Final Cost / Benefit Report

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1 Costs and Benefits of Compliance to Standards

Government has made a commitment to safer water via introduction of the proposed Health (Drinking Water) Amendment Bill (the Bill). The Bill requires water suppliers to take all practical steps to comply with the drinking water standards (DWSNZ). To assist the implementation of the Bill to improve drinking water quality a financial assistance package is also proposed, and in order to scope the size and implementation objectives of this package, the costs and benefits of full compliance with the Bill are required.

The work below is intended to scope the economic consequences of moving from an environment where compliance with the drinking water standards is 'voluntary', to one where compliance is 'mandatory'. It is not intended to be a full Cost/benefit analysis which indicates whether an intervention should proceed or not. Instead the results will inform subsequent work on the need for, size and targeting of, a possible assistance package to facilitate the implementation of the Bill.

The implications of upgrading all drinking water suppliers to provide 'standards-compliant' water are presented under the following headings:

1. Approach and Methodology
2. Cost of delivering standards-compliant water
3. Tangible benefits of standards-compliant water
4. Intangible benefits of standards-compliant water
5. Summary of findings

1.1 Approach and methodology

The cost of upgrading all water supplies to comply with DWSNZ is based on an engineering assessment of this task, using the Ministry of Health's record of all registered water suppliers, as held in the Water Information NZ database. This database is known to provide a very good record of larger council owned systems, but has gaps in the smaller system end, estimated to be approximately 10% of the total population. The cost to upgrade each individual system has been estimated[1] and then summed to provide a national total. Cities which are fully compliant or declared an intention to be compliant have been excluded from the analysis, since that cost is considered to be sunk, and will not influence the need for a future financial subsidy. This approach reflects the cost of a regulatory regime which is 'mandatory', as opposed to the current regime which is 'voluntary'. Alternative opinions from engineers have been used to generate a level of uncertainty in these estimates as well as including an allowance for unregistered systems.

[1] This estimate uses per capita costs over a range of population bands.

The potential benefits from this upgrade are determined by observing the burden of disease currently attributable to drinking water[2]. Information from the following sources has been used to determine this burden of disease:

1. Notifiable disease system. Records notifiable disease as outbreaks which are usually assigned a most-likely cause, and individual illness which generally does not have a causal factor assigned. Under-reporting and establishing a causal relationship to drinking-water are significant factors to be considered.
2. Published work on causal relationships for factors such as food, drinking–water, swimming, person-to-person …
3. Expert advice from public health physicians.

To facilitate the comparison between engineering upgrade costs and associated reduction in the risk of disease, we measure these disease risks using an economic analysis based on the cost of lost production, direct medical costs and an estimate of the cost of premature mortality[3]. The increased use of standards-compliant drinking water will reduce this burden of disease, and the risk of serious outbreak, but is unlikely to remove it completely. Therefore this estimate of the total avoidable cost provides an upper bound on the tangible benefits likely from compliance with the Bill[4].

Point estimates are estimated for both engineering cost and costs of disease. Where possible error bounds have been separately estimated based on known ranges to the underlying physical process. Statistical[5] analysis of uncertainty has not been used since it would imply a greater knowledge of the underlying physical process than is currently known.

In addition to the tangible benefits, we have considered the other ‘intangible’ benefits that good quality water brings. No attempt has been made to quantify these due to the significant conceptual and measurement difficulties involved. However we note that examples abound where outbreaks have produced a much larger impact on public life

[2] The burden of disease is generally gastro-enteric illness, especially from the pathogens recorded by the notifiable disease system. See attachment three for the individual pathogen involved.

[3] Analysis of alternative health interventions frequently use disability adjusted life years (DALYs) to assess intervention issues. We have chosen to use an ‘economic’ approach due to the large component of ‘time off work’ caused by gastro-intestinal disease. In addition the main aim of this study is to provide guidance on the benefits of alternative engineering solutions, to make drinking water safer. Hence we wish to compare the benefits in dollar terms of safer water with the costs of better oversight and improved engineering installation. In most health Cost/Benefit analysis the issue is often to determine the best use of a given budget in terms of buying the most Disability Adjusted Life Years (DALYs) achieved, and hence achieving the highest $/DALY. For estimating the optimal investment for achieving safer water we have therefore used an economic approach which compares engineering cost against avoidable cost of reducing risk of illness.

[4] Contingent valuations (i.e. willingness to avoid pain and suffering) have been avoided in the tangible evaluation due to the ambiguity surrounding their results, i.e. the stated willingness to pay and the actual amount respondents do pay. However LTSA’s government sanctioned valuation of a statistical life ($2m) has been used.

[5] Monte Carlo simulations were considered using expected distribution of critical factors such as the degree of under-reporting, and the causation of drinking-water to disease. The approach was not pursued in order to maintain simplicity in a model which was already overly complicated, and also since knowledge of these distributions was less well known than the point estimates themselves.

and public policy, when compared to a similar morbidity/mortality in other areas of public safety, such as transport.

1.1.1 Roof-collection systems

Roof-collection systems are treated separately since the health risks involved are reasonably well known, and they are often the default option if a reticulated supply is not available.

It has been estimated that there are 100,000[6] households plus marae, camps and commercial premises (300,000 persons or 8% of the population) supplied via roof-supply systems.

[6] *Microbiological Health Risks of Roof-collected Rain Water – A Review;* Abott et al, 2003

1.2 Cost of Delivering Standards-Compliant water

The compliance costs for reticulated systems have been treated separately from that of roof-collection systems.

1.2.1 Cost of compliance for reticulated systems

The drinking water standards are currently a voluntary code of compliance. Proposed legislation will require suppliers to take ‘all practical steps’ to comply with the standards. To estimate an upper bound on costs we have assumed ‘all practical steps means full compliance to the standards. We have estimated costs on the following basis:

1. Intention to comply with revised standards
   Systems which have declared an intention to comply with the revised standards have been removed from the analysis. This includes most large cities. Other systems which currently

2. Upgrade for compliant systems
   Systems which currently comply will need minor modifications to meet the new requirements. Either improved filtration or ‘bolt-on’ UV systems have been costed.

3. Non-compliant systems
   Plants which are currently have an ‘E’ grade or known to be obsolete have been costed on a complete replacement of the treatment plant using modern technology.

4. National data-base
   An estimate of the national cost has been performed using the WINZ[7] data-base. The per person cost of upgrade/replacement derived above has been used to estimate total costs for plants within size bands.

For systems currently compliant to DWSNZ 2000, the revisions in DWSNZ 2004 impose costs for the following additional requirements:

- Additional barriers for Cryptosporidium
  Additional filtration barriers are required for Cryptosporidium or disinfection options using UV among others are available[8]. The need for this investment differs depending on the experience of the engineer. Some have said that improved operations skill is all that is needed (at marginal cost), while others say the coloured and ‘soft’ nature of many New Zealand source waters makes it difficult to meet the standards 95% of the time (measured daily), without investing

[7] WINZ records all registered water supplies in the country including self-serve buildings. It is estimated that (50-90%) of supplies serving <500 persons are not currently registered. These are suppliers such as golf and sports clubs and commercial operators such as dairy sheds and factories.
[8] This is a small protozoan whose oocysts are highly resistant to Chlorine disinfection unlike Giardia which can be treated with reasonable contact time with Chlorine.

in more sophisticated control mechanisms such as storage (upstream or down-stream), clarifiers to remove dissolved organics and improved filtration. All parties agree on the need to improve operator performance.

- Lowered risk of outbreak
  The Bill requires additional work to prepare Public Health Risk Management Plans and for increased monitoring of water quality.

Total cost estimates have been generated with the following assumptions:

1. Costs are based on an assumed use of 300L/day/person, with no allowance made for spare capacity. There high variability in water usage around the country[9] which can range from 200L/person/day to over 1,000L/person/day in some areas. As a result there is significant uncertainty in these costs due to the per person variability in usage.
2. Water suppliers are excluded where they have publicly committed to spending money to upgrade to the new standards[10].
3. Secure ground water is excluded (Christchurch, Lower Hutt, Hastings …)
4. Supplies who are not currently registered are not included[11].
5. The engineering requires use of a ‘bolt-on’ UV plant[12] plus other minor work where existing plant is adequate (graded ‘A’ to ‘D’), whereas an ‘E’ graded plant requires a complete plant replacement.

Per person cost estimates were provided by an engineer based on different sized plants, allowing for the costs of a minor verus major upgrade. These costs form the basis of all subsequent work, and are:

Capital Upgrade Costs (Per Person):

Plant size (by population served)	Upgrade plants graded ‘A’	Upgrade plants graded ‘D’ to ‘B’	Upgrade plants graded ‘E’
<50	$400	$400	$2,500
50-500	$148	$148	$1,281
500 - 1,000	$70	$83	$1,032
1,000 - 5,000	$25	$36	$777
5,000 - 10,000	$12	$18	$621
10,000 - 50,000	$10	$14	$463
50,000 - 100,000	$10	$13	$400
100,000+	$10	$12	$400

[9] 200L/person/day is estimated to be normal household use. However actual plant size and therefore per person usage must account for industrial and gardening use which can increase this to 1,000L/day in some South Island towns and 300L/day which we understand is used for planning purposes in Auckland, and which these costs are nominally based on.
[10] Excluded cities are Auckland, Whangarei, Hamilton, Tauranga, Wellington, Palmerston North, Ashburton, Dunedin, Gisborne, Invercargill, Nelson, Dunedin, Oamaru, Taupo, Timaru.
[11] Perhaps 50%-90% of suppliers in the <50pop and 50% in the 50-500pop are not registered. These costs are not included.
[12] This is costed based on using a ‘bolt-on’ UV system with minor adjustments to the filters to allow for automatic by-pass when turbidity levels are exceeded, with the assumption that water clarity is sufficient for UV to be effective. In some cases additional storage (either upstream or downstream) will be required to ensure turbidity spikes in the source water can be controlled, or that additional treatment in the form of clarifiers/filtration is required to remove suspended matter from the water prior to disinfection.

Cost estimates to upgrade all registered water supplies are[13]:

Plant band (by population)	Total Population served	Avg plant size (population)	Distribution Zones	Band Cost	Per person cost
<50	12,815	22	433	$14,083,175	$1,099
50-500	113,783	217	681	$70,331,188	$618
500 - 1,000	68,030	707	109	$28,224,793	$415
1,000 - 5,000	385,675	2,501	180	$83,039,413	$215
5,000 - 10,000	232,912	6,460	37	$42,494,204	$182
10,000 - 50,000	316,854	21,898	30	$8,390,951	$26
	1,130,069			$246,563,725	

Total estimated cost for registered reticulated systems is[14]:

Cost source	Data source	CAPEX ($m)	OPEX ($m/annum)	Annualised Cost ($m/annum)
Upgrade plant	PW	$246		$21.6
Operating costs (UV bulbs, operators…)	PW		$5.9	$5.9
Increased monitoring	ESR		$7.2	$7.2
PHRMPs	ESR	$4	$0.7	$1.0
TOTAL		$250	$13.8	$35.7

Note CAPEX has been converted to an annualised operating costs using 8.8% which reflects local body costs of capital and the life-time of the assets (typically 40years+).

Therefore total costs of compliance for all registered reticulated systems is estimated to be:

$35.7m/annum ($21m/annum - $46m/annum)

1.2.2 Cost of compliance for roof-supply systems

The costs of compliance with the proposed legislation are estimated to be:

Cost source	Recurring Cost ($m/annum)
2,570 new self-serve houses/annum (2.5% of total stock being replaced)	$14.1
5% self-serve buildings modified/annum (require building permit and forced to upgrade to 'potable' water)	$27.5
TOTAL	$41.6

The need to upgrade drinking water when on receipt of building permit will depend on council policy which may vary by district. Hence this cost[15] is probably an upper estimate:

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[13] Excludes secure bore water (Christchurch, Lower Hutt, Hastings). Analysis of the small plants <500 pop, in the WINZ data-base suggest 45% require upgrade, 10% are on secure bore and require nothing and 45% require new plant.

[14] Alternative engineering approaches have yielded total costs to upgrade all plants at $100m. This could reduce annualised costs by $12m.

$41.6m/annum or $416/household/annum

[15] Treatment costs are estimated at $2,500 for UV and filtration initial cost with $300/annum (for 10 years) to replace filters and UV bulbs.

1.3 Tangible Benefits of Standards-Compliant Water

When drinking water is made compliant with the drinking water standards, we expect the risk of disease to be reduced. Issues discussed in this analysis are:

- Burden of disease due to all drinking water sources
- Burden of disease due to roof-collection systems
- Risk of serious outbreak
- Risk of emergent pathogens
- Avoidable costs for reticulated systems

1.3.1 Burden of disease due to all drinking water sources

Based on work by ESR (see attachment three), we have estimated the burden of disease due to all drinking water sources based on published work for infectious disease in New Zealand from food borne sources. These estimates have been corroborated with personnel working in the field, and supplemented where necessary with overseas experience. These are tangible costs due to lost productivity, medical cost and mortality due to waterborne disease[16]:

$15.2m/annum ($10m/annum - $31m/annum) = total burden of disease

1.3.2 Burden of disease due to roof-collection systems

The burden of disease due to roof-supply systems relies heavily on Australian experience and especially South Australia where 42% of the population relies on roof-water (relative to <8% in New Zealand). The results suggest that while most tank water show signs of faecal contamination, there was little evidence of elevated illness for roof-water relative to city supply[17], possibly due to immunisation affects, or the dominant effect of other vectors of gastro-enteric disease (food, people/animal contact, poor hygiene …).

Campylobacter and Salmonella typhimurium infection from bird, rodent and possum droppings can lead to disease[18], and birds in particular can be a problem. A

[16] Note the mortality costs have used government endorsed LTSA estimates of $2m for a 'statistical' life. Medical costs are primarily due to hospitalisations, which would be re-prioritised to other disease if waterborne illness was reduced, rather than returned to the Government to be re-allocated elsewhere. In this sense the freeing up of these resources for other medical uses has been included as a benefit.

[17] A South Australian study among children indicated no observable difference in gastro-intestinal rates between city water and those fed from a variety of sometimes poorly maintained roof-systems. See . http://www.ircsa.org/pdf/10th/3_03.pdf. Anecdote from Australian experience indicate the possible dual role of bio-film in possibly removing nutrient feeding pathogens and 'drop-out' inside a water tank whereby pathogens are removed from suspension in the water. Both functions provide a Log 1-2+ reduction in pathogens and significantly improves the quality of the outgoing water.

[18] http://www.dhs.sa.gov.au/pehs/publications/monograph-rainwater.pdf

Campylobacteriosis outbreak in Waikato, affecting 49 adults and children at a camp, has been linked to turkeys[19] roosting on the roof where rain-water was collected.

Sources of disease from roof-collection systems are estimated to be:

Pathogen	Cases	Cost/case	Total cost per annum
Campylobacter[20]:	6,000 cases[21]	$533	$3.2m
Salmonella:	224 cases[22]	$526	$0.35m
E. Coli o157	10 cases[23]	$60,000	$0.6m
TOTAL			$4.1m

Source: Attachment three below

Total avoidable cost if standards of roof-collection could be improved are:

$4.1m/annum or $41/household/annum

1.3.3 Risk of serious outbreak

Serious outbreaks of a scale such as 'Walkerton' are very rare events, in the same manner as serious earthquakes are. They only occur in reticulated systems which

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[19] Simmons G, Sharma K, Ma L, Hankins J, Hood D. An outbreak of Campylobacteriosis associated with a school camp in the Waikato. New Zealand Journal of Environmental Health 2003; 26(1):7-16.

[20] The following data provides further evidence of the reduced role that tank-water has on Campylobacteriosis, relative to major risks such as eating chicken and handling animals:

Table 2 Risk Factors for Campylobacteriosis Identified by Eberhart-Phillips *et al.* (1997)

Risk Factor	Adjusted Odds Ratio*	95% confidence interval
Rainwater source for home water supply	3.11	1.30, 7.41
Preference for chicken liver ≥ 1/month	2.47	1.22, 4.98
Preference for chicken pieces ≥ 1/week	1.44	1.10, 1.89
Puppy ownership	3.94	1.57, 9.88
Eating chicken raw or undercooked within the last 10 days	3.71	2.24, 6.13
Eating any chicken prepared at a sit down restaurant within the last 10 days	3.53	2.17, 5.72
Eating chicken prepared at someone else's house within the last 10 days	1.77	1.12, 2.80
Not eating baked/roast chicken within the last 10 days	1.75	1.33, 2.32
Eating barbecued chicken within the last 10 days	1.88	1.05, 3.36
Drinking unpasteurised milk within the last 10 days	3.92	1.66, 9.27
Handling calf faeces within the last 10 days	4.40	1.34, 14.39
Sewerage problems at home within the last 10 days	4.35	1.55, 12.18
Eating other raw or undercooked meat or fish within the last 10 days	3.67	2.07, 6.50

* Adjusted for age, sex and region.

Potential Transmission Routes Of *Campylobacter* From Environment To Humans; Baker, Ball et al, 2002; http://www.moh.govt.nz/moh.nsf/ea6005dc347e7bd44c2566a40079ae6f/d9a729032610c1e6cc256ca5006cface/$FILE/CampylobacterReport1.pdf. The above results are largely confirmed by inspectors who investigate outbreaks in rural areas.

[21] G. Simmons, Assessing the Microbial Health Risks of Potable Water, 2001, http://www.eng.warwick.ac.uk/ircsa/pdf/9th/07_01.pdf, estimated the risk at 2% of total Campylobacter cases. Subsequent personal communication based on an analysis of Northland, revises that estimate to be closer to 5%, or 50% of the total attributable to water-borne illness. We have used the higher value (5%) in our estimates.

[22] Other sources of contamination are from vectors such as rats and possums, and dust which can carry Protozoa, E. Coli O157 and Salmonella from poultry. These risks appear to be small in comparison to Campylobacteriosis from birds.

[23] 1 case has been reported due to tank water being replenished from surface water. We have allowed for a factor of 10 for under-reporting.

serve relatively large numbers of people. We have accounted for this cost in an actuarial manner similar to an 'insurable' risk to account for this risk on an annualised basis. The costs are:

Cost of outbreak: NZ$140m[24]
Recurrence rate: 35 years (see attachment three for details)

Annualised costs are therefore:

$4m/annum ($2m/annum - $6m/annum) = $140/35

Risks must be considered in the light of the pathogen implicated:

1. Campylobacter at $533/case[25] or
2. E. Coli O157 at $60,000/case[26]

Depending on which pathogen is involved has significant implications for the costs of an outbreak. Campylobacter is widely distributed, relatively infectious and the most common cause of outbreak. But the impact of infection is mostly time off work with few long-term effects. E. Coli O157 (or other subtypes) on the other hand is relatively rare, is highly infectious and can have significant long-term consequences. E. Coli O157 appears to be a significant risk for water sources subject to faecal contamination from cattle where high concentrations can build up, such as insecure wells and pipe systems[27]. To our knowledge an E. Coli O157 outbreak has not yet been observed in surface water sources where the contamination can be diluted.

1.3.4 Risk of Emergent Pathogen

Pathogens continue to evolve and previously benign species can become virulent and highly toxic to humans, i.e. E. Coli variants such as O157 were not known prior to 1982.

Currently toxin producing pathogens (i.e. Cyanobacteria (blue-green algae)) are generally not a significant risk, except for the Waikato where agriculture runoff is creating conditions for occasional blooms. Where this is a risk, as at Hamilton[28], it is managed using activated carbon which relatively expensive. However the risk is growing. Cyanobacteria blooms which were previously unknown, have been

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[24] 2,300 cases affected by E. Coli O157 @ $60k/case as at Walkerton. See attachment three for details.
[25] See attachment three, Table 1 for calculations of the costs per case which generally involved time off work.
[26] See attachment three, Table 1 for calculations of the costs per case which are heavily influenced by the children requiring long-term dialysis and less so by the high mortality from this pathogen.
[27] Walkerton and the New York state fair both involved water from wells, although the oubreak in Cabool Missouri in 1993 (243 cases and 4 deaths) http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=1416555&dopt=Abstract was linked to broken distribution pipes.
[28] Ozone disinfection can also be used to mitigate taste and odour problems. While the toxins from these organisms are highly toxic, in most cases the toxicity is associated with strongly disagreeable odour and taste which usually prevents a toxic dose being consumed. However deaths in Brazil and hospitalisations in Australia (see WHO guidelines on cyanobacteria) attest to this organism's danger. Expert advice currently regards this as a low albeit growing risk (see attachment three).

observed in Lakes Taupo and in other catchments where agricultural runoff is increasing nutrient levels in catchments previously unaffected by this activity.

If burden of disease costs are not currently observable, they have not been included in the analysis.

1.3.5 Avoidable health costs for reticulated systems

For community reticulated systems the avoidable health costs are made up of the following :

Issue	Cost per annum
Observed 'burden of disease' from all sources	$15.2m
Less that due to roof-collection systems	-$4.1m
Plus the incidence of a rare but serious outbreak	$4.0m
TOTAL	$15.1m

$15.1m/annum ($9m/annum - $34m/annum) = avoidable cost for reticulated systems

This avoidable cost seems to fall unevenly on the population. Generally speaking lower graded and smaller plants are expected to be a much greater per person risk of outbreak than larger and higher graded plant. Increasing scale economies mean that larger plants are generally better engineered with more barriers and more professional supervision than others. However this does not mean there is zero risk with large plants[29]. Unfortunately the data required to scientifically quantify these risks is not currently available.

[29] A Cryptosporidum outbreak in Milwaukee affected 400,000 persons and it is claimed resulted in 100 deaths mainly from AIDS and immunologically compromised persons.

1.4 Intangible benefits of compliance to standards

Good quality drinking water brings benefits beyond the tangible economic gains itemised above. It is often described as a 'basic right' which we in most parts of New Zealand tend to take for granted because good quality water is readily available. However in some areas this is not the case, and it is well to consider the wider implications that good quality water brings to society:

1. Avoiding 'pain and suffering'
   People increasingly value their health and leisure time and are usually prepared to 'pay' to avoid illness, beyond its direct economic impact, although this is heavily determined by socio-economic circumstance. Therefore good quality water brings additional value to most people in the form of greater certainty of a healthy outcome. The US Environmental Protection Agency (USEPA) value this in the context of their 'tort' based legal system of awarding damages for 'pain and suffering' and estimate this using a 'leisure time' argument which they value approximately the same as the lost-productivity costs[30], although this approach is a contentious one among the economic community[31]. In New Zealand the ACC regulations value 'pain and suffering' almost at $0. Hence the value of 'pain and suffering' could lie somewhere between $0 and the US estimate of 'pain and suffering' being the value of lost productivity due to waterborne illness; $7.5m[32].

2. 'Sanctity' of public infrastructure:
   Users benefit both in terms of having 'peace of mind' and avoiding costs[33] by being able to put their faith in public infrastructure. Hence the blood bank in New Zealand is protected via testing that goes well beyond what a simple cost/benefit would justify. It is needed to maintain unquestioning public trust in this service. The public supply of drinking water raises similar issues, although compared to the blood supply, people receiving drinking water are better able to manage their risk exposure. However if that trust is ever questioned, it typically must be bought back at a cost which is much greater than mere money. Major public enquiries, restructuring of institutions and campaigns to regain public trust are some the costs incurred. We observe in the Walkerton disaster and Sydney 'protozoa' outbreak[34] that the public enquiries and restructuring of public institutions go well beyond what would be expected if a similar problem had occurred in other areas of public life, such as transport.

3. Protection of 'clean, green and secure' image:
   SARS has provided some indication of the capacity of outbreaks to have significant economic impacts by reducing the movement of people. Work by

[30] See estimate in the EPA's long-term 2 enhanced surface water treatment rule, p47741; http://www.epa.gov/safewater/lt2/pdfs/fr_lt2_full.pdf.
[31] See comment at http://www.mindfully.org/Food/Foodborne-Illness-Costs-USDA.htm.
[32] See attachment three for details.
[33] They do not need to test the water or take avoidance action to boil water or buy clean sources.
[34] The 1998 Sydney 'protozoa' incident resulted in a 'boil water' notice, despite there being no recorded incidence of disease. However it caused a public furore and resulted in a major enquiry, restructuring of institutions and calls to invest more heavily in water treatment systems.

Ministry for the Environment estimates an upper bound of $938[35]m on a value of the 'clean, green' image. Factors contributing to this are:

a. Immigrants are drawn to New Zealand primarily for life-style choice[36]. This 'trade' is currently estimated to be worth $880[37]m/annum.
b. Tourism brings in $6bn/annum, and the Ministry of Tourism has a separate bid for improving sanitary infrastructure in 'tourist' towns.
c. Some food exports to countries such as Japan and Europe are believed to earn premiums due to the perception of New Zealand as a 'clean, green and secure' source. Total food exports are; $10.3[38]b/annum.

4. Social cohesion

Experience from a pilot project in the Hokianga indicates health gains are not the only benefits from a drinking water project, especially for isolated communities. Benefits also occur due to improved social cohesion and confidence brought about by the debate and commitment which such projects require.

5. Equity of access

Should good quality drinking water be considered a 'basic right'? Equality of access to basic services such as good quality drinking water removes some barriers to social and economic progress in remote and small communities, in a similar manner that primary and secondary education is provided by government as a basic right.

In addition visitors to remote regions (both local and international) would benefit by reducing the risk of illness and not having to adjust their behaviour when they move from urban into rural environments.

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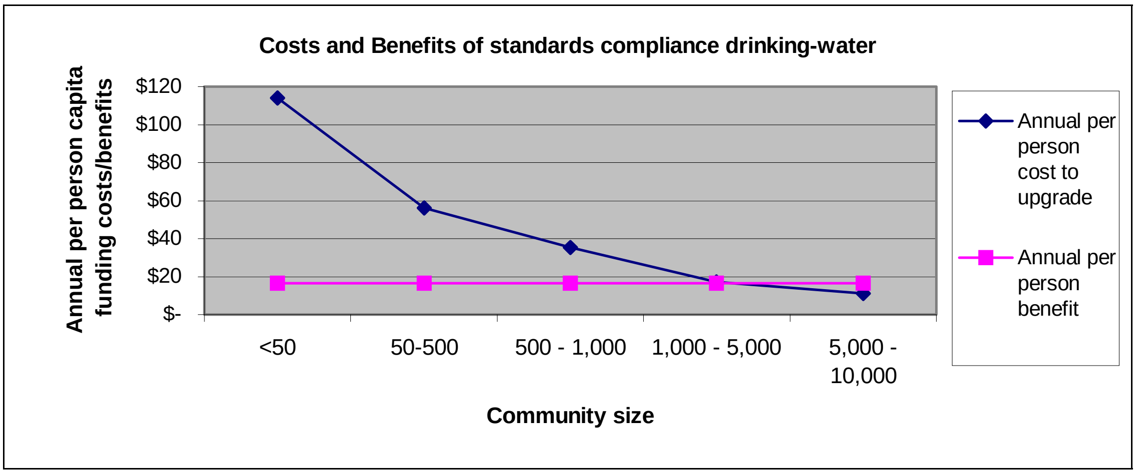
[35] See: http://www.mfe.govt.nz/publications/sus-dev/clean-green-image-value-aug01/executive-summary-aug01.pdf
[36] According to the *Longitudinal Immigration Survey: New Zealand*: http://www.immigration.govt.nz/Research/lisnz/lisnz.htm
[37] See ANZ analysis: http://www.anz.com/nz/tools/library/mf/mf20040326.pdf
[38] MFE 2000: Valuing NZ's clean and green environment: http://www.mfe.govt.nz/publications/sus-dev/clean-green-image-value-aug01/chapter-2-aug01.pdf

1.5 The impact of scale economics

There are strong economies of scale in upgrading drinking water systems to be standards-compliant. As a result large cities find it very much easier to deliver good quality drinking water due to favourable economics and operational demands than small communities. However the benefits of not getting sick tend to be the same no matter where you live. The following graph indicates both the cost of upgrade, and the benefit of avoiding the current level of waterborne sickness spread over the population in these bands (916,000):



The results indicate that is it is not 'economic' for communities smaller than approximately 3,000 to comply fully with the drinking water standards, since the costs exceed the nominal benefits[39]. This aligns reasonably well with anecdotal experience which indicates compliance problems with towns smaller than 2,000 persons.

The above indicates the difficulty of applying drinking-water standards for both small and large communities. A rule which is 'economic' for large cities, and by default for the nation (since most people live in large cities), is probably not 'economic' for small communities. If legislation is to be passed which requires rule based standards be applied, there are three main ways of handling this:

1. Pragmatic approach
   This allows smaller communities to choose the standard of services they can afford, considering fully the risks, benefits and compliance costs. In essence they choose the freedom to live with a higher level of risk than other communities. Whether this imposes significant costs on others, especially central government, is an issue that will need to be tested in such a regime. 'All practical steps' as used in the Bill has the capability of delivering this, depending on the criteria used to test that 'all practicable steps' have been taken. These should be specified in the manual that drinking water assessors use to approve risk management plans.

[39] The benefit estimate is approximate. It has been derived using the $15.1m/annum of observed water-borne illness in reticulated systems, and spreading it evenly over the population all towns <10,000 persons, i.e. 916,000 persons.

2. Subsidy
   'Taxing' larger urban areas and in the sense of central government providing financial assistance to small communities out of the general taxation pool, ensures the 'surplus' benefit enjoyed by larger communities is shared out to smaller communities to deliver the same or similar standards-compliant water.

3. Combination
   A combined approach of providing financial assistance to smaller communities and being pragmatic where risks can be appropriately managed is also an option.

1.6 Summary of findings

It is not the intent of this document to analyse the Costs and Benefits of the proposed intervention, namely mandatory compliance regime to DWSNZ, to make a judgment on whether it should proceed or not. The intent is simply to inform policy on implementation of the Bill, and the need for an assistance package. The following results are presented to inform implementation policy, and the degree to which discretion should be exercised where it is provided for in the legislation such as using 'all practicable steps', and adjusting policy via council's record of community consultation, being the Long Term Council Community Plan (LTCCP).

1.6.1 Community reticulated systems

Within the bounds of uncertainty around the point estimates, and including the significant intangible benefits, it would appear there are grounds for this intervention to be seriously considered. However the result also suggests that investments will need to be considered carefully to ensure good value is achieved from skill transfer and plant investment:

Issue	Description	Economic impact	Uncertainty ($m/annum)
Costs	Cost of compliance to standards	$36m/annum	$12m- $46m/annum
Benefits	Avoidable direct cost of illness	$15m/annum	$13m – $37m/annum
	Avoiding 'pain and suffering'	Loss of leisure time and 'enjoyment of life'.	$0m – $5m/annum
	Mitigating risk of serious outbreak	The Walkerton disaster cost $140m+, but is considered to be a very rare event[40].	Included above
	Sanctity of Public infrastructure	Institutional change, and public enquiries.	
	Clean, green and secure	Some % of $938m	
	Social cohesion/Equity of access	Possibly arrests social decline in remote regions.	

1.6.2 Roof-collection systems

Roof-collection systems are not directly addressed by the Bill. They tend to be a discretionary item covered by the Building Act which councils and their inspectors have some discretion over policy. The following suggests a standards compliant approach is probably not justified, except in specific circumstances when the risks are high, such as for visitors or for heavy faecal contamination (especially from birds).

Issue	Description	Economic impact	Uncertainty ($m/annum)
Costs	Cost of compliance to standards	$42m/annum	$30m - $50m/annum est.
Benefits	Avoidable direct cost of illness	$4m/annum	$2m - $5m/annum est.
	Avoiding 'pain and suffering'		$0m – $3m/annum

[40] See Attachment three where the detailed costs of this outbreak are presented.

2 ATTACHMENT THREE: Calculation of Benefits

2.1 Background burden of disease model

The following table represents our best estimates of the annual ‘background’ burden of disease due to drinking water. It is based on the number of cases reported annually to the notifiable disease system operated by ESR for the Ministry of Health.

The process used to develop the following table was as follows:

1. Each pathogen known to be carried by drinking-water was separately analysed.
2. The number of cases reported each year was extracted from the notifiable disease system.
3. Under-reporting was estimated using expert advice and published literature and the total incidence of disease nation-wide was calculated.
4. Drinking water as a known cause was estimated using expert advice and information from outbreaks where causal agents have been more reliably established from scientific analysis.
5. Cost per case were taken from published literature. Protozoa and E. Coli O157 costs were estimated using estimates for time off work, hospitalisations, long-term morbidity and mortality data from US data (USEPA) and Communicable Disease Centre (CDC).
6. The process was QA’d by public health physicians and economists working in this area.

Table one:

Waterborne Ilness in New Zealand

Pathogen	TOTAL Incidence per 100,000 (corrected for under-reporting)	Reported Incidence per 100,000 (ESR 2004)	% reported (NZ Med J, 2000..)	Cases per annum	Cost per case (1999 $s)	Proportion waterborne	% hospitalised	% mortality (based on EPA data)	Avg days off work	Time off work ($ks)	Mortality ($ks)	Medical ($ks)	Total ($ks)
Campylobacteriosis	3,040	400	13%	121,600	$533	10%	0.3%	0.005%	5	$5,046	$1,216	$219	$6,481
Ecoli O157 (VTEC)	9	3	35%	343	$60,000	20%	12.0%	0.4%	6	$34	$549	$3,532	$4,114
Cryptosporidiosis	200	20	10%	8,000	$978	30%	4.0%	0.02%	6	$1,195	$960	$192	$2,347
Giardiosis	250	25	10%	10,000	$855	20%	2.0%	0.02%	5	$830	$800	$80	$1,710
Salmonellosis	112	35	31%	4,480	$526	5%	1.0%	0.02%	3.5	$65	$90	$0	$118
Yersiniosis	62	12	20%	2,480	$891	10%	0.5%		9	$185	$0	$36	$221
Toxins (algae ...)	414	207	50%	16,560	$221	5%	0.3%		2	$137	$0	$46	$183
Virus (incl. Hep A)	478	72	15%	19,120	$204	2%	0.0%	0.002%	2	$63	$15	$0	$78
										$7,557	$3,629	$4,104	$15,253

NOTES:

This data is based on work published in the NZ Med J, 2000, V113 p278-284, ‘Economic Cost to New Zealand of foodborne infectious disease’ (Lake,Baker,Garrett,Scott,Scott) augmented with data from other sources as required:

1. *Annual Summary of Outbreaks in New Zealand, 2002, by ESR*
2. *New Zealand Public Health surveillance Report Summer 2004*
3. *www.cdc.gov (US communicable disease unit)*
4. *Information reviewed via personal communication with the Medical Officer of Health in MidCentral (Dr Donald Campbell)*

Data modified from the above source is:

Cryptosporidiosis	*Time off-work estimated using Netherlands study: http://www.eurosurveillance.org/em/v01n02/0102-222.asp*
	*Cost per case est. 6 days off work/7*$581/wk income + $2m*0.0002(fatality risk) + $2k*0.04(hospital risk mainly applies to children)*
Giarida	*As above using 5 days off work since it is a less aggressive organism*
Ecoli 0157	*% waterborne calculated using CDC reported outbreaks ex US (30%), modified for NZ. Under-reporting is estimated ONLY.*
	$60k/case is highly dependant on number of children with kidney failure needing long-term dialysis. Costs using Walkerton data = (7 deaths @$2m/case + 27 dialysis cases costing $150k/annum for 30yrs).
Salmonella	*Risk associated with roof-collection systems where poultry have access to roof collection systems or other vectors (animal or wind) are involved.*
Under-reporting	*Derived from the study above based on an Engish Infectious Intestinal study. Protozoa values derived from US CDC experience.*

2.2 Under-reporting

Under-reporting for gastro-enteric disease is significant issue, for instance in the Te Aute Campylobacter outbreak only 1% of cases were reported, although the nominal rate of reporting is considered to be in the 5%-20% range for these infections. In addition there is difficulty in attributing disease to drinking water sources.

The literature reports a 13%[41] reporting of true disease for most gastro-intestinal illness. This under-reporting is due to:

1. Low presentation to the GP,
2. GPs not always requesting stool samples,
3. New Zealand's passive reporting system which requires GPs to notify illness when they detect it. However in some areas there are informal links between the labs and the Medical Officers of Health which improve the reliability of reporting.

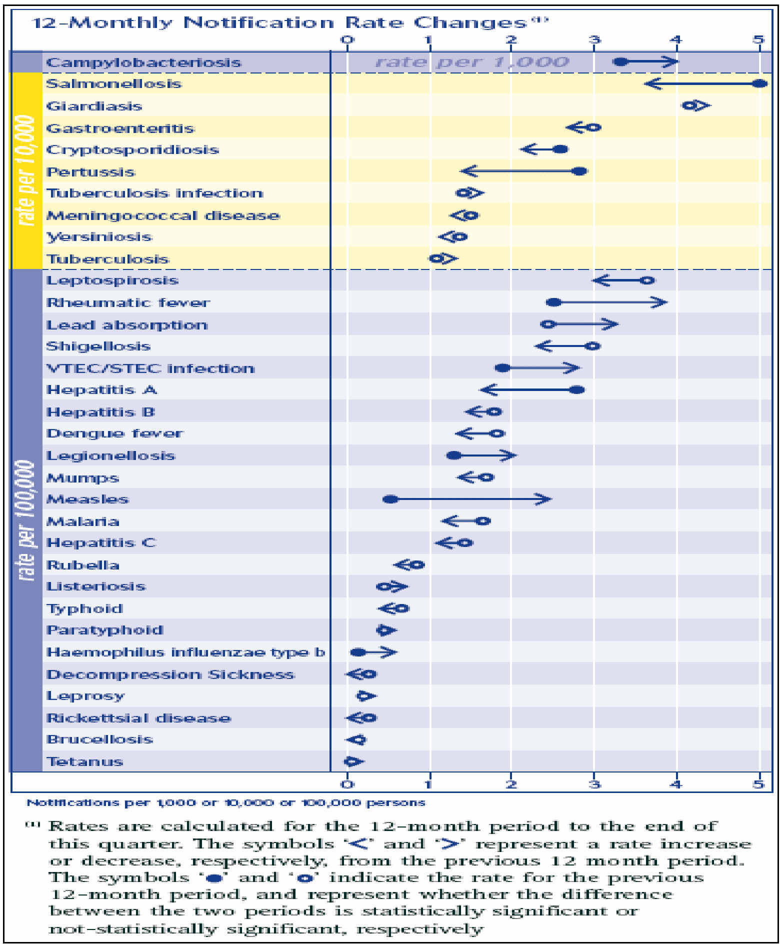
The burden of disease model uses values derived from the published literature, where available or expert opinion otherwise. Under-reporting is the most significant variant in estimating cost variability, and values ranging from 5% to 20% have generally been used for the sensitivity analysis.

Most under-reporting is due to disease in children. Children are particularly susceptible to gastro-intestinal disease with a South Australian study indicating an average 4.7[42] events per annum. Many of these go un-reported. However these cases are only of 'economic' significance if they force carers to take time off work or serious enough to warrant hospitalisation in which case the likelihood of reporting is high. Low presentation to GPs is particularly prevalent in rural areas and anecdote from professionals working in the field suggests very low reporting, particularly for children, and where access to a GP is difficult. The economic impact of this low-presentation is not easily quantifiable. If carers are not working, the economic impact is likely to be low.

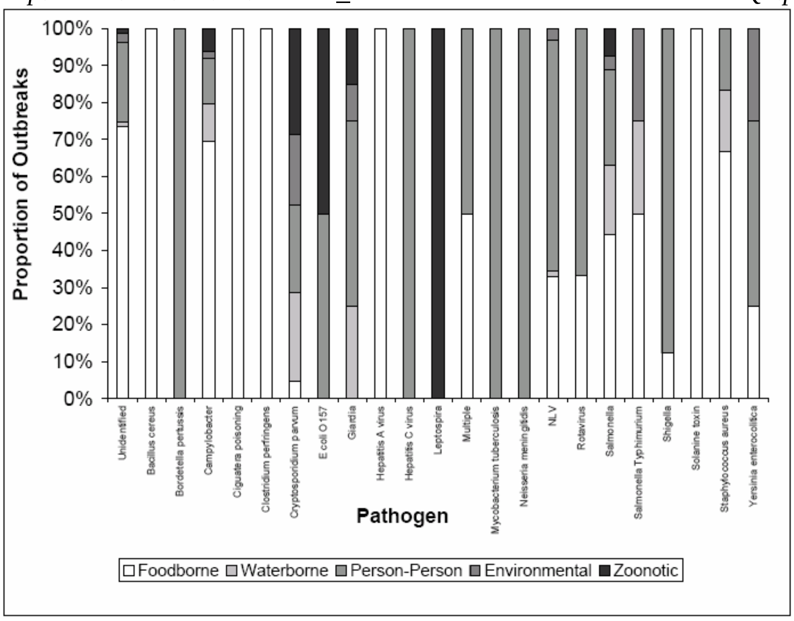
2.3 Notifiable disease

The notifiable disease incidence as recorded by ESR on an annualised basis is:

[41] Wheeler, Seethi et al, BMJ 1999, 93: 57-63.
[42] http://www.ircsa.org/pdf/10th/3_03.pdf. This study also indicated that for the specific South Australian environment there was no demonstrable difference in illness rates between city and roof-supply water.



Source: New Zealand Public Health surveillance Report Summer 2004, http://www.surv.esr.cri.nz/PDF_surveillance/NZPHSR/NZPHSR2003Q4.pdf



Source: Annual Summary of Outbreaks in New Zealand, 2002, by ESR http://www.surv.esr.cri.nz/PDF_surveillance/AnnSurvRpt/2002AnnualSurvRpt.pdf

Results are summarised:

Organism	Reported cases per 100,000 pop all sources[43]	Waterborne contact risk	Morbidity/Mortality
E. Coli O157	1.4[44] US 3 NZ	30% US <10% NZ (no recorded sources yet)	1. 3% hospitalisation[45]. Haemolytic Urinary Syndrome (HUS) especially in children. 50% of HUS patients result in long-term dialysis. 50% of elderly HUS patients die. 2. 1% serious illness 3. 0.4% mortality
Campylobacter	20 US 320 NZ	10% NZ	1. 7% hospitalised[46] 2. 0.1% serious due to Guillain-Barre syndrome, a paralysis that lasts several weeks and usually requires intensive care 3. 0.005% mortality
Crytosporidium	25 NZ	25% NZ	4. 1% hospitalisation[47] 5. 0.02% mortality in AIDS and immune compromised
Giardia	10 US 40 NZ	25% NZ	6. 1-20% hospitalisation[48] 7. 0.02% mortality in AIDS and immune compromised (see cryptosporidiosis above)
Salmonella	140 US 45 NZ	15% NZ	8. 10% hospitalisation 9. 0.02% mortality[49]
Norovirus	30 NZ	2%	10. 3% hospitalisation 11. 0.2% mortality[50]

2.4 Risk of Outbreak using North American experience

In addition to the background burden of disease, there are costs incurred due to very rare but high cost events caused by serious outbreak. New Zealand has not experienced such events but North America has. In NZ$ terms, the direct medical and economic costs of an event such as the Walkerton tragedy are estimated to be:

2,300[51] cases @ $60k[52]/case = $NZ140m[53]

[43] US data from CDC: www.cdc.gov and NZ data from ESR outbreak data above.
[44] Derived from CDC data: http://www.cdc.gov/ncidod/dbmd/diseaseinfo/escherichiacoli_a.htm, which reported 61 deaths in the US in 2002, of which we estimate from the detailed causal analysis that 30% are due to waterborne contamination. Causal relationships are very sensitive to single outbreak events which affect large numbers (>1,000) of people.
[45] Derived from Walkerton experience as recorded later in this attachment
[46] Infectious Diseases In New Zealand:2002 Annual Surveillance Summary http://www.surv.esr.cri.nz/PDF_surveillance/AnnSurvRpt/2002AnnualSurvRpt.pdf
[47] ESR Outbreak Summary for 2002.
[48] CDC fact sheet: http://www.cdc.gov/epo/mmwr/preview/mmwrhtml/ss4907a1.htm
[49] CDC fact sheet: http://www.cdc.gov/ncidod/dbmd/diseaseinfo/salmonellosis_g.htm
[50] Annual Summary of Outbreaks in New Zealand, 2002, by ESR
[51] 2,300 cases of infection were reported in the Walkerton outbreak for a town of 4,000 persons.

The recurrence rate of this sort of serious outbreak in New Zealand will depend on:

- Observed serious outbreaks per annum
- Population exposed
- Prevalence in the environment of the pathogen E. Coli O157 which was primarily implicated
- Relative risks of systemic failure leading to outbreak

Insufficient information on this form of outbreaks exists within New Zealand. We have therefore used data from North America which has a much larger population base albeit with some environmental differences.

Issue	North America	New Zealand
Observed outbreaks per annum	1[54]	Not available
Population exposed	310[55]m	4m
Notifiable cases of E. Coli O157 per 100,000 pop	1.4[56]	2.8
Risk of systemic failure	1	1.25[57]

Using this data on the basis that no action is taken to reduce the risk of systemic failure, we calculate the expected New Zealand recurrence rate of a serious outbreak to be:

New Zealand risk of outbreak per annum =
*North American outbreaks per annum **
*(Relative exposure * Relative pathogen prevalence * Relative risk of systemic failure)*

$m/annum	Recurrence rate (years)		NZ pop	North American pop	NZ prevalence	North American prevalence	Relative risk of systemic failure in NZ
$4.0	35		4	310	2.8	1.6	1.25

E. Coli notifications in New Zealand have been growing at 8%/annum for the last five years. On the assumption that the prevalence of the pathogen is increasing in line with that growth, and that it will impact all sources of the disease equally, we expect

[52] See table one above which documents derivation of this cost estimate. Note it is very sensitive to the number of children requiring long-term dialysis and less so to the mortality rate from this pathogen.
[53] A Canadian media report using their cost per fatality and liability for dialysis costs were of the order of $CAD400m. We prefer the NZ$ estimate based on local costs which will generally be much lower than a North American litigious environment.
[54] Cases are Milwaukee, Walkerton, New York state fair …
[55] 290m (US) + 20m (Canada)
[56] *Notifiable and Other Diseases in New Zealand*, ESR, 2003, p52. This data compares the notifiable cases per 100,000 between US (1.4), Canada (4.1) and New Zealand.
[57] The relative risk of systemic failure is a complex issue depending on the relative technology, training, and motivation to run systems professionally. Many observers consider local systems are at greater risk than their North American counterparts. The choice of 1.25 (25% greater risk) reflects a 'best guess' estimate of the greater risk that NZ systems face of failure.

the value of $4m/annum will also increase by 8%/annum in line with the growing prevalence of the pathogen.

Note the sensitivity has been estimated based on:

- At the low end, the incidence of serious outbreak in the US being 0.5/annum rather than 1/annum in the model.
- At the upper end, the risk of systemic failure being 2, rather than the 1.25 used.

2.5 Risk of Outbreak using New Zealand experience

Local outbreak data from ESR provides the following estimate of cases reported to the notifiable disease system:

Area	**Year**	**Number Affected**	**Cases**	**Outbreak of:**
Queenstown	1984	3,500	3,500	Gastrointestinal symptoms
Ashburton	1986	19	19	Campylobacteriosis
Central Otago	1989	3	3	Salmonellosis
Canterbury camp	1990	42	42	Campylobacteriosis
Hawkes Bay	1991	12	12	Campylobacteriosis
Northland	1992	14	14	Campylobacteriosis
Hawkes Bay	1992	97	97	Campylobacteriosis
Auckland	1993	34	34	Giardiasis
South Canterbury	1993	>20	30	Campylobacteriosis
Timaru	1994	6	6	Campylobacteriosis
Raurimu	1994	16	16	Campylobacteriosis
Northland camp	1995	34	34	Salmonellosis
Hutt Valley	1995	100	100	Gastroenteritis
Waikato	1995	170	170	Campylobacteriosis
Mt. Hutt Ski Field	1996	>60	90	Gastroenteritis
Northland	1996	30	30	Hepatitis A
Ashburton	1996	33	33	Campylobacteriosis
Nelson	1996	>10	15	Gastroenteritis
Waikato	1996	14	14	Giardiasis
Buller	1996	4	4	Giardiasis
Peketa	1996	3	3	Giardiasis
Hawkes Bay	2001	95-185	185	Campylobacteriosis
Outbreaks per annum			1.3	
Avg cases per annum			262	
Camplylobacter cases/annum			37	

Source: ESR data (personal communication) slightly amended as indicated

We note the extreme sensitivity of the average number of cases per annum to the Queenstown outbreak. Unfortunately this sort of rare and high impact event is typical for this type of risk. Estimating insurable premiums for classes of earthquake risk involves similar issues. It emphasises the need to use a very large experience base when estimating the cost impact of these events.

Despite the difficulties of using this data, we have estimated the risk of serious outbreak event as follows:

Outbreaks/annum: 1.3
Incidence of campylobacter: 400 cases/annum/100,000 @ 10% waterborne

Incidence of E. Coli O157: 3 cases/annum/100,000 @ 20% waterborne

The mechanism whereby systemic failure causes Campylobacter outbreaks is very similar to the mechanism for E. Coli O157, i.e. they are both bacteria which react to disinfection in a similar way. However there are differences:

- Campylobacter is commonly distributed in the environment and carried by most animals. E. Coli O157 is less common although it has been said that 15% of cattle carry the pathogen.
- N_{50} doses at which 50% of healthy people are expected to be infected are quite different: 896(Campylobacter)[58] versus 70,000 (E. Coli O157)[59], i.e. Campylobacter is >70 times more infectious than E. Coli O157 and 1,000 times more infectious than Salmonella which is another common pathogen. This partly explains the significant difference in risk of outbreak between the pathogens.

Therefore using the observed incidence of systemic failure AND assuming these are all due to Campylobacter we get an upper bound estimate of serious outbreaks due to E. Coli O157:

Outbreak $k/annum based on observed cases/annum	**Cases/annum**	**Campylobacter incidence**	**% waterborne**	**E. Coli O157 incidence**	**% waterborne**	**E. Coli O157 $k/case**
$705	261	400	10%	9	20%	$60

To be conservative in our estimate of risk, we have chosen the $4m/annum figure calculated above using the North American experience.

58

59 See *Draft Risk Assessment of the Public Health Impact of E. Coli O157 in ground beef*: FSIS publication: http://www.fsis.usda.gov/oppde/rdad/frpubs/00-023nreport.pdf

3 ATTACHMENT SEVEN: Engineering report

The following has been extracted from the engineering report used to base the cost estimates on:

Estimation of Required Capital Spending

To Upgrade To Proposed Drinking Water Standards

The cost of upgrading the treatment plants throughout the country for the supply of domestically consumed drinking water has been estimated as follows:

The treatment plant gradings as per WINZ database have been taken as current. The populations being served by the plants as per the database have been used to establish the size of the issue at each treatment plant. The upgrading cost formulas derived have been used against the database to calculate a theoretical total upgrade cost.

The treatment plants have been placed into three categories:
1. Those grading "A" where little upgrade cost is necessary.
2. Those grading "B", "C" or "D" where a treatment process is already in place but where significant upgrading will be necessary
3. Those grading "E" where we believe that the most cost effective solution might be to replace the treatment plant in it's entirety.

The following is a breakdown of each of the above three categories looking at the individual plant upgrade costs over a range of populations being served. Attached as appendix are block diagrams of the assumed necessary modifications.

An important assumption is that each person serviced will consume 300 litres of treated water per day. This clearly does not account for all of the water treated at a typical plant. Commercial and Industrial use is not estimated, nor is water consumed per household for uses that are non-domestic in character - e.g. car washing and watering of lawns and gardens.

1. For those plants with existing "A" Grading:

These plants should be able to achieve the DWSNZ2000 (Post 2004) standard with very little plant modifications. Most of these plants already have "full treatment" facilities, including flocculation, clarification, filtering and disinfection. Overseas evidence suggests that these plants can generally be tuned to provide water ex the filters at less than 0.1NTU for most of the time. *(DWSNZ2000 post 2004 required 0.1NTU or better for 95% of the time).*

The drinking water standard does however require turbidity meters able to operate with confidence at around 0.1NTU. This will generally require an upgrade of the instrumentation. There would also be value in adding automatic valves and pipework to each filter such that water from the filter with turbidity in excess of a pre-determined value (0.5NTU or less), would be automatically diverted away from "FINISHED TREATED WATER".

The cost of installing pipework, valves, turbidity instrumentation and automation is estimated at $100,000 per filter.

It is assumed that an "average" filter produces some 3 million litres per day, sufficient for 10,000 persons on a domestic basis.

2. For those plants with existing "B", "C" or "D" gradings:

These plants will generally require greater upgrade than **1.** above. Assuming that the use of ultraviolet light as a treatment process will allow a relaxation of the 0.1 NTU turbidity requirement to 1.0 NTU then the addition of a U/V treatment process giving a dose of $40mJ/cm/^2$ immediately after the present filter would provide a simple, economical approach.

Estimated costs to purchase, install and commission a U/V plant for various population groups, again assuming 300 litres/day/person for domestic consumption are:

Population Persons	**Plant Size L/hr**	**Cost $**	**Cost/Person $**
500	7,000	15,200	30.00
1,000	11,000	20,500	20.50
2,800	39,000	33,000	11.80
6,000	82,000	50,000	8.30
10,000	136,000	60,000	6.00
18,300	250,000	90,000	4.90

Assuming that the majority of plants with "B", "C" or "D" gradings would be without turbidity measurement on each filter on a continuous basis, we believe it prudent to add the upgrade costs in **1.** (*i.e. for plants grading "A")*, to the estimated U/V installation costs for plants grading "B", "C" and "D".

The estimates for total requirements for these plants is therefore:

Population Persons	**Plant Size L/hr**	**Cost $**	**Cost/Person $**
500	7,000	60,000	120.00
1,000	11,000	72,000	72.00
2,800	39,000	100,000	35.70
6,000	82,000	134,000	22.30
10,000	136,000	160,000	16.00
18,300	250,000	270,000	13.70

3. For those plants with existing "E" grading:

In this case the following assumptions have been made:

A new water treatment plant is required to meet the proposed DWSNZ2000 (Post 2004) Standard as distinct from an upgrade on any existing plant.

The treatment plant capacity is 300 litres person person per day of treated drinking water.

An existing site and a suitable raw water supply was available.

There would be some down-stream treated water storage already available and useful within the existing systems, but some extra storage would be advantageous to reduce the need to vary the flow rate through the plant to cover peaks in usage. For this reason we have included for extra downstream storage for 50% of a days requirement.

5. There would be a requirement for some upstream detention/storage of raw water. The main purpose is to enable high turbidity raw water to be bypassed. Effectively, during storm type events little or no water would enter the detention storage and the treatment plant would consume the storage. Raw water would be re-admitted to the detention storage after the turbidity had reduced to an acceptable level. For costing purposes the detention/storage volume has been set at two days normal plant operation.

The plants estimated, take water from an existing raw water supply, treating it (*double, dual media filters with flocculation),* added chlorine as disinfection and pump to storage. The estimates included site works, installation, operator training, O+M manuals etc.

Population Persons	Plant Size **L/hr**	**Cost $**	**Cost/Person $**
500	7,000	556,000	1,112.00
4,400	60,000	3,012.000	685.00
18,300	250,000	8,900.000	486.00

Applying this data to information contained within the WINZ database yields the following capital costs.

Cost to upgrade a plant currently graded ‘A’ to one capable of meeting the 2003 revised standards.

Total population	Population band	Plants	Avg pop	**Cost per person**	**Total Cost**
0	< 50	0			
1,066	50-500	5	213	$148	$157,768
1,220	500 - 1,000	2	610	$70	$85,400
58,018	1,000 - 5,000	19	3,054	$25	$1,450,450
35,855	5,000 - 10,000	6	5,976	$12	$430,260
280,930	10,000 - 50,000	12	23,411	$10	$2,809,300
159,419	50,000 - 100,000	2	79,710	$10	$1,594,190
1,555,112	100,000+	3	518,371	$10	$15,551,120
2,091,620					$22,078,488

Cost of upgraded plants currently graded ‘B’, ‘C’ or ‘D’ to one capable of meeting the 2003 revised standards

Total population	Population band	Plants	Avg pop	**Cost per person**	**Total Cost**
75	< 50	3	25	$400	$30,000
13,377	50-500	58	231	$148	$1,979,796
27,039	500 - 1,000	40	676	$83	$2,244,237
179,905	1,000 - 5,000	73	2,464	$36	$6,476,580
125,504	5,000 - 10,000	19	6,605	$18	$2,259,072
369,398	10,000 - 50,000	13	28,415	$14	$5,171,572
371,200	50,000 - 100,000	6	61,867	$13	$4,825,600
205,000	100,000+	2	102,500	$12	$2,460,000
1,291,498					$25,446,857

Cost of upgrading plants currently graded as ‘E’ by installing new treatment equipment.

Total population	Population band	Plants	Avg pop	**Cost per person**	**Total Cost**
60	<50	2	30	$2,500	$150,000
10,909	50-500	41	266	$1,281	$13,974,429
15,719	500 - 1,000	23	683	$1,032	$16,222,008
59,420	1,000 - 5,000	26	2,285	$777	$46,169,340
50,058	5,000 - 10,000	7	7,151	$540	$27,031,320
24,900	10,000 - 50,000	2	12,450	$463	$11,528,700
161,006					$115,075,797

Cost of upgrading Ungraded plants. This is difficult to estimate as the scope ranges from completely new plants to relatively simple upgrades. The extremes of the ranges of costs are below.

UNGRADED (New Plant)					
Total population	Population band	Plants	Avg pop	Cost per person	**Total Cost**
1676	<50	62	27	$2,500	$4,190,000
40,141	50-500	220	182	$1,281	$51,420,621
8,561	500 - 1,000	13	659	$1,032	$8,834,952
53,667	1,000 - 5,000	20	2,683	$777	$41,699,259
35,365	5,000 - 10,000	5	7,073	$540	$19,097,100
67,239	10,000 - 50,000	5	13,448	$463	$31,131,657
206,649					$156,373,589

UNGRADED (Plant Upgrade)					
Total population	Population band	Plants	Avg pop	Cost per person	**Total Cost**
1676	<50	62	27	$400	$670,400
40,141	100-500	220	182	$148	$5,940,868
8,561	500 - 1,000	13	659	$83	$710,563
53,667	1,000 - 5,000	20	2,683	$36	$1,932,012
35,365	5,000 - 10,000	5	7,073	$18	$636,570
67,239	10,000 - 50,000	5	13,448	$14	$941,346
206,649					$10,831,759

<u>Note</u>: This does not include any allowance for PHRMP related costs, and does not look at the supplies that are not the primary source of domestic water for the population – i.e. it does not include private water supplies to accommodation establishments, airports, commercial premises, schools, hospitals, industry, marae, recreational and sporting facilities.

A particularly important block here is the self-service "buildings" that will come within the Building Act requirements. For simple buildings where a simple double cartridge filter plus U/V will suffice, we would estimate the Capital cost per supply at $3000 per installation.

At the other end of the scale are large industrial self-service water supplies - e.g. Dairy Factories, Meat Works etc, where the Capex might be $1 million or more. These installations have not been included in any of the above four categories.

Estimate of Operating Cost Increases Associated with Plants Upgraded to Proposed Drinking Water Standards

The following are estimates of the increased Opex costs, deleting interest and depreciation. Note: also excluded are costs associated with PHRMP's.

1. **Treatment Plants - Grade A**
   No increase in testing - it's already being done.
   Some increase in attention to chemical dosing; probably within the capability of existing operations. Some increased maintenance on turbidity meters, divert valves etc. Estimate 4% of capital cost.
   i.e. $0.40/person/year. The WINZ database suggests that there are 1.75 million people in this category, therefore estimated Opex increase $700,000/year.

2. **Over 50,000 People - Grade B**
   These supplies are generally artesian or "secure" groundwater supplies distributed without disinfection. The current grading system restricts such plants to Grade B as highest. It is unlikely that communities served by those plants will wish to change. If such a situation is accepted then the costs in **1.** above would apply. If it became necessary to disinfect such supplies it might involve an Opex cost increase of approx $1.00 /person/year. The WINZ database suggests 570,000 people in this category.
   Estimated increase in Opex cost $800,000/year.

3. **Less Than 50,000 People - Grade B & Any Plants Graded C or D**
   The Capex proposal for these plants is to install U/V systems. Such equipment will involve increased operational costs as far as the U/V plant is concerned. However, the relaxed requirement for turbidity, (0.5 NTU to 1.0 NTU) will allow a reduction in treatment costs for the existing plant. The operational costs, electricity, new lamps, U/V dose equipment, calibration etc is probably fairly linear compared to output at approx $1.30/person/year.

   Since this group is presently unlikely to be testing to the level required by DWSNZ2000, there will be a cost increase associated with increased quality assurance. This would be likely to cost about $1.00/ person/year. This group has a population of approx 1.2 million making the estimated increase Opex cost $2.76m.

4. For Plants Graded E

The Capex proposal for these plants is to install completely new treatment plants. The increase in operational costs might vary from zero where there is a poorly performing existing plant, to near full cost of operating a satisfactory plant, where there is just a pump at present. The proposed Capex plant is fairly automatic and should be able to be operated at approx $20 / person/year.

WINZ data suggest that there is approximately 160,000 people in this category. Assuming that about half have some treatment now, the increase in Opex cost for this group is estimated at about $1.6m.

5. By Addition the estimated total increased Opex cost for groups **1.** and **4.** above is $5.86m per year.

Note: that this does not include any allowance for PHRMP related costs, and does not look at the supplies not currently registered with WINZ. A particularly important block here is the self-service "buildings" that will come within the Building Act requirements. For simple buildings where a simple double cartridge filter plus U/V will suffice, we would estimate the Opex cost per supply at $300 per year.

At the other end of the scale are large industrial self-service water supplies - e.g. Dairy Factories, Meat Works etc, where the increase in annual Opex might be $100,000 or more. These installations have not been included in any of the above four categories.