- Turbidity must not exceed 0.5NTU for more than 3 minutes at any time in the month.

Turbidity data from Filter 3 at the Te Marua WTP for the month of February 2011 is shown in Figure 3. This is a typical line graph, similar to a SCADA trend. It shows that the turbidity was less than 0.1NTU for nearly all the time but it is not possible to derive percentage compliance from this type of graph. It is also difficult to compare filter performance using this time of graph.

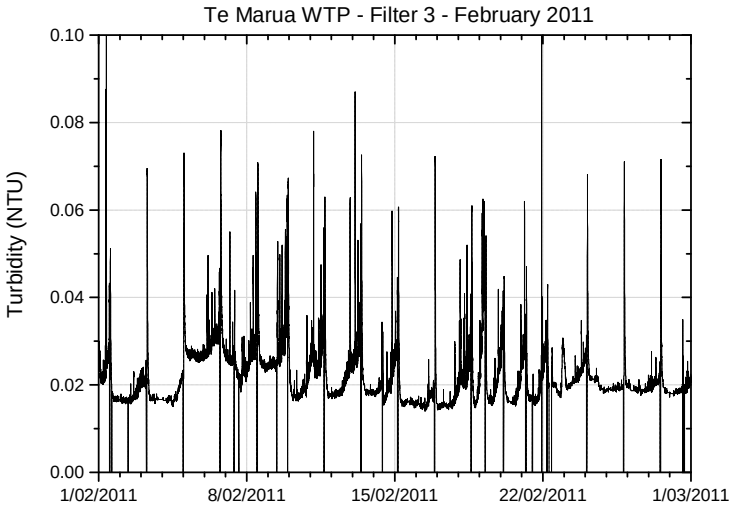

Figure 3: ***Te Marua WTP Filter #3 Turbidity***

Figure 4 shows the turbidity data for all six filters at the Te Marua WTP for the month of February 2011. This form of plot is called a cumulative frequency graph. It is possible to derive percentage compliance from this type of graph and it facilitates easy comparison of filter performance. The 95 and 100 percentile values for the US Partnership for Safe Water initiative are shown for reference.

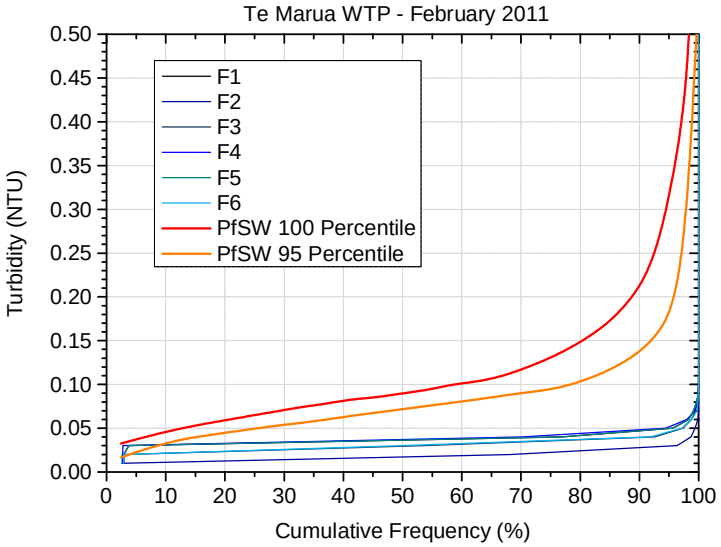

Figure 4: ***Te Marua WTP Filter Turbidity Cumulative Frequency Graph***

A third type of plot is shown in Figure 5. This is a box plot and shows the statistical spread of turbidity data for all the Te Marua filters. The box shows the 25 and 75 percentile values, the bars show the 5 and 95 percentile values and the crosses show the 1 and 99 percentile values.

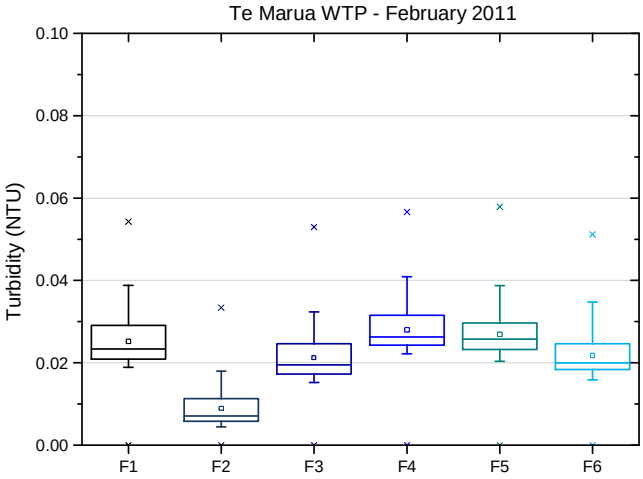

Figure 5: ***Te Marua WTP Filter Turbidity Box Plot Graph***

These three graph types show that the performance of the filters at the Te Marua WTP met the protozoal compliance requirements for the month of February.

The turbidity data from the Te Aroha WTP is presented in Figures 6 to demonstrate that it is not just larger plants that can achieve this onerous turbidity targets. The data in Figures 6 shows that the Te Aroha WTP also met the protozoal compliance requirements for the month of February

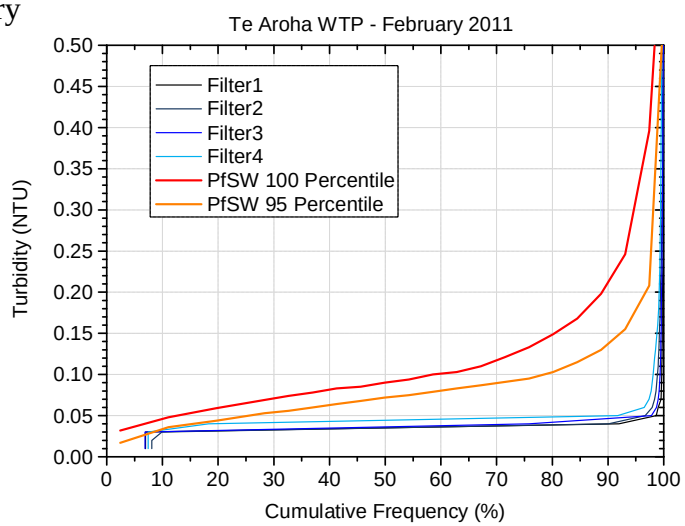

Figure 6: ***Te Aroha WTP Filter Turbidity Cumulative Frequency Graph***

4.2 Bacteriological Compliance

In order to demonstrate bacteriological compliance both plants have to meet the following criteria:

- Treated water FAC, pH and turbidity must be measured every minute;
- FACE must be >0.2mg/L for not less than 98% of each day;
- Turbidity must be <1.0NTU for not less than 95% of each day;
- Turbidity must not exceed 2.0NTU for more than 3 minutes in the day;
- Chlorine T_{10} contact time must be greater than 30 minutes.

Both Te Marua WTP and Te Aroha WTP meet these requirements each and every day.

5.0 SUMMARY

There are some key differences between New Zealand and Australia in the approach taken to managing drinking water supplies. These can be summarised as follows:

- Water supplies must comply with the drinking water standards in New Zealand – it's the law.
- On-line instrumentation is used for compliance in New Zealand.
- The Log removal concept is used for Protozoal Compliance in New Zealand.
- The FACE concept is used for bacteriological Compliance in New Zealand.
- Water supplies are graded and results are published in New Zealand.

Having highlighted the differences between the two approaches the pertinent question would appear to be "Has the approach used in New Zealand improved drinking water quality?" The data in Figure 7 shows that the answer is an unequivocal yes. Furthermore it doesn't always require expensive plant upgrades to achieve compliance. For most sites it is possible to achieve compliance by optimising existing assets.

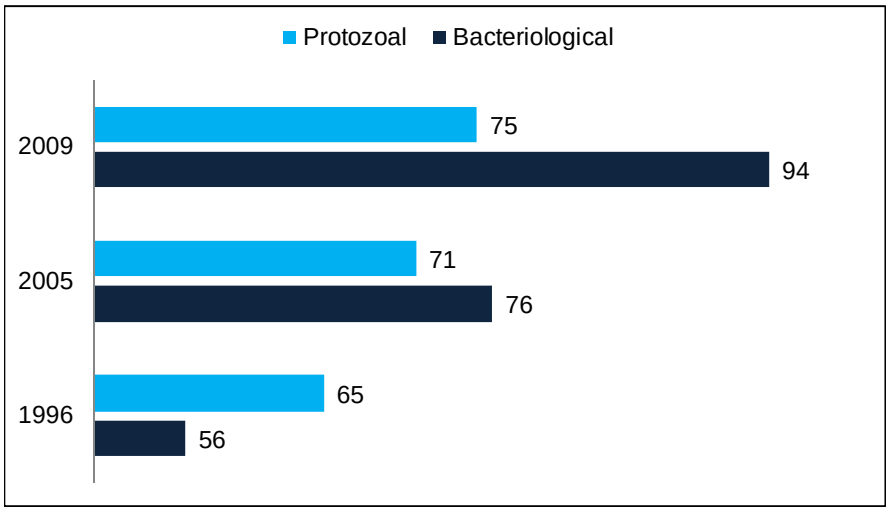

Figure 7: ***% NZ Population with compliant drinking water***

6.0 ACKNOWLEDGMENTS

The author would like to thank Greater Wellington Regional Council and Matamata Piako District Council for permission to use their water quality data.

7.0 REFERENCES

Ball, A (2007). *Estimation of the burden of water-borne disease in New Zealand: Preliminary report*. Ministry of Health, New Zealand. ISBN: 978-0-478-30768-9

Ministry of Health, New Zealand. (2006). *A Summary of the Annual Review of the Microbiological and Chemical Quality of Drinking-Water in New Zealand 2005*.

Ministry of Health, New Zealand. (2011). *Annual Review of Drinking-Water Quality in New Zealand 2009/10*.