

<b>WATER &amp; WASTE COMMITTEE</b> <b>18 SEPTEMBER 2008</b>	<b>1</b>
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## DOUGLAS COMMUNITY WATER REFERENCE GROUP

Bruce Gardiner : 24/1/5-32: #1823340

### **RECOMMENDATION:**

**That Council resolve to:**

- 1. Establish a community water reference group with the role of advising both Council and the community on water supply and water quality issues in the Mossman/Port Douglas, Whyanbeel and Daintree Village water supplies.**
- 2. Appoint the Chair of Water & Waste Committee as the chair of the reference group and the Division 10 Councillor as the deputy chair.**
- 3. Invite the following to join the group:**
  - a. Representative from Port Douglas & Daintree Tourist Association**
  - b. Representative from Port Douglas Chamber of Commerce**
  - c. Queensland Health**
  - d. 4 Community representatives as follows:**
    - 1 Port Douglas representative**
    - 1 Mossman representative**
    - 1 Whyanbeel system representative**
    - 1 Daintree Village representative.**
- 4. Provide administrative support to the group through Water & Waste operational budgets.**

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### **INTRODUCTION:**

The Douglas community supported the implementation of a chemical free water supply in 2003. This chemical free supply does not provide any residual disinfection once the water leaves the treatment plants and enters the pipe network and reservoirs. This leaves the water susceptible to bacteriological contamination that would normally be rendered safe by chlorine disinfection.

Cairns Regional Council adopted the following resolution in General Business of the May Water & Waste Committee meeting:

*'That Council supports the continuation of the current chemical free treatment methods in the former douglas shire as it currently complies with the Australian Drinking Water Quality Guidelines.'*

Recent testing of reservoirs in Douglas has revealed low levels of bacteriological contamination in 7 out of 13 reservoirs. These results do not meet the Australian Drinking Water Guidelines. Advice to the community to boil water prior to consumption has been issued based on advice from Queensland Health.

The community in Douglas clearly has a strong affinity with their water supply and have expressed the view that they should be involved in any decisions about the future of the water supply. This report outlines the actions currently being taken to address the recent contamination issues and provides a recommendation that a community advisory group be established to assist Council in managing these and other water quality risks into the future.

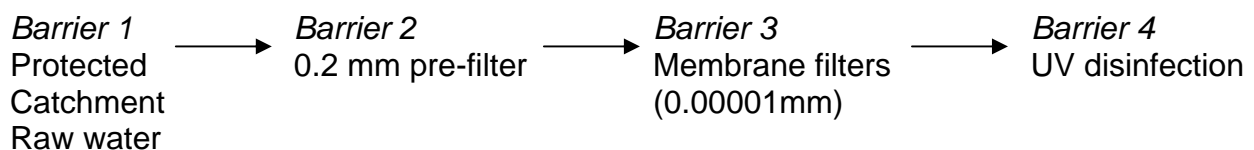
### **BACKGROUND:**

The former Douglas Shire Council (DSC) has 3 reticulated water supply schemes servicing over 90% of the 11,000 population in region. The 3 schemes are:

1. Mossman/Port Douglas scheme – supplying the Mossman and Port Douglas urban areas
2. Whyanbeel scheme – supplying Whyanbeel, Miallo, Newel Beach, Rocky Point and Wonga Beach
3. Daintree scheme – supplying Daintree Village.

Three new treatment plants were constructed in 2004 at a cost of approximately \$15 million for the 3 supply schemes. The same treatment processes are in place at all three plants as shown in the following diagram.

#### *Current Water Treatment Processes*



The hollow fibre membrane filtration component of the treatment process could be considered close to best practice and provides a very high level of treatment due to the very small pore size of the membranes (0.01 microns or 0.00001 mm). The membranes are capable of removing the potential contaminants of sediment and other particulate matter, bacteria, giardia, cryptosporidium, and most large viruses.

Council has previously been advised of the characteristics of the UV disinfection system and the potential issues associated with this form of disinfection. In summary, UV provides an instantaneous disinfection but does not provide any residual protection once the water enters the reticulation network and storage tanks. Water quality is therefore susceptible to contamination from ingress into the network, for example during a pipe burst, ingress into a reservoir, or from backflow from contaminated water from a connection to the network.

### Water Quality Testing

Water quality records to date indicate that Douglas Shire have tested the water at various locations in the pipe network generally on a monthly basis since 2003. There have been the occasional incidence of bacteriological contamination since that time. Advice from staff is that re-testing of site that experienced a failure has not returned positive results for bacteria.

Water quality testing has continued at the same locations since the amalgamation with the frequency increased to weekly. Additional sites have also been added into the testing regime.

Testing of a sample collected from the 10 ML Reef Park reservoir in Port Douglas on 26 August returned a low level of the indicator bacteria Escherichia Coli (E Coli). Upon re-test the low levels of E Coli were confirmed. This reservoir was subsequently isolated from the supply network.

Testing of samples from 13 reservoirs on Monday 1 September 2008 revealed 7 out of the 13 had low levels of E Coli. The results are provided below.

Reservoir	E.Coli (cfu/100mL)	Total Coliforms (cfu/100mL)
Daintree	2	>80
De Meio	3	33
Rocky Point	4	>80
Craiglie	2	>80
Flagstaff 1	6	>160
Flagstaff 3	4	>80
Mowbray	12	>80

Routine reticulation samples collected on Tuesday 2 September revealed no E Coli contamination in the pipe network.

On Wednesday 3 September, following discussion with Queensland Health, 36 samples were collected from the reticulation network. The results of this testing has revealed that there was no E Coli contamination in the reticulation network in the areas sampled.

That the samples tested from the pipe network continue to return zero contamination is curious to say the least. One possible explanation could be that the 250 ml sample collected for testing in the pipes simply misses the randomly distributed bacteria.

Water testing of samples collected on 8 September have confirmed the contamination of the above reservoirs and the absence of contamination in the pipe network.

### Water Quality Guidelines

Under the Australian Drinking Water Quality Guidelines, the bacteria E Coli is widely used as an indicator of faecal contamination of water supplies. Only certain variants of E. Coli are actually capable of causing disease. However, if E Coli is present, then there is a probability that other bacteria, viruses or pathogens such as Giardia and cryptosporidium may well be present. There have been several incidents throughout the world where E Coli outbreaks from drinking water have caused deaths and epidemics of gastroenteritis.

Under the Guidelines E Coli should not be detected in a minimum 100 mL sample of drinking water. If detected, immediate action should be taken. Queensland Health standards are that 0 E Coli should be present in the reticulation network.

Total coliform tests are used to detect the presence of a broad range of bacteria, only some of which indicate the presence of faecal contamination. There are many environmental coliforms that are not of faecal origin and may represent release from pipe or sediment biofilms or ingress of soils as a result of faults or repairs, or disinfection failure. As such, total coliforms are not used as specific indicator of concern but more a guide to suggest further testing should be undertaken on specific bacteria.

### Advice from Queensland Health

Advice has been sought from Queensland Health on the appropriate approach to take with regard to notification of the public of the current water quality results. I have attached the relevant recommendation from Public Health below:

‘We urge Council to remind the residents who use this water supply of the nature of the treatment, the fact that there is no residual disinfection, the fact that the reservoirs are exposed to contamination from bird faeces, vermin, cockroaches etc, and that the water has a long history of failures in regard to E. coli testing. Informing the public of these issues is a duty of care by the local government as it has chosen to provide an untreated water supply.

In particular, given the potential health risks, the Council should also remind affected residents that people in particular who are immuno-compromised, elderly or frail, or infants are advised by Queensland Health to only consume water that has been subject to further in-house treatment such as boiling of the water. Alternately the community could purchase bottled water for use in these situations.

In the event Council decides to take this course of action, it is recommended that the community be advised that the water used for consumption (drinking and food preparation) is boiled to ensure adequate sterilization.

**Advices to the community can be in the form of print, television or radio media and should be undertaken as a matter of priority. ‘**

Further advice from Queensland Health following review of the test results was as follows:

‘In this case the failed test results would indicate that a person could potentially be harmed by drinking the water in the event they contract disease’.

### Action taken to date

In an effort to remove the contamination and clear the boil water advice as soon as possible, low level doses of chlorine were added to the two contaminated reservoirs in Port Douglas on the weekend of 9/10 September. As most of Port Douglas was receiving water direct from the treatment plant at the time, any exposure of consumers to chlorine would have been minimal. The two contaminated reservoirs at Flagstaff Hill were taken out of service on Tuesday 8 September following review of ability to supply town.

Chlorine dosing in the Reef Park 10 ML reservoir has been successful in eliminating the E Coli contamination. This reservoir will be sealed and brought back on line following 3 consecutive days testing with no contamination evident. It is imperative that this reservoir be put back on line as soon as possible to secure supplies to the town.

For the remaining reservoirs, letter drops have been completed on 10 September advising residents to boil water and that the water would be chlorine dosed and the tanks sealed as soon as possible.

Following consultation with Queensland Health, the boil water advice for Port Douglas was lifted at 11:00am 10 September 2008 based on the contaminated reservoirs being isolated and the pipe network samples returning no evidence of contamination.

### **COMMENT:**

The majority of the reservoirs are not fully sealed and in some cases have large openings to the atmosphere that would allow contamination from birds, insects, lizards and the like to easily enter (see photographs in appendices). It is likely that this is the source of the contamination. Work on sealing the reservoirs commenced on Monday 8 September and is likely to take several weeks if not months. This may include re-roofing some reservoirs.

Council is in a very difficult situation with regard to the water supplies in the Douglas area. On the one hand Council has supported the desire of the community to have chemical free water supply. On the other hand we have legal obligations as a water service provider to provide safe drinking water. The impact of tourist losing confidence in the quality of water supply could be catastrophic to the economy in the area.

In the coming weeks the reservoirs will be sealed and this will hopefully reduce the risk of contamination. Operational actions such as periodic (eg 6 monthly) chlorination of the entire system, together with an active flushing program will assist in maintaining water quality in the system.

In the medium to long-term, there may be repeat episodes of bacteriological contamination and other events that require careful management and discussion with the community. One potential method of doing this will be to set up a community advisory group to have input into how these risks may be managed into the future. This will assist the community to have input into the decision making process as well as provide Council an avenue to report back to the community.

The potential makeup of the reference group would include the following:

- Divisional 10 Councillor – Julia Leu
- Chair Water & Waste Committee – Paul Gregory
- Representative from Port Douglas Tourism
- Representative from Chamber of Commerce
- Queensland Health
- 4 Community representatives as follows:
  - Port Douglas representative
  - Mossman representative
  - Whyanbeel system representative
  - Daintree Village representative.

Administrative support would be provided by Water & Waste and technical experts would be invited to address the group as needed.

There has been suggestions in the local Media in Port Douglas that Water & Waste operations staff released water that was unfit for drinking from the 10 ML reservoir at Reef Park. This allegation is categorically incorrect.

The 10 ML reservoir had been off-line for between 12 and 18 months. It was thoroughly cleaned using an underwater vacuum by a professional diver whose suit was disinfected prior to entering the tank. Once the tank was cleaned, the water was thoroughly tested and re-tested to ensure that the water met the Health Standards and would pose no threat to public health. The water was then slowly blended into the reticulation network.

To suggest that staff would not meet their legal obligations under the Public Health Act 2005 that are punishable by up to 2 years imprisonment is extremely unpalatable and a slur on the professionalism of all staff involved.

### **CONSIDERATIONS:**

#### **Corporate and Operational Plans:**

This issue related directly to Key Goal 5 Our Water Supply in the former Cairns City. The Former Douglas Shire's corporate plan contains the following relevant strategies:

Strategy 4.5: Maintain and enhance the water supply network in accordance with the triple bottom line concept with a focus on customer service, cost effectiveness and the environment.

Strategy 4.7: Develop and implement a range of services that meet the health, safety and lifestyle needs of the community and conform with legislative requirements.

#### **Statutory:**

Council as a registered water service provider has statutory obligations with respect to providing safe drinking water to the community. The following extracts from the Public Health Act (2005) is of relevance.

**57C When drinking water is unsafe**

Drinking water is unsafe at a particular time if it would be likely to cause physical harm to a person who might later consume it, assuming nothing happened to it after that particular time and before being consumed by the person that would prevent its being used for its intended use.

**57E Supply of unsafe drinking water**

A drinking water service provider must not supply drinking water that the provider knows, or reasonably ought to know, is unsafe.

Maximum penalty--3000 penalty units or 2 years imprisonment.

Policy:

Council has adopted a Drinking Water Quality Policy with the following intent:

To establish a policy for the implementation and maintenance of a Drinking Water Quality Management System that is consistent with the Australian Drinking Water Guidelines.

Financial and Risk:

There will be a financial impact on operational budgets in undertaking the maintenance work on the reservoirs. This could be in the order of \$500,000 and will be addressed at budget review time. There will be increased operational costs associated with operating and maintaining the water supplies in the Douglas region due to the susceptibility to contamination.

Council should note that unbudgeted operational expenditure of over \$500,000 has already been incurred to date on bringing the water treatment plants to a satisfactory standard.

The human health risks due to poor water quality have been discussed in the report.

Sustainability:

The issue of a chemical free water supply is a significant one for sections of the Douglas community. Council has signalled its intent of meeting the aspirations and expectations of the community by supporting the current water supply processes.

**CONSULTATION:**

Advice has been sought from Queensland Health and Natural Resources and Water Drinking Water Regulator Section on the water quality issues. The specific risks in the Mossman/Port Douglas supply have also been reviewed by experts from Water Futures who are well respected in the Australian and international scientific community.

**OPTIONS:**

Council could choose not to establish a community based water reference group. The preferred option would be to establish the group as a matter of priority due to the current water quality situation.

**CONCLUSION:**

It is recommended that Council resolve to:

1. Establish a community water reference group with the role of advising both Council and the community on water supply and water quality issues in the Mossman/Port Douglas, Whyanbeel and Daintree Village water supplies.
2. Appoint the Chair of Water & Waste Committee as the chair of the reference group and the Division 10 Councillor as the deputy chair.
3. Invite the following to join the group:
  - e. Representative from Port Douglas & Daintree Tourist Association
  - f. Representative from Port Douglas Chamber of Commerce
  - g. Queensland Health
  - h. 4 Community representatives as follows:
    - 1 Port Douglas representative
    - 1 Mossman representative
    - 1 Whyanbeel system representative
    - 1 Daintree Village representative.
4. Provide administrative support to the group through Water & Waste operational budgets.

**ATTACHMENTS:**

Advice from Queensland Health  
 Photographs of reservoirs  
 Australian Drinking Water Guidelines - Fact Sheets

Bruce Gardiner  
**General Manager**  
**Water & Waste**



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**From:** Paul Endres [mailto:Paul\_Endres@health.qld.gov.au]  
**Sent:** Thursday, 4 September 2008 12:45 PM  
**To:** Gardiner Bruce

**Subject:** RE: Presence of E. coli detected in the former Douglas Shire Council water supplies

Hi Bruce,

I refer to our discussions regarding failed water test results in the Port Douglas area. I understand that water analysis from seven (7) of thirteen (13) storage reservoirs in the Port Douglas area water supply system have failed to meet the requirements of the Australian Drinking Water Guidelines 2004, in that the reported samples contain levels of up to 12 *E.coli* per 100 ml of water. Despite this the reticulation system has indicated acceptable results. I agree, it is unusual and I note your activities to try and solve this problem. I further understand that the reservoirs indicated with failed results have been isolated from the system, and Council is presently taking samples throughout the reticulation network to check standards.

In light of this, and following your request, I offer the following recommendations for consideration by Cairns Regional Council:

Available information suggests that these drinking water supplies have a history of similar failures over a long period of time, both before and after the introduction of the current treatment processes in recent years. Our primary and longstanding concern is that there is no residual disinfection after the water leaves the treatment plants. Moreover the reservoir system is not enclosed which exacerbates the risk. Historically our firm recommendation (both before and after the introduction of the new micro water filter system) has been to ensure a residual chlorine level is maintained in the reticulation network. This is the most appropriate safeguard to public health as it provides a safe drinking water supply.

We urge Council to remind the residents who use this water supply of the nature of the treatment, the fact that there is no residual disinfection, the fact that the reservoirs are exposed to contamination from bird faeces, vermin, cockroaches etc, and that the water has a long history of failures in regard to E. coli testing. Informing the public of these issues is a duty of care by the local government as it has chosen to provide an untreated water supply.

In particular, given the potential health risks, the Council should also remind affected residents that people in particular who are immuno-compromised, elderly or frail, or infants are advised by Queensland Health to only consume water that has been subject to further in-house treatment such as boiling of the water. Alternately the community could purchase bottled water for use in these situations.

In the event Council decides to take this course of action, it is recommended that the community be advised that the water used for consumption (drinking and food preparation) is boiled to ensure adequate sterilization.

Most importantly remember that "Hot Water Burns Like Fire". Water at **60 degrees celsius** (NB this is less than the temperature of boiling water) can cause a major burn in less than a second. It is very important to prevent hot water burns by keeping hot water away from children and older people.

**Advices to the community can be in the form of print, television or radio media and should be undertaken as a matter of priority.**

As indicated by you, water leaving the plant is returning acceptable water quality. This indicates that the water is contaminated post treatment, which could possibly occur in the storage reservoirs - particularly if the reservoirs are not adequately protected from intrusion by pests, animals or other sources of contamination.

I recommend that an audit of the water storage and service lines associated with the system is conducted to ensure all potential sources of contamination are eliminated. I note that this process had been commenced which is appreciated.

I would also like to remind you that the Water Supply (Safety and Reliability) Act 2008 commenced on 1 July, 2008 and the Public Health Regulation has been amended to include standards for drinking water. At present the new Queensland Healths drinking water standards only include a standard of E. coli/100 mL being zero in the reticulation system.

The *Public Health Act 2005* has a number of provisions relating to drinking water that commenced on 1 July 2008. The provisions relate to defining when drinking water is unsafe and an offence about providing unsafe drinking water.

These provisions are:

### **S57 C When drinking water is unsafe**

Drinking water is **unsafe** at a particular time if it would be likely to cause physical harm to a person who might later consume it, assuming nothing happened to it after that particular time and before being consumed by the person that would prevent it being used for its intended use.

### **S57E Supply of unsafe drinking water**

A drinking water service provider must not supply drinking water that the provider knows, or reasonably ought to know, is unsafe.

Maximum penalty - 3000 penalty units or 2 years imprisonment

In this case the failed test results would indicate that a person could potentially be harmed by drinking the water in the event they contract a disease.

Thank you for your enquiries and please do not hesitate to contact me if you require any further assistance.

Kind regards

Paul Endres  
**Director Environmental Health Services**  
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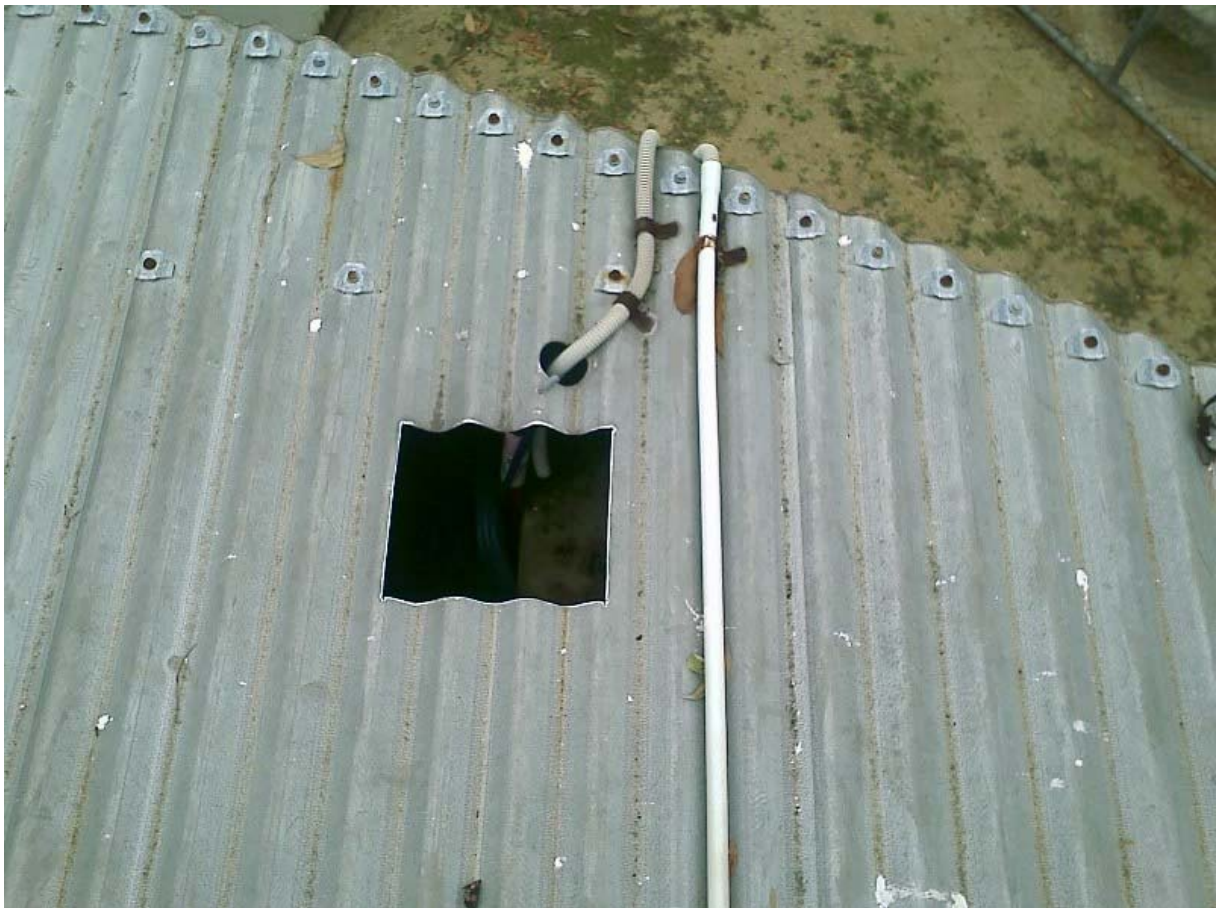
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**Examples of areas where contamination can enter reservoirs at Flagstaff Hill**



## Escherichia coli and thermotolerant coliforms

(revised 2002)

### GUIDELINE

**Escherichia coli (or thermotolerant coliforms) should not be detected in a minimum 100 mL sample of drinking water. If detected, immediate action should be taken (see summary table of microbiological guidelines).**

### GENERAL DESCRIPTION

Coliforms are gram-negative, nonsporing rod-shaped bacteria capable of aerobic and facultative anaerobic growth in the presence of bile salts or other surface active agents with similar growth-inhibiting properties. They are found in large numbers in the faeces of humans and other warm-blooded animals.

Thermotolerant coliforms are more specific indicators of faecal contamination than total coliforms.

Either thermotolerant coliforms as a group, or *Escherichia coli*, can be used to indicate the presence of contamination. Tests for thermotolerant coliforms can be simpler but *E. coli* is a better indicator because some environmental coliforms are thermotolerant (*Klebsiella*, *Citrobacter* and *Enterobacter*). *E. coli* is the most common thermotolerant coliform present in faeces and is regarded as the most specific indicator of recent faecal contamination.

Thermotolerant coliforms, including *E. coli*, can ferment lactose (or mannitol) at  $44.5 \pm 0.2^\circ\text{C}$  with the production of acid within 24 hours. Thermotolerant coliforms that produce indole from tryptophan at  $44.5 \pm 0.2^\circ\text{C}$  are regarded as being *E. coli*. *E. coli* also give a positive result in the methyl-red test and a negative Voges-Proskauer test and cannot use citrate as the sole source of carbon. Also, most *E. coli* produce the enzyme  $\beta$ -glucuronidase.

### AUSTRALIAN SIGNIFICANCE

*E. coli* (or thermotolerant coliforms) are used as specific indicators of faecal contamination and hence the safety of water for drinking. However, some waters can support survival or regrowth of environmental thermotolerant coliforms. Where this is suspected, *E. coli* should be used.

### TREATMENT OF DRINKING WATER

Treatment by chlorination or other acceptable forms of disinfection inactivates *E. coli*, (or thermotolerant coliforms) in water, provided the turbidity is low.

### METHOD OF IDENTIFICATION AND DETECTION

*E. coli*, (or thermotolerant coliforms) numbers can be determined using membrane filtration (MF) for concentration of the organisms from water, followed by growth in enrichment/selective media or multiple tube dilution (most probable number – MPN) procedures (AS 4276.6 and 4276.7 1995). Specific secondary tests are used with both MF and MPN procedures to confirm the identification of thermotolerant coliforms.

Alternatively, the presence of *E. coli*, can be detected by testing for the production of the enzyme  $\beta$ -glucuronidase (APHA method 9223 1998). Test methods include the enzyme substrates such as 4-methylumbelliferyl- $\beta$ -D-glucuronide (MUG) which is hydrolysed by  $\beta$ -glucuronidase to produce the fluorogenic metabolite 4-methylumbelliferyl. Both enumeration and presence/absence tests are available.

As the detection of any *E. coli*, in 100 mL of drinking water requires further action, either form of test is acceptable.

NOTE: Important general information is contained in PART II, Chapter 5

## HEALTH CONSIDERATIONS

Thermotolerant coliforms are normal inhabitants of the intestine, are always present in high numbers in human and animal faeces, and are generally regarded as specific indicators of faecal contamination. However, environmental thermotolerant coliforms, which can occur in some waters, are of lesser significance. *E. coli*, is the most specific indicator for faecal contamination. While most thermotolerant coliforms are nonpathogenic there are some pathogenic subtypes of *E. coli*, that can cause enteric illness including enteropathogenic, enteroinvasive, enterotoxigenic and enterohaemorrhagic strains (Bopp 1999).

Enteropathogenic *E. coli*, have been associated with outbreaks of infantile gastroenteritis but experiments in adult volunteers have shown that they also cause disease in adults. The pathogenic mechanisms employed by these organisms are not fully understood.

Enteroinvasive *E. coli*, (EIEC) produce dysentery by a mechanism similar to *Shigella* spp. These organisms invade the colonic mucosa and cause bloody diarrhoea. This property seems to be restricted to a few O sero-groups.

Epidemiological evidence suggests that enterotoxigenic *E. coli* (ETEC) are responsible for most episodes of *E. coli* diarrhoea, particularly in developing countries. ETEC strains can cause a cholera-like syndrome in infants, children and adults, producing a heat-labile enterotoxin (LT) related to cholera enterotoxin and/or a heat-stable enterotoxin (ST). The action of LT is the same as the cholera toxin. The ability of ETEC to cause disease depends not only on the production of enterotoxin but also upon the ability of these organisms to colonise the small intestine. Various colonising factors or adhesins have been described.

Enterohaemorrhagic *E. coli* (EHEC), including serogroups such as O111 and O157 are relatively rare strains that produce large quantities of shiga-like (or vero) toxins that can cause illness ranging from mild diarrhoea to haemorrhagic colitis. The latter is characterised by blood-stained diarrhoea accompanied by abdominal pain. In addition, EHEC strains can cause haemolytic uraemic syndrome (HUS), which is characterised by acute renal failure and haemolytic anaemia. The infectious dose may be very low.

Standard *E. coli* identification methods cannot be used to detect EHEC strains. *E. coli* O157:H7 does not grow above 41°C on selective media and it does not produce β-glucuronidase. However, specific testing is not recommended unless presence is suspected.

## DERIVATION OF GUIDELINE

*E. coli* (or thermotolerant coliforms) should not be present in a minimum 100 mL sample of drinking water. The presence of these organisms is indicative of faecal contamination and suggests a potentially serious fault in the integrity of the water supply system.

The effect on the community of noncompliance with the guideline will depend on the *E. coli* strain involved, whether faecal pathogens are also present, the number of organisms and the presence of susceptible individuals.

## REFERENCES

- APHA Method 9223 (1998). Standard methods for the examination of water and wastewater, 20th edition. American Public Health Association, Washington.
- AS 4276.6 (1995). Thermotolerant coliforms and *Escherichia coli* – Estimation of most probable number (MPN). Australian Standards, Standards Association of Australia, Sydney, NSW.
- AS 4276.7 (1995). Thermotolerant coliforms and *Escherichia coli* – Membrane filtration method. Australian Standards, Standards Association of Australia, Sydney, NSW.
- Bopp CA, Brenner FW, Wells JG and Strockbine NA (1999). *Escherichia*, *Shigella* and *Salmonella*. In: Murray PR, Baron EJ, Pfaller MA, Tenover FC and Tenover RH (eds), *Manual of Clinical Microbiology*, 7th edition. ASM Press, Washington DC, pp 459–474.

NOTE: Important general information is contained in PART II, Chapter 5

## Coliforms

(Revised 2002)

### GUIDELINE

***Due to the lack of direct health significance, no guideline value is proposed for coliforms (excluding Escherichia coli).***

### GENERAL DESCRIPTION

Coliforms are a diverse group of bacteria including *Escherichia coli* and other thermotolerant coliforms (see also Fact Sheet on *Escherichia coli* and *thermotolerant coliforms*). Faecal material contains large numbers of coliform bacteria but there are many species that occur naturally in the environment. Coliforms are gram-negative nonsporing rod-shaped bacteria, capable of aerobic and facultative anaerobic growth in the presence of bile salts or other surface-active agents with similar growth-inhibiting properties. They are able to ferment lactose with the production of acid within 48 hours at 35–37°C. Fermentation by these organisms begins with the cleavage of lactose into galactose and glucose by the enzyme  $\beta$ -galactosidase. Coliforms are oxidase-negative.

It should be noted that the above characteristics are not taxonomic criteria, but practical working definitions used for water examination purposes.

Some test methods may identify aeromonads, which can also produce acid from lactose, as presumptive coliform organisms unless excluded by subsequent confirmatory tests. Aeromonads are oxidase positive.

### TREATMENT OF DRINKING WATER

Treatment by chlorination or other acceptable forms of disinfection inactivates these microorganisms in water, provided the turbidity is low.

### METHOD OF IDENTIFICATION AND DETECTION

Total coliforms can be quantified in water by using membrane filtration (MF) for concentration of the organisms from water, followed by growth in enrichment/selective media or multiple tube dilution (most probable number – MPN) procedures (AS 4276.4 and 4276.5 1995). Specific secondary tests are used with both MF and MPN procedures to confirm the identification of coliform organisms.

Alternatively, the presence of coliform bacteria can be detected by testing for the production of the enzyme  $\beta$ -galactosidase (APHA method 9223 1998). Enzyme substrate tests incorporate chromogenic substrates such as ortho-nitrophenyl- $\beta$ -D-galactopyranoside (ONPG) or chlorophenol red- $\beta$ -D-galactopyranoside (CPRG). When the substrates are hydrolysed, a colour change is produced. Test methods may also include a substrate such as 4-methylumbelliferyl- $\beta$ -D-glucuronide (MUG), which is hydrolysed by the enzyme  $\beta$ -glucuronidase, produced by most *E. coli*, to form the fluorogenic metabolite 4-methylumbelliferyl. It has been reported that more coliform bacteria may be detected using enzyme substrate based methodology in comparison to MF based methodology (Adcock and Saint 1997).

### HEALTH CONSIDERATIONS

Total coliforms (excluding *E. coli*) are not considered useful as indicators of the presence of faecal contamination and enteric pathogens. There are many environmental coliforms that are not of faecal origin. The presence of these coliforms may represent release from pipe or sediment biofilms or ingress of soils as a result of faults or repairs, or disinfection failure.

NOTE: Important general information is contained in PART II, Chapter 5

Australian Drinking Water Guidelines

#### DERIVATION OF GUIDELINE

Coliforms can be used in operational monitoring to indicate inadequate treatment, breakdowns in system integrity or the presence of biofilms. No guideline value is established, if used, numbers should be established on a system specific basis, taking into consideration relevant historical data and an understanding of the characteristics of the system.

#### REFERENCES

Adcock PW and Saint C (1997). Trials of Colilert System. *Water*, 24(2), 22–25.

APHA Method 9223 (1998). Standard Methods for the Examination of Water and Wastewater, 20th Edition. American Public Health Association, Washington.

AS 4276.4 (1995). Coliforms – Estimation of most probable number (MPN). Australian Standards, Standards Association of Australia, Sydney, NSW.

AS 4276.5 (1995). Coliforms – Membrane filtration method. Australian Standards, Standards Association of Australia, Sydney, NSW.

NOTE: Important general information is contained in PART II, Chapter 5

Australian Drinking Water Guidelines