Northland Regional Council Recreational Swimming Programme
Safeswim Summer Review 2023/2024

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1.0 Background

1.1 Recreational Swimming Water Quality Programme

Northland's Recreational Swimming Water Quality Programme (RSWQP) has been running since 2009. The programme was developed utilising the Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas (MfE, 2003). The aim of the programme is to provide information on microbiological contamination at popular freshwater and coastal swimming sites around Northland, allowing the public to make informed decisions on where to swim. The RSWQP was established as a joint project administered by Northland Regional Council (NRC) in partnership with Ngā Tai Ora, Te Whatu Ora – Health New Zealand, Far North District Council (FNDC), Whangārei District Council (WDC) and Kaipara District Council (KDC).

The national guidelines outline categories of faecal indicator bacteria for recreational swimming sites based on a known relationship between faecal indicator bacteria and pathogens. *Escherichia coli* (*E. coli*) and enterococci are used in the national guidelines as indicators of microbial contamination at freshwater or coastal swimming sites respectively. The national guidelines outline three response categories – these are shown in Table 1.

Table 1. National guideline categories for recreational swimming sites and associated responses.

Category	Freshwater sites (E. coli)	Open Coastal Sites (Enterococci)	Enclosed Coastal Sites (Enterococci)	Response
Surveillance	≤260/100mL	≤140/100mL	≤140/100mL	No response necessary – continue weekly sampling.
Alert	260-550/100mL	140-280/100mL	140 - 280/100mL	Collect follow-up sample. Consider microbial source tracking to isolate source of faecal contamination.
Action	>550/100mL	>280/100mL	>280/100mL	Collect follow-up sample. Undertake microbial source tracking to isolate source of faecal contamination. Undertake sanitary survey when applicable. Erect warning signs.

The RSWQP traditionally started each year in December and finished in March, with samples collected every Monday and sample results received on Wednesday. This 48-hr window between sampling taking place and results being communicated to the public is a shortfall of this approach. For instance, by the time sample results are communicated to the public the conditions may have changed at the sampled swimming site(s). Thus, any information communicated about sample results collected using this method is out-of-date and may not reflect the present water quality status at Northland's swimming sites.

1.2 Safeswim

Recognising the limitations of the traditional RSWQP sampling approach, Auckland Council developed the Safeswim programme in 2017 to provide real-time water quality predictions. This programme ensures water users can make informed decisions on when and where to swim based on current information. Safeswim achieves this by combining current environmental data (e.g., rainfall) with predictive models that are underpinned by regular sampling, together allowing real-time microbial water quality predictions to be made at monitored swimming sites. Ultimately, Safeswim has proven to be a very successful and useful tool for informing the public of recreational swimming health risks and is currently recognised by the World Health Organisation as best practice.

The Northland Regional Council - along with our other Northland partners - recognised the benefits of predictive modelling for Northland's recreational swimming sites. Working with Auckland Council and other Safeswim partners, Council looked to utilise the wealth of water quality data collected over the years to develop predictive models at our monitored swimming sites. To date, over 16,000 samples (alongside continuous hydrological data) have been collected at 100+ swimming sites across Northland since the RSWQP began. Following a successful trial using this data, 49 coastal and 19 freshwater sites went live on Safeswim on 1 December 2022 (see Figure 1). In 2023, 6 coastal swimming sites were added to Safeswim. Therefore, 56 coastal and 19 freshwater swimming sites around Northland are currently live on Safeswim.
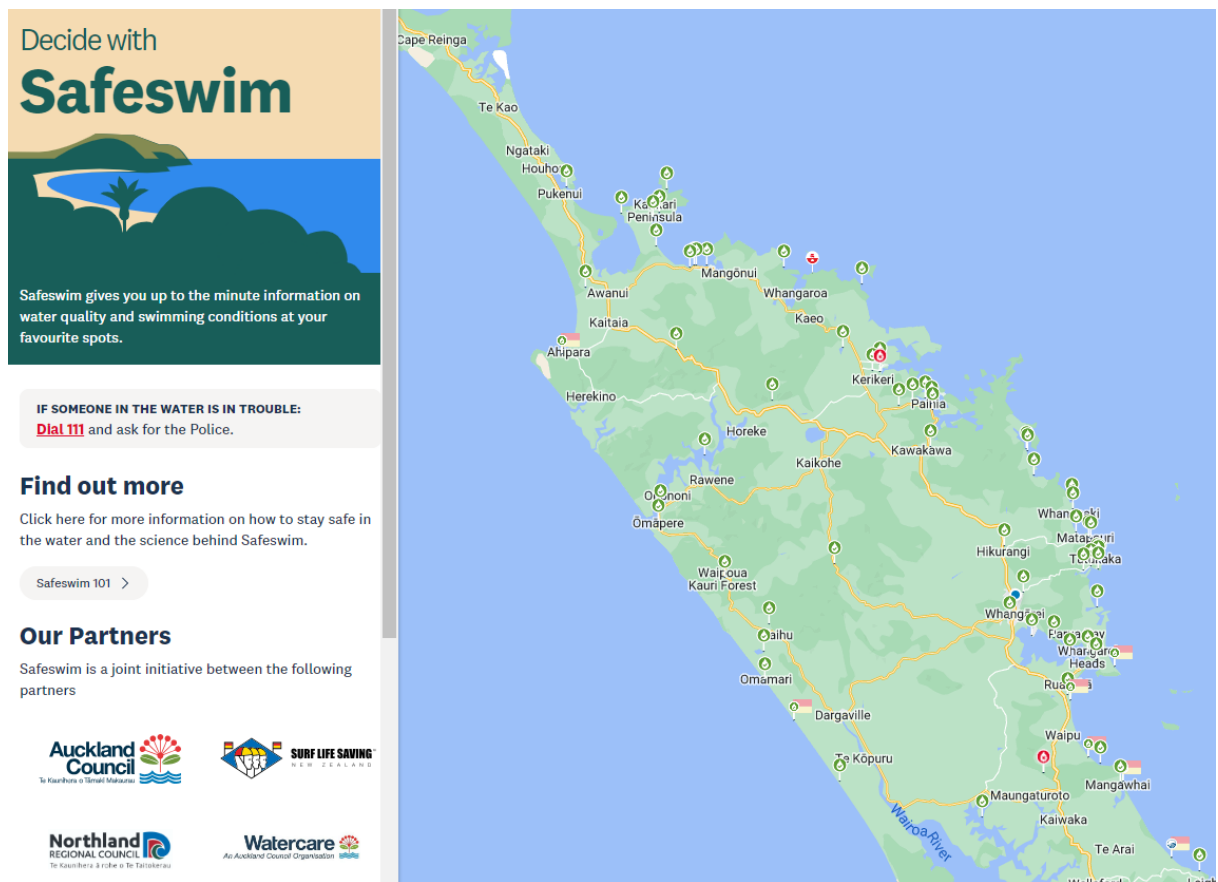
Figure 1. Northland's recreational swimming sites on Safeswim.

The swimming sites displayed on the Safeswim website: https://www.safeswim.org.nz/ provide 15 to 60-minute water quality predictions depending on the predictive model used. These predictions identify the risk of microbial contamination to recreational water users. Additionally, information is listed for each site regarding lifeguarded beaches, tides, weather, physical hazards, and other relevant information. When water quality at a swimming site is predicted to meet the national guidelines for safe swimming, a green water droplet (indicating a low risk of illness from swimming) is displayed (see Figure 2). When water quality is predicted to exceed the national guidelines, a red water droplet is displayed advising unsuitable swimming conditions.

Figure 2: Real-time water quality predictions at three of Northland's coastal swimming sites on Safeswim.

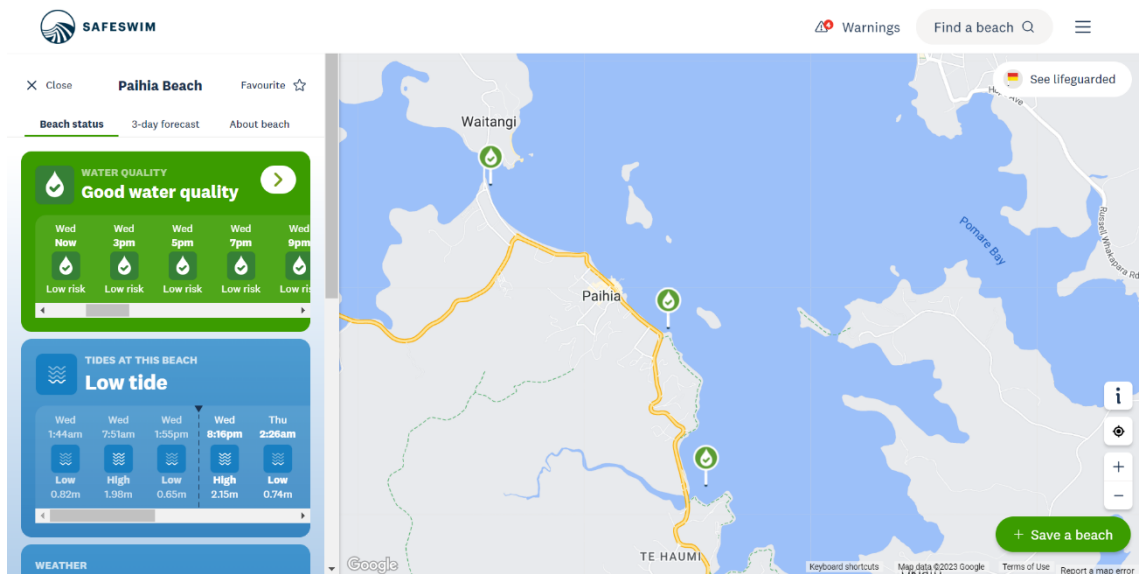Safeswim can override site predictions and/or issue temporary warnings in real-time if there is information that needs to be communicated to the public. In 2023, during Cyclone Gabrielle and the other significant flooding events experienced across Northland and Auckland, Safeswim was used to communicate the risks of swimming during/post these events to the public.

Whilst providing the public with a greater understanding of real-time water quality at their favourite swimming sites, Safeswim also allows Northland Regional Council to better manage its resources, spread sampling over the year, and still be able to provide valuable water quality information over peak holiday periods when the information is most needed.

1.3 Model Development

Safeswim makes use of a few modelling approaches to predict water quality: Black box models, Criteria models, and Permanent status models (green/red).

To build predictive models for each of Northland Regional Council's monitored recreational swimming sites, historic data was analysed to determine the best model available to predict water quality. Data had to meet certain criteria for each modelling approach; models were subsequently approved by an expert health panel before going live on Safeswim.

A Black box model is a regression-based model that is built based on a strong correlation between rainfall and microbial contamination events. This model establishes a relationship between input variables (e.g., rainfall) and an output variable (i.e., faecal indicator bacteria concentration), based on relatively simple linear statistical techniques. This model requires large datasets to be constructed effectively (Puhoi Stour, 2020).

Criteria models are based on a set of criteria that are developed using expert judgement. The development of a criteria model is based on historical sample results, but the use of professional judgement allows subjectivity to be included in the model framework. Criteria models have similar data requirements and limitations to Black box models. However, Criteria models only predict risk level pertaining to national guideline compliance/failure and not concentrations of faecal indicator bacteria, like in Black box models (Puhoi Stour, 2020).

Overall, each predictive model used on Safeswim is underpinned by ongoing sampling, ensuring that model accuracy is maintained or improved over time. To do this, model predictions and sample results are compared to a literature-based accuracy performance standard of 80% (i.e., model prediction agrees with sample results at least 80% of the time).

There are a few sites in Northland that have been allocated a Permanent green status. These sites have had very few guideline exceedances over years of monitoring, meaning that they are highly likely to be safe for recreational water users regardless of weather conditions. Conversely, one of Northland's monitored swimming sites has consistently displayed poor water quality over years of monitoring and was given a Permanent red status on Safeswim. Ongoing sampling at this site has indicated that water quality has improved over time; hopefully, these changes will satisfy the development of a Criteria or Blackbox model in the future.

1.4   Sampling

Sampling continues to be undertaken annually across the recreational swimming season (i.e., December to March). Throughout the 2023-24 recreational swimming season, Northland Regional Council collected:

- 133 coastal samples across 59 coastal sites, with 127 'surveillance' samples and 5 'alert' samples collected; 1 sample exceeded the 'action' level outlined in Table 1.

- 234 freshwater samples across 20 freshwater sites, with 163 'surveillance' samples, 33 'alert' samples and 38 'action' samples collected.

- 24 samples were analysed with Microbial Source Tracking (MST) to identify the source(s) of microbial contamination of a non-compliant (i.e., 'action level') sample.

Sampling over the 2023-24 season included sites not currently displayed on Safeswim, with additional samples collected for future model development. All the sample results recorded over this season can be accessed on the Land Air Water Aotearoa (LAWA) website: http://www.lawa.org.nz/explore-data/swimming/. Where applicable, water quality predictions displayed on LAWA reflect Safeswim model predictions.

2.0 Results

For the purposes of this report, sample results and model predictions were accumulated from 1 December 2023 to 4 March 2024, totalling 95 days. To assess whether sample results aligned with model predictions, sample results were first separated into two categories: 'surveillance' and 'amber' (within guidelines), or 'action' (above guidelines), as outlined in Table 1. These results were then assessed against the closest one-hour model prediction at each site.

Consistent with the national guidelines, Safeswim reporting statistics are constrained to periods of peak use (i.e., between 6 am to 9 pm over the summer period). Reporting statistics account for a swimmable period of 15 hours per day, totalling 1,425 potential swimmable hours across the 2023-24 recreational swimming season. At each site, the percentage of these hours that are compliant with national guideline values is the primary measure of swimmability on Safeswim.

2.1 Coastal

A total of 56 coastal sites were displayed on Safeswim over the 2023-24 recreational swimming season. Sites were sampled quarterly (Permanent green/Black box model sites) or monthly (Criteria model sites) depending on data requirements. Overall, 94% of the samples collected across the season agreed with Safeswim model predictions.

Samples at 53 sites agreed with Safeswim model predictions 100% of the time. One sample at Ruakaka River at Below Motor Camp exceeded guideline values when the Safeswim model prediction did not indicate unsuitable swimming conditions (i.e., model underrepresenting swimming risk). Six samples were within guideline values when the Safeswim model prediction did indicate unsuitable swimming conditions (i.e., model overrepresenting swimming risk). These samples were collected at Mangawhai Heads at Motor Camp (n=1) and Tauranga Bay Estuary at Spit (n=5).

Twelve samples were collected at Tauranga Bay Estuary at Spit over the 2023-24 season, with samples analysed for both Enterococci and *E. coli*. For Enterococci, all twelve samples were within guideline values. For *E. coli*, seven samples were within guideline values. Therefore, as the Safeswim model at this site is 'Permanent red', there is 0% model similarity for Enterococci and 58% model similarity for the *E. coli* sample results; both similarity percentages fail the model predictive accuracy assessment. Therefore, monthly samples will continue to be collected at this site throughout 2024. Additionally, the ongoing suitability of a 'Permenant red' model at this site will be reviewed before the 2024-25 recreational swimming season begins.

Table 2. Safeswim coastal sites and their predicted swimmability over the 2023-24 recreational swimming season.

Coastal sites	Model	% swimmable hours
Ahipara at Kaka Street	Black box	98.1
Baylys Beach at Sea View Road	Permanent green	100
Cable Bay at East Beach	Permanent green	100
Church Bay at Mid Bay	Black box	99.6
Coopers Beach Foreshore	Black box	98.2
Glinks Gully at Marine Drive	Permanent green	100
Hokianga Harbour at Horeke Wharf	Black box	95.5
Houhora at Houhora Heads Road	Criteria	94.1
Kowharewa Bay	Black box	93.6
Langs Beach at Mid Beach	Black box	99.2
Little Cable Bay at SH10	Criteria	97.2
Maitai Bay at South End	Permanent green	100
Mangawhai Heads at Motor Camp	Black box	89.3
Mangawhai Heads at Open Coast	Permanent green	100
Matapouri Bay at Northern Bridge	Black box	100
Matapouri Bay at Southern Bridge	Black box	99.6
Matauri Bay at Campground	Permanent green	100
McLeod Bay at Playground	Black box	100
Ngunguru Estuary at Motor Camp	Black box	96.1
Ngunguru Estuary at School	Black box	93.6
Oakura Bay at North End	Permanent green	100
Ocean Beach at Mid Beach	Permanent green	100
Ohawini Bay	Black box	99.2
Omamari Beach	Permanent green	100
Omapere at Old Wharf Road	Permanent green	100
One Tree Point at Intertidal Beach	Permanent green	100
Onerahi at Opposite Playground	Black box	99.4
Opononi at Hokianga Harbour	Permanent green	100
Otamure Bay	Black box	100
Pacific Bay	Black box	99.2
Pahi at Jetty	Permanent green	100
Paihia at Seaview Road	Black box	100

Coastal sites	Model	% swimmable hours
Paihia at Te Haumi	Black box	100
Paihia at Waitangi Bridge	Black box	100
Pataua South at East End	Black box	100
Rangiputa at Rangiputa Road	Criteria	94.1
Rawene at Past Ramp	Black box	95.6
Ruakaka Beach at Surf Club	Permanent green	100
Ruakaka River Below Motor Camp	Black box	95.8
Russell Foreshore Off Main Wharf	Permanent green	100
Sandy Bay at Mid Beach	Permanent green	100
Taipa Estuary at Boat Ramp	Black box	94.6
Tamaterau Bay at Whg. Heads Rd	Criteria	95.8
Taupo Bay at Mid Beach	Criteria	97.3
Tauranga Bay Estuary at Spit	Permanent red	0
Taurikura Bay	Criteria	95.7
Teal Bay	Black box	100
Tinopai at Below Puapua Creek	Criteria	98.2
Tinopai at Below Shops	Permanent green	100
Tokerau Beach at Melissa Road	Criteria	87.0
Uretiti Beach at Tip Road	Permanent green	100
Waipu Cove at Beach	Permanent green	100
Wellington Bay	Black box	100
Whananaki at East Beach	Black box	100
Whatuwhiwhi at Holiday Park	Criteria	90.2
Woolleys Bay at Mid Beach	Permanent green	100

Over the 2023-24 recreational swimming season, the average swimmability recorded on Safeswim was 96% across all of Northland's coastal swimming sites. All swimming sites considered to have a percentage swimmability score at or below 90% are currently sampled monthly to further validate the models used for these sites (see Table 2).

2.2   Freshwater

A total of 19 freshwater swimming sites were displayed on Safeswim over the 2023-24 recreational swimming season. Sites were sampled weekly over the 2023-24 season, with 87% of samples collected aligning with Safeswim model predictions.

Samples at 6 sites aligned with model predictions 100% of the time. 12% of sample results (n=26) exceeded guideline values when Safeswim model predictions indicated suitable swimming conditions (i.e., model underrepresenting swimming risk). Conversely, 1% of sample results (n=3) were within guideline values when Safeswim model predictions indicated unsuitable swimming conditions (i.e., model overrepresenting swimming risk).

Three sites failed the model predictive accuracy assessment: Ahuroa at Piroa Falls, Kerikeri at Stone Store and Hatea at Whangarei Falls. Twelve water samples were collected at each site over the 2023-24 recreational swimming season. At Piroa Falls, nine samples exceeded guideline values when the Safeswim model prediction indicated suitable swimming conditions. At Kerikeri at Stone Store, four samples exceeded guideline values when the Safeswim model prediction indicated suitable swimming conditions. Additionally, one sample was within guideline values when the Safeswim model prediction indicated unsuitable swimming conditions. Lastly, at Hatea at Whangarei Falls, three samples exceeded guideline values when the Safeswim model prediction indicated suitable swimming conditions. Moving forward, more intensive sampling will occur at these sites to develop their respective Safeswim models.

Table 3. Safeswim freshwater sites and their predicted swimmability over the 2023-24 recreational swimming season.

Freshwater sites	Model	% swimmable hours
Ahuroa at Piroa Falls	Black box	80.8
Hatea at Whangarei Falls	Black box	81.7
Kaihu at Swimming Hole	Black box	95.3
Kerikeri at Rainbow Falls	Black box	82.2
Kerikeri at Stone Store	Black box	70.7
Lake Manuwai at Boat Ramp	Criteria	94.7
Lake Ngatu at South End	Permanent green	100
Lake Rotopokaka (Coca-Cola)	Criteria	90.3
Lake Taharoa at Pump House	Permanent green	100
Lake Waro at Launch Site	Black box	100
Mangakahia at Swimming Hole	Black box	94.6
Raumanga at Raumanga Valley Park	Black box	92.4
Tirohanga at Tirohanga Road	Black box	95.5
Victoria at DOC Reserve Crossing	Black box	95.9
Waipapa at Charlies Rock	Black box	98.3
Waipapa at Waihou Valley	Black box	100
Waipoua at Swimming Hole	Black box	95.4
Waitangi at Lily Pond	Black box	99.2
Waitangi at Wakelins	Black box	100

Over the 2023-24 recreational swimming season, the average swimmability recorded on Safeswim was 93% across all of Northland's freshwater swimming sites. As discussed above, sites predicted to have a percentage swimmability score at or below 90% are currently sampled monthly to validate the models used at these sites (see Table 3).

2.3   Microbial Source Tracking

Select sample results in the 'alert' or 'action' national guidance categories were further analysed with Microbial Source Tracking using PCR (i.e., analysing DNA to identify microbial contamination sources). PCR analysis was undertaken for ruminant (e.g. cattle, sheep), avian (e.g. wildfowl) and two human markers (HR183 and HumM2).

Over the 2023/24 recreational swimming season, 24 samples were analysed with MST across 13 swimming sites. Figure 3 indicates that avian and ruminant markers were the dominant microbial contamination sources detected in these samples. Importantly, ruminant was the dominant source identified in samples taken at Ahuroa at Piroa Falls. Additionally, ruminant and avian markers were co-dominant sources detected in samples from Hatea at Whangarei Falls and Tauranga Bay Estuary at Spit. Overall, these results inform the water quality and compliance monitoring that Northland Regional Council will undertake in the future.

Figure 3. Number of occurrences of avian, human, and ruminant markers detected using MST over the 2023-24 recreational swimming season.

3.0 Future Model Developments

A minimum of four samples are currently collected each year at monitored recreational swimming sites with Black box and Permanent green/red models. Monthly sampling is currently undertaken at sites with Criteria models, with the aim to develop these into Black box models in the future.

Only three monitored swimming sites in the RSWQP are not visible on Safeswim; all three are coastal swimming sites. Northland Regional Council will continue to collect monthly samples at these sites throughout 2024, with the aim to display these sites on Safeswim before the 2024-25 recreational swimming season commences.

4.0 Summary

The second season of Northland Regional Council's use of Safeswim was considered a success with an overall level of agreement of 90% between model predictions and sample results. As this season's result only provides a small 'snapshot' of model performance, a full review will be undertaken in 2026 to validate Northland's Safeswim models after three years of using Safeswim; this will give a more comprehensive overview of model performance and will further indicate where model revisions are necessary.

This report concludes that Safeswim continues to be an effective tool to communicate health risks at Northland's recreational swimming sites to the public. This report also highlights that one coastal site, and three freshwater sites, require extra sampling to take place throughout 2024 to improve their respective models. Importantly, a review will be conducted before the start of the 2024/25 recreational swimming season, with the intention to refine these models and create new models for the remaining coastal swimming sites yet to be published on Safeswim.

5.0 References

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