Safeswim: a sea change in assessing beach water quality risk

Stormwater 2018
23 May 2018

Dr Martin Neale, Puhoi Stour Limited,
Andrew Schollum, Puhoi Stour Limited,
Ben Tuckey, DHI,
Kris Fordham, Civix Limited,
Nick Brown, Auckland Council.

What is Safeswim?

Weather forecasts

- Information important for SW management
  - Rain forecasts
  - Help to protect life and property

Tasman Tempest: Auckland's wettest March day in 58 years

NICOLE LAWTON
Last updated 19:55, March 13 2017

LAWRENCE SMITH/Stuff.co.nz

A deluge caused major flooding in the West Auckland suburb of New Lynn on Sunday. Resident James Ellis' home was waterlogged.

The Tasman Tempest dumped more rain in some places in six days than is usually expected for the entire month of March, new figures reveal.

The storm, which battered Northland, Auckland and Waikato from Tuesday to Sunday, washed away weather records held in some places for decades, Niwa said.

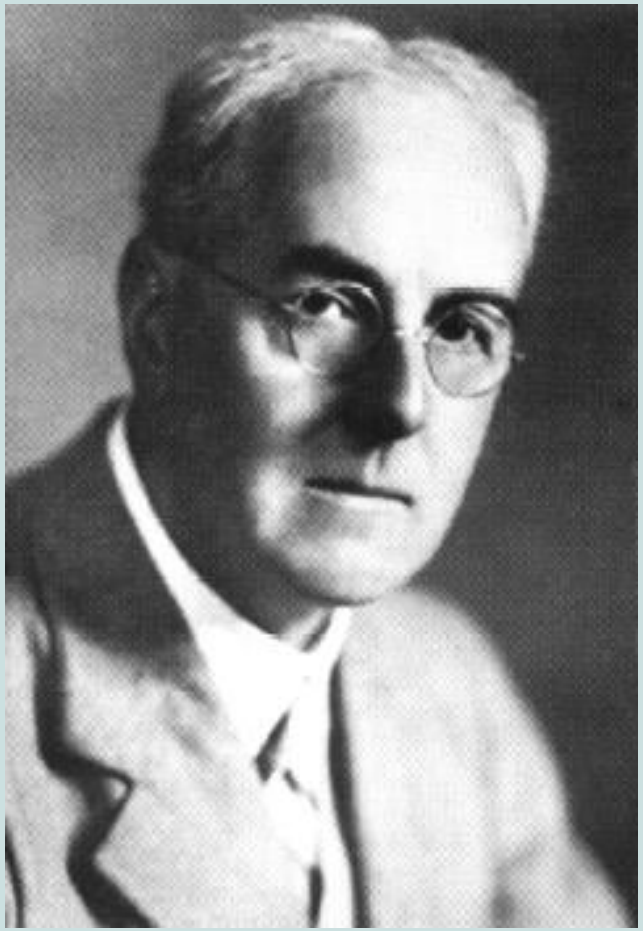
It caused widespread flooding, property and livestock losses and power outages to more than 2.2 million residents.

Weather forecasts

- A brief history…
- 18th century
  - Entirely subjective

Weather forecasts

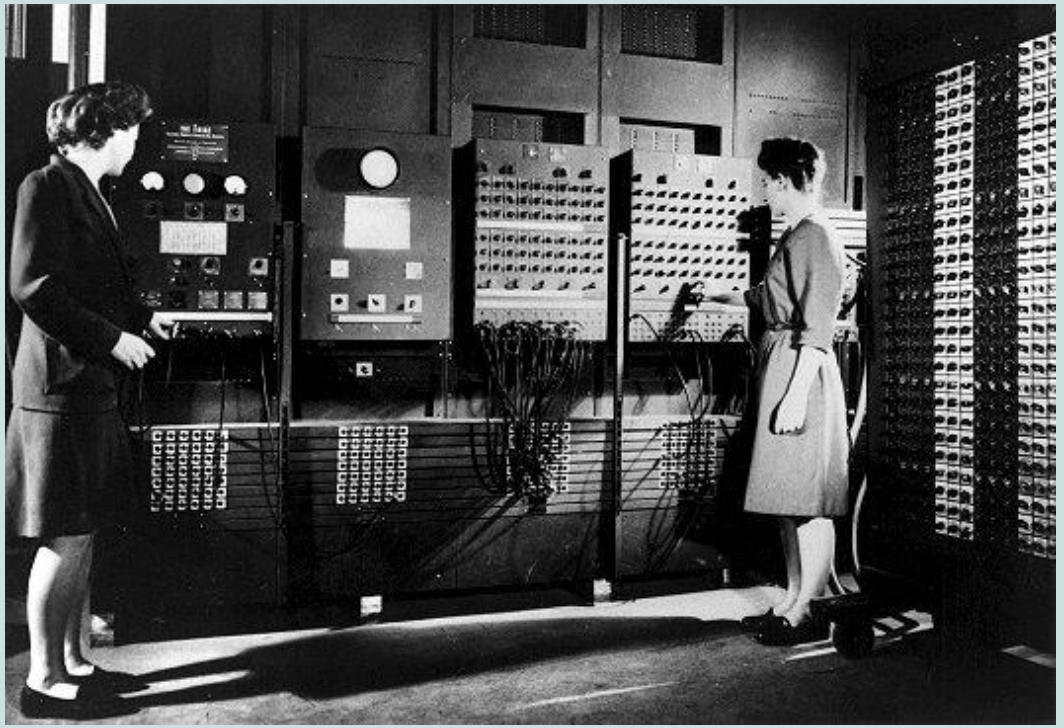
- A brief history…
- 18th century
  - Entirely subjective
- 1922
  - First numerical forecast



Lewis Richardson

Weather forecasts

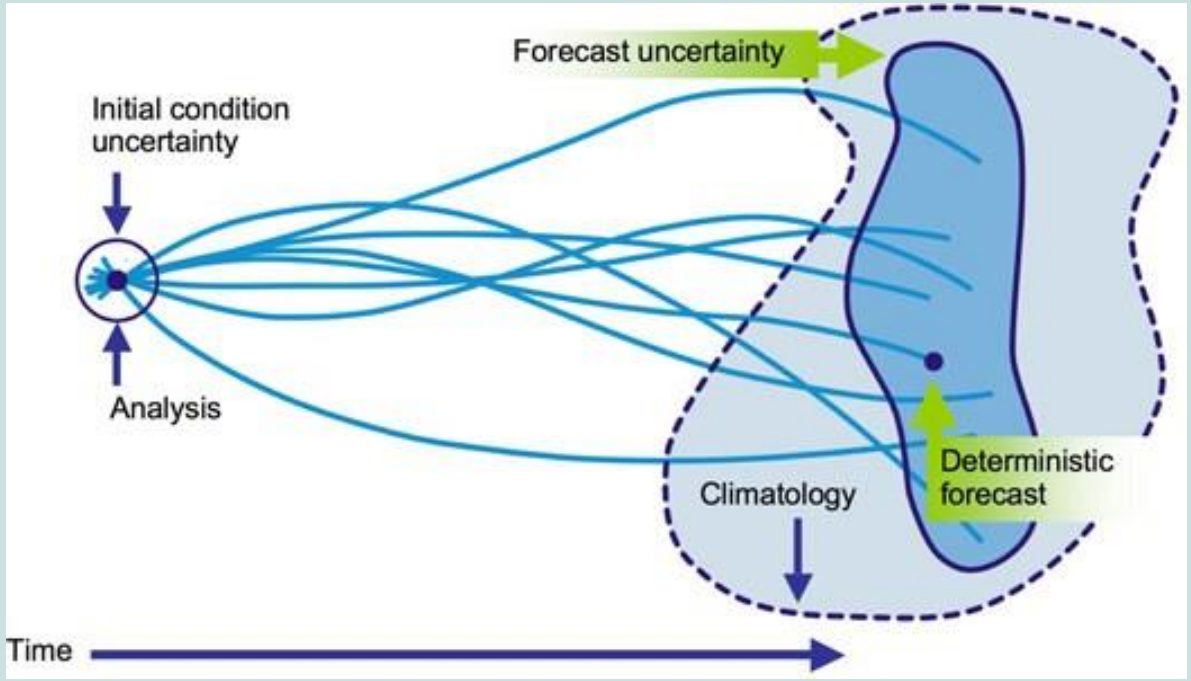
- A brief history…
- 18th century
  - Entirely subjective
- 1922
  - First numerical forecast
- 1951
  - First computer based forecast



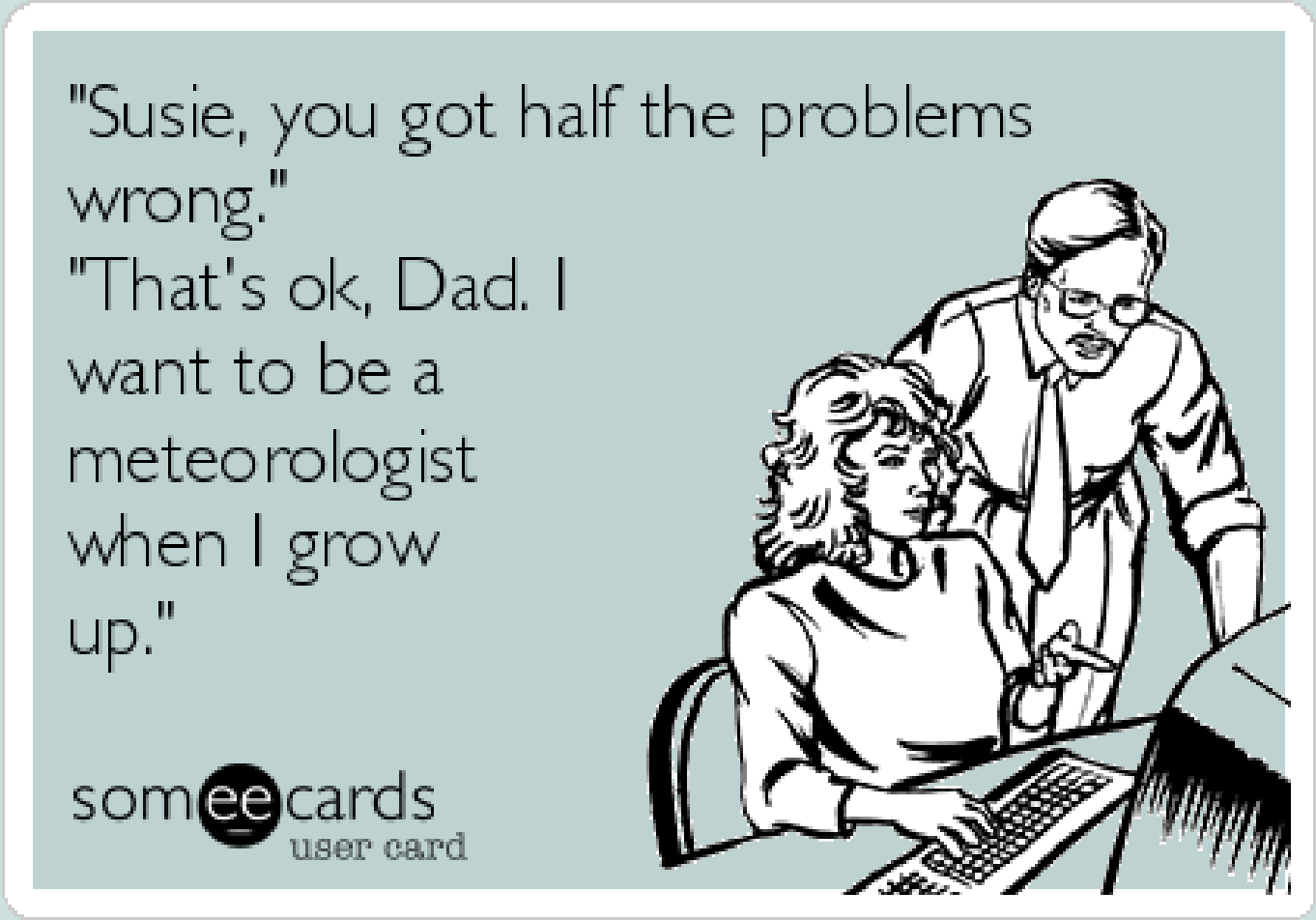
Electronic Numerical Integrator and Computer (ENIAC)

Weather forecasts

- A brief history…
- 18th century
  - Entirely subjective
- 1922
  - First numerical forecast
- 1951
  - First computer based forecast
- 1992
  - Ensemble forecasts

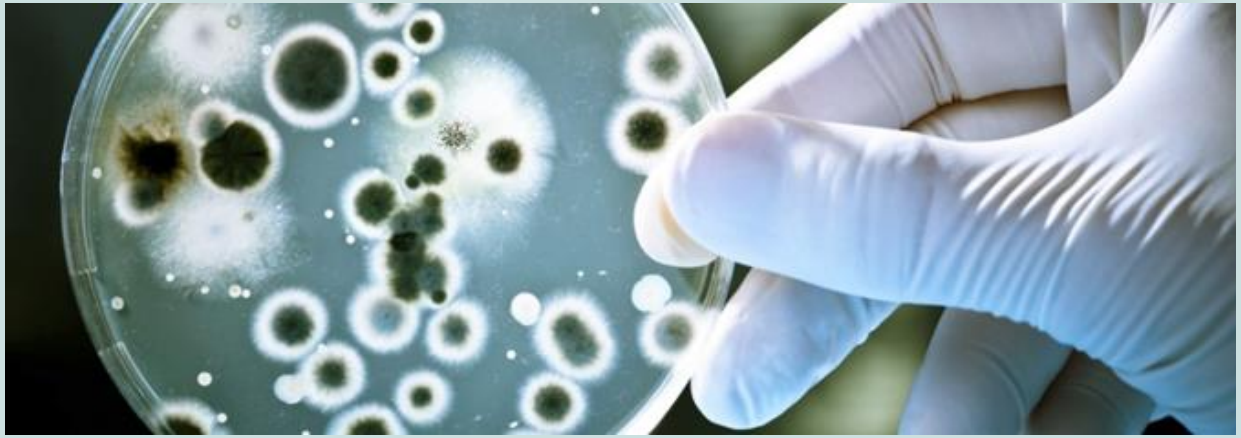


Weather information



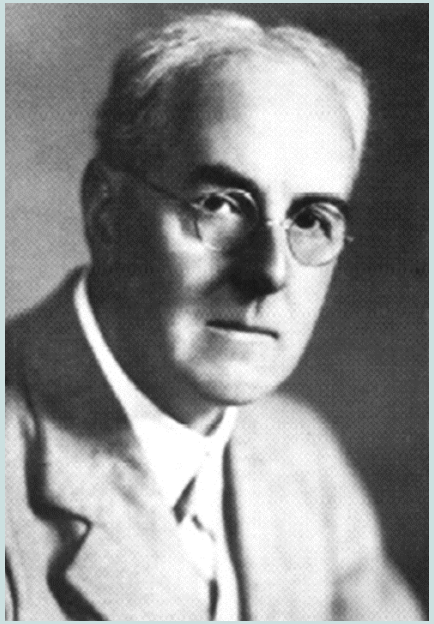
Beach water monitoring

- Time delay between sample collection and results available
    - Water quality varies quicker than the analysis time (~48 hours)

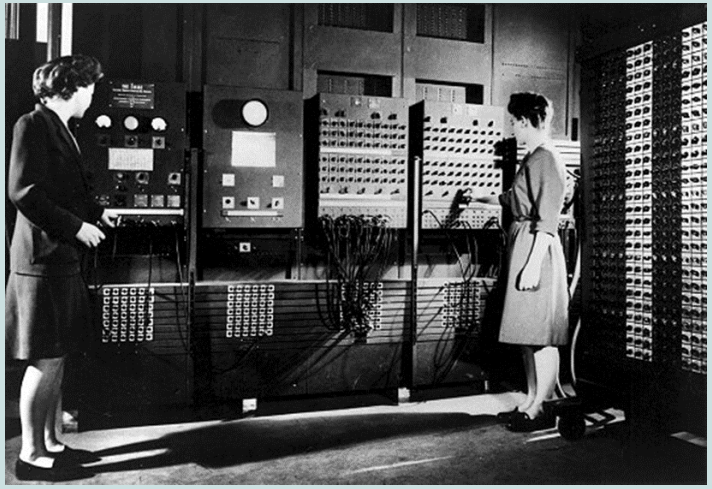


Beach water monitoring

- 48 hour information delay…



1922
6 weeks



1951
24 hours

Beach water monitoring

- Time delay between sample collection and results available
    - Water quality varies quicker than the analysis time (~48 hours)
- Weekly monitoring underestimates frequency of contamination events
    - Most contamination events last less than 24 hours
    - Missed 70% of guideline exceedances in California study

Auckland City Bathing Wa...

https://www.infoatsea.com/NZ/animation

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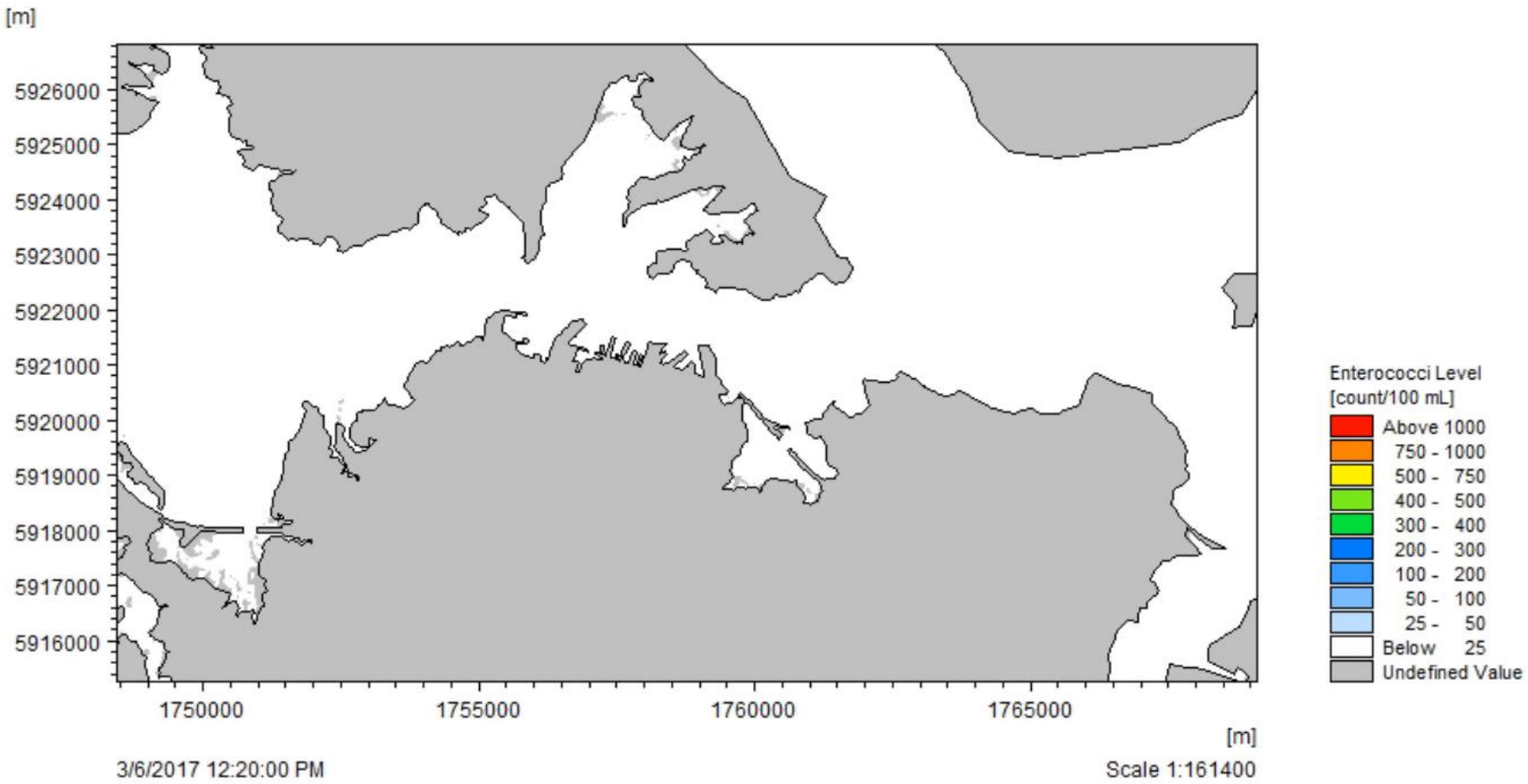
Period: 2017-03-06 00:00 → 2017-03-09 00:00

2017-03-06 00:00 → 2017-03-09 00:00

Timestep: 2017-03-06 12:20

2017-03-06 00:00 | 2017-03-07 12:00 | 2017-03-09 00:00

Pollution Plume



11:48 AM
16/03/2017

Model predictions validated

	6 March	8 March		15 March
Beach	Safeswim	Model Forecast	Sample Results	Safeswim
Pt Chev	<10	1881 (383-6400)	277 (74-1396)	<10
Herne Bay	<10	1267 (255-3380)	328 (20-644)	<10
Home Bay	10	773 (234-2472)	554 (74-2755)	<10
St Mary's Bay	<10	481 (345-650)	545 (10-3076)	<10
Okahu Bay	<10	467 (126-1049)	2783 (63-15531)	<10
Mission Bay	<10	386 (23-1675)	1179 (512-3609)	<10
Kohimarama	<10	692 (18-2154)	1964 (457-5794)	10
St Heliers	<10	92 (5-960)	504 (52-1918)	<10

False sense of security

- Red Beach (North Auckland)
  - Weekly monitoring programme
    - 330 samples (1995 – 2017)
    - 1 Guideline exceedance (4th January 2012)

False sense of security

- Red Beach (North Auckland)
  - Weekly monitoring programme
    - 330 samples (1995 – 2017)
    - 1 Guideline exceedance (4th January 2012)
  - Targeted sampling
    - 8th November 2017 (6mm rain)
      - 4 of 9 samples exceeded guidelines
      - Stream sample 17,239
    - 18th January 2018 (12mm rain)
      - 7 of 9 samples exceeded guidelines
      - Stream sample 5,475

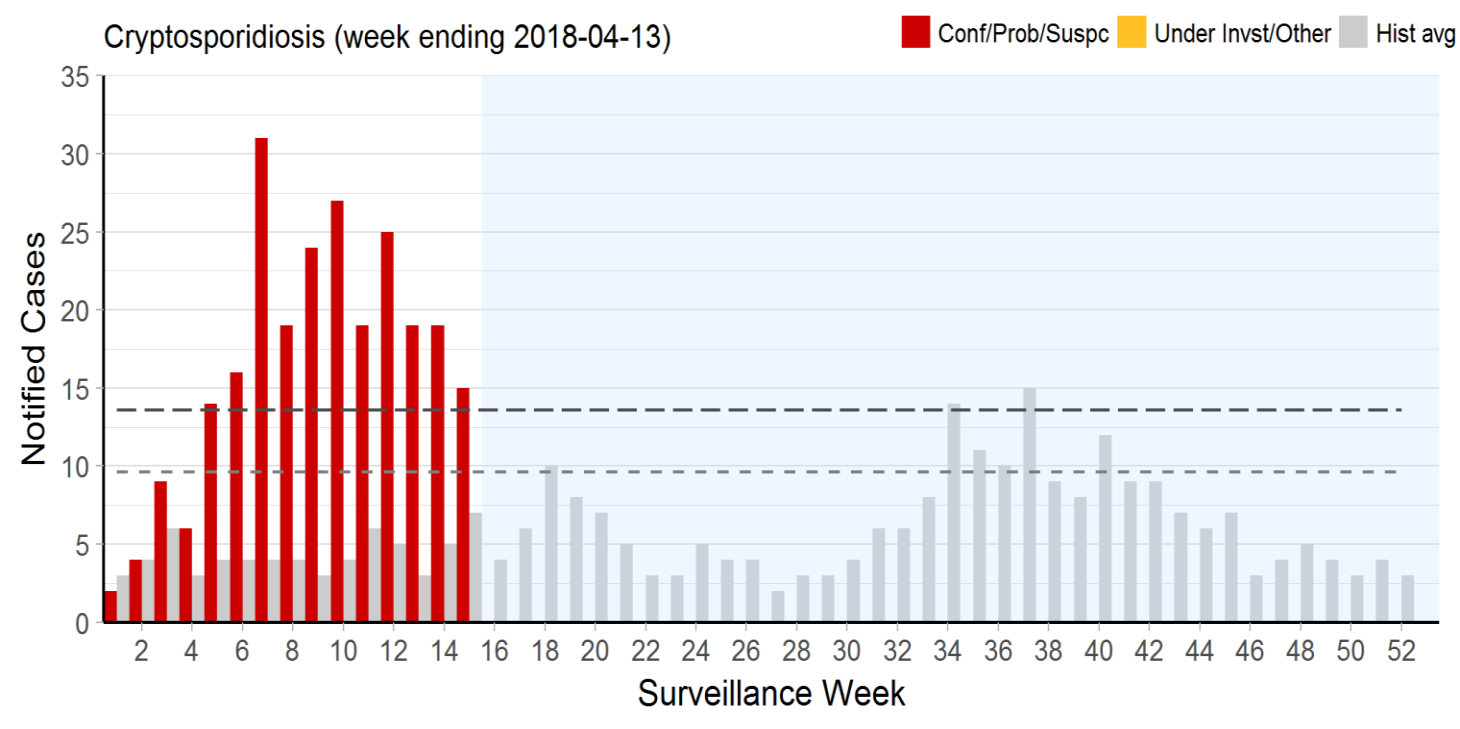
False sense of security

Date	Rain (mm)	Beach	Stream	DNA source tracking
8 November 2017	8	683	17,329	
22 November 2017	0	10	12,033	
11 December 2017	5	160	3,448	
18 December 2017	10	9,804	12,033	
18 January 2018	17	833	5,475	Human, dog, avian
2 February 2018	19	504	2,460	Human, dog, avian
5 February 2018	25	189	20,460	Human, dog, avian
14 February 2018	1	393	2,310	*Pending…*
21 February 2018	1	201	8,840	*Pending…*

Monitoring shortcomings

- Well recognised by the scientific community
  - Increasing use of models (e.g. Scotland, Melbourne, Hong Kong)
- Agencies in NZ have relied on outdated guidelines

Meanwhile, in Auckland…



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NEW ZEALAND / HEALTH

Surge in Auckland stomach bug complaints after storms

3:07 pm on 18 August 2017

Share this

Rowan Quinn, Reporter
rowan.quinn@radionz.co.nz

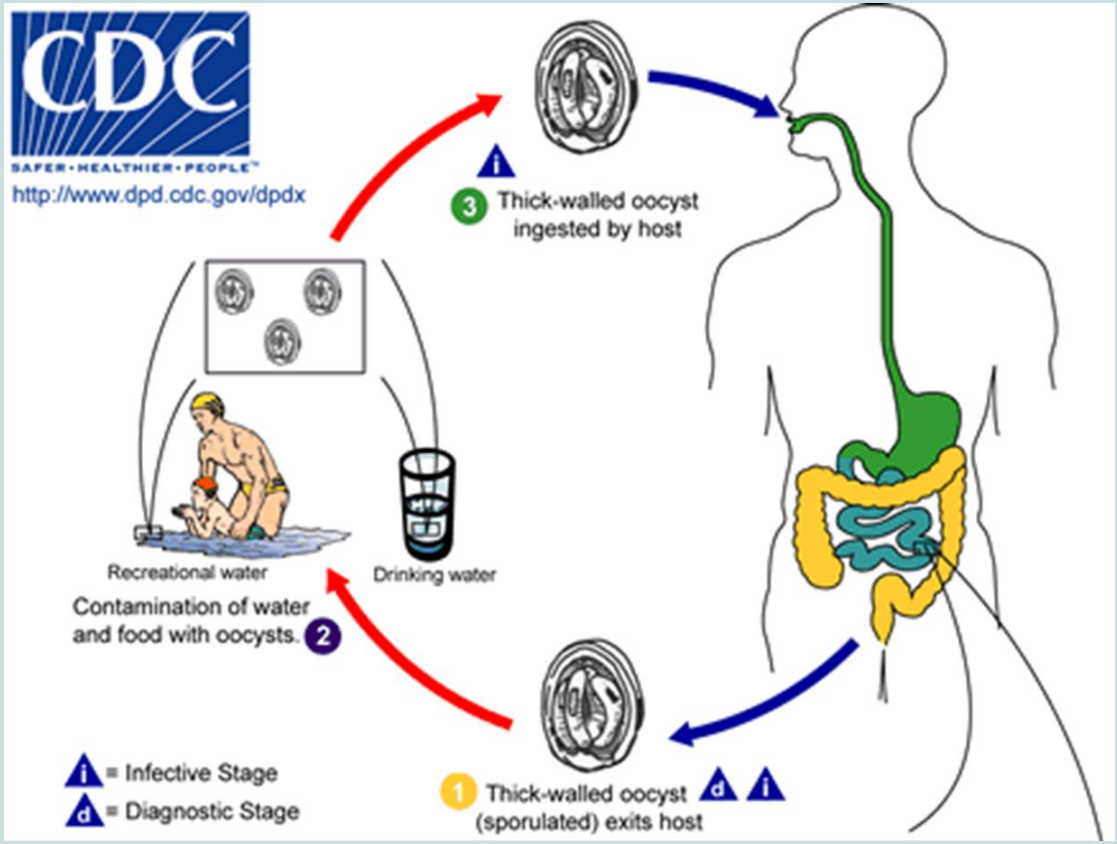
The number of people contracting nasty stomach bugs in Auckland is spiking after every storm, prompting health authorities to look at whether the city's sewage system is to blame.

Influx of stomach bugs as Auckland's water quality drops

ADAM JACOBSON
Last updated 12:15, February 19 2018

Problem definition

- Flawed monitoring programme
  - Water quality problems under assessed
- Poor water quality after rainfall
- Links with health effects
- Robust model, but how robust?



Model performance

- Assessment during 2016-17 austral summer
  - Comparison with weekly monitoring
  - Sample size 64 (8 beaches x 2 times of day x 4 days)

		Weekly monitoring results		
		Green	Amber	Red
Targetted sampling results	Green	5	0	0
	Amber	5	0	0
	Red	52	0	2

		Model forecast		
		Green	Amber	Red
Targetted sampling results	Green	3	1	1
	Amber	1	1	3
	Red	10	5	39

Model performance

- Assessment during 2016-17 austral summer
  - Comparison with weekly monitoring

		Weekly monitoring results		
		Green	Amber	Red
Targetted sampling results	Green	5	0	0
	Amber	5	0	0
	Red	52	0	2

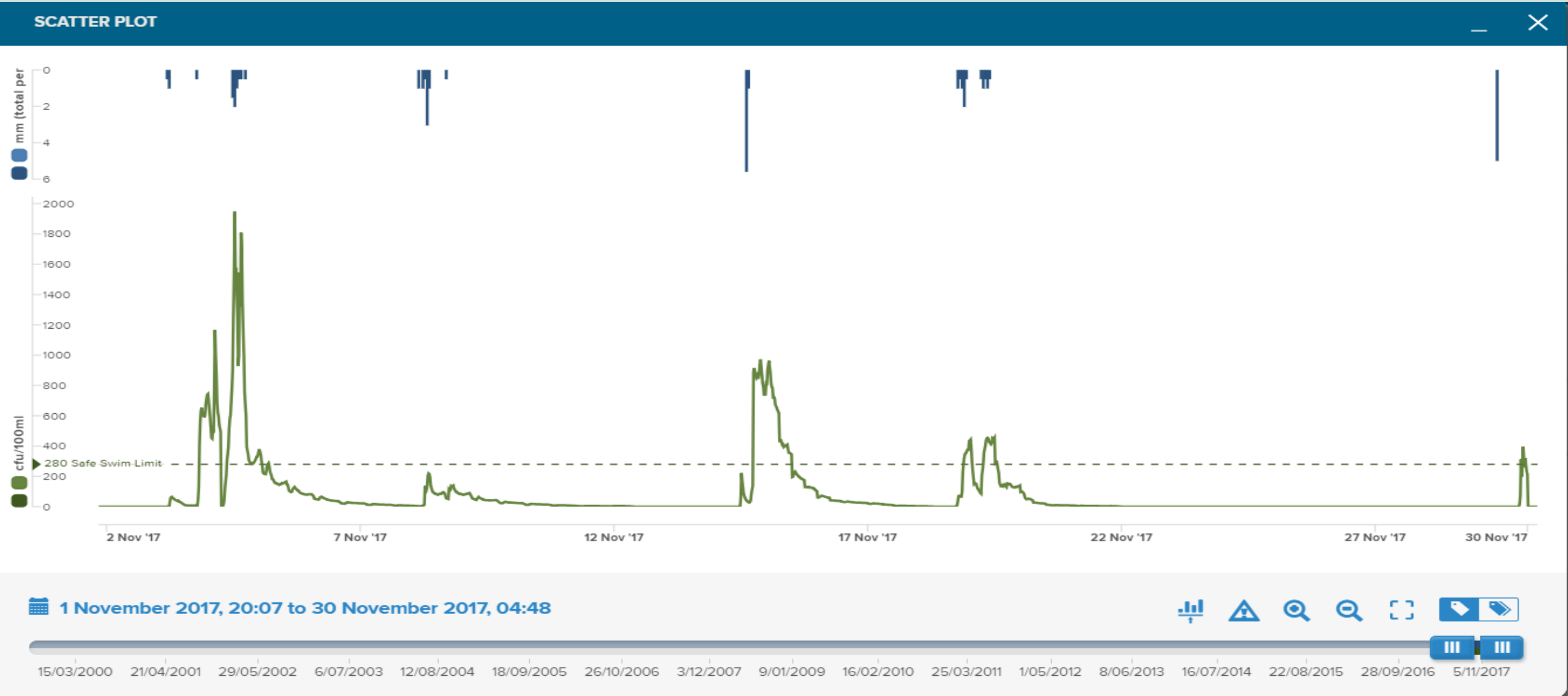
		Model forecast		
		Green	Amber	Red
Targetted sampling results	Green	3	1	1
	Amber	1	1	3
	Red	10	5	39

Model performance

- Assessment during 2016-17 austral summer
  - Comparison with weekly monitoring

Measure	Model forecast	Weekly monitoring
Accurate	43 of 64 = 67%	7 of 64 = 11%
Accurate or precautionary	48 of 64 = 75%	7 of 64 = 11%
False negatives (i.e. high risk)	16 of 64 = 25%	57 of 64 = 89%
Guideline exceedances detected	39 of 54 = 72%	2 of 54 = 4%

The value of real time data



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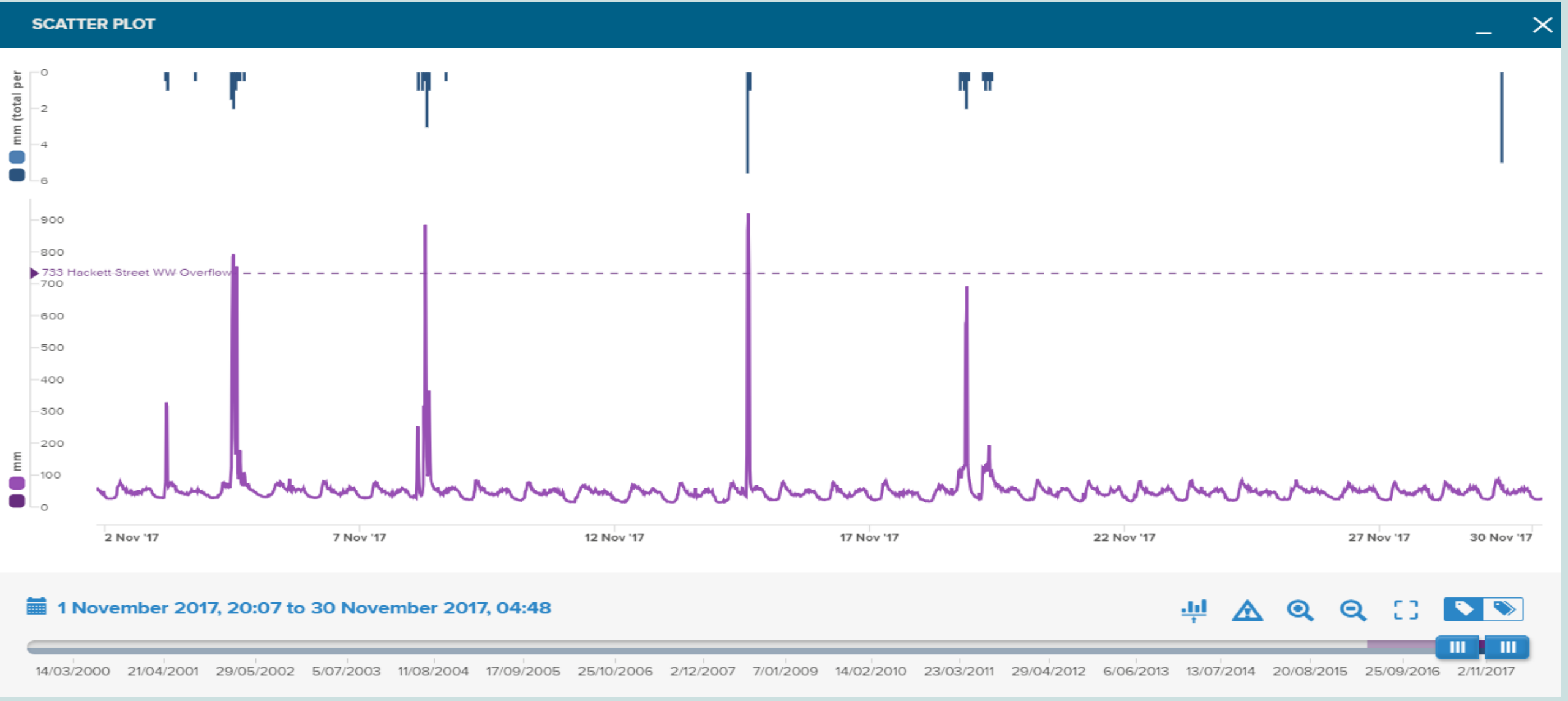

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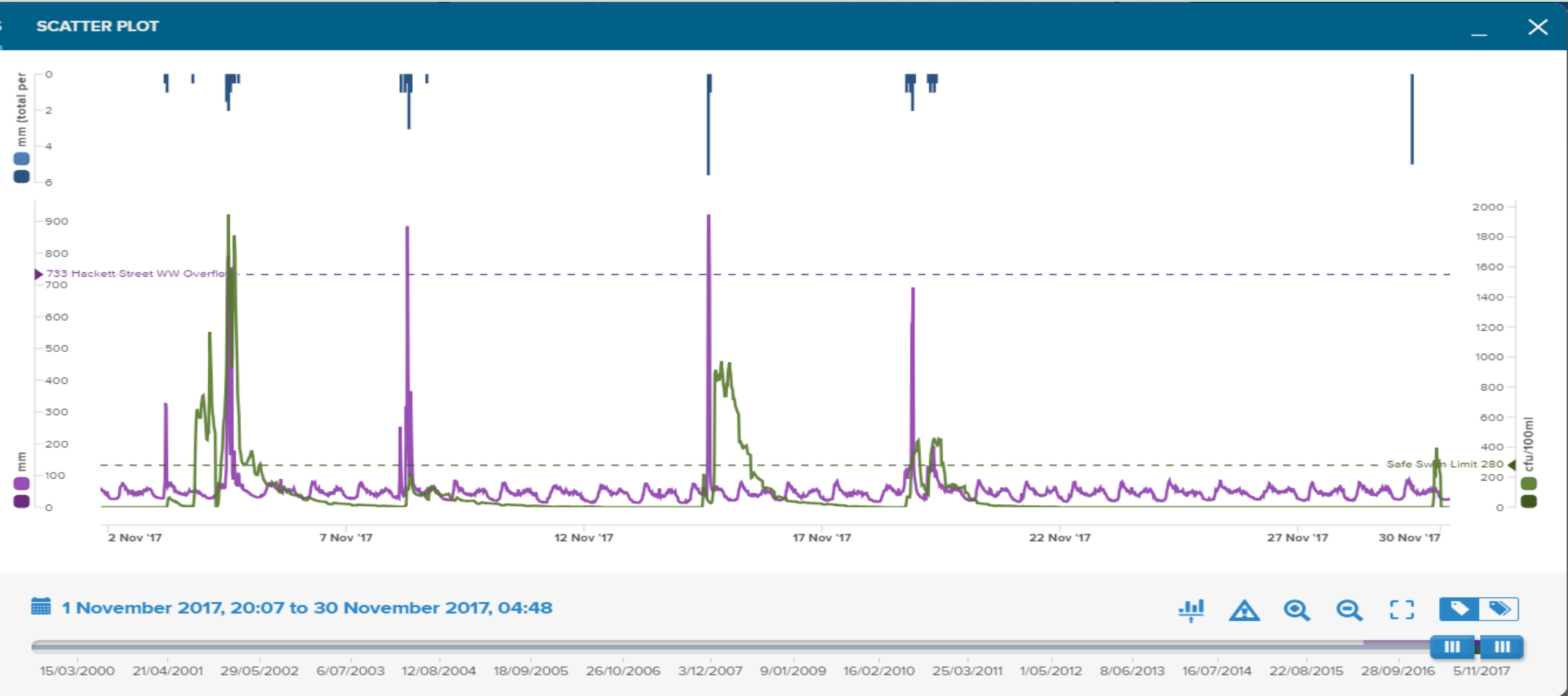

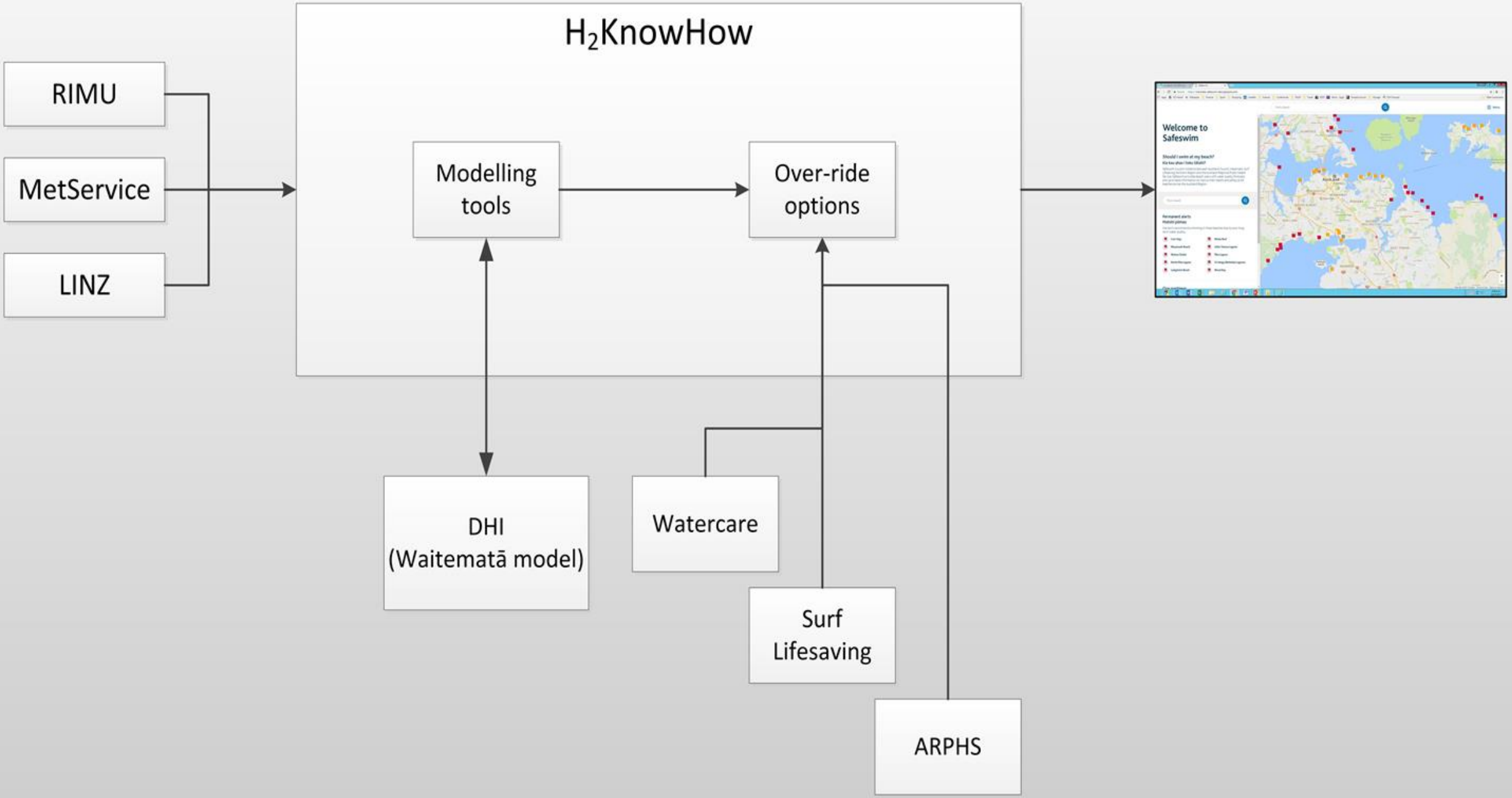
H2KnowHow
RIMU
MetService
LINZ
Modelling tools
Over-ride options
DHI (Waitematā model)
Watercare
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ARPHS
Welcome to Safeswim

New Safeswim

- Go live 3 November 2017
- Model based system
  - Real time monitoring
  - Manual alerts
- Intensive sampling to support models
  - Validation and refinement
  - Additional testing
    - Freshwater inputs
    - DNA-based testing for identifying source of contamination

NEW ZEALAND

Andrew Jeffs: Auckland beach warnings are backed by stringent testing

1 Mar, 2018 5:00am · 4 minutes to read

Signs warning the public of the presence of health risks at a beach are preferable to a summer-ruining gastro bug. Photo / Dean Purcell

NZ Herald
By: Andrew Jeffs

System performance

- 2018 assessment
  - ~Daily sampling
    - 17 days between 23 January and 16 February 2018
    - 3 beaches
      - Mission Bay
      - Okahu Bay
      - St Heliers

Date	Targetted sampling	Monitoring model	Safeswim model	Inactive model
23/1/18				
24/1/18				
25/1/18				
26/1/18				
30/1/18				
31/1/18				
1/2/18				
2/2/18				
5/2/18				
7/2/18				
8/2/18				
9/2/18				
12/2/18				
13/2/18				
14/2/18				
15/2/18				
16/2/18				

Date	Targetted sampling	Monitoring model	Safeswim model	Inactive model
23/1/18		False positive		
24/1/18				
25/1/18				
26/1/18				
30/1/18				
31/1/18				
1/2/18		False negative		
2/2/18		False positive		
5/2/18		False negative		
7/2/18		False positive		
8/2/18				
9/2/18				
12/2/18		False negative		
13/2/18				
14/2/18		False positive		
15/2/18				
16/2/18		False negative		

Date	Targetted sampling	Monitoring model	Safeswim model	Inactive model
23/1/18		False positive		
24/1/18				
25/1/18				
26/1/18				
30/1/18				
31/1/18				
1/2/18		False negative		
2/2/18		False positive		
5/2/18		False negative		
7/2/18		False positive		
8/2/18				
9/2/18			False positive	
12/2/18		False negative		
13/2/18				
14/2/18		False positive		
15/2/18				
16/2/18		False negative	False negative	

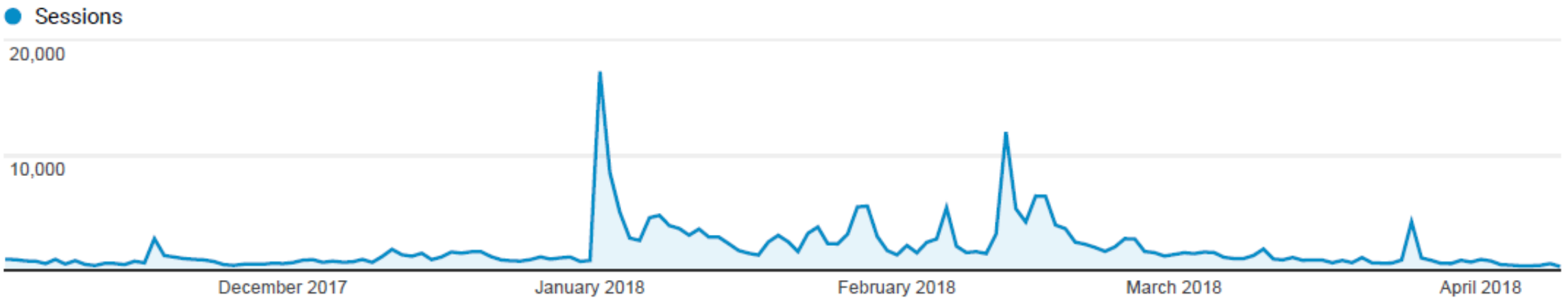
Date	Targetted sampling	Monitoring model	Safeswim model	Inactive model
23/1/18		False positive		
24/1/18				
25/1/18				
26/1/18				
30/1/18				
31/1/18				
1/2/18		False negative		False negative
2/2/18		False positive		
5/2/18		False negative		False negative
7/2/18		False positive		
8/2/18				
9/2/18			False positive	
12/2/18		False negative		False negative
13/2/18				False negative
14/2/18		False positive		
15/2/18				
16/2/18		False negative	False negative	False negative

Model performance

- 2018 Assessment
  - ~Daily sampling at Mission Bay

Measure	Safeswim model	Monitoring model	Inactive model
Accurate	15 of 17 = 88%	9 of 17 = 53%	12 of 17 = 71%
Accurate or precautionary	16 of 17 = 94%	15 of 17 = 76%	12 of 17 = 71%
False negatives (i.e. high risk)	1 of 17 = 6%	4 of 17 = 24%	5 of 17 = 30%
Guideline exceedances detected	4 of 5 = 80%	1 of 5 = 20%	0 of 5 = 0%

Programme awareness



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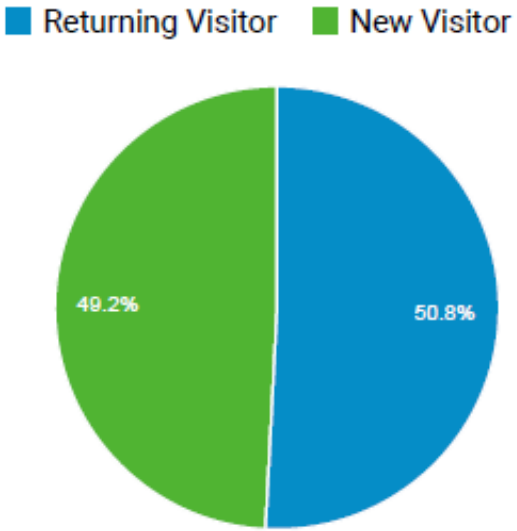


NZ

Programme awareness

NEW ZEALAND

John Roughan: Whatever has happened to 'she'll be right'?

6 Jan, 2018 5:00am

Influx of stomach bugs as Auckland's water quality drops

ADAM JACOBSON
Last updated 12:15, February 19 2018

ABIGAIL DOUGHERTY/STUFF

More than 30 Auckland beaches received health warnings in February after periods of heavy rain.

Cases of a waterborne bug which causes diarrhoea and nausea are rising across Auckland.

Auckland Regional Public Health Service (ARPHS) has reported a steadily increasing number of people with the microscopic parasite cryptosporidium, with 53 instances so far in February, compared to 29 in January and 11 in December.

Symptoms of cryptosporidiosis, which is contracted through contact with faeces, include diarrhoea, nausea, vomiting, stomach cramps, lack of appetite, and a fever, though some people show no symptoms.

NEW ZEALAND

Andrew Jeffs: Auckland beach warnings are backed by stringent testing

1 Mar, 2018 5:00am

4 minutes to read

Signs warning the public of the presence of health risks at a beach are preferable to a summer-ruining gastro bug. Photo / Dean Purcell

NZ Herald
By: Andrew Jeffs

Programme awareness

- Media analysis (Allpress et al, 2018)
  - 74 water quality articles since launch
    - 76% referred to Safeswim
  - 14% ‘negative impression’
    - ~50% balanced

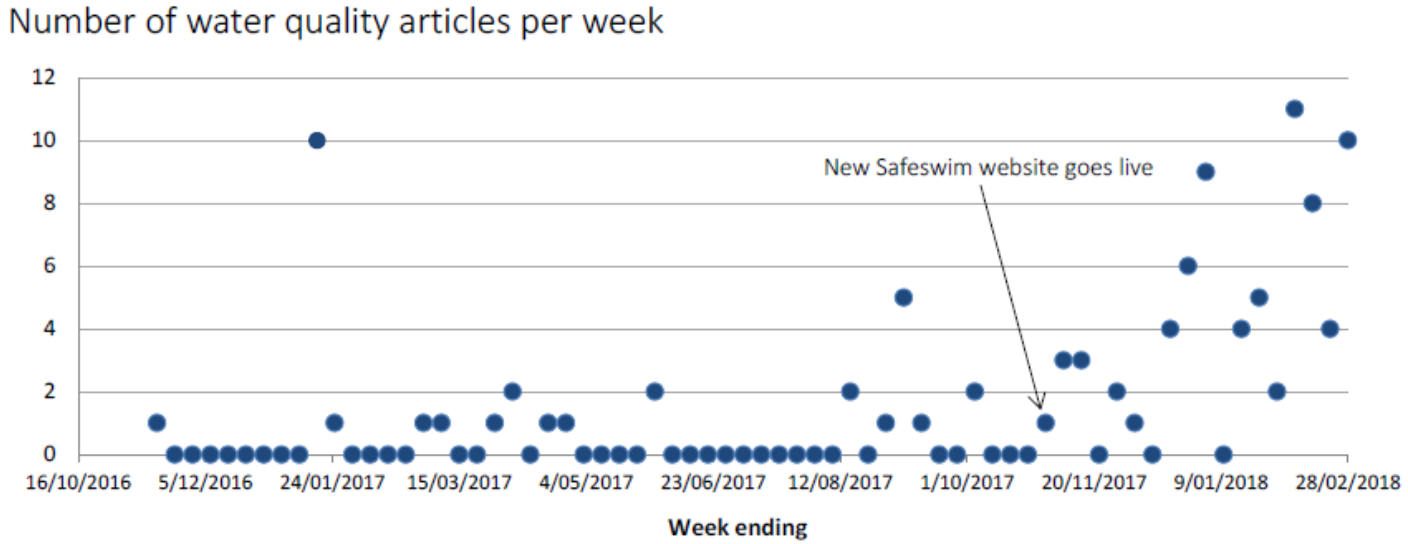


Figure 22. Number of media articles per week (Nov 2016 - February 2018)

Key points

- Public health risk at beaches
  - Solutions to many problems are long term, technically challenging and expensive
- Model performance superior to monitoring approach for managing public health risk at beaches
  - Only method that can provide risk information before exposure to the risk
  - Models can be configured to forecast 3 days in advance
- Transition to a model based approach is primarily a social challenge, less so a technology challenge
  - Innovation (contrary to guidelines) is difficult
  - Public communication and education key

Key points – rising to the challenge…

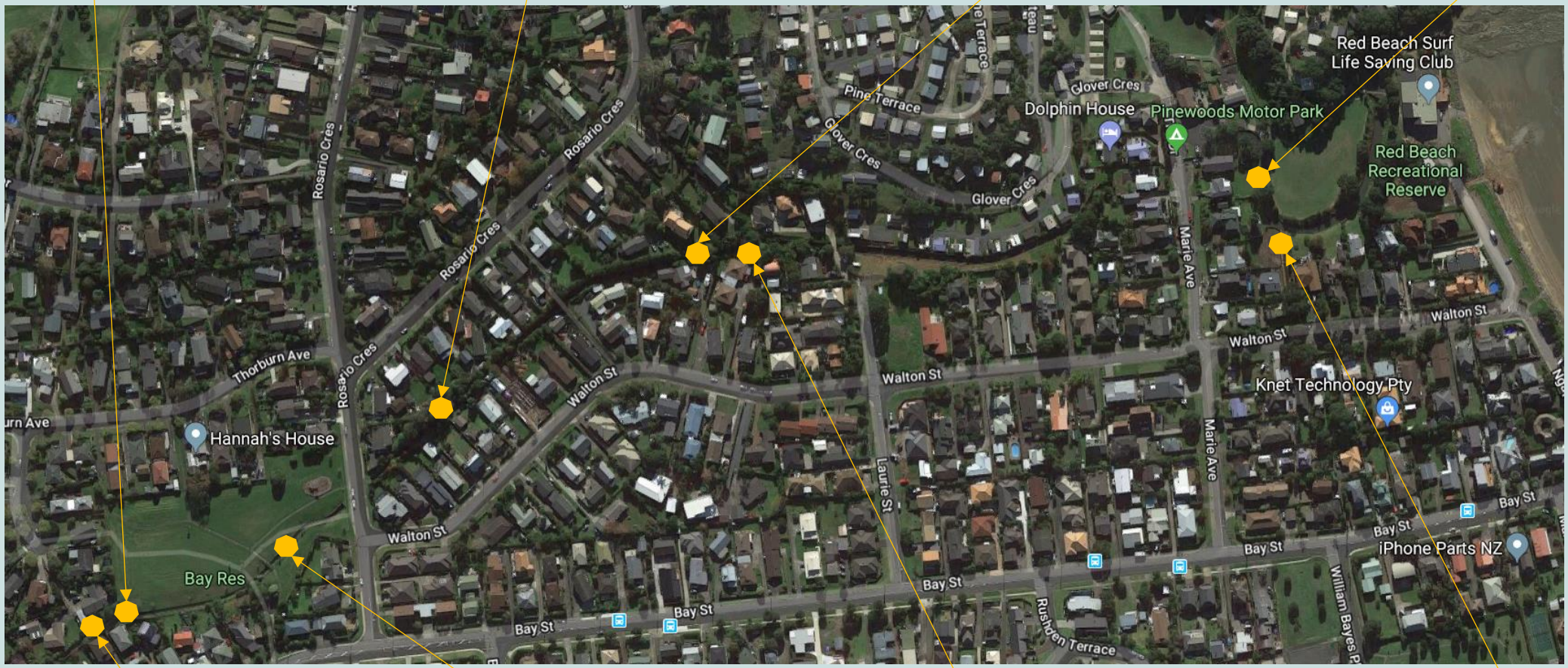
- Elevated importance of water quality
  - $7 billion in new LTP
  - Targeted water quality rate in LTP
- Safe Networks programme
  - Targeted identification and elimination of pollution sources
  - Guided by community outcomes (i.e. Safeswim)
    - Problem definition
    - Success = less Safeswim alerts
  - Tiered investigations
    - Beach scale
    - Identify problematic discharges
    - Network investigations
    - Surgical interventions

Site 3 SW pipe
(Rosario Res)

Site 8 SW pipe
(behind 131 Rosario Cres)

Site 7 SW pipe
(behind 107 Rosario Cres)

Site 2 Main Stream
(behind 21 Marie Avenue



Site 4 Main Stream
(Above all pipes)

Site 5 SW pipe
(Rosario Res)

Site 6 SW pipe
(behind 33 Walton Street)

Site 1 Tributary
(behind 15a Marie Avenue)

Site 3 – Stormwater pipe

- Rosario Reserve
  - 750mm SW pipe
  - Signs of detergents in wet weather

Date	Rain	E. Coli	DNA
5 February 2018	21	46,110	Human, dog & avian
5 April 2018	0	2,280	TBC

Site 3 SW pipe
(Rosario Res)

Site 8 SW pipe
(behind 131 Rosario Cres)

Site 7 SW pipe
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Site 2 Main Stream
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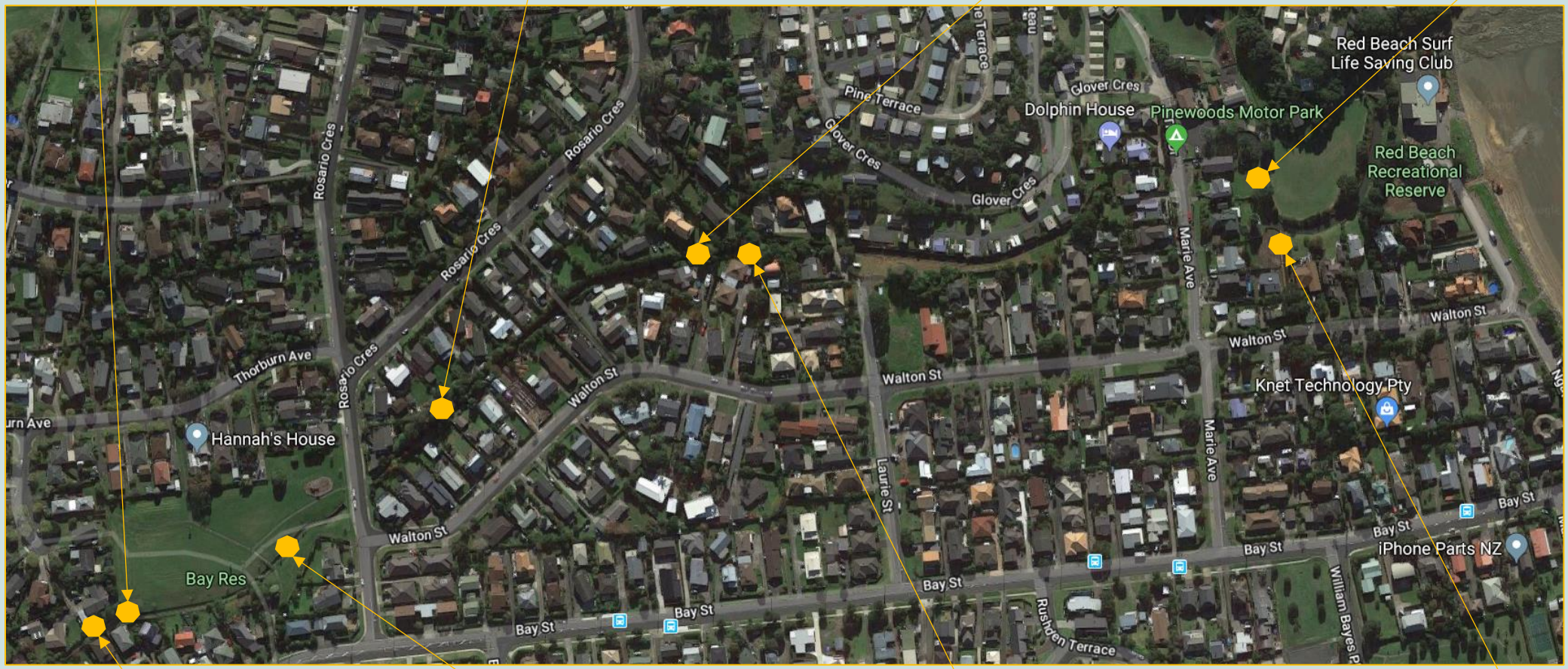

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The Safeswim partnership

Auckland Council
Te Kaunihera o Tāmaki Makaurau

SURF LIFE SAVING
NORTHERN REGION

Watercare
An Auckland Council Organisation

Auckland Regional Public Health Service
Rātonga Hauora ā Iwi o Tamaki Makaurau

AUCKLAND DISTRICT HEALTH BOARD
Te Toka Tumai

Waitemata District Health Board
Best Care for Everyone

COUNTIES MANUKAU HEALTH

Working with the people of Auckland, Waitemata and Counties Manukau

Acknowledgements

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