Getting the water quality outcomes we want

Drinking water and health outcomes

water NEW ZEALAND
The New Zealand Water & Wastes Association Waiora Aotearoa
A consistent approach across the 3 waters sector

Jim Graham
Principal Adviser Water Quality
Water New Zealand

How much?

Infective dose 500?, 50?, 10?

50 x 5500 = 275,000 bacteria

1% of water consumed as drinking water …. x 100 =
27,500,000
That's 27.5 million bacteria

500,000 campylobacter organisms per gram or sheep faeces

So 55 grams of faeces or 11 teaspoons of faeces

How much?

One cow produces as much faeces as 16 people

One sheep produces as much faeces as 10 people

6,700,000 dairy cows in NZ
3,700,000 beef cattle in NZ
29,800,000 sheep in NZ

Equivalent to	107,200,000
	59,200,000
	298,000,000
	464,400,000 people

Another way to look at it

Cattle: Number of defecations

- 9 – 16, average 12 per day
- Average 2kg per defecation
- Total output of 25kg per cow per day

9 million cattle in NZ

230,000 tonnes faecal material per day…

84 million tonnes per year

Why is it important?

UN Sustainable Development Goal 6:

Ensure access to water and sanitation for all

Reducing open defecation

But is it the same?
and
Does it make people sick?

Disease Burden

"… Ministry of Health in 2007… estimated the overall burden of sporadic or underlying drinking water-borne gastrointestinal disease at 18,000 to 34,000 cases per year."

"In 2010, the Law and Economics Consulting Group… estimated there were 35,000 cases of acute gastrointestinal illness contracted from reticulated drinking water per year."

"The Inquiry heard evidence that a figure of 100,000 cases plus per year was more likely to be accurate…"

Three broad categories of contaminates

Microbiological contaminants

Chemical contaminants

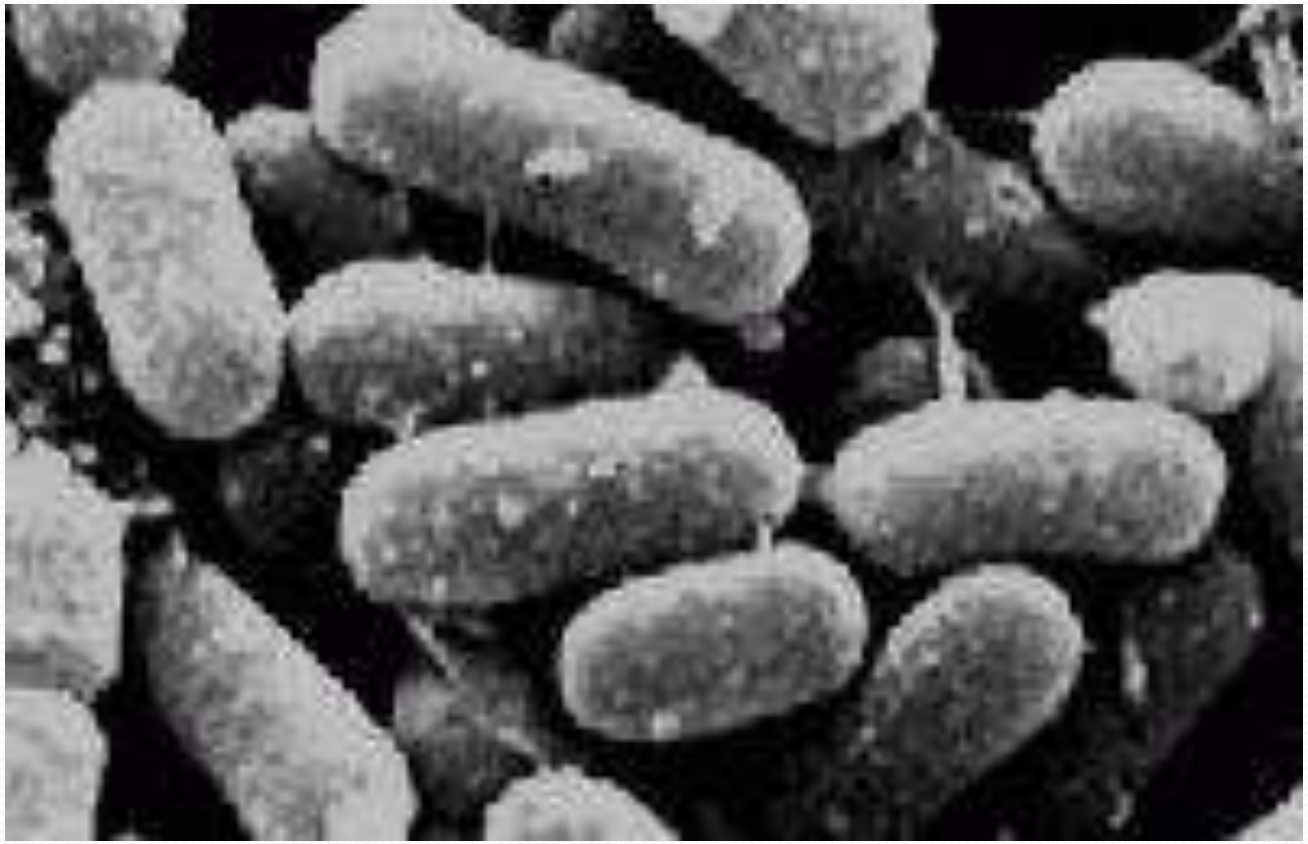
Physical contaminants

Four broad groups of microbiological contaminates

Bacteria
Viruses
Protozoa
Cyanobacteria

Gastro-enteric illness

Bacteria



- Small single celled organisms.
- Reproduce by binary fission
- Exponentially growth
- Some can be pathogens
- Animal or human faecal source.
- Usually cause an enteric disease.
- typhoid (*Salmonella typhi*)
- cholera (*vibrio cholera*)
- salmonella (various species)
- Campylobacter (*Campylobacter jejuni*)

- Bacteria are killed by chlorine, inactivated by UV and can be removed by some types of filter.

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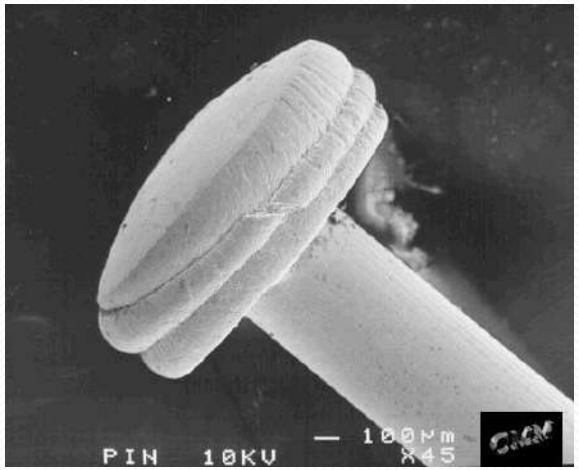
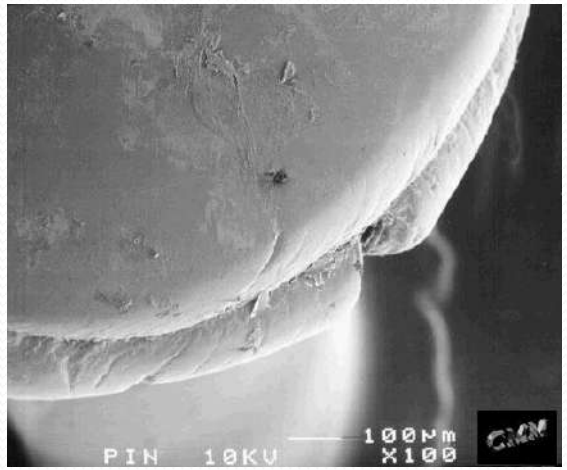
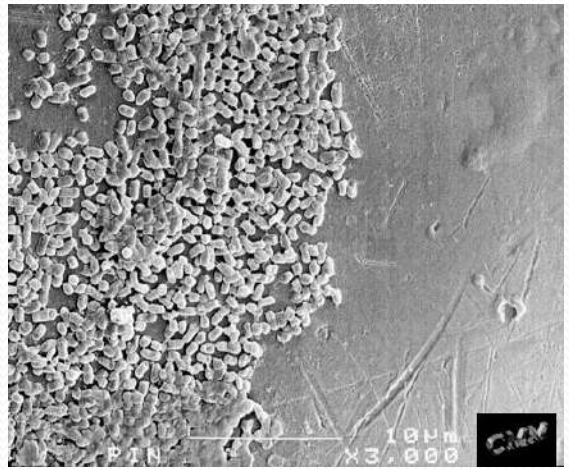
How large are bacteria?



Enlarged 45 times



100 times



3000 times

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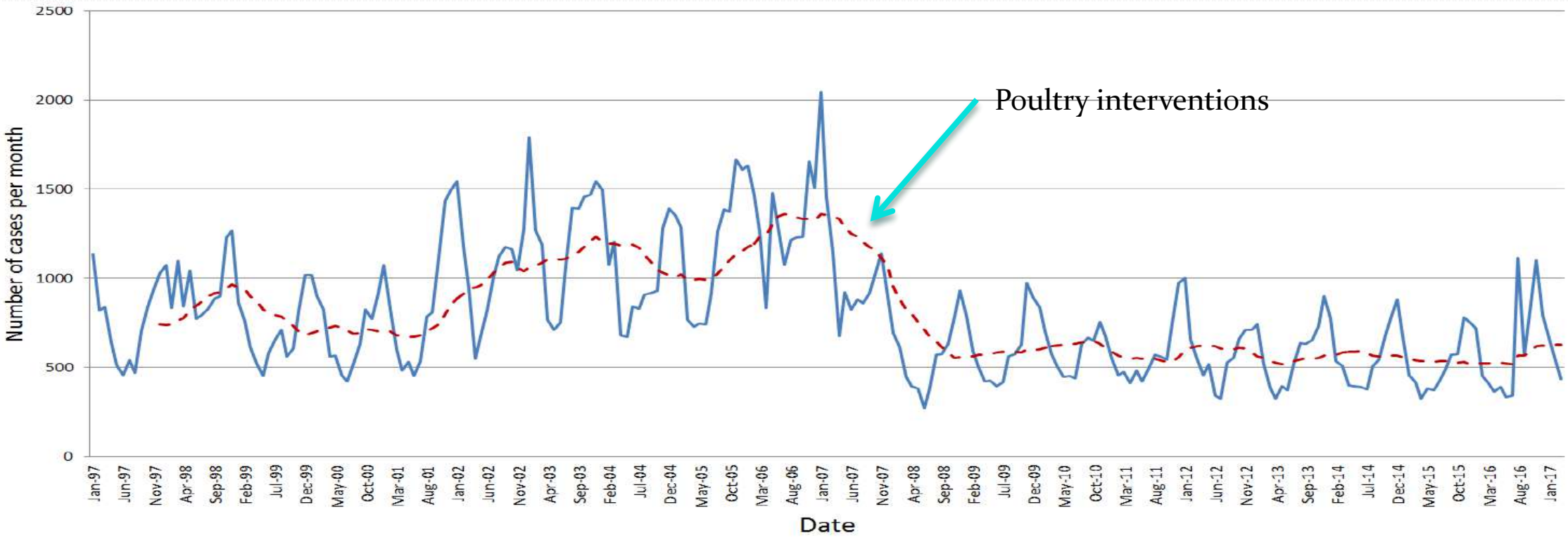
Campylobacteriosis cases



50% decline in notifications and hospitalisations. Estimated $50-$70M saving per annum

NZ drinking water outbreaks: Campylobacter

1986 - Ashburton, 19 cases in two weeks attributed to poorly chlorinated drinking water drawn from river

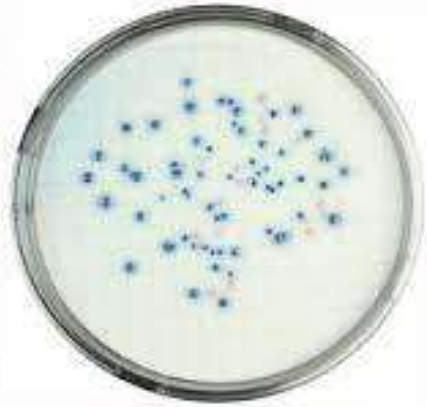
1990 – 44 cases linked to livestock contaminating camp water supply

1997 – 67 cases linked to drinking water contaminated with river water

2008 – Pahiatua, Manawatu 9 cases linked to rainfall and river flow

2012 – Darfield incident 110 cases

2016 – Havelock North 5500 cases



E. coli bacteria?

- *Escherichia coli* or *E. coli*
- found in enormous numbers in the gut of mammals.
- *E. coli* are used as an indicator of faecal contamination of water.
- an **indicator organism**.
- testing for *E. coli* to demonstrate DWS compliance.

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E. coli 0157:H7

- Produces a toxin which can cause kidney damage
- Was responsible for 7 deaths when the water supply at Walkerton, Ontario was contaminated in 2000

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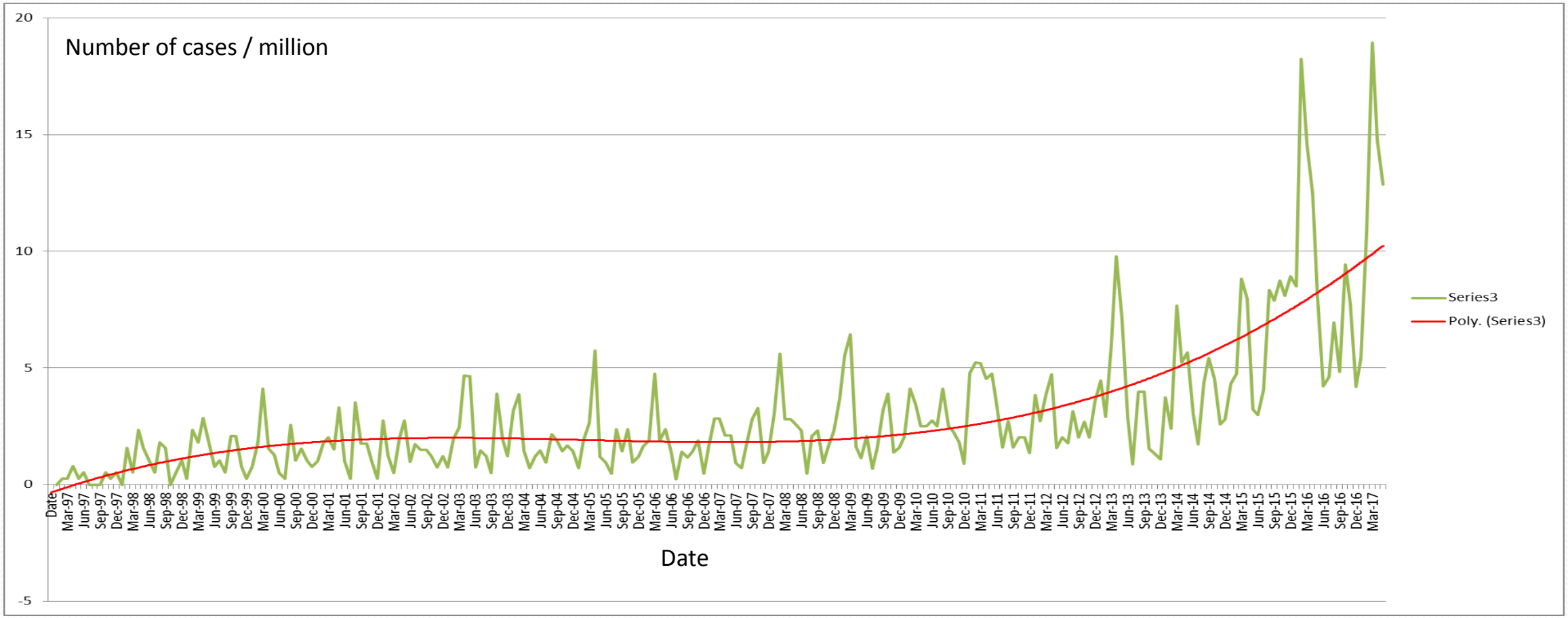
E. coli 0157 reported cases in New Zealand

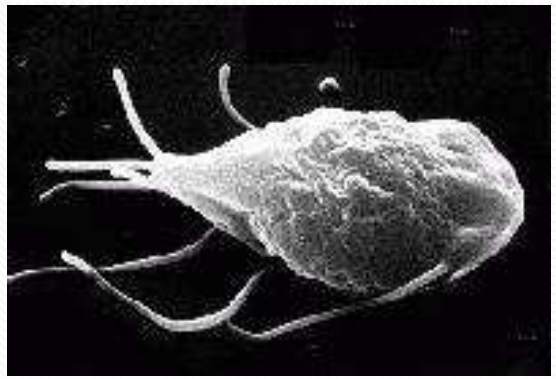


First case in 1993

Rate in 2014 = 2.3 x rate in 2004

Protozoa

- In the environment they form a cyst or oocyst.
- Associated with cattle
- Very resistant to chlorine.
- Inactivated by UV
- Removed by filtration (with a coagulant)
- No medical treatment for Cryptosporidiosis



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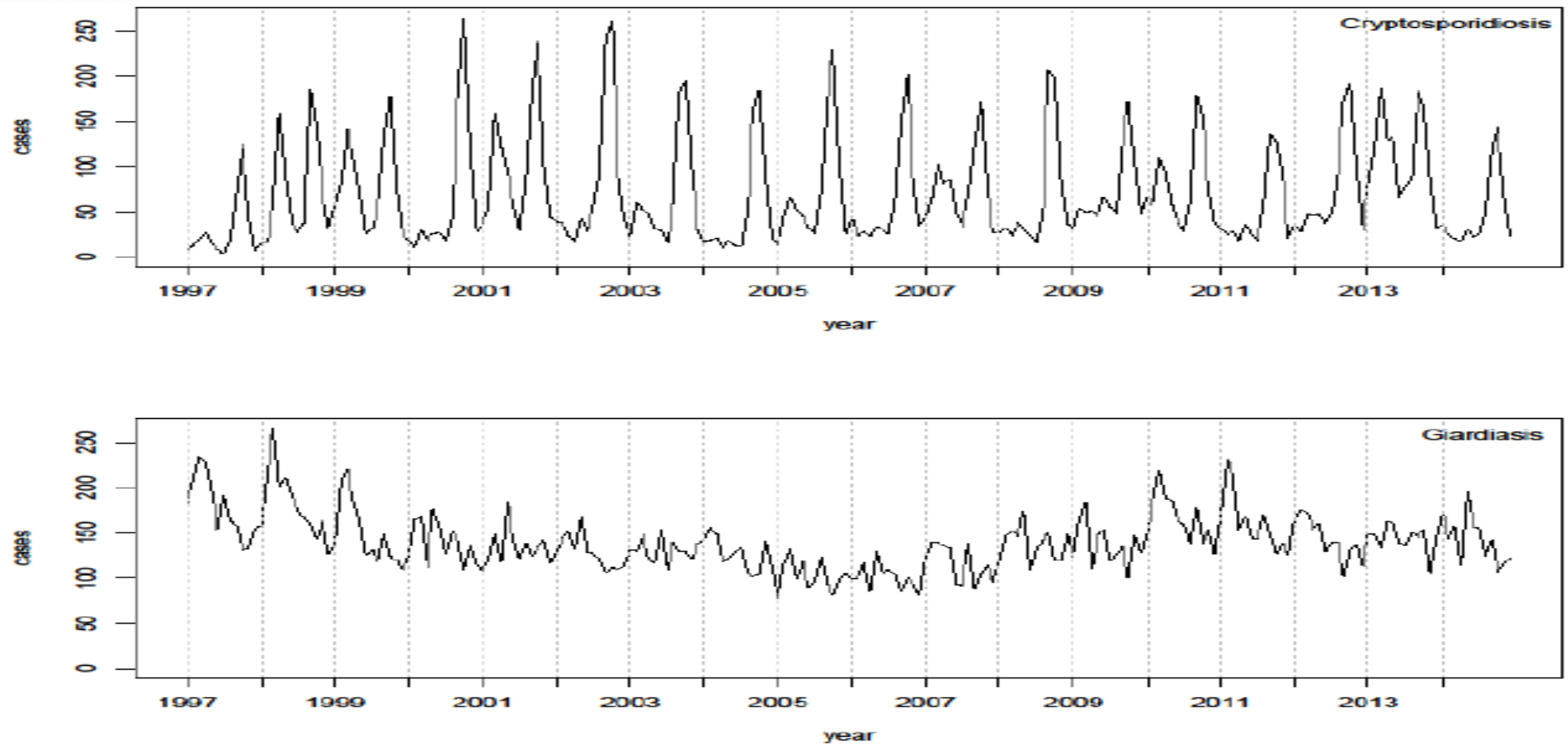
Cryptosporidium and Giardia illness rates

	Cryptosporidiosis	Giardiasis
Country	Rate /1000 people	Rate/1000 people
New Zealand	23.8	32.9
Australia	15.8	N/A
United Kingdom	8.5	5.5
United States	2.8	6.7
Germany	1.6	5.5

Cryptosporidium and Giardia seasonal patterns



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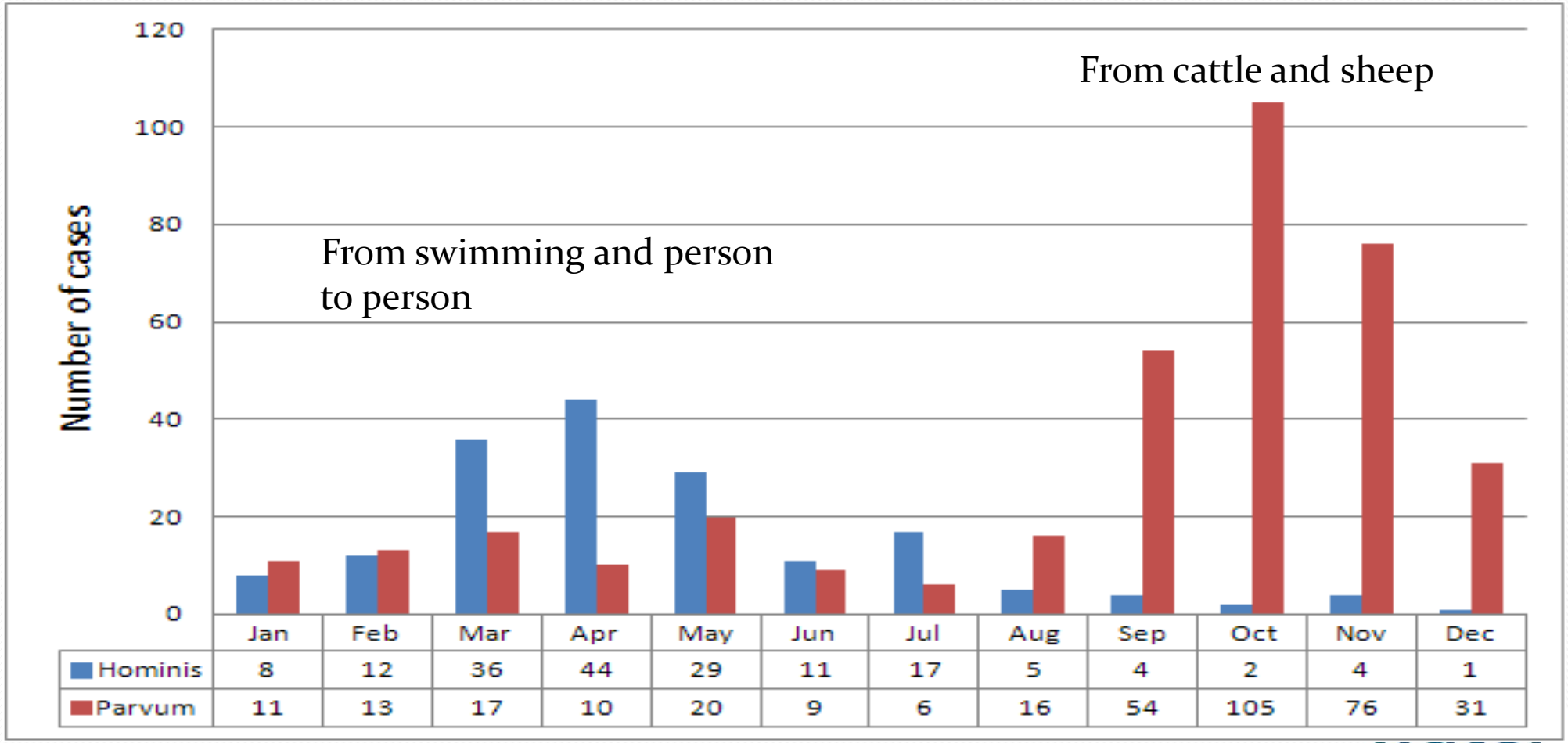
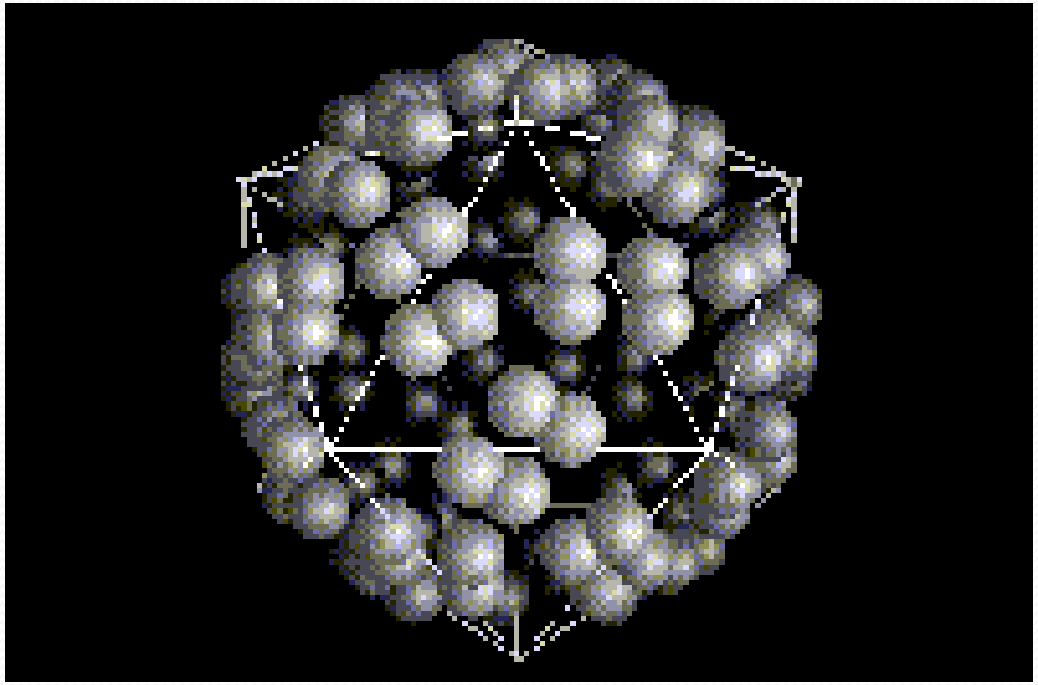
Cryptosporidium and Giardia seasonal patterns



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Hominis	8	12	36	44	29	11	17	5	4	2	4	1
Parvum	11	13	17	10	20	9	6	16	54	105	76	31

Viruses



- Smaller than bacteria
- Are not living organisms
- Use a living cell to reproduce
- Hepatitis A
- Viruses are thought to be killed by chlorine
- But many are not controlled by UV
- Can survive for long periods in ground water

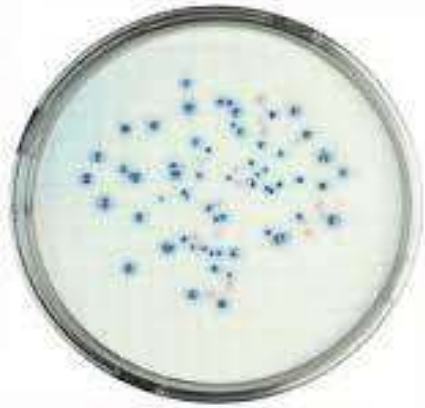
But is it the same?

Cattle, cows and sheep equivalent to **464,400,000 people** *or* **230,000 tonnes** faecal material per day

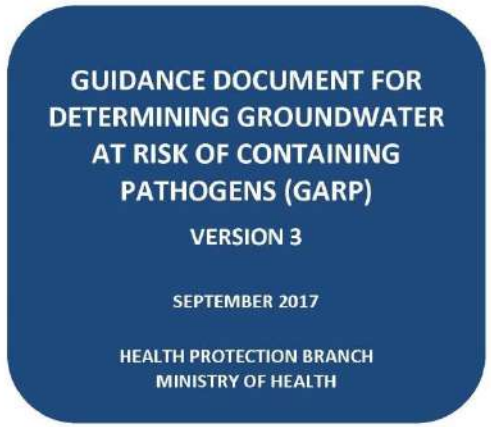
Source	Contaminants
Humans	bacteria, protozoa , viruses
Cattle, cows, sheep	bacteria, protozoa

Micro-organism	Disinfectant
Bacteria	UV, chlorine
Protozoa	UV
Viruses	chlorine

E. coli: What does/doesn't it tell us?



GARP



BRITISH COLUMBIA

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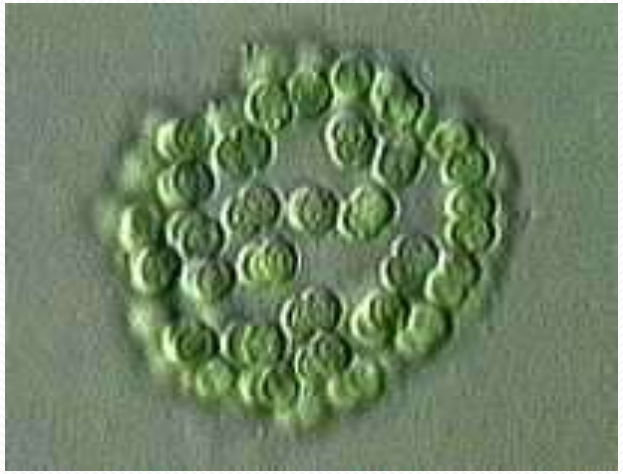
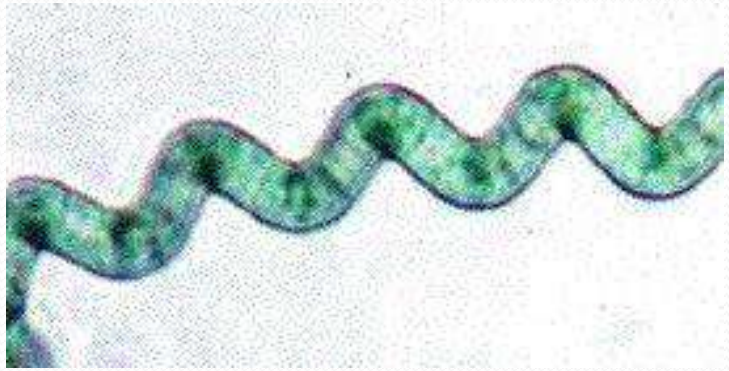
Cyanobacteria





- Emerging problem for drinking-water supplies.
- A kind of cross between bacteria and algae
- Blooms in a water column
- Mats on stones.
- Many different types.
- Some produce toxins and others do not.
- Release cyanotoxins when cells disrupted.
- Affect nervous system , the liver, or skin.

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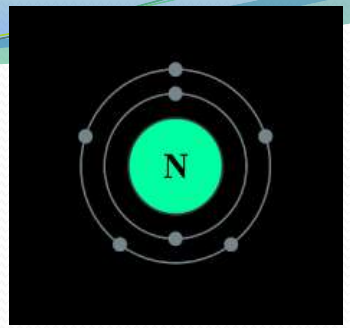
Nitrogen



Nitrogen is very soluble and flows in water easily over land or through soil.

Nitrogen comes mostly from fertiliser applied to the land and urine patches from cows

Nitrogen effects

Nitrogen and phosphorus promote plant growth which can result in eutrophication (and promotes cyanobacteria growth)

Nitrogen (as nitrate) is very toxic to fish and other aquatic organisms and to people

Blue baby syndrome

- Nitrate is biologically inert
- Microflora in the gut of infants converts nitrate to nitrite
- Nitrite then converts haemoglobin to methaemoglobin
- Methaemoglobin blocks the uptake of oxygen by the blood

Contaminants of emerging concern
Endocrine disruptors

Where do we find endocrine disruptors?

Naturally occurring or man-made substances that mimic or interfere with the function of hormones in the body

- Arsenic
- Triclosan (antibacterial used in soaps and toothpaste)
- Agrichemicals
- Industrial polymers
- Preservatives in cosmetics
- Ingredients in sunscreen
- Contraceptive pills
- Plastic bottles

Why are they important?

Virtually all body functions are initiated, controlled or regulated by hormones, including:

- Metabolism
- Growth
- Reproduction
- Sleep
- Mood

Hormones are produced by the endocrine system

Why are they important?

- Have an effect at very low doses
- Have a wide range of effects
- Persistent effects sometimes observed long after exposure
- Ubiquity of presence
- Growing use of hormonally active pharmaceuticals
- Endocrine disruptors may affect DNA

What effective can they have?

Endocrine disruptors have been associated with many health effects:

- Immune effects
- Metabolic process effects
- Brain development
- Behaviour
- Abnormalities of the reproductive system
- Disorders of fertility and reproductive systems
- Endometrioses
- Eg control of glucose homeostasis can impact diabetes, obesity, and cardiovascular disease

Where have we seen effects?

Sensitive organisms like frogs growing extra legs and changing gender

Possible endocrine sensitive human health outcomes

- Breast and prostrate cancer increases
- 4x increase in ectopic pregnancies in US between 1970 – 1987
- Doubling of cases of cryptorchidism in UK between 1960 – 1985
- 42% decrease in sperm count world wide between 1940 - 1990

What is the significance of drinking water as a pathway?

Take home messages

- Water-borne pathogens are highly prevalent in livestock in New Zealand
- Surface waters are frequently contaminated with animal and bird associated pathogens
- The quantity of animal faeces required to make large numbers of people ill is very, very small
- There is a clear link between human and animal faeces and human illness with water as the pathway
- There are a number of emerging water related contaminants that are becoming more significant to drinking water supply