Sydney Water Inquiry

FIRST INTERIM REPORT

POSSIBLE CAUSES OF CONTAMINATION

STATEMENT BY PETER MCCLELLAN QC

In accordance with my terms of reference I have today provided the Government with my first Interim Report which discusses possible causes of the recent contamination to Sydney's water supply.

Investigations have shown that although *Cryptosporidium* and *Giardia* contaminated Sydney's water supply there has been no significant increase in sickness. This is likely to be explained by recent studies showing that many of the organisms were dead.

Following investigation I have concluded that some of the possible causes of the contamination are unlikely. It is, however, not possible for me to reach a firm conclusion as to the cause of the events until further investigations that I have commissioned have been concluded.

These investigations will focus on the catchment, the treatment plant and a section of the distribution system immediately down stream of the treatment plant.

There is no common national standard for acceptable levels of *Cryptosporidium* and *Giardia* in drinking water. This creates difficulties for the authorities involved.

I have recommended to the Government that it ask, as a matter of urgency, the National Health & Medical Research Council to consider appropriate national guidelines.

The report also raises concerns about intermittent contamination as a result of last week's subsequent test results. I am satisfied that this issue is being addressed as a matter of priority.

This includes the commissioning of independent experts to oversee rigorous testing and assessment of Sydney's water supply.

The issues before the Inquiry are complex and will take further time to resolve.

I shall report further on issues such as the procedures involved in alerting the public in the near future.

Wednesday 19 August 1998

Sydney Water Inquiry

First Interim Report

Possible Causes of Contamination

August 1998

Peter McClellan QC

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For further information please telephone the Sydney Water Inquiry Secretariat

GOP Box 5341
SYDNEY NSW 2001

Tel: (02) 9228 5586
Fax: (02) 9241 5434

URL: http://www.premiers.nsw.gov.au/pubs.htm

Sydney Water Inquiry Secretariat

Chief Secretary's Building
121 Macquarie St
Sydney NSW 2000

Mr R Carr
Premier of New South Wales
Level 40
Governor Macquarie Tower
1 Farrer Place
SYDNEY NSW 2000

Dear Mr Carr

Please find attached, for your consideration, the Sydney Water Inquiry's *First Interim Report – Possible Causes of Contamination*. This report has been developed with the maximum amount of consultation possible within the available time frame.

I shall report to you on other issues raised by the Terms of Reference at an early date.

Yours sincerely

Peter McClellan QC

Executive Summary

Evidence of contamination of Sydney's water supply by the organisms *Cryptosporidium and Giardia* was evident on 21 July 1998. Under the existing arrangements Sydney Water informed the Health Department of the event. The levels did not raise health concerns. Low levels of *Cryptosporidium* and *Giardia* are commonly found in water supplies throughout the world.

Sydney Water continued testing the water at various points and by Sunday 26 July high, and in some cases extremely high, readings were found. On the afternoon of Monday 27 July a boil water alert, a common response to contamination, was issued for the Eastern CBD. It was believed that the contamination was contained and may be due to a combination of a broken sewer main and a broken water main, perhaps arising from one of the major construction projects in the area.

Results showing low levels of contamination were obtained on Tuesday 28 July and in the earlier part of Wednesday 29 July. But then, late in the afternoon and early evening, high readings became available from samples at Prospect Filtration Plant, Potts Hill reservoir and some locations further down the system. A decision was made that evening, after consideration of whether to alert the area of Sydney supplied through Prospect (about 85% of Sydney residents), to issue a new boil water alert confined to the area serviced by the Potts Hill reservoir – generally the area south of the Harbour.

On Thursday 30 July high readings were obtained from water sampled at Palm Beach. A Sydney-wide alert was declared. The Government announced the formation of an expert panel to advise on water safety. Public concern required Ministerial response to the problem and the Hon Craig Knowles, Minister for Urban Affairs and Planning, assumed the task of keeping the public informed until the crisis passed and the water supply was declared safe on Tuesday 4 August.

Since the major event, there have been some low readings but on Thursday 13 August higher levels were measured at the distribution chamber downstream of the Prospect plant. Testing has shown that these organisms were dead. Further positive, although lower, readings were obtained on Friday.

The expert committee has considered both readings but has not advised a boil water alert. However, it is plain that there is a continuing source of intermittent pollution at or near the Prospect facilities. This must be dealt with as a priority. It would be unacceptable if a component of the treatment or distribution system is contributing contamination to Sydney's water supply.

The Government formed an Inquiry and I was appointed its Chair on 5 August 1998. I was asked to provide an interim report within ten days with respect to the possible cause of the contamination and the procedures which were followed to bring the matter to the attention of the public.

This interim report discusses the possible causes of the contamination.

Notwithstanding the enormous efforts of the secretariat staff and those required to give information to the Inquiry, it has not been possible to complete a report dealing with the management of the events. In part this is due to the receipt of the further elevated readings at the Prospect distribution chamber which has, quite properly, diverted the efforts of Sydney Water. It is not yet possible to make conclusions about the cause of the events. Whether this will ever be possible will depend on further work which is presently being done at my request as a matter of urgency.

I have considered all the possible causes suggested by every party. None can be ruled out but some I consider unlikely. Others to varying degrees are possible and may have operated in combination to cause the event.

The measured levels of contamination in Sydney were high and in some cases extreme. However, it is believed that many of the organisms which were found were either dead or decaying. With respect to *Giardia*, it is generally killed by chlorine which is added to Sydney's water.

Only one species of *Cryptosporidium (C. parvum)* is dangerous to health but as yet no one has confirmed whether it was present in the water. The tests for species are complex and take some weeks to obtain a result. I have asked that further tests be undertaken as a matter of urgency.

The evidence available to me indicates that the events have not been followed by any identifiable increase in disease. This may be because many of the organisms were dead, however, the levels identified undoubtedly justified major health concern.

From the evidence presently available to me I consider it unlikely that there was a localised contamination event and I doubt that the Potts Hill reservoir was the source of pollution. The water supply throughout Sydney was contaminated and I am satisfied that the organisms had entered the system by the time water passed into the distribution chamber about 800m downstream of the Prospect plant.

The source of the contamination may have been the scouring of a channel taking raw water into the Prospect plant or some unusual event in the catchment. At present there is no evidence of such an unusual event.

Other sources which have been suggested are unusual activity in the plant, associated with routine maintenance which, due to its relatively recent commissioning, had not previously been undertaken. The filters may not have functioned with full efficiency and contaminants may have collected and concentrated in the clear water tanks and ultimately been released to the system by some other event. Australian Water Services Pty Ltd (AWS) argue with great care that the plant was not the source of the contamination. However Sydney Water have submitted to me that the plant has a high probability of being the cause. I am not persuaded that the plant was the source but will need further time to consider the Australian Water Services data particularly with engineers from Sydney Water and other experts before reaching a definite conclusion.

Following the readings obtained downstream of the plant on 13 August and 14 August, a further significant theory has been developed. Because the Prospect plant now provides the hydraulic balance for the system, if the levels in the tanks at the plant fall below the external water table, there may be an inflow of groundwater into the supply system downstream of the Prospect plant. The inflow could be considerable in some circumstances and would bring in groundwater, which has tested with high levels of *Cryptosporidium* and *Giardia*. The possibility is being urgently investigated at my request. At present it reflects one logical resolution of the available data.

It may be important to the event that the Prospect plant was undergoing maintenance, which led to a significant lowering of the water in the balance tanks. In addition Sydney has recently experienced heavy rains increasing run-off and groundwater levels. If this groundwater is entering the system it has a potential to provide levels of organisms which were identified in the recent events.

I am advised by experts from Australia and overseas and accept that events such as those experienced are always complex and take time to analyse before reaching conclusions with respect to the cause. Sometimes a cause is never found.

The Inquiry has made progress in other areas within its Terms of Reference. Many questions have been raised with respect to both the management of the incident and the management of the system including the operating relationship between Sydney Water, the Health Department and AWS. Already new arrangements are in place for notifying the public – the responsibility now being assumed by the Health Department rather than Sydney Water. This change is in my view appropriate. In addition the Health Department and the panel of experts have produced a new draft protocol for future events. I am not satisfied that the current draft protocol is appropriate but have asked that it be pursued expeditiously.

One matter which the protocol should define is the level of contamination by *Cryptosporidium* and *Giardia* at which various bodies respond and in particular the levels required for a health alert or consideration of advice to boil water. These matters are complex and from my early inquiries there is no common view throughout the world. However, the issue is important and appropriate guidelines will assist in the management of any future problems. My view is that Government should seek the urgent assistance of the National Health and Medical Research Council in reviewing the present guidelines.

There are many other matters which require consideration by the Inquiry and I shall provide a further report at an early date.

The Water Supply System

Sydney's water supply is largely drawn from catchments on four main river systems - the Upper Nepean, the Warragamba, the Shoalhaven and the Woronora. The water system that supplies the majority of Sydney's population is the Warragamba system. The other systems supply residents of Sutherland Shire, Campbelltown, the Blue Mountains and the Illawarra.

Sydney's water supply is delivered by pipeline from Warragamba Dam to Prospect Water Filtration Plant. The Prospect plant supplies about 85% of Sydney's water. Water supplies for the Penrith and Emu Plains areas and lower towns of the Blue Mountains are drawn from the pipeline before it gets to Prospect and delivered to Orchard Hills Water Filtration Plant.

All potable water supplied by Sydney Water is filtered, disinfected and fluoridated at one of eleven water filtration plants in the system. An extensive network of pumps, pipelines, reservoirs and nearly 20,000 km of pipes distributes water from the plants to residents.

Water is distributed from Prospect Water Filtration Plant to Pipe Head by tunnels and mains, with some areas supplied directly from these mains**.** From Pipe Head, water for the inner city, suburbs south of Sydney Harbour and inner western suburbs is carried by tunnel and mains to two large service reservoirs at Potts Hill and then by two tunnels (the Pressure Tunnel and City Tunnel) which terminate at Waterloo and Dowling Street pumping stations.

Water for the northern suburbs and Warringah is supplied by two pumping stations - one at Prospect and one at Ryde. The water for Ryde is supplied from Pipe Head.

See Attachments A and B for diagrams of the system before and after the Prospect plant.

Cryptosporidium and *Giardia* in Drinking Water

What are the bugs?

Both *Cryptosporidium* and *Giardia* only reproduce inside humans and animals and are described as parasitic protozoa.

Cryptosporidium comes in a number of species but only *Cryptosporidium parvum* has been identified as causing disease in humans. Symptoms of the disease include nausea, flu-like illness and a mild to severe diarrhoea with abdominal cramps which can last up to two weeks. In people with damaged immune systems (e.g. cancer, transplantation patients and AIDS patients) the situation is more serious. *Cryptosporidiosis* is a cause of death in the AIDS population. There is no medical treatment for infection with *C. parvum*. It is not presently known if the *Cryptosporidium* found in Sydney drinking water were *C.parvum* or some other benign species. This can only be determined after further extensive testing which has not yet commenced. *Cryptosporidium* appears to be completely resistant to normal chlorine treatment.

Giardia intestinalis (also known as *G.duodenalis* or *G.lamblia*) may cause acute or chronic diarrhoea in human beings which typically lasts for two weeks but may, if untreated, last for six weeks. Even after treatment, symptoms may recur. These symptoms consist of diarrhoea, nausea, abdominal cramps and prolonged infection, which can have serious health consequences. Giardiasis can be treated with the drugs metronidazole or tinidazole. The parasite is only infective when alive and is killed by appropriate levels of chlorine which are normally included in water treatment.

Giardia is a relatively common infection in the Australian community, especially in young children. *Cryptosporidium* infection however is much less common. Transmission of either disease by drinking water supplies appears to be much less common than person to person contact.

Are there standards for *Cryptosporidium* and *Giardia* levels in drinking water?

Our current level of medical knowledge is generally insufficient to enable regulatory standards for these organisms to be set. Most countries, including Australia, do not have standards. Of course, any level of live *Cryptosporidium* and *Giardia* in drinking water requires careful consideration. However, there are presently different views as to the level of contamination which justifies a boil water alert. This is an issue which will be further considered in the final report but requires urgent review by an appropriate body. At a national level, that body would be the relevant committee of the National Health and Medical Research Council.

What are the consequences of *Cryptosporidium* and *Giardia*?

There have been many outbreaks of human disease due to the consumption of contaminated water but in recent years outbreaks due to *Cryptosporidium* have been the most commonly identified. This is thought to be largely because the organism has a low infective dose, which means that only small numbers of organisms need to be ingested to cause disease.

The largest reported outbreak involved over 400,000 people in the city of Milwaukee in 1993. This outbreak resulted in excess of 100 deaths among persons with immune deficiencies. In general, during outbreaks of waterborne cryptosporidiosis, the levels of organisms seen in the drinking water have been low and in some cases have not been detected.

Outbreaks of giardiasis linked to treated drinking water are very much less common because the organisms can be killed by disinfection with chlorine. However their presence may indicate either a failure of the filtration system or ingress of water into the distribution system.

What were the health effects of this incident?

The levels of contamination of the water supply found during this event were sufficiently high to cause concern that they may have endangered the health of the public. If the organisms which were found were of the specific types known to infect humans and were live, then significant disease would be expected in the population of Sydney. Whilst many people will have developed immunity to infection naturally, some people would be susceptible and drinking water containing infectious parasites would result in disease. A human volunteer study showed that levels of 132 live *Cryptosporidium* would cause disease in 50% of a susceptible population. The levels found in Sydney drinking water were at a level which would have resulted in an average consumption of up to 10 *Cryptosporidium* per person per day.

The Health Department has intensively investigated the levels of both of these diseases within the community. To date, no increase in infection with *Cryptosporidium* has been identified. A small increase in the level of *Giardia* infection has been demonstrated but it is not clear if this is due to consumption of contaminated water. Other possible explanations include fluctuations in disease unrelated to water or increased detection of disease due to increased testing.

How is drinking water treated?

Water treatment processes have been developed in recent years which enable many potential contaminants to be removed from drinking water. Chlorine is used to inactivate viruses and bacteria. Parasites which are chlorine resistant, and other matter, is removed by filtration. Modern filtration plants such as Prospect involve a process of coagulation, flocculation, filtration and disinfection. Coagulation ensures particles have no charge. Flocculation causes small particles to clump together to form larger particles. The filtration involves passing the water which has been coagulated and flocculated through sand filters. This form of filtration can be expected to remove 99% of particulate matter. The operators of the Prospect plant claim that their filters remove at least 99.9% of all *Cryptosporidium* and *Giardia* organisms.

After a period of filtration, the filters may become clogged, reducing the flow of water through them. At this point they are "backwashed". Backwashing involves reversing the flow of water through the filters at a high rate to wash free particles which are then collected for disposal. After backwashing, filters are returned to use. The water used to clean the filters (the backwash water) must be cleaned by settling or some other process to remove particles before being returned to the front of the works for re-treatment.

The frequency of backwashing filters depends largely upon the amount of particulate material which is applied to them. The efficiency of particle removal from the backwash water is critical to the efficiency of the plant. Unless adequate removal occurs, the backwash water can contribute high concentrations of contaminants to the incoming water.

Chlorine is used for disinfection and will kill most micro-organisms. It maintains a "residual" beyond the treatment plant, preventing bacteria from growing in the water distribution system. Since chlorine disinfection does not affect the viability of *Cryptosporidium*, optimisation of treatment must concentrate on filtration and coagulation.

How are *Cryptosporidium* and *Giardia* detected?

Cryptosporidium appears in water as a robust structure known as an "oocyst" which may survive several months or longer. *Giardia* appears as a similar form known as a "cyst" which may survive in water for several months.

Detection of *Cryptosporidium* and *Giardia* in water sources is technically challenging. It is not generally possible to culture *Cryptosporidium* or *Giardia* which precludes traditional, culture-based, analytical methods. Both *Cryptosporidium* and *Giardia* potentially have a very low infectious dose and accordingly methods of analysis have to be very sensitive. To get the required sensitivity, large volumes of water (10-5000 litres) are analysed. To analyse these volumes, water samples have to be concentrated. Along with the cysts and oocysts, large amounts of other particulate material are also concentrated. The second step of analysis generally involves some purification of oocysts from the extraneous particles. After purification *Cryptosporidium* oocysts and *Giardia* cysts are generally identified and counted. This is achieved by using specific "tags" for the two parasites which fluoresce when viewed under a microscope. These methods cannot determine if the *Cryptosporidium* or *Giardia* are alive. Additional tests using another fluorescent dye (DAPI) can help decide if *Cryptosporidium* is alive.

Sydney Water tested the samples and then some were re-tested by Thames Water Utilities (UK). There was a large number of algae present in some samples which makes testing more difficult but these tests largely confirmed the results of Sydney Water.

I have received submissions which argue that the test results obtained by Sydney Water may be false. This is particularly suggested by Australian Water Services Pty Ltd (AWS), the operator of the treatment plant. Although I cannot yet be certain, I am reasonably satisfied that the results have revealed the presence of both organisms, although many were either dead or decaying, which suggests that they may have been in the environment for some time.

Summary of the Events

On 21 July a low level of *Giardia* [3 *Giardia* cysts per 100 litres (3G)] was confirmed at the Prospect distribution chamber. On the same day low levels of both *Giardia* (2G) and *Cryptosporidium* [2 oocysts per 100 litres (2C)] was found at Potts Hill reservoir. These were detected as part of routine water sampling.

Under the existing arrangements Sydney Water informed the NSW Health Department of the event. The levels did not raise health concerns.

Further tests of the positive sites and additional tests of various other sites around Prospect and Potts Hill were commissioned. Test results received the next day showed all clear, except one sample from Sydney Hospital (0C/1G).

On Thursday 23 July, results from a retesting of the Sydney Hospital site on 22 July showed a higher positive result (43C/19G). Surrounding sites tested showed all clear.

Test results received on the Friday from a sample taken the previous night showed the all clear for all areas tested except an outlet at Sydney Hospital (1C/0G) and at the Art Gallery (16C/16G), which are both fed from the same main. At this stage, it was considered that a localised contamination problem existed.

On Saturday, further tests from samples collected the previous day showed positive levels at the Art Gallery (10C/106G), Macquarie Street (15C/161G) and Crown Street pumping station (10C/5G). At this stage, tests were ordered throughout a wider part of the Sydney distribution system. After flushing of most of the affected area, tests of the first flush water from College Street showed high readings (104C/461G).

On Sunday 26 July, test results received from the previous day's samples showed extremely high levels from Macquarie Street (376C/3952G), College Street (170C/332G) and the Art Gallery (200C/963G) and lower levels from Crown Street Reservoir (6C/20G). Test results for Prospect plant, Potts Hill, Thornleigh and West Ryde were negative, however the City Tunnel at Greenacre showed a low positive result (0C/8G). This was the first positive reading received outside the Eastern CBD (other than the initial low readings from Prospect distribution chamber and Potts Hill).

If these elevated readings were found in a significant section of a water supply system they could justify a health alert.

On Monday 27 July a public notice was issued warning persons in the affected area of the Eastern CBD not to drink unboiled water. Results from Sunday tests were received later that day showing the all clear. A reading at the corner of Liverpool and Crown Streets showed positive readings (1C/16G).

Results received on Tuesday 28 July indicated some further low positive results from sites tested on the previous day, including Macquarie Street (2C/1G), College Street (4C/6G) and Crown Street reservoir (0C/14G). Other Eastern suburbs sites tested negative. However, a site at Rhodes tested positive also (0C/4G).

On Wednesday 29 July, early samples received from Potts Hill reservoir showed two all clear and one with a low count (5C/2G). Later in the day, sample results from the CBD showed five sites clear and low counts at Art Gallery (4C/0G), College Street (2C/0G), Macquarie Street (1C/0G) and Crown Street (1C/0G). Llewellyn Street also tested positive (0C/4G).

Late that afternoon, a sample result from the sediment at Prospect Water Filtration Plant clear water tank Number 1, which was offline, showed a high positive (96C/42G per 4 grams of sediment). Later that evening, further results taken from samples earlier in the day showed high positive results at Potts Hill reservoir (10C/48G), the City Tunnel (24C/27G) and further down the Pressure Tunnel at Enfield (12C/136G). Another low count at Rhodes, sourced from the Potts Hill reservoir, was also received (1C/1G).

In light of these positive readings at sites beyond the Eastern CBD, a public alert was issued advising people serviced by the Potts Hill system to boil their drinking water. This was defined as “an area east of Bankstown – Silverwater; south of the Harbour and north of the Georges River”.

On Thursday 30 July, test results showed a high positive reading at Palm Beach (365C/151G). At this point, a precautionary boil water advice was issued to apply to the entire Prospect system. A positive reading was also received at Warragamba pipeline Number 2 (409C/70G), which was immediately closed. Three positive readings were received at Potts Hill (the highest of which was 273C/109G). A sample at Prospect distribution chamber also tested positive (2C/1G).

On Friday 31 July the Minister for Urban Affairs and Planning, the Hon Craig Knowles, after meeting with the Premier, announced the formation of an expert panel to advise on when the water supply was

safe. The panel comprises Australia's leading experts in infectious diseases and microbiology. It is responsible for reviewing all test results as they become available and advising on the criteria to decide when it is officially safe to drink the Sydney water.

From Sunday 2 August to Tuesday 4 August, periodic announcements were made lifting the boil water advice for identified postcode areas, on the advice of the expert panel. On 4 August the precautionary boil water notice was lifted for all areas of Sydney.

Inquiry Process

The Inquiry has been assisted by a wide range of operational, management and scientific experts. Mr David Harley and Mr Bernie McKay are acting as advisers to the Inquiry. Mr Harley is Chairman of the NSW Environment Protection Authority and is a former Chair of the Sydney Water Board. Mr McKay is a former head of the South Australian, New South Wales State and Commonwealth Departments of Health and a former Chairman of the National Health and Medical Research Council.

I have received detailed submissions and other material from Sydney Water Corporation, the NSW Health Department, the Environment Protection Authority and Australian Water Services Pty Ltd (AWS). Detailed discussions have been conducted with these organisations over the last ten days and I appreciate the significant efforts of staff and consultants to assist the Inquiry and, at the same time, manage the ongoing problems.

Together with the advisers, I have inspected various aspects of the system and the Prospect plant as well as Australian Water Technology's testing laboratory where many of the water tests have been undertaken.

The Inquiry has consulted a range of national and international scientific experts including:

- Dr Colin Fricker - Head of Microbiology for Thames Water, UK.
- Mr John Gaston – Senior Consulting Civil Engineer, CH2M Hill, USA.
- Dr Duncan Veal – Senior Lecturer in Biology, Macquarie University.
- Dr John Walker – Head of Parasitology, Westmead Hospital.
- Dr Jerry Ongerth – Visiting Professor, Department of Water Engineering, UNSW.

Possible Causes of the Contamination

Possible Cause 1: A Localised Contamination Event in the Eastern CBD.

Examination of test results reveal high levels of contamination and, in some locations, extremely high levels. These levels were initially obtained in areas around and close to the Central Business District. The hypotheses suggested to explain these levels include those which were considered by Sydney Water during the incident:

- Cross connection between sewer and water pipes in Sydney Hospital.
- Pressure drop in the reticulation system causing a backflow of contaminated water to the water system.
- Broken water main in Crown Street.
- Construction work on the Eastern Distributor and/or the new swimming pool in Hyde Park causing breakages in water and sewer pipes with cross contamination.
- Flushing of the distribution system, particularly at fire hydrants following identification of the initial levels, may have disturbed or concentrated material in the system.

Interim evaluation

Apart from a contribution to high readings coming from the flushing process, I am presently satisfied that theories about a localised contamination may be rejected for the following reasons:

- No cross connections were found in Sydney Hospital even after intensive investigations.
- Chlorine levels in the water were not reduced to a level which would indicate a major cross connection or backflow, nor were any traces of coliform bacteria found in the distribution system. If there had been a backflow or major cross connection, both these events would have been likely.
- There were no reports of consumer complaints about dirty water which would be common if there were cross connections or backflows.

- Intensive checks of the distribution system by experienced engineers revealed no evidence of cross contamination.
- It has been suggested that the samples taken from flushing of fire hydrants may be more likely to show elevated levels of contamination. An analysis of samples taken from the hydrants revealed 56% positive. However, the pattern of samples was mixed. The hydrant at Sydney Hospital, sampled nine times, was negative the first three, then positive twice, negative once and positive for the last three.
- It has also been suggested that the intensive flushing of the system which followed the initial identification of contaminated water may have disturbed residual contaminants in the pipes at dead ends or in the biofilm (the film which inevitably occurs within water pipes). Although with disturbance this is possible, I doubt whether it has contributed significantly to the incident except perhaps to further elevate some of the levels which were measured.
- Subsequent events and testing supported a wider system problem.

Possible Cause 2: Contamination at Potts Hill Reservoir.

This reservoir is a major distribution point and provides water to areas including Ashfield, Silverwater, East Hills, the city, the eastern suburbs and some southern suburbs, as shown in the diagram at Attachment A. It is the only uncovered reservoir in the Sydney distribution system and accordingly is more vulnerable to contamination.

It is a vital point in the system which Sydney Water has already decided should be covered.

This reservoir and its outlets were sampled 13 times between July 21 and August 1, and was positive six times; four of the positive samples occurred on July 28. The organisms could have come from upstream of the reservoir or from contamination confined to the reservoir itself.

Possible sources of contamination from within the reservoir include:

- birds which may carry disease organisms.

- other animals which may have entered the reservoir and caused contamination.
- surface flows into the reservoir.

Interim evaluation

My present view is that it is unlikely that the Potts Hill reservoir was the source of the contamination. There is no evidence of animal activity or any other contaminant within it. Although the presence of bird faecal matter is possible, the likely volume would not be high enough to cause the levels recorded in the east Sydney area. The discovery of positive readings, some quite high, at points in the distribution system above Potts Hill indicates a source other than the reservoir. The possibility of surface flows as a possible cause was discounted after inspection.

Possible Cause 3: Catchment Area Impacts on the Inflow to the Prospect Plant.

It has been suggested that a single event or a combination of events in the catchment areas could have contributed to the high levels found both in the Prospect plant and throughout the system. Possible events include:

- Raw water turbidity events possibly associated with rainfall.
- Septic systems in The Oaks draining into the dam.
- Scouring of the Upper Canal during an environmental flow test.
- Dead dogs and foxes found in the Upper Canal.
- Extraction of water from lower levels of Warragamba that have demonstrated high levels of organisms. (Work done by Sydney Water staff during and prior to this incident has found both *Cryptosporidium* and *Giardia* in Warragamba and some of its tributaries.)

Raw water turbidity events possibly associated with rainfall

The breaking of the drought and higher rainfalls may have resulted in increased runoff of contaminated material into the catchment (for example, runoff from a dairy or other livestock areas).

Raw water turbidity increased rapidly at the Prospect plant on July 13. Turbidity is a measure of the "cloudiness" of the water. Turbidity alone does not indicate the presence or absence of *Cryptosporidium* or *Giardia* although it may indicate the presence of organisms. The raw water prior to this incident had a low turbidity, which increased to greater than ten times the original level in a very short period of time late on July 13. The turbidity then dropped as quickly as it had increased. There was no indication of rainfall over the Waragamba catchment during this period, and only two minor storms had occurred on July 6 to 7 and July 9. There was another event when the raw water turbidity increased to more than ten times during the period from late on July 25 until late on July 26 and then again from midday on July 27 until midday on July 28. These increases could be explained by a rainstorm over the Warragamba catchment area that extended from July 19 until July 30 with varying intensity and caused localised runoff. Rain also fell in the vicinity of the five dams in the Upper Canal catchment area at this time.

Septic systems in The Oaks draining into the dam

There is a suggestion that there may be a source of potential contamination coming from the Werriberri creek area tributary to Warragamba Dam in an area known as The Oaks. This area is not presently sewered.

Scouring of the Upper Canal for an environmental flow test

On 7 July the Upper Canal was scoured and the waters discharged to the intake of Prospect plant. The flow rate in the canal was ramped up during an "Environmental Test" in the Nepean River and the flow was increased over a period of several hours and then reduced again. Instead of allowing the extra flow to spill over the weir and proceed downstream, that flow was taken into the Upper Canal. The flow in the canal increased from an estimated 100 ML/day to approximately 600 ML/day. The effect was to greatly increase the velocity in the canal and scour material from the bottom and sides. This material was then taken into the Prospect plant. Review of the data indicates that the turbidity did not increase dramatically because of this incident. However, if *Cryptosporidium* and *Giardia* were present in the canal they would have been washed into the intake of the Prospect plant.

The Upper Canal high flow incident undoubtedly carried a lot of material into the plant. Because of the open nature of the canal that material could have included high numbers of organisms. The plant turbidity did increase during this period by a slight amount, indicating the possible presence of increased particle passage. It is likely that this incident contributed to the overall contamination of the plant, but the timing and magnitude is not such that it could be the sole cause of the high levels found starting on 22 July.

Dead dogs and foxes found in the Upper Canal

The catchment is regularly patrolled and dead animals are found from time to time. They are a potential source of contamination of the raw water entering the Prospect plant. I am informed that some dead animals have been removed from the canal and have tested negative for *Cryptosporidium* and *Giardia*.

Interim evaluation

Any one or a combination of these factors is a likely source of a continuing contamination of the water feeding the Prospect plant. Because there were insufficient tests of the canal undertaken prior to and during the incident, it is not possible to determine whether a concentrated load of contaminated water was introduced into the plant. However, the records of the operation of the plant, particularly turbidity levels during the incident may indicate that this did not occur.

Although it is apparent that each of the identified sources would provide a contribution to the background levels of *Cryptosporidium* and *Giardia* arriving at the plant, I doubt whether an event of sufficient significance occurred to cause a large concentration to enter the plant and overload the filtration system. However, great care must be taken in the management of a drinking water catchment. A build up of background levels has a potential to concentrate the organisms in the downstream system either as part of the filtration process or within the distribution network.

Possible Cause 4:
Contamination at the Prospect Plant.

There are a number of possible the causes within Prospect plant. They include:

- Release of sediment deposits from the inlet chamber during flow surges.
- Loss of dilution water, reducing the effectiveness of the coagulation process.
- Problems in the backwash procedure.
- Cleaning of clear water tanks and the use of a bypass channel.

AWS have strongly denied that any of these sources could have caused the high levels found during the event. They have presented a detailed case. However Sydney Water have submitted to me that the plant has a high probability of being the cause. They have also made a detailed presentation.

Release of sediment deposits from the inlet chamber during flow surges

The inlet chamber takes the water from the inlet canal and directs it to the chemical feeding and filtration facilities. Inspection by divers revealed that approximately 2/3 of the floor of that chamber is covered with sediment washed in from the source canal. The sediment is from 20 to 100 mm deep and supports a healthy growth of aquatic weeds

Loss of dilution water, reducing the effectiveness of the coagulation process

There were four instances in July when the coagulation process was not operating in an optimal mode because the dilution water pumps had stopped or the flow was interrupted for some reason. Loss of dilution water will lessen the effectiveness of the coagulation process. This could allow passage of particles the size of *Cryptosporidium* and *Giardia* through the filters and into the reticulation system. During these four instances there was a rise in the filtered water turbidity level that indicates an increased number of particles were passing through the plant and into the system.

However, the concentration of the organism which would have been required to create the levels measured in the raw water system would have to have been higher than ever has been seen in any water sample. Although these malfunctions could have contributed to a problem, they could not account for the high numbers found in the system.

Problems in the backwash procedure

Until 29 July, the water that had been backwashed from the filters had been treated and returned to the inlet of the plant. If the organisms were present in the influent water and trapped in the filters, they would have been present in the backwash water. If they were not removed in the treatment process (settling in the thickeners) they would have been fed back into the plant and could contribute to the contamination. Water that came from the centrifuge used to concentrate the sludge taken from the thickeners also was put into the inlet of the plant after passing through the thickeners and could have contained organisms.

Cleaning of clear water tanks and the use of a bypass channel

The clear water tanks become repositories for sediments which may allow *Cryptosporidium* and *Giardia* to build up over time as part of normal operations. During the course of the incident, both the tanks were taken off line sequentially for their first maintenance since the plant commenced operation.

On July 21 and 22, two incidents occurred related to the cleaning operations to be carried out in the two tanks. Both of these incidents resulted in an increase in the turbidity of the water leaving the tanks after filtration.

On July 21, the filtered and finished water turbidity increased. plant operations personnel indicated that the levels in the tanks were being lowered to facilitate cleaning of the tanks. Their goal was to reduce the level in the tanks to 30 % of capacity and then isolate tank Number 1. In fact the level lowered to approximately 24 % before the process was reversed. The dilution water pumps for the coagulant chemical will not operate below the 27 % level in the tank, and as a result the efficiency of the coagulation is reduced. This, in turn, reduces coagulation effectiveness and impacts the ability of the filters to remove particles. Individual filter data indicates that turbidity levels also increased. In response to this problem, the flow

into the plant was increased rapidly to raise the level in the tank, increasing the filtration rate during a time when the coagulation process was not operating in an optimal mode. The turbidity in the treated water leaving the tank increased significantly from 9 am until midnight when it returned to its original level. The increased levels were nevertheless within the agreed specifications for the plant.

The loss of dilution water and the attempt on 21 July to take a clear water tank off line had the potential to reduce the efficiency of the plant and provide an opportunity for the parasites to pass through the filters. In addition the ramp up of the system on the 21 July had the potential to disturb any organisms contained in the sediment in the tanks which later proved to test positive in a significant concentration in one test. AWS dispute the legitimacy of the test.

The second incident involving the clear water tank occurred on 22 July when the tank levels were again lowered and a bypass channel between the clear water tanks, which could have become a repository for sediments containing parasites, was used for the first time. There is a possibility that stored material in the bypass channel may have been released. During this incident the finished water turbidity increased but within specification.

Both the 21 July and 22 July events correlate with the high organism levels found in East Sydney on 24 and 25 July.

A sample taken on 29 July in the water of the online clear water tank provided a high reading. AWS questioned the technique used to procure this sample. Tests in the sediment of tank Number 2 taken on 5 August also showed positive readings.

AWS has also claimed that none of the operational events in July 1998 could have been the source of the high level of contamination reported in the distribution system, unless implausibly high *Cryptosporidium* and *Giardia* concentrations were present in the raw water at that time. AWS has obtained expert opinion that confirms an examination of filter turbidity levels which indicate that the filters were providing effective removal of turbidity and microbial contamination. They point out that there is no evidence of failure at the plant and that none of the events, either together or separately, could explain the extraordinarily high levels measured. AWS claim that the tank cleaning operations did not result in the discharge of sediment from clear water tank Number 1 at levels which would present a health risk. AWS also advise that the Prospect plant was in compliance with stringent standards of the US Interim Enhanced Surface Water Treatment Rule in relation to turbidity. Sydney Water

disputes that the analysis of the performance of the plant cannot explain the events which occurred.

Interim evaluation

At present I am not persuaded that the plant was the source of the contamination. However it is apparent that the plant operated at various times during the event in other than its normal manner, and filtration was at times less than optimum. It will also be neccessary to understand the significance of the contamination found in the clear water tanks. I will need to consider further the views of both AWS and Sydney Water before reaching a definite conclusion.

Possible Cause 5: Potential Impacts Downstream from the Prospect Plant.

In recent days two potential sources of contamination downstream of the Prospect plant have been identified. As water leaves the plant it enters the Sydney water system and is carried in two pipelines through a junction chamber and then into a distribution chamber. From that chamber it is dispersed through the system. The two pipes are below ground and made of concrete. Whether they are in good condition or whether they could allow inflow is unknown. However, if they do permit inflow, contamination is possible.

At the junction chamber there is a pipeline leading from the Prospect reservoir which enables the system to draw from the reservoir if required. The pipe system has barriers at the reservoir and a steel separator within the junction chamber. It does not appear to be a secure system.

These details are shown in Attachment C which is a map of the Prospect plant and surrounds.

Contamination from the old pipeline

There is evidence of an infestation of bats in the pipeline which could be a source of both C*ryptosporidium* and *Giardia*. Water was found in the pipes. AWS tests indicate the presence of fluoride and chlorine within the pipeline which suggests flows between it and the distribution system. It has been proposed that water from the pipe which contains the droppings could have penetrated the junction chamber. If this has occurred then the polluted water could explain the reported contamination. This possibility is made more likely

during high rainfall, especially if pressure in the mains is reduced or increased.

Contamination from ground water surrounding the pipeline

A test by Sydney Water has shown that surface water near the pipeline downstream of the Prospect plant may be heavily contaminated. With recent rain the groundwater level has increased. At the same time and at various stages of the maintenance cycle at the Prospect plant, the pressure in the mains would probably have been reduced. This will occur when the water level of the clear water tanks is lowered. The consequence may be that, if the pipes allow inflow, then changes of pressure will draw groundwater into the water main. Calculations suggest that sufficient contaminated water could have been drawn in to cause the elevated levels recorded during the event.

Interim evaluation

Because of the quite recent discovery of these possible explanations for the events, they have not yet been fully evaluated. Further work is urgently being undertaken at my request. Although I am not persuaded that this mechanism necessarily caused the contamination, it may reflect one logical resolution of the available data.

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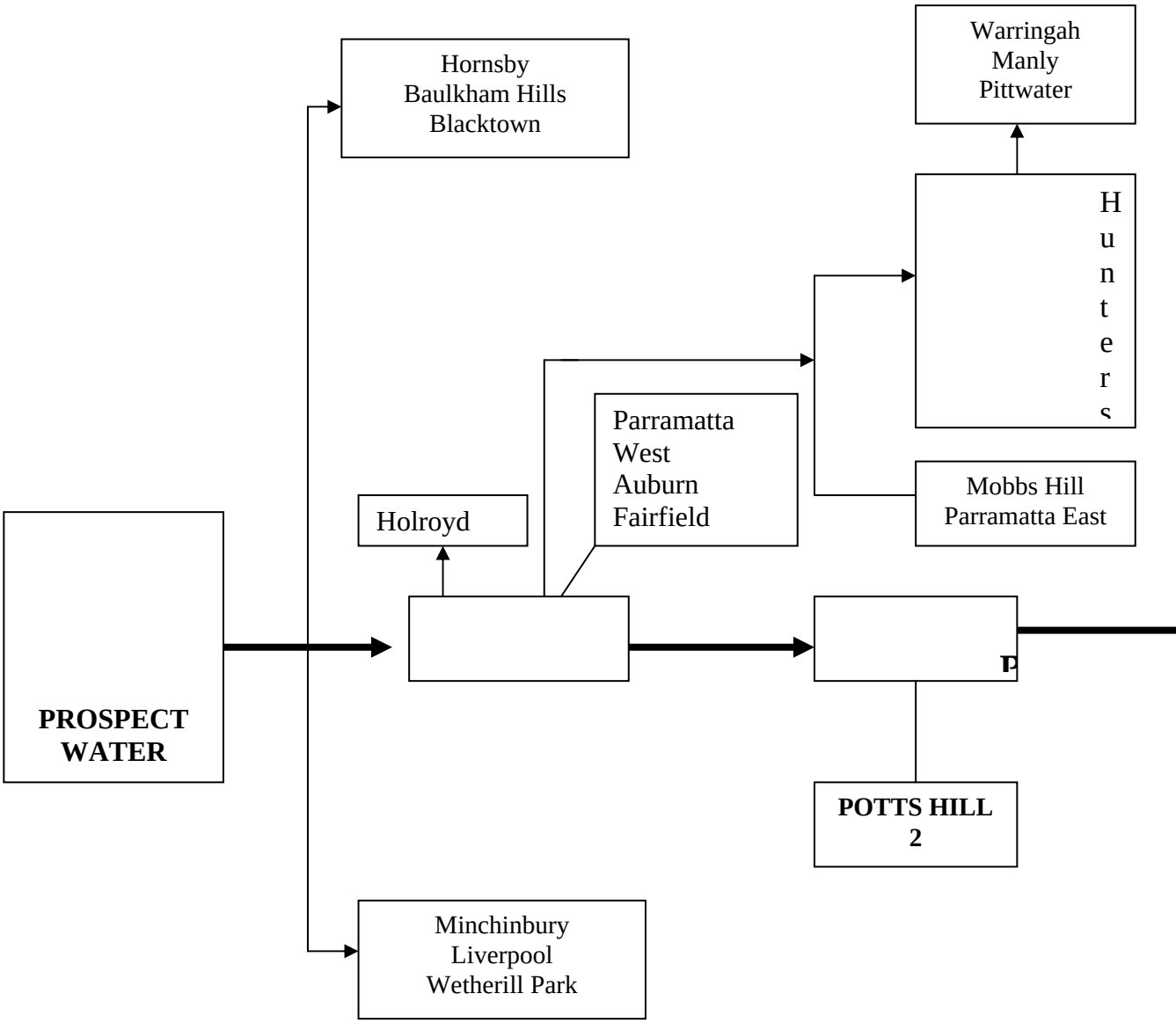
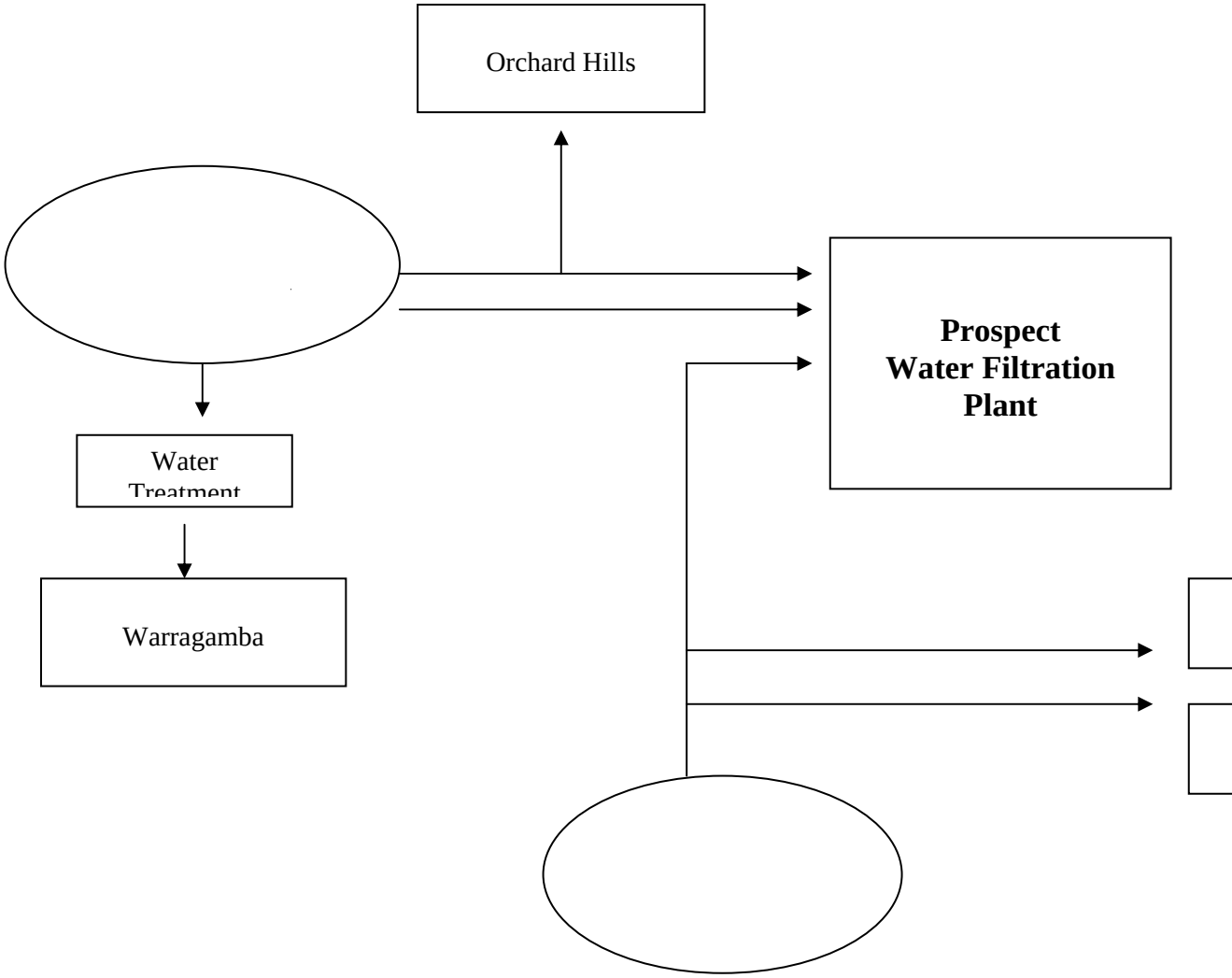


Not to scale or complete; schematic only.
*Sutherland is also supplied from the Woronora


Orchard Hills
Prospect
Water Filtration
Plant
Water
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