CITY OF CAPE TOWN
ISIXEKO SASEKAPA
STAD KAAPSTAD

COASTAL WATER QUALITY INVESTIGATION

Compiled by

City of Cape Town

Coastal Management Branch

22 November 2024

Summary

Both the Strand swimming area and Strand Surfing area (colloquially referred to as "Pipe") are exposed to wastewater derived pollution via multiple sources and rainfall appears to have a significant impact on water quality at both locations. Strand swimming area during summer months without rainfall comfortably meets standards for coastal recreation. The surfing area during summer also meets the sufficient category but it appears that it is also impacted by the Lourens River mouth, and not just rainfall. There should be a standard advisory at Strand Beach that swimming and surfing during or within 24 hrs of a rainfall event may expose users to increased pollution risk.

Introduction

Coastal Water quality at the Strand Surf Lifesaving Club and at the Strand surfing area, known locally as "Pipe" has been of concern for many years. Annual calculations of water quality categories for these areas as per the National Water Quality Guidelines over 12 month periods has over many years resulted in a POOR rating. This concern has increased in recent years as the Trappies Sewer line has failed on numerous occasions – a major failure in September 2023 resulted in a three week beach closure - , winter stormwater ingress into the Trappies Sewer has become a bigger problem and contamination from multiple rivers and large stormwater drains are all impacting the area. The pollution challenge is made more complex in this area due to the localised coastal hydrodynamic conditions which plays a major role in retaining pollution along this shoreline (Figure 1 refers).

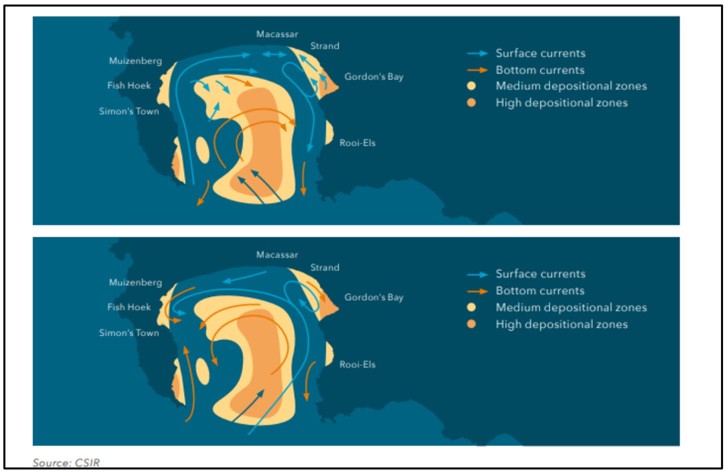

Figure 1. Typical current patterns and depositional zones in False Bay in south-easterly (top) and north-westerly wind conditions (bottom).

Long term data (2006 – 2019) suggests the significant impact of rainfall events on water quality readings and outcomes. As an example, in 2016 with reduced rainfall leading into the drought, water quality was calculated as EXCELLENT at Strand Beach clearly suggesting the role of urban run-off as a major contributor to poor results.

Site	2014	2015	2016	2017	2018	2019
Macassar Beach	Poor	Good	Sufficient	Poor	Poor	Poor
Strand Beach	Poor	Sufficient	Excellent	Poor	Poor	Poor

Table 1. Annual water quality classification at recreational nodes within Gordon's Bay and Strand area. Water quality is classified according to DEA (2012) and is based on enterococci values only.

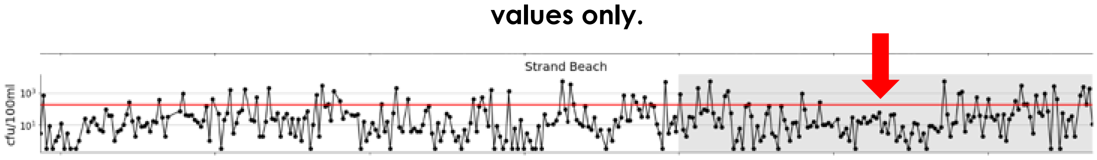

Figure 2. Enterococci counts for Strand Beach 2006 to 2019. In 2016 the driest year since 1977 shows reduced enterococci spikes.

A research project was initiated in October 2023 and then further enhanced in September 2024 following engagement with the Strand Surf Lifesaving Club.

Questions:

1. **What is the water quality for both sites in the Strand as calculated over a full year?**
2. **What is the water quality calculated for summer?**
3. **What is the water quality if measured daily in summer?**
4. **Does daily sampling (Monday to Friday) provide evidence that rainfall is one of the primary drivers of poor water quality outcomes**
5. **Would an increased frequency of weekly monitoring confirm a suspected distinct summer/winter difference in water quality?**

Approach

- Weekly water samples collected were analysed by either the SABS Laboratory or WALAB Laboratory, both of which are SANAS accredited for intestinal enterococci enumeration in sea water.
- Daily samples (Monday to Friday) were collected and analysed by WALAB Laboratory from Monday 23rd September and is ongoing.
- Samples were collected consistently between 10am and 12pm, chilled, and submitted to the relevant laboratory within required time frames.
- Intestinal enterococci were enumerated in line with SANAS standard methodologies (using accredited membrane filtration methods for quantifying enterococci). Intestinal enterococci were used as they are the internationally accepted FIB for assessing levels of wastewater pollution and associated human health risk in coastal and marine environments. The rationale for using enterococci is provided in **Box 1.** Further information on the use of enterococci can be found in the CCT Know Your Coast 2023 report (page 9).
- In line with the South African Department of Environmental Affairs "South African Water Quality Guidelines for Coastal Marine Water - Volume 2: Guidelines for Recreational Use", the upper limit for the 95th percentile of results indicating pollution is 200 CFU/100ml of intestinal enterococci. As a precaution, 200 CFU/100ml has also been used in this report for a single sample limit of good water quality. This is a more cautious approach than the 2012 Guidelines that recommend a single sample threshold of 240 CFU/100ml for the operational management of beaches in South African sea water.
- Recreational Water Quality categories are determined for each set of results as follows:
    - National Recreational Water Quality Guidelines recommend determining the 95th and 90th percentiles of intestinal enterococci counts to determine the recreational water quality of a given beach. The City has been using the Hazen method as it provides a conservative estimate of water quality, while the guidelines do not specify what method to use. The guideline thresholds are laid out below:
        - 95th Percentile should be ≤ 100 CFU for Excellent water quality
        - 95th Percentile should be ≤ 200 CFU for Good water quality
        - 90th Percentile should be ≤ 185 CFU for Sufficient water quality

- The 2021 World Health Organisation Guidelines on Recreational Water Quality use the below classification system. For this report, the rounded 95th percentile method has been used:
  - 95th Percentile for Category A: ≤ 40 CFU /100ml
  - 95th Percentile for Category B: 41-200 CFU /100ml
  - 95th Percentile for Category C: 201-500 CFU /100ml
  - 95th Percentile for Category D: >500 CFU /100ml
  - The WHO does not prescribe a specific acceptable class of water.
  - Class A and B are within tolerable levels of risk according to the South African (and most other) guidelines on recreational water quality.
- Rainfall data sourced from City of Cape Town's Woodhead weather station.

Table 2. Risk Criteria for Recreational Use of Coastal Waters in South Africa

Grade	Estimated risk of illness per exposure*	Enterococci (cfu**/100 mℓ)	Escherichia coli (cfu/100 mℓ)
Excellent	<2,9% gastrointestinal (GI) illness risk	< 100 (95 percentile)	< 250 (95 percentile)
Good	<5% GI illness risk	< 200 (95 percentile)	< 500 (95 percentile)
Sufficient	<8,5% GI illness risk	< 185 (90 percentile)	< 500 (90 percentile)
Poor	> 8,5% GI illness risk	> 185 (90 percentile)	> 500 (90 percentile)

** Exposures are defined as 10 minutes of swimming with three head immersions.*
*** Colony-forming units*

Percentiles and category calculations

Hazen Method

The Hazen method is a statistical approach used to analyse enterococci levels in water quality data. It is generally a very conservative way of determining water quality (i.e., it will err on the side of worse water quality estimates):

- **Ranking the Data**: All enterococci measurements are arranged in order from the smallest to the largest value. Each measurement is assigned a rank.
- **Percentile Calculation**: The method identifies the value at which a specified percentage of the data lies below it (e.g., the 90th or 95th percentile).
- **Interpolation**: To achieve greater precision, the Hazen method uses interpolation. This means it calculates a value that might fall between two actual measurements to give a more accurate percentile estimate.

For example:

- For an excellent rating, 95% of the data points must be below 100 cfu/100 ml. The Hazen method determines this cut-off point even if it doesn't align perfectly with an actual measurement.

BOX 1: ENTEROCOCCI: GLOBAL GOLD STANDARD AS FAECAL INDICATOR BACTERIA

Faecal indicator bacteria (FIB) are measured as a surrogate for a complex suite of pathogens (bacteria, viruses, and others) present in sewage and used to estimate the risk of gastrointestinal and other health effects in humans using recreational waters.

- The WHO guidelines 2003 stated "*Escherichia coli* is intrinsically suitable for fresh waters but not marine waters" (WHO 2003). The updated WHO 2021 guidelines also support using only intestinal enterococci as a FIB in marine environments.
- No statistical relationship has been established for *E. coli* that can support a clear dose–response guideline value in marine waters.
- At the time of writing these guidelines, only enterococci had been used in epidemiology studies addressing marine and fresh waters and shown to reflect, in a dose–response manner, gastrointestinal illness in recreational water users (Wade et al., 2010).
- These FIB are not themselves the causative agents of illness.
- Monitoring of two FIB introduces avoidable complexity in analysis and interpretation of results (WHO 2021), without improving the management of human health risk.

At present, most global health and environmental authorities agree on using intestinal enterococci as the sole FIB in marine environments in their respective guidelines for recreational water quality. This includes the World Health Organisation Guidelines on Recreational Water Quality (2021), United States Environmental Protection Agency (US EPA 2012), Heath Canada (2024), New Zealand Ministry of Health (2021), and Australian National Health and Medical Research Council (2008).

- A series of five epidemiological studies conducted by the US EPA between 2003 and 2009 (Wade et al 2010) confirmed that intestinal enterococci are the appropriate faecal indicator bacteria for seawater, and found that *E. coli* did not display a clear dose-response relationship between bacterial levels and the gastrointestinal illness risk to recreational users in seawater. These studies followed numerous others conducted in the 1980's that were the basis for intestinal enterococci being widely adopted as the main FIB in marine environments (Cabelli et al., 1982; Cabelli, 1983; Dufour, 1984).
- A 2019 report compiled for the government of New Zealand reviewed over 100 published scientific papers to determine whether enterococci are still the most appropriate FIB in coastal waters. The report recommended minor updates to thresholds but found enterococci to be effective for weekly monitoring of faecal contamination risk posed to recreational users of coastal waters (McBride et al. 2019).
- Any suggestion that enterococci are monitored in an effort to provide "better" results is not supported by long term data sets. Enterococci have been found to be a more sensitive indicator bacteria in seawater than *E. coli*, having been shown to exceed single sample standards most often during all weather and environmental conditions (i.e. dry weather, wet weather, along beach's, and near stormwater inputs) (Noble et al 2003).
- Intestinal enterococci's unique resistance to salinity (and ability to grow in saline environments) is thought to contribute to their "better performance as indicators of human health risk in marine recreational waters than members of the coliform group" such as *E. coli* (Byappanahalli et al. 2012). Past studies have demonstrated that intestinal enterococci have a significantly longer survival time in marine environments than *E. coli* (Fragala and Hanes, 1967; Sieracki, 1980; Noble et al. 2001). These studies also noted *E. coli* are more sensitive to sunlight than enterococci.

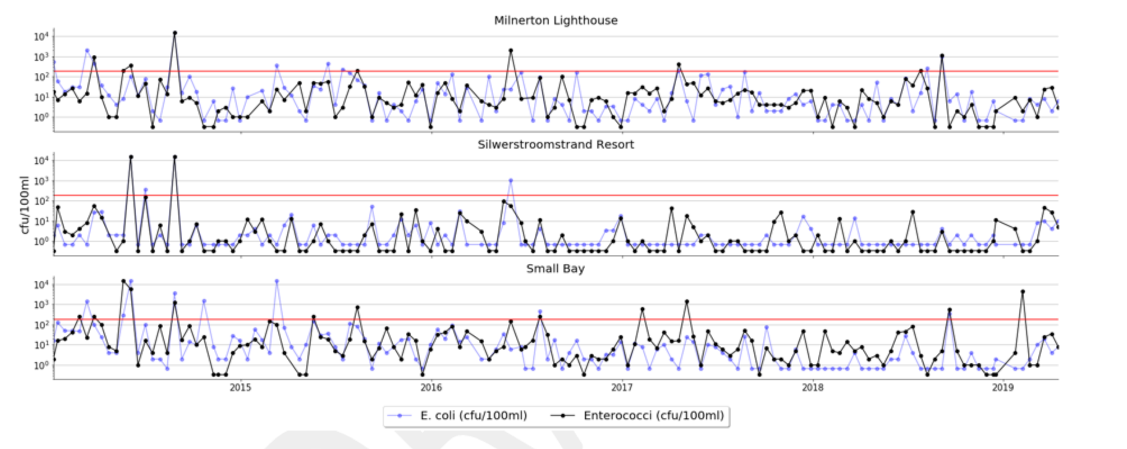

Figure 4.5: Time series of E. Coli and enterococci counts at recreational nodes within the Table Bay and West Coast area from January 2014 to May 2019. The red line indicates the 185 cfu/100 ml threshold used to classify the water quality as Poor based on enterococci 90^{th} percentiles (DEA, 2012). The y axis is on a logarithmic scale.

Site Selection and Monitoring Frequency

The sample sites were selected to specifically reflect the swimming area as set out by the lifesaving club and the surfing area known locally as "Pipe". Site location was done for the daily sites with members of the surfing community and lifesaving club.

Figure 3. Location of Sample Sites at Strand Beach and Strand "Pipe" surfing area

Results

All data are presented in raw form in Annexure A. The certified laboratory datasheets are available for all data points on request.

Findings and Analysis

1. Strand Beach swimming area

Weekly data

- Between October 2023 and 15 November 2024 52 weekly samples were taken at Strand swimming area.
- Of these 9 (17%) exceeded an upper limit count of 200/100ml – this is a high proportion of exceedances.
- The majority (90%) of exceedances occurred between the recognised rainfall months in Cape Town (April to September) suggesting a strong rainfall link.
- Using all weekly samples across the 13.5 months the water quality category using the Hazen Method and the Ranked Percentile is ***POOR*** and the WHO category is C (5-10% risk).
- Using only data from winter months the water quality category using the Hazen Method and the Ranked Percentile is ***POOR*** and the WHO category is C(5-10% risk)
- Using only data from summer months the water quality category using the Hazen Method and the Ranked Percentile is ***EXCELLENT*** and the WHO category is A

Method	95th Percentile	90th Percentile	Overall	Winter	Summer
National Water Quality Guidelines Hazen Method	**450**	**450**	**POOR**	**POOR**	**EXCELLENT**
WHO Guidelines on Recreational Water Quality 2021 Rounded 95th Percentile	**450**	**NA**	**C**	**D**	**A**

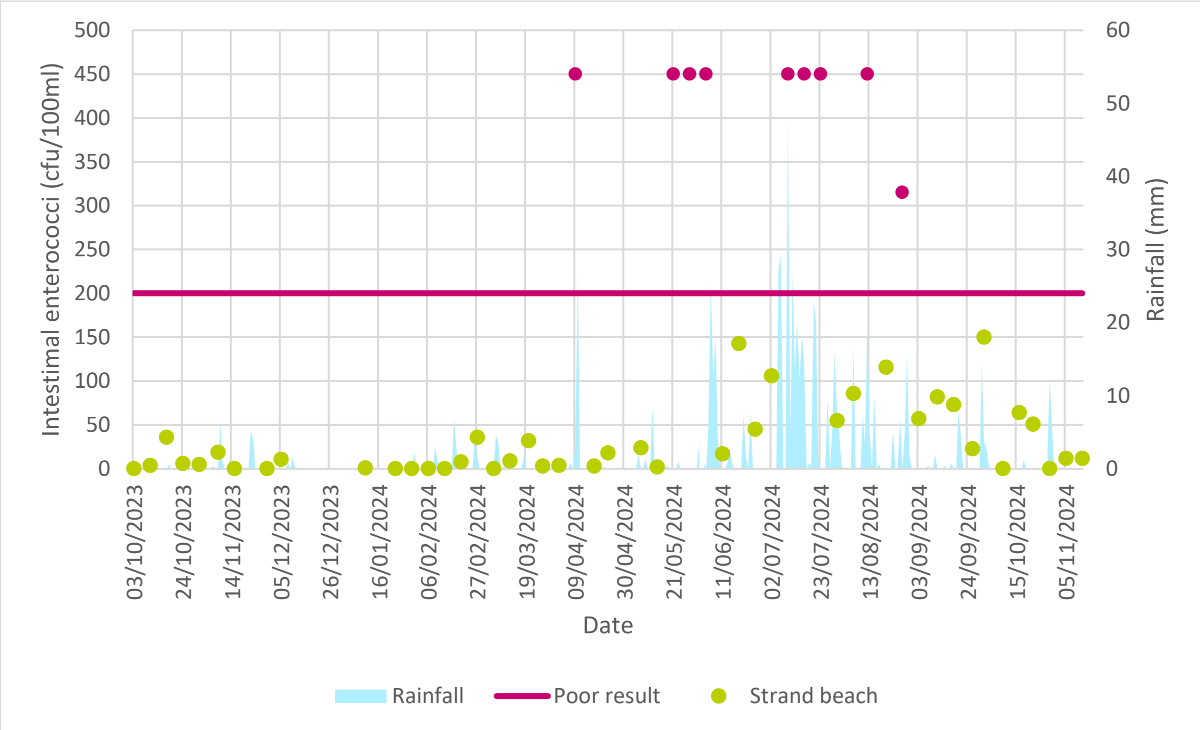

Figure 4. Weekly results of intestinal enterococci monitoring at Strand beach swimming areas.

Daily data

- Daily samples (Monday to Friday) were collected from the 23rd September and remains ongoing
- As of the 22nd November 44 samples had been analysed and only two exceeded the upper limit of 200 cfu/100ml. Both these exceedances are directly correlated with rainfall events
- Using all daily data for the period 23 September to 22nd November the water quality category is ***SUFFICIENT***

Method	95th Percentile	90th Percentile	Result
National Water Quality Guidelines Hazen Method	215	136	**SUFFICIENT**
WHO Guidelines on Recreational Water Quality 2021 Rounded 95th Percentile	170	N/A	**B**

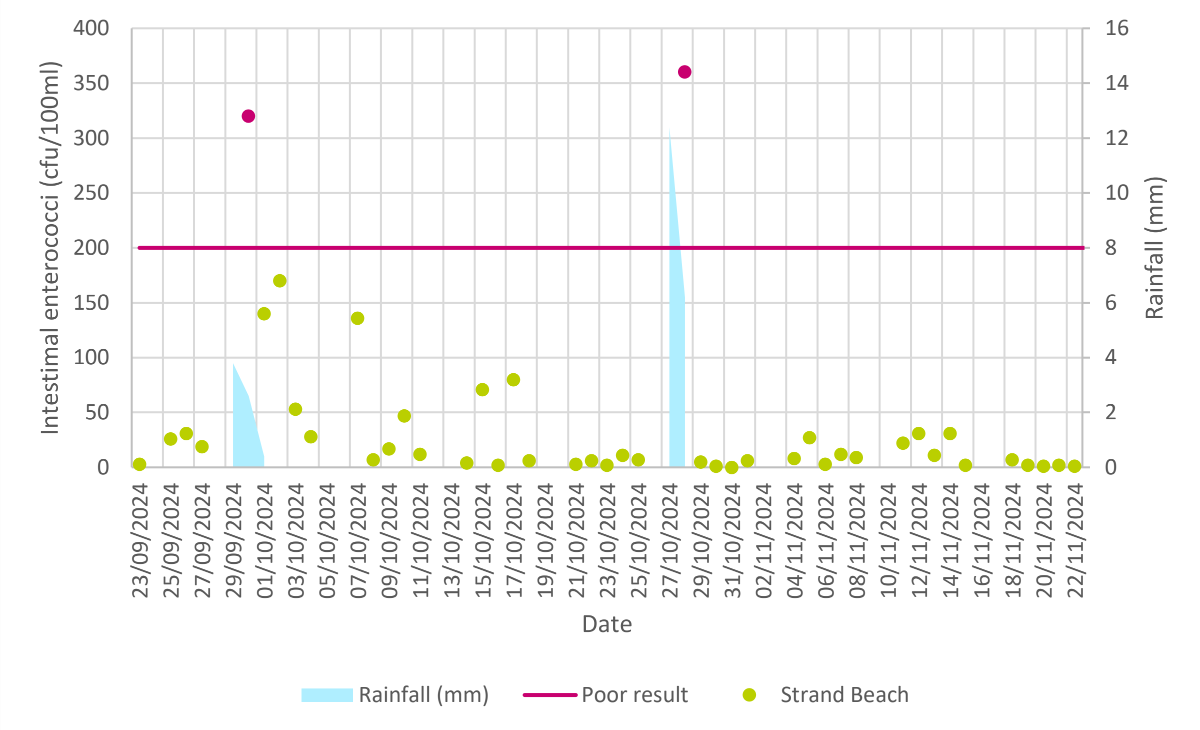

Figure 5. Daily results of intestinal enterococci monitoring at Strand beach swimming areas.

2. Strand "Pipe" surfing area

Weekly Data

- Between October 2023 and 15 November 2024 52 weekly samples were taken at Strand surfing area
- Of these 17 (32%) exceeded an upper limit count of 200/100ml – this is a very high proportion of exceedances.
- While the majority of the exceedances occurred in the winter rainfall months, a significantly concerning number occurred throughout the year indicating the likely chronic contamination from the Lourens River and even the Eerste River.
- Using all weekly samples across the full 13.5 months the water quality category using the Hazen Method is ***POOR*** and the WHO category is C (5-10% risk)
- Using only data from winter months the water quality category using the Hazen Method and the Ranked Percentile is ***POOR*** and the WHO category is D (>10% GI risk)
- Using only data from summer months the water quality category using the Hazen Method ***POOR*** the WHO category improves only to C (5-10% risk)

Method	95th Percentile	90th Percentile	Overall	Winter	Summer
National Water Quality Guidelines Hazen Method	**1040**	**450**	**POOR**	**POOR**	**POOR**
WHO Guidelines on Recreational Water Quality 2021 Rounded 95th Percentile	**1040**	**NA**	**D**	**D**	**C**

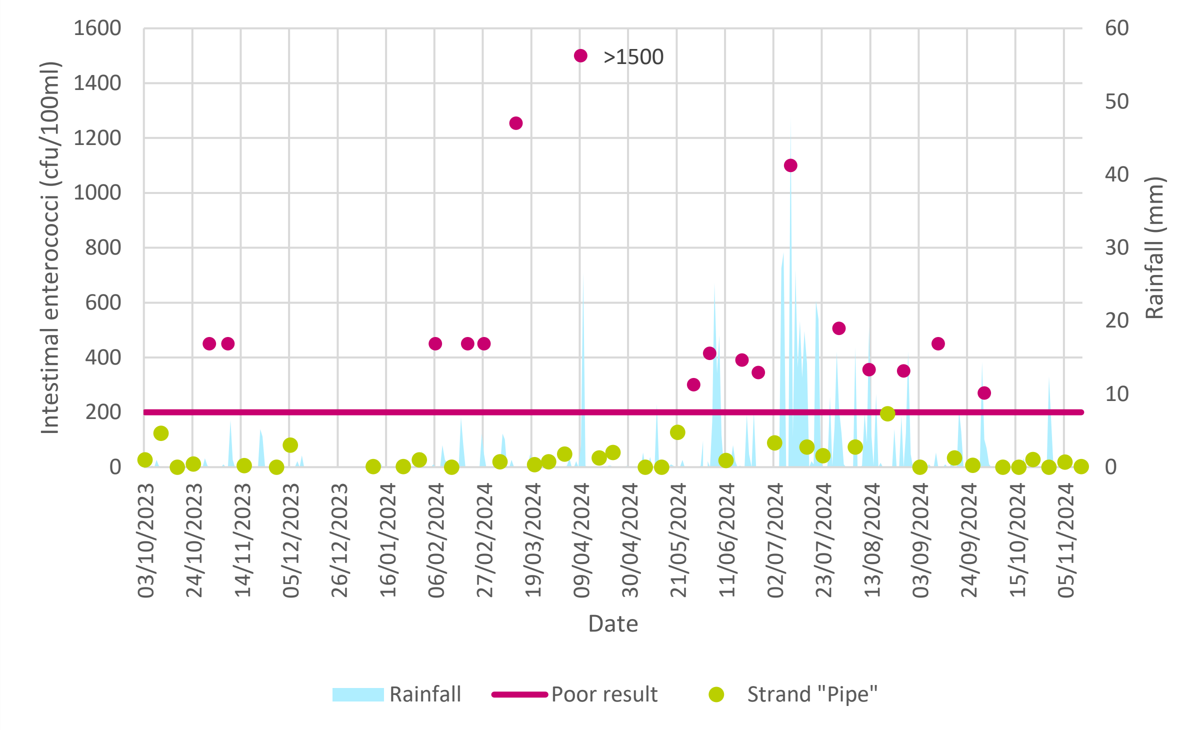

Figure 6. Weekly results of intestinal enterococci monitoring at Strand "Pipe" surfing area with recorded rainfall (mm)

<u>Daily Data</u>

- Daily samples (Monday to Friday) were collected from the 23rd September and remains ongoing
- As of the 22nd November 44 samples had been analysed and only three exceeded the upper limit of 200/100ml. Two of these exceedances are directly correlated with rainfall events.
- Using all daily data for the period 23 September to 22 November the water quality category is ***SUFFICIENT***.

Method	95th Percentile	90th Percentile	Result
National Water Quality Guidelines Hazen Method	**349**	**146**	**SUFFICIENT**
WHO Guidelines on Recreational Water Quality 2021 Rounded 95th Percentile	**216**	**NA**	**C**

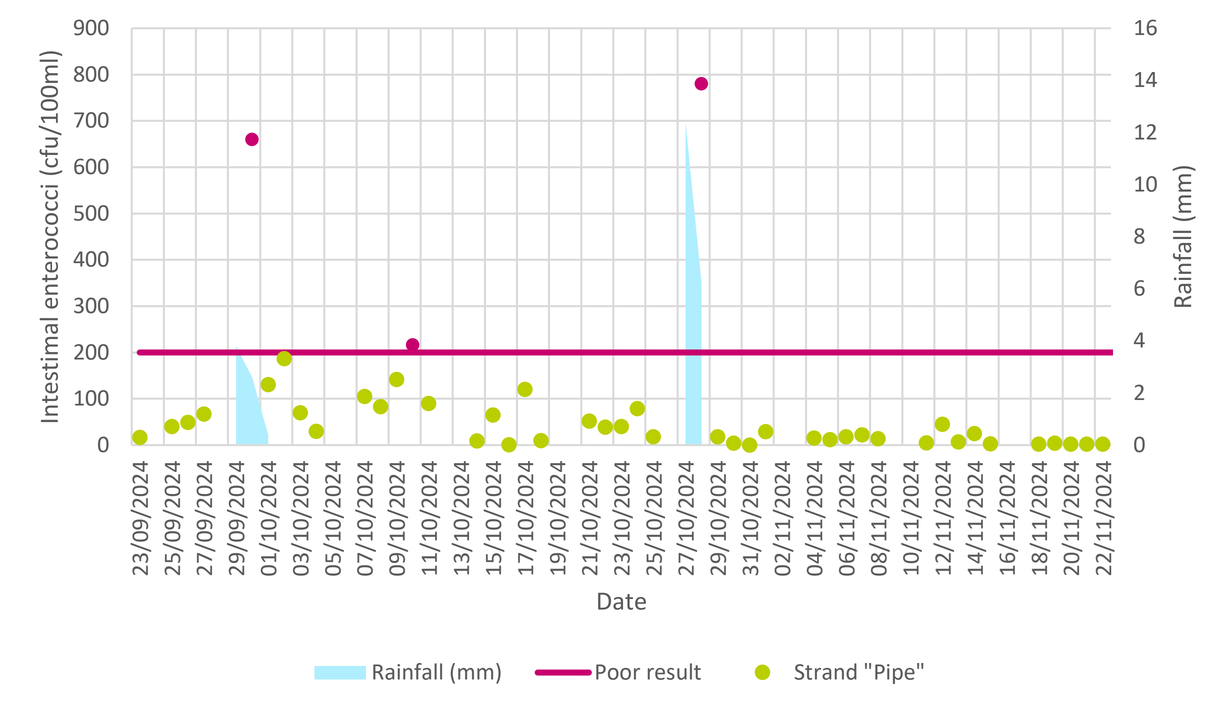

Figure 7. Daily results of intestinal enterococci monitoring at Strand "Pipe" surfing area with recorded rainfall (mm)

Overall Findings

1) Both the Strand swimming area and Strand Surfing area (pipe) are exposed to wastewater derived pollution via multiple sources
2) Rainfall has a significant impact on water quality at both locations
3) The surfing area may also be impacted by the Lourens River and possibly even the Eerste River depending on oceanographic currents and river output volumes.
4) Lower flow of rivers during summer may reduce the impact on the surfing area
5) Strand swimming area during summer months without rainfall easily meets standards for coastal recreation as calculated by both the National Water Quality Guidelines and the WHO Guidelines
6) Daily data suggests that pollution from rainfall events clears within 24 hrs of the event
7) Increased frequency of testing during the summer months would lead to improved water quality categories at both sites for summer
8) Winter months will remain problematic due to the multiple sources of pollution associated with increased rainfall run-off, sewer ingress, sewer failure, stormwater discharge and local oceanographic characteristics
9) There should be a standard advisory at Strand Beach that swimming and surfing during or within 24 hrs of a rainfall event may expose users to higher levels of pollution.

Next Steps

The following recommendations are made based on the findings above:

1) Standard City coastal water quality sampling frequency at these two locations should be increased to weekly
2) The current daily sampling research should continue through summer to confirm whether increased sampling frequency results in improved water quality over time
3) The daily sampling research should be done in winter to confirm the suspected chronic pollution related to urban runoff/sewer ingress/failure and how severe this is

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ANNEXURE A: RAW COASTAL WATER QUALITY FOR WEEKLY DATA, STRAND

Table 1: Weekly data

Date	Strand Beach	Strand "Pipe"
Tuesday, 03 October 2023	<1	27
Tuesday, 10 October 2023	4	123
Tuesday, 17 October 2023	36	0
Tuesday, 24 October 2023	6	11
Tuesday, 31 October 2023	5	>150
Wednesday, 08 November 2023	19	>150
Wednesday, 15 November 2023	<1	6
Wednesday, 29 November 2023	<1	0
Tuesday, 05 December 2023	11	80
Wednesday, 10 January 2024	1	2
Tuesday, 23 January 2024	<1	2
Tuesday, 30 January 2024	<1	26
Tuesday, 06 February 2024	<1	>150
Tuesday, 13 February 2024	<1	0
Tuesday, 20 February 2024	8	>150
Tuesday, 27 February 2024	36	>150
Tuesday, 05 March 2024	<1	20
Tuesday, 12 March 2024	9	1254
Wednesday, 20 March 2024	32	9
Tuesday, 26 March 2024	3	20
Tuesday, 02 April 2024	4	47
Tuesday, 09 April 2024	>150	>1500
Wednesday, 17 April 2024	3	33
Tuesday, 23 April 2024	18	53
Tuesday, 07 May 2024	24	0
Tuesday, 14 May 2024	2	0
Tuesday, 21 May 2024	>150	127
Tuesday, 28 May 2024	>150	300
Tuesday, 04 June 2024	>150	415
Tuesday, 11 June 2024	17	24
Tuesday, 18 June 2024	143	390
Tuesday, 25 June 2024	45	345
Tuesday, 02 July 2024	106	88
Tuesday, 09 July 2024	>150	1100
Tuesday, 16 July 2024	>150	73
Tuesday, 23 July 2024	>150	42
Tuesday, 30 July 2024	55	505
Tuesday, 06 August 2024	86	73
Monday, 12 August 2024	>150	355
Tuesday, 20 August 2024	116	195

Date	Strand Beach	Strand "Pipe"
Tuesday, 27 August 2024	315	350
Tuesday, 03 September 2024	57	0
Wednesday, 11 September 2024	82	>150
Wednesday, 18 September 2024	73	34
Thursday, 26 September 2024	23	7
Tuesday, 01 October 2024	150	270
Wednesday, 09 October 2024	<1	0
Wednesday, 16 October 2024	64	0
Tuesday, 22 October 2024	51	28
Tuesday, 29 October 2024	<1	0
Tuesday, 05 November 2024	12	18
Tuesday, 12 November 2024	12	2

Table 2: Daily data

Date	Strand Beach	Strand "Pipe"
Monday, 23 September 2024	3	17
Wednesday, 25 September 2024	26	40
Thursday, 26 September 2024	31	49
Friday, 27 September 2024	19	67
Monday, 30 September 2024	320	660
Tuesday, 01 October 2024	140	131
Wednesday, 02 October 2024	170	187
Thursday, 03 October 2024	53	70
Friday, 04 October 2024	28	30
Monday, 07 October 2024	136	105
Tuesday, 08 October 2024	7	83
Wednesday, 09 October 2024	17	142
Thursday, 10 October 2024	47	216
Friday, 11 October 2024	12	90
Monday, 14 October 2024	4	9
Tuesday, 15 October 2024	71	65
Wednesday, 16 October 2024	2	1
Thursday, 17 October 2024	80	120
Friday, 18 October 2024	6	10
Monday, 21 October 2024	3	52
Tuesday, 22 October 2024	6	39
Wednesday, 23 October 2024	2	40
Thursday, 24 October 2024	11	79
Friday, 25 October 2024	7	18
Monday, 28 October 2024	360	780
Tuesday, 29 October 2024	5	18
Wednesday, 30 October 2024	1	4

Date	Strand Beach	Strand "Pipe"
Thursday, 31 October 2024	0	0
Friday, 01 November 2024	6	29
Monday, 04 November 2024	8	15
Tuesday, 05 November 2024	27	12
Wednesday, 06 November 2024	3	18
Thursday, 07 November 2024	12	22
Friday, 08 November 2024	9	14
Monday, 11 November 2024	22	5
Tuesday, 12 November 2024	31	45
Wednesday, 13 November 2024	11	7
Thursday, 14 November 2024	31	25
Friday, 15 November 2024	2	3
Monday, 18 November 2024	7	2
Tuesday, 19 November 2024	2	4
Wednesday, 20 November 2024	1	2
Thursday, 21 November 2024	2	2
Friday, 22 November 2024	1	2