



## **Disinfection By-Products Submission to the National Health and Medical Research Council November 7 2016**

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Friends of the Earth has conducted sporadic research into disinfection by-products in drinking water, particularly up to 2013. The major interest has been the collection of data pertaining to breaches of the ADWG's (Australian Drinking Water Guidelines). This research has only looked at three states Tasmania, Victoria and South Australia, as our capacity is extremely limited. Right to Information and Freedom of Information Requests have been the source of most of the information, as well as Drinking Water Quality Annual Reports conducted by several Victorian water authorities.

The information is probably nothing new in terms of risks associated with DBP's (Disinfection By-Products), however what is worth acknowledging that increasingly, the community is becoming more informed and concerned about drinking water issues. These issues often relate to basic understandings of whether specific guidelines have been met or not. However the public is becoming better educated particularly concerning the health related issues surrounding chlorinated drinking water supplies.

A quick glance over water quality reports reveals that in terms of guideline levels breached by a plethora of substances, it does not take very long to see that DBP's are often a stand out in terms problems in a number of communities. It is also interesting to note that despite their prevalence, the community is largely uninformed about DBP's and their potential health impacts. Perhaps this is because the DBP issue is complicated and is not as "clearly understood" as other issues eg heavy metal contamination.

It is also interesting to note that if water authorities take action to remove DBP's, other DBP's can be formed, particularly with the use of chloramination. This also means that simple solutions are in fact quite difficult to determine. A risk trade-off is the end result.

From the research that FoE has generated it is clear, that generally speaking, the highest risk of high levels of DBP's exceeding the levels specified in the ADWG, occur in small communities, often at the end of the supply network. In Victoria some work has been done, particularly since the Millenium Drought, to get alternative water sources to these stressed communities and to change the water treatment process to facilitate lower DBP levels,

particularly for THM's (Trihalomethanes). Again this is not groundbreaking information but may be of interest in terms of getting a grasp on what is happening in often neglected parts of the country.

It is also evident from our research that if guideline levels for THM's are reduced for example, to levels equivalent to the United States (80µg/L) the majority of the Australian population could be currently consuming drinking water at levels well exceeding the US Guidelines. It is strange that few studies have been carried out in Australia looking at the possible health implications of exposure to high levels of DBP's in drinking water.

## **Contents**

**FoE's major concerns: p3**

**Studies of Interest: p6**

**Tasmania: p8**

**Victoria: p9**

**Westernport Water: p9**

**Grampians Wimmera Mallee Water: p10**

**Central Highlands Water: p13**

**Wannon Water/Barwon Water: p15**

**South Australia: p17**

**NDMA: p22**

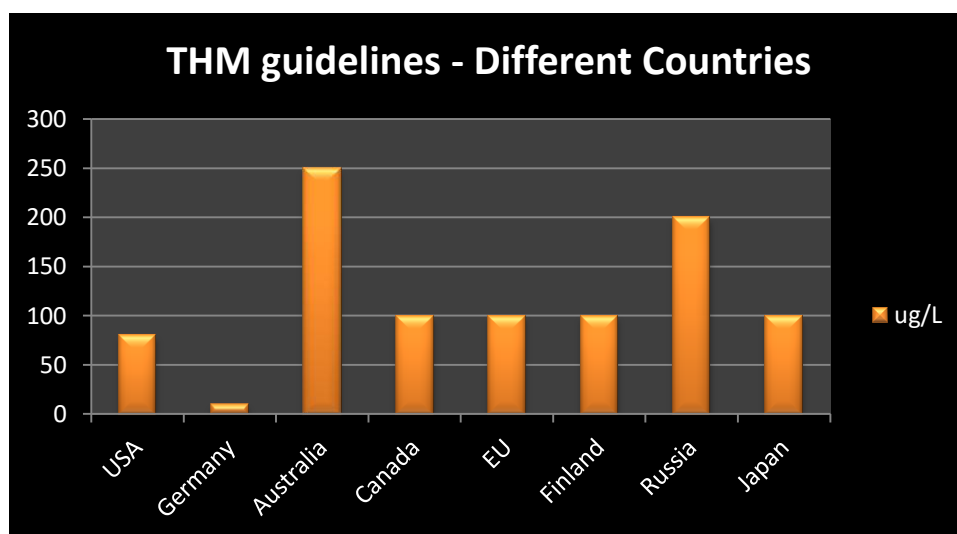
**Climate Change and Drinking Water: p24**

## FoE's major concerns include:

- FoE's major concern is that current Australian guidelines do not take into account exposure of DBP's via dermal exposure and inhalation. They only take into account drinking water. Exposure levels from showering, breathing or swimming in water containing high levels of DBP's are not factored into Australian guidelines and this has been the case since 1996. (If an average person drinks 2L of water per day, bathing, showering or swimming could increase the daily exposure to DBP's by another 50-100%). *“Although drinking water studies in laboratory animals might reflect human risks associated with oral exposure, they may not adequately represent risks from dermal or inhalation exposures. The latter exposures lack first-pass liver metabolism and may result in a relatively greater extrahepatic distribution of bromodichloromethane than from oral exposure alone. Indeed, blood levels of trihalomethanes including bromodichloromethane were four to five times higher in people who took 10-minute showers or bathed for 10 minutes than in people who drank one litre from the same tap water source in 10 minutes (Backer et al., 2000). Thus, evaluations of human risk to bromodichloromethane in tap water need to account for all potential routes of exposure, not just oral”.*

(NTP TECHNICAL REPORT ON THE TOXICOLOGY AND CARCINOGENESIS STUDIES OF BROMODICHLOROMETHANE (CAS NO. 75-27-4) IN MALE F344/N RATS AND FEMALE B6C3F1 MICE (DRINKING WATER STUDIES) NATIONAL TOXICOLOGY PROGRAM P.O. Box 12233 Research Triangle Park, NC 27709 February 2006. NTP TR 532NIH Publication No. 06-4468. National Institutes of Health Public Health Service. U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES)

- The NHMRC and other Australian agencies have failed to provide funding for long term health studies on effects exposure to high levels DBP's in Australian drinking water. These levels are likely to be higher in Australian than many other countries.
- Australian THM Guidelines appear high in regards to overseas guidelines. No explanation is given as to why Australian guideline levels are higher than those overseas.



- How does the health guideline pertain to foetuses, babies and small children? The guidelines are supposed to take into account a lifetime exposure. However, small children may be exposed to high levels of DBP's for their entire short lives, as several communities on Phillip Island were during 2005-12. Does exposure to BDCM (Bromodichloromethane) for example, for the first five to six years or life increase cancer risk?

*“Preliminary animal studies indicate that BDCM and other trihalomethanes that contain bromine may be more toxic than chlorinated trihalomethanes such as chloroform. For this reason, and based on the availability of scientific data for BDCM, a separate guideline was also developed for BDCM. BDCM is considered to be a probable carcinogen in humans, with sufficient evidence in animals and inadequate evidence in humans. Animal studies have shown tumours in the large intestine in rats. Among the four trihalomethanes commonly found in drinking water, BDCM appears to be the most potent rodent carcinogen, causing tumours at lower doses and at more target sites than the other three compounds. Exposure to BDCM at levels higher than the guideline value has also been linked to a possible increase in reproductive effects (increased risk for spontaneous abortion or stillbirth) above what can normally be expected. Further studies are required to confirm these effects.”*

<http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/trihalomethanes/guide-eng.php>

- Some studies (acknowledged by Government Agencies) have also stated that high levels of TTHMs have been responsible for reproductive problems and miscarriages <http://water.epa.gov/drink/contaminants/index.cfm>
- Other studies have not found associations. However FoE believes it better to err on the side of caution and decrease guideline levels in accordance with trends overseas.
- What are synergistic effects of exposure to a range of DBP's at the same time? For many communities a whole gamut of DBPs' may be in their drinking water. What are the impacts of combined levels of DBP's? Guidelines appear to be tailored for single DBP's (excluding THM's).
- Impacts of DBP's from climate change. Friends of the Earth is already aware that climate change poses risks to drinking water quality. These risks include longer more intense droughts (raising organic molecule and salt levels in depleted reservoirs), increasing risk from bushfires, heavier more intense rainfall creating more risk of landslips and turbidity of water supplies etc.
- Increases in temperature, due to climate change, also create increases in water temperature also increasing risk of formation of DBP's.
- How do the guidelines take into account problems with compromised immune systems or people suffering from chemical sensitivity or diseases such as Multiple Chemical Sensitivity? Surveys conducted by the Department of Health in SA in 2002 and 2004 suggest that 0.9 percent of the population may have MCS, while an

estimated 16.4 percent may experience some chemical sensitivity. Interstate and overseas research has shown that up to 6 percent of the population may have MCS, with between 10-25 percent experiencing sensitivity to chemicals.

<http://sacfs.asn.au/download/Inquiry%20into%20Multiple%20Chemical%20Sensitivity%20%2822nd%20Report%20of%20the%20Social%20Development%20Committee%29.pdf>

- In light of the previous point, alternative treatments such as Chloramination may increase health problems such as skin rashes in susceptible people, yet decrease their risk of developing bladder cancer from THM exposure.
- What role do genetic factors have in making people more susceptible to DBP's eg the GSTT1 Gene?
- Exposure of pregnant women to elevated levels of THM's is also a concern. *A California study indicates that THMs may be responsible for reproductive problems and miscarriage. The study found a miscarriage rate of 15.7 percent for women who drank five or more glasses of cold water containing more than 0.075 mg/l (75 parts per billion) TTHM, compared to a miscarriage rate of 9.5 percent for women with low TTHM exposure. In addition to these risks, TTHMs are linked to bladder cancer, heart, lungs, kidney, liver, and central nervous system damage.*  
<http://water.epa.gov/drink/contaminants/index.cfm>
- DBP's have also been detected in high levels in swimming pools. Although water from swimming pools is not supposed to be consumed, there is little doubt that swimmers and particularly young children, may swallow volumes of swimming pool water which may also contain high levels of DBP's. How are swimming pool exposures not also factored into health guidelines?

*“Adults ingest on average half an ounce of water every time they swim, while kids usually swallow double that, germ expert [Kelly Reynolds](#), PhD, at the University of Arizona, tells BuzzFeed Health”.* [https://www.buzzfeed.com/carolinekee/swimming-pools-are-germ-cocktails?utm\\_term=.rb5QlaEDGD#.fw00LWk5p5](https://www.buzzfeed.com/carolinekee/swimming-pools-are-germ-cocktails?utm_term=.rb5QlaEDGD#.fw00LWk5p5)

*“The average amount of water swallowed (45min) by non-adults and adults was 37 ml and 16 ml, respectively”.* [J Water Health](#). 2006 Dec;4(4):425-30. Water ingestion during swimming activities in a pool: a pilot study. [Dufour AP](#)<sup>1</sup>, [Evans O](#), [Behymer TD](#), [Cantú R](#). <https://www.ncbi.nlm.nih.gov/pubmed/17176813>

- FoE has concerns that the ADWG for NDMA, currently set at 100ng/L may be too high.

## Recent (non-exhaustive) Studies of Interest

DNA methylation levels and long-term trihalomethane exposure in drinking water: an epigenome-wide association study. ***“Our results suggest that THM exposure may affect DNA methylation in genes related to tumors, including colorectal and bladder cancers. Future confirmation studies are required.”***

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4622514/>

Colon and rectal cancer incidence and water trihalomethane concentrations in New South Wales, Australia ***“A positive association was observed between colon cancer and water bromoform concentrations in men. Given the potential population impact of such an association, further research into the relationship between THMs, particularly brominated species, and colorectal cancer is warranted.”***

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4088985/>

Assessment of lifetime exposure to trihalomethanes through different routes. ***“Between 21% and 45% of controls unexposed to THM through ingestion were evaluated as moderately or highly exposed through showering or bathing, and 5-10% were exposed through swimming in pools.”***

<https://www.ncbi.nlm.nih.gov/pubmed/16556748>

Bladder cancer and exposure to water disinfection by-products through ingestion, bathing, showering, and swimming in pools. ***“Bladder cancer risk was associated with long-term exposure to THMs in chlorinated water at levels regularly occurring in industrialized countries.”***

<https://www.ncbi.nlm.nih.gov/pubmed/17079692>

Drowning in disinfection byproducts? Assessing swimming pool water. ***“The positive health effects gained by swimming can be increased by reducing the potential adverse health risks.”***

<https://www.ncbi.nlm.nih.gov/pubmed/17310693>

Low concentrations of bromodichloromethane induce a toxicogenomic response in porcine embryos in vitro. ***“... we showed that exposure to low concentrations of BDCM (10 and 100ppb) during the first week of embryo development induced adverse effect on the blastocyst rate and alteration of the estradiol pathway. Our results also suggest that blastocysts exposed to BDCM present transcriptomic and epigenomic adaptive modifications compatible with the cardiac anomalies observed by previous studies of newborns exposed to BDCM during gestation.”***

<https://www.ncbi.nlm.nih.gov/pubmed/27671623>

Disinfection By-Product Exposures and the Risk of Specific Cardiac Birth Defects.

<https://www.ncbi.nlm.nih.gov/pubmed/27518881>

Trihalomethanes in drinking water and the risk of death from esophageal cancer: does hardness in drinking water matter? ***“Our findings showed that the correlation between TTHM exposure and risk of esophageal cancer development was influenced by Ca and Mg levels in drinking water.”***

<https://www.ncbi.nlm.nih.gov/pubmed/23294300>

Biological and statistical approaches for modeling exposure to specific trihalomethanes and bladder cancer risk. ***“Total THM ( $\mu\text{g/L}$ ) provided a proxy measure of DBPs that yielded the strongest dose-response relationship with bladder cancer risk.”***

<https://www.ncbi.nlm.nih.gov/pubmed/23648803>

Long-term exposure to trihalomethanes in drinking water and breast cancer risk in the MCC-Spain study International Society for Environment Epidemiology (ISEE) 2016 Conference Abstract Number: P3-101 | ID: 3062 ***“Conclusions: Long-term exposure to residential TTHMs was related to breast cancer at the highest exposure categories (corresponding to levels around the regulated limits in the EU and USA), although a dose-response relationship was not clear for different routes of exposure. This large epidemiological study with extensive exposure assessment overcomes several limitations of previous studies”***

Risk of congenital anomalies in relation to the uptake of trihalomethane from drinking water during pregnancy ***“This study shows some evidence for an association between the internal dose of THM and the risk of congenital anomalies. In particular, increased prenatal exposure to brominated THM might increase the risk of congenital heart and musculoskeletal anomalies.”*** <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3607117/>

Exposure to Brominated Trihalomethanes in Water During Pregnancy and Micronuclei Frequency in Maternal and Cord Blood Lymphocytes ***“These findings suggest that exposure to BTHM may increase the frequency of MN in maternal binucleated lymphocytes.”*** <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3888564/>

Trihalomethane exposure and biomonitoring for the liver injury indicator, alanine aminotransferase, in the United States population (NHANES 1999-2006). ***“Results from this study suggest a need for further characterization of ALT activity and possibly other hepatic or metabolic diseases in populations with elevated drinking water THM concentrations.”*** <https://www.ncbi.nlm.nih.gov/pubmed/25847167>

Predictors of blood trihalomethane concentrations in NHANES 1999-2006. ***“We identified several factors associated with blood THMs that may affect their metabolism. The potential health implications require further study.”*** <https://www.ncbi.nlm.nih.gov/pubmed/24647036>

Trihalomethane exposure and biomonitoring for the liver injury indicator, alanine aminotransferase, in the United States population (NHANES 1999-2006). ***“Results from this study suggest a need for further characterization of ALT activity and possibly other hepatic or metabolic diseases in populations with elevated drinking water THM concentrations”.*** <https://www.ncbi.nlm.nih.gov/pubmed/25847167>

Case control study of the geographic variability of exposure to disinfectant byproducts and risk for rectal cancer ***“We also observed a geographic pattern of increased risk of rectal cancer in areas with the highest levels of bromoform in the county.”*** <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1890278/>

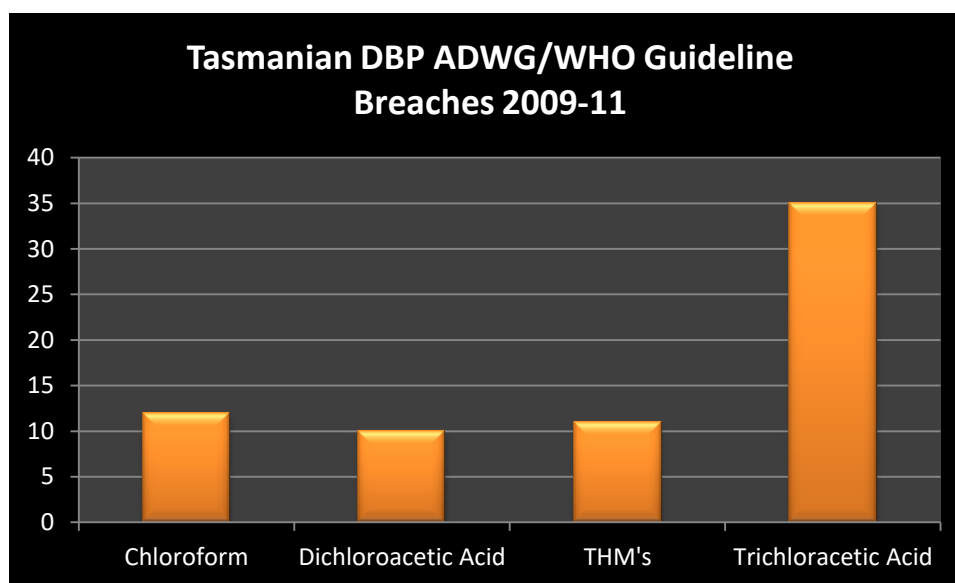
Occurrence and Mammalian Cell Toxicity of Iodinated Disinfection Byproducts in Drinking Water. ***“In general, compounds that contain an iodo-group have enhanced mammalian cell cytotoxicity and genotoxicity as compared to their brominated and chlorinated analogues.”*** <http://pubs.acs.org/doi/abs/10.1021/es801169k>

Mammalian cell cytotoxicity and genotoxicity of the haloacetic acids, a major class of drinking water disinfection by-products <http://onlinelibrary.wiley.com/doi/10.1002/em.20585/full>

## Tasmania

Friends of the Earth completed two short reports into Tasmanian drinking water, the first covered the years 2009-11 and the second covered the years 2013-14

The 2009-11 report saw 68 breaches to the Australian Drinking Water Guidelines for DBP and WHO Guidelines. All the WHO Guideline breaches (12) were for Chloroform at the community of Colebrook. 10 Dichloroacetic Acid breaches were detected at Ouse and Hamilton. The most common breaches were for Trichloroacetic Acid (35) at Colebrook, Ouse, Hamilton and Wayatinah.



Trichloroacetic Acid was detected at Colebrook in November 2011 at a level of 344µg/L, Dichloroacetic Acid was detected at Ouse in July 2011 at 237µg/L. Chloroform was detected at Colebrook at 570µg/L in May 2011. Trihalomethanes were detected at Colebrook at 510 µg/L.

Colebrook recorded 30 DBP breaches 2009-11, Ouse recorded 18 DBP breaches, Hamilton recorded 12 breaches and Wayatinah 8 breaches.

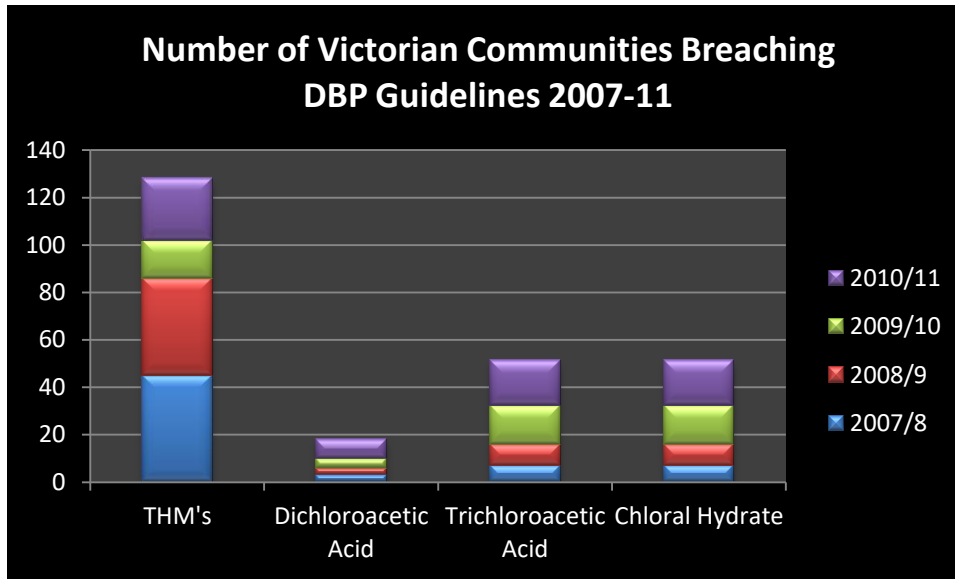
<http://www.foe.org.au/sites/default/files/TasDrinkingWaterLeadAluminiumFinal.pdf>

The communities of Colebrook and Tunbridge both breached the THM ADWG in 2013-14, with one detection at Colebrook measuring 310µg/L. The BDCM level at Tunbridge reached 74.5µg/L during the same year. Trichloroacetic Acid reached a level in Colebrook in 2013-14 of ~310µg/L, with an annual average of 199µg/L. Seven Tasmanian communities breached the Trichloroacetic Acid during 2013-14: Currie 163µg/L, Geeveston-Kermantie 170µg/L, Hamilton 163µg/L, Ouse 153µg/L, Roseberry 105µg/L, Wayatinah 110µg/L

During 2013-4, 5 communities recorded Dichloroacetic Acid Levels above 100µg/L. Colebrook 133µg/L, Currie 115µg/L, Hamilton 100µg/L, Ouse 120µg/L, Roseberry 150µg/L.



# Victoria



*This list is based on data sourced from Water Quality Reports published by various Victorian water authorities 2007-11*

## Westernport Water

<http://www.foe.org.au/sites/default/files/WesternportWaterDBP.pdf>

A report pertaining to Westernport Water (mainly Phillip Island) was produced in 2014. It covered the years 2005-12. In some locations average BDCM levels exceeded WHO guideline levels of 60µg/L for over 7 years. Could Phillip Island have one of the longest period in Australia for high levels of BDCM? These high levels also correspond with the Millennium Drought 1995-2009, which appears to have caused drinking water problems in a number of regions of Victoria.

Between 2005-12 BDCM levels exceeded WHO Guideline more than 250 times in the Westernport Water network. There were also breaches to ADWG THM Guideline (breached 63 times between 2006-12 with the worst years being 2007-8). The WHO guideline for Dibromochloromethane was also breached several times. The problem seemed to be resolved by switching treatment to Chloramination. The chloramination by-product NDMA was first detected at San Remo at 7ng/L in April 2013.

The eight year BDCM averages for the following communities were of most concern: Cowes 63µg/L, Ventnor 61µg/L, Sunset Strip 62µg/L and Rhyll.

Some street addresses where water samples were taken saw higher BDCM averages between 62µg/L -79µg/L for periods between 22-86 months.

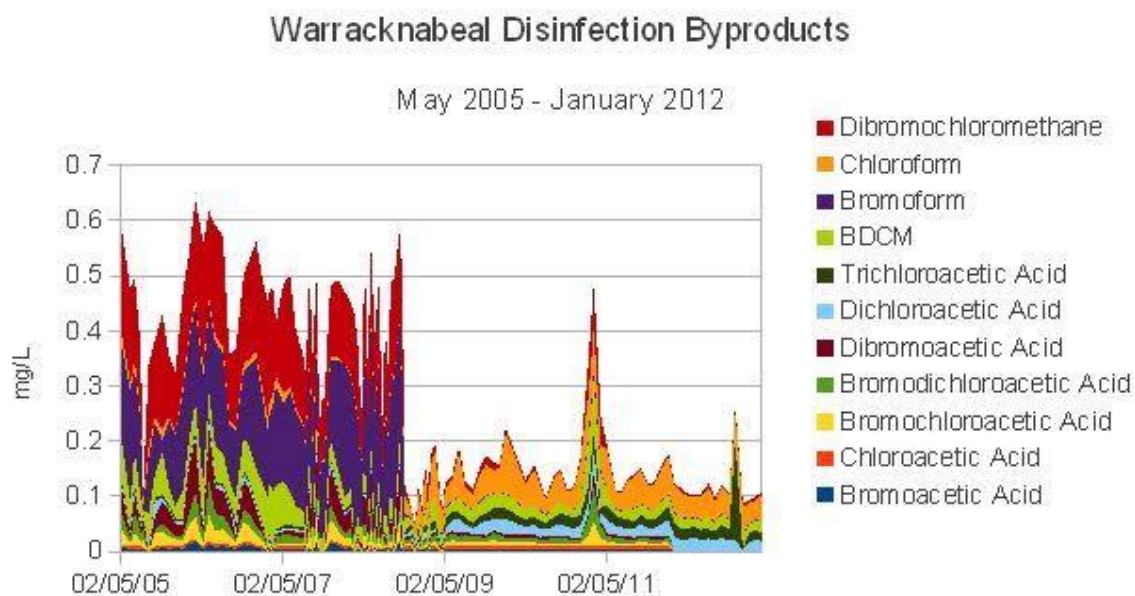
## Grampians Wimmera Mallee Water

[http://www.foe.org.au/sites/default/files/GWMWaterReportFinal\\_0.pdf](http://www.foe.org.au/sites/default/files/GWMWaterReportFinal_0.pdf)

This case study provided interesting insights into water quality problems associated with long term drought, bushfires and flooding. These events could become more widespread in many regions across Australia, as the impacts of climate change occur. This case study also raised questions about total amounts of DBP's at a given time, in comparison to ADWG which refer to singular DBP measurements, not combinations (except THM's). What is the synergistic effect of multiple DBP's at the same time?

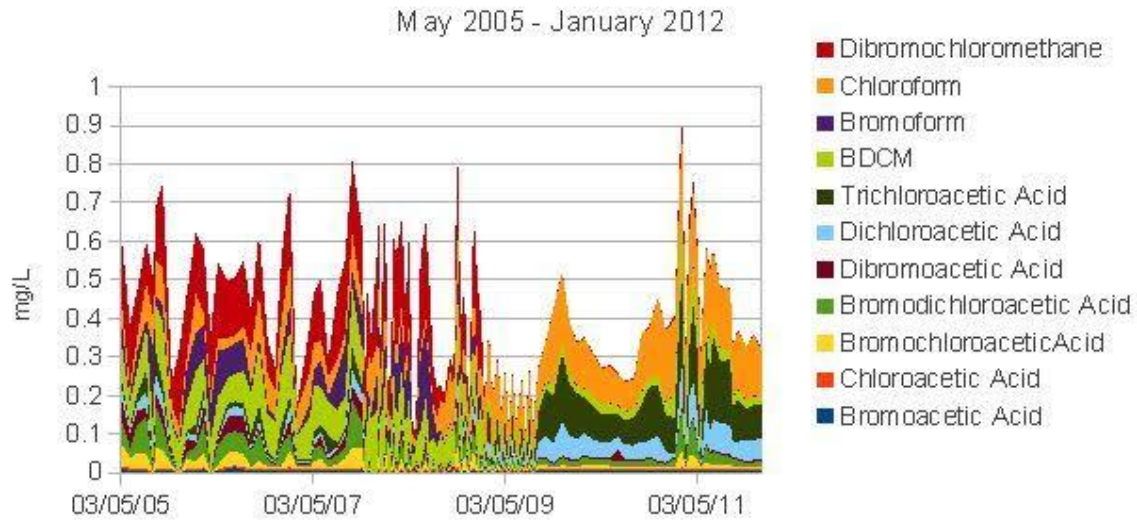
### Report Conclusions (graphs have been inserted for this submission)

*"1. Drought caused widespread increases in Trihalomethanes in numerous town water supplies in the Grampians Wimmera Region between 2005-2009, in many cases well above World Health Organisation and Australian Drinking Water Guidelines.*



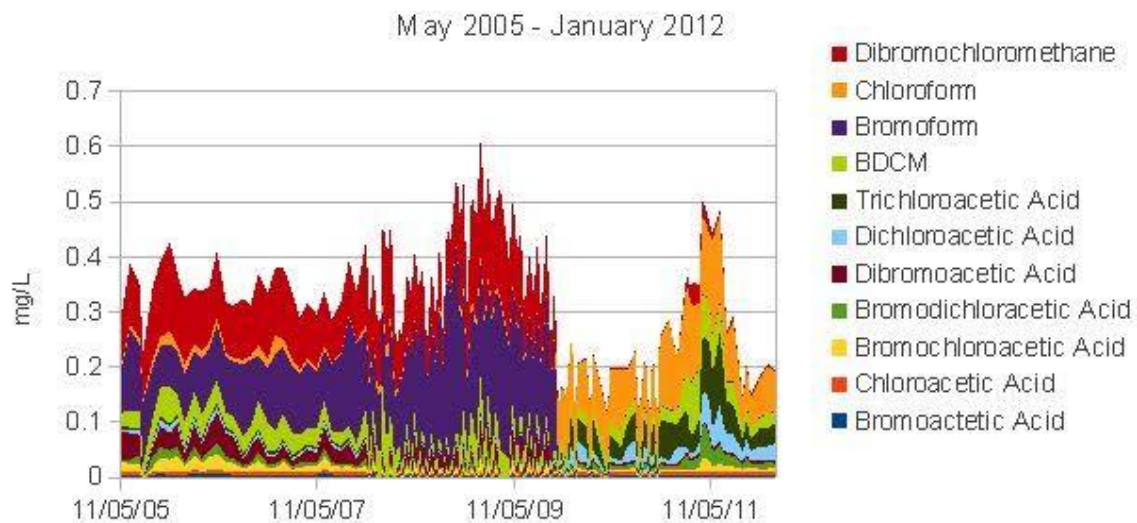
*2. The increases in Trihalomethanes were also associated with increased levels of salts remaining in water held in town storages.*

### Beulah Total Disinfection Byproduct Detections



3. A flush of “fresher” water after the drought (between October 2008 – October 2009) and connection of the Wimmera Mallee Pipeline initially saw better quality water arrive at towns that had suffered large from amounts of THM's during the drought.

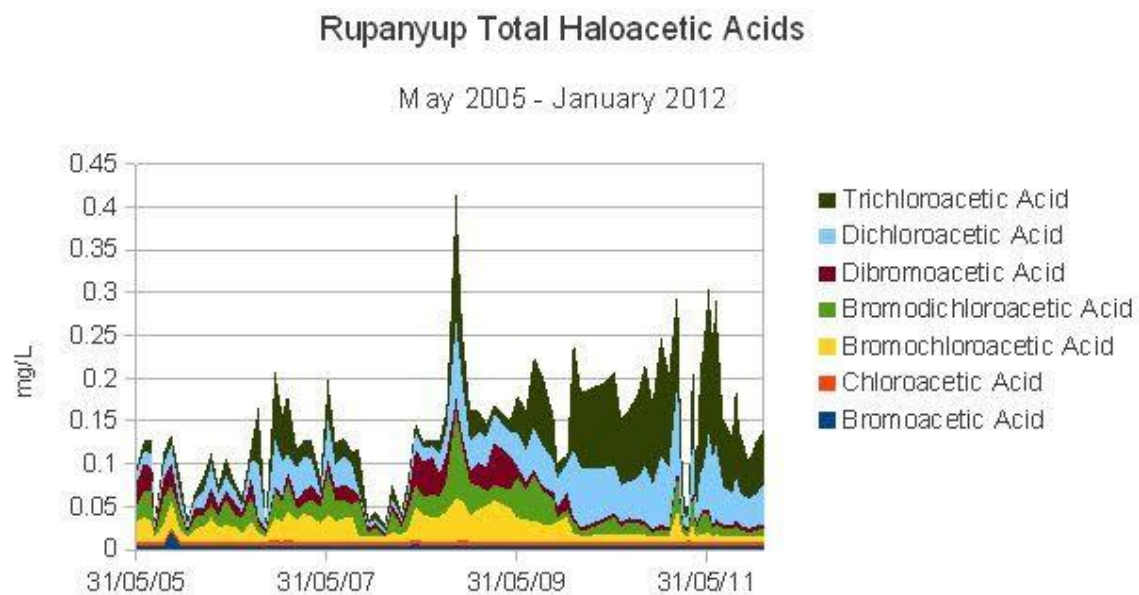
### Donald Total Disinfection Byproducts



4. Sharp decreases of Trihalomethanes occurred in several communities receiving water from the pipeline. Average decreases were 47%. Bromoform and Dibromochloromethane were significantly reduced, however chloroform eventually increased an average of 3 times in the communities studied.

5. In terms of Haloacetic Acids, all 9 communities saw decreases in formation of Bromochloroacetic Acid and Dibromoacetic Acid. All communities in this case study saw increases in exposure to Dichloroacetic Acid and all observed significant increases in the

*production of Trichloroacetic Acid (between 146 and 4000%) after pipeline water was supplied to their towns. These increases could also be attributed to the January 2011 floods.*



*6. Six communities in this case study saw increases (by between 43 and 130%) in Total Haloacetic acid exposure after receiving “fresh water” from the pipeline - an increase over 9 communities of 38.9%.*

*7. Seven communities were declared regulated in February 2012, highlighting the fact that new pipeline water has not led to a positive outcome in these communities.*

*8. Significant impacts on Grampians Wimmera source water at Lake Bellfield between 2005-11 was caused by fire, drought and flood. These circumstances were beyond the control of GWMWater, yet could signify similar events unfolding in the future, potentially caused by climate change. These water quality issues were the worst recorded for GWMWater.*

*9. Between 2007 and 2009 Lake Bolac and Willaura were receiving drinking water with levels of Chlorite 1.5 to 2 times above the Australian Drinking Water Guideline level of 0.8mg/L.*

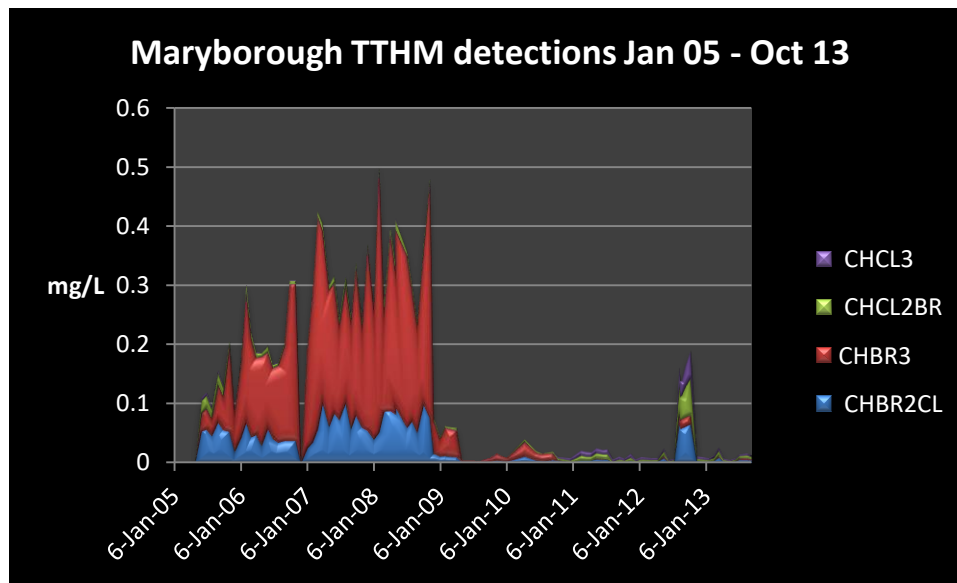
*10. For the communities studied in this case study, the primary concerns according to World Health Organisation Guidelines appear to be in descending order, Bromodichloromethane, Dibromochloromethane, Bromoform, Dichloroacetic Acid, Trichloroacetic Acid.*

**Chlorite** Australian Guideline: 0.8mg/L  
WHO Guideline: 0.7mg/L

Average Chlorite Levels for Lake Bolac 2007-9: 1.7887mg/L (224% above ADWG)  
Average Chlorite levels for Willaura 2007-9: 1.2876mg/L (161% above ADWG guideline)

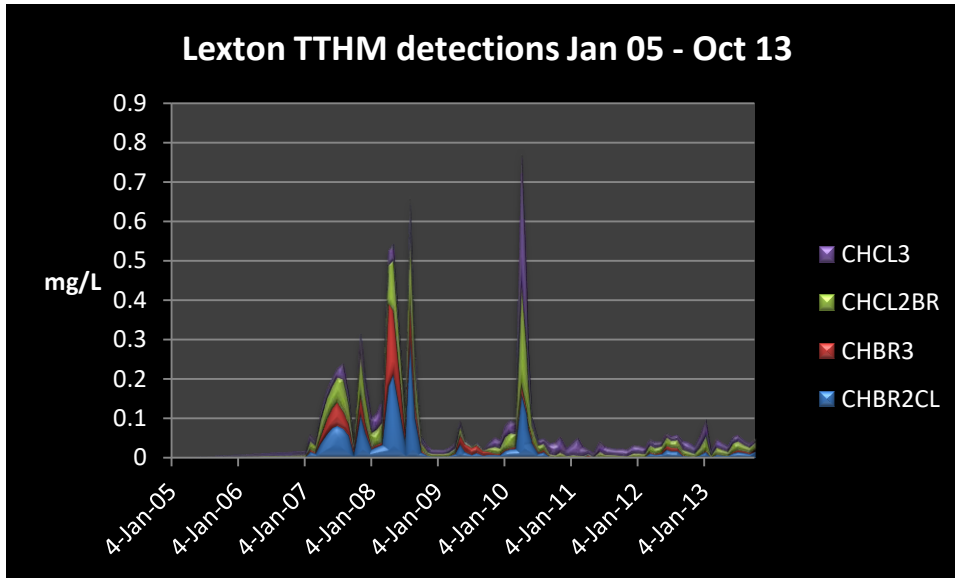
## Central Highlands Water

The Maryborough region of Central Victoria also suffered from the Millennium drought. The water supply – Tullaroop Reservoir (Talbot & Evansford Reservoirs) became “more saline” as water levels dropped, seeing an increase in THM’s. Water Chloramination started in this system in January 2009. Communities serviced: Adelaide Lead, Alma, Bowenvale, Carisbrook, Craigee, Daisy Hill, Majorca, Maryborough, Talbot, Timor. All communities saw similar THM issues. Avoca and Lexton supplied under separate systems.

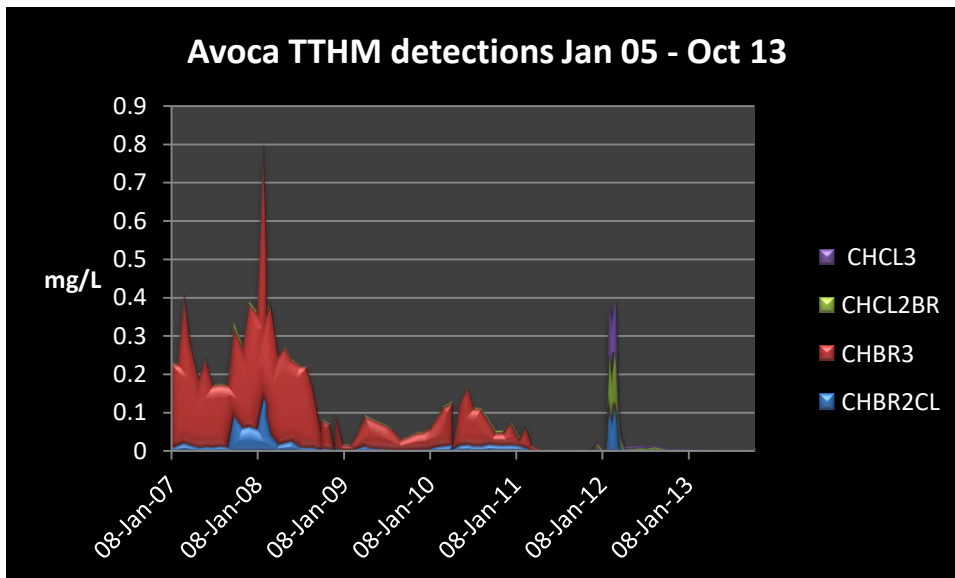


Bromoform dominated TTHM detections during the Millennium Drought, until chloramination. Interestingly Friends of the Earth has been contacted by members of the public since 2013 from Maryborough complaining about the smell of the water and reactions to skin. Showering has become problematic for some residents and some have mentioned that they break out in rashes after showers. Many are now relying on tank water. NDMA was first detected in the Maryborough supply network in December 2014. Highest NDMA levels recorded (2014-15) were 19ng/L.

*“Elevated trihalomethane results from the 2012/13 financial year in the Ballarat and Maryborough water supply systems were due to a temporary period of reversion to chlorination to manage system nitrification and improve disinfectant residuals.”*



Interestingly Lexton recorded high levels of NDMA 20-67ng/L over 2010-11. Lexton has a different water supply than Maryborough.



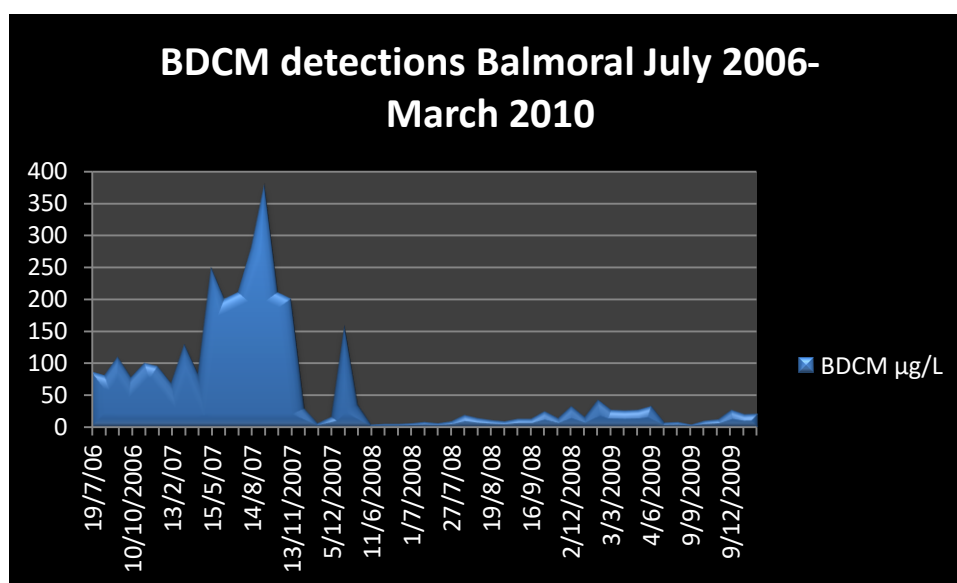
Bromoform was the dominant THM in this water supply as well.

## Wannon Water/Barwon Water

[http://www.foe.org.au/sites/default/files/SWVicWater\\_0\\_0.pdf](http://www.foe.org.au/sites/default/files/SWVicWater_0_0.pdf)

The following points were included in the above report.

*“5. Balmoral recorded levels of Bromodichloromethane (BDCM) six times higher than WHO Guidelines in September 2007 and recorded the highest average levels within the study area of BDCM for 17 months in 2006/7 (average over this time was 138.75µg/L). A new water treatment plant has significantly improved Balmoral's drinking water and resolved this issue, however for at least 17 months Balmoral residents were supplied with drinking water containing double the guideline level of BDCM.*”



***BDCM detections at Balmoral 2006-09. No detailed information was forthcoming for other THM detections from Balmoral in the information sent to Friends of the Earth from Wannon Water.***

6. *The highest average levels of BDCM recorded over 6 years were Coleraine and Sandford.*

7. *The greatest number of BDCM detections above the WHO Guidelines was Coleraine with 20.*

8. *Balmoral, Sandford, Glenthompson and Dunkeld all had BDCM averages above WHO Guidelines for longer than 6 months.*

9. *Coleraine is still sourcing BDCM tainted water above WHO Guidelines.*

10. *Moorabool River source water also breaches BDCM guidelines on occasions causing problems at Meredith and potentially Geelong and surrounding communities. The highest recorded BDCM level in the Moorabool catchment was recorded in February 2012”.*

Between May 2002 to June 2008 Balmoral THM detections >250µg/L 55 times, <250µg/L 2 times. June 2008 to August 2010 Balmoral THM detections >250µg/L 1 time, <250µg/L 34 times.

Highest Balmoral THM Detections on a year by year basis

970µg/L 388% above ADWG 2007/8

750µg/L 300% above ADWG 2005/6

740µg/L 296% above ADWG 2006/7

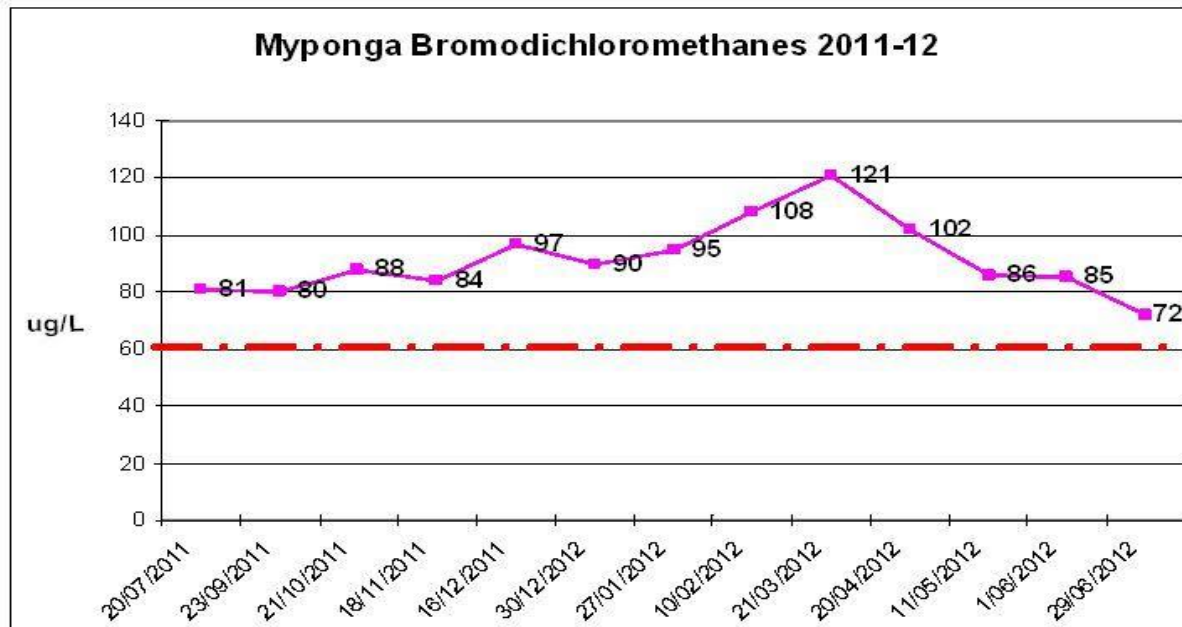
260µg/L 104% above ADWG 2009/10

*“Prior to the construction of the Balmoral Water Treatment Plant, the water from Rocklands was directly disinfected with sodium hypochlorite which resulted in the production of trihalomethanes at levels which exceed the Safe Drinking Water Regulations. Construction of a new water treatment plant was completed in January 2008. The new water treatment plant process involves coagulation, flocculation, dissolved air flotation, filtration and disinfection. The commissioning of this plant and the changing of the disinfection from chlorination to chloramination resulted in a reduction of the levels of trihalomethanes being generated. The water now complies with the requirements of the Safe Drinking Water Regulations 2005.”*  
(Drinking Water Annual Report 2007/8 p17)



## South Australia

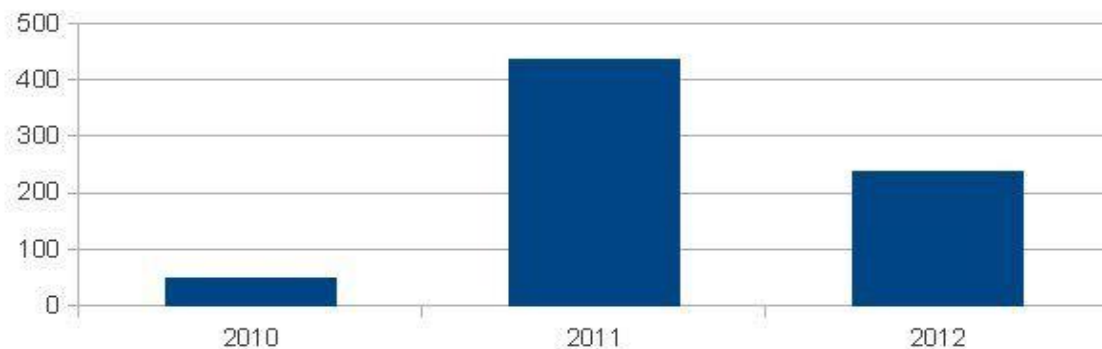
In October 2012, Friends of the Earth produced a detailed report focussing on SA Water breaches to the Australian Drinking Water Guidelines. The report can be found at: [http://www.foe.org.au/sites/default/files/SAWater2012a\\_0.pdf](http://www.foe.org.au/sites/default/files/SAWater2012a_0.pdf)



The substance of most concern was the THM Bromodichloromethane (or Dichlorobromoform), with 2300 detections above WHO Guidelines. The report also detailed that for some communities, levels of Bromodichloromethane were above safe drinking water levels for the best part of a decade.

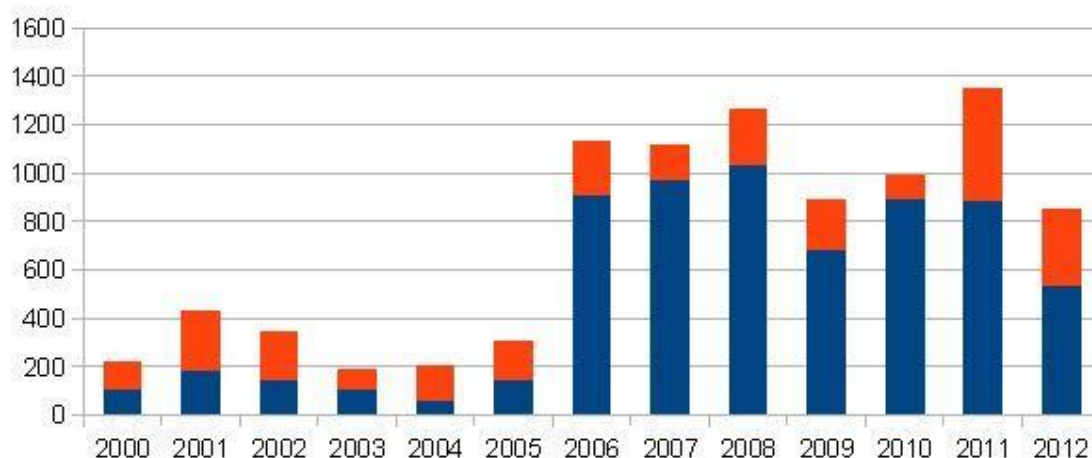
### SA Water Bromodichloromethane (BDCM) detections above WHO Guidelines

November 2010 - July 2012

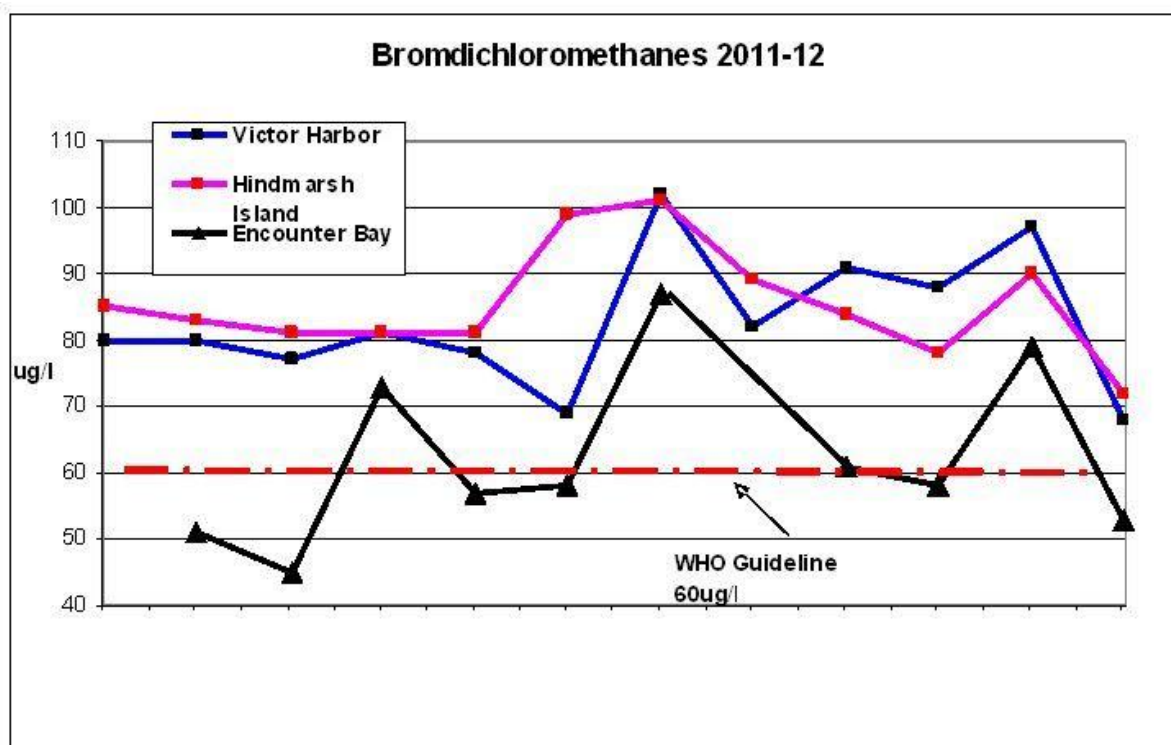


## SA Water ADWG - WHO Breaches 2000 - 2012

ADWG (Blue) - WHO (Red)



Bromodichloromethane/Dichlorobromoform detections at Victor Harbor averaged  $76.2\mu\text{g/L}$  over the 12 year period, meaning that this community was drinking this substance at an average of 27% above safe levels as determined by the World Health Organisation for the best part of a decade.

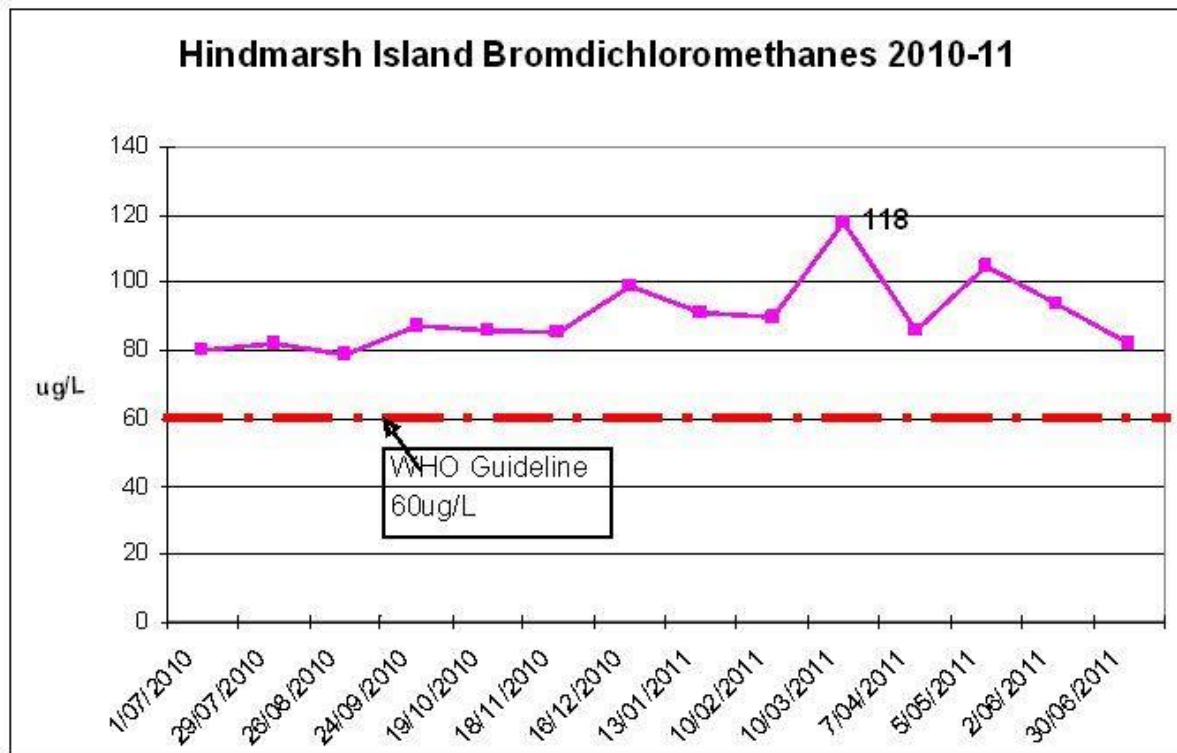
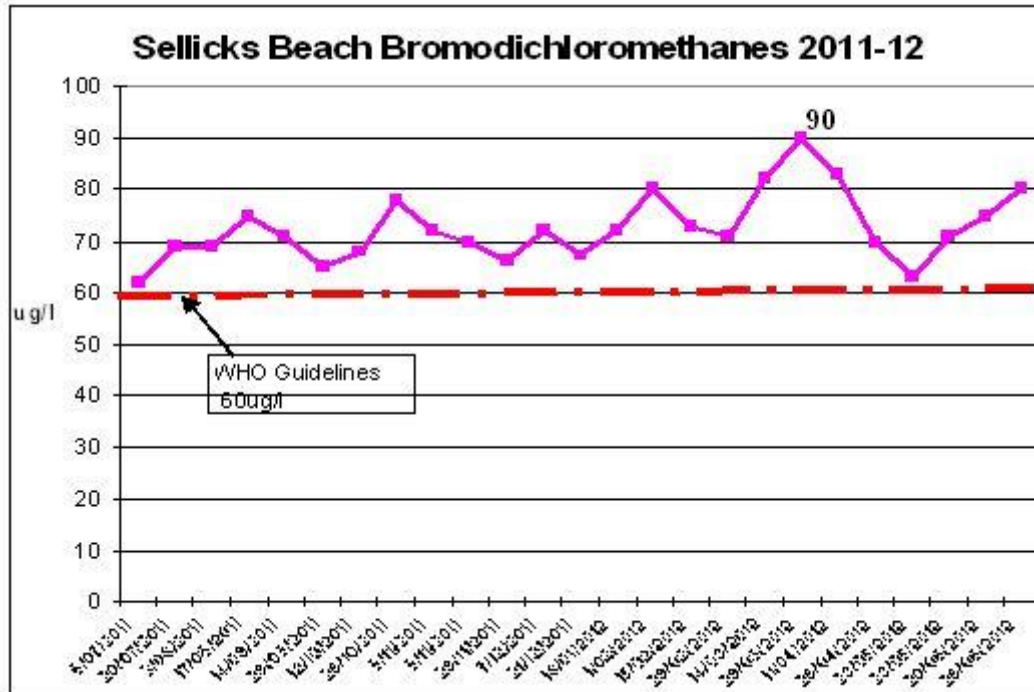


In South Australia January 2000 – July 2012:

Highest THM levels recorded: Wudinna  $1064\mu\text{g/L}$  20/2/01, Ceduna  $996\mu\text{g/L}$  19/2/01, Ceduna  $994\mu\text{g/L}$  19/3/01. Are these the highest THM levels ever recorded in Australia?

Highest Bromodichloromethane/Dichlorbromoform levels recorded: Kingscote 138µg/L 20/3/00, Swan Reach 131µg/L 11/1/01, 29/12/09 Port Wakefield 125µg/L.

Highest Bromoform levels: Ceduna 818µg/L 19/2/01, Wudinna 812µg/L 20/2/01, Ceduna 781µg/L 19/3/01. Are these the highest Bromoform levels recorded in Australia?



Highest Chloroform levels: Paringa 390µg/L 18/1/11, Cooltong 372µg/L 16/2/11, Cooltong 351µg/L 13/3/12.

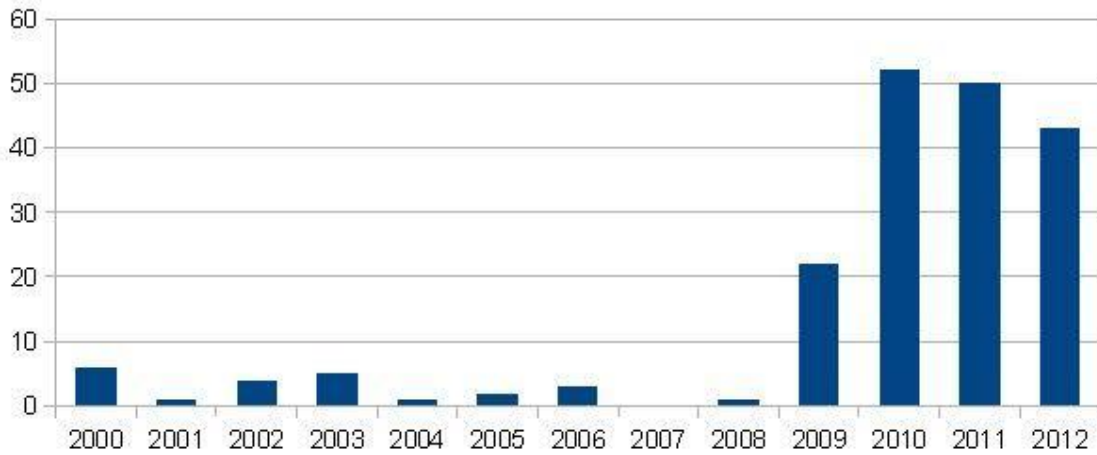
Highest Dibromochloromethane/Dibromochloroform: Brownlow 175µg/L 21/2/11,  
Brownlow 156µg/L 7/3/11, Emu Bay 148µg/L 14/2/11.

**ADWG Guideline Levels For Chloral Hydrate**

Highest Chloral Hydrate levels recorded by SA Water 2000-2012: 0.088mg/L Balaklava  
18/3/02.

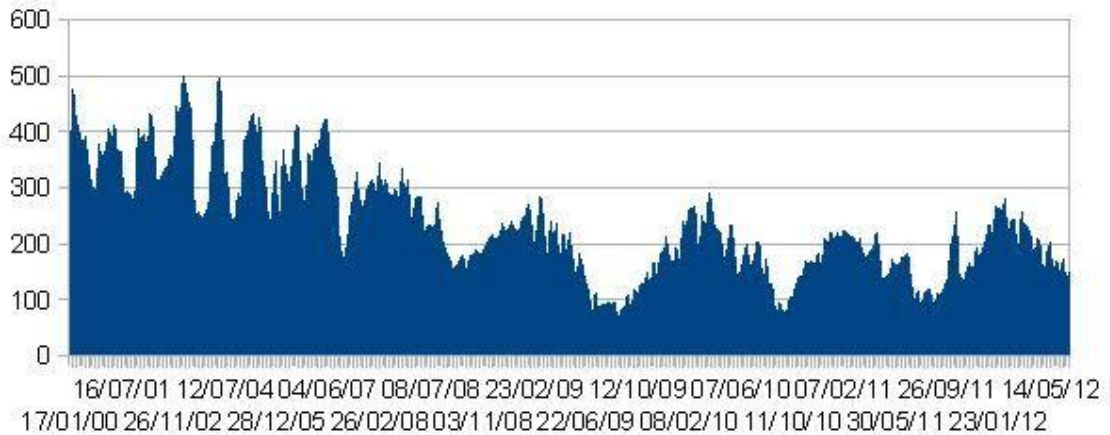
**Chloral Hydrate/Trichloroacetaldehyde**

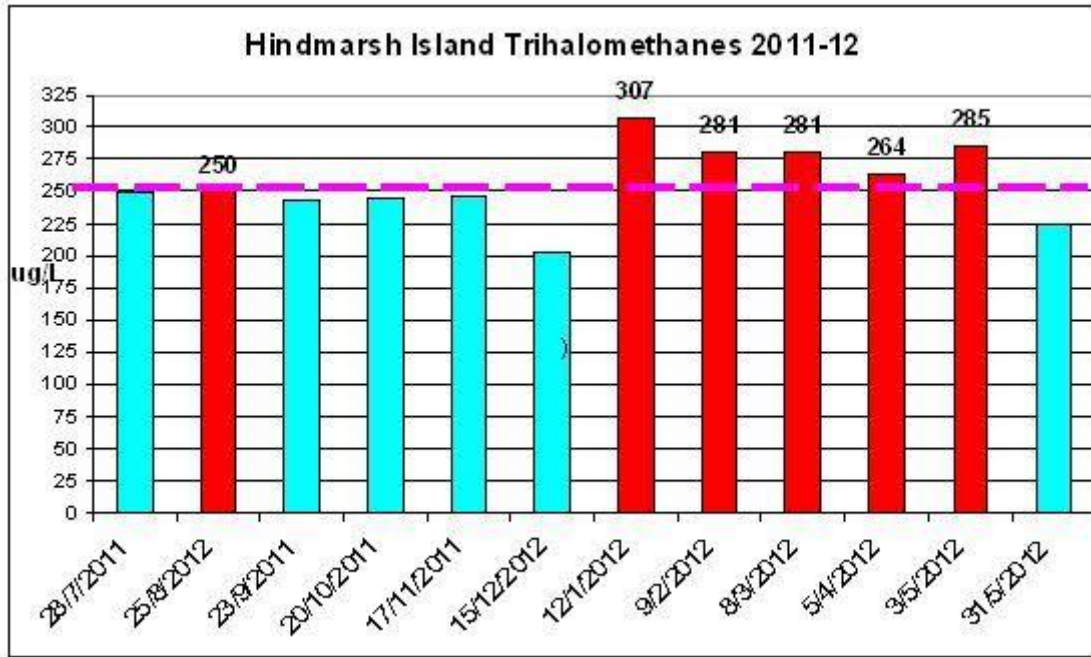
SA Water ADWG Breaches January 2000 - July 2012



**THM detections Kingscote 2000 - June 2012**

ADWG Guideline 250ug/L

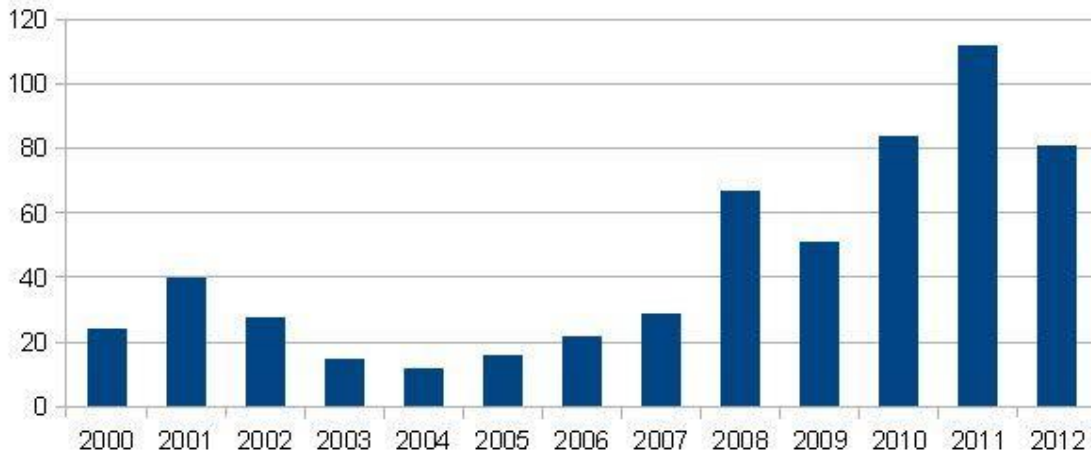


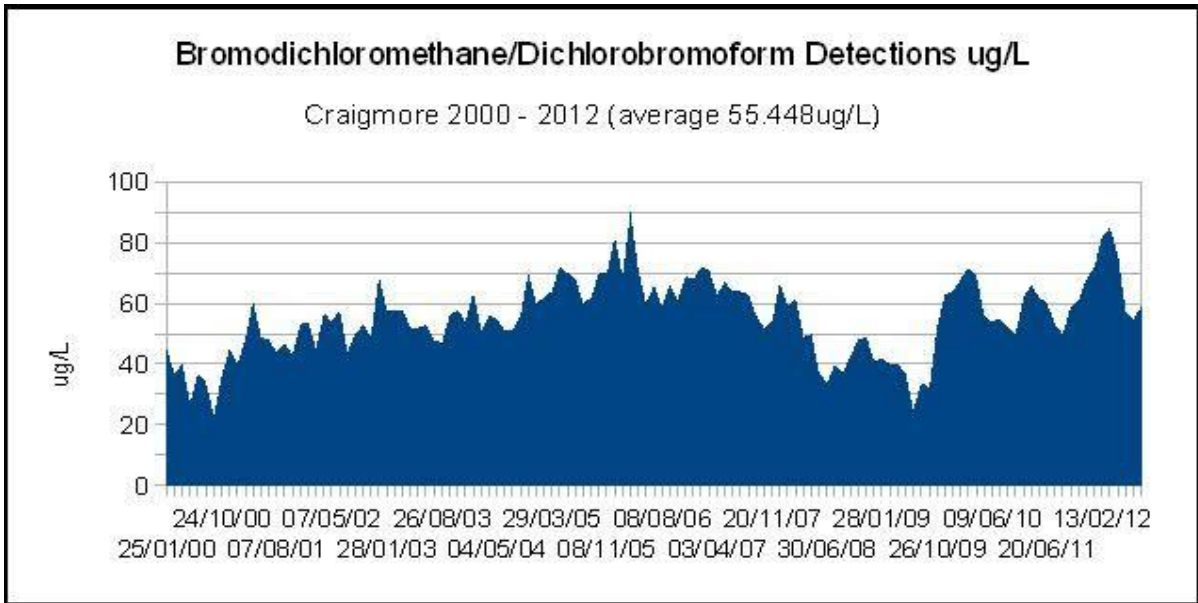


Trihalomethanes were the next most commonly detected substance (581). These were concentrated mainly on Kangaroo Island, however detections have increased significantly since 2010, particularly in locations in the lower Murray such as Hindmarsh Island.

### SA Water Trihalomethane ADWG Breaches

January 2000 - July 2012

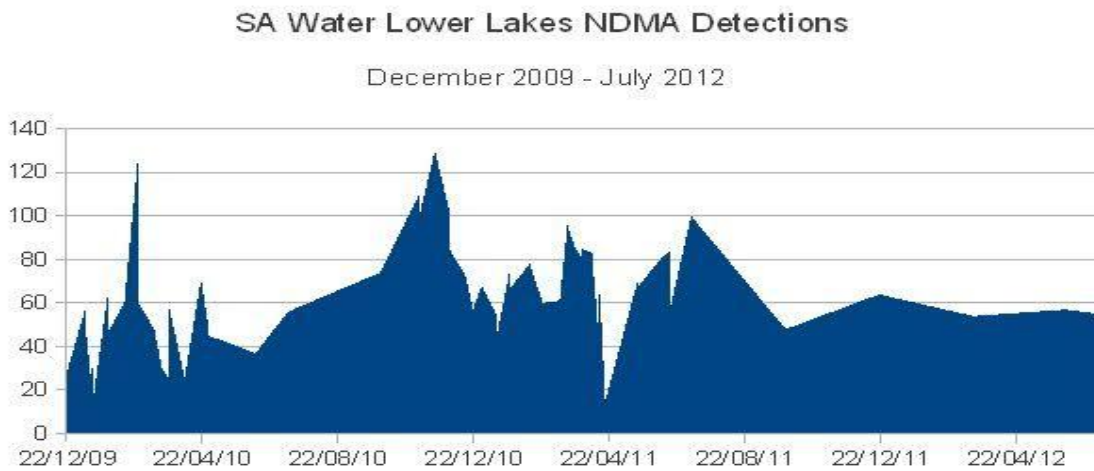




*High BDCM levels were also recorded in Adelaide suburbs*

**NDMA Detections (South Australia and Victoria)**

Levels of N-Nitrosodimethylamine – a suspected carcinogen – breached guidelines levels regularly in the SA Lower Lakes, with the highest level recorded at Keith 140µg/L in November 2011.



*Lower Lakes detection area recorded consistently higher than normal NDMA levels*

[http://www.foe.org.au/sites/default/files/FoeADrinkingWaterQualityProject2012\\_0.pdf](http://www.foe.org.au/sites/default/files/FoeADrinkingWaterQualityProject2012_0.pdf)

The Highest NDMA levels recorded in South Australia 2007-12 were at Keith 140ng/L 17/11/10 and Lower Lakes 130ng/L 24/2/10 and 17/11/10.

Victorian NDMA Detections include:

8/6/13 Warrnambool 3ng/L, 4/7/14 Simpson 7ng/L, 4/7/14 Cobden 6ng/L, 4/8/14 East Zone Headworks (Warrnambool) 6ng/L, 5/28/14 Cavendish 32ng/L, 2/9/14 White Swan Entry 6ng/L (Ballarat), 2/9/14 Lal Lal Entry 5ng/L (Ballarat), 11/12/14 Lal Lal CW 5ng/L (Ballarat), 2/12/14 White Swan Entry 5ng/L (Ballarat), 11/12/14 Maryborough Entry 18ng/L, 12/3/15 Maryborough Entry 19ng/L, 11/6/15 Maryborough Entry 19ng/L, 8/9/15 White Swan Entry 6ng/L, 8/9/15 Lal Lal CW entry 5ng/L.

Lexton CWS DW Plant -2 chlorinated, post disinfection 25ng/L 2/6/10. Lexton Customer Tap 20ng/L 2/6/10,

Lexton CWS DW Plant -2 chlorinated, post disinfection 25ng/29/9/10 55ng/L, Lexton Customer Tap 54ng/L,

Lexton CWS DW Plant -2 chlorinated, post disinfection 25ng/74ng/L 1/12/10. Lexton Customer Tap 67ng/L 1/12/10,

Lexton CWS DW Plant -2 chlorinated, post disinfection 25ng/74ng/L 25/5/11. Lexton Customer Tap 39ng/L 25/5/11

White Swan CWS DW Plant 1-chloraminated post disinfection 1/12/10 4ng/L 25/5/11 4ng/L  
Wendouree Customer Tap DW Plant 1 24 detention 1/12/10 5ng/L, 25/5/11 4ng/L

The source of NDMA into White Swan Reservoir (Ballarat) could also be from the Goldfields Superpipe (completed in 2008)

“More recently, rubber components such as valves and joiners/O-rings that are used in treatment plant pumps and in distribution systems have been found to leach significant levels of nitrosamines into the water supply (Morran et al., 2011).

Source: NDMA ATTRACTING INTERNATIONAL ATTENTION The latest news on nitrosamines G Newcombe, J Morran, J Culbert

## Climate Change and Drinking Water



**Disinfection by-products** (From *Chain Reaction* #126, April 2016, national magazine of Friends of the Earth, Australia [www.foe.org.au/chain-reaction](http://www.foe.org.au/chain-reaction))

With treatment plants having to cope with a range of potentially dangerous substances such as viruses, pathogens and bacteria, the pressure to disinfect water by increasing chlorine can also cause potential problems. As water becomes more salty and water levels in reservoirs drop, chlorine used as a disinfectant can react with these organic molecules to create disinfection by-products (DBPs). Some DBPs have been linked to bladder cancer. Higher water temperatures can also cause disinfection by-product problems, including water supplied via pipelines. In October 2012 Friends of the Earth revealed that many thousands of people in South Australia, including suburbs of Adelaide, had been exposed to drinking water with high levels of the Trihalomethane, Bromodichloromethane, in some areas for over a decade.

Many small communities in Victoria's Wimmera region, who source their drinking water from the Grampians, suffered high levels of chlorine DBPs during the millennium drought of the 2000s. A severe water shortage was experienced across the region, with the capacity of some of the regions headwork reservoirs falling as low as 2.5%. The prolonged drought meant that communities who were reliant on water being channelled to their communities from the headwork reservoirs found that this could not occur, and were left with older water which had been retained in their town storages. This water became more saline and the salinity directly impacted on the concentration of DBPs produced.



Following the DBP problem, in January 2011, heavy rain caused 200 landslips in the Grampians including many in the Lake Bellfield catchment, the major water supply catchment in the region. The catchment had also been severely burnt by bushfires in 2006. Severe sedimentation problems eventuated. Ten thousand people in 19 communities were impacted as their communities did not have water treatment plants to treat the sediment. Water supplies to many of the regions towns were undrinkable between 2011-12. A new range of DBPs was also formed as a result of the erosion problems.

As a way to reduce DBPs, water authorities sometimes add ammonia to chlorine as a means of extending the lifetime of the disinfectant. This treatment is known as chloramination. Chloraminated water can cause some health problems and aggravate others such as skin, digestive and respiratory ailments. Residents from the Victorian town of Maryborough have recently been in contact with Friends of the Earth regarding the poor quality of their recently chloraminated drinking water supply. The region recorded high levels of the DBP trihalomethanes (most notably Bromoform) between January 2007 and January 2009. Source water from nearby Tullaroop Reservoir had fallen dramatically. Since chloramination, the DBPs have significantly decreased, but now the community faces chloramination concerns.

This scenario will also play out across many regional centres across Australia in the following decades as they make the switch to chloramination.