Department of Environment
and Resource Management

Escherichia coli (E. coli) monitoring guidance notes

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Department of Environment and Resource Management

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Contents

Purpose

These guidance notes have been prepared to assist drinking water service providers meet the necessary requirements for monitoring of *Escherichia coli (E. coli)* in drinking water supplies.

Number of samples required

Reticulation system for a drinking water service

The minimum number of samples required in a reticulation system, for a drinking water service, is prescribed in Schedule 3A of the Public Health Regulation 2005 (the Regulation). These requirements are summarised in Table 1 for reference.

Table 1 includes the total minimum number of routine samples required for the year to comply with the Regulation for any given reticulation system population. Guidance is also provided in column 4 to assist drinking water service providers to meet the minimum weekly and monthly sampling requirements and to more evenly distribute the number of samples across the year.

If using the recommendations in Table 1, column 4, there will be a small shortfall for most population categories in the total number of samples for the year. This shortfall will need to be made up when designing your program.

Examples:

For a population of 12 000:

The minimum sampling requirement is:

- one sample per week plus
- at least two additional samples each month.

Minimum number of samples required = (52 weeks x 1) + (12 months x 2) = 76 samples per year

The minimum sampling requirement should be used.

For a population of 26 000:

The minimum sampling requirement is:

- one sample per week plus
- at least five additional samples each month.

Minimum number of samples required = (52 weeks x 1) + (12 months x 5) = 112 samples per year

The minimum sampling requirement is one sample per week but for more even distribution it is recommended that at least two samples per week be collected (Table 1, column 4). This provides 104 samples per year. The additional eight samples required can be allocated over the 12 month period when designing the program.

For a population of 68 000:

The minimum sampling requirement is:

- one sample per week plus
- at least 13 additional samples each month.

Minimum number of samples required = (52 weeks x 1) + (12 months x 13) = 208 samples per year

The minimum sampling requirement is one sample per week, but for more even distribution, it is recommended that at least four samples per week be collected (Table 1, column 4). This provides the required 208 samples per year.

Treatment and transmission components of a drinking water service

The frequency of sampling, and the sampling locations for *E. coli*, in both treatment and transmission components of a drinking water service, are not set in the Regulation or by the regulator. They should be determined by the drinking water service provider (DWSP) on a case-by-case basis. The monitoring program for treatment and transmission components of a drinking water service must be documented in either the approved Drinking Water Quality Management Plan (DWQMP) or supplied to the regulator in accordance with a monitoring and reporting notice.

Detection of *E. coli* in any sample

The standard for *E. coli* in the treatment, transmission or reticulation component of a drinking water service is nil colony forming units (cfu) per 100mL for each sample. Any positive *E. coli* result must be reported to the regulator (refer to Attachment 1 of the *Drinking Water Service Provider Monitoring and Reporting Requirement Notice* and *the Drinking Water Quality: Incident Reporting Form*).

If *E. coli* is detected in a sample, a follow-up sample from the same location must be taken immediately and tested for *E. coli*. Immediately means as soon as practicable, allowing for possible constraints in collecting, transporting and submitting the sample to the laboratory for analysis, consistent with the protocols for accepting samples.

In addition to the required follow-up sample, an investigation as to the cause of the positive result should be undertaken and corrective actions taken as necessary. Investigations should, as a minimum, include checks on the disinfection system, disinfectant residuals and the integrity of reservoirs and the reticulation system.

The follow up sample is additional to the minimum total number of samples required as detailed above, and as such, does not form part of routine monitoring for assessment against the annual value.

Routine monitoring should resume at the location which returned the positive result once *E. coli* is not detected in a follow-up sample, investigations have been completed and corrective actions, if required, have been implemented. Routine monitoring at other sampling sites should continue during the follow-up sampling and investigation phase.

Designing a monitoring program for a reticulation system

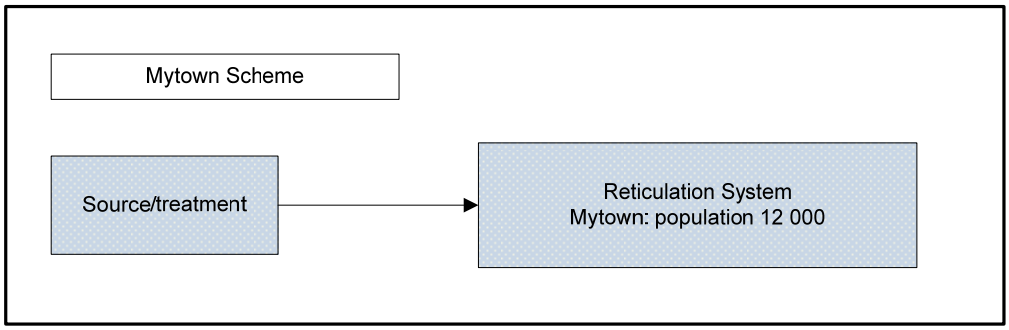
A DWSP must monitor and report on *E. coli* for their drinking water service. In most instances a DWSP will own connected infrastructure for the treatment, transmission and reticulation components of a drinking water service. These connected components are considered to comprise a 'drinking water scheme'. A DWSP's drinking water service may include more than one drinking water scheme. Providers should design their monitoring program to ensure all reticulation systems owned by the provider are monitored regularly to achieve at least the minimum *E. coli* monitoring requirements. The requirements of the Regulation summarised in Table 1 apply only to the reticulation component of the scheme.

As outlined in Table 1, the minimum number of *E. coli* samples is dependent upon the total population supplied by the reticulation system. The location of each sampling point should be determined by the DWSP, be risk-based and provide reasonable representation of the whole reticulation system and quality of water provided to consumers. A sampling point to indicate the quality of water entering the system, taken from either the treatment plant or from an upstream bulk water service provider, should be included. Sampling points should be rotated on a week-to-week or month-to-month basis, depending on the size of the reticulation system, to ensure the whole system is represented in the monitoring program.

Guidance on selecting sampling points is provided in section 9.6 of the Australian Drinking Water Guidelines which can be accessed from the National Health and Medical Research Council website <www.nhmrc.gov.au>. A section of the advice is reproduced below under Sample point selection.

Examples

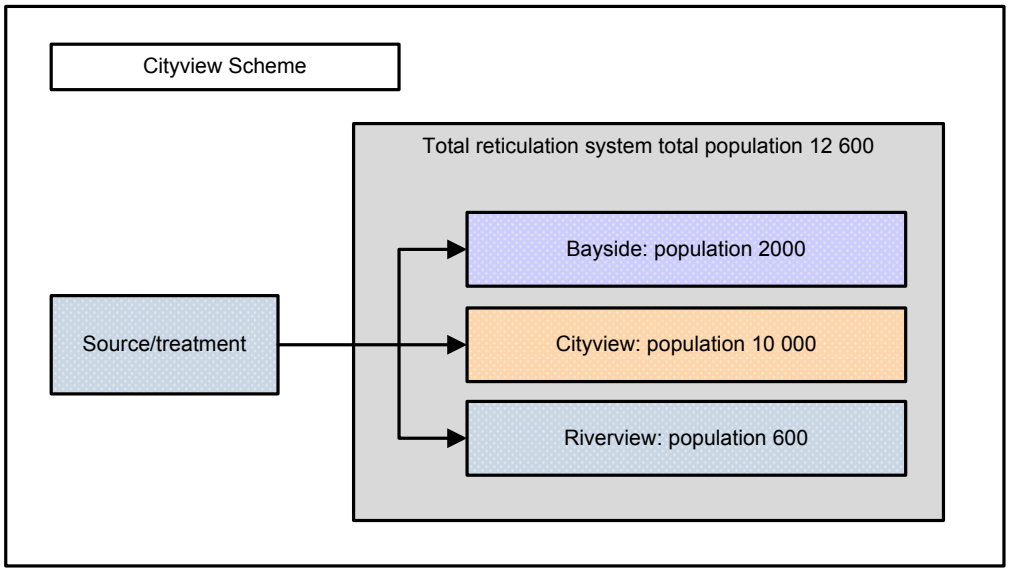
Single drinking water scheme in which the reticulation system provides water to a discrete town or location.



- Minimum number of routine *E. coli* samples required is 76 per year
- Minimum sampling requirement is one sample per week
- Each month at least two additional samples should be collected

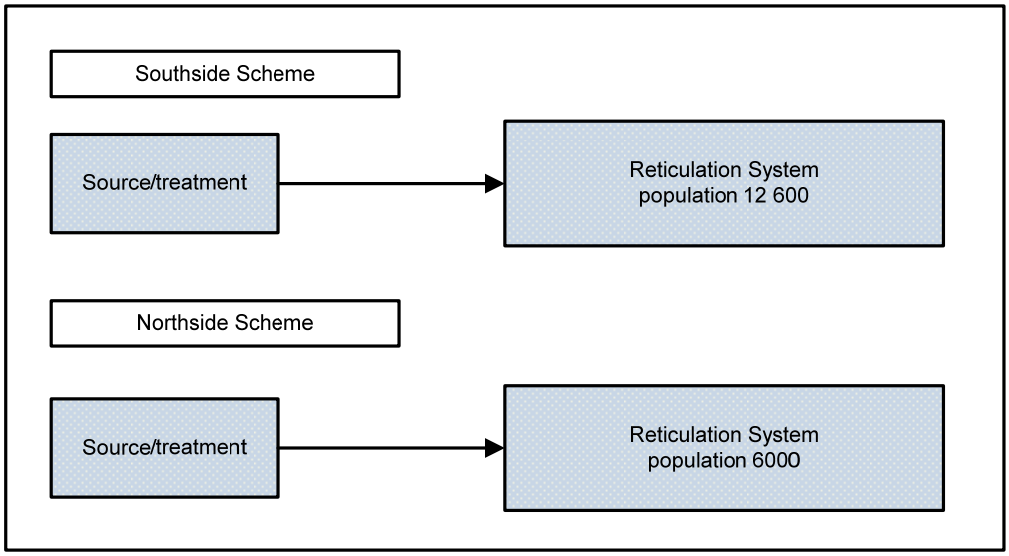
- More than one sample point should be chosen to ensure coverage of the whole reticulation system. A sampling point to indicate the quality of water entering the system, taken from either the treatment plant or from an upstream bulk water service provider, should be included.
- Sample collection should be rotated through the selected sample points on a regular basis. For example, if six sample points were chosen for the system, then each sample point would be monitored at least once per month. If three sample points were chosen for the system, then each point would be sampled twice per month.

Single drinking water scheme in which reticulation system provides water to multiple discrete towns or locations.



- Minimum number of routine *E. coli* samples required is 76 per year
- Minimum sampling requirement is 1 sample per week
- Each month at least two additional samples should be collected
- More than one sample point should be chosen to ensure coverage of the whole reticulation system and should include sampling points in each of the three towns. A sampling point to indicate the quality of water entering the system, taken from either the treatment plant or from an upstream bulk water service provider, should be included.
- Sample collection should be rotated through the selected sample points on a regular basis. For example, if six sample points were chosen for the system, then each sample point would be monitored at least once per month. If three sample points were chosen for the system, then each point would be sampled twice per month.

DWSP owns more than one scheme. The reticulation system of each scheme must be monitored and reported on separately.



- For Southside scheme: minimum number of routine *E. coli* samples required is 76 per year
- For Northside scheme: minimum number of routine *E. coli* samples required is 64 per year
- For both schemes:
  - More than one sample point should be chosen to ensure coverage of the whole reticulation system for each scheme
  - Sample collection should be rotated through the selected sample points on a regular basis.

Sample point selection

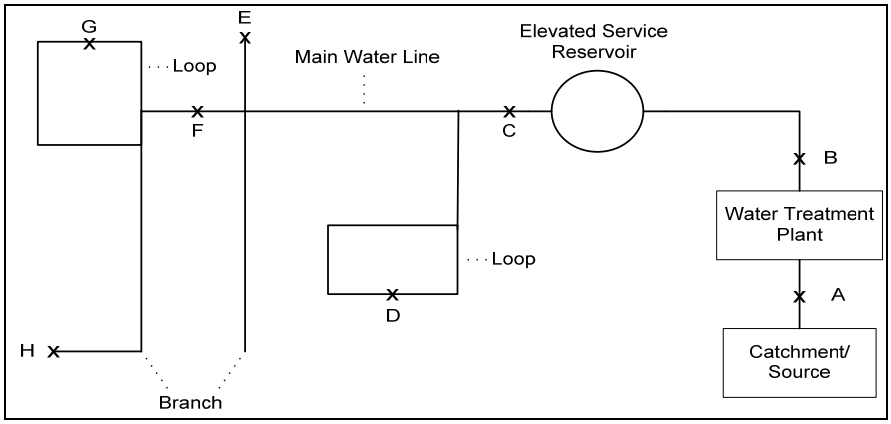
The following is an extract from Section 9.6 of the Australian Drinking Water Guidelines.

'When selecting sample points within the distribution system, the following factors should be considered:

- The distribution of sample points throughout the system, including the extremities, must reflect the numbers of people supplied by the different parts of the system, especially for systems drawing on surface water. For instance, if five per cent of consumers are serviced by distribution loops, then five per cent of samples should be taken from distribution loops.
- Water quality in a given pressure zone can be affected by the specific conditions in that zone; therefore, each pressure zone must be adequately monitored.
- When a system has more than one water source, the location of sample points must be in relative proportion to the number of people served by each source, and sample points must be located at the entry points to the system for the different sources. Similarly, systems with one source and more than one treatment plant must be sampled at the entry point from each plant to the system. Any areas where supply is likely to alternate between different sources should be sampled; as such changes may be noticeable to the consumer and be a source of complaint.
- If a service reservoir has no sampling tap, a sample point should be located sufficiently close to the reservoir to represent the water quality within the reservoir.

The system in Figure 9.1 is representative of a town with a population of approximately 5000 people with one source of water. A similar approach should be used by larger authorities to determine sampling points within supply districts of larger schemes. The selected sample points used in this example would satisfy the requirement to sample as close as practicable to the point of use, and to sample over the whole water supply system.'

Figure 9.1 Example of a water distribution system for 5000 people[1]



Point A is representative of the quality of raw water (see note (a) below)

Point B is representative of the quality of water leaving the treatment plant (see note (b) below)

Point C is representative of the water quality within the elevated service reservoir

Points D and G are representative of water quality in a distribution loop such as in a sub-development

Points E and H are representative of the water quality in a branch line or a branch line dead end

Point F is representative of water in the main line

Points D to H are representative of the quality of water supplied to consumers.

Notes

(a) While the requirements of the Regulation apply to the reticulation system, a service provider should conduct appropriate *E. coli* monitoring of its source water (Point A) to understand source water quality, variability and risk. This information contributes to the risk assessment and development of a drinking water quality management plan. This testing is not used for compliance assessment against the Regulation.

1 Source: Australian Drinking Water Guidelines (Section 9.6), National Health and Medical Research Council

(b) It is appropriate to include Point B as one of the sampling points in a monitoring program for a reticulation system to indicate the quality of water entering the system, either from the treatment plant, or if there is no treatment plant, the water source for the reticulation system.

Meeting the 98 per cent annual value

The Regulation requires that 98 per cent of samples taken in a 12-month period should contain no *E. coli*. This is the annual value in Schedule 3A of the regulation.

This requirement comes into effect once you have 12 months of data and should be assessed every month based on the previous 12 months data (so that it is a rolling assessment). An example calculation is given in Table 3.

As shown in column 5 of Table 1, the fewer samples you collect, the fewer failures (a failure is the detection of *E. coli* in a sample) are allowed for in meeting the 98 percent annual value. Even at the required minimum weekly frequency of monitoring, there is a chance that contaminated water may be provided during periods when the supply is not being monitored. From a statistical viewpoint, if water is sampled once per week, then even if all samples are free of contamination, there is no guarantee that all of the water in the system is free of contamination all of the time. The more samples taken, and the more frequently they are taken, the higher the degree of confidence. Therefore, consideration should be given to collecting more samples than the minimum required in the Regulation. The frequency of sampling should be increased particularly at times associated with events such as flooding or interruptions to supply or repair work.

For small communities, with a population of less than 1000, where a minimum of monthly testing is required, particular emphasis should be placed on operational measures such as regular inspections of raw water sources and reticulation systems and their integrity, operation and maintenance of equipment and operational monitoring such as turbidity and residual chlorine.

Analysis and laboratories

E. coli testing may be done by:

- your organisation's own laboratory if you have the capability for this analysis

or

- an external laboratory.

There is no requirement that the laboratory be National Association of Testing Authorities (NATA) accredited.

Table 2 lists the contact details for the Queensland Health Forensic and Scientific Services (QHFSS) laboratory and some of the larger local government laboratories that are available to analyse samples for the presence of *E. coli* and perform other analyses. This list does not include all laboratories available for *E. coli* testing in Queensland. If you already use a laboratory, or are aware of other laboratories in your area that are not on this list, you may use them. Information on other laboratories may be obtained from the Yellow Pages (under Chemist—Consulting and/or Industrial) or the NATA web page at <www.nata.asn.au>.

Issues to consider in choosing a laboratory are:

- distance and access to laboratory: samples for *E. coli* must be kept chilled and delivered to the laboratory within 18 to 24 hours of collection (requirements should be confirmed with the laboratory of your choice)
- capacity of the laboratory to monitor for *E. coli* in drinking water (refer to section on *E. coli* versus thermotolerant coliforms)
- cost:
    - QHFSS will provide *E. coli* testing at no charge for small to medium DWSPs, while large DWSPs will be charged at a cost recovery rate (refer to memo from QHFSS in the information pack). Service providers will need to meet their own collection and transport costs
    - you should contact other laboratories individually about their charges.

Once you have chosen a laboratory, you should contact them directly about their protocols for collection and submission of samples and the provision of suitable sample bottles.

Providers should be aware of the times of the year when access to laboratories may be limited (for example during public holiday periods) and should plan appropriately to ensure the minimum required sampling frequencies can be met. Obtaining extra samples just prior to the commencement of any laboratory closure period or immediately following this period should be considered.

If you may have significant operational issues in meeting the requirements of the Regulation for any of your reticulation systems, please complete the Drinking water quality: potential issues with meeting monitoring requirements for *Escherichia coli (E. coli*) form. In completing this form you are **not** exempt from meeting your obligation under the Regulation. The information supplied will be used by the regulator to assess your situation, and in collaboration with you, identify options to overcome these issues whilst meeting the legislative requirements of the *Water Supply (Safety and Reliability) Act 2008*.

E. coli versus thermotolerant coliform testing

The Regulation standard specifies testing for *E. coli*. Some laboratories may analyse samples for thermotolerant coliforms rather than *E. coli* as the Australian Drinking Water Guidelines currently allow both as indicators of faecal contamination. While the test for thermotolerant coliforms can be simpler, *E. coli*, which is a member of the thermotolerant coliform group, is regarded as the most specific indicator of recent faecal contamination. Thermotolerant coliforms also include some environmental coliform organisms such as *Klebsiella, Citrobacter* or *Enterobacter* which are not indicators of recent faecal contamination.

Where a sample is analysed for thermotolerant coliforms, a positive test result should be considered to be a positive *E. coli* result for incident reporting purposes and must be reported immediately. This is because of the additional time it takes to confirm a positive thermotolerant coliform result as *E. coli*. Where a sample is positive for thermotolerant coliforms, the following actions should be undertaken immediately by the provider:

- commence corrective actions
- commence confirmation testing to determine whether the sample is positive for *E. coli*
- report the positive result and corrective actions to the regulator.

Providers should ensure that the method used for confirmation testing is able to provide results within 24 hours with the regulator being advised of the results. If the sample is found to be positive for *E. coli*, the requirements of incident reporting, under the notice, apply. If the sample is confirmed as negative for *E. coli*, there is no incident and no further action is undertaken by the regulator.

To achieve compliance with the requirements of the Regulation, and requirements set out in the Water Quality and Reporting Guideline for a Drinking Water Service September 2010, providers must monitor their drinking water supplies for *E. coli*.

Laboratories that analyse samples for thermotolerant coliform are urged to consider changing to methods that directly detect *E. coli* as soon as possible.

Guidance on sample collection procedures

To ensure the validity of test results, all samples must be collected using acceptable sampling techniques and appropriately prepared sample bottles. Samples must be correctly handled, preserved and transported to the laboratory within the necessary timeframes. Sampling, handling and transportation requirements may vary depending on the parameter for which the sample is to be analysed and the laboratory's analytical methods.

The information package contains a copy of Sampling Procedures for Drinking Water, prepared by QHFSS, which provides guidance on:

- how to collect samples from a tap, surface water or ground waters
- suitable containers and preservation requirements for different QHFSS for the various types of analysis.

If you use another laboratory for water testing please contact them directly for details of their protocols and requirements for collecting and submitting samples.

The laboratory of your choice should provide appropriately prepared sample bottles and requirements for submitting samples for analysis.

Table 1: Minimum requirements for routine testing for *E. coli* in a reticulation system of a drinking water service (based on requirements of Schedule 3A of the Public Health Regulation (2005))

Population supplied by the drinking water service[1]	Minimum monitoring frequency as per the Public Health Regulation (2005)	Minimum number of routine samples required per year	Suggested minimum number of samples per week to evenly distribute the minimum number of samples over the year[2]	Maximum number of failures allowed in a 12 month period to meet the 98% annual value (based on minimum number of routine samples)[3]
1000 or less	1 sample per month	12	1 sample per month	0
1000 to 5000	1 sample per week	52	1	1
5001 to 10,000	1 sample per week plus additional 1 sample per month	64	1	1
10,001 to 15,000	1 sample per week plus additional 2 samples per month	76	1	1
15,001 to 20,000	1 sample per week plus additional 3 samples per month	88	1	1
20,001 to 25,000	1 sample per week plus additional 4 samples per month	100	1	2
25,001 to 30,000	1 sample per week plus additional 5 samples per month	112	2	2
30,001 to 35,000	1 sample per week plus additional 6 samples per month	124	2	2
35,001 to 40,000	1 sample per week plus additional 7 samples per month	136	2	2
40,001 to 45,000	1 sample per week plus additional 8 samples per month	148	2	3
45,001 to 50,000	1 sample per week plus additional 9 samples per month	160	3	3
50,001 to 55,000	1 sample per week plus additional 10 samples per month	172	3	3
55,001 to 60,000	1 sample per week plus additional 11 samples per month	184	3	3
60,001 to 65,000	1 sample per week plus additional 12 samples per month	196	3	4
65,001 to 70,000	1 sample per week plus additional 13 samples per month	208	4	4

Population supplied by the drinking water service[1]	Minimum monitoring frequency as per the Public Health Regulation (2005)	Minimum number of routine samples required per year	Suggested minimum number of samples per week to evenly distribute the minimum number of samples over the year[2]	Maximum number of failures allowed in a 12 month period to meet the 98% annual value (based on minimum number of routine samples)[3]
70,001 to 75,000	1 sample per week plus additional 14 samples per month	220	4	4
75,001 to 80,000	1 sample per week plus additional 15 samples per month	232	4	4
80,001 to 85,000	1 sample per week plus additional 16 samples per month	244	4	5
85,001 to 90,000	1 sample per week plus additional 17 samples per month	256	4	5
90,001 to 95,000	1 sample per week plus additional 18 samples per month	268	5	5
95,001 to 100,000	1 sample per week plus additional 19 samples per month	280	5	5
100,001 to 110,000	6 samples per week plus additional 1 sample per month	324	6	6
110,001 to 120,000	6 samples per week plus additional 2 samples per month	336	6	6
120,001 to 130,000	6 samples per week plus additional 3 samples per month	348	6	7
130,001 to 140,000	6 samples per week plus additional 4 samples per month	360	7	7
Above 140,001	6 samples per week plus additional 1 sample per month for each additional 10,000 population increment above 100,000			

1. Requirements apply to individual reticulation systems

2. Some additional samples will be required to meet the total yearly number for most population groups.

3. A failure is the detection of *E. coli* in a sample. Annual compliance is based on routine samples only, not follow up samples when *E. coli* is detected.

Table 2: List of laboratories and contact details

Laboratory	Address	Contact
Queensland Health Forensic and Scientific Services	Queensland Health Forensic and Scientific Services 39 Kessels Road Coopers Plains Qld 4108	For *E. coli*: John Bates (07) 3274 9101 or Bruce Gray (07) 3274 9075 For other parameters, see the Sampling Procedures for Drinking Waters document in information pack.
Brisbane City Council	Scientific Analytical Services Laboratory 180 Ashridge Road Darra Qld 4076	Mr R Gray (07) 3407 2666
Cairns Regional Council	Cairns Water Laboratory Services 38 MacNamara Street Cairns Qld 4870	Ms R Lale (07) 4044 8330
Citiwater – Townsville City Council	Citiwater Laboratory Services Douglas water Treatment Plant Angus Smith Drive Douglas Qld 4814	Mr P Mockeridge (07) 4775 5891
Gold Coast City Council	Scientific Services Laboratory Shelter Road Coombabah Qld 4215	Ms J Higgins (07) 5581 7100
Toowoomba Regional Council	Toowoomba City Council Laboratory Services Shuttlewood Strret Toowoomba Qld 4350	Mr J Mills (07) 4688 6271
Wide Bay Water Corporation	Scientific Services Microbiology 27-31 Ellengowan Street Urangan Qld 4655	Mrs S Stephenson (07) 4194 7751
Simmonds and Bristow Pty Ltd	40 Reginald St Rocklea Qld 4106	Ms Helen Simpson (07) 3710 9100

Table 3: Example for calculation of 12 month 'rolling' annual compliance assessment

Year	**2008**												**2009**		
Month	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M
No. of samples collected	13	13	14	13	14	13	13	14	13	13	14	13	13	13	13
No. of samples in which *E. coli* is detected (i.e. a failure)	1	2	0	0	0	0	0	0	1	0	0	1	0	0	0
No. of samples collected in previous 12 month period	na	na	na	na	na	na	na	na	na	na	na	160 (J-D)	160 (F-J)	160 (M-F)	159 (A-M)
No. of failures for 12 month period	na	na	na	na	na	na	na	na	na	na	na	5	4	2	2
% of samples that comply	na	na	na	na	na	na	na	na	na	na	na	96.9%	97.5%	98.7%	98.7%
Comply with annual value	na	na	na	na	na	na	na	na	na	na	na	no	no	yes	yes

na: not applicable if data not available for previous 12 months