Independent Pricing and Regulatory Tribunal

Final Report

Benefits of water quality in Sydney

Dr Richard Tooth, Dr Howard Zhang

11 October 2018

About Sapere Research Group Limited

Sapere Research Group is one of the largest expert consulting firms in Australasia and a leader in provision of independent economic, forensic accounting and public policy services. Sapere provides independent expert testimony, strategic advisory services, data analytics and other advice to Australasia's private sector corporate clients, major law firms, government agencies, and regulatory bodies.

Sydney	Canberra	Melbourne
Level 14, 68 Pitt St Sydney NSW 2000 GPO Box 220 Sydney NSW 2001 Ph: +61 2 9234 0200 Fax: +61 2 9234 0201	GPO Box 252 Canberra City ACT 2601 Ph: +61 2 6100 6363 Fax: +61 2 9234 0201	Level 8, 90 Collins Street Melbourne VIC 3000 GPO Box 3179 Melbourne VIC 3001 Ph: +61 3 9005 1454 Fax: +61 2 9234 0201
Wellington	**Auckland**	
Level 9, 1 Willeston St PO Box 587 Wellington 6140 Ph: +64 4 915 7590 Fax: +64 4 915 7596	Level 8, 203 Queen St PO Box 2475 Auckland 1140 Ph: +64 9 909 5810 Fax: +64 9 909 5828	

For information on this report please contact:

Name:	Dr Richard Tooth
Telephone:	+61 2 9234 0216
Mobile:	+61 412 105 817
Email:	rtooth@srgexpert.com

Contents

Appendices

Tables

Glossary

2010 Study	Moore et al. (2010). 'Cost benefit analysis of raising the quality of New Zealand networked drinking water'
ABS	Australian Bureau of Statistics
ADWG	Australian Drinking Water Guidelines
AGI	Acute gastrointestinal illness
AUD	Australian Dollar
CBA	Cost benefit analysis
Danish Study	Hasler et al. (2005). 'Valuation of groundwater protection versus water treatment in Denmark by Choice Experiments and Contingent Valuation'
GP	General Practitioner
IBS	Irritable Bowel Syndrome
IPART	The Independent Pricing and Regulatory Tribunal
NZD	New Zealand Dollar
MBS	Medicare Benefits Schedule
WTP	Willingness to pay

1. Introduction

The Independent and Pricing Regulatory Tribunal (IPART) is reviewing the Sydney Water Corporation Operating Licence, with an amended licence expect to commence on 1 July 2019. IPART is undertaking a cost benefit analysis (CBA) to support the review.

As part of the CBA, IPART is considering the question: Is a licence requirement to be consistent with the Australian Drinking Water Guidelines (ADWG) justified on cost-benefit grounds?

To assist in answering this question, IPART sought our support in estimating the benefits of treating water to the level implied by the adoption of the ADWG. The scope of this analysis in this paper is limited to largely leveraging analysis undertaken by Sapere resources in 2010 on a CBA of improving drinking water quality in New Zealand (hereafter the 2010 Study).[1] To meet limitations in time and budget, the paper leverages significantly on the analysis and assumptions in the 2010 Study. Accordingly, this paper should be read in conjunction with the 2010 Study.

The next section provides a brief background to water quality issues and the approach used to estimate the benefits of water quality. Section 3 then provides analysis and results.

The details of the calculations are provided in an accompanying spreadsheet.

1 Moore et al (2010).

2. Background and approach

2.1 Background

Sydney Water undertakes a number of activities to treat the water they supply to reduce the health risks and to comply with ADWG. The consequences of not undertaking these treatment activities — and consequently poor water quality — are potentially significant. Water is a known potential carrier of pathogens and chemicals that can cause disease in humans. The impacts of these diseases range from mild discomfort to death.

The costs associated with poor water quality include:[2]

- health costs, including costs associated with:
  - endemic disease
  - the risks associated with large scale outbreaks of disease
- avoidance costs by water users, for example, the costs of purchasing bottled water and/or boiling water
- management costs associated with managing a water crisis
- the social impact of a loss of confidence in water quality.

Conversely the benefits of improved water quality are the avoidance of these costs.

2.2 Approach

There are two broad approaches used to quantify the benefits of improve drinking water quality. These are:

- estimating the willingness-to-pay (WTP) of the community for water quality
- conducting bottom-up estimates of the benefits to the community.

It is difficult to use the WTP approach for two reasons. First, there is limited relevant research that may be used to develop estimates. Second, estimates from this approach risk being inaccurate due to a lack of consumer understanding and because there are externalities (primarily related to the lost productivity for employers) associated with poor water quality. Nevertheless, the result of this approach may be useful in providing a lower bound of the benefits.

In this report we apply the bottom-up approach following the method adopted in the 2010 Study, updated with more recent and relevant research as appropriate. The 2010 Study describes its approach as involving estimating the sum of benefits relating to avoided costs associated with:

- Endemic diseases associated with acute gastrointestinal illnesses (AGI)

---

[2] The scope of this report is on water quality issues that are not-noticeable by the drinker.

- Risk of epidemic (associated with AGI)
- Diseases related to chemical contaminants.

The approach used for this paper follows the 2010 Study. To enable the work to be conducted within a reasonable time and budget a number of simplifying assumptions have been made. In particular, the default assumption for most non-financial modelling-parameters (e.g. % of cases hospitalised due to Cryptosporidiosis) are taken from the 2010 Study.[3]

Consistent with the 2010 Study we have not quantified a number of potential benefits (e.g. avoided costs to international reputation) that are expected to be relatively small and/or very difficult to quantify. Benefits quantified and not-quantified are summarised in Appendix 1 and described in the 2010 Study (pp. 127–128).

3 All financial figures have been updated.

3. Analysis and results

3.1 Benefits of avoided endemic disease

The endemic costs of poor water quality are separately calculated for a number of diseases and aggregated. For most types of diseases, the following formula is applied:

endemic costs per disease =

the change in incidence of disease due to poor water quality

multiplied by

cost per disease case (i.e. cost per person if caught the disease).

3.1.1 Incidence of disease

The 2010 Study used the following assumptions and approach to estimate the change in the incidence of disease from meeting water quality standards.

- The rate of water-borne disease where drinking water standards were met was assumed to be zero
- The incidence of disease where drinking water standards were not met was estimated as:[4]

The incidence of disease where drinking water standards not met per person	=	Estimated cases of a disease in NZ	×	Estimated proportion that are waterborne	÷	Population where drinking water standards are not met

The 2010 Study results were used to form a preliminary set of Low, Medium and High scenarios. Additional scenarios were developed using information provided by NSW Health.

3.1.2 Cost per disease case

To estimate the variable "cost per disease case", the following costs were computed for each type of disease. (Note: underscored variables are those that have been updated for this study):

- Medical costs:
  - General Practitioner (GP) cost = % of cases go to GP × number of GP visits × cost of GP consultation
  - Specialist consultation cost = % of cases go to specialist c number of specialist visits × cost of specialist consultation
  - Pharmaceutical cost[5] = % cases visiting a doctor[6] × average cost of medicine used + % community cases (cases not visiting a doctor) × average cost of medicine used

[4] See 2010 Study (sect. 4.4.4). Note: the 2010 Study did not report the per-person incidence.

[5] Pharmaceutical costs incurred on hospital cases are not captured in this sub-category.

where

Average cost of medicine used[7] = Frequency of using each type of medicine × cost of each type of medicine

- Hospital cost = % of hospitalisation × Average case-weight per discharge × cost per case-weight
- Laboratory cost = % cases visiting a doctor × Likelihood a test is requested × cost(s) of relevant test(s)

- Non-medical costs:
  - Loss of production cost = loss of productive days × value of a productive day

    where:

    loss of productive days = weighted average number of days lost (for community cases, GP cases and hospital cases) for both patients and carers

    value of a productive day = value of paid work + value of unpaid work
  - Travel cost = Cost per km × expected travel distance of a return trip × expected number of visits (for each type of visit, e.g. GP visit)
  - Loss of life cost = % of deaths per disease case × number of years lost × value of a statistical life year

    where

    value of a statistical life year = value of a statistical life ÷ life expectancy
- A number of non-standard costs — due to availability of additional literature, the costs of some diseases (e.g. Irritable Bowel Syndrome (IBS)) were estimated using alternative approaches.

The key assumptions are described in Appendix 2. Further details can be found in the accompanying spreadsheet.

3.1.3 Summary of endemic costs

The results depend significantly on which assumptions (either those contained in the 2010 Study or those provided by NSW Health) are used for the change in incidence of disease.

Using the change-in-incidence-of-disease assumptions from the 2010 study, the total endemic costs are estimated to be $214 per-person per-year (in 2018 AUD). Of note

- by disease, most (84%) of the cost is attributable to two diseases: Campylobacteriosis ($90) and IBS ($90).
- by cost-category, most (~90%) of the cost is attributable to loss of 'productive days' (which includes loss of paid and unpaid time) associated with the diseases.

---

6 Doctor refers to GP or specialist.

7 The frequency of medicine usage and the type of medicine used vary depend on whether a patient has seen a doctor or obtained over the counter medicine. Sequelae generally last longer than AGI, and this duration factor is captured by the frequency of usage.

The 2010 Study included revised alternative set of assumptions (e.g. relating to change in incidence of disease) that were used to generate a low and a high estimate. Using these 2010 Study assumptions:

- the low estimate is $155 per-person per-year
- the high estimate is $369 per-person per-year.

NSW Health provided alternative estimates of the change in incidence of disease if there were reduced water treatment. NSW Health estimates significantly smaller changes in incidence of disease, and particularly so for Campylobacteriosis. These differences are in part due to two factors.

First, NSW Health assumed a much lower percentage change in disease incidence arising from a change in water-treatment than is incorporated in the 2010 Study.[8] In our opinion, there is no clear evidence as to which assumptions should be used. We note that:

- The 2010 Study had considered the research referred to by NSW Health in developing its assumptions and had adopted a different method.
- Sydney Water's source water (being Warragamba dam) is generally considered to be of high quality.

Second, the disease notification rates (which form the baseline for a percentage change) differ. For most diseases they are comparable but for Campylobacteriosis they are significantly lower in NSW than the comparable figures that recorded in the 2010 Study. In part, this may because NSW had recently started capturing notifications for Campylobacteriosis;[9] however, there are still large differences between other Australian States and the 2010 Study.

In light of the above factors we consider two alternative scenarios:

- a NSW low estimate equal to $118 per person, formed using NSW Health assumptions for change in incidence of disease[10]
- a NSW revised estimate equal to $131 per person, formed using NSW Health data on disease incidence but with a percentage change in disease incidence equal to half that assumed by the 2010 Study for Campylobacteriosis.

---

8 The 2010 Study assumed a percentage reduction from improved water treatment.

9 That is, notification may be low in part due to transitional issues.

10 Where NSW data was not available, the 2010 Study assumptions were used. The baseline rate of Campylobacteriosis notifications were adjusted because the existing data is only for a part of a year.

3.2 Other costs that might be included in the bottom-up estimate

3.2.1 Disease related to chemical contaminants

In 2010 Study, a cost associated with disease related to chemical contaminants was estimated. In the 2010 Study, this was calculated to be 0.2 per cent of the cost (across NZ), which in Australian in 2018 is around $0.43 per person. We conclude that this cost is immaterial.

3.2.2 Averting behaviour costs

In response to reduced drinking water quality, customers may choose a number of averting behaviours including boiling water, purchasing bottled water and installing 'point of use systems' such as water filters.

The 2010 Study (p. 149) considered the cost of averting behaviour during epidemics (see section 3.2.3 below) but dismissed the ongoing cost primarily on the basis that 'The costs may be quite small due to a lack of awareness of water quality and thus a low level of avoidance activity'. The 2010 Study also noted there was a lack of research that has the estimated the cost of ongoing avoidance activities. We are unaware of any subsequent relevant research on averting behaviour.

Point of use systems are available that can filter out most pathogens,[11] and consequently including these costs of filtration in addition to endemic costs would be, in effect, be double counting[12] and so should be excluded from the ongoing cost of poor water quality.

Nevertheless, the cost of such systems provides another data-point (similar to the WTP estimates) of the value to consumers of higher quality drinking water. The cost of a point-of-use water filtration for drinking and cooking use is estimated to be in the order of $500–$900 plus $250–$350 for installation and $200–$300 per year for maintenance, which equates[13] to around $116 per person per year over a 15 year period, excluding the inconvenience cost of the system.[14]

3.2.3 Risks of epidemic and costs of averting behaviour

The cost of increased risk of epidemic (large scale outbreaks) is in addition to the cost of endemic disease. As noted in the 2010 Study (Section 9), epidemics usually involve both the same costs as in the case of endemic disease, but also a range of response costs. The response costs by themselves can be significant. For example, the 1998 Sydney water crisis (see Box 1 below) caused boil-water alerts to be issued for 35 days and a substantial increase

11 See Steen (2018).

12 If averting behaviour was significant we would expect the costs of endemic disease would be reduced.

13 Source: Aquastream (undated). See also Steen (2018) for a description of the type and effectiveness of filtering systems. See accompanying spreadsheet for detailed assumptions.

14 Inconvenience costs include the issue that such systems produce water slowly and need time to replenish the reservoir.

in Sydney Water's operating expenses. A 2004 study speculated that around the boil water alerts affected half of Sydney's population resulting in total aversion costs of $308 million (in 2004) in addition to Sydney Water's costs of around $36 million (in 2004).

Due to the lack of information, the 2010 Study did not explicitly place a benefit of adherence to drinking water quality standards associated with epidemics. Rather it reported that (p. 200) "avoided costs equivalent to $4m per year is likely to represent an upper limit on the benefits from an avoided epidemic." This was based on a study that estimated that a large scale outbreak could be expected to occur in NZ once every 35 years.

Since the 2010 Study there was an outbreak in Havelock North, NZ. The costs of Havelock North outbreak was estimated[15] in FY 2017 to be NZD$21m for a population of 14,118; (i.e. NZD $1,490 (AUD $1,355) per resident). The health costs were only 12 per cent of the total costs. The bulk of the cost (59%) related to imposed costs on households in terms of their ability to go about their 'normal' activities in life. This is similar to the results of the Monash Model reported in the 2010 Study (pp. 50–51), which estimated 'Costs of avoidance behaviour' would be 65.8% of costs.

In summary, due to the low probability, it is difficult to assign a cost. Nevertheless an indicative cost has been estimated as $4 per-person per-year, using the prior Sydney Water crisis per-person cost estimate updated to 2018 combined with the assumption of an outbreak once in every 35 years.

Box 1: Costs of the 1998 Sydney water crisis.

The 1998 outbreak of *Cryptosporidium* and *Giardia* contamination in Sydney caused boil water alerts to be put into place for 35 days. The operating expenses and foregone revenue to Sydney were estimated by the Productivity Commission at $74.6 million. This included abnormal operating expenses included compensation to customers, insurance claims, monitoring and testing costs, inquiry costs, and other costs (Hrudey & Hrudey 2004).

Jaguar Consulting (2004) undertook a broader estimate of the costs. Costs from direct health effects and indirect costs were estimated to be nearly negligible; however the costs of averting behaviours were extremely large. These 'averting behaviour costs' included cash expenses (e.g. boiling water costs, buying bottles of water or substitutes) and the loss of utility. Based on a previous study[16] that had estimated the average aversion costs per person per day for a giardiasis outbreak, they estimated the total aversion behaviour costs for Sydney (based on assumption that half of Sydney's 3.6 million population was affected for 35 days) to be around $308 million in 2004.

Source: 2010 Study, Jaguar Consulting (2004).

15 Moore et al. (2017).

16 The original source is assumed to be Harrington et al (1989).

3.3 Willingness to pay for clean drinking water

The 2010 Study examined the existing research on the willingness to pay (WTP) by consumers for clean drinking water. The 2010 Study (p. 53) noted that:

> *The best example we found of a willingness to pay study for clean drinking water was Hasler et al (2005), which estimates and compares consumers' willingness to pay for safe, untreated, ground water and treated ground water. Danish drinking water policy is based on the assumption that the public prefers clean groundwater to water that has been treated, and the study tests this assumption. While Danish consumers do not face a market price, they are charged for drinking water.*

We conducted a search for more recent research but did not find anything more relevant than the Danish Study (Hasler et al., 2005).[17] Using the Danish Study, the 2010 Study (pp. 53–54) estimated the annual WTP by households for "good drinking water quality" from purified water was NZD 93 to NZD 160 in addition to what households already pay for drinking water. Allowing for the NZD:AUD exchange rate and inflation, this is approximately equal to $121 per household per year, which is around $43 per-person per-year.[18]

3.4 Other analysis

In response to an IPART information request Sydney Water provided some additional information on the cost and net benefits of water filtration. In particular, Sydney Water:

- estimated that in 'ballpark' terms, the total cost of all their water filtration plants is about $150 million a year
- noted the results of a cost benefit assessment that was undertaken in the early 1990s to inform the decision to build water treatment plants at Prospect, Macarthur, Illawarra and Woronora. The present value (as at 1991) of the estimated net benefits to the Sydney region was estimated to be $1,220 million, equivalent to approximately $40 per person per year.[19]

If the per-person net-benefits can be inflated by CPI then the total benefits of water treatment in 2018 are in the order of $106 per person being the sum of

- per-person *costs* of filtration equal to $30 per person, and
- per-person *net benefits* of filtration of $77.

---

17 We undertook searches use search terms including 'willingness to pay', 'drinking water' 'quality' and also checked articles that cited the Danish Study. No relevant studies (covering developed countries) were found.

18 This is based on the assumption of 2.8 people per household in Greater Sydney (source: Census 2016).

19 These results are summarised in Chapman and Cuthbertson (1996). The analysis considered benefits relating to reduced risks to health, avoided costs of averting behaviours by the consuming public and industries, as well as reduced costs associated with cleaning and damage to infrastructure.

4. Conclusion and commentary

In summary, using the change of incidence of disease assumed for the NSW Revised Scenario and the assumptions as documented, the annual per-person costs associated with reduced drinking water quality are estimated as:

- Endemic disease costs: $131 per-person, primarily related to loss of 'productive days' associated with Campylobacteriosis and IBS
- Averting behaviour costs: immaterial outside periods of epidemic
- Chemical disease costs: assumed to be immaterial, but have allocated an additional $0.43 per-person based on the 2010 Study
- Epidemic-related costs: $4 per-person — an indicative estimate based on the 1998 Sydney incident.

Given the above, we recommend using a base estimate of $135 per-person per-year for the benefits of meeting ADWG. The results from the scenarios range from $122 per-person per-year (NSW Health Low scenario) to $369 per-person per-year (2010 Study high scenario).

We note that the lower estimate ($122) is similar to the costs ($116 per-person per-year as estimated in section 3.2.2) associated with a household installing point-of-use water filtration.[20] This amount excludes the inconvenience costs of relying on point-of-use filtration; nevertheless, an advantage of this measure is that it is independent of assumptions relating to the change in incidence of disease.

The information provided by NSW Health suggests that the 2010 Study high scenario is unlikely. Nevertheless, we recommend being conservative and continuing to use the $369 per-person per-year as the upper-bound. The estimates of change in incidence of endemic disease due to water treatment are highly uncertain. Furthermore there is potential for the costs of an outbreak to be higher than that assumed in the 2010 Study high scenario. For example, if the risk of outbreak is twice that which has been assumed[21] and the per-person cost of the outbreak is higher (similar to that experienced in the Havelock North outbreak) the epidemic costs will increase from the current $4 to $84 per-person per-year.

20 We note this is also similar to the amount implied by 1991 CBA analysis for water filtration discussed in section 3.4.

21 That is, twice every 35 years rather than once every 35 years.

References

Abelson, P., Potter Forbes, M., & Hall, G. (2006). *The annual cost of foodborne illness in Australia*: Australian Government Department of Health and Ageing.

Aquastream (undated). *What does it cost to install and maintain a home water filter system?* Available at https://www.aquastream.com.au/blog/aquastreams-blog/what-does-it-cost-to-install-and-maintain-a-home-water-filter. Accessed 4 September 2018

Chapman R and Cuthbertson S, (1996). Sydney's Water: A Suitable Case for Private Treatment, *Agenda - A Journal of Policy Analysis and Reform*, 1996, vol. 3, issue 1, 45-58.

Harrington, W., Krupnick, A.J. and Walter O. Spofford, J. (1991), *Economics and Episodic Disease: The Benefits of Preventing a Giardiasis Outbreak*, Resources for the Future. Quality of the Environment Division

Hasler, B., Lundhede, T., Martinsen, L., Neye, S., & Schou, J. S. (2005). *Valuation of groundwater protection versus water treatment in Denmark by Choice Experiments and Contingent Valuation*: National Environmental Research Institute.

Hrudey, S & Hrudey, E, (2004), *Safe drinking water, lessons from recent outbreaks in affluent nations*, 2004, IWA Publishing, London, p. 352.

Jaguar Consulting Pty Ltd, (2004) Drinking water quality Regulatory framework for Victoria: Regulatory impact Statement for the Safe drinking water Regulations 2004.

Moore, D., Black M., Valji Y. and Tooth R. (2010), Cost benefit analysis of raising the quality of New Zealand networked drinking water, report for NZ Ministry of Health. Available at https://www.health.govt.nz/publication/drinking-water-cost-benefit-analysis.

Moore D, Drew R, Davies P and Rippon R. August 2017. The Economic Costs of the Havelock North August 2016 Waterborne Disease Outbreak. Wellington: Sapere Research Group Ltd. Available at https://www.health.govt.nz/publication/economic-costs-havelock-north-august-2016-waterborne-disease-outbreak

Steen, Matthew. (2018). *Water filters - do you need one?* Available at https://www.choice.com.au/food-and-drink/drinks/water/articles/water-filters-do-you-need-one. Accessed 4 September 2018.

Appendix 1 Overview of benefits

Table 1: Benefits of water quality quantified and not-quantified

Category	Quantified	Not-quantified
Health benefits	• Reduced direct medical costs	• Health benefits for visitors
Non-health benefits	• Reduced mortality • Lost productivity (including unpaid work or leisure activity) • Transport costs	• Lost paid work days –sick person and caregivers • Avoided costs of individual's water quality management • Household costs • Increased employment opportunities from compliance upgrades • Improved communication • Innovation benefits
Other intangible benefits		• International reputation and Tourism • Aesthetic benefits • National confidence in infrastructure • Improved equity • Pain and suffering • Legislative clarity

See Table 33 (pp. 127–128) of the 2010 Study for a description of the benefits.

Appendix 2 Benefit assumptions

Table 2: Key variables used for estimating benefits related to endemic disease

Category	2010 Study	This study	Note
% incremental risk per person per disease	Depends on disease type	Different scenarios	2010 Study estimates used to provide one set of scenarios. Estimates provided by NSW Health used as basis for two alternative scenarios.
GP consultation cost	NZD $57	AUD $58.5 – $89.6	Adopting the approach in Abelson et al. (2006) and numbers from Medicare Benefits Schedule (MBS) 2018, initial and subsequent GP consultation costs are estimated to be $89.6 and $58.52, respectively.
Frequency of GP visit per disease case	1 (In most cases)	No change	
% cases go to GP	Depends on disease type	No change	
Specialist consultation cost	NZD $95	AUD $107.9 – $129.3	Similar to approach to GP consultation cost
% AGI cases develop sequelae	Depends on disease type	No change	
Laboratory faecal culture testing cost	NZD $13.51	AUD $52.9	Estimated using MBS 2018 figure
Laboratory REA testing cost	NZD $49.2	AUD $68.9	Estimated using MBS 2018 figure
Price of a standard unit of case-weight	NZD $3,336	AUD $4,487	2017-18 NZ case-weight price in AUD
Per unit pharmaceutical costs	NZD $3.94 - $14.44	AUD $7-$15	Updated using information from Australian websites and Sydney local Pharmacies
Value of daily paid work	NZD $120.29	AUD $189	Estimated using Australian Bureau of Statistics (ABS) data and the approach in the 2010 study
Value of daily productive unpaid work	NZD $59.4	AUD $111	Estimated using ABS data and the approach in the 2010 study
Number of productive days loss per disease case (for both patients and carers)	Depends on disease type	No change	

Category	2010 Study	This study	Note
Probability of developing Irritable Bowel Syndrome (IBS)	9% of AGI cases who visit a GP develop IBS	No change	
Direct medical cost of IBS	NZD $1,625	AUD $1,557	Based on international literature in 2010 converted to AUD and inflated
Other immaterial values	Other costs that are immaterial to the key results were updated using a range of methods including using locally sourced values and adjustment of NZ value for exchange rate and inflation		