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Report to the Utility Services Committee
from Nick Hewer-Hewitt, Quality Assurance Officer, Strategy and Asset Group

Sydney Water Supply Contamination Crisis

1. Purpose

- To provide the Utility Services Committee with information about events leading up to and during the recent Sydney water supply contamination crisis. This summary is based on articles from various Australian newspapers, as well as information from a number of sites on the Internet. It is a summary of publicly available information and does not purport to be a technical critique.
- To give a brief comparison between the operations of Sydney Water and those of the Wellington Regional Council.
- To explain what filter backwash recycling is and give an overview of the United States Environmental Protection Agency's (USEPA) proposed rule on recycling treatment plant filter washwater.

2. Catchment Management

Sydney's main water supply is the Warragamba Dam on Lake Burragorang, situated in the southeast corner of the Blue Mountains National Park. The catchment area covers about 9,050 km². However, only 3,625 km² has restricted public access and of that only a third is *Schedule 1 land* which has the tightest restriction. This includes a 3 km exclusion zone behind the dam.

In the couple of years leading up to the contamination incident a number of financial cutbacks have caused the reduction of the number of Sydney Water rangers, who manage the catchment. This has resulted in an increase in day trippers, bush walkers and 4WD enthusiasts straying into the protected areas.

There have even been cases of anglers chartering helicopters to take them into the catchment.

About 15 percent of the catchment is in private ownership. A reduction in the resources allocated to catchment management has allowed landowners to delay fixing or erecting fencing around the waterways feeding the lake, leading to reports of cattle roaming and defecating in the water.

There are a number of communities in the catchment as well. Articles and reports reveal that not many of these communities are connected to main sewage systems. Household waste stored in septic tanks overflowing into catchment waterways have been documented, as well as villagers pouring waste down stormwater drains to avoid the cost of pumping out septic tanks. The Werriberri Stream, which flows through The Oaks Village on its way to the lake, recorded *Cryptosporidium* levels of 99,490 oocysts/100 litres in 1994. Levels as low as 10 oocysts/100 litres can make people sick. In 1996 280,000 faecal coliforms were found in 100 mL of stream water.

In comparison, Wellington Regional Council catchments are carefully managed and monitored. Records over the past few years show that there have been very low numbers of *Cryptosporidium* oocysts detected in some of our catchments on a very few occasions. *Giardia*, at levels generally less than 5 cysts/100 litre, have been detected on a few occasions. The yearly average for faecal coliforms (FC) has been 24 FC/100 mL sample in the Kaitoke Catchment, 47 FC/100 mL in the Orongorongos, and 39 in the Wainuiomata Catchment.

3. Treatment Plants

Sydney's Prospect Treatment Plant, which treats water from Lake Burragorang, is a direct filtration plant. In fact, publications and articles refer to it as the Prospect Filtration Plant. In direct filtration a coagulant is added to incoming water which then goes straight to the filters. The process relies on the time between coagulant addition and filtration for the floc to form, and on the filters alone to arrest the floc. The disadvantages of direct filtration are that floc formation is sensitive to the conditions within the plant and the process relies entirely on the filters to remove the floc. Prior to the contamination incident, the time between filter backwashes was approximately 72 hours. It is understood that this has now been reduced to 40 hours. Backwash water is normally recycled back into the treatment process.

The Te Marua treatment process has a sedimentation stage between coagulant addition and filtration. After the coagulant has been added the water goes onto the sedimentation tanks or "clarifiers". In the closely controlled conditions within these tanks the floc has good conditions to form and settle. The clean water is laundered off the top and goes to the filters. The advantage of this dual process is that a large majority of the material is removed by sedimentation prior to filtration, reducing the loading on the filters.

During times of high demand the capacity of the Te Marua plant is increased by up to 30 ML/day by running "Stream 2". "Stream 2" is a clarifier bypass stream that uses only direct filtration. With the plant running in this mode, there is increased loading on the filters and the time between backwashing the filter reduces to about 24 hours. If the filter cycle times are not reduced, the turbidity of the treated water may rise, indicating an increase in the number of particles passing through the filter. These particles could be pathogens, including *Giardia* and *Cryptosporidium*. *Cryptosporidium* has not been detected in our treated water. A single test from Wainuiomata treated water in August 1998 gave 1 *Giardia* cyst per 100 litres of water. All other results have been negative. This can be compared to 200-300 *Giardia* cysts per 100 litres detected in treated Sydney water and 20 *Cryptosporidium* oocysts in a 100 litre sample. Provision has been made in the capital works programme for upgrading of Stream 2. At this stage it is not clear which is the best process to use. Process trials will be undertaken over a period of a year starting in a few months time.

The Wainuiomata Treatment Plant operates using a different process; Dissolved Air Floatation. Dissolved Air Flotation performs the same role as sedimentation but the floc floats on the surface of the water from where it is removed. However, there are currently occasional short turbidity "spikes", which have an associated risk that pathogens may pass into the treated water. Current work to extend coagulant mixing times is aimed at eliminating these spikes.

4. Filter Backwash Recycling

Filter backwash recycling occurs when the water used for backwashing (cleaning) the filters is returned to the inlet of a plant. Some treatment plants treat this backwash water before returning it to the plant by putting it into settling tanks and allowing the impurities to settle out. This process is used at both Te Mama and Wainuiomata. There is a lack of information about the process used at the Prospect plant. However, a number of articles suggest that experts believe that questionable operating practices that recycled 30 ML/day of backwash water back into the plant may have contributed to the accumulation of pathogens in the plant. The practices used have since been reviewed and there is now a complete ban at the plant on recycling filter washwater.

The USEPA is currently looking very closely at the issue of recycling washwater that may lead to accumulation of protozoa (micro-organisms) in treatment plants. At this stage they have a proposed rule out for comment. The proposed rule requires the USEPA to have regulations in place by August 2000. While the proposed rule does not make any recommendation, it does acknowledge that some States have regulations in place that specifically ban recycling washwater, whereas other States have defined maximum turbidity values for returning the water into the plant.

The proposed rule and the comments from the American Water Works Association and a number of water supply utilities have attracted the attention of

the Ministry of Health in New Zealand. Adoption of such a rule in the United States could well lead to similar restrictions being put in place in New Zealand.

The implications of this for our treatment plants would be that we would have to look at alternative means of disposing of our liquid waste. Another possibility may be refining our backwash water treatment process to bring the recycled water into line with some form of a restrictive standard set by the Ministry of Health.

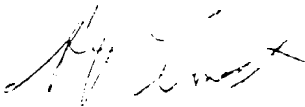
5. Conclusions

The Te Marua and Wainuiomata Water Treatment Plants incorporate a dual process for removing solids and are therefore much more likely to remove *Giardia* and *Cryptosporidium* than Sydney's Prospect plant. Even so we must remain vigilant with regard to catchment management. The future is likely to bring increased standards for water treatment. To meet these increased standards future capital investment to further improve our treatment plants may be required.

6. Recommendation

That the report be received and the information noted

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Attachment 1 : *Summary of the Sydney Water Supply Contamination Crisis*

Summary of the Sydney Water Supply Contamination Crisis

The following is a chronological summary of articles taken from the Sydney Morning *Herald* and The *Australian* newspapers concerning the protozoa (micro-organism) contamination of the Sydney City water supply. Most of the information was taken from the Internet version of the newspapers. It has not been possible to check the articles for errors of fact or for omission of relevant information. Rather, it is a summary of the events as reported by the news media.

Wednesday, 29 July 1998

Health and water authorities waited two days before making public that high levels of *Cryptosporidium* and *Giardia* had been found in the city supply. Staff first detected parasites in a water main near Parliament House on Friday, 24 July. On Saturday, *Giardia* levels were 200-300 cysts/100 L sample, while *Cryptosporidium* readings were just under 20 oocysts/100 L sample (*Drinking Water Standards for New Zealand 1995* levels are 0 cysts/100 L sample).

Sydney Water and New South Wales Health did not meet to discuss notifying the public until Monday. After this meeting Sydney Water issued a news release at 5 pm on Monday warning city residents within a 2 km radius of College Street to boil water for at least a minute before using it.

A Sydney Water spokesperson said that pipes in the area contaminated were flushed and by Monday the parasite readings were zero.

A New South Wales Health spokesperson said no illnesses had been reported and the precautionary warning was issued on Monday when the test results were available. *On Monday, new evidence came to light showing the source of the organisms was possibly due to a problem with the pipes that allowed contaminated water to be sucked in, she said. No relationship has been established between finding Cryptosporidium in drinking water at any level, in Australia or elsewhere, and effects on human health.*

Thursday, 30 July 1998

On the Wednesday night at 11.40 pm most of Sydney's residents were told to boil all tap water because of a potential risk from *Giardia*. Tests around the city had found two batches of contamination of *Giardia*. The warning did not mention *Cryptosporidium*. Results of

preliminary testing on the Tuesday had shown “zero to barely detectable” levels of the parasites in two water mains.

A Sydney Water spokesman said that they would continue doing more tests to make sure that they would find what was causing the problem.

Friday, 31 July 1998

At 8.00 pm on Thursday night health warnings were issued to all metropolitan areas after the discovery of another parasitic contamination.

The NSW Premier, Mr Carr, immediately set up an inquiry saying that he would sack any Sydney Water bureaucrat found to have failed their public duty.

Sydney Water confirmed on the Thursday that the source of the contamination was the Prospect Treatment Plant. They also said that the plant outlet was shut off and all water for Sydney was now being drawn from Warragamba Dam. Mr Carr also ordered Sydney Water to pay rebates on bills to consumers inconvenienced by having to buy bottled water. The chairman of the Environmental Protection Authority, Mr David Harley, was appointed to head the inquiry.

The Managing Director of Sydney Water, Mr Chris Pollett, said that the cause of the Prospect contamination was unknown. It was either contamination from a dead animal, a failure of the plant’s filtration system, or a combination of both. *I am confident to say that we have located the source of the problem and we have fixed it*, he said. *In all likelihood, the Giardia entered the water supply from the upper canal of Prospect or from the filters within the plant.*

A spokesman for the Australian Society for Microbiology warns against over-treatment and over diagnosis as the symptoms the parasite causes are common and mostly due to other causes. Thousands of Australians become infected with the *Giardia* protozoan each year. Not all will become sick and many of those who develop symptoms will recover without treatment. A microbiologist at the University of Melbourne has suggested that up to 2 percent of healthy babies might be carrying the parasite.

The contract between Sydney Water and the operator, Australian Water Services, does not target *Giardia* and *Cryptosporidium*. It is believed that the *Giardia* cysts had passed through the Prospect Treatment Plant. A Sydney Water spokesman confirmed that the privatised treatment plants did not have to target the parasite cysts. The Managing Director of Australian Water Services said the plant was *meeting all the requirements* and all other questions should be directed to Sydney Water.

Concerns were raised that Sydney Water was failing its health obligations at a time when the State Government is taking record dividends from Sydney Water. This includes \$250 million last year and an estimated \$280 million this financial year.

In 1996 Sydney Water signed a memorandum of understanding (MoU) for the Department of Health to take over regulation of water health matters. The MoU was only finalised this year.

The MoU does not specifically mention *Giardia* or *Cryptosporidium* but does require Sydney Water to report anything of “public health significance”. An Independent MP and water campaigner said that a 1994 parliamentary inquiry had highlighted the *Cryptosporidium* issue in particular but Sydney Water and the previous State Government had disregarded the inquiry’s 43 recommendations.

Sydney’s HIV community was officially advised to no longer drink tap water because it is at most risk of suffering or dying from *Cryptosporidium*. Many among Sydney’s ethnic communities remained unaware of the contaminated water. It was identified that a comprehensive strategy was needed to reach all people regardless of their linguistic background.

The New South Wales Chamber of Commerce warned employers that under the Occupational Health and Safety Act it was their responsibility to ensure a safe working environment with clean drinking water. Unions endorsed the warning.

Saturday, 1 August 1 1998

The \$13 billion Sydney Water Corporation has been fully aware of unexplained high levels of protozoa in all of its major water storages for at least six years.

No sources were identified but domestic, feral, and native animals were the key suspects.

In 1992 an environmental pathogens expert warned that treatment plants would have to remove *Cryptosporidium* oocysts by more than 99.9 percent to meet an acceptable risk level. However, when Sydney Water let contracts for four new private water treatment plants it did not specify *any* targets for *Cryptosporidium* or *Giardia*. There was a *Cryptosporidium* outbreak in Sydney last year and there have been reports of a more serious one in 1996, in the inner city area, which was not made public.

The Environmental Protection Authority warned against swallowing beach, creek and harbour water because of efforts by Sydney Water flushing the contaminated system into the stormwater drains.

Tests began on two dead foxes found in the watercourses feeding the Prospect Plant.

A New South Wales infectious diseases expert said that there had not been any increase in the number of people seeing their doctors with gastrointestinal illnesses.

Supermarkets report bottled water sales increase by up to 300 percent. An estimated \$3 million worth of bottled water has been sold in Sydney over the last three days. One household water filter company said that in a 48 hour period sales went from \$10,000 to more than \$100,000.

On the Friday Sydney Water refused to release test results showing the levels of oocysts and could not reveal where the tests were taken, saying only that the levels recorded were *low*.

The class action specialist legal firm, Slater and Gordon, has received dozens of inquiries from businesses and individuals following the health alert on contaminated water. A spokesperson said *The legal opinion is that Sydney Water has a contract to supply businesses and households with drinkable water and they have not done that. Therefore people are entitled to compensation.* Meanwhile the Australian Auditor-General has queried why there are no health guidelines for the levels of protozoa.

The Health Department said that families who keep the water temperature in their hot water cylinders low to prevent youngsters burning themselves should increase the temperature to about 70° C to kill the protozoa .

Dead dogs were not to blame. Sydney Water, Managing Director, Mr Chris Pollett said *It's doubtful that the odd dead animal would cause what we have seen, My belief is that it's more than likely that you've got natural occurring Giardia coming down the canal in the raw water. It's gone through the plant. The difference this time is that it's come out the other side.*

Sunday, 2 August 1998

Sydney Water has flown in a team from the South Australian Water's Australian Water Quality Centre (AWQC) to help resolve the contamination. The AWQC is an internationally recognised centre of excellence in water quality and treatment research.

Monday, 3 August 1998

Residents of 31 southern and central west suburbs (approximately 1.33 percent of people affected) received the all clear to drink tap water but the State Government has admitted that it may never know what caused the crisis.

Water campaigners and the press are starting to question the State Government's selection of Mr David Harley to head the independent inquiry, because he was the chairman of the Sydney Water Board during the early tendering for the new treatment plants.

Testing is still being carried out as 280 workers continue to drain and flush sections of the city's 14,000 km network of water mains. Technicians at the Prospect Plant hope to open up the treated water reservoir, which had been shut off when the crisis began, after water from the Warragamba Dam had been given the all clear.

A confidential report promoting the reuse of Sydney's sewage effluent for drinking water is about to be released. The report urges strong action to support an "informed decision" in 12 years on a \$3.5 billion shift to potable reuse.

Experts who dealt with the 1993 Milwaukee outbreak, in which 104 people died, warned that the only way to protect tap water from another outbreak is to add \$100 million ozonation plant to the system. At the time of the Milwaukee outbreak the United States' safe standard

turbidity level for *Cryptosporidium* was 5 NTU. At the height of the outbreak the levels leaving the Milwaukee plants only ever reached 1.7 NTU. Milwaukee's epidemiologist said that genetic testing had shown *the source of Cryptosporidium* was human, leading many to believe the local sewage system was the problem.

Sydney Water Chairman, Mr David Hill, said that he is *very unhappy* with the discovery of the protozoa in the drinking water but has denied he had been keeping a low media profile. Mr Hill has been preselected for Labour in the Federal seat of Hughes.

Tuesday, 4 August 1998

One hundred and six suburbs (approximately 20.8 percent of people affected) are now clear to drink tap water but the boil water warning still remains for the other suburbs.

The Prospect Filtration Plant was never taken out of service as publicly announced and 3.5 million people were exposed from as early as 21 July, six days before the first alert. Sydney Water has been accused of clearly misleading the public when it claimed five days ago that the Prospect plant was being bypassed. Australian Water Services confirmed that it was not taken off line at any stage but had continued to supply treated and filtered water directly to the mains system.

The Government removed the chairman of the contamination inquiry after doubts were raised about his impartiality because of his previous role as the Chairman of Sydney Water during the early tendering stages for the new treatment plants. However, he has been retained in an advisory role *because he may know where some of the bodies are buried back then*.

Wednesday, 5 August 1998

Sydney's water crisis was announced over when tap water was declared fit to drink. The board of Sydney Water announced a \$35 million, six point plan to guard against further outbreaks. However, a key part of the plan to divert treatment plant backwash water into a nearby reservoir appeared in doubt because the EPA warned that such a process would need to be examined *very carefully*. It is believed the contamination penetrated the drinking water during filter backwashing. The plan includes \$25 million to fast track the sewerage of villages in the collection catchment area as sewage overflow is a suspected source of the contamination, daily water testing at the privately operated plants, improved controls on raw water entering the plants, and a ban on recycling filter backwash water.

The next step of imposing State targets for protozoan removal could require new treatment processes costing up to \$300 million in Sydney. It would also pressure water supply managers around the country to follow suit, which could cost billions of dollars. The State Government would have to amend the Sydney Water's present operating licence and such amendments would require the approval of both Houses of Parliament and either the agreement of Sydney Water or an adjudication on any disagreement by the Independent

Licence Regulator. However, a senior State parliamentary advisor said that any thoughts on changes would have to await the inquiry into how health threatening the micro-organisms are.

A major design flaw was exposed when workers trying to isolate the plant found that if they did so the pressure would break the main above ground supply pipes. This leaves Sydney with no way of bypassing the plant in case of emergency.

Thursday, 6 August 1998

The legal firm, Slater and Gordon, launched an extended class action in the Federal Court on behalf of anyone who has been adversely affected. The case is listed for mention on 31 August.

Allegations have been made that the Chairman of Sydney Water, Mr David Hill, pressured the Health Department into retracting a city-wide alert. Sources in the Department of Health and Sydney Water said that during an angry conversation Mr Hill threatened the department's chief spokeswoman with the sack after she issued a city-wide alert, to which she replied that he could not sack her as he was not her boss. Mr Hill has denied the allegations. The Health Department had warned television and newspapers at 11.40 pm on Wednesday the 4th of the alert but an hour later Sydney Water retracted the warning and issued a revised statement limiting the areas affected and removing the fact that the protozoa had been found at the treatment plant. Less than 24 hours later further testing revealed more contamination and a city-wide alert was issued by Sydney Water.

Friday, 7 August 1998

Sydney Water did no testing for the protozoa in the plant supply route until the bugs showed up in the tap water. Originally Sydney Water said that testing was done in the canal fortnightly but had not been checked for a month prior to 21 July, the day that the contamination crisis began. However, now it says that it had never tested before the 21st and was unable to say when the water had last been tested. The latest admissions on testing suggest that there was no way of knowing if protozoa were present. Therefore any failure at the plant may have caused the crisis. The press have also found that:

- A Sydney Water team working on the pilot plant trials was aware of the protozoa threat and developed an inexpensive early warning system to show particles the size of cysts and oocysts were penetrating the filters. However, this was not used.
- Experts believe that the practice of recycling 30 ML/day of filter backwash water may have caused the parasites to accumulate in the plant.
- Australian Water Services approached Sydney Water early this year to upgrade the plant to include targeting for the protozoa but this did not happen.

The practice of recycling water was banned this week but it has been learnt that questions were raised within the international water industry at least as early as 1988 about recycling backwash water, following an outbreak of *Cryptosporidium* affecting tens of thousands of people in Southwest England .

The New South Wales Government has offered a one-off \$8 to \$10 discount on water bills as compensation to the 3 million people affected by the crisis. The Opposition has said it is an insult.

Wednesday, 19 August

Sydney Water's managing director resigned.

Thursday, 20 August 1998

The chairman of Sydney Water resigns following political and public pressure.

Wednesday, 26 August

All Sydney household were issued boil water notices again after tests showed *Cryptosporidium* contamination levels of 1050 oocysts/100 litres in the city. These levels are higher than the last contamination alert two weeks before.

Thursday, 27 August

Three experts have been called in from overseas to advise on the water contamination. Two are from Chicago and one is from Thames Water.

Health authorities cannot guarantee the safety of Sydney's drinking water from future outbreaks of dangerous parasites as evidence mounts that the main filtration plant was failing to stop the bugs.

Saturday, 29 August

Sydney Water's lawyers have criticised the independent inquiry into the crisis saying that they will take legal action if the findings are unfair to their clients.

There has been no rise in illness reported since the first water crisis last month.

Levels of *Giardia* and *Cryptosporidium* were discovered to be as high as 9445 oocysts/100 litres downstream of the Prospect Filtration Plant.

Monday, 31 August

Sydney Water has changed the source of the bulk of the city's water supply in a effort to cut the chances of another outbreak of contamination.

The class action against Sydney Water appeared in the Federal Court. The case involves more than 500 claimants.

Wednesday, 2 September

The all clear to drink tap water was given to 250,000 residents. Latest test results showed water at the filtration plants are safe. However, authorities need three clear tests within 36 hours, in the distribution system, before boil water notices can be lifted.

Consumer and "Green" groups are drafting a proposal advocating criminal prosecutions of water treatment plant operators. This proposal is based on a consultation paper being circulated in Britain.

The Prospect Water Treatment Plant

[Extracted from Sinclair Knight Merz press release dated 30 September 1997]

The Prospect water Treatment Plant is the largest direct filtration water treatment plant in the world. It has an initial capacity of 3,000 ML/day and the capability to be augmented to 4,200 ML/day capacity in the future, almost equivalent to filtering Sydney Harbour three times every year.

The plant, designed by the Prospect Water Group - a joint venture of CMPS&F Environmental and Sinclair Knight Merz, has won the Project Development-Infrastructure Category Award at the Institution of Engineers, Australia (Sydney Division) Engineering Excellence Awards 1997. It also received a "Special Commendation" by the panel judging the JJC Bradford Award for the best overall project. The Prospect Water Group was assisted in the design by two major international consulting groups, Montgomery Watson and Camp Dresser McKee.

The AUD\$200 million plant was delivered by Australian Water Services on a "Build, Own and Operate" basis to Sydney Water, enabling it to supply water to approximately 80 percent of Sydney's 3.5 million people. Australian Water Services is a joint venture of Lend Lease, Australia's premier property and financial services company, and Lyonnaise des Eaux, the worlds leading private water company.

Prospect Water Group Chairman, John Winton, said the plant operates 24 hours a day and uses innovative water filtration techniques to purify the water. *It can currently filter up to 3 billion litres of water a day, and provides water that is consistently clean,* Mr Winton said.

The plant has set a benchmark across the globe for all future water filtration plants, particularly in relation to its environmental attributes.

The detailed design of Prospect commenced in October 1993 based on process design parameters and operational requirements established by Australian Water Services (but understood to have been initially set by Sydney Water). Construction commenced in December 1993 and the plant was commissioned in September 1996. The design process included a critical appraisal of the water treatment process requirements and the development of a compact, cost effective and environmentally sensitive plant arrangement.

The features of the Prospect Water Filtration Plant are many and varied, and include:

- Prospect is the world's largest single stage-developed water filtration plant.
- The project is a WIN/WIN situation for NSW - the public sector acts as a regulator, while the private sector shares some of the risks.
- The project was completed in just under three years - some months ahead of schedule, and at a cost less than it would if it had been designed and constructed under conventional methods.
- The plant uses an advanced high-rate filtration process.

Coagulants are added to the raw water, enabling colour and suspended matter to bind together and be captured in the downstream filters. Provision has been made for pH adjustment at several points upstream, providing the ability to remove manganese and colour, as well as minimising downstream lime addition. The water then flows by gravity down through large sand filters, and clean, clear water comes out through the bottom. There are 25 sand filters at the Prospect Plant, each half the size of an Olympic Swimming Pool. The filters can be backwashed automatically up to three times a day.

Finally, small amounts of fluoride and chlorine are added to the water, fluoride as required by the Health Authority for dental health purposes and chlorine to disinfect the water and prevent the regrowth of micro-organisms.

Australian Water Services will operate the plant for the next 25 years.