Multi-barrier approach and Havelock North in August 2016

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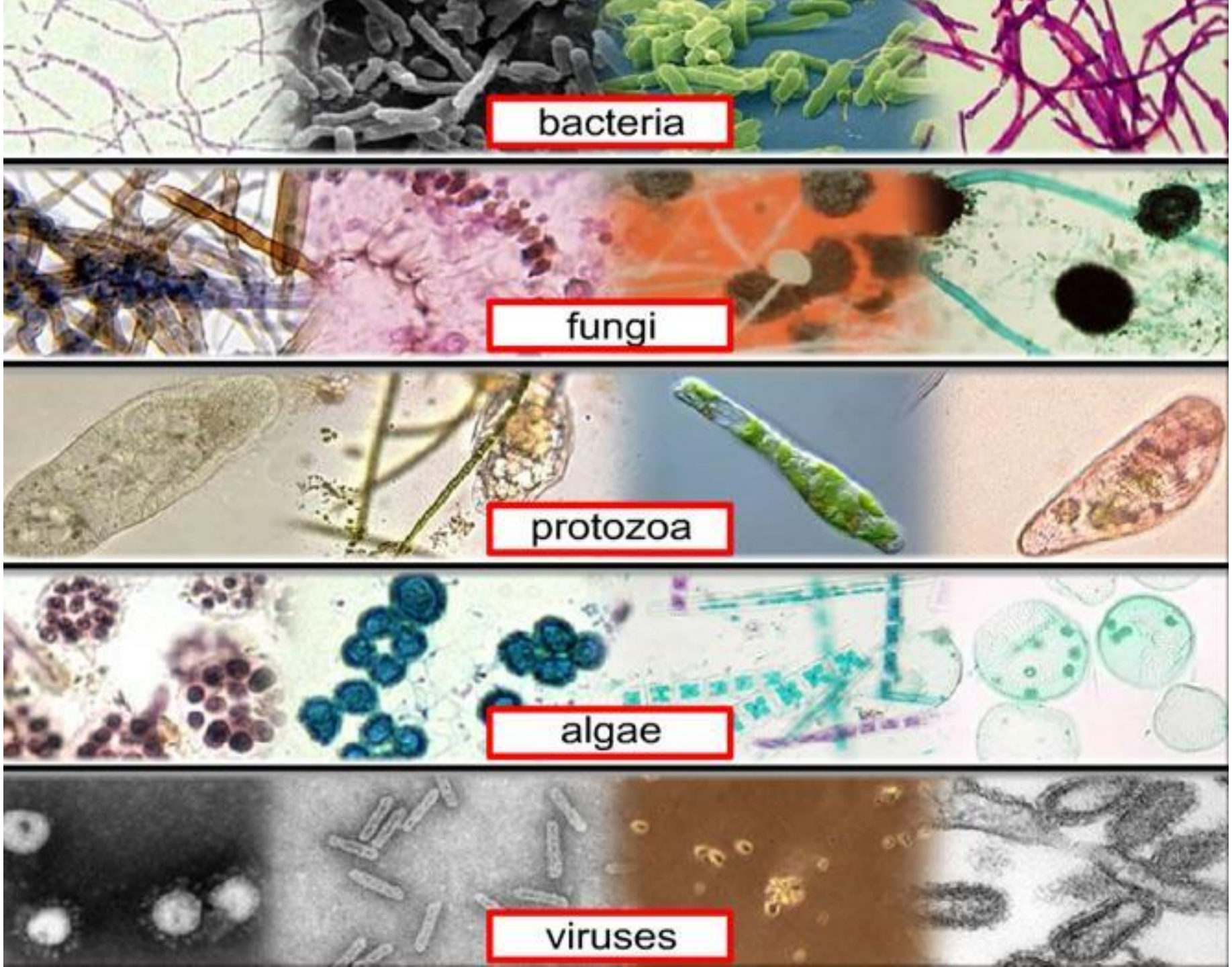
The Future of Our Water
Peak Vision Church, Havelock North

Micro-organisms



0.001 mm

1/1,000 mm

TOPICS

Pathogens

Sources

Drinking Water

Outbreaks

Groundwater

0.000005 -0.0003 mm

1/10,000 mm

THE HUMAN MICROBIOME

Bacteria, fungi, and viruses outnumber human cells in the body by a factor of 10 to one. The microbes synthesize key nutrients, fend off pathogens and impact everything from weight gain to perhaps even brain development. The Human Microbiome Project is doing a census of the microbes and sequencing the genomes of many. The total body count is not in but it's believed over 1,000 different species live in and on the body.

600+ SPECIES

in the mouth, pharynx and respiratory system include:

- Streptococcus viridans
- Neisseria sicca
- Candida albicans
- Streptococcus salivarius

25 SPECIES

in the stomach include:

- Helicobacter pylori
- Streptococcus thermophilus

1,000 SPECIES

in the skin include:

- Pityrosporum ovale
- Staphylococcus epidermidis
- Corynebacterium jeikeium
- Trichosporon
- Staphylococcus haemolyticus

500–1,000 SPECIES

in the intestines include:

- Lactobacillus casei
- Lactobacillus reuteri
- Lactobacillus gasseri
- Escherichia coli
- Bacteroides fragilis
- Bacteroides thetaiotaomicron
- Lactobacillus rhamnosus
- Clostridium difficile

60 SPECIES

in the urogenital tract include:

- Ureaplasma parvum
- Corynebacterium aurimucosum

Pathogens

- Viruses
  - Norovirus
  - Enterovirus
  - Rotovirus
- Bacteria
  - *Campylobacter*
  - *Salmonella*
  - *E. coli* O157
- Protozoa
  - Giardia
  - Cryptosporidium

Notified Diseases in New Zealand (Selected)

Disease	2016 Cases	Current Rate per 100 000	
	NZ	NZ	Hawkes Bay
Campylobacteriosis	7457	159.2	817.8
Cryptosporidiosis	1061	22.6	41.1
Giardiasis	1615	32.4	40.3
Legionellosis	243	5.1	1.2
Leptospirosis	93	2.4	2.1
Listeriosis	37	0.5	0.6
Salmonellosis	1097	22.7	22.3
Shigellosis	174	4.1	2.5
VTEC/STEC infection	422	9.2	7.4
Yersiniosis	858	19.2	14.3

Higher reported recreational water contact

www.surv.esr.cri.nz

Campylobacteriosis

Campylobacter jejuni

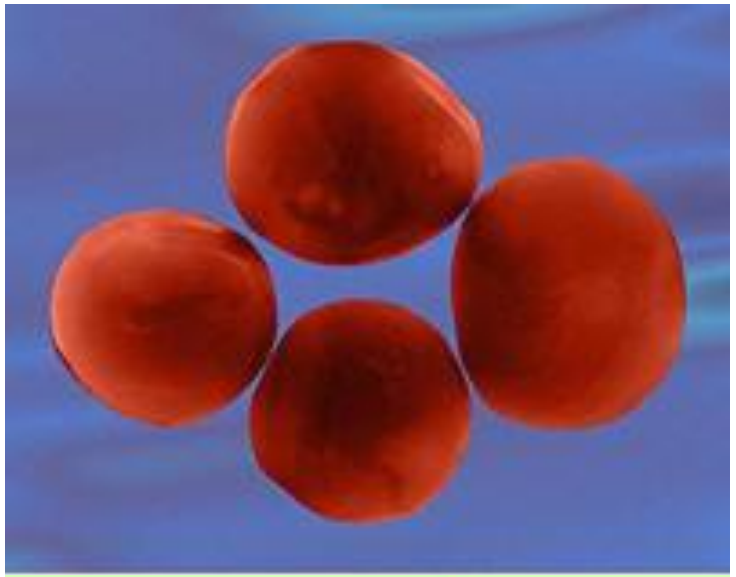
- Illness onset 1 to 10 days following ingestion of the bacteria.
- Diarrhoea, severe abdominal pain, vomiting, fever, nausea
- Reactive arthritis, guillain barre syndrome

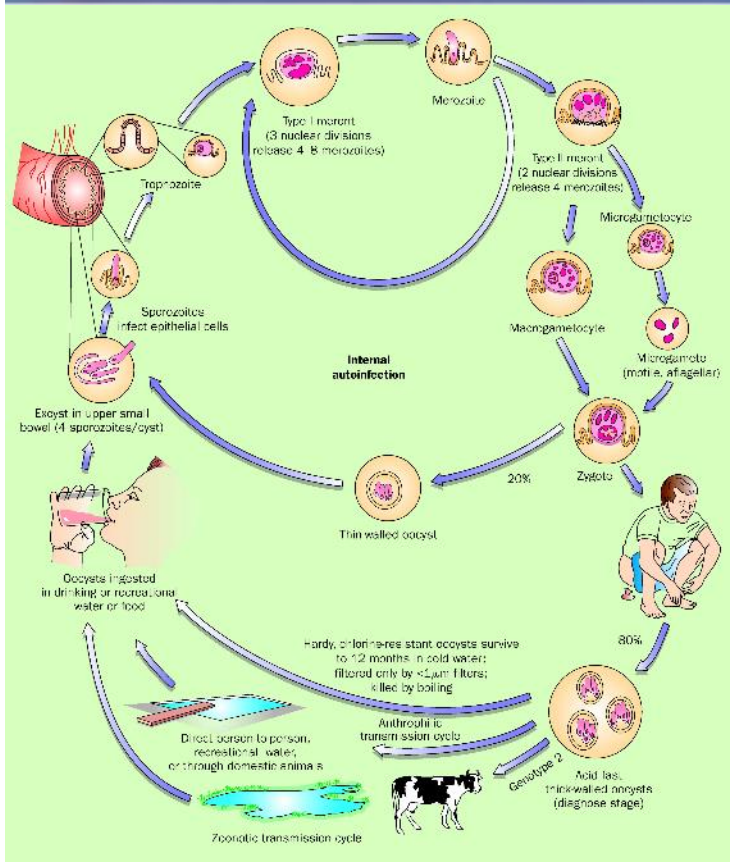
E. coli O157 (STEC/VTEC)

- Illness onset 3 to 9 days (mean 4 days) following ingestion of the bacteria.
- Bloody diarrhoea, severe abdominal pain, vomiting, no fever
- 10% of children infected develop *Haemolytic Uraemic Syndrome (HUS)*
  - Renal failure leading to kidney dysfunction, seizures, coma,
- 1% of STEC cases result in death.

Cryptosporidum

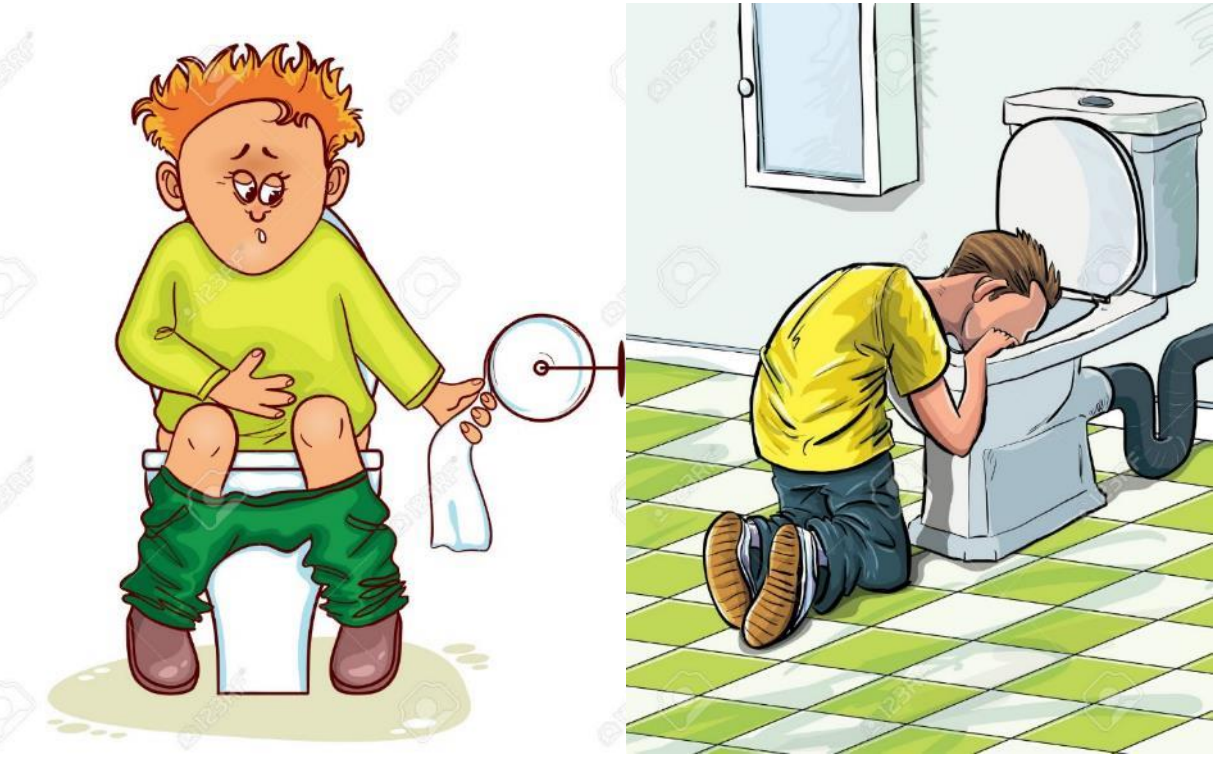
- Incubation period 1–14 days, with an average of 7 days
- Copious watery non-bloody diarrhoea, vomiting, anorexia, fever, malaise, and abdominal cramping for up to 2 weeks
- Resistant to chlorine
- Survive for months
- Found 155 mammals





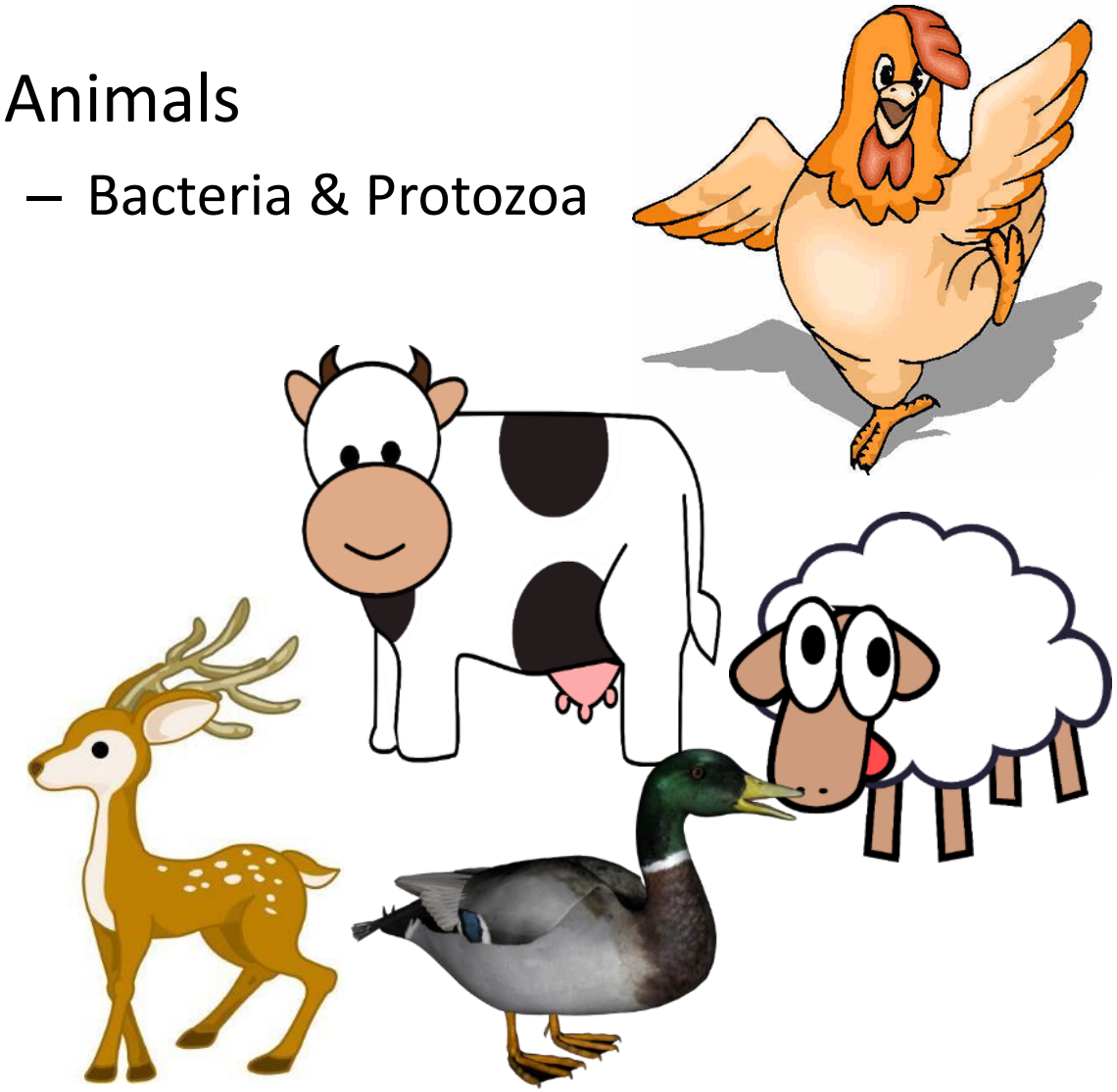
Sources of pathogenic micro-organisms

- Humans
  - Viruses, Bacteria & Protozoa



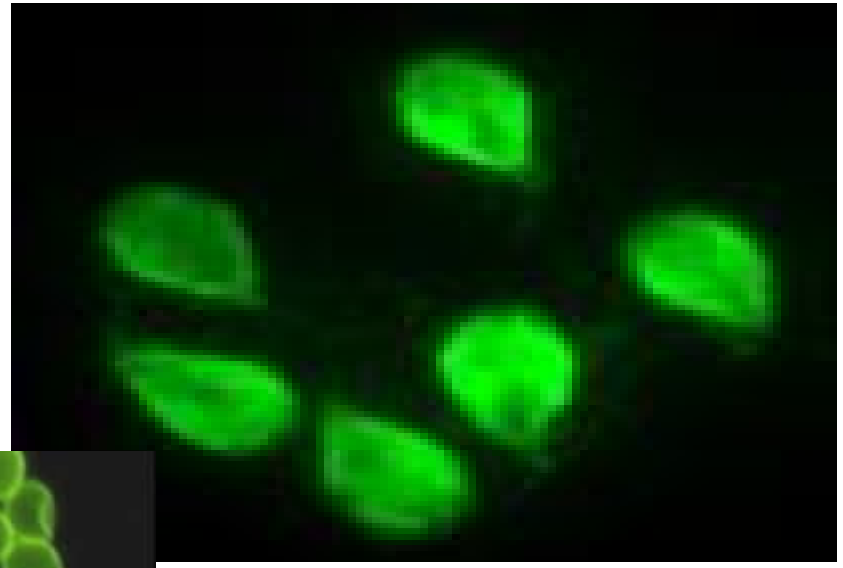
Excrete 10,000,000,000 cysts per day

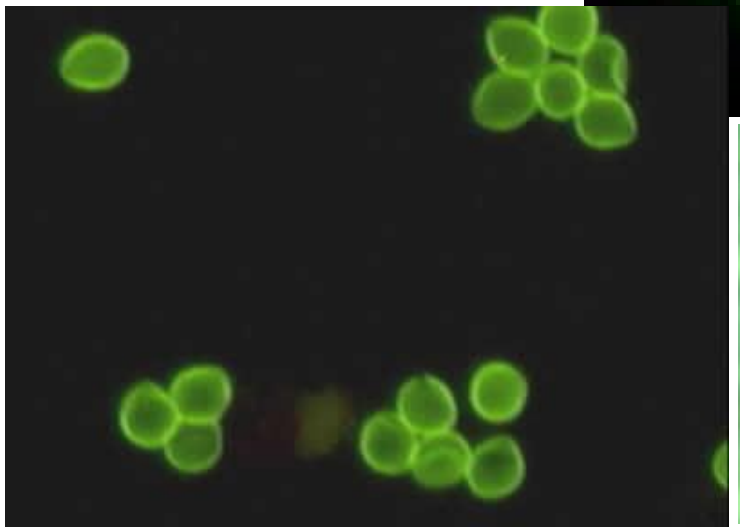
- Animals
  - Bacteria & Protozoa

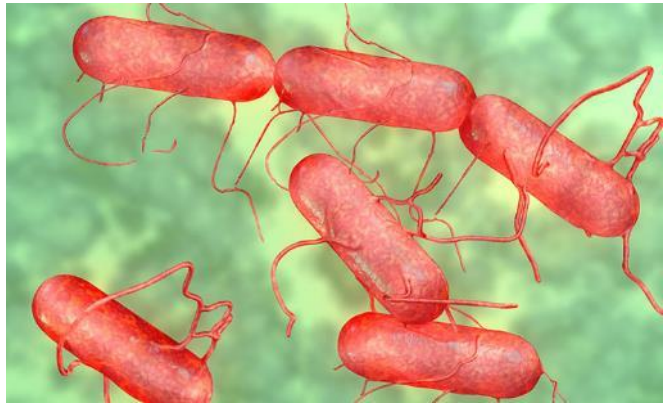


Lamb faeces (105 samples)

- *Campylobacter*
  - 81% samples positive
  - 1 – 4,600,000 cfu/g
- *Cryptosporidium* spp.
  - 37% samples positive
  - 1 – 73,882 oocysts/g
- *Giardia* spp.
  - 28% samples positive
  - 1 – 733 cysts/g
- STEC
  - 3.8% positive
- *Salmonella*
  - 1.9% positive







EM Moriarty , N McEwan , M Mackenzie , N Karki , LW Sinton & DR Wood (2011) Incidence and prevalence of microbial indicators and pathogens in ovine faeces in New Zealand, New Zealand Journal of Agricultural Research, 54:2, 71-81, DOI:10.1080/00288233.2011.556129

Multi-barrier Approach to Safe Drinking Water

- Protection of source of the water
- Water treatment
  - Remove Particles
  - Inactivate organisms
- Secure Distribution system
- Monitor water quality
- Response to adverse water test results

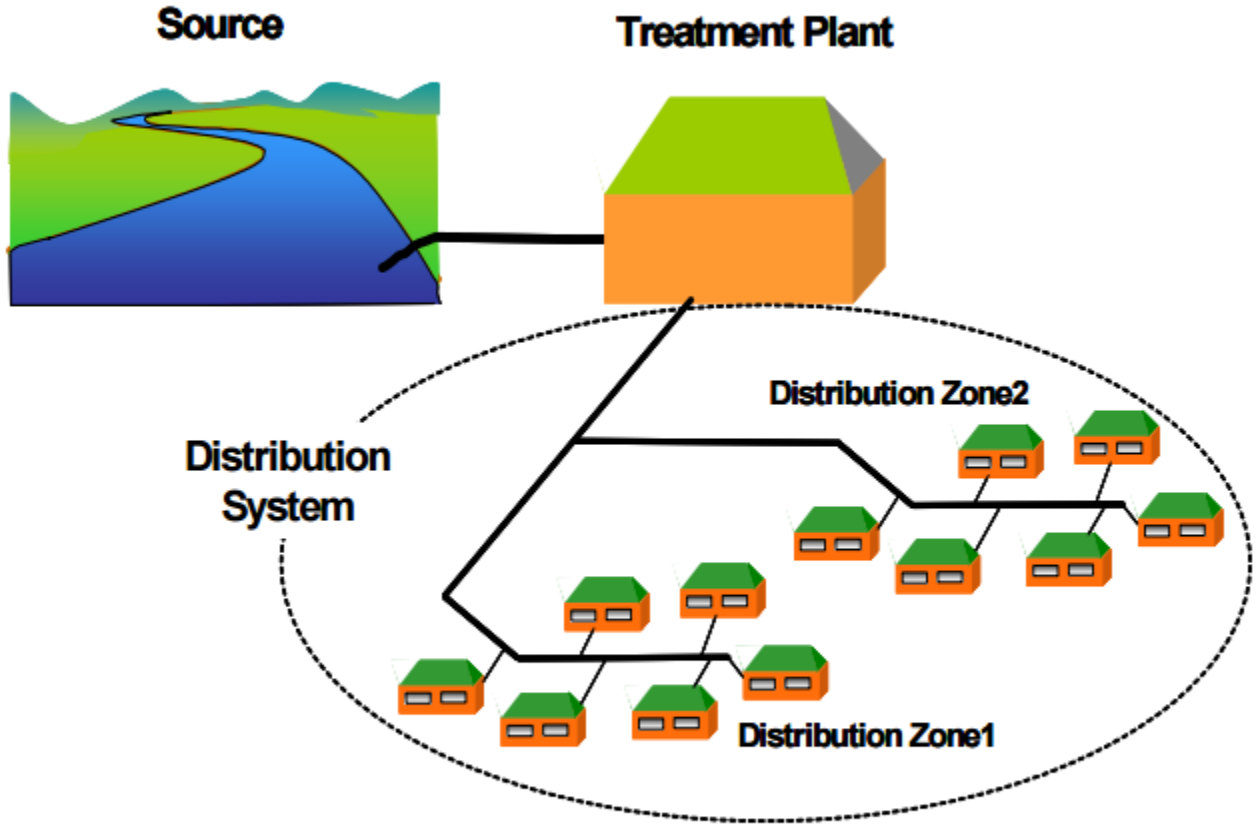


Figure 2 Water supply system components – distribution system containing two distribution zones

Outbreaks due to contamination surface water

Year of Outbreak	Location	Pathogens	Cases Confirmed	Total Cases Estimated	Comments
2001	North Battleford, SK, Canada	*Cryptosporidium parvum* type 1 (human)	375	5,800–7,100 50 hospitalised	Sewage discharges upstream drinking water intake
2010	Õstersund, Sweden	*Cryptosporidium*	>29	27,000 270 hospitalised	
2001	Te Aute, College, Hawkes Bay, NZ	*Campylobacter jejuni*		95–185	Cattle
2012	Darfield NZ	*Campylobacter jejuni*	29	138	Sheep Rainfall

Outbreaks due to contamination ground water sources

Year	Location	Pathogens	Cases Confirmed	Total Cases Estimated	Comments
2000	Walkerton, ON, Canada	*Escherichia coli* O157:H7, *Campylobacter*	163 (E) 105 (C) 12 both	2,300 27 HUS 7 deaths	Cattle manure Rainfall Treatment failure
2000–01	Asikkala, Finland	*Campylobacter jejuni*	71	1450	Rainfall No treatment
2002	Transtrand, Sweden	Norwalk-like virus	4	~500	Leaking sewer pipe near bore No treatment

Outbreaks due to contamination in reticulation

Year	Location	Pathogens	Cases Confirmed	Cases Estimated	Comments
2007	Nokia, Finland	*Campylobacter* spp., Norovirus, *Giardia*, *Salmonella* spp. *Clostridium difficile*, Rotavirus	2 deaths	6,500	cross-connection at sewage treatment plant
2008	Alamosa, CO, USA	*Salmonella*	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	*Cryptosporidium cuniculus*	22	422	Rabbit in backwash tank

Dr. Steve E. Hrudey, *Converting Hindsight into Foresight*

Documented waterborne outbreaks in New Zealand, 2005–2013

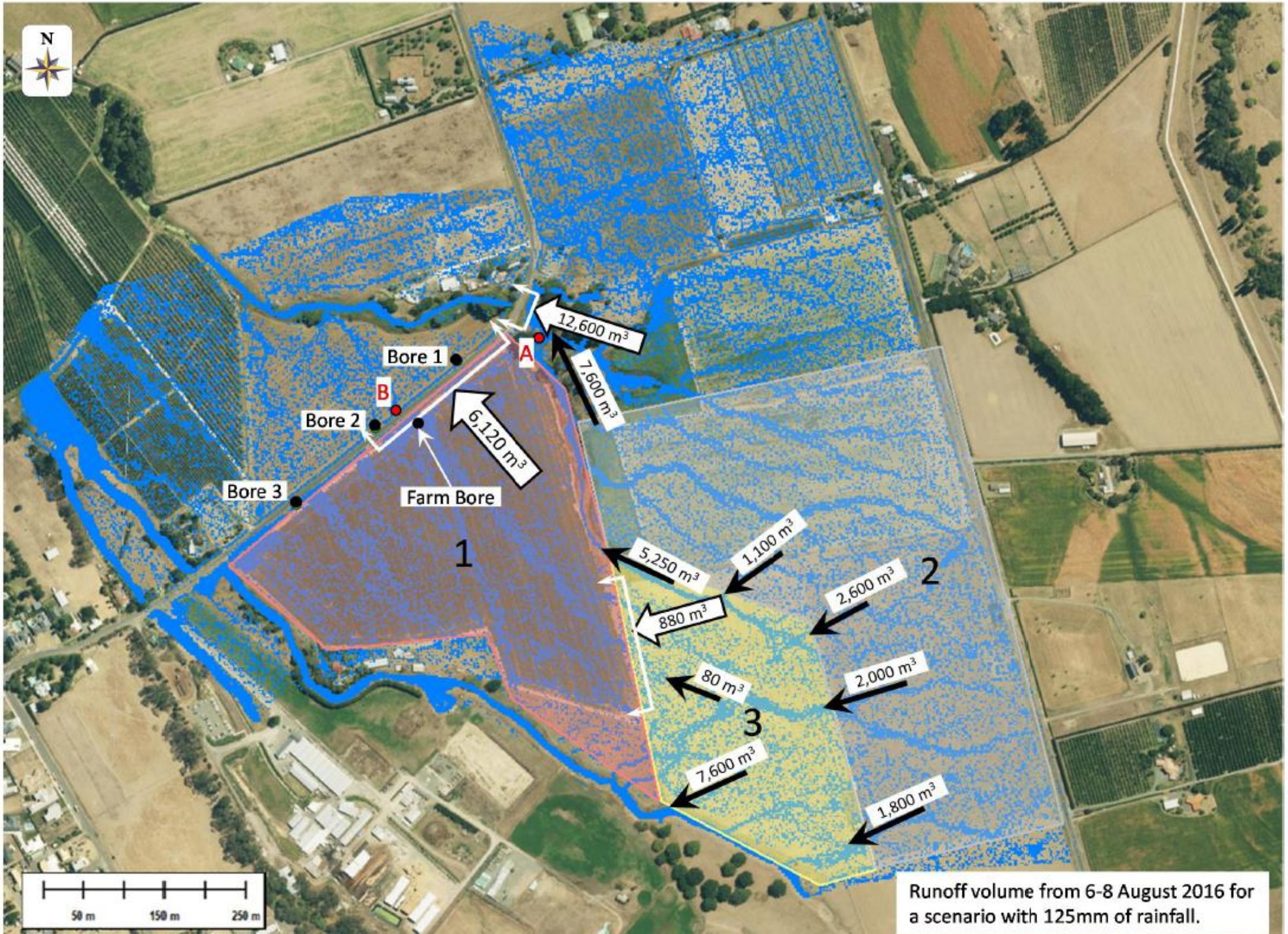
Year	Incident	Causal agent	Cases	
			Confirmed	Probable
2005	Bridge Valley camp	Campylobacter	3	10
2005	Hawke's Bay school camp	Campylobacter	6	34
2005	Med student camp, Canterbury	Campylobacter	13	21
2005	Otago bowling tournament	Campylobacter	8	13
2006	Cardrona Skifield	Norovirus	218	
2006	School camp, 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	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 & water supplies	Norovirus	48	5
2013	Nelson Lakes Scout camp	Gastro – unknown cause		13

Ministry of Health. 2016. *Guidelines for Drinking-water Quality Management for New Zealand* (2nd edn). Wellington: Ministry of Health.

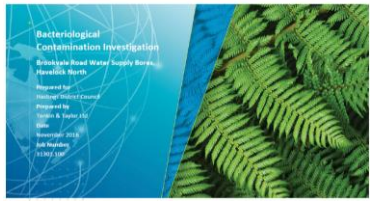
August 2016


Springs
Mangateretere Stream
Bore 1 chamber
Control cabinet
Dye monitoring equipment
Blind culvert
Northern roadside drain
Stormwater flow direction
BROOKVALE ROAD
Dye introduction point
Overland Flow
Mangateretere Stream
Paddock 2
Southern roadside drain
Paddock 1
Bore 1890
Stormwater flow direction
Overland Flow
Stormwater pipe under
Brookvale Road
flow Sth to Nth in floods
Water reticulation control valve
Overland Flow
Sump pump discharge pipe
Bore 2 Chamber
Control cabinet
Stormwater bypass pipe
N

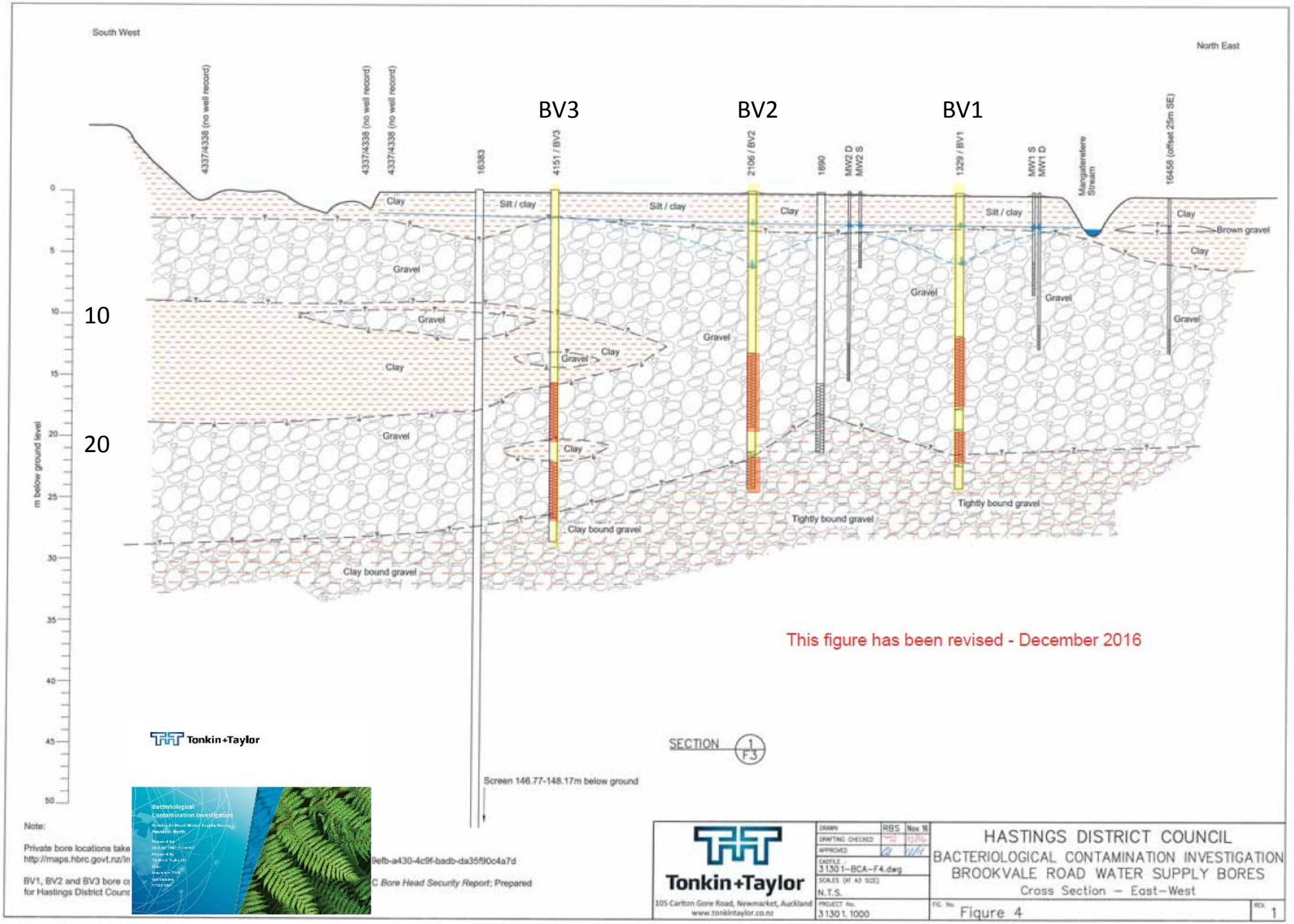
Figure 3 Brookvale Water Supply Bores: Maximum flood extents for flood depths over 10 mm over the simulation period with flood volumes

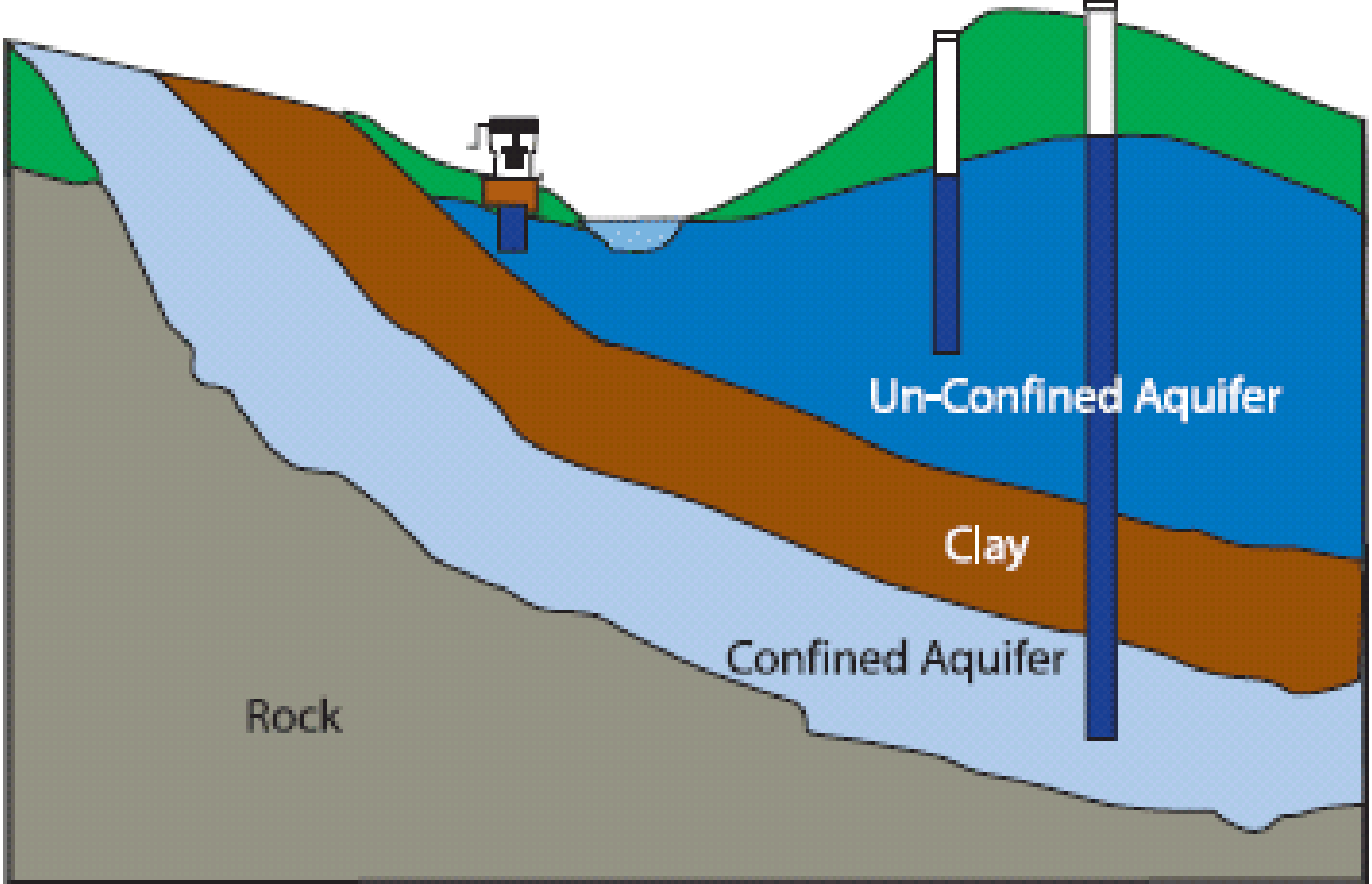


Tonkin+Taylor



Mangateretere Stream Pond


South West
North East
BV3
BV2
BV1
4337/4338 (no well record)
4337/4338 (no well record)
4337/4338 (no well record)
16383
4151 / BV3
2106 / BV2
1890
MV2 D
MV2 S
1329 / BV1
MV1 S
MV1 D
Mangateretere Stream
16458 (offset 25m SE)
m below ground level
0
5
10
15
20
25
30
35
40
45
50
10
20
Clay
Silt / clay
Silt / clay
Clay
Silt / clay
Clay
Brown gravel
Clay
Gravel
Gravel
Clay
Gravel
Clay
Gravel
Gravel
Gravel
Gravel
Gravel
Clay
Clay
Clay bound gravel
Clay bound gravel
Tightly bound gravel
Tightly bound gravel
Screen 146.77-148.17m below ground
SECTION 1 F3
This figure has been revised - December 2016
Tonkin+Taylor
Note:
Private bore locations take
http://maps.hbrc.govt.nz/In
BV1, BV2 and BV3 bore co
for Hastings District Counc
9efb-a430-4c9f-badb-da35f90c4a7d
C Bore Head Security Report; Prepared
Tonkin+Taylor
105 Carlton Gore Road, Newmarket, Auckland
www.tonkintaylor.co.nz
DRAWN RBS Nov 16
DRAFTING CHECKED
APPROVED
CADFILE 31301-BCA-F4.dwg
SCALES (AT A3 SIZE) N.T.S.
PROJECT No. 31301.1000
HASTINGS DISTRICT COUNCIL
BACTERIOLOGICAL CONTAMINATION INVESTIGATION
BROOKVALE ROAD WATER SUPPLY BORES
Cross Section – East–West
FIG. No. Figure 4
REV. 1


Un-Confined Aquifer
Clay
Confined Aquifer
Rock

Alluvial gravel aquifer

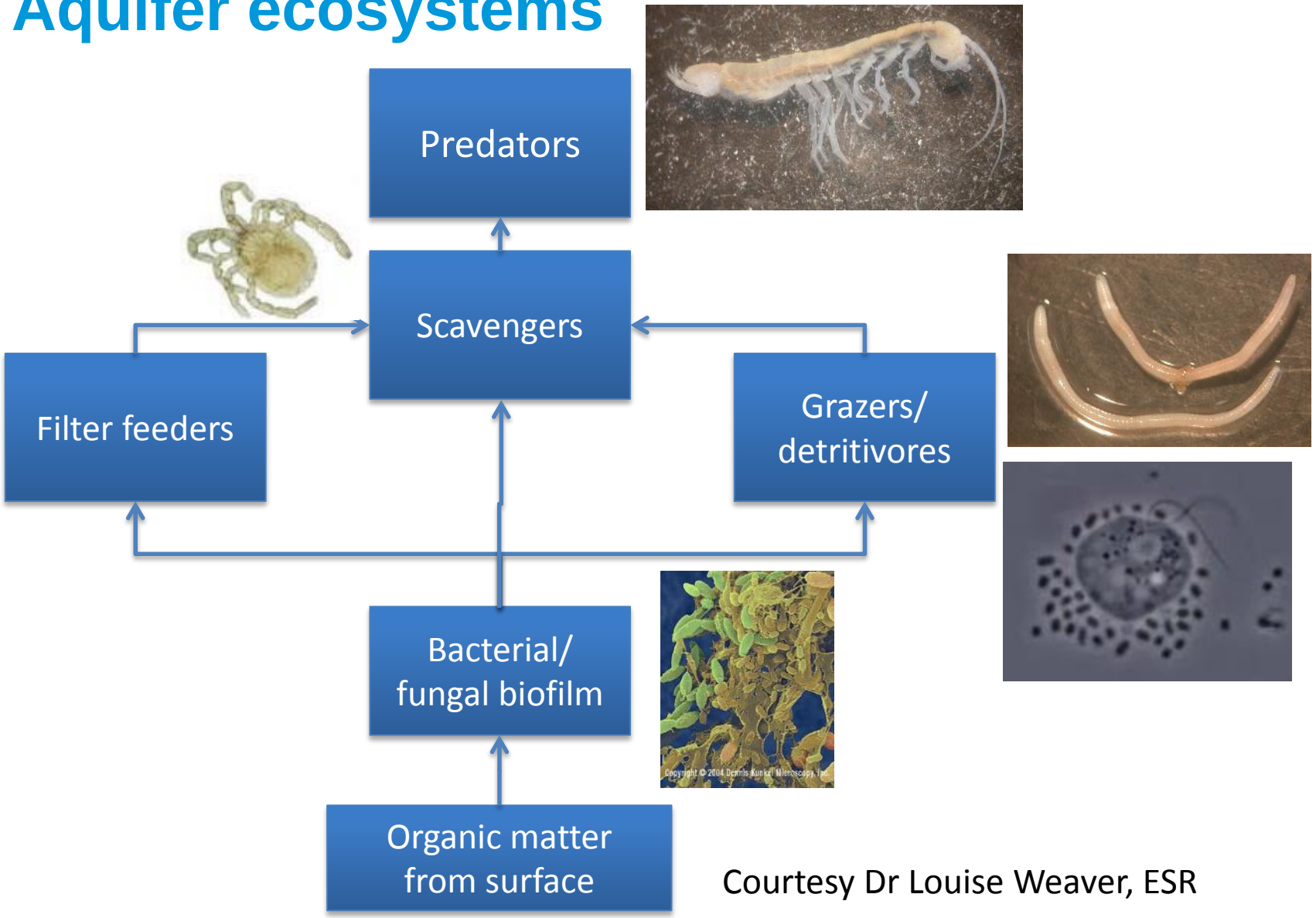
- Three main textures
  - Sandy gravel
  - Sand
  - Open frameworks

Murray Close & Lee Burbery

Stygofauna

http://www.northerndailyleader.com.au/story/1634823/mite-bugging-santos/

Aquifer ecosystems



Courtesy Dr Louise Weaver, ESR

Microbial Inactivation & Removal

Filtration

Predation

Starvation

Increase transport times and matrices

Sunlight

Desiccation

Avoid direct deposition

Multi-barrier Approach to Safe Drinking Water

- Protection of source of the water
- ~~Water treatment~~
  - ~~Remove Particles~~
  - ~~Inactivate organisms~~
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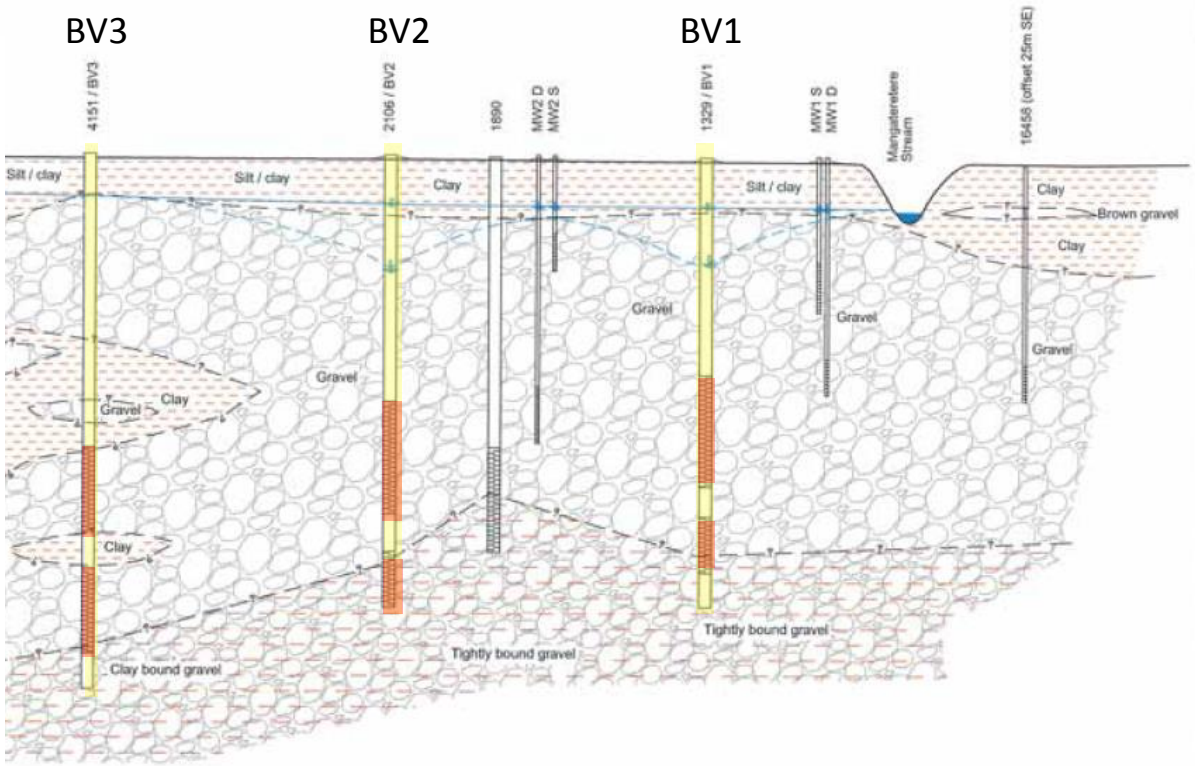

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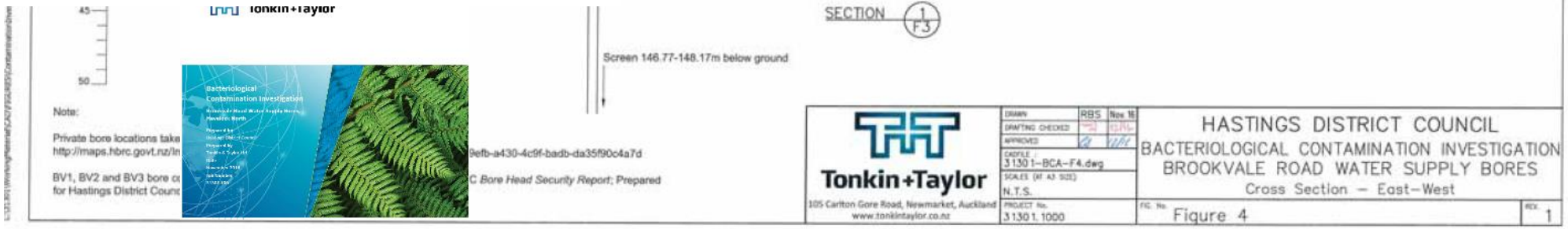

Conclusions

- Microorganisms are everywhere – both good & bad
- Human sewage/faeces is biggest risk
- Animal faeces likely to contain pathogens
  - but may differ in quantity and types
- Drinking water needs a multiple barrier approach
  - Weakness/absence of any one stage needs to recognised and either fixed or compensated for by enhancing other barriers
- Reduce pathogenic risk in recreational/source waters by increasing opportunities for inactivation or removal of microorganisms

Government Inquiry into Havelock North Drinking Water

https://www.dia.govt.nz/Government-Inquiry-into-Havelock-North-Drinking-Water

Overview

On 12 September 2016, the Government announced that an Inquiry into the Havelock North water supply contamination incident would be held.

The Inquiry members appointed are Hon Lyn Stevens QC (chair), Dr Karen Poutasi CNZM and Anthony Wilson ED*.

The Inquiry follows the widespread outbreak of gastroenteritis in Havelock North in August 2016, with more than 5000 people falling ill, following the confirmation of the presence of E. coli in the water supply. Testing through the health system led the Hastings District Council and the Hawke's Bay District Health Board staff to suspect that Campylobacter as the primary infectious agent.

Drinking water supplies across New Zealand rely on different methods of take and treatment, depending on the nature and security of the water source. Drinking water supplies are regulated under the Health Act 1956 and the source of drinking water is regulated under the Resource Management Act and National Environmental Standards for sources of drinking water. The National Environmental Standards are given effect to by the Hawke's Bay Regional Council.

New Zealanders expect that water reticulated to their homes and businesses for drinking purposes will be safe to