Issues Regarding Melbourne Drinking Water & Pesticides

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Friends of the Earth

Photo: Yering Gorge Offtake – Yarra River Water is pumped from this point into Sugarloaf Reservoir.

Contents

Glossary

ADWG	Australian Drinking Water Guidelines
ANZECC	Australia and New Zealand Guidelines For Fresh Water Quality 2000
mg/L	Milligrams per Litre (parts per million)
ug/L	Microgram per Litre (parts per billion)
VCAT	Victorian Civil and Administrative Tribunal

1. Key Regulatory Points

1) Lack of adequate testing for the full range of pesticides by water authorities means that pesticide residues remain unreported.

2) There are no regulations in place in Australia that require biocide information to be reported and there are no government or private bodies who have responsibility for monitoring biocide application.

3) Under current regulations, The Victorian State Government (Department of Primary Industry) is responsible for Control of Use of pesticides – past point of sale – meaning that they should also be responsible for pesticide data collection information. The Federal Governmental regulator, the APVMA (Australian Pesticides Veterinary Medicines Authority) currently has no role past point of sale.

4) Without proper data information regarding use rates and quantities of pesticides used within water supply catchment, it is impossible for water authorities to know exactly what pesticides are being used where and in what quantities, making accurate testing impossible.

5) The current regulatory system does not properly take into account the potential low dose impacts from endocrine disrupting pesticides and it needs to adapt to new scientific developments in this area of expertise. The safe drinking water guideline in Australia for Atrazine is 20ug/L, yet hormonal impacts have been measured at 200 times less than this amount.

6) The European Union Drinking Water Standards have a limit for Atrazine 200 times less than the equivalent limit used in Australia. The European Standard has been breached 7 times at the Sugarloaf offtake during 2010-11.

7) There is little known about the ecological risk associated with detections of combinations of fungicides downstream from horticultural regions.

8) The Yarra River remains a non proclaimed water supply, even though it provides the largest number of Victorian's with drinking water. Almost every other community in Victoria has proclaimed water supplies, but not the Yarra. Proclamation could mean further landuse controls in the catchment.

9) Agricultural Pesticide users should contribute to the costs of testing for pesticide residues by water authorities.

2. Yarra Summary

Virtually no testing for currently used pesticides was conducted by Melbourne Water or its predecessor, the Melbourne Metropolitan Board of Works between the commissioning of Sugarloaf reservoir in November 1980 and 2008, despite the Upper Yarra catchment being one of Australia's most intensively farmed and sprayed regions.

There is a very high likelihood that pesticides have been pumped from the Yarra River, into Sugarloaf reservoir consistently over the past 30 years.

Melbourne Water should immediately implement steps to remove the risk of pesticide pollution at Winneke Treatment Plant. Yarra source water should be treated with Ozone and Biologically Activated Carbon for best filtration of pesticides.

Atrazine has recently been detected in Yarra River source water at levels in breach of European Water protection standards and also at levels that have induced hermaphroditism in frogs. Simazine has also been detected at similar levels.

Sugarloaf provides drinking water to almost 40% of Melbourne's population [almost 7% of Australia's population].

The filtration process used at Sugarloaf, at Winneke Treatment Plant, was never designed to filter out pesticides.

Pesticide monitoring in the early 1980's revealed that pesticides were being detected upstream of Sugarloaf and downstream of Sugarloaf Reservoir.

Recent research has determined that 3 of the pesticides detected in the 1980 studies, DDE, Dieldrin and 2,4-D are suspected endocrine disruptors, meaning that low dose exposure could be more dangerous than previously acknowledged. It is highly likely that organochlorine insectides such as Dieldrin would entered the Melbourne Water supply system in the 1980's. Dieldrin has been reported to have a half life in water of 4 years.

Levels of DDT detected in 1980 would also be higher than future ANZECC (Australian and New Zealand Guidelines For Fresh Water Quality) Guidelines, meaning that the ecological status of the river would also likely to be impacted.

Government reports in the early 1980's acknowledged that Woori Yallock and Wandin Yallock creeks were suffering from ecological stress, with pesticides being the most likely reason. Few further ecological/pesticide studies in the waterways of the upper Yarra occurred for almost 30 years.

In 1988 a number of farms in the Gembrook area (45-50km upstream of Sugarloaf Reservoir) were quarantined due to unacceptably high levels of Dieldrin in soils. Prior to 1987 Dieldrin had been used extensively in the Gembrook region, to control pests including wireworm, a pest in potato

crops. Australia stopped the use of Dieldrin in 1988. Residues of Dieldrin remain in sediment and surface water of the Upper Yarra River over 20 years since its use was discontinued.

From the mid 1990's vineyards expand significantly in the Yarra Valley. Vineyards are heavily reliant on pesticides, with over 100 types of pesticides allowed to be used.

Water quality risk assessments for the mid Yarra were not commissioned by Melbourne Water until 2003.

Pesticide testing by Melbourne Water concentrated only on organochlorines and 2,4-D until August 2005, when Atrazine was added. Atrazine has been consistently detected by Melbourne Water since July 2010.

MIS funded strawberry farms and their agricultural spray regimes raised controversy in the Woori Yallock Creek catchment during 2007 and 2008.

Melbourne Water admit in their December 2007 Catchment risk assessment that "*The Sugarloaf catchment contains a significant area of high and very high biocide risk* allotments".

By August 2010, Melbourne Water increased testing to 136 pesticides and a number of pharmaceuticals. This had reduced back to 32 pesticides in June 2012.

Testing by Melbourne Water from July 2010 and August 2011, has found low levels of pesticides at the offtake to Sugarloaf Reservoir for 11 pesticides (31 detections). Testing has also detected low levels of pharmaceuticals. Most frequently detected pesticides include Simazine, DEET, Metolachlor, Atrazine and MCPA.

Sugarloaf Reservoir water itself appears to be untested for pesticides.

The final summary points all refer to the recently published '*Effects of Pesticides Monitored with Three Sampling Methods in 24 Sites on Macroinvertebrates and Microorganisms' published in early 2011.*

- This study revealed 43 pesticides detected in waterways in the Upper Yarra above the offtake to Sugarloaf Reservoir, with 26 detected in sediments.

- Fungicides are seen as a major problem (particular*ly Trifloxystrobin)*, as well as insecticides and herbicides.

- In terms of drinking water most concerns could be the relatively high levels of: Simazine, Fipronil, Pirimicarb and Methiocarb. Detected at much higher levels than the Melbourne Water tests conducted between July 2010 and April 2011.

- In terms of ANZECC guidelines there are serious considerations, with three pesticides, DDT, Chlorpyrifos and Simazine all breaching the ANZECC guidelines for both 99% and 95% trigger levels. Also of concern is that for 86% [37/43] of the pesticides detected, there is no current ANZECC guideline.

- The impacts of pesticides on macroinvertebrates include reductions in numbers at certain sites and deformities in Chironomid mouthparts.

- There are no guideline levels under 2011 Australian Drinking Water Guidelines for 53.49% of the pesticides detected [23 of the 43 pesticides detected in surface water] in the study.
- Melbourne Water Testing of 136 pesticides in August 2010, would still have missed 24 (55.8%) of pesticides detected in surface water in the 2011 study. Melbourne Water have now reduced this monitoring back to 32 pesticides.
- Melbourne Water Testing 1980-05 would miss 41 (95.3%) of pesticides detected in this study in surface water.

- Between November 1980 and November 2011, Melbourne Water would have missed at least 92% of pesticides detected in the 2011 study due to inappropriate and lax pesticide testing.

Photo June 2012: Water is pumped from the Yarra River at this location. Yering Pump House – Yering Gorge. 31 Positive Pesticide Detections were recorded by Melbourne Water at this location between July 23 2010 – August 11 2011 along with seven types of pharmaceuticals. Winneke Treatment Plant was never designed to filter out pesticides.

3. Introduction: Lack of Information and Lack of Adequate Testing

Melbourne Water is often claimed to be amongst the safest in the world. (52) Reports often repeat assertions that because our drinking water is supplied from closed forested catchments, that we have little to be concerned about in regards to drinking water risks. It would appear however that few Melbournians are aware that a large proportion of its residents are actually drinking water draining some of the most intensively farmed regions of Australia. These agricultural lands can often be sprayed with a wide variety of agricultural pesticides, which in turn can end up in local waterways, partlicularly in the event of heavy rainfall.

It has generally been considered that smaller rural communities are more at risk from exposure to pesticides in drinking water.

"Australia's major cities are well served with respect to drinking water treatment, while many regional areas receive no water filtration, or comparatively less sophisticated treatment." (1)

However from research conducted by Friends of the Earth it would appear that many urban communities are also at risk from pesticides pollution in water supplies.

Some examples of pesticide levels found in water supplies in Australia include:

- Triclopyr detected at 0.08mg/L in 2007 (8 times the then 2004 Australian Drinking Water Guidelines Health Limit) at the inflow to Wingecarribee Water Filtration Plant in NSW. (Water from Wingecarribee is used to supply local communities (eg Picton, Bargo) and to supplement other Sydney catchments in times of drought (Sydney, Penrith and lower Blue Mountains, Warrangamba, Campbelltown). (2)

- Streams flowing into Warren Reservoir supplying Adelaide recorded Atrazine levels of up to 150ug/L in July 1998 (3), with almost 900 detections of the herbicides Atrazine and Hexazinone being detected in Borossa Reservoir and treatment plant, South Para and Warren Reservoirs between 1997 and 2000. (48) The Highest Atrazine reading in a reservoir was 43.6ug/L in South Para Reservoir July 1998. (48)

- The SA Engineers and Water Supply Department also recorded many examples of Aldrin and Dieldrin in South Australian Bores, Reservoirs and Surface Water in the 1970's and 1980's. (4).

- High Levels (up to six times higher than 2011 drinking water guidelines) of the organochlorine insecticide Dieldrin detected in Coffs Harbour rainwater tanks in the 1980's. [62]

- In February 2002 (5), Dumbleton Weir which supplies Mackay in Queensland with drinking water had levels of Diuron of 8.5ug/L.

- The Geelong storage at Wurdi Boluc recorded levels of 2,4-D at 34ug/L in May 2003 (6), whilst a channel supplying the small town of Kerang recorded levels of the insecticide Esfenvalerate 65ug/L in October 2005. (7)

Friends of the Earth has compiled hundreds of pesticide pollution incidents in Australian water supplies over the past few years, including over 400 in Victoria – with over 56% of those incidents occurring between 2008-2011. Since 2008, there have been over 150 pesticide detections in the Upper Yarra River, arguably making it one of the most polluted, if not the most polluted waterway in Australia due to pesticides. Testing up to 2008 in the Upper Yarra for currently used pesticides was almost non-existent, a situation which also applied to most water supplies elsewhere in Australia.

"Water quality compliance monitoring varies significantly across the states. For a large proportion of supply systems, testing is infrequent and the range of parameters is small, particularly in comparison to metropolitan utilities. Utilities may be missing contamination events due to the method of testing, and the risk to communities may therefore be higher than what is reflected in the water quality results." (8)

"Pesticides and herbicides are not included in compliance testing for many regional towns. The ADWG recommends monthly testing where pesticides have been previously detected or where their use indicates detection would be likely. Considering the proximity to agricultural areas for many of the selected towns, contamination events may be going unnoticed, jeopardising the health of the community. Herbicides were detected in one drinking water supply in Tasmania and the likely source was an adjacent pine plantation. Herbicides have also been detected in water supplies in other parts of Australia." (9)

Water authorities are not in a position to even know what pesticides are being used within their water supply catchments. There needs to be better communication between water authorities and agrochemical users, including records sent to water authorities on a yearly basis or presented on request from a water authority if a pollution incident occurs.

Concerns regarding this lack of information was expressed in May 2006 in Gippsland Water's submission to the Review of the Agriculture and Veterinary Chemicals (Control of Use) Regulation 1996; *"Records are kept for the application of restricted chemical products, but not for the other commonly used products that have environmental or health implications. Gippsland Water has had difficulty in obtaining information on the chemicals in use within a catchment area upstream of a Water Treatment plant and town water supply...Currently there is no common record of chemical products that are likely to be applied in agricultural areas within potable water catchments."* (10)

Users of Agricultural pesticides in Victoria have to keep records within 48 hours of using an agricultural chemical product and keep those records for a minimum of two years. Surely it is not impossible for that information to be provided to water authorities if the pesticide is used within a domestic water supply catchment?

Melbourne Water have also expressed a concern regarding lack of information pertaining to biocides used within their catchments;

"The accuracy of the biocide application information is unknown as there are no regulations in place in Australia that require biocide information to be reported and there are no government or private bodies who have responsibility for monitoring biocide application. The application rates used in this study are based on the best available information. However, it is likely that different application rates and different biocides could be applied to some properties." (11)

This also brings into question who should pay for such testing? Why should water consumers be made to incur extra costs when they are not responsible for the problem?

Spraying Vineyards 3km upstream from the Sugarloaf Offtake – Yarra Glen. Over 100 hundred pesticides are registered for use in Vineyards in Victoria.

4. Land Use Planning – Why Is the Yarra Water Supply Not A Proclaimed Water Supply?

In Victoria, almost all water catchments that are used as domestic water supplies, are protected under the Catchment and Land Protection Act 1994. Once a catchment is declared, approvals for activities that occur within the catchment under other statutes and statutory planning schemes must be referred to the responsible land manager authority for approval.

In Victoria 134 water supply catchments are officially recognised by the State Government. These consist of Declared Water Supply Catchments which were formerly known as Proclaimed Water Supply Catchments and Special Area Plans which were formally listed as Land Use Determinations.

A full list of Proclaimed Water Supply Catchments and catchments containing Special Area Plans can be viewed at the following website: http://vro.dpi.vic.gov.au/dpi/vro/vrosite.nsf/pages/dwsc_areas

It appears odd that the Yarra River Catchment is not listed as either a Proclaimed Water Supply Catchment or has a Special Area Plan, even though the Yarra River provides approximately 40% of Victorian's with drinking water. Many much smaller communities source their drinking water from protected catchments, but this is not the case for Melbournians – particularly those sourcing water from Sugarloaf Reservoir.

Under Section 27 of the Catchment and Land Protection Act 1994, Melbourne Water could recommend to the Minister that land within its region be declared an open potable water supply catchment. Declaring the Yarra as a Proclaimed Water supply Catchment would allow Melbourne Water to become a statutory referral authority, pursuant to Clause 66 of the Planning Scheme. It would also allow for the development of a Special Area Plan which could provide for land use conditions which would be enforceable by the Secretary of the Department of Sustainabilty and Environment.

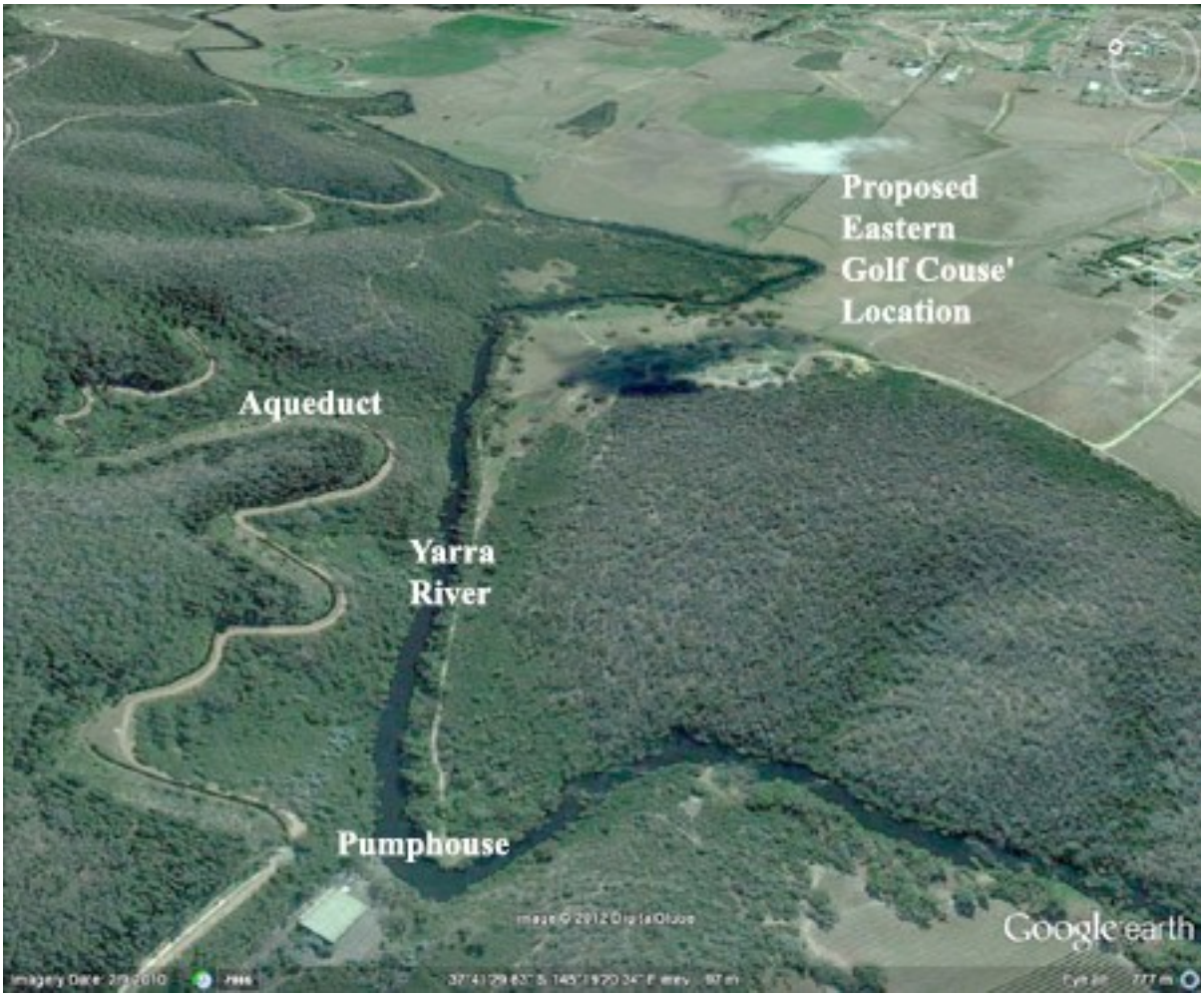
Without this change in status of the Yarra River, Melbourne Water, local councils and VCAT (Victorian Civil and Administrative Tribunal) will not have the power to apply stricter guidelines regarding planning applications, development applications and assure that developments, including agricultural development will be sited and managed to protect the quality of water in the Yarra Catchment.

Eastern Golf Course Proposal

In 2010, Eastern Golf Course applied for a planning permit with Yarra Ranges Shire to develop a golf course on a site, one kilometre from the Sugarloaf Reservoir offtake. Yarra Ranges Shire voted 5/4 to support the development. However the development was opposed in VCAT by Healesville Environment Watch Incorporated, Bill Boerkamp and Friends of the Earth Melbourne. The objectors won a temporary reprieve from development (possibly >18 months) based on the risks associated with 100 year flood levels and access to and from the main clubhouse, but not from pesticide application. As of June 2012, the course is awaiting final approval from Melbourne Water, before the development will once again go through the planning process with the local shire. The course is proposing to use 34 pesticides. A copy of FOE's December 2010 objection can be viewed here: http://www.foe.org.au/sites/default/files/VCATDec10Final.pdf

In a separate case, Western Water vs Rozen & Anor [2008], it has been determined that land use planning in open, potable water supply catchments should take into account the precautionary principle, meaning that decision makers should be cautious when considering planning applications. However Friends of the Earth remains concerned that because the Yarra Catchment is not a proclaimed water supply, even though it supplies more water to more people than any other catchment in Victoria, that the precautionary principle will not be applied to developments such as the Eastern Golf Course. Information on the implications of the Rozens case can be viewed here:

http://www.mondaq.com/australia/article.asp?articleid=80652



Google Earth image looking east, showing Yarra River Yering Pumphouse. Also showing location of proposed Eastern Golf Course with its possible use of 34 pesticides – much of which will be used on a floodplain. In times of flood, floodwater backs up across the floodplain, as the narrow confines of Yering Gorge act as a "Choke" on the Yarra River, holding back vast quantities of flood water before it flows through the gorge.

5. Water Treatment at Winneke Treatment Plant

According to Melbourne Water, Winneke Treatment Plant is the major water treatment plant for Melbourne (33). Water is sourced from both Maroondah Reservoir via the Maroondah Aqueduct and the Yarra River by the Yering Gorge Pump Station.

"Sugarloaf Reservoir is a concrete faced rockfill embankment, supplemented by two saddle dams, forming an off-stream storage 33km north east of Melbourne. It is Melbourne's fourth largest reservoir being completed in 1981 with a capacity of 96,000ML" (38)

Water from Sugarloaf Reservoir receives what Melbourne Water calls *"full treatment"* (34), and includes: Coagulation and clarification (to cause the colour and turbidity particles to settle out), Filtration (to remove most of the remaining suspended solids), Disinfection, Fluoridation and pH correction. This *'full'* treatment type is basically the standard type used in Australia. Sand filters are used at Winneke. Added substances at Winneke include: Polyelectrolyte (filter aid), Alum (coagulation), chlorine gas, Fluorosilicic acid, Lime and Sodium Hypochlorite.

Water Treatment Background

"Coagulation and Floculation occurs before filtration: This process brings together particles in the raw water supply, forming floc. Coagulants such as Aluminium Sulphate and Polyelectrolytes also encourage the formation of floc. This process maximises the removal of particulates and colour later in the treatment process. Treatment of the water then removes the dosed coagulants. Substances used in this stage can include: Aluminium Sulphate (alum), Aluminium Chlorohydrate, Synthetic Organic Coagulant Polymer and Polyacrymalide (Floculant Polymer).

Filtration removes, bacteria, dirt and other materials from the water: This is the key process which removes pollutants from water which may be present in the source water. Sand filters are commonly used in Australia, and some filters also contain layers of gravel and in some cases filter coal. Coagulated water is passed through a 'floc blanket' which traps suspended particles. The floc sinks to the lower levels of the sedimentation tank and is removed off as inert slurry. The remaining water is then collected usually in a series of channels and is then passed through multimedia filters, which remove smaller particles. There are several different types of filtration processes: 1) Dissolved Air Flotation Filtration, 2) Direct Filtration, 3) Conventional Clarification/Filtration, 4) Microfiltration, 5) Reverse Osmosis.

Disinfection: The most widely used drinking water disinfectant in Australia is Chlorine. Chlorine Gas or Sodium Hypochlorite Solution are added to the water to destroy viruses or bacteria that may cause illness. Chlorine can also be added at storage tanks or pump stations along the water distribution network. Chlorine is usually maintained at levels which are below taste and odour detection levels of people, but this can change particularly in times of increased demand for water, particularly in hot weather. Disinfection Byproducts (DBP's) are created when chlorine reacts with organic molecules, such as algae. Some DBP's have been associated with cancer."(35)

Winneke has a capacity of 560ML/day and the treatment plant has five reticulation clarifiers and 14 sand filters each handling approximately 40ML/day. Water is pumped from the Yarra River by the Yering Gorge Pumping Station and stored in Sugarloaf Reservoir (96GL capacity). Water is pumped from Sugarloaf by the Reservoir Pump Station. Alum is added to the water before it goes through

the reticulation clarifiers and then sand filters. Chlorine and Lime is then added before the water goes through the final 200ML storage. Fluoride is then added before transfer.

Melbourne Water recently looked at enhancing their treatment options when considering pumping water from the Goulburn River via the North South Pipeline. (37) Goulburn River water was seen to increase the risk of higher protozoa and algal contamination. Existing strategies to counter these problems is increased Ultra Violet (UV) disinfection and reservoir aeration. Melbourne Water has apparently considered UV and Ozone/GAC (Granular Activated Carbon) at Winneke, however these are not planned to be part of the current plant until 2017 (37), nor is the use of (PAC) Powder Activated Carbon. In terms of pesticides in source water, these are more likely to be detected in Yarra water, rather than Goulburn water, inferring that it is odd that Melbourne Water only looked at the new treatment options when considering a new source of water, highlighting the higher risks associated with protozoa and algal blooms, in comparison to risks associated with pesticides. Another Melbourne Water study found that Goulburn River water was more risky in terms of alkalinity, colour, nitrogen and turbidity. (38)

Photo: Sugarloaf Reservoir June 2012. Atrazine and its close relative, Simazine have been recently detected in Yarra waters at the pumping station at Yering Gorge. Higher levels of Atrazine and Simazine were detected further up the river in 2008/9. Both are known to be Endocrine Disruptors [“Chemical Castrators”]. In terms of Atrazine turning male frogs into hermaphrodites “If you take five grains of salt, divide this weight by 5000, that is the amount of atrazine that causes these abnormalities." (61) ***The Treatment plant at Sugarloaf Reservoir, Winneke, was never designed to specifically filter out pesticides.***

6. Water Treatment and Pesticides

Varying water treatment types have differing levels of success when filtering out pesticides. A number of studies have been conducted investigating which water treatment options are best to use in filtering out pesticides. It is interesting to note that standard testing as used at Winneke Treatment Plant has little effect in the removal of pesticides, particularly mobile pesticides.

The following is a transcript from the 4th day of a VCAT hearing 18 November 2010. [VCAT REF NO: P1970/2010 - 215-217 Victoria Road, Yering – Eastern Golf Course vs Friends of the Earth Melbourne, Healesville Environment Watch and Bill Boerkamp].

The quotes are attributed to water expert Dr Dan Deere (Water Futures Pty Ltd). Question asked by Barrister Andrew Walker.

Dr Dan Deere: *"... The Winneke Treatment Plant is what we would call a classical conventional treatment plant, the most common kind of plant in the world for treating water ... Basically you run the water through large beds of sand and other materials, granular media filters. You add some alum which is a coagulant, basically aluminium, salt to help to stick things together and you run them through the sand and it's designed to pull out certain types of micro-organism which is the main objective. Then add chlorine as a disinfectant and that is the most common kind of water treatment around. The two main functions are to remove just dirt, particles, lumps and sediment and pathogenic micro-organisms. That's what it's designed to do, that's all you'd rely on it to do. Now by coincidence that kind of plant could reduce the concentrations of some other things but you wouldn't rely on it for that reason. If you wanted to remove for example pesticides you'd have to go for either a reverse osmosis type desalting membrane as you'd use on a desalination plant or an oxidation process like ozonation and an activated carbon process which is not in place there. There are those plants around the country but not at this site. So the important point to note then is that this plant's designed to remove pathogens and sediments. It's not designed in any way to remove anything else. It's not designed or intended to remove biocides for example or other organic compounds. Some of them will be removed to some extent or reduced by that - just incidentally but that's not something that's quantified and not something you'd rely upon."*

Q: Andrew Walker: *"And if pesticides were detected at the intake what would have to be done in terms of infrastructure to reduce the pesticide levels?"*

A: Dr Dan Deere: *"There would, if pesticides were routinely found in that source water, you'd have to go to a major plant upgrade to remove those pesticides ... [you] may have an ozone-BAC type reactor [where] ozone breaks down the pesticides and activated carbon [where] the carbon absorbs the pesticides. The combination of the two is quite effective. Or reverse osmosis which would be impractical, you wouldn't use that you'd use ozone-BAC."*

Q: Andrew Walker: *"And any idea of the costs of such infrastructure?*

A: Dr Dan Deere: *"Yes it's hard to say but it would be tens of millions of dollars for a plant of that size."*

Friends of the Earth also asked a question to Melbourne Water at a separate meeting regarding the issue of Winneke Treatment Plant never being constructed to filter out pesticides. The answer from Melbourne Water was *"that's correct"* [pers comm].

A USEPA study published in 2001 found *p4 "The processes that appear to have the most impact on*

pesticide removal – granular activated carbon (GAC) and powdered activated carbon (PAC) ... Other methods, such as "softening", reverse osmosis, and air stripping are also less frequently used to remediate water quality concerns..." (39)

The following statement is disturbing as it reveals that conventional water treatment methods similar to those used at Sugarloaf Reservoir have little success in removing pesticides from water.

p5"EPA's preliminary review of the literature indicates that conventional treatment (such as coagulation/flocculation, sedimentation, and filtration) has little or no effect on the removal of mobile (hydrophilic or lipophobic) pesticides. Disinfection and softening can facilitate alteration in the chemical structure of the pesticide, or transformation" (39)

p11"Powdered activated carbon (PAC) filtration, granulated activated carbon (GAC) filtration, and reverse osmosis (RO) have been demonstrated to be highly effective processes at removing organic chemicals, including certain pesticides (primarily acetanilide herbicides), but specific data on removal of most pesticides are not available."(39)

p13 "Granular activated carbon (GAC) under the SDWA is the best available technology (BAT) for removing synthetic organic chemicals (SOC); virtually all pesticides are SOCs. Other recommended BATs are aeration technologies for removal of dibromochloropropane and chlorination or ozonation for removal of glyphosate." (39)

p20 "Miltner et al., (1989) provide information on the possible removal of pesticides with conventional treatment ... No removal of the triazine pesticides, linuron, and carbofuran was observed. The removal of alachlor and metolachlor was low and ranged from 4 to 11 % percent."(39)

p21 "The process of softening or softening-clarification was evaluated for its ability to remove pesticides from water. Data collected from the full-scale treatment plants indicated that atrazine, cyanazine, metribuzin, alachlor and metolachlor at initial concentrations in parts per billion level (µg/L) were not removed during the softening-clarification process. In contrast, parent carbofuran was reported as 100% removed." (39)

p24 "The effect of chlorination on pesticides was also evaluated at full-scale treatment plants in Ohio (Miltner et al., 1989)... For atrazine, cyanazine, simazine, alachlor, metolachlor, and linuron, the removal efficiencies were either zero or extremely low. Slight removal was observed for carbofuran. Up to 98 % removal was reported for metribuzin.(39)

P25 "Miltner et al. (1987,1989) studied the removal of atrazine and alachlor using PAC (Powder Activated Carbon)...The percent removal ranged from 28% to 87% for atrazine and 33% to 94% for alachlor. As the PAC dose increased, sorption removal efficiencies likewise increased..."(39)

p27 "The performance of GAC in removing pesticides from raw water has been demonstrated by the studies of Miltner et al. (1989) who used pesticides belonging to triazine, acetanilide, and dinitroaniline classes ... Relative to the initial concentrations of the pesticides, the percent removal of the two acetanilide pesticides (72 - 98%) was higher than those of the triazine pesticides (47 - 62%). The highest removal efficiency (>99%) by Filtrasorb 400 was reported for pendimethalin."(39)

Semi permeable membranes used in Reverse Osmosis Filtration appear to have the greatest capacity to filter out pesticides.

p30 "A short-term laboratory test conducted by Chian (1975) demonstrated that NS-100 membrane

was able to remove 97.8% of atrazine compared to 84.0% removal using CA membrane. Since then, other studies by several investigators (Eisenberg and Middlebrooks, 1986; Lykins et al., 1988; Miltner et al., 1989; Fronk et al., 1990) generally indicated that thin film composite membranes have superior performance in removing pesticides compared to those of CA and polyamide membranes..." (39)

Other membranes, nanofiltration, airstripping and integrated membrane/absorbent systems all have high levels of pesticide removal.

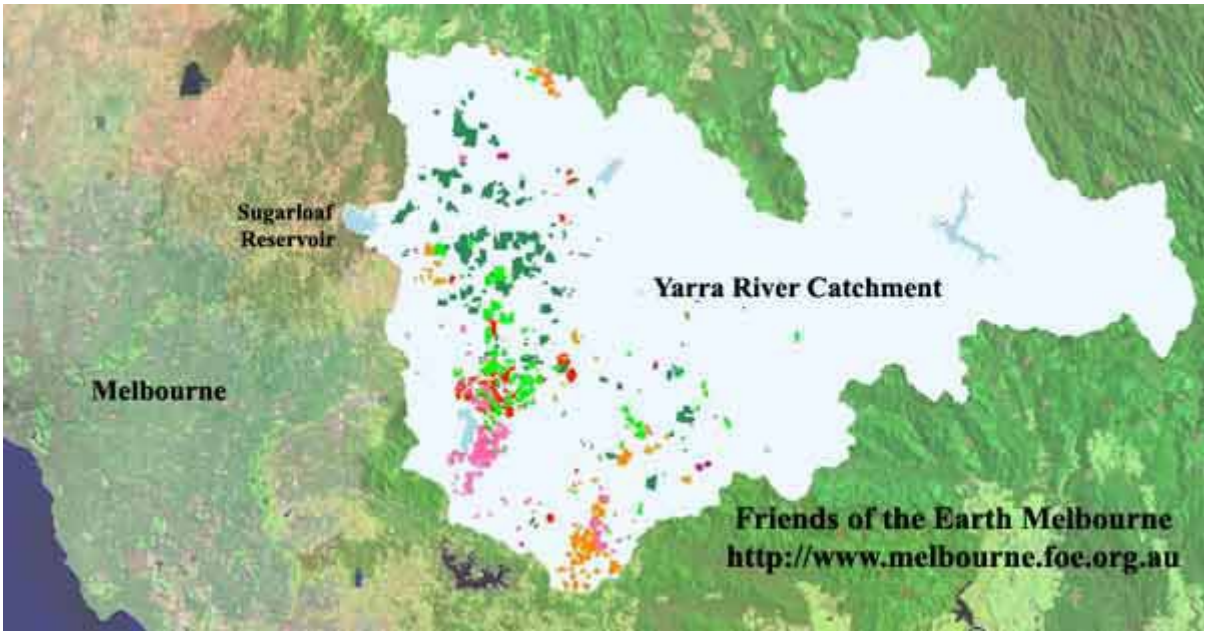
Another concern is that pesticides can be transformed into different substances depending on the type of treatment used. Lime softening (changing water pH) and disinfection with chemical oxidants can lead to pesticide transformation. *p33 "The preliminary recovery data suggest that organophosphates may be oxidized in treated water to form relatively stable, toxic transformation products." p34 "Certain pesticides belonging to organophosphate and carbamate classes are susceptible to transformation during chlorination of raw water."*(39)

A recent Indian study has also investigated 'standard' water treatment processes in relation to removing Endocrine Disrupting Chemicals. [Note that the higher removal rate (82.6%) was achieved with standard treatment plus ozonation and chloramination – which is not used at Sugarloaf].

"Atrazine removal between 11.8% (Treatment Process: Preoxidation (Cl2), coagulation/flocculation, sedimentation, chlorination, filtration, and chlorination) & 82.6% (Treatment Process: Coagulation/flocculation, sedimentation, ozonation, dual-media filtration, and chloramination)" (44)

7. Upper Yarra Land Use – Communities Sourcing Drinking Water From Sugarloaf

The quality of drinking water being supplied to Melbourne's Sugarloaf Reservoir has long been a concern to Friends of the Earth. Concerns have been raised that there has been little monitoring of water for pesticide residues by Melbourne Water and its predecessor the Melbourne Metropolitan Board of Works (MMBW), since Sugarloaf reservoir was commissioned in November 1980. In 2007 Friends of the Earth conducted land use mapping in the Upper Yarra catchment and was surprised with the results, with anywhere between 280 – 355 pesticides likely to be used in the catchment. The land just east of Silvan Reservoir is one of Australia's most densely farmed regions and all drains into the Yarra River via Wandin Yallock and Woori Yallock catchments.



Breakdown of Agricultural Land Use in Catchment Above Sugarloaf Offtake. Friends of the Earth Melbourne 2008.
Dark Green=Vineyards, Light Green=Orchards, Red=Berry Farms, Pink=Cut Flowers, Orange=Potatoes, Tan=Vegetables

Vineyards 3904.3ha	Potatoes: 989ha	Tree Plantations: 117.47ha
Orchards (Apples,Citrus):1549.2ha	Berries (Strawberries, Rasberries) 936.52ha	Olives 32.94ha
Cut Flowers/Nurseries:1225.9ha	Vegetables: 490.37ha	Improved Pasture ?

Melbourne Water supply treated water to the three retail managers, Yarra Valley Water, South East Water and City West Water (soon also to Westernport Water). The retail managers rely on Melbourne Water to also test the water for pesticides.

Most of the catchments that Melbourne Water sources its water from are 'closed/protected' catchments – mainly native forest cover. Sugarloaf Reservoir however sources its water directly from the Yarra River at Yering Gorge, 35km north east of Melbourne's CBD, meaning that Sugarloaf is exposed to more potential agricultural contaminants than other reservoirs in the Melbourne Water Network. Sugarloaf Reservoir is also connected to the Maroondah Reservoir via an aqueduct and pipeline. Therefore the water at Sugarloaf is a *'shandy'* of Maroondah and Yarra River water. Maroondah sources its water from a closed forested catchment.

Sugarloaf Reservoir lies approximately 35km north east of Melbourne's CBD.

Sugarloaf Reservoir provides drinking water to almost 1.5 million* people. (1.5 million people represents ~37.5% of Melbourne's population and ~6.6% of Australia's population).

These people are mainly in Melbourne's northern suburbs of; Alphington, Arthurs Creek, Balwyn,

Balwyn East, Balwyn North, Banyule, Box Hill North, Briar Hill, Brunswick, Brunswick East, Brunswick West, Bulleen, Bundoora, Burwood, Camberwell, Canterbury, Coburg, Croxton, Deepdene, Diamond Creek, Doncaster, Doreen, Eaglemont, Eltham, Epping, Fairfield, Glen Iris, Greensborough, Greythorn, Hawthorn, Hawthorn East, Heidelberg, Heidelberg Heights, Heidelberg West, Hurtbridge, Ivanhoe, Kangaroo Ground, Keon Park, Kew, Kingsbury, Lalor, Lower Plenty, Maclead, Malvern, Mernda, Mill Park, Mont Albert, Montmorency, Northcote, Northland Centre, Nutfield, Pascoe Vale, Plenty, Preston, Research, Reservoir, Rosanna, Smiths Gully, South Morang, Templestowe Lower, Thomastown, Thornbury, View Bank, Watsonia, Wattle Glen, Whittlesea, Yallambie, Yarrambat.

Sugarloaf Reservoir also supplies almost 500,000 customers of City West Water in the following regions; Werribee, Little River, Altona, Werribee South, Footscray, Deer Park, East Keilor, Strathmore, Moonee Ponds, Parkville.

Generally speaking almost all water supplied to South East Water does not come from Sugarloaf Reservoir and a percentage supplied to Yarra Valley Water also does not come Sugarloaf. Water quality from closed catchment sources is likely to be good, with bushfires posing a significant risk to water quality.

Sugarloaf Reservoir sometimes supplies South East Water Customers, particularly in drier times. Suburbs include; Albert Park, Balaclava, Gardenvale, Garden City, Fishermens Bend, Elwood, Elsternwick, Melbourne, Middle Park, Prahan, Ripponlea, South Melbourne, South Yarra, Southbank, St/Kilda/West, St.Kilda/East, Windsor.

8. Past Studies – Pesticides in Upper Yarra

Two studies conducted in 1980 and 1981 did reveal that pesticide pollution in Upper Yarra was occurring, but little else eventuated until July 2010, when Melbourne Water significantly increased, for a short time, their testing regimes, possibly as a result of coming to terms with some of the implications of the soon to be published (January) 2011 report *'Effects of Pesticides Monitored With Three Sampling Methods in 24 Sites on Macroinvertebrates and Microorganisms – Environmental Science and Technology'.* (25) The pesticide samples used in this report were the result of a wide range of pesticide samples conducted in the upper Yarra catchment in 2008-9.

Past studies of the Yarra Catchment showed that pesticides were detected at numerous sites in the Upper Yarra including a site just downstream of Yering Gorge. Yering Gorge is significant as a pumping station was built soon after the study was completed in order to supply the newly constructed Sugarloaf Reservoir. Levels of Dieldrin were recorded at levels which would represent a value of almost 7% of the 2011 Australian Drinking Water Standards. What quantities of Dieldrin were actually pumped into the reservoir itself are unknown, nor is the amount of Dieldrin or other organochlorines remaining in reservoir sediment. Use of Dieldrin was not stopped in Australia until 1988. Dieldrin is an organochlorine insecticide and is highly persistent and has recently been detected in sediment in locations in the Upper Yarra catchment at rates as high as 20ug/kg. (25)

Dieldrin became infamous in the late 1980's in the upper Yarra when farms were quarantined because of unacceptably high levels of Dieldrin in soils. It had been used extensively in potato crops as a means of controlling wireworm. Cattle would then ingest Dieldrin when they were left to graze pastures that had previously been planted for potatoes. Dieldrin and other organochlorines are known to accumulate in body fat. DDT and Lindane had been used in Australia as insecticides for approximately 30 years previously. Malathion is a organophosphate insecticide and 2,4-D a commonly used herbicide used to kill broadleaved weeds.

Positive Pesticide Detections 1980 at a site downstream of proposed Yering Gorge Pumps (12)
(ADWG = Australian Drinking Water Guidelines)

Pesticide	Amount	% of 2011 ADWG Guideline	%of 1980 Water Quality Guideline
DDE	0.01ug/L	?	?
DDT	0.01ug/L & 0.007ug/L	0.11% & 0.078%	0.33% & 0.233%
Dieldrin	0.02ug/L	6.667%	2%
Lindane	0.002ug/L	0.02%	0.002%
2,4-D	1.1ug/L	3.667%	1.1%
Malathion	2.6ug/L	3.714%	2.6%

Note: DDT and its metabolite DDE are known to have endocrine disrupting ability. Dieldrin has also been determined to have non-monotonic dose responses in cell culture experiments. (50)

The following table presents information sourced from the Pesticide Action Network (51) on each of the above pesticides. The information reveals that 4/6 of the pesticides are Suspected Endocrine Disruptors, possibly meaning that levels far lower than those that are regarded as being safe by

regulatory agencies, may have been causing some harm to human health. It is also disturbing to note that if these low level detections were being observed in 1980, it is highly likely that these residues would have continued at unrecorded events into the future. However because the Melbourne Metropolitan Board of Works did not test for pesticides until the mid 1990's then that information will never be known.

Petsicide/Type	Acute Toxicity	Carcinogen	Cholinesterase Inhibitor	Groundwater Contaminant	Developmental/ Reproductive Toxin	Endocrine Disruptor
2,4-D	Moderate	Possible	No	Potential	Suspected	Suspected
4,4-DDD	?	?	No	?	?	?
4,4-DDE	Slight	Yes	No	?	Yes	Suspected
4,4-DDT	?	?	No	?	Yes	?
Dieldrin	Yes	Yes	No	?	?	Suspected
Malathion	Moderate	Possible	Yes	Potential	?	Suspected

The Yarra River also has important ecological significance providing key habitat for a number of threatened species. In terms of native fish the Yarra River contains perhaps the world's most viable population of Macquarie Perch. It also contains Murray Cod and Australian Grayling all listed under the Federal EPBC Act. Other species such as Platypus also inhabit the river. Under the current 2000 ANZECC Guidelines which supposedly underpin ecological protection of waterways by providing toxicant limits adopted by State Environment Protection Policies, many pesticides remain unaccounted for under the guidelines. Of the 6 pesticides detected in the above quoted 1980 study, only 3 have ANZECC Guideline trigger levels in the most recent 2000 version, with levels detected in 1980, breaching future guidelines for DDT.

Pesticide	% of 2000 ANZECC Guidelines 99% Trigger Level	% of 2000 ANZECC Guidelines 95% Trigger Level
DDT: 0.01ug/L & 0.007ug/L	166.7% & +16.7%	= & 70%
Lindane: 0.002ug/L	2.85%	1%
2,4-D: 1.1ug/L	0.786%	0.393%

Agricultural areas in the Yarra catchment Upstream of Sugarloaf Reservoir are granted a 95% protection limit under the State Environment Protection Policy (Waters of Victoria), which relies on 2000 ANZECC Guidelines to determine this level. One wonders why a water supply for 1.5 million people is not warranted 99% trigger levels for toxicants. The 1980 study showed that levels of DDT were above the future 99% trigger level for toxicants in freshwater ecosystems and just under and level to 95% trigger levels.

It should also be pointed out that the EPA study also found traces of pesticides at 6 sites further upstream of the Sugarloaf offtake (12). Traces included DDE, DDT, Dieldrin, Lindane, 2,4,5-T, TDE,

and 2,4-D. The highest readings were Dieldrin at 0.3ug/L and DDT at 0.08ug/L. Residues of 2,4-D, 2,4,5-T, Lindane and DDT metabolites were also detected.

Studies carried out in 1982 and 1983 also detected organochlorines in the upper Yarra. The 1982 and 1983 studies concentrated on the Woori Yallock and Wandin Yallock Catchments, which flow into the Yarra River about 25km upstream from Yering Gorge and the pumps to Sugarloaf Reservoir. These were also key catchments of concern in the study published in 2011 showing that not much has changed in terms of lessening the pesticide loads into these waterways in the past 30 years.

Whilst the maximum levels recorded were well below recommended maximum residues limits for pesticides in potable water supplies, they exceed ported threshold levels for the protection of aquatic organisms from chronic sublethal effects by as much as a factor of 40." (13)

"Wandin Yallock-Woori Yallock System. The faunal community in Wandin Yallock Creek, site 7, showed very marked signs of stress... On the basis of available water quality data, pesticides appear to be the most likely toxic influence at this site. TDE, DDE, DDT and Dieldrin have been detected in the sediments at a site 2 km downstream of a major market gardening and horticultural area, and DDT and Dieldrin have been found in sediments of a site in the middle of the market gardening area, (EPA 1982)... Water samples from the above sites have indicated the presence of DDT, Dieldrin, Lindane, 2,4,5-T and, at the lower site, 2,4-D., (EPA 1982)... In 23 of the 26 cases, the levels of pesticides in these water samples exceeded the Interim Threshold Estimates, by as much as an order of magnitude... It thus seems likely that the fauna is being exposed to chronic sublethal levels of pesticides... As available data suggest that the toxicity of pesticides in combination is frequently additive and often syngergistic (NAS/NAE 1973), the possibility of acute toxic effects must be acknowledged (EPA 1982). The EPA (1982) study found the greatest amounts of pesticides were present in winter water samples from Wandin Yallock Creek, and suggested that this may be due to remobilization of sediments during high flow periods..." (14)

Site 6, Woori Yallock Creek may also be affected by pesticides. TDE, DDE, DDT and Dieldrin have been detected in sediment samples at a site upstream of Wandin Yallock Creek confluence, and 8km downstream of areas of intensive market gardening and potato growing (EPA 1982)... Because understanding of transport mechanisms of pesticides in water and sediments is insufficient, it is not possible to estimate likely pesticide levels at Site 6." (14)

Another study published in 1983 looked at pesticide transport in three sub catchments of the Upper Yarra Catchment. The pesticides Dieldrin, DDT, DDE, Linuron and 2,4,5-T were detected. Pesticides at one location were most frequently detected in flows during vegetable washing operations. Pesticide concentrations were also generally higher in storm flow samples. Pesticide loads transported from catchments were generally between 1.3 and 9.3 mg/ha and between 134 and 228mg/ha in relation to vegetable washing plants. A sample of Dieldrin was recorded at 10.36ug/L in this 1991/2 study, almost 35 times over the 2011ADWG but also well upstream of the offtake to Sugarloaf. (15)

The authors wrote; *"The concentrations of Dieldrin and DDT do not appear to present problems for drinking water supply in the Yarra River itself although, on occasions the concentrations detected in flows from cultivated land during storms and operation of vegetable washing plants exceeded health criteria".* (15)

Note also that the half life of Dieldrin in water has been estimated to be 4 years.(64)

Since the time of these reports the levels of agricultural production in the Upper Yarra has expanded significantly. It could be argued that if vineyards are included, the current amount of intensively sprayed agriculture in the Upper Yarra Catchment was in 2008, 9000ha+, an 10 fold increase on the 870ha intensive cropping figure quoted in the above study in 1983, potentially meaning higher pesticide volumes at a catchment level, also potentially meaning higher levels of pesticide loads transported from catchments, depending on the pesticide and site conditions. In recent years there has been controversy over MIS funded berry farms and recent detections of Atrazine are most likely associated with cropping probably in riparian zones in the catchment. The Strawberry farms expansion has been most controversial and even the Strawberry industry recently vowed to crack down on growers overusing pesticides.(53) The issue of water supply contamination has also been raised publicly. *"They have been spraying two to three times a week for eight months using turbo sprays that can send the pesticide drifts up to 10 kilometres away, and this is part of the Melbourne water catchment."* (54)

February 2008: Woori Yallock Creek. Strawberry pesticide spraying in Melbourne's water supply. According to local residents the following pesticides are commonly used by the Strawberry industry:

The fungicides - Pyrimethanil, Myclobutanil, Iprodione, Carbendazim, (Carbendazim has recently been linked to deformed fish controversy in Qld), Trifloxystrobin, Captan, Fenhexamid, Thiram, Quinoxyfen. The insecticides - Spinosad, Methanol/Methomyl, Pirimicarb, Fipronil, Maldison, Trichlorfon. The miticides - Bifenazate,Etoxazole, Milbemectin. The herbicides - Glufosinate-Ammonium, Carfenatrazone-ethyl, diquat/paraquat. The soil fumigant - chloropicrin and the massive off-label use of Chlorpyrifos for control of Western Flower Thrip.

Aerial View 2009, Strawberry farms alongside Woori Yallock Creek, a major tributary of the Yarra River.

"...These factory farms create dead zones environmentally with large areas of native vegetation removed, gas soil sterilisation, filling in of the flood plain (which disrupts the ecology and waterways) and huge amounts of turbo-jet spraying of fungicide and insecticide, almost daily, from now until April" (16)

It is not therefore not impossible that pesticides could be pumped into Sugarloaf Reservoir from the Yarra River and not impossible that further testing conducted in higher risk times, such as high rainfall events, could reveal levels of pesticide higher than those sampled in 1980. It is strange that Melbourne Water discontinued future pesticide testing until well into the 1990's, and then only for organochlorines when a host of other pesticides would have also been used in the catchment. The question remains: *Have Melbournians been exposed to low levels of pesticides in their drinking water over the past 30 years?*

9. Melbourne Water Pesticide Testing Regimes and Risk Assessment 1996 – 2012

"MWC commissioned ECOS Environmental Consulting in 2002/03 to prepare a water quality risk assessment for the Mid-Yarra catchment (also referred to as the Sugarloaf catchment). The study identified the areas around Sugarloaf reservoir, Silvan reservoir and Yering Gorge pump station as having the highest risk to water quality. ECOS was then engaged to carry out a second stage study to assess these areas in greater detail. (17)

The Mid-Yarra catchment contains a wide variety of landuses, including residential, rural residential, industrial zones, modified pasture and a range of irrigated crops. A range of point sources exists within the catchment, including sewerage treatment plants, emergency relief structures, sewerage pump stations, and storm water outfalls. ECOS identified pathogens, nutrients, suspended solids, biocides, heavy metals and other chemicals as the key hazards." (17)

"The potential sources of each hazard were separated into diffuse and point sources. For diffuse sources, risk scores were allocated to each allotment based on the Australian Land Use and Management classification (ALUM) codes and the biocides that are likely to be applied to that allotment. The risk scores were divided by the log of the distance to Yering Gorge, based on which a range of maps was produced showing the anticipated risk to water quality from pathogens, nutrients and biocides.

The key findings of this analysis were:
• The identification of the highest risk landuses based on biocide risk,
• A list of the highest risk biocides,
• An understanding of the main sources of non-biocide risks within the Mid-Yarra catchment, upstream of Yering Gorge,
• The identification of the location and type of point sources of contamination within the study catchment, and
• An assessment of the risks from a traffic accident within the catchment." (18)

"Key biocides Sugarloaf: Metham, Chloropicrin, Methylbromide, Captan, Chlorothalonil, Pyrimethanil, Hexazinone, 1,3-dichloropropene, Ipriodione, MCPA" (19)

"Summary of Biocide Risks
The Sugarloaf catchment contains a significant area of high and very high biocide risk allotments. The high risks are related to irrigated horticulture, bulb and flower production and irrigated vegetable production. Significant areas of moderate biocide risks exist due to grazing pasture and forestry." (19)

"Risk Assessment Summary – Sugarloaf Catchment
Biocides:

Likelihood: Rating - Likely. Rationale - Catchment contains a large number of intensive

horticulture industries, forestry, and pastures. MWC is not aware of biocides being found previously in this catchment. However, monitoring for biocides is generally confined to small scale research studies and MWC has no reliable evidence to support an assessment of the likelihood that biocides would be present. Of any of the catchments, biocides are most likely to be found in Sugarloaf.

Consequence: Rating - Catastrophic. Rationale - The health impacts of biocides are uncertain and generally of a chronic nature. It is possible that long term exposure could cause cancer within a sub-set of the population resulting in shortened life expectancy in some people. Risk Rating High" (20)

Friends of the Earth started applying via Freedom of Information requests to Melbourne Water in 2008 regarding what pesticides the authority was testing for and what had been detected. The first results FoE received in early 2008 caused some concern. FoE was at that time unaware of the Drinking Water Risk Assessment which had been completed by Melbourne Water in December 2007. No information has been received from Friends of the Earth about actual pesticide screening tests being conducted in Sugarloaf Reservoir itself, or tap samples from suburbs consuming water from Sugarloaf. It would appear that this testing has not been done by Melbourne Water (58).

The first Freedom of Information request covered the period 1996 to January 2008. It revealed that Melbourne Water were only testing for a range of organochlorines* and 2,4-D. Generally speaking there were two pesticide testings per year across all their reservoirs with the tests concentrating on Aldrin, Chlordane, Lindane, DDT, Dieldrin, Heptachlor, Heptachlor Epoxide and 2,4-D. Atrazine was only included in the testing regimes from August 1 2005. Most of the organochlorines would not have been used in the catchment since the early 1990's. (*Please note: DDT use banned in 1990, Dieldrin banned 1988, Aldrin banned 1994, Heptachlor banned 1997, Lindane deregistered 1985, Chlordane banned 1997)

The only positive samples detected by Melbourne Water during the period were at a location not sourcing from the Yarra – Johns Hill Plant (Kallista), where in February 2000, Aldrin was detected at 0.02ug/L, Lindane at 0.02ug/L and Heptachlor at 0.013ug/L. (21)

In the FoI request FoE requested information going back until 1977, but information was granted only from 1996, meaning that either there were no records from 1977 to 1996 or no testing was being carried out.

So what FoE could glean from this information is that Melbourne Water up to 2008 were only testing for two currently used pesticides, 2,4-D and Atrazine, when over 300 pesticides may have been in use in the Yarra Catchment and may have been used in the catchment since the commissioning of Sugarloaf in November 1980. Essentially there was a period of 30 years when no government authority actually knew what pesticides were being washed into the Yarra and possibly pumped into Sugarloaf Reservoir.

"But while Melbourne Water tests twice yearly for atrazine to a level of .5ppb, it does not test for its close chemical relative simazine, which is used on Yarra Valley vineyards ... Melbourne Water understands that simazine is used infrequently in the Yarra Valley, and because of this infrequency of use and its degradation in the environment, testing is not conducted, consistent with our risk assessments," a Melbourne Water spokesman said. Age Newspaper July 15 2007. (61)

Mid 2008: Melbourne Water increases Pesticide Testing Range to 35.

In mid 2008 testing for pesticides was expanded by Melbourne Water to now include: Hexazinone, MCPA, Triclopyr, Asulam, Glyphosate, Captan, Carbaryl, Chlorpyrifos, Esfenvalerate, Maldison, Mancozeb, Parathion Methyl, Propargite, Simazine, Picloram, Cyprodinil, Metham, Methyl Bromide, Pyrimethanil, 1,3 dichloropropene, Iprodione, Methomyl, Bromoxynil, Metiram, Chlorothanlonil, Chloropicrin. This is in addition to the pesticides already tested for Aldrin, Dieldrin, Chlordane, DDT, Heptachlor, Heptachlor epoxide, Lindane, 2,4-D and Atrazine. (22)

August 2010: Melbourne Water increases Pesticide Testing Range to 136.

Aldicarb, Aldrin, Allethrin, Ametryn, AMPA, Asulam, Atrazine, Azinphos Methyl, Benalaxyl, Bendiocarb, BHC, Bifenthrin, Bioresmethrin, Bitertinol, Bromacil, Bromophos, Bromoxynil, Cadusafos, Captan, Carbaryl, Carbofenthion, Carbofuran, Chlordane, Chlorpyrifos, Chloropicrin, Chlorothanlonil, Chlorfenvinphos, Chlorpyrifos, Coumaphos, Cypermethrin, Cyfluthrin, Cyprodinil, Dalapon, DDT, DEET, Deltamethrin, Diazinon, Dicamba, Dichloran, Dichlorfluanid, Dichlorvos, Diclofop-Methyl, Dicofol, Dieldrin, Dimethoate, Diquat, Diuron, Endosulfan, Endrin, Esfenvalerate, Ethion, Ethoprophos, Etrimifos, Famphur, Fenamiphos, Fenchlorphos, Fenitrothion, Fenthion, Fenvalerate, Fipronil, Fluometuron, Fluroxypyr, Fluvalinate, Furalaxyl, Glyphosate, Haloxyfop, Heptachlor, Heptachlor epoxide, Hexachlorobenzene, Hexazinone, Iprodione, Isophenphos, lambda-Cyhalothrin, Lindane, Malathion, MCPA, MCPB, Mecoprop, Metalaxyl, Metham, Methidathion, Methiocarb, Methomyl, Metolachlor, Methoxychlor, Methyl Bromide, Metiram, Metribuzin, Nonachlor, Oxadiazon, Oxamyl, Oxychlordane,Oxyfluorfen, Paraquat, Parathion, PCB, Pendimethalin, Permethrin, Phenol, Phenothrin, Phorate, Phosmet, Picloram, Piperonyl Butoxide, Pirimicarb, Pirimphos Methyl, Procymidone, Profenofos, Prometryn, Propanil, Propazine, Propiconazole, Prothiofos, Pyrazophos, Pyrimethanil, Simazine, Sulprofos, Tebuthiuron, Terbufos, Terbutryn, Terbuthylazine, Tetrachlorvinphos, Tetradifon, Tetramethrin, Transfluthrin, Triclopyr, Tri-allate, Trifluralin, Vinclozolin, 1,3 dichloropropene, 2,4-D, 2,4-DP, 2,4-DB, 3 4 Dichloroaniline. (23)

May 2012 testing reduced back to 32 pesticides (58)

Alpha-BHC, Beta-BHC, Delta-BHC, 2,4-D, 4.4'-DDD, 4.4'-DDE, 4.4'-DDT, Aldrin, Atrazine, Chlordane (cis), Chlordane (trans), Chlorfenvinphos-E, Chlorfenvinphos-Z, Chlorpyrifos, Chlorpyrifos methyl, Diazinon, Dichlorvos, Dieldrin, Dimethoate, DDT (total), Endosulfan, Endosulfan sulfate, Endrin, Ethion, Fenthion, Heptachlor, Heptachlor epoxide, Lindane (BHC-gamma), Malathion, Pirimiphos ethyl, Prothiofos, Total Chlordane

10. Melbourne Water Positive Pesticide Results 2010-11

31 Positive Pesticide Detections by Melbourne Water at Yarra Offtake to Sugarloaf Reservoir between July 23 2010 – August 11 2011(excluding pharmaceuticals) ug/L (24) (25)

Date	Pesticide and Level Detected	% of 2011 ADWG Health Value	2011 ADWG Health Value
2/7/10	3-amino-246-triiodobenzol acid 0.001ug/L	No Guideline	No Guideline
2/7/10	5-amino-246-triiodoisophthalic acid 0.001ug/L	No Guideline	No Guideline
23/7/10	Triclopyr 0.011ug/L	0.055%	20ug/L
23/7/10	MCPA 0.02ug/L	0.05%	40ug/L
23/7/10	Metolachlor 0.0123ug/L	0.0041%	300ug/L
20/8/10	Simazine 0.013ug/L	0.065%	20ug/L
20/8/10	Atrazine 0.023ug/L	0.115%	20ug/L
10/9/10	Simazine 0.16ug/L	0.8%	20ug/L
10/9/10	Atrazine 0.018ug/L	0.09%	20ug/L
10/9/10	MCPA 0.03ug/L	0.075%	40ug/L
10/9/10:	Metolachlor 0.017ug/L	0.006%	300ug/L
10/9/10	DEET 0.01ug/L	No Guideline	No Guideline
7/1/11	DEET 0.04ug/L	No Guideline	No Guideline
7/1/11	Metolachlor 0.1ug/L	0.033%	300ug/L
11/2/11	2,4-D 0.02ug/L	0.067%	30ug/L

11/2/11	DEET 0.022ug/L	No Guideline	No Guideline
11/2/11	Metolachlor 0.273ug/L	0.091%	300ug/L
11/2/11	Simazine 0.026ug/L	0.13%	20ug/L
21/3/11	DEET 0.05ug/L	No Guideline	No Guideline
21/3/11	Glyphosate 0.5ug/L	0.05%	1000ug/L
7/4/11	DEET 0.05ug/L	No Guideline	No Guideline
4/5/11	DEET 0.016ug/L	No Guideline	No Guideline
18/5/11	Atrazine 0.056ug/L	0.28%	20ug/L
18/5/11	Simazine 0.012ug/L	0.06%	20ug/L
14/7/11	Atrazine 0.173ug/L	0.865%	20ug/L
14/7/11	Metolachlor 0.013ug/L	0.00433%	300ug/L
14/7/11	Simazine: 0.134ug/L	0.67%	20ug/L
11/8/11	Atrazine 0.188ug/L	0.94%	20ug/L
11/8/11	Dicamba 0.03ug/L	0.03%	100ug/L
11/8/11	MCPA 0.07ug/L	0.175%	40ug/L
11/8/11	Simazine 0.038ug/L	0.19%	20ug/L

The most frequent detections by Melbourne Water appear to occur in July 2010, with the highest amount of combined pesticides detected in March 2011 (Glyphosate & DEET). A pattern is emerging with pesticides being detected by Melbourne Water for most months of the year, with July to September being the months were most pesticides are detected. It would appear that atrazine

poses the highest risk in terms of human health. Although levels recorded for all pesticides are well below those set in the Australian Drinking Water Standards, there have been 8 instances of levels of pesticide above the EU direction of 0.1ug/L. (Most commonly, Metolachlor 3 and Atrazine 2).

Hydrolysis (decomposition of a chemical compound by reaction with water) half life for Simazine, Atrazine, Dicamba, Glyphosate and 2,4-D is approximately one month for each herbicide. (200 days for Metolachlor), meaning that residues of pesticides pumped into Sugarloaf may have been breaching European Standard of 0.1ug/L between July and October 2011. It would also be interesting exercise analysing sediment inside Sugarloaf, which surely must have traces of organochlorines and other pesticides.

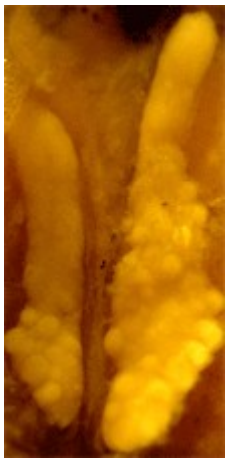
Australian Drinking Water Guidelines: Developed by the National Health and Medical Research Council and designed as a reference in how to achieve safe good quality water and how it can be achieved and how it can be assured. The ADWG rely on risk based management and calculations for guidelines for chemicals can be explained as follows. (65) In terms of Atrazine for example published in the 2011 Guidelines *"The health-based guideline of 0.02 mg/L for atrazine was determined as follows: 0.02 mg/L = 0.5 mg/kg bodyweight/day x 70 kg x 0.1*
divided by 2 L/day x 100 . where:

- *0.5 mg/kg bw/day is the NOEL based on a long-term (2-year) study in rats.*
- *70 kg is taken as the average weight of an adult.*
- *0.1 is a proportionality factor based on the assumption that 10% of the ADI will arise from the consumption of drinking water.*
- *2 L/day is the estimated maximum amount of water consumed by an adult.*
- *100 is the safety factor applied to the NOEL derived from animal studies. This safety factor incorporates a factor of 10 for interspecies extrapolation and 10 for intraspecies variation. "*

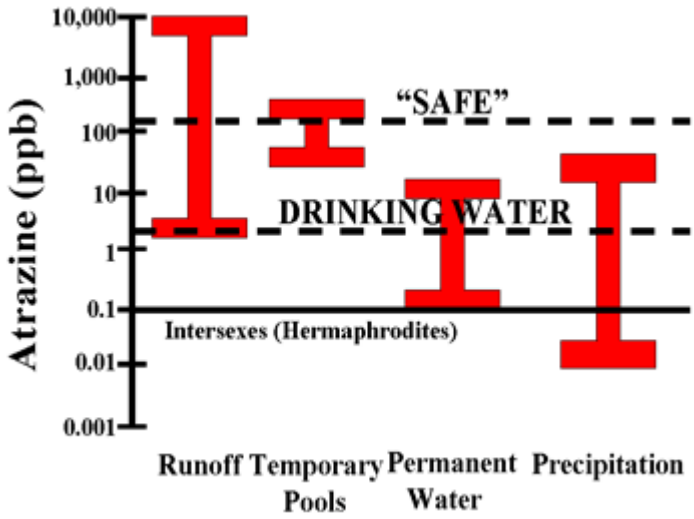
European Union Drinking Water Standards: Pesticide Standards in Europe allow for far lower pesticide residues than the standards used in Australia Council Directive 98/83/EC on the quality of water intended for human consumption. Adopted by the European Council, on 3 November 1998, allows for a value of 0.1ug/L for pesticides, with a pesticide total value (sum of pesticides found) of 0.5ug/L (45). The Australian Drinking Water Guidelines therefore allow Atrazine at 200 times higher than the European standard. It is also possible that Atrazine works on hormonal levels at levels as low as 0.1ug/L, meaning that such low levels of the herbicide cannot be discounted. It should also be pointed out that Atrazine has been denied regulatory approval by the European Union and is, thus, banned, in Europe.

"Surprisingly, frog hormones are very similar, and in some cases identical, to human hormones," he says. "So what affects a frog may also affect humans." (57)

"New data suggest that atrazine may represent a serious ecological concern due to its endocrine disruptor characteristics. Hayes et al. (2002) found that African clawed frogs (Xenopus laevis) exposed to concentrations of atrazine > 0.1 ug/l induced hermaphrodism. Exposure to higher concentrations (> 1 ug/l) demasculinized the larynges of exposed males, and testosterone levels decreased when exposed to 25 ug/l atrazine. These studies indicate that atrazine could have endocrine disruptor effects on native frog populations. " (46) (47)



"Atrazine induces gonadal malformations in males. The testes in this Northern leopard frog have been feminized. Not only have eggs developed, but they have accumulated yolk and are bursting through the surface of the testes." (55)



"Levels of atrazine in a variety of aquatic habitats as determined by literature review. Bars show minimum and maximum reported levels. The solid black horizontal line shows the concentration that chemically castrates and feminizes amphibians. The effective concentration in amphibians (0.1 ppb) is 30 times lower than the current USEPA drinking water standard (3 ppb) and 3000 times lower than the current EPA maximum contaminant (SAFE) level. Also of note, enough atrazine returns to the earth in rainwater (.5 million pounds per year) at high enough concentrations to chemically castrate and feminize amphibians. Figure adapted from Hayes et al" (56)

[Note this is a US graph: The Australian "safe" drinking water guideline for atrazine is 20ug/L (ppb), reduced from 40ppb in 2011].

Atrazine would be used either as a pre and post emergent herbicide for the control of grass and broadleaf weeds in certain cropping situations. If Melbourne Water have been testing for it since 2005 and not detected it until 2010, perhaps land management practices in the upper Yarra Catchment have changed or perhaps Melbourne Water are now testing at a different location.

Simazine would be likely to used more widely across the Yarra catchment for weed control in lupins, orchards and certain other horticultural and non-crop situations.

All readings coming under the ANZECC guidelines, although the simazine level is of most concern. However it should be noted that the ANZECC Guidelines are now 12 years old and could be considered to be well out of date. In light of this, recent research which included assessing pesticide amounts in the Yarra River has determined that *"standard approval procedures for pesticides are too narrow and should be reconsidered"*and *"that pesticide concentrations in rivers rated "safe" by standard methods reduced the populations of sensitive organisms by 27 to 61 per cent"* (59)

Recent Pesticide Detections By Melbourne Water in Relation to ANZECC Ecological Levels

Date	Pesticide Detected and Amount	% of 2000 ANZECC Guidelines 99% Trigger Level	% of 2000 ANZECC Guidelines 95% Trigger Level
20/8/10	Simazine 0.013ug/L	6.5%	0.406%
20/8/10	Atrazine 0.023ug/L	3.286%	0.177%
10/9/10	Simazine 0.16ug/L	80%	5%
10/9/10	Atrazine 0.018ug/L	2.571%	0.138%
11/2/11	2,4-D 0.02ug/L	0.014%	0.007%
11/2/11	Simazine 0.026ug/L	13%	0.813%
21/3/11	Glyphosate 0.5ug/L	0.135%	0.042%
18/5/11	Atrazine 0.056ug/L	8%	0.4%
18/5/11	Simazine 0.012ug/L	6%	0.375%
14/7/11	Atrazine 0.173ug/L	24.7%	1.331%
14/7/11	Simazine 0.134ug/L	67%	4.187%
11/8/11	Atrazine 0.188ug/L	26.85%	1.446%
11/8/11	Simazine 0.038ug/L	19%	1.187%

Professor Hayes, who has written several previous papers examining atrazine's effects on wildlife, said the findings should raise alarms about human health.

"It's a chemical … that causes hormone havoc," he said. "You need to look at things that are affecting wildlife and realise that, biologically, we're not that different." (63)

Landuse Woori Yallock Creek headwaters, looking north west towards Sugarloaf Reservoir. Some of Australia's most intensively farmed agricultural land lies in this catchment, particularly in the Wandin Yallock tributary.

11. Pharmaceuticals

Melbourne Water has also detected a range of pharmaceuticals at the Sugarloaf Reservoir Offtake in recent years. Of concern is the detection of Triclosan which for the past decade has come under increasing attention. Pharmaceuticals have not been studied at any great length during the research of this report. As of 2012, Melbourne Water is not currently testing for pharmaceuticals. (49)

More information on Triclosan can be found here:
http://www.beyondpesticides.org/antibacterial/health/index.htm

Toxicant	Date	Detection
Erythromycin	2/7/10	0.01ug/L
Hydrochlorothiazide	2/7/10	0.03ug/L
Salicyclic Acid	2/7/10	0.3ug/L
Tramadol	2/7/10	0.02ug/L
Venlaxafine	2/7/10	0.03ug/L
Carbamazepine	23/7/10	0.02ug/L
Hydrochlorothiazide	23/7/10	0.03ug/L
Salicyclic Acid	23/7/10	0.1ug/L
Tramadol	23/7/10	0.01ug/L
Triclosan	23/7/10	0.11ug/L
Venlaxafine	23/7/10	0.01ug/L
Cholesterol	23/7/10	1200ng/L
Caffiene	20/8/10	0.03ug/L
Venlaxafine	20/8/10	0.01ug/L
Cholesterol	20/8/10	290ng/L
Hydrochlorothiazide	20/8/10	0.01ug/L
Triclosan	10/9/10	0.01ug/L
Venlaxafine	21/3/11	0.01ug/L
Carbamazepine	7/4/11	0.02ug/L
Venlaxafine	7/4/11	0.01ug/L

Lilydale Sewerage Treatment Plant and its proximity to Sugarloaf Reservoir. Sewerage from a number of treatment plants upstream of Sugarloaf is the likely source of the pharmaceuticals that have been detected at Sugarloaf Reservoir offtake.

12. 2011 Upper Yarra Study – Effects of Pesticides Monitored With Three Sampling Methods In 24 Sites On Macroinvertebrates and Micro-organisms.

The study, '*Effects of Pesticides Monitored with Three Sampling Methods in 24 Sites on Macroinvertebrates and Microorganisms'* (25) published in Environmental Science and Technology (January 2011) was the most thorough pesticide sampling program ever conducted in the Yarra catchment and the first study for almost 30 years. Sampling was conducted between spring 2008 and summer 2008/9 with monitoring occurring in 24 sites. The study was primarily focussed on the Upper Yarra catchment, but some samples were also taken from 2 sites in urban Melbourne, 2 sites from the Mornington Peninsula and two west of Geelong. 19 testing sites in 14 waterways occurred in the Upper Yarra catchment above the offtake to Sugarloaf Reservoir. [Interestingly none of the pesticides detected in this study were detected by Melbourne Water testing during the same time period. This is not surprising as the testing regimes employed by Melbourne Water during 2008-9 would have missed ~74% of the pesticides detected in this study.]

43 pesticides were detected in surface water in the catchment upstream of Sugarloaf Reservoir. 26 detected in sediment. Examples of the highest readings for the various pesticides can be sourced in the second part of the report. (26)

The report was not designed to take into account implications of pesticides on drinking water, but was rather *"...to investigate the relationship between pesticide toxicity and macroinvertebrate community composition and the density of selected groups of microorganisms...in streams of southern Victoria over a 5 month period of five months for 97 pesticides..."*(25)

However it is of major concern to Friends of the Earth that so many pesticides have been detected within the Melbourne water supply, with most concerns in terms of potential impacts on human health being, Fipronil, Methiocarb, Pirimicarb, Simazine and Dieldrin.

The report found that *"...insecticides only exceeded -2 for log TU$_{DM}$, whereas herbicides only reached -2 for log TU$_{SC}$, indicating that insecticides and herbicides primarily represent a risk for invertebrates and for primary producers respectively. By contrast, the fungicides trifloxystrobin. Chlorothalonil, Iprodione, and Pyrimethanil exceeded both the log TU$_{DM}$ and TU$_{SC}$ of -2 and thus are ecotoxicologically relevant to both trophic levels. The mode of action of most fungicides is less selective compared to current use herbicides and insecticides, and they may therefore exert negative impacts on a range of non-target organisms. The fungicide trifloxystrobin was most frequently identified as the most toxic compound when regarding both the maximum mTU$_{DM}$ and mTU$_{SC}$...The high relevance of fungicides in terms of toxicity may be a result of the type of agriculture of our study region (mainly grapevine, fruit, and vegetable production) as fungicides were less relevant in regions with soy bean, cereal and oilseed production. However, our study highlights that fungicides may play a larger role for toxicity on freshwater communities than is currently acknowledged..."* (25)

It is also likely that pesticides in streams at certain levels reduce macroinvertebrate numbers and could be implicated in deformities of macroinvertebrates including mouthpart deformities in Chironomids.

Pesticide Detections (below) taken from '*Supporting Information for the Paper: Effects of Pesticides Monitored With three Sampling Methods in 24 Sites on Macroinvertebrates and Microorganisms'* (26) published in Environmental Science and Technology (January 2011).

Highest Readings found in Surface Water ug/L – upstream of Sugarloaf Offtake – [exact locations not published].

Pesticide Detected	% of 2011 ADWG Health Value
4,4-DDD 0.022ug/L	
4,4-DDE 0.024ug/L	
4,4-DDT 0.046ug/L	0.51%
Atrazine 0.31ug/L	1.55%
Azoxystrobin 0.02ug/L	
Carbaryl 0.039ug/L	0.13%
Chlorpyrifos 0.04ug/L	0.4%
Cyproconazole 0.39ug/L	
Cyprodinil 0.02ug/L	0.02%
DEA 1.3ug/L	
DIA 1.3ug/L	
Dieldrin 0.022ug/L	7.33%
Diflenoconazole 0.15ug/L	
Dimethoate 0.094ug/L	1.34%
Dimethomorph 0.01ug/L	
Endosulfane 0.012ug/L	0.06%
Fenarimol 0.2ug/L	0.5%
Fenoxycarb 0.034ug/L	
Fipronil 0.22ug/L	31.43%
Hexazinone 0.96ug/L	0.24%

Imidacloprid 0.59ug/L	
Indoxacarb 0.33ug/L	
Iprodione 3ug/L	3%
Metalaxyl 0.012ug/L	
Methiocarb 1.2ug/L	17.14%
Myclobutanil 2.9ug/L	
Penconazole 0.05ug/L	
Pendimethalin 0.04ug/L	0.01%
Pirimicarb1.45ug/L	20.71%
Prochloraz 0.06ug/L	
Procymidone 0.91ug/L	
Propargite 0.15ug/L	2.14%
Propiconazole 0.021ug/L	0.02%
Pyraclostrobin 0.1ug/L	
Pyrimethanil 70ug/L	
Simazine 15ug/L	75%
Tebuconazole 0.04ug/L	
Tebufenozide 0.045ug/L	
Tetraconazole 0.059ug/L	
Triadimefon 0.012ug/L	0.01%
Triadimenol 0.02ug/L	
Trichlorfon 0.006ug/L	0.09%
Trifloxystrobin 0.73ug/L	

Although none of the pesticides detected in this study breach ADWG's, and many were detected kilometres upstream of the offtake to Sugarloaf Reservoir, there would be mostly concerns regarding the readings for: 1. Simazine, 2. Fipronil, 3. Pirimicarb and 4. Methiocarb. It is also worth considering that there are no ADWG's for over 53% of the pesticides detected in this study. It is also

worth noting that of the 4 pesticides of most concern, Melbourne Water testing of 2008/9 would only have been looking at Simazine – which was not detected by Melbourne Water testing.

Sediment Samples were also taken during this study, meaning that a reservoir of pesticides remain in stream sediment ready to be remobilised in the future. Substances in underline and bolded represent pesticides not detected in surface water. There are no ADWG's regarding pesticides contained within sediments in domestic water supplies. Pesticide laden sediment can become remobilised in the water column during large rainfall/storm events.

Sediment Samples.

4,4-DDD 29ug/kg, 4.4-DDE 32ug/kg, 4,4-DDT 13ug/kg, Atrazine 2ug/kg, Carbaryl 0.039ug/kg, Chlorpyrifos 42ug/kg, Cyprodinil 2ug/kg, **Diazinon 17ug/kg,** Dieldrin 20ug/kg, Fipronil 5ug/kg, **Hexachlorobenzene 4ug/kg,** Imidacloprid 10ug/kg, Indoxacarb 9ug/kg, Iprodione 170ug/kg, **Linuron 18ug/kg,** Metalaxyl 1ug/kg, Myclobutanil 120ug/kg, **Oxadixyl 2ug/kg,** Pirimicarb 26ug/kg, **Propyzamide 180ug/kg,** Pyraclostrobin 1ug/kg, Pyrimethanil 272ug/kg, Simazine 260ug/kg, **Spinosad 100ug/kg,** Tebufenozide 2ug/kg, Trifloxystrobin 793ug/kg. (26)

In terms of ANZECC guidelines there are serious considerations, with three pesticides, DDT, Chlorpyrifos and Simazine all breaching the ANZECC guidelines for both 99% and 95% trigger levels. Also of concern is that for 86% of the pesticides detected, there is no current ANZECC guideline. This is clearly an unsustainable outcome particularly in relation to the detection of fungicides.

A study published in September 2011 on fungicides in the Yarra River summarised by saying;

"Generally the concentrations of the fungicides detected were several orders of magnitude lower than reported ecotoxicological effect values, suggesting that concentrations of individual fungicides in the catchment were unlikely to pose an ecological risk. However, there is little information on the effects of fungicides, especially fungi and microbes, on aquatic ecosystems. There is also little known about the combined effects of simultaneous low-level exposure of multiple fungicides to aquatic organisms. Further research is required to adequately assess the risk of fungicides in aquatic environments." (32)

Pesticide	Highest reading surface water	% of 2000 ANZECC Guidelines 99% Trigger Level	% of 2000 ANZECC Guidelines 95% Trigger Level
DDT	0.046 ug/L	766%	460%
Atrazine	0.31 ug/L	44.286%	2.385%
Chlorpyrifos	0.04 ug/L	1000%	400%
Dimethoate	0.094 ug/L	94%	62.667%
Endosulfan	0.012 ug/L	40%	6%
Simazine	15 ug/L	7500%	4687%

Melbourne Water and Regulatory Testing Shortfall Summary For Pesticides Detected in 'Effects of Pesticides Monitored With Three Sampling Methods In 24 Sites On Macroinvertebrates and Micro-organisms'.

No guideline level under 2011 Australian Drinking Water Guidelines: 23/43 pesticides [53.49%]

No ANZECC Guidelines: 37/43 pesticides [86.04%]

Current Melbourne Water Testing of 136 pesticides since August 2010 [arguably the most robust in the country], would still miss 24 (55.8%) of pesticides detected in this study in surface water.

Melbourne Water testing 2008 would miss 38 (74.4%) of pesticides detected in this study in surface water.

Melbourne Water Testing 1980-05 would miss 41 (95.3%) of pesticides detected in this study in surface water.

13. More information on pesticides of most concern to drinking water quality in the Upper Yarra Catchment

Atrazine: Triazine herbicide. Pre and post emergent herbicide which can be used both pre and post-emergence for the control of grass (such as Brome Grass) and broadleaf weeds in crops such as sorghum, maize, sugarcane, lupins, pine and eucalypt plantations, and triazine tolerant (TT) canola. Atrazine is one of the most widely used herbicides in Australian agriculture. Atrazine is a known groundwater pollutants and remains in sediment in the Upper Yarra at rates as high as 2ug/kg.

Chlorpyrifos: Organophosphorus insecticide used on a range of crop protection and pest control applications. Has been used in Australia for over 30 years. It is a known cholinesterase inhibitor. Has been found in Upper Yarra sediments at rates as high as 42ug/kg.

DDT: Organochlorine Insecticide – Persistent Organic Pollutant. Broad spectrum insecticide with use peaking in 1974. Banned in Australia in 1990. Remains in sediment in the Upper Yarra at rates as high as 13ug/kg.

Dieldrin: Organochlorine Insecticide – Persistent Organic Pollutant. Banned in 1988. In early 1988 a number of farms in the Gembrook region were quarantined because of unacceptably high levels of dieldrin in soil. Once used as a wood preservative, insecticide and termiticide. *"In agriculture it had reasonably extensive use in the control of various insect pests on a wide range of crops and livestock, including the control of wireworms and other insect pests in onion and potato crops."* (43) Lowest pesticide/water guideline under ADWG 0.0003mg/L. Dieldrin is highly persistent and remains in sediment in locations in the Upper Yarra catchment at rates as high as 20ug/kg.

Dimethoate: Organophosphorus, broad spectrum, systemic insecticide able to enter the sap stream of plants. It has been used in Australia since the 1960's. Used to control a wide range of insects on tree and vine crops; fruit and vegetable crops; field and pasture crops, Also used as a fruit dip; a post-harvest dip (for quarantine treatment only) and a seed dressing. use On 6 October 2011 the APVMA suspended the use of dimethoate on a number of food crops due to potential dietary risks. Acceptable Daily Intake was reduced by 95%.

Fipronil: Phenyl pyrazole insecticide used in agricultural and veterinary situations. "*It controls insect pests in a wide range of agricultural crops, it is used as an insecticidal seed dressing, and it is used for the control of termites, cockroaches and ants in residential and commercial buildings. In veterinary situations, fipronil products are used as spray or concentrated spot-on formulations to control fleas, ticks and other ectoparasites on dogs and cats, and the products are used for the treatment and control of flea allergy dermatitis".* (42) Used commonly against locusts. Fifth lowest pesticide/water guideline under ADWG 0.0007mg/L. Remains in sediment in locations in the Upper Yarra at rates as high as 5ug/kg.

Methiocarb: Non-systemic carbamate pesticide. *"In Australia, methiocarb is registered for use in the control of snails, slugs, wireworm and birds in a range of agricultural and domestic (in or around the home garden) situations. Major agricultural uses of methiocarb include grapevines, citrus, berries, pastures, cereals, and ornamentals. Methiocarb is available as either bait granules (BA 20g/kg methiocarb) or wettable powder (WP 750g/kg methiocarb) formulations"* (41)

Pirimicarb: A carbamate insecticide. A wettable powder, used for aphid control on crops (fruit, vegetables, cut flowers) and pastures. Remains in sediment in locations in the Upper Yarra at rates

as high as 26ug/kg,

Simazine: Triazine herbicide. Registered for use as an algicide in swimming pools, for weed control in chickpeas, lupins, TT canola, orchards and certain other horticultural and non-crop situations. Remains in n sediment in locations in the Upper Yarra at rates as high as 260ug/kg,

14. Endocrine Disruption

"*Vandenberg et al. conclude that there is consistent evidence that dioxin, atrazine, BPA and perchlorate have effects at low doses and, furthermore, that the effects observed depend on the dose. If correct, the consequences for regulatory toxicology are fundamental: if low dose effects cannot be inferred from high-dose studies then the method used to evaluate almost all chemicals for safety must be unsound."* (60)

According to the Pesticide Action Network, many of the pesticides detected in the Yarra studies are suspected endocrine disruptors.

Endocrine disruptors (EDCs) are chemicals that interact with and disrupt human and animal hormones which regulate reproduction, metabolism, development behaviour, immune function, stress and growth. An increasing body of scientific research is finding endocrine disruptors in a range of materials including pharmaceuticals, components in plastics such as Bisphenyl A, Dioxin and Dioxin like products, some pesticides, Polychlorinated Biphenyls, Perflurooctanoic Acid (PFOA) and phthalates. Everyday items such as plastic bottles, non-stick cookware, metal food cans, detergents, flame retardants, food additives, toys, cosmetics and pesticides may also act as endocrine disruptors.

Scientists have also determined that some chemicals react differently at low doses than they do at high doses. The lower doses could cause more problematic health effects for instance than the same chemical at a higher dose. This is of particular concern in regards to chemicals that mimic hormones.

These chemicals, can disrupt crucial life functions particularly in young children and foetuses. Hormones regulate body functions such as digestion, growth and sexual function, so any disruption of proper hormonal function can create health problems. The body uses very low dose effects for hormones to carry out their normal functions. It has been argued in terms of endocrine disruption that *"no dose is low enough"*. The endocrine disrupting interference can cause problems with natural hormones in regards to synthesis, secretion, transport, activity, or elimination for natural hormones. This interference or hormone blocking/mimicking in turn can alter hormone signalling.

With 'dose makes the poison' thinking dominating toxicology, traditional toxicologists didn't pursue the possibility that there might be effects at levels far beneath those used in standard experiments. No health standards incorporated the possibility. Over the past 15 years, however, as scientists began to explore the impacts of endocrine disrupting compounds - compounds that behave like hormones or interfere with hormone actions - many examples of non-monotonic dose response began to be published in scientific journals. (29)

The relatively recent discovery of non-monotonic response curves, where the shape of the dose response curve can reverse as the contamination level goes up and the true impact of endocrine disrupting pesticides has led scientists to call for an overhaul regarding how toxicological assessment for a range of chemicals is currently carried out. This paradigm shift is already occurring, however regulators may take longer to adopt these changes.

"We recommend that procedures to establish acceptable exposure levels for endocrine-disrupting

compounds incorporate the inability for high-dose tests to predict low-dose results. Setting acceptable levels of exposure must include testing for health consequences at prevalent levels of human exposure, not extrapolations from the effects observed in high-dose experiments. Scientists trained in endocrinology must be engaged systematically in standard setting for endocrine-disrupting compounds." (30)

In the United States there is pressure building to alter the current assessment of chemicals, which emphasises toxicity, whilst not thoroughly taking into account more subtle issues, such as endocrine disruption.

"*Groups representing 40,000 researchers and clinicians are urging federal agencies responsible for the safety of chemicals to examine the subtle impact a chemical might have on the human body rather than simply ask whether it is toxic. In an open letter to the Food and Drug Administration and the Environmental Protection Agency to be published Friday in the journal, Science, the scientists say the regulatory agencies need to tap into genetics, developmental biology, endocrinology and other disciplines when they analyze the safety of chemicals used in everyday products. "Although chemical testing and risk assessment have long been the domain of toxicologists, it is clear that the development of improved testing guidelines and better methods of assessing risks posed by common chemicals to which all Americans are exposed requires the expertise of a broad range of scientific and clinical disciplines," said the letter, which was signed by eight scientific societies.* (31)

In terms of the endocrine disrupting properties of the herbicides atrazine and (most likely) simazine:

"Atrazine induces aromatase expression in cells and animals after exposure; this ultimately causes an increase in the conversion of testesterone to estrogen. This effect has been reported in all vertebrate classes examines: fish, amphibians, reptiles, birds and mammals, including human cell lines. Another well documented effect of atrazine is that it decreases androgen synthesis and activity, again, in every vertebrate class examined. In addition, endocrine disrupting effects of atrazine occur through a number of other mechanisms, including antiestrogenic activity, altered prolactin release, and increased glucocorticoid release from the adrenal among others." (50)

"In 2002, one of the first published studies to connect atrazine exposures to altered gonadal morphology examined X. laevis frogs exposed to 0.01–200 ug/liter throughout larval development. All doses from 0.1–200 ug/ liter produced gonadal malformations including the presence of multiple gonads and hermaphroditism. ..Additional studies showed that low-dose atrazine exposure (0.1–200 ug/liter in the water) during sexual differentiation caused testicular dysgenesis, testicular resorption, and testicular aplasia in male frogs, and others indicated effects on sex ratios. Importantly, these effects were not all observed at the same atrazine concentration, and the studies were conducted in several different species, with some reporting effects at low doses but no effects at higher doses and others reporting effects in some but not all species." (50)

15. Appendices

Substances Detected in Yarra River Sugarloaf Offtake by Melbourne Water and EPA, and 2011 Yarra River Study

EDCs with reported low-dose effects in animals (or humans, where stated) (50)

Substance	Type	EDC Action	Affected End Point
2,4-D*	Herbicide		
3-amino-246-triiodobenzol acid	Plant Growth Regulator		
5-amino-246-triiodoisophthalic acid			
Atrazine	Herbicide	Increases aromatase expression	Male Sexual differentiation/development
Caffeine	Crystalline Xanthine Alkalide		
Carbamazepine	Anti-convulsant/mood stabilising drug		
Chlorpyrifos [1]	Insecticide	Antiandrogenic	Acetylcholine receptor binding (brain)
Cholesterol	Waxy Steroid of Fat		
DDE	Insecticide Breakdown Product		
DDT	Insecticide	Binds ER	Neurobehaviour
DEET	Insecticide		
Dieldrin	Insecticide		
Erythromycin	Macrolide Antibiotic		
Glyphosate	Herbicide		
Hydrochlorthiazide	Diuretic Drug		
Lindane	Insecticide		
Malathion	Insecticide		
MCPA*	Herbicide		
Metolachlor	Herbicide		
Salicyclic Acid	Monohydroxybenzoic Acid		
Simazine	Herbicide		
Tramadol	Analgesic		
Triclopyr*	Herbicide		
Triclosan	Antibacterial/Anti-fungal Agent	Antithyroid effects, androgenic and estrogenic activity	Altered uterine responses to ethinyl estradiol
Venlafaxine	Antidepressant		

Examples of Non Monotonic Dose Response Curves (NMDRC's) in cell culture experiments

(50)

Substance	Type	Nonmonotonic Effect	Cell Type
2,4-D*	Herbicide		
3-amino-246-triiodobenzol acid	Plant Growth Regulator		
5-amino-246-triiodoisophthalic acid			
Atrazine	Herbicide	Cell number	IEC-6 intestinal cells
Caffeine	Crystalline Xanthine Alkalide		
Carbamazepine	Anti-convulsant/mood stabilising drug		
Cholesterol	Waxy Steroid of Fat		
DDE	Insecticide Breakdown Product	β-Hexosaminidase release	HMC-1 mast cells, GH3/B6/F10 pituitary cells
DDT	Insecticide	Cell number	MCF7 breast cancer cells
DEET	Insecticide		
Dieldrin	Insecticide	β-Hexosaminidase release	HMC-1 mast cells
Erythromycin	Macrolide Antibiotic		
Glyphosate	Herbicide	Cell death, aromatase activity, ERβ activity	HepG2 liver cells
Hydrochlorthiazide	Diuretic Drug		
Lindane	Insecticide		
Malathion	Insecticide		
MCPA*	Herbicide		
Metolachlor	Herbicide		
Salicyclic Acid	Monohydroxybenzoic Acid		
Simazine	Herbicide		
Tramadol	Analgesic		
Triclopyr*	Herbicide		
Triclosan	Antibacterial/Anti-fungal Agent		
Venlafaxine	Antidepressant		

Examples of NMDRCs in Animal Studies (50)

Substance	Type	Nonmonotonic Effect	Organ/Sex/Animal
2,4-D* (with Dicamba + Mecoprop)	Herbicide(s)	Number of implantation sites, number of live births	Female/Mice
3-amino-246-triiodobenzol acid	Plant Growth Regulator		
5-amino-246-triiodoisophthalic acid			
Atrazine	Herbicide	Time to metamorphisis. Survivorship Patterns. Growth Parameters.	Thyroid axis/*Rhinella arenarum* (South American toad). Four species of frogs. *Bufo americanus*
Caffeine	Crystalline Xanthine Alkalide		
Carbamazepine	Anti-convulsant/mood stabilising drug		
Chlorpyrifos [1]	Insecticide	Body Weight	Male/rats
Cholesterol	Waxy Steroid of Fat		
DDE	Insecticide Breakdown Product		
DDT	Insecticide	Number of pups, sex ratios, neonatal body weight, male anogenital distance	Mice
DEET	Insecticide		
Dieldrin	Insecticide		
Erythromycin	Macrolide Antibiotic		
Glyphosate	Herbicide		
Hydrochlorthiazide	Diuretic Drug		
Lindane	Insecticide		
Malathion	Insecticide		
MCPA*	Herbicide		
Metolachlor	Herbicide		
Salicyclic Acid	Monohydroxybenzoic Acid		
Simazine	Herbicide	Estrous Cyclicity	Reproductive axis/female/mice
Tramadol	Analgesic		
Triclopyr*	Herbicide		
Triclosan	Antibacterial/Anti-fungal Agent		
Venlafaxine	Antidepressant		

NMDRCs for EDCs identified in the epidemiology literature (50)

Substance	Type	Affected Endpoint	NMDRC	Study Subjects
2,4-D*	Herbicide			
3-amino-246-triiodobenzol acid	Plant Growth Regulator			
5-amino-246-triiodoisophthalic acid				
Atrazine	Herbicide			
Caffeine	Crystalline Xanthine Alkalide			
Carbamazepine	Anti-convulsant/mood stabilising drug			
Cholesterol	Waxy Steroid of Fat			
DDE	Insecticide Breakdown Product	BMI, triglyceride levels, HDLcholesterol. Risk of rapid infant weight gain. Telomere length in peripheral leukocytes	Highest risk in groups with intermediate exposures (quartile 3). For infants born to women of normal weight prepregnancy, risk is highest with intermediate exposures. Increased length with intermediate exposures (quintile 4)	CARDIA participants (n 90 controls from nested case control study). Infants from Childhood and the Environment project, Spain (n 374 from normal prepregnancy weight mothers; n 144 from overweight mothers). Adults aged 40 (Korea, n 84)
DDT	Insecticide			
DEET	Insecticide			
Dieldrin	Insecticide			
Erythromycin	Macrolide Antibiotic			
Glyphosate	Herbicide			
Hydrochlorthiazide	Diuretic Drug			
Lindane	Insecticide			
Malathion	Insecticide			
MCPA*	Herbicide			
Metolachlor	Herbicide			
Salicyclic Acid	Monohydroxybenzoic Acid			
Simazine	Herbicide			

Tramadol	Analgesic			
Triclopyr*	Herbicide			
Triclosan	Antibacterial/Anti-fungal Agent			
Venlafaxine	Antidepressant			

*Can also contain low levels of Polychlorinated dibenzo-p-dioxins and dibenzofurans (PCDD/Fs) formed during the manufacture of chlorinated pesticides and can remain in the products as impurities.(40)

Pesticides Detected in Yarra River with information sourced from Pesticide Action Network database: http://www.pesticideinfo.org/ (51)

Petsicide/Type	Acute Toxicity	Carcinogen	Cholinesterase Inhibitor	Groundwater Contaminant	Developmental/ Reproductive Toxin	Endocrine Disruptor
2,4-D	Moderate	Possible	No	Potential	Suspected	Suspected
3-amino-246-triiodobenzol acid						
4,4-DDD	?	?	No	?	?	?
4,4-DDE	Slight	Yes	No	?	Yes	Suspected
4,4-DDT	?	?	No	?	Yes	?
5-amino-246-triiodoisophthalic acid						
Atrazine	Slight	Yes	No	Yes	?	Suspected
Azoxystrobin	Not Acutely Toxic	Not Likely	No	Potential	?	?
Carbamazepine						
Carbaryl	Moderate	Yes	Yes	Potential	Yes	Suspected
Chlorpyrifos	Moderate	Not Likely	Yes	?	?	Suspected
Cyproconazole	Slight	Yes	No	?	?	?
Cyprodinil	Slight	Not Likely	No	Potential	?	?
DEA	?	?	No	?	?	?
DEET	Slight	Unclassifiable	No	?	?	?
DIA						
Dieldrin	Yes	Yes	No	?	?	Suspected
Diflenoconazole						
Dimethoate	Yes	Possible	Yes	Potential	Yes	Suspected
Dimethomorph	Slight	Not Likely	No	Potential	?	?
Endosulfan	Yes	Not Likely	No	?	?	Suspected
Fenarimol	Slight	Not Likely	No	Potential	?	Suspected
Fenoxycarb	Slight	Yes	Yes	Potential	Yes	Suspected
Fipronil	Moderate	Possible	No	Potential	?	Suspected
Glyphosate	Slight	Not Likely	No	Potential	?	?
Hexazinone	Yes	Unclassifiable	No	Yes	?	?
Indoxacarb	Moderate	Not Likely	No	?	?	?
Iprodione	Slight	Yes	No	Potential	?	Suspected

Lindane	Yes	Yes	No	?	?	Suspected
Malathion	Moderate	Possible	Yes	Potential	?	Suspected
MCPA	Slight	Possible	No	?	?	?
Metalaxyl	Moderate	Not Likely	No	Potential	?	?
Methiocarb	Yes	Unclassifiable	Yes	Potential	?	?
Metolachlor	Slight	Possible	No	Yes	?	Suspected
Myclobutanil	Slight	Not Likely	No	?	Yes	Suspected
Penconazole	Not Acutely Toxic	?	No	?	?	Suspected
Pendimethalin	Slight	Possible	No	?	?	Suspected
Pirimicarb	Moderate	Yes	Yes	?	?	?
Prochloraz	Slight	Possible	No	?	?	Suspected
Procymidone	Not Acutely Toxic	Yes	No	?	?	Suspected
Propargite	Yes	Yes	No	?	Yes	?
Propinconazole						
Pyraclostrobin	?	Not Likely	No	Potential	?	?
Pyrimethanil	Not Acutely Toxic	Possible	No	?	?	Suspected
Simazine	Slight	Unclassifiable	No	Yes	Yes	Suspected
Tebuconazole	Moderate	Possible	No	Potential	?	Suspected
Tebufenozide	Slight	Not Likely	No	Potential	?	?
Tetraconazole	Moderate	Yes	No	Potential	?	?
Triadimefon	Moderate	Possible	No	Potential	Yes	Suspected
Triadimenol	Moderate	Possible	No	?	?	Suspected
Triclopyr	Slight	Unclassifiable	No	?	?	?
Trichlorfon	Moderate	Yes	Yes	?	?	Suspected
Trifloxystrobin	Slight	Not Likely	No	?	?	?

16. Response Letters

Responses From Authorities to FoE Concerns regarding 'Sampling Information for the Paper Effects of Pesticides Monitored With three Sampling Methods in 24 Sites on Macroinvertebrates and Microorganisms' published in Environmental Science and Technology (January 2011).

Greg Williamson General Manager Agvet Chemicals and Farm Leadership Programs Department of Agriculture, Fisheries and Forestry (after letter sent to Hon. Joe Ludwig) April 1 2011: *"...The Victorian Department of Primary Industries was involved in the study and is responsible for interpreting the results and determining if any action is necessary, including determining the sources from which the pesticides originated.* ***In a situation where a state considers that the use of a registered pesticide may have unintended consequences, including breaching health standards, the authority may undertake further investigations. The Victorian Government has not notified the authority of any concerns relating to pesticides in the upper Yarra River..."***

John Merritt CEO/EPA 31/3/2011 "*...I am aware of the study you refer to and note that streams that contribute to Melbourne's water supply all had levels within the Australian Drinking Water Guidelines. While this is comforting, we know it is better not to have any pesticides in any stream. Regarding your specific request for EPA to begin a monthly monitoring program for pesticides, this is unlikely to happen for a number of reasons. The large cost for monthly monitoring for hundreds of pesticides is a significant factor. But more importantly, routine monthly monitoring is probably not the most effective means for detecting toxicants which vary considerably in concentration depending on rainfall and streamflow. More targeted studies, such as those being undertaken by the Centre for Pollution Identification and Management (CAPIM), and with whom EPA is partner, are more likely to be successful in detecting such pollutants. We will continue to work with landholders and resource managers to reduce the risk of pesticides and other toxicants to the environment and will take action if breaches of the law occur.*

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