

How much of an issue is microbial contamination of our water?

What's the sources of contamination of our water?

How are we trying to keep our water safe for drinking and recreation?

One Health
AOTEAROA



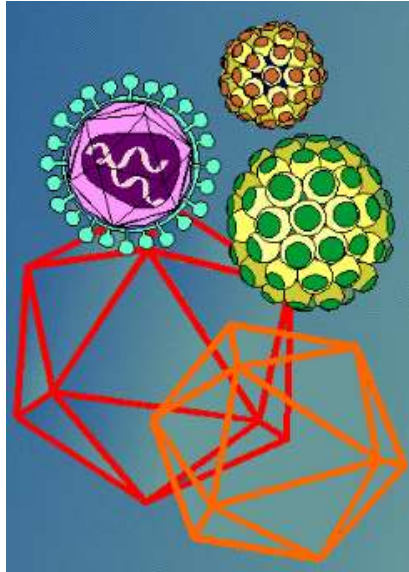
5th Symposium
WELLINGTON | 2019

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11 December 2019

Waterborne Pathogens

Viruses

- Norovirus
- Enteroviruses
 - Polioviruses,
 - Echoviruses
 - Coxsackieviruses A & B
- Hepatitis A & E Viruses
- Adenoviruses
- Reoviruses
- Rotaviruses
- Caliciviruses
- Astroviruses
- Picornavirus/parvoviruses
- Coronaviruses

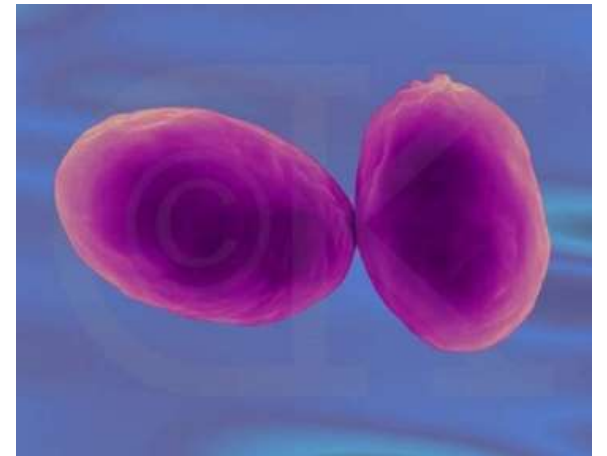


Bacteria

- Salmonellae
- Shigella spp.
- Campylobacter spp.
- Yersinia enterocolytica
- Escherichia coli
- Vibrio cholerae
- Aeromonas spp.
- Helicobacter pylori
- Legionellosis
- Leptospirosis

Protozoa

- Giardia intestinalis
- Cryptosporidium parvum
- Entamoeba histolytica
- Toxoplasma gondii
- Microsporidia
- Naegleria fowleri



**HOW MUCH OF AN ISSUE IS MICROBIAL
CONTAMINATION OF OUR WATER?**

Recreational Water and Infection: A Review of Recent Findings

Lorna Fewtrell • David Kay

Study	Area	Water type	Participants	Risk of GI illness (95% CI)
Dorevitch (CHEERS)	Chicago	Freshwater	10,747	1.46 (1.08-1.96)
Marion	Ohio	Freshwater	965	3.2 (1.1-9.0)
Arnold	California	Marine	5,454	1.9 (1.17-3.06)
Colford	California	Marine	9,525	1.38 (1.03-1.86)
Papastergiou	Greece	Marine	4,367	3.6 (1.28-10.13)
Harder-Lauridsen	Copenhagen	Marine	838	5.0 (4.0-6.39)
Wade (NEEAR)	USA	Marine	6,331	2.56 (1.29-5.11)

2012 Hampton Court Swim

2.25 miles river swim in Thames River

Hampton Court Bridge downstream to Kingston Bridge

1,100 swimmers

1 hospitalised

Facebook page 40 swimmers reported illness

636 valid surveys, 338 illness

Attack rate >31%

Sewage overflow?

Gastrointestinal virus?

HALL, V., TAYE, A., WALSH, B., MAGUIRE, H., DAVE, J., WRIGHT, A., . . . CROOK, P. (2017). A large outbreak of gastrointestinal illness at an open-water swimming event in the River Thames, London. *Epidemiology and Infection*, 145(6), 1246-1255.



RESEARCH

Open Access



Estimate of incidence and cost of recreational waterborne illness on United States surface waters

Stephanie DeFlorio-Barker^{1*}, Coady Wing², Rachael M. Jones¹ and Samuel Dorevitch^{1,3}

	USA
Population	329,245,000
Recreation Events	4 billion
Annual illness	90 million
Costs	US\$3 billion

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Estimate of incidence and cost of recreational waterborne illness on United States surface waters

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	USA	NZ ?
Population	329,245,000	4,780,000 ?
Recreation Events	4 billion	58 million ?
Annual illness	90 million	1.3 million ?
Costs	US\$3 billion	NZ \$65 million ?

Notified Diseases in New Zealand (Selected)

Disease	2018 Cases	Rate per 100 000
Campylobacteriosis	6,957	142.4
Cryptosporidiosis	1,611	33
Giardiasis	1,585	32.4
Legionellosis	212	4.3
Leptospirosis	116	2.4
Listeriosis	30	0.6
Salmonellosis	1,100	22.5
Shigellosis	220	4.5
VTEC/STEC infection	926	19
Yersiniosis	1,208	24.7

Higher reported recreational water contact

www.surv.esr.cri.nz

Documented waterborne outbreaks in New Zealand, with probable links to drinking water, 2005–2016

Year	Incident	Causal agent	Cases	
			Confirmed	Probable
2005	Bridge Valley camp	Campylobacter	3	10
2005	Hawke's Bay school camp	Campylobacter	6	34
2005	Med student camp, Canterbury	Campylobacter	13	21
2005	Otago bowling tournament	Campylobacter	8	13
2006	Cardrona Skifield	Norovirus	218	
2006	School camp, Te Kuiti	Campylobacter	2	20
2007	School camp, Wellington	Gastro – unknown cause	96	
2007	Northland school	Gastro – viral unknown cause	17	
2008	Springston	Campylobacter	5	39
2008	South Canterbury youth camp	Campylobacter	2	13
2010	Golden Bay Holiday Park	Norovirus		
2010	Waiouru Commanders' Course	Campylobacter	1	15
2011	Runanga drinking-water supply	Campylobacter	4	
2012	Darfield drinking-water supply	Campylobacter	29	138
2012	Hawke's Bay camping ground drinking-water	Campylobacter	28	
2012	Cardrona Hotel and water supplies	Norovirus	48	5
2013	Nelson Lakes Scout camp	Gastro – unknown cause		13
2016	Havelock North	Campylobacter	967	5,500

Stomach bug lays 110 low in Darfield

CAROLINE KING AND GEORGINA STYLIANOU



Last updated 05:00 25/08/2012



0



Like



0



+1



Share

Darfield teen Chloe Walker has had a bucket by her side for a week.

The 13-year-old is among more than 110 people to have been hit with gastroenteritis, a serious stomach illness, in the Darfield area after drinking contaminated water.

Chloe's family were using boiled water after a notice was issued. A warning came after E. coli was found in some parts of the water.

However, on one occasion Chloe "forgot" to use boiled water to brush her teeth.

The next day, the Darfield High School student had a sore throat.

Then, came the onslaught of vomiting and diarrhoea.

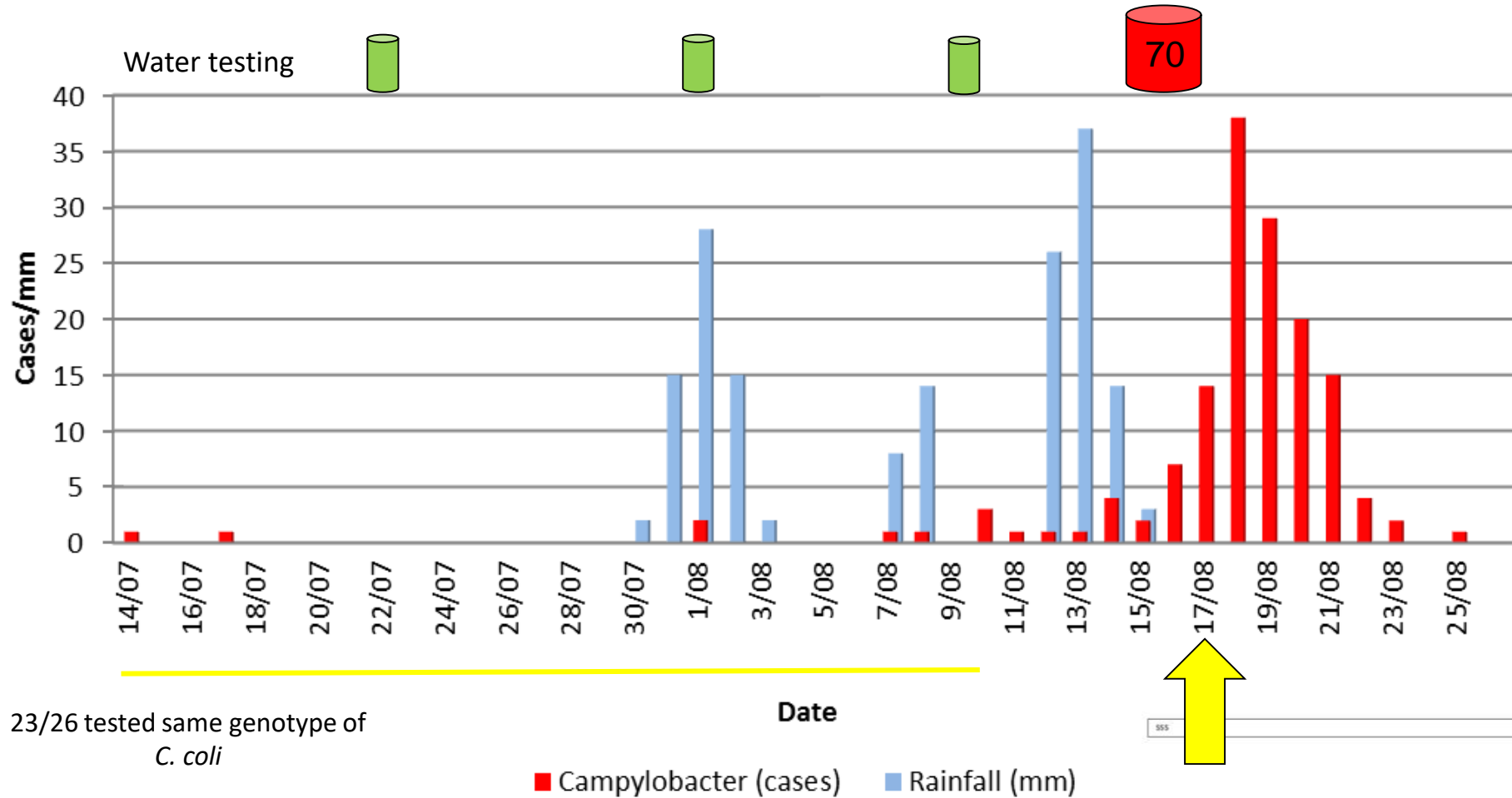
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A waterborne outbreak of campylobacteriosis in the South Island of New Zealand due to a failure to implement a multi-barrier approach

Nadia Bartholomew, Cheryl Brunton, Peter Mitchell, Judy Williamson and Brent Gilpin

Darfield 2012 outbreak



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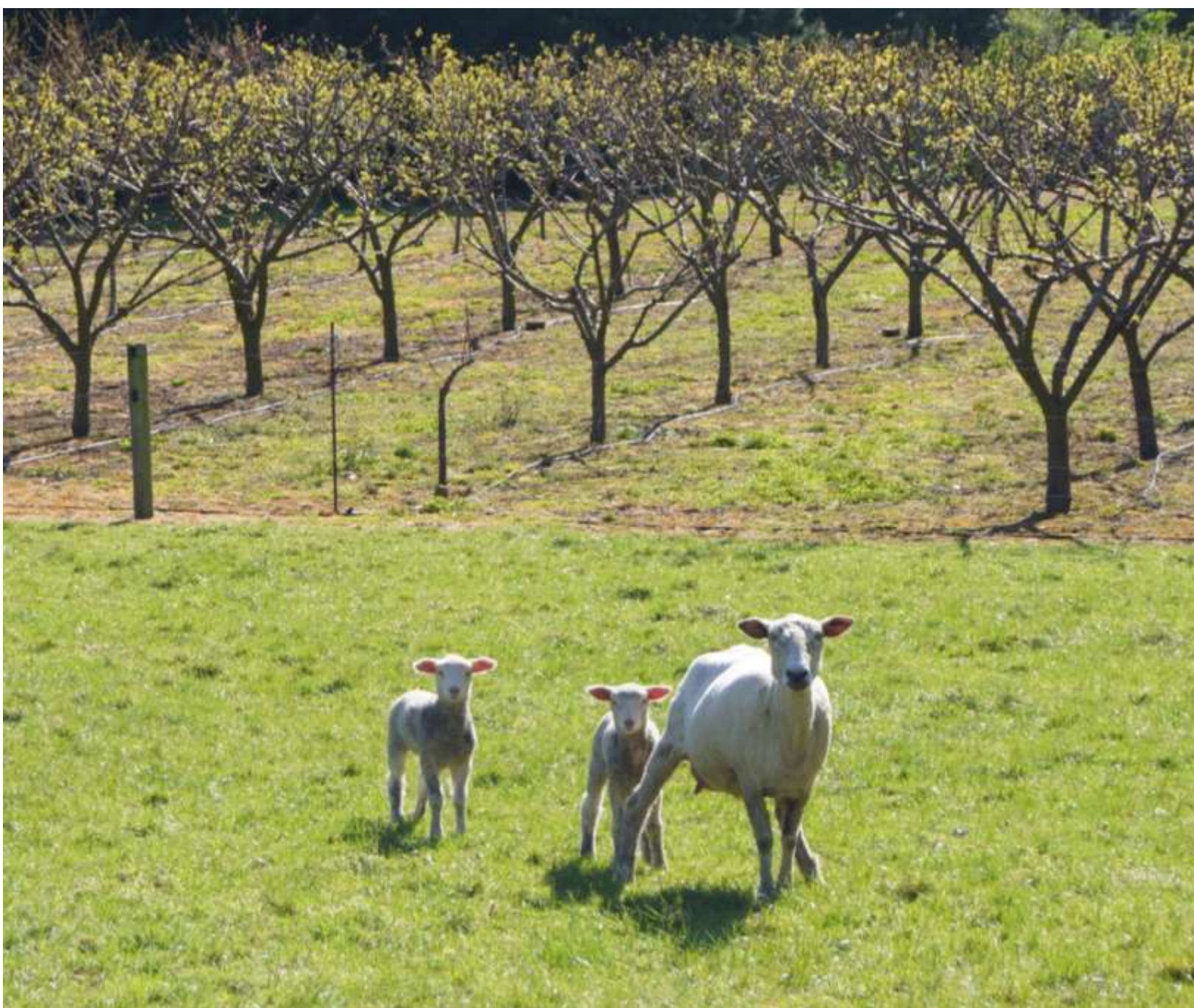
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Darfield Water Supply 2012

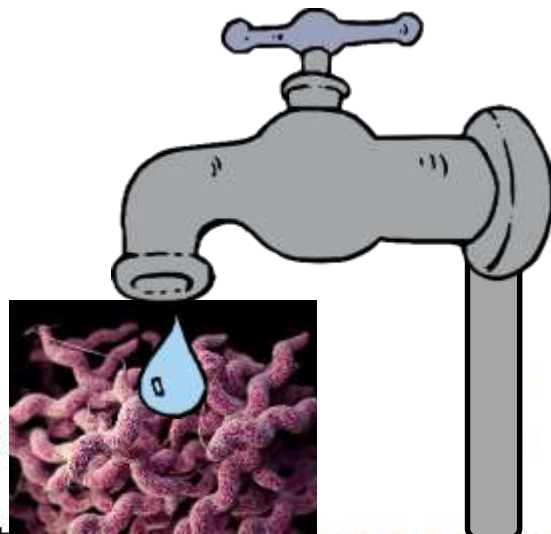
3283 population



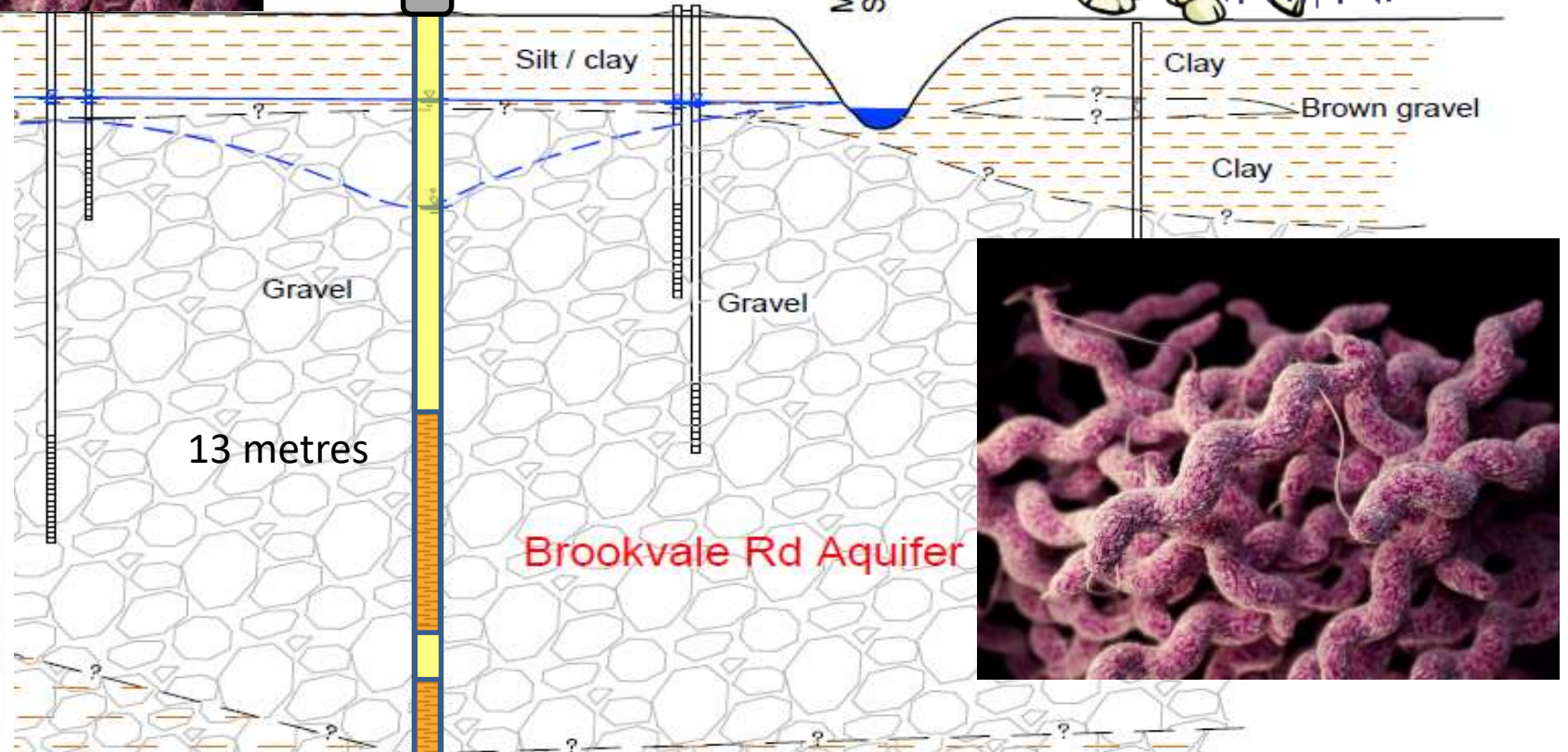


August 2016

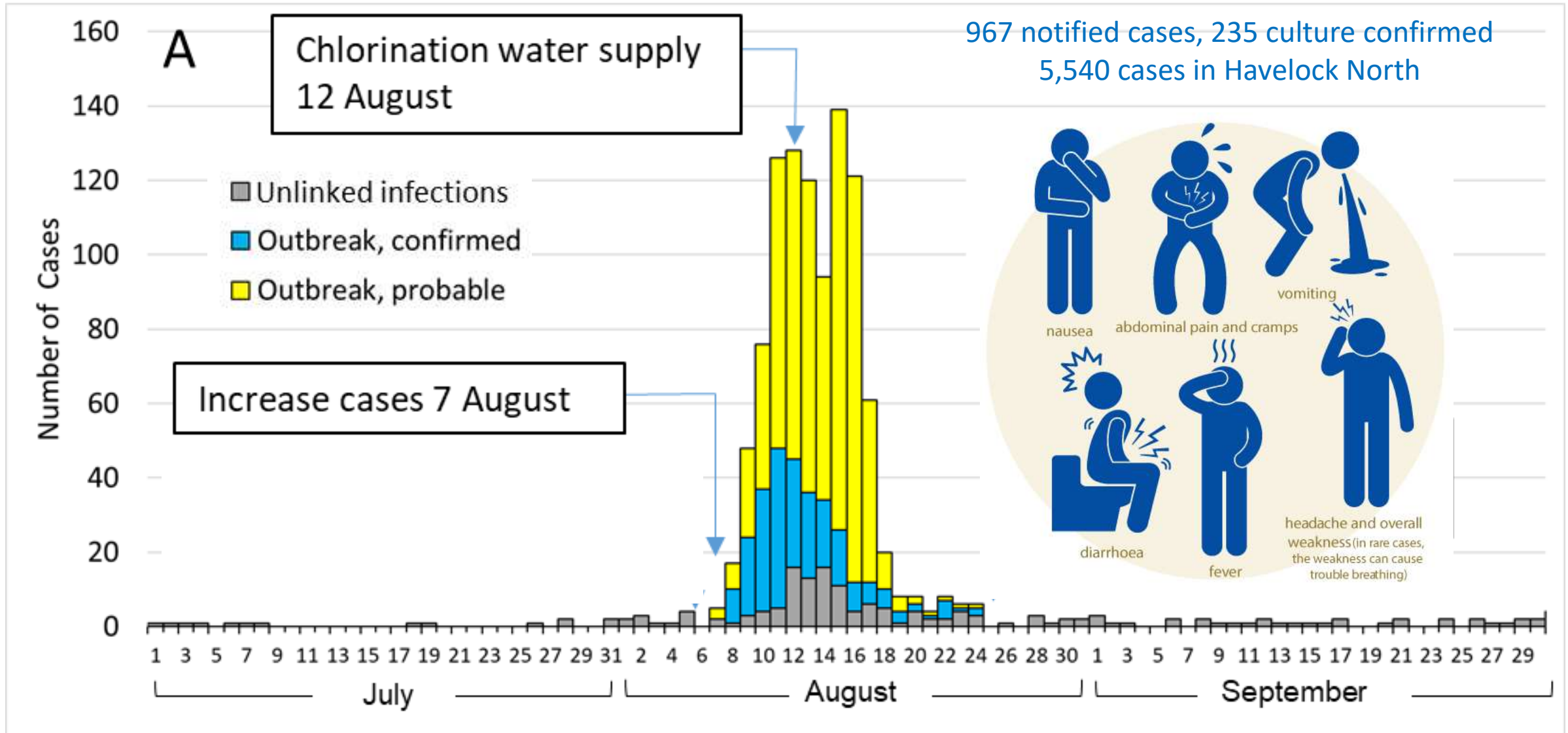




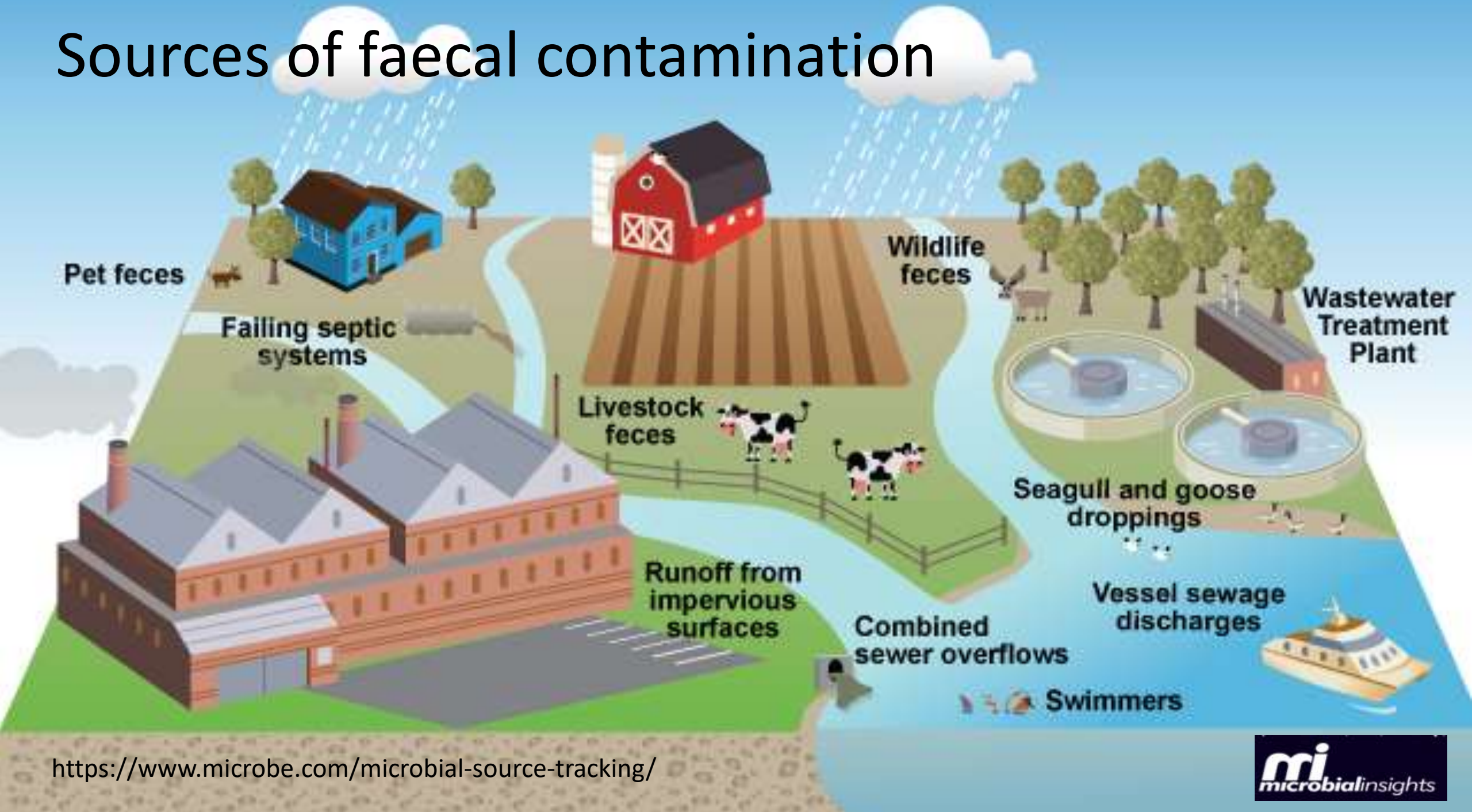
165mm (6.5 inches)
rain in 24 hours



Illness Onset of notified cases in Hawkes Bay



Sources of faecal contamination



Recreational water quality guidelines

- National survey of microbiological water quality 1998-2000
 - 725 samples, 25 sites, 10 microorganisms
- NZ guidelines based on quantitative microbial risk assessment (QMRA) for campylobacteriosis
- *E. coli* concentrations associated with *Campylobacter* infection estimated → numeric limits

<0.1% infection

1% infection

5% infection

<130 *E. coli* MPN/100 ml

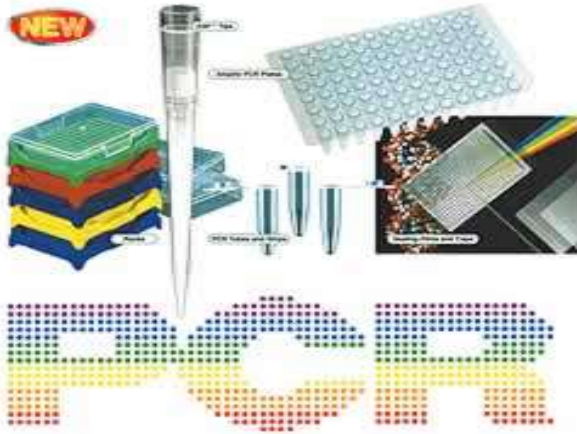
260 *E. coli* MPN/100 ml

550 *E. coli* MPN/100 ml



Faecal Source Tracking

Molecular markers



Indicative:
human,
ruminants
pigs, dog,
horses,
possum
ducks,

Concentrate water samples
100 ml



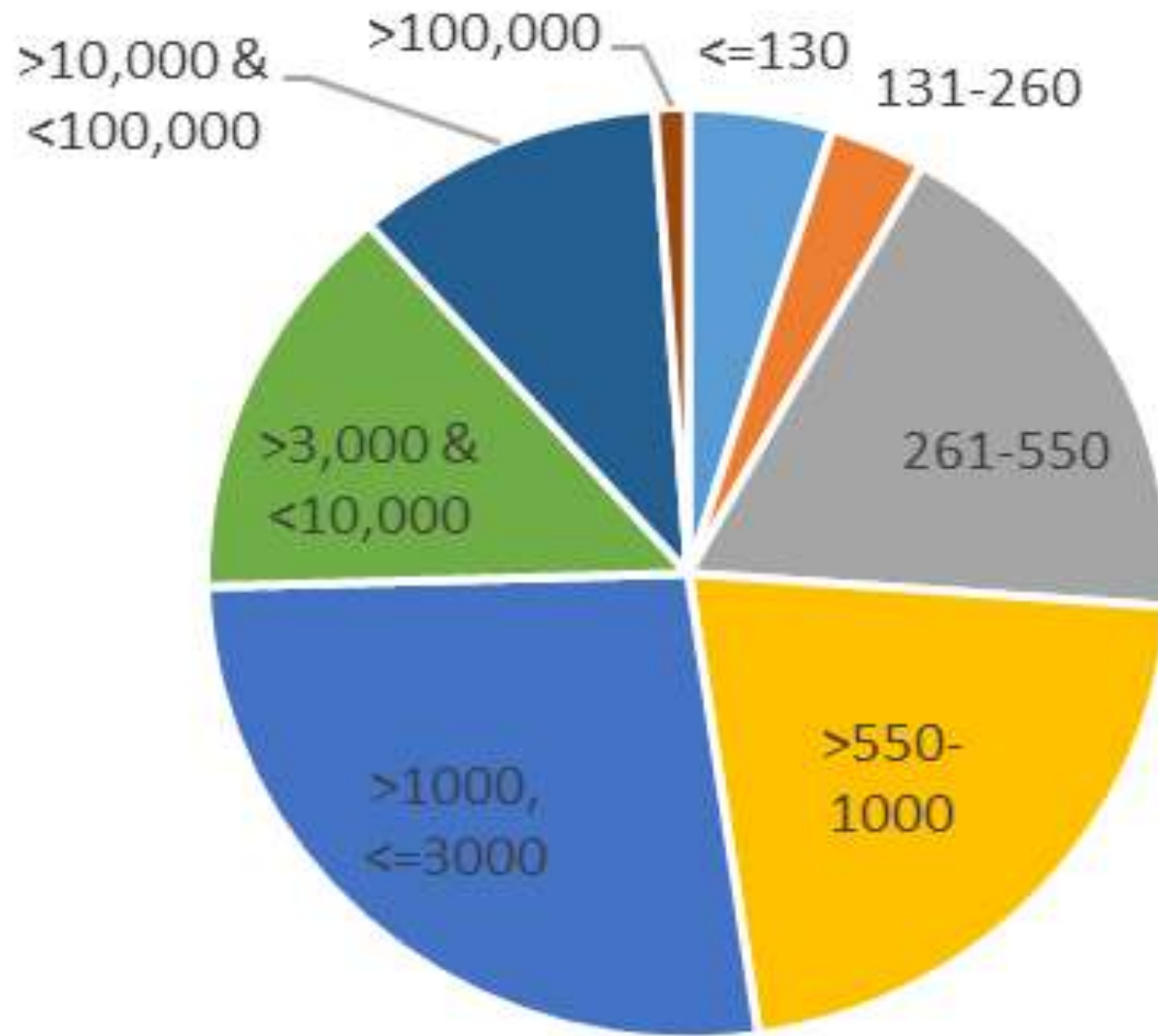
Extract total DNA



Source specific PCR
amplification(s)

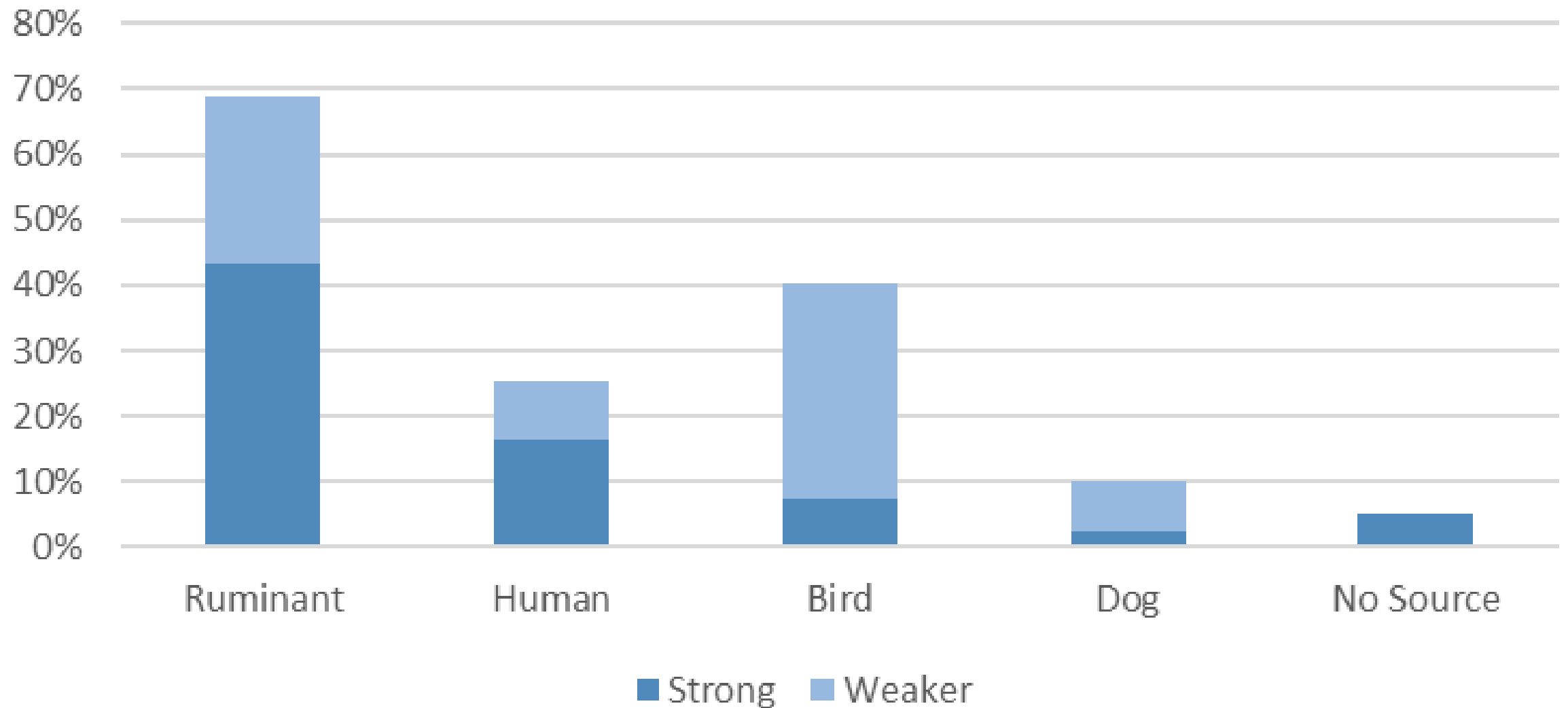


E. coli/100 ml

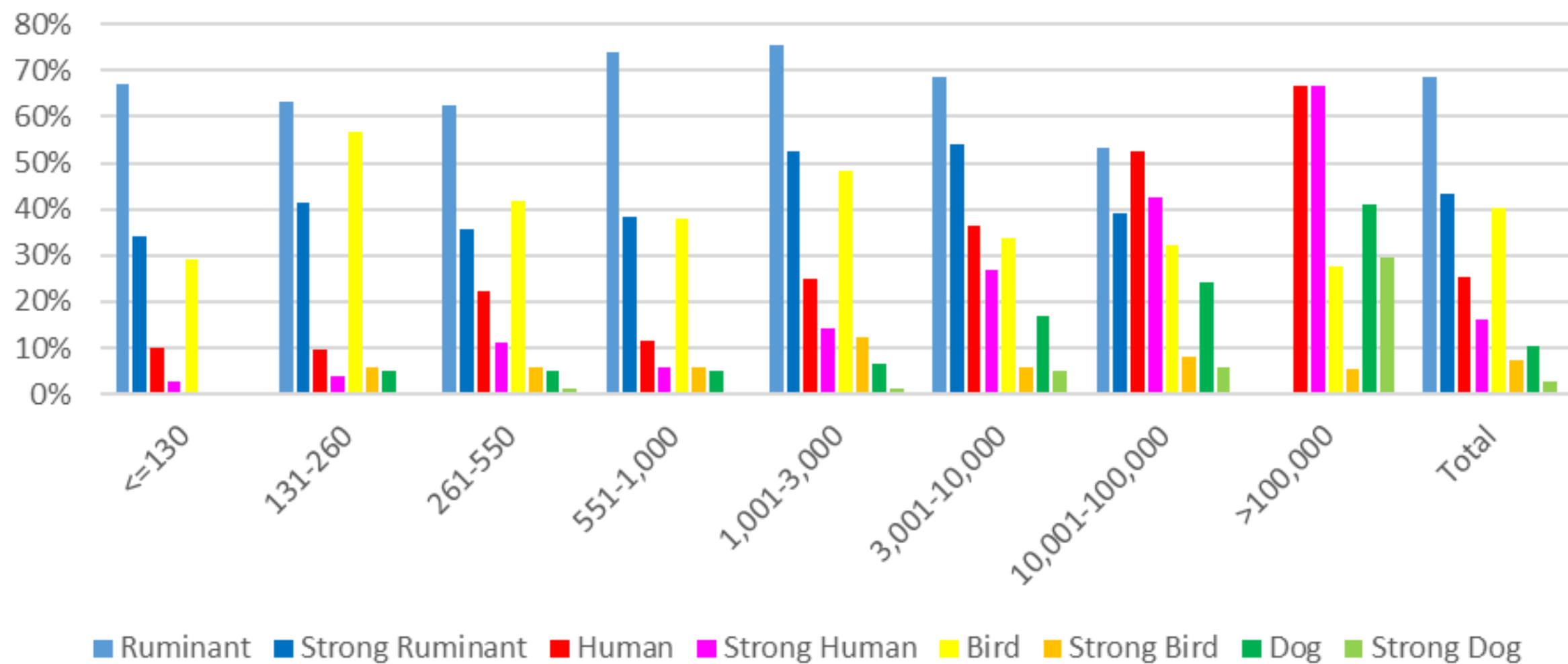


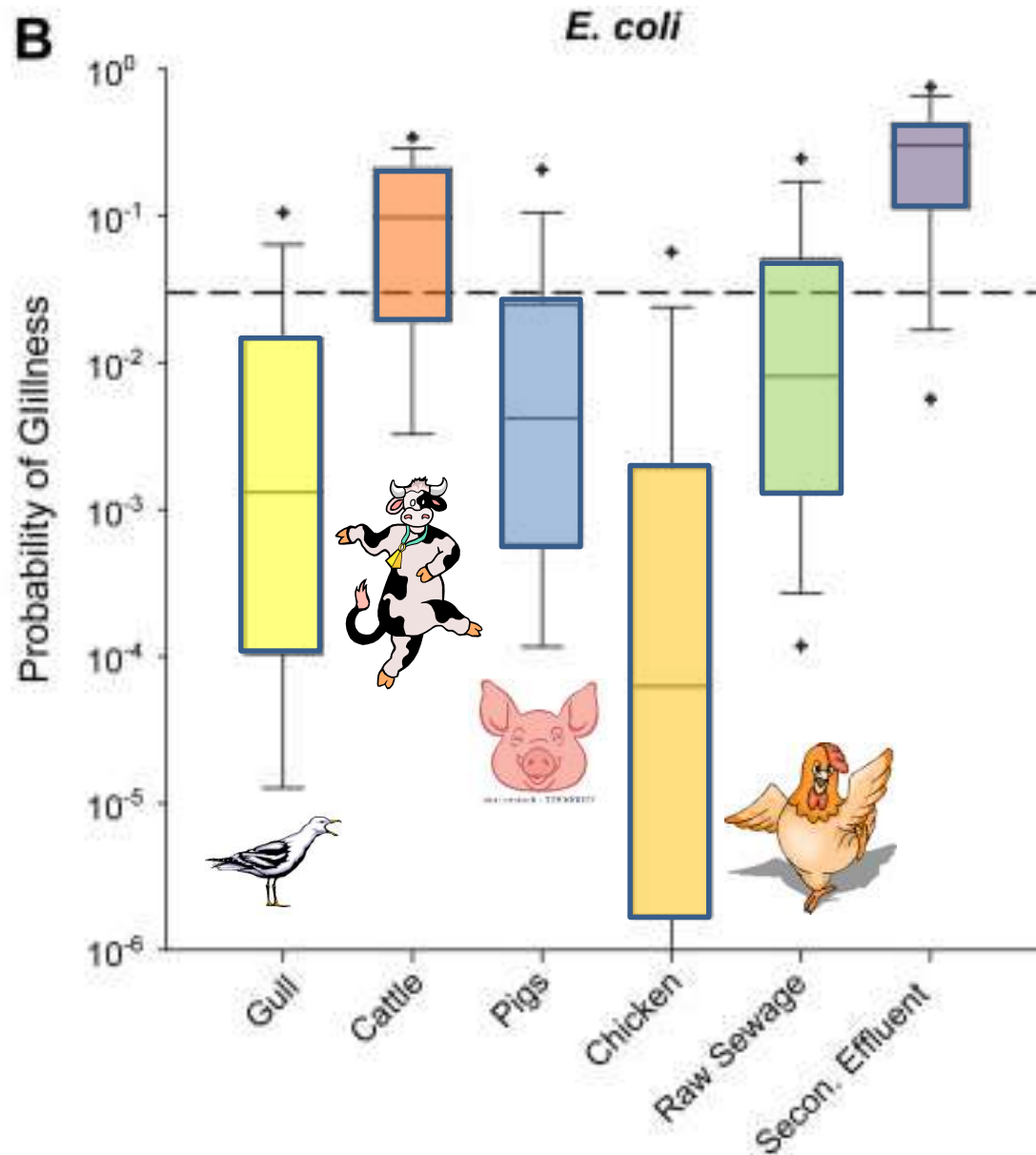
1,615
Samples
Analysed

Contamination sources identified in water samples



Percentage of samples with E. coli levels that have...





Probability of gastrointestinal illness from ingestion of water containing fresh faecal pollution at densities of and 126 cfu 100 mL⁻¹ *E. coli*

WATER RESEARCH 44 (2010) 4674–4691

Available at www.sciencedirect.com

ScienceDirect

journal homepage: www.elsevier.com/locate/watres

Estimated human health risks from exposure to recreational waters impacted by human and non-human sources of faecal contamination[☆]

Jeffrey A. Soller^{a,*}, Mary E. Schoen^b, Timothy Bartrand^c, John E. Ravenscroft^d, Nicholas J. Ashbolt^b

**WHAT ARE/CAN WE DO TO KEEP OUR WATER
SAFE?**



Mana Atua – Mana Tangata – Mana Whenua

Te Mana o te Wai

The health of our Wai: The health of our Nation

OBLIGATION

1

The first
is to the water,
to protect its health and
its mauri

2

The second
is providing for
essential human health
needs such as drinking
water

3

The third
is for other consumption
provided that such use does
not adversely impact the
mauri of freshwater

PRINCIPLES

Mana
whakahaere

Kaitiakitanga

Manaakitanga

Governance

Stewardship

Care, respect

LEADERSHIP

Iwi/Hapū/Māori Landowners/Whānau/Hapori

Crown
Central & local governance

Community

NGĀ RITENGA

Te Tiriti o
Waitangi te
tāhuhu o te
Kaupapa o te wai

Te Mana o te wai
– Te Mauri o te
wai

Te Mana
Motuhake o ia
wai o ia iwi o ia
hapū ki te wai

Te Kaitiakitanga
o ngā hapū me
ngā iwi ki te wai

Te Mana
Whakahaere o
ngā hapū me
ngā iwi ki te wai



Action for healthy waterways

- Te Mana o te Wai
- New attributes National Policy Statement (NPS)
 - Nutrients, sediments, fish/macroinvertebrates, macrophytes, Oxygen
- No more draining of wetlands, no more piping streams
- Minimum standards wastewater discharges
- All farmers need farm plan by 2025
- No new irrigation or dairy conversions
- Reduce nitrate/nitrogen levels
- 5 m fencing waterways
- Controls intensive winter grazing and feedlots.
- New freshwater QMRA

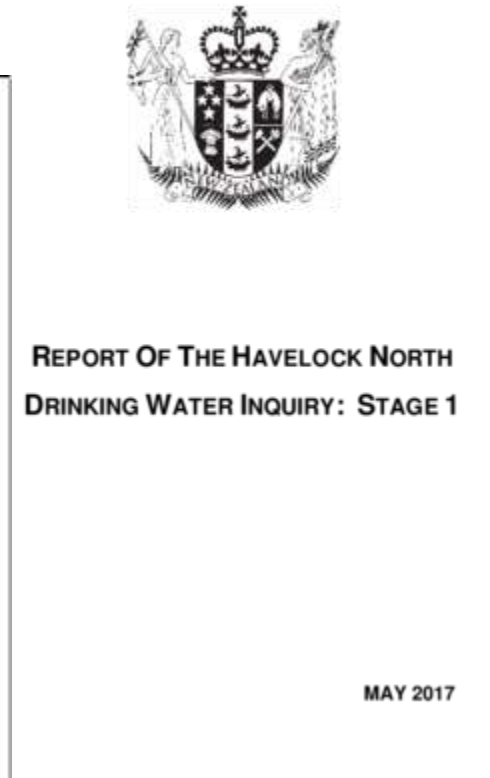
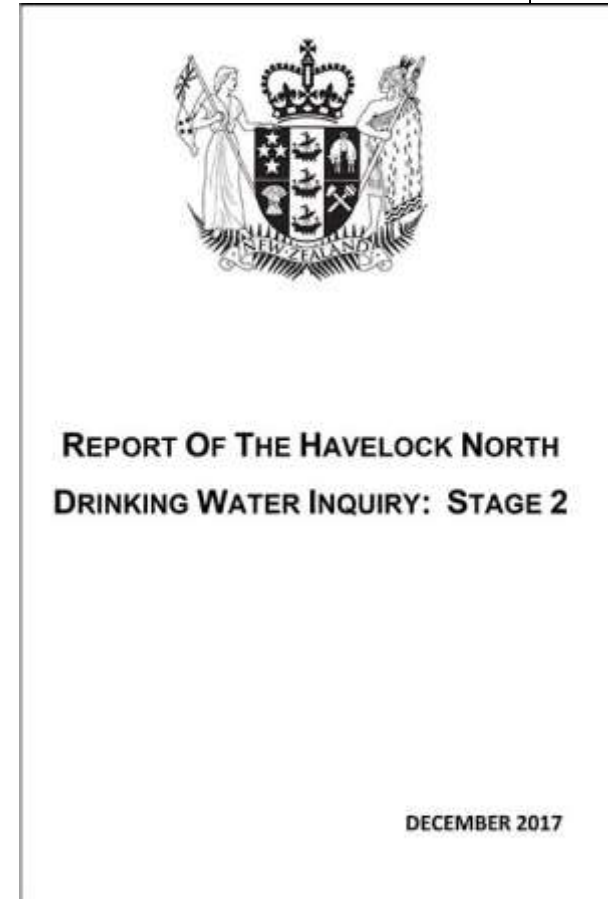


The Havelock North Water Inquiry



The Havelock North water inquiry panel Dr Karen Poutasi, left, Lyn Stevens QC and Anthony Wilson

https://www.nzherald.co.nz/the-country/news/article.cfm?c_id=16&objectid=11900132



The Havelock North Water Inquiry

Recommendations

- *Abolish the Secure Classification System*
- *Encourage Universal Treatment*
- *Establish a Drinking Water Regulator*
- *Amend RMA, Health Act, Accelerate NES Regulations Review*
- *Establish a Licensing and Qualifications System for Drinking Water Suppliers and Operators*
- *Review and Strengthen Enforcement of Water safety plans*
- *Improve the Testing and Laboratories Regime*
- *Prohibit New Below-ground Bore Heads*

Ministry of Health

- Changes to the Drinking Water Standards
 - Requirement for total coliforms in addition to *E. coli*.
 - Removal of presence/absence testing (must be quantitative)
 - Change to chlorine contact times, log credits
- Health Act 31 July 2019
 - Remove requirement to consult 3 years, gazette 2 years
 - Remove all practical steps
 - Water Safety Plans must include timetables
 - Streamline process for appointment of drinking water assessors
 - Raise public health to be equal or greater requirement than affordability

Three Waters Review (DIA)

- Improve the regulation and supply arrangements of drinking water, wastewater and stormwater
- A new regulatory framework for drinking water will include:
 - an extension of the regulatory coverage to all drinking water suppliers, except individual household self-suppliers;
 - a multi-barrier approach to drinking water safety, including mandatory disinfection of water supplies, with exemptions only in appropriate circumstances;
 - stronger obligations on water suppliers and local authorities to manage risks to sources of drinking water;
 - strengthened compliance, monitoring and enforcement of drinking water regulation.
- While regional councils will remain the primary regulators for the environment, there will be stronger central oversight of wastewater and stormwater regulation, including:
 - requirements for wastewater and stormwater operators to report annually on a set of national environmental performance measures;
 - national good practice guidelines for the design and management of wastewater and stormwater networks; and
 - monitoring of emerging contaminants in wastewater and stormwater, and coordinating national responses where necessary.
- New drinking water regulator

OneHealth Opportunities...

- Ongoing Research Need
 - Evidence base for policy and ongoing evaluation of effectiveness
 - Understand sources and transmission pathway of micro-organisms
 - Transition to *E. coli* PLUS
- Document and investigate disease incidence
 - Learn (and relearn) how contamination occurs
 - Raise awareness to ensure importance is recognised
- Recognise and respond to change

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- **Hawkes Bay DHB:** Nicholas Jones, Rachel Eyre and team
- **Hawkes Bay Regional Council, Hastings District Council, Tonkin & Taylor**

ESR Water & Wastewater Science & Research



Thankyou

Outbreaks due to contamination surface water sources

Year of Outbreak	Location	Pathogens	Cases Confirmed	Total Cases Estimated	Comments
2001	North Battleford, SK, Canada	<i>Cryptosporidium parvum</i> type 1	375	5,800–7,100 50 hospitalised	Sewage discharges upstream drinking water intake
2010	Östersund, Sweden	<i>Cryptosporidium</i>	>29	27,000 270 hospitalised	
2011	Sweden	<i>Cryptosporidium hominis</i>		18,500	
2002	Spain	<i>Shigella sonnei</i>	181	756	Heavy rainfall
2004	Norway	<i>Giardia</i>	1,300	4,000-6,000	Lake
2008	Sweden	<i>Norovirus</i>	33	2,400	Heavy rainfall
2013	Oregon, USA	<i>Cryptosporidium</i>	23	2,780	Heavy rainfall

S. E. Hrudey, E. J. Hrudey; Common themes contributing to recent drinking water disease outbreaks in affluent nations. *Water Supply* 1 September 2019; 19 (6): 1767–1777.

Treatment Failures

Outbreaks due to contamination ground water sources

Year	Location	Pathogens	Cases Confirmed	Total Cases Estimated	Comments
2000	Walkerton, ON, Canada	<i>Escherichia coli</i> O157:H7, <i>Campylobacter</i>	163 (E) 105 (C) 12 both	2,300 27 HUS 7 deaths	Cattle manure Rainfall Treatment failure
2000–01	Asikkala, Finland	<i>Campylobacter jejuni</i>	71	1450	Rainfall No treatment
2002	Transtrand, Sweden	Norovirus	4	~500	Leaking sewer pipe No treatment
2009	Tune, Denmark	<i>Campylobacter jejuni</i>		~770	Heavy rainfall
2010	Koge, Denmark	<i>Campylobacter jejuni</i>	61	~400	Heavy rainfall

S. E. Hrudey, E. J. Hrudey; Common themes contributing to recent drinking water disease outbreaks in affluent nations. *Water Supply* 1 September 2019; 19 (6): 1767–1777.

Outbreaks due to contamination in reticulation

Year	Location	Pathogens	Cases Confirmed	Cases Estimated	Comments
2007	Nokia, Finland	<i>Campylobacter</i> spp., Norovirus, <i>Giardia</i> , <i>Salmonella</i> spp. <i>Clostridium difficile</i> , Rotavirus	2 deaths	6,500	cross-connection at sewage treatment plant
2008	Alamosa, CO, USA	<i>Salmonella</i>	124 1 death	1300 20 hospital	vermin contamination of water storage tank
2008	Adliswil, Switzerland	pathogens not identified	-	180	cross-connection at sewage treatment plant
2008	Northampton, England	<i>Cryptosporidium cuniculus</i>	22	422	Rabbit in backwash tank
2010	Saratoga Springs, USA	<i>Campylobacter</i>	17	>333	

S. E. Hrudey, E. J. Hrudey; Common themes contributing to recent drinking water disease outbreaks in affluent nations. *Water Supply* 1 September 2019; 19 (6): 1767–1777.