Safeswim - predicting recreational water quality at Auckland’s beaches

15th World Congress on Environmental Health
20 March 2018

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The Safeswim partnership

Auckland Council
Te Kaunihera o Tāmaki Makaurau

SURF LIFE SAVING
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An Auckland Council Organisation

Auckland Regional Public Health Service
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AUCKLAND DISTRICT HEALTH BOARD Te Toka Tumai
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COUNTIES MANUKAU HEALTH
Working with the people of Auckland, Waitemata and Counties Manukau

What is Safeswim?

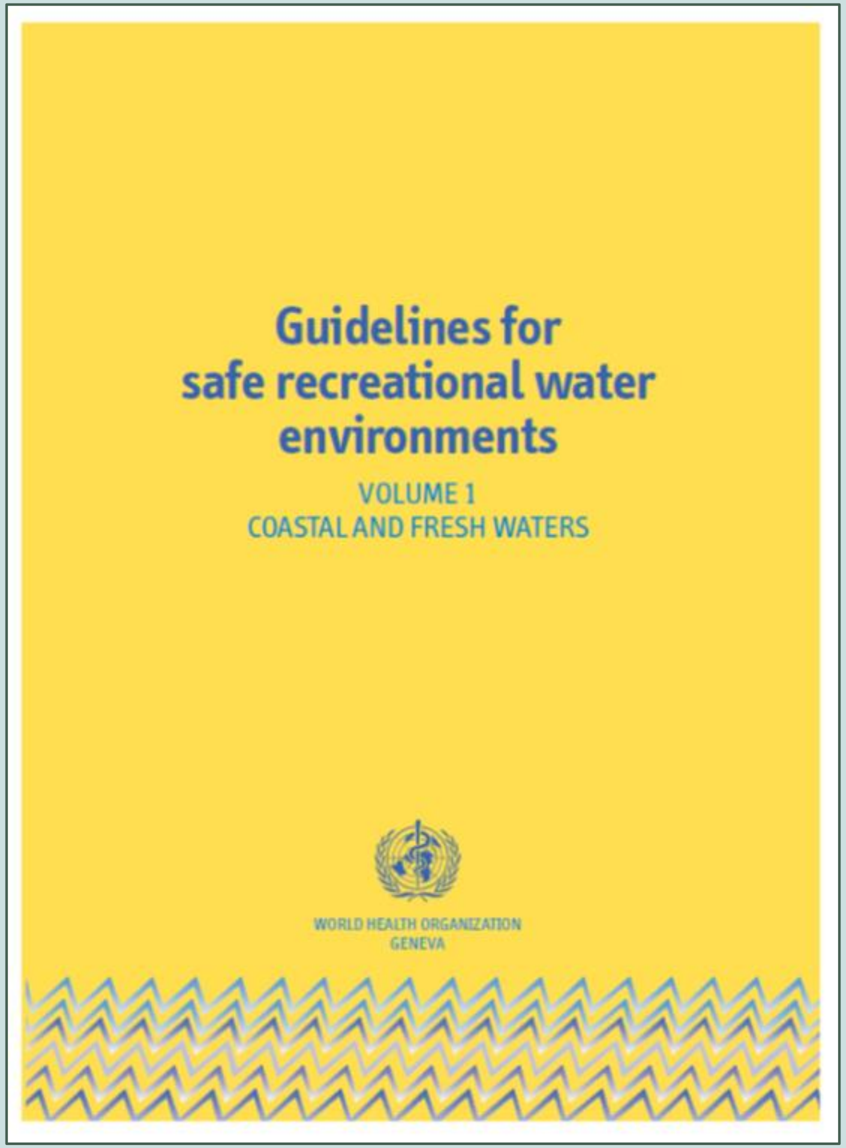
What is Safeswim?

- Public health risk from recreation in contaminated water
  - Multiple epidemiological studies
    - 250 million cases of gastrointestinal illness per annum
    - 50 million cases of respiratory illness
    - 2003 US$12 billion

- In Auckland, this risk is ‘managed’ through the Safeswim programme
  - Broadly consistent with WHO (2003) and NZ (2003) guidelines
  - Monitoring of Faecal Indicator Bacteria (FIB)
    - Enterococci in marine water
    - *E. coli* in fresh water

The Guidelines

- World Health Organisation
  - Published in 2001, modified in 2003



The Guidelines

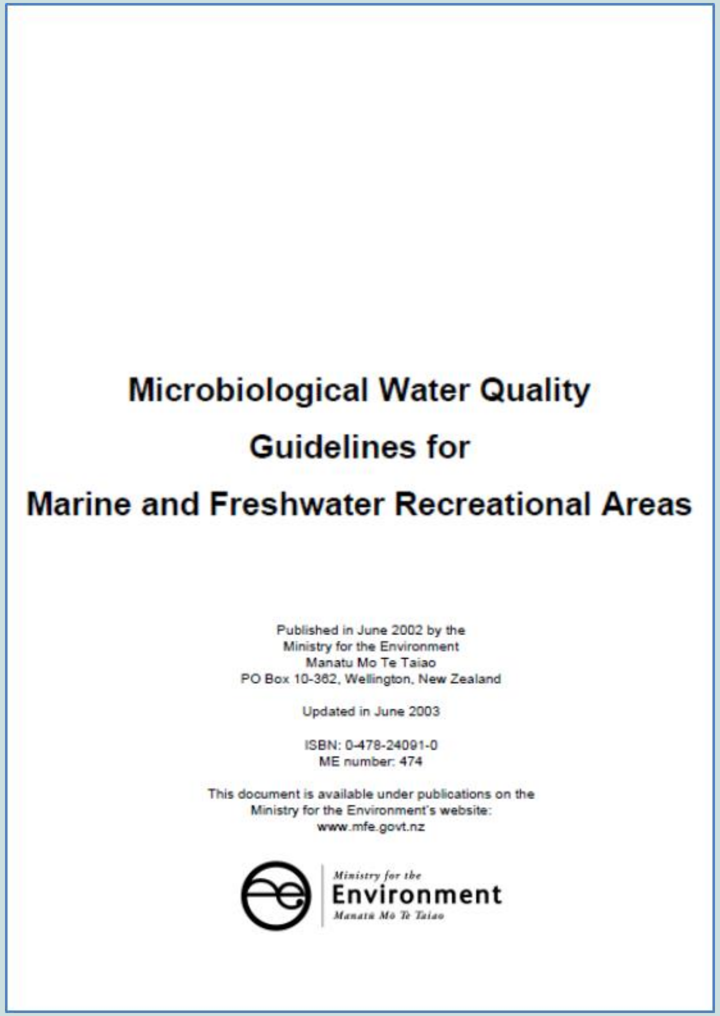
- World Health Organisation
  - Published in 2001, modified in 2003
- Described approach for grading beaches
  - Average risk based on long term data

TABLE 4.7. GUIDELINE VALUES FOR MICROBIAL QUALITY OF RECREATIONAL WATERS

95th percentile value of intestinal enterococci/100 ml (rounded values)	**Basis of derivation**	**Estimated risk per exposure**
≤40 **A**	This range is below the NOAEL in most epidemiological studies.	**<1% GI illness risk** **<0.3% AFRI risk** The upper 95th percentile value of 40/100 ml relates to an average probability of less than one case of gastroenteritis in every 100 exposures. The AFRI burden would be negligible.
41–200 **B**	The 200/100 ml value is above the threshold of illness transmission reported in most epidemiological studies that have attempted to define a NOAEL or LOAEL for GI illness and AFRI.	**1–5% GI illness risk** **0.3–1.9% AFRI risk** The upper 95th percentile value of 200/100 ml relates to an average probability of one case of gastroenteritis in 20 exposures. The AFRI illness rate at this upper value would be less than 19 per 1000 exposures, or less than approximately 1 in 50 exposures.
201–500 **C**	This range represents a substantial elevation in the probability of all adverse health outcomes for which dose–response data are available.	**5–10% GI illness risk** **1.9–3.9% AFRI risk** This range of 95th percentiles represents a probability of 1 in 10 to 1 in 20 of gastroenteritis for a single exposure. Exposures in this category also suggest a risk of AFRI in the range of 19–39 per 1000 exposures, or a range of approximately 1 in 50 to 1 in 25 exposures.
>500 **D**	Above this level, there may be a significant risk of high levels of minor illness transmission.	**>10% GI illness risk** **>3.9% AFRI risk** There is a greater than 10% chance of gastroenteritis per single exposure. The AFRI illness rate at the 95th percentile point of >500/100 ml would be greater than 39 per 1000 exposures, or greater than approximately 1 in 25 exposures.

The Guidelines

- New Zealand (MfE/MoH)
  - Published in 2002, modified in 2003
- Replicated WHO approach for grading beaches
- Added a ‘surveillance’ mode based on single sample results
  - USEPA
  - Australia
  - Europe



Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas

Published in June 2002 by the
Ministry for the Environment
Manatu Mo Te Taiao
PO Box 10-362, Wellington, New Zealand

Updated in June 2003

ISBN: 0-478-24091-0
ME number: 474

This document is available under publications on the
Ministry for the Environment's website:
www.mfe.govt.nz

Surveillance monitoring

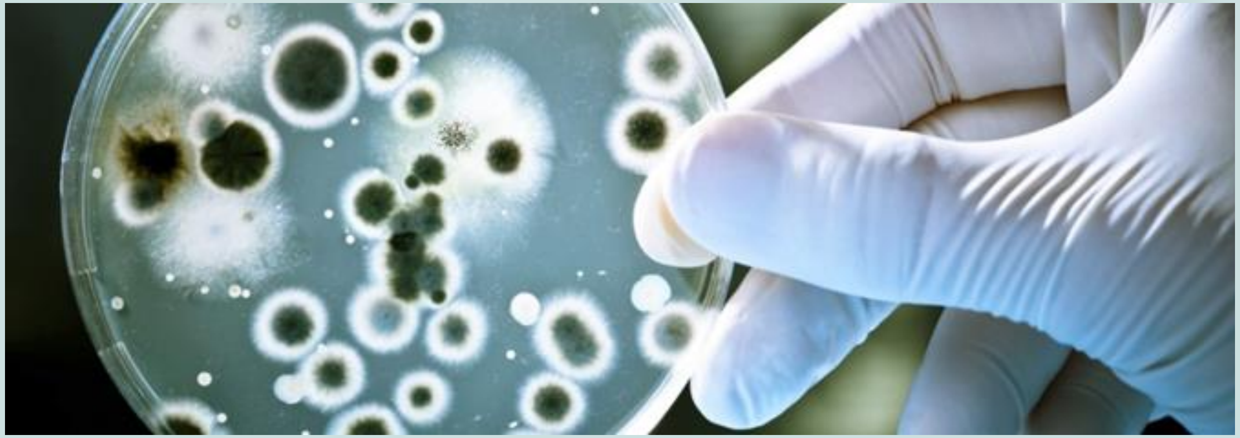
- Two key problems
  - Weekly monitoring underestimates frequency of contamination events
    - Missed 70% of guideline exceedances in California study

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

Surveillance monitoring

- Two key problems
  - Weekly monitoring underestimates frequency of contamination events
    - Missed 70% of guideline exceedances
  - Time delay between sample collection and results available
    - Water quality varies quicker than the analysis time (~48 hours)



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

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


NEW ZEALAND

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

6 Jan, 2018 5:00am

4 minutes to read

Havelock North effect

Ministry report reveals Havelock water failed annual bacteria test before outbreak

22 Apr, 2017 5:38pm

3 minutes to read

NEW ZEALAND

1 news now

'Third world problems'- Reporters discuss NZ's drinking water after gastro outbreak in Hawkes Bay

Sat, Dec 9

Share

Source: 1 news

What about recreation?

Gastrointestinal Illness among Triathletes Swimming in Non-Polluted versus Polluted Seawater Affected by Heavy Rainfall, Denmark, 2010-2011

Nina Majlund Harder-Lauridsen[1], Katrin Gaardbo Kuhn[1], Anders Christian Erichsen[2], Kåre Mølbak[1], Steen Ethelberg[1*]

1 Department of Infectious Disease Epidemiology, Statens Serum Institut, Copenhagen, Denmark, 2 DHI Group, Hørsholm, Denmark

Abstract

Recent years have seen an increase in the frequency of extreme rainfall and subsequent flooding across the world. Climate change models predict that such flooding will become more common, triggering sewer overflows, potentially with increased risks to human health. In August 2010, a triathlon sports competition was held in Copenhagen, Denmark, shortly after an extreme rainfall. The authors took advantage of this event to investigate disease risks in two comparable cohorts of physically fit, long distance swimmers competing in the sea next to a large urban area. An established model of bacterial concentration in the water was used to examine the level of pollution in a spatio-temporal manner. Symptoms and exposures among athletes were examined with a questionnaire using a retrospective cohort design and the questionnaire investigation was repeated after a triathlon competition held in non-polluted seawater in 2011. Diagnostic information was collected from microbiological laboratories. The results showed that the 3.8 kilometer open water swimming competition coincided with the peak of post-flooding bacterial contamination in 2010, with average concentrations of 1.5×10^4 *E. coli* per 100 ml water. The attack rate of disease among 838 swimmers in 2010 was 42% compared to 8% among 931 swimmers in the 2011 competition (relative risk (RR) 5.0; 95% CI: 4.0-6.39). In 2010, illness was associated with having unintentionally swallowed contaminated water (RR 2.5; 95% CI: 1.8-3.4); and the risk increased with the number of mouthfuls of water swallowed. Confirmed aetiologies of infection included *Campylobacter, Giardia lamblia* and diarrhoeagenic *E. coli*. The study demonstrated a considerable risk of illness from water intake when swimming in contaminated seawater in 2010, and a small but measureable risk from non-polluted water in 2011. This suggests a significant risk of disease in people ingesting small amounts of flood water following extreme rainfall in urban areas.

In Auckland

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NEW ZEALAND / HEALTH

Surge in Auckland stomach bug complaints after storms

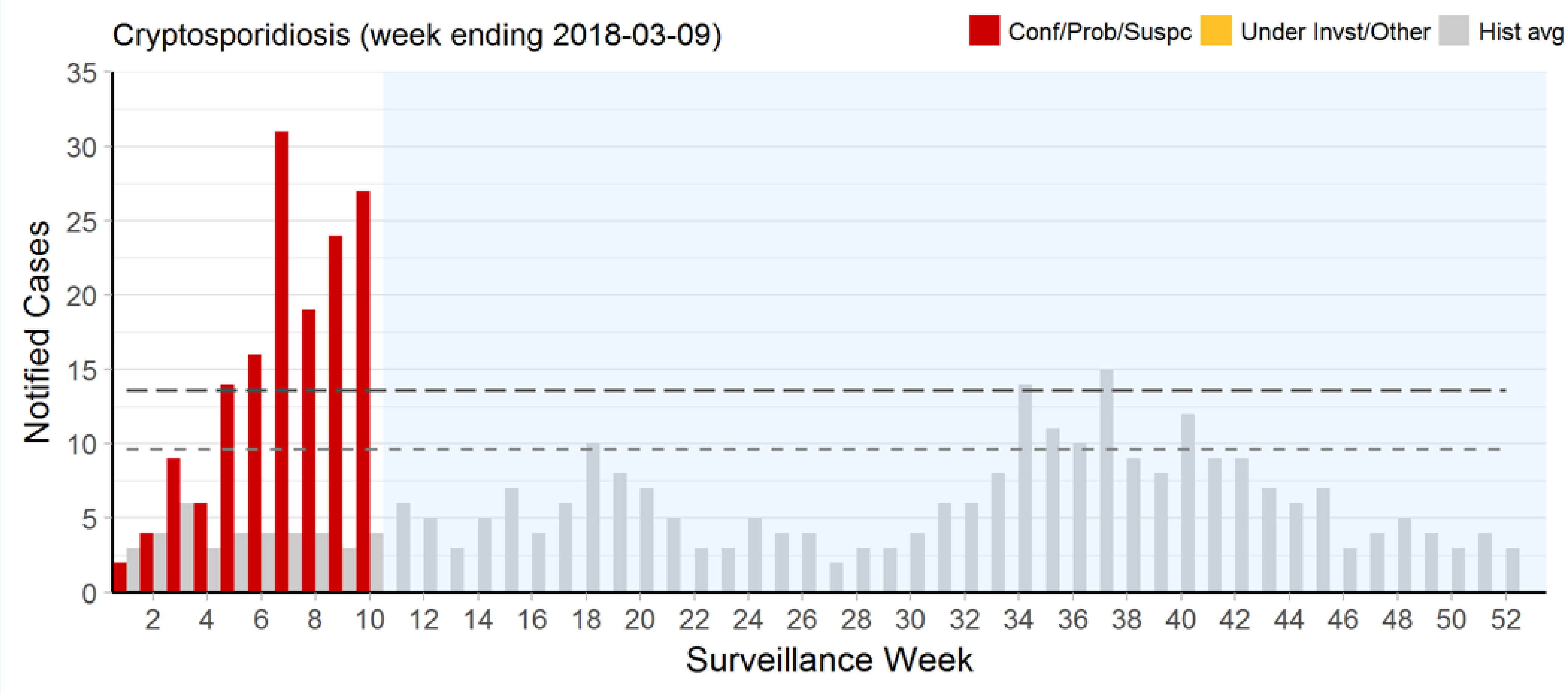
3:07 pm on 18 August 2017

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.

In Auckland



Cryptosporidiosis (week ending 2018-03-09)
Conf/Prob/Suspc
Under Invst/Other
Hist avg
Notified Cases
0
5
10
15
20
25
30
35
2
4
6
8
10
12
14
16
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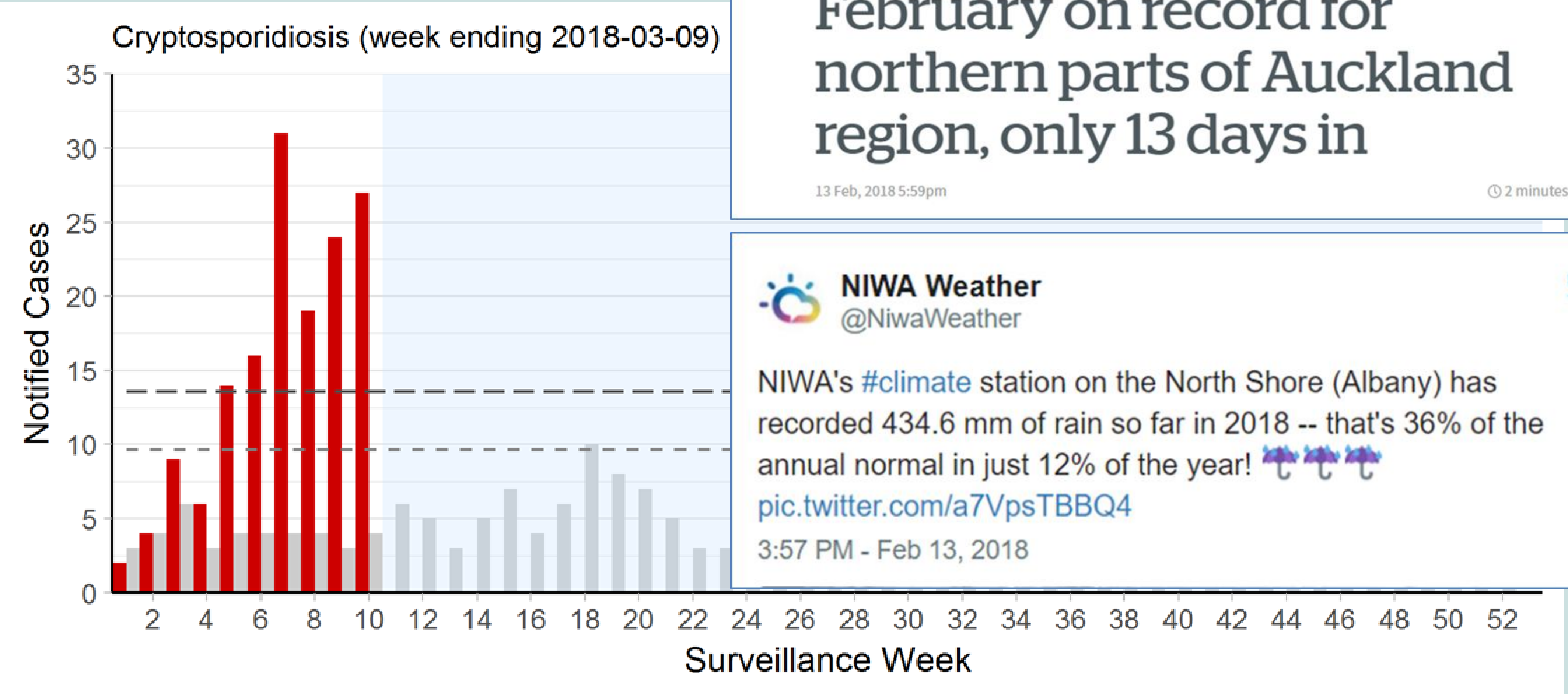
52
Surveillance Week

In Auckland



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Soggy start to the year: Wettest February on record for northern parts of Auckland region, only 13 days in

13 Feb, 2018 5:59pm

2 minutes to read

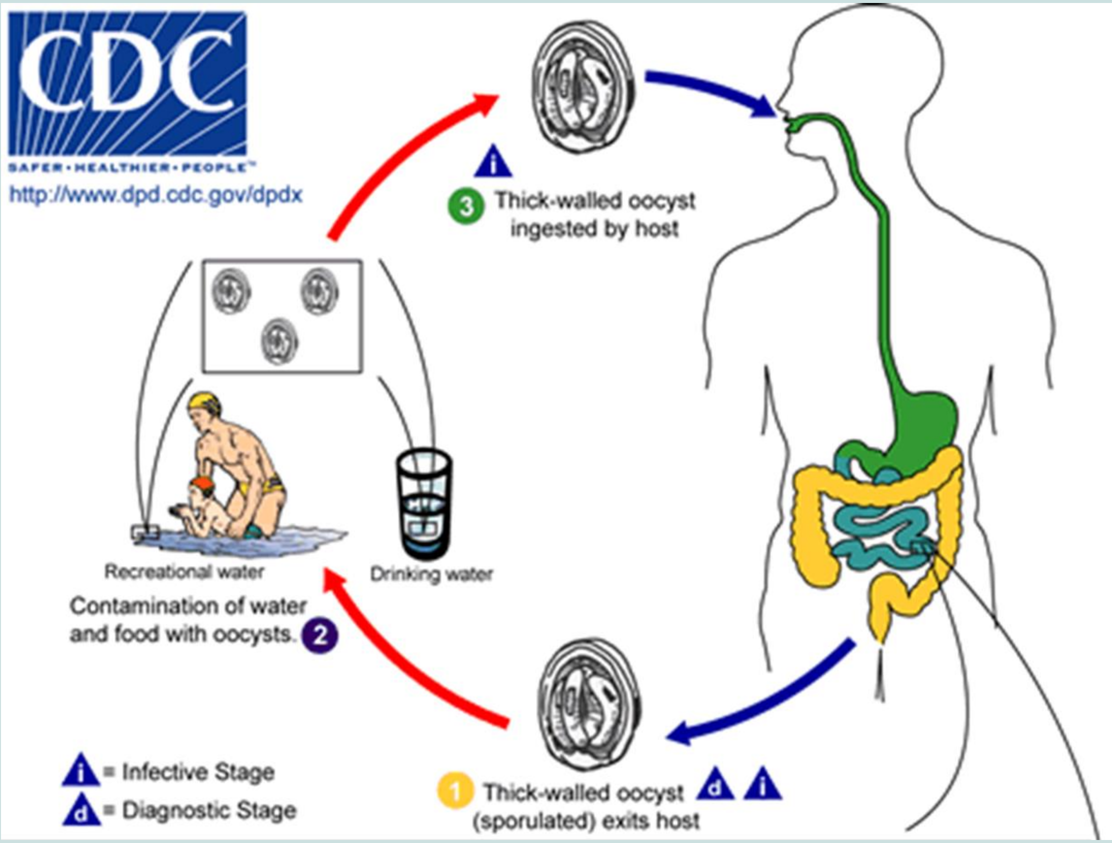
NIWA Weather
@NiwaWeather

NIWA's #climate station on the North Shore (Albany) has recorded 434.6 mm of rain so far in 2018 -- that's 36% of the annual normal in just 12% of the year! ☔☔☔
pic.twitter.com/a7VpsTBBQ4

3:57 PM - Feb 13, 2018

Problem definition

- Flawed monitoring programme
  - Water quality problems under assessed
- Poor water quality after rainfall
- Potential 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

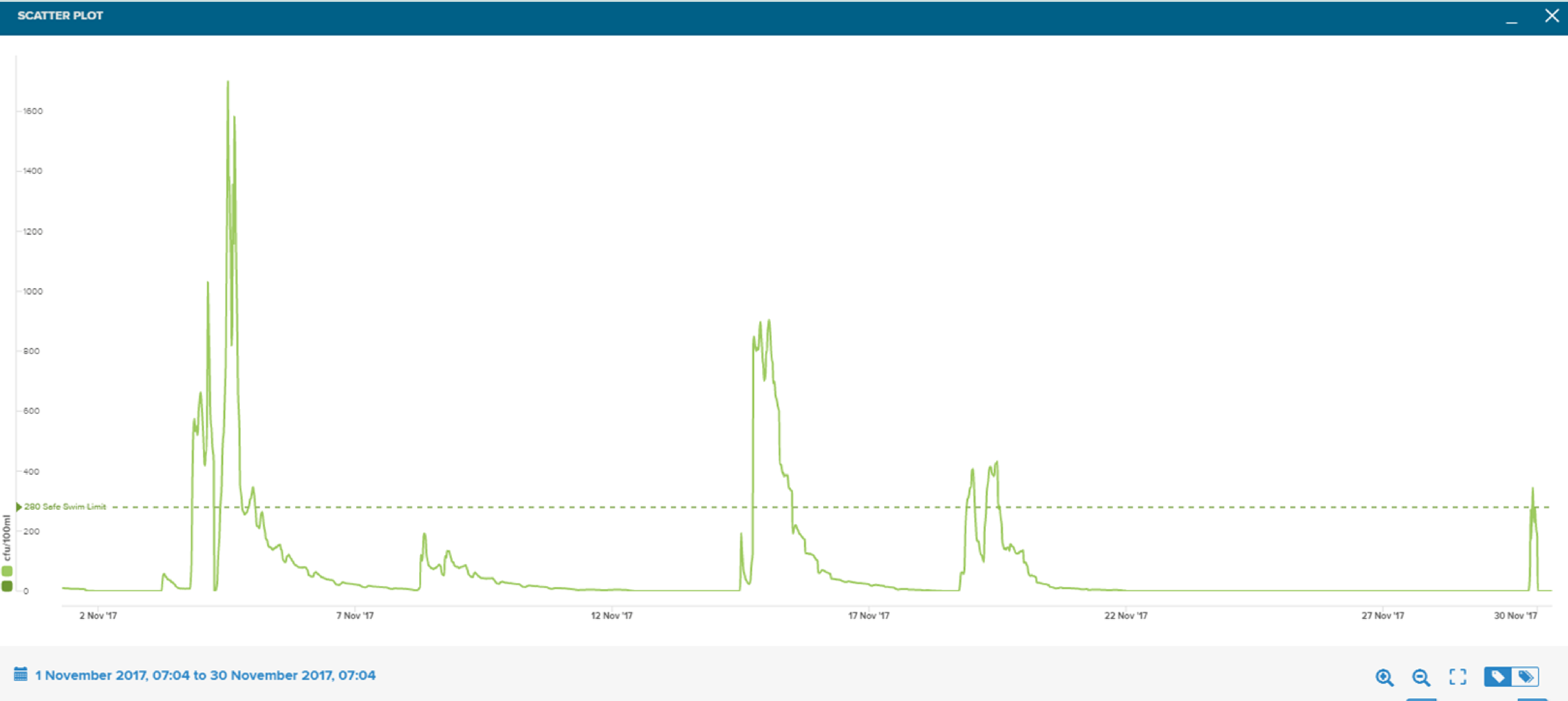
		Model forecast		
		Green	Amber	Red
Targetted sampling results	Green	3	1	1
	Amber	1	1	3
	Red	10	5	39

Model performance

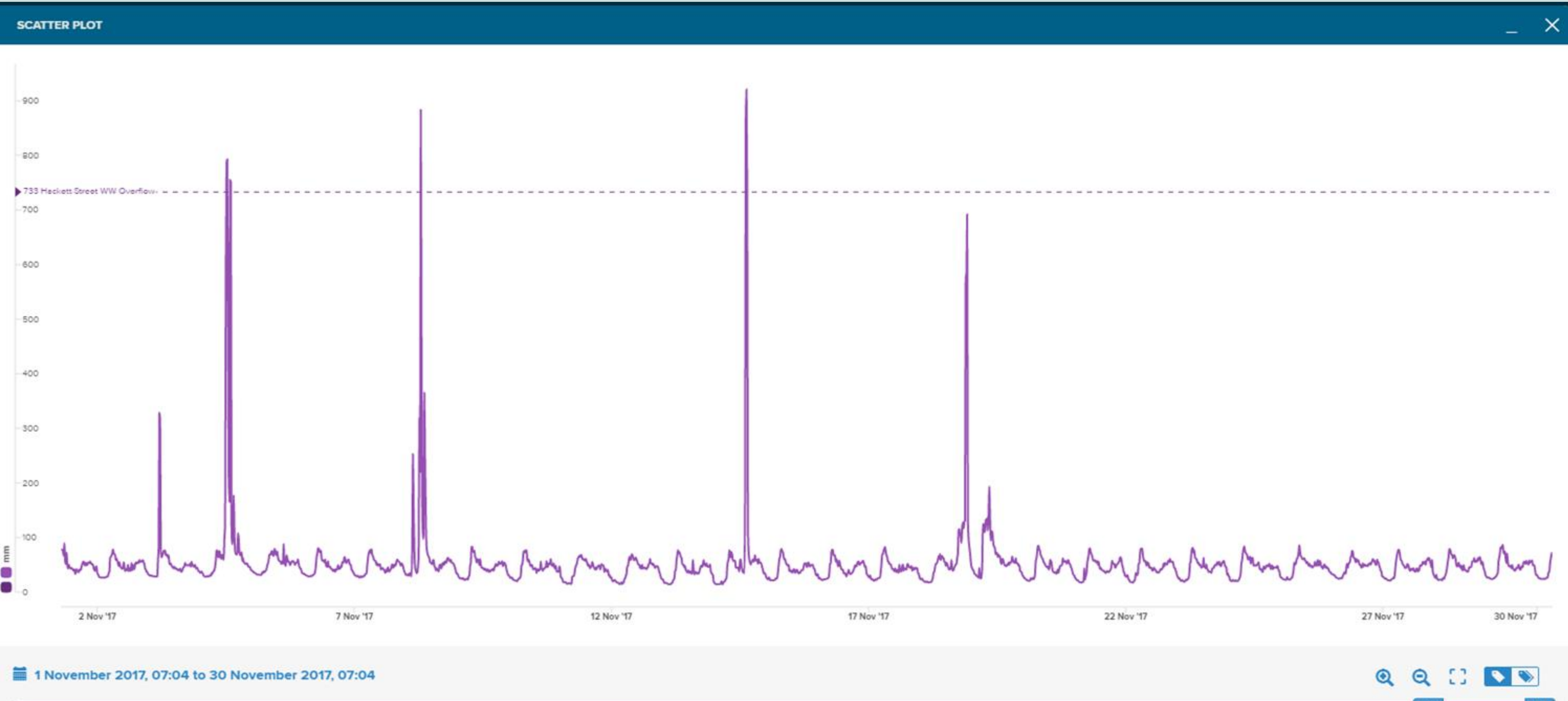
- Assessment during 2016-17 austral summer
  - Comparison with weekly monitoring

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%

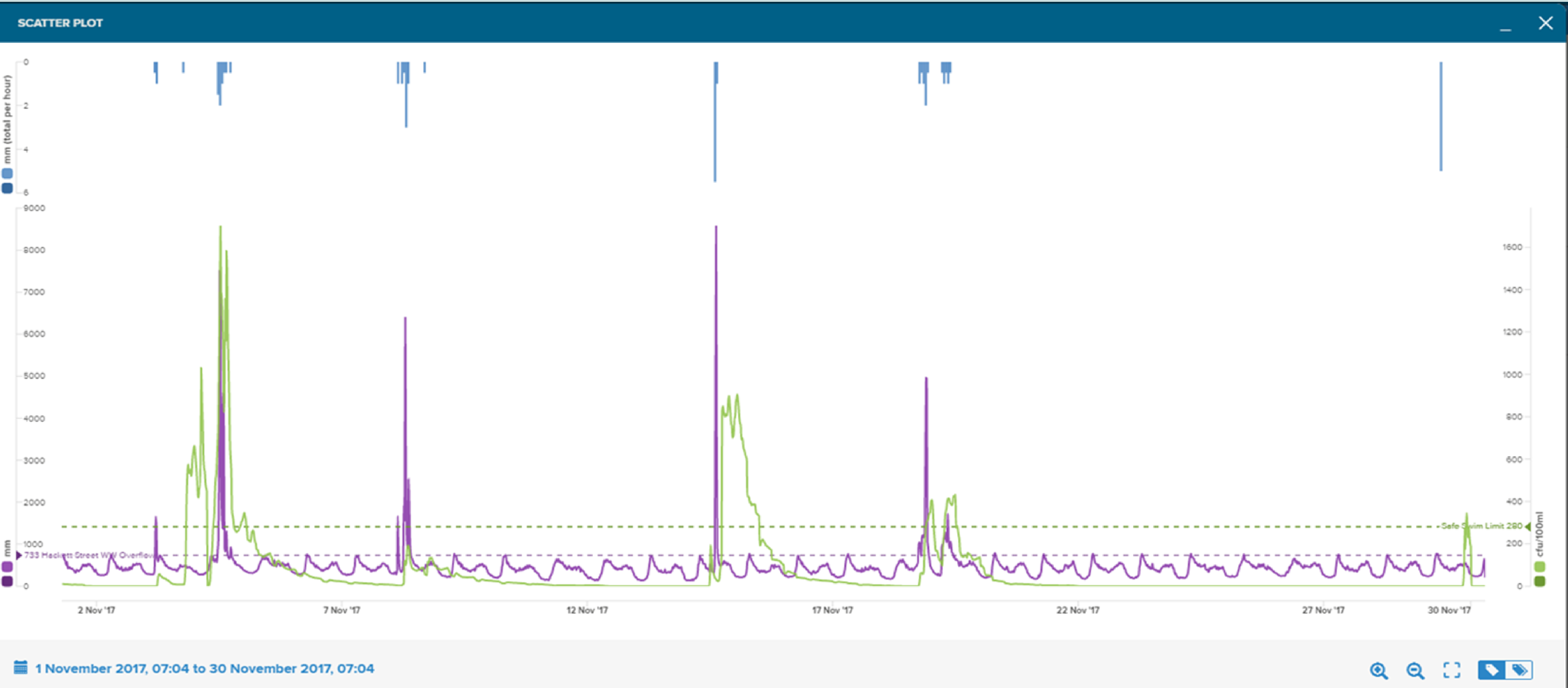
The value of real time data

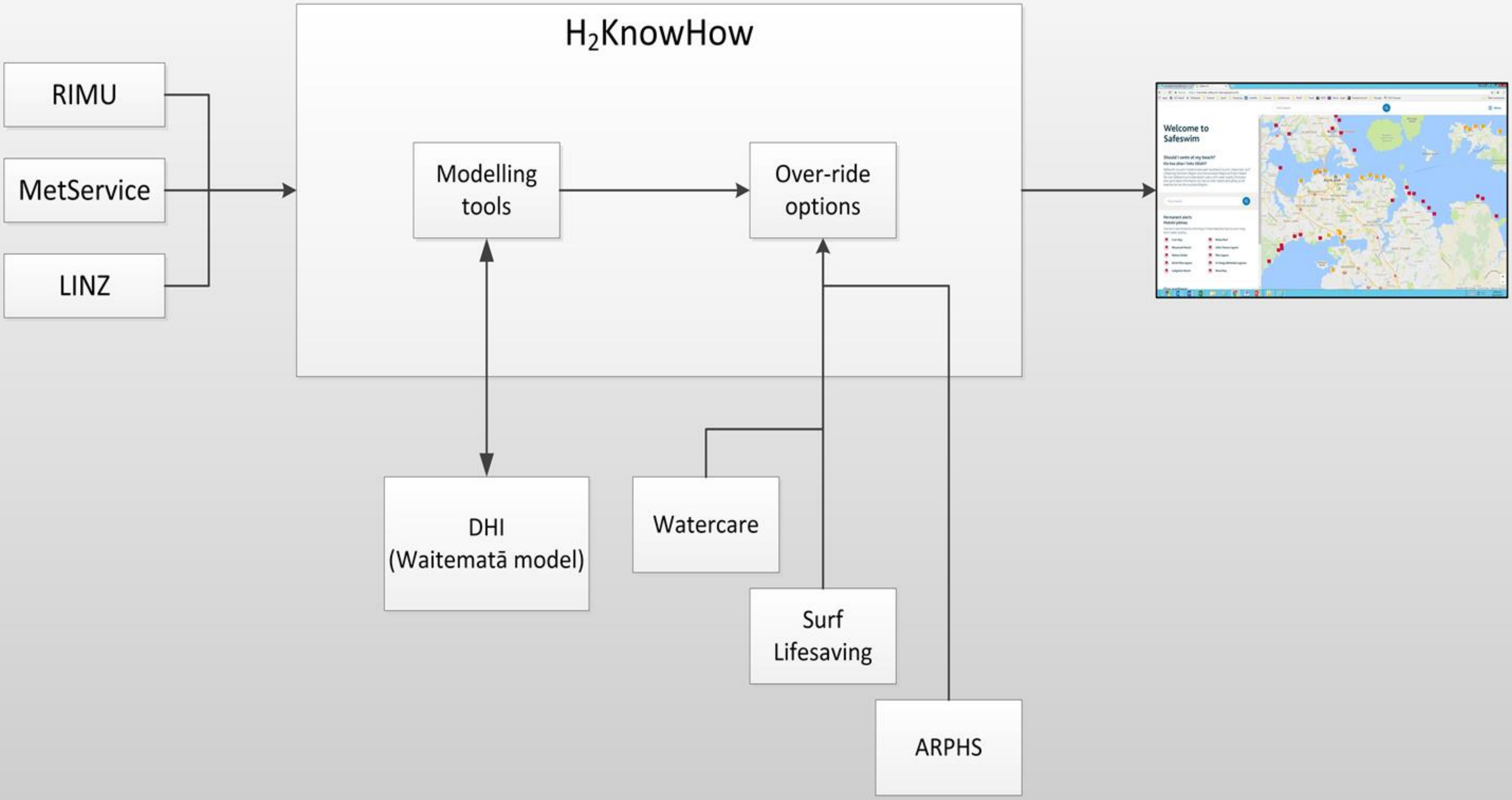


The value of real time data



The value of real time data





H$_2$KnowHow
RIMU
MetService
LINZ
Modelling tools
Over-ride options
DHI (Waitematā model)
Watercare
Surf Lifesaving
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

Model performance

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

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Date	Targetted sampling	Safeswim model	Persistence 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	Targeted sampling	Safeswim model	Persistence 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				

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Model performance

- 2018 Assessment
  - ~Daily sampling at Mission Bay

Measure	Safeswim model	Persistence 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%

Key points

- Public health risk at our beaches
  - Solutions to problems are long term, technically challenging and expensive
- Model performance superior to monitoring approach for managing public health risk at Auckland’s 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

Safeswim | H2KnowHow | Auckland Council GeoMaps | Wairau @ Testing Station | Auckland - Radar Area | Programme Overview | Auckland's Safeswim a

Secure | https://www.safeswim.org.nz

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Water quality forecast

Today

Morning	Afternoon	Evening
Low risk	Low risk	Low risk

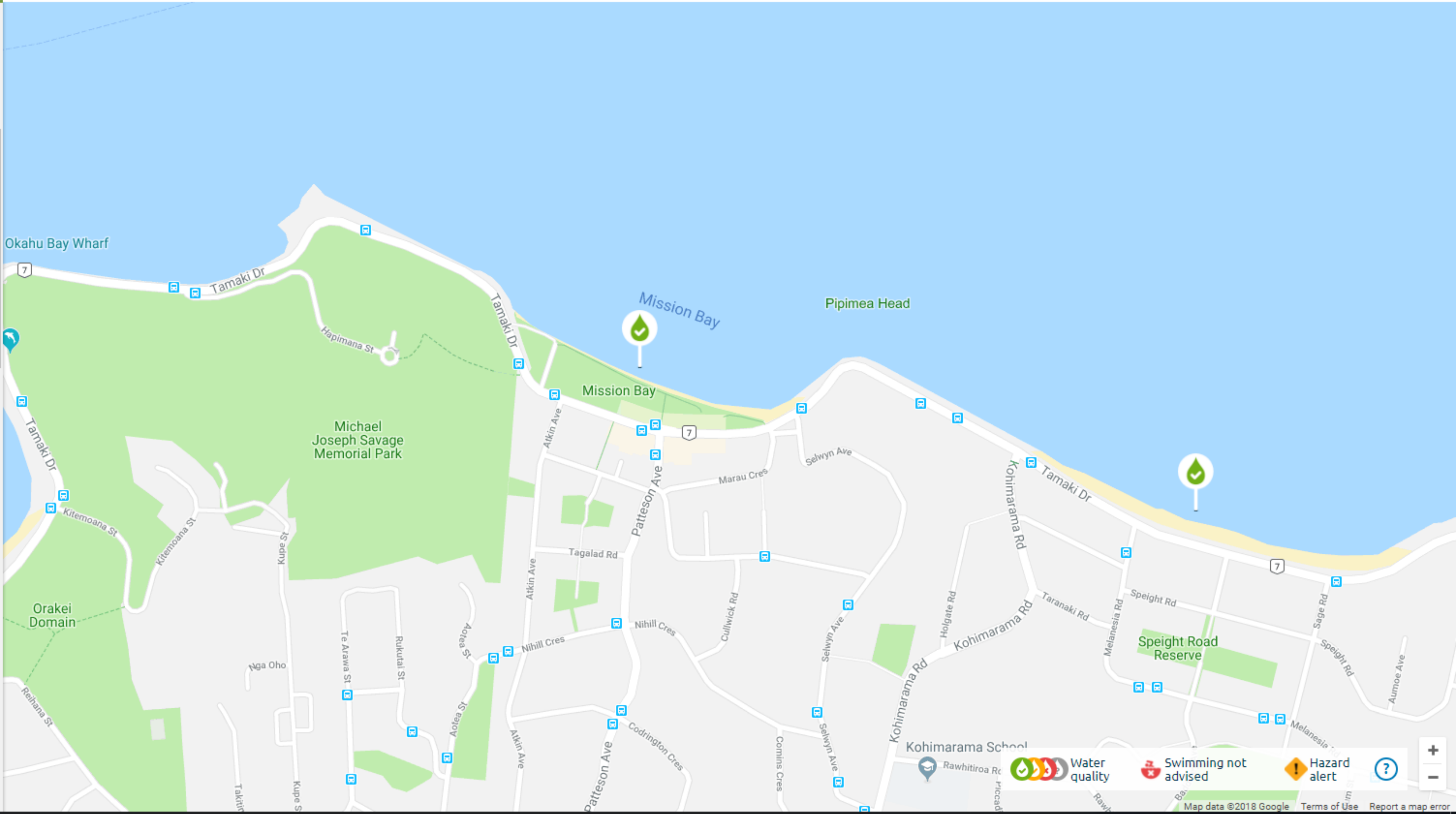
Tomorrow

Morning	Afternoon	Evening
Low risk	Low risk	Low risk

- Show more

Thursday

Morning	Afternoon	Evening
Low risk	Low risk	Low risk



ENG US 8:52 AM 20/03/2018

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