Ministry of Marine Resources
TU'ANGA O TE PAE MOANA
COOK ISLANDS

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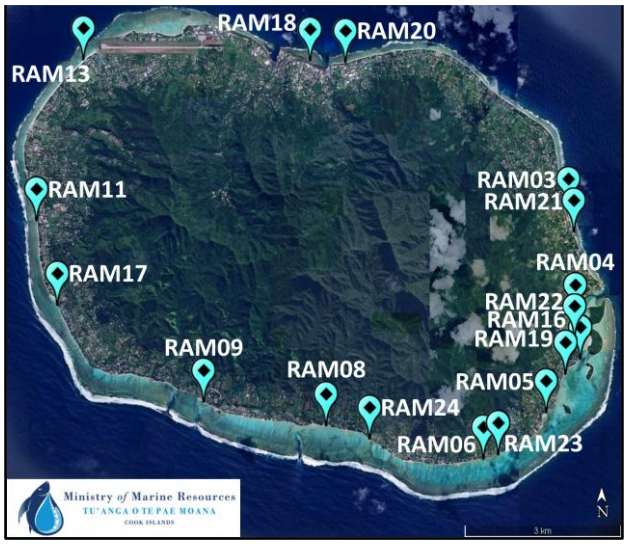
RAROTONGA WATER QUALITY REPORT
DECEMBER 2025

SUMMARY

Water samples were collected on Tuesday 2nd December. Weather observation was a combination of slight wind, sunny and overcast with random rain showers prior to and on the day of sampling. Tides varied between high and low during sample collection. Muri Aroko was not sampled due to restricted access. The remaining sixteen lagoon sites were accessible and sampled. Algae such as Boodlea, Enteromorpha and Rhipidosiphon were observed at six sites on the southeastern side of the island between Muri Buoy and Totokoitu Station, except at Muri Koka. Delays in receiving our reagents order from suppliers resulted in no bacteria data for this month. Lack of water (dry) or stagnancy (no flow) or ebb flow (current flowing inland) from seawater influence (high tide) were observed at all stream sites and therefore were omitted from sampling. Summary table for total suspended solids and dissolved oxygen results and levels below.

Lagoon Site	Site ID	Total Suspended Solids (mg/L)	Dissolved Oxygen (%)
Pouara Raui	RAM03	0.3	159
Avana Mudflats	RAM04	1.4	103
Paringaru	RAM05	3.0	131
Tikioki Packing Shed	RAM06	2.5	110
Totokoitu Station	RAM08	1.3	117
Papua	RAM09	0.3	125
Arorangi School	RAM11	1.0	145
Social Centre	RAM13	4.8	120
Muri Buoy	RAM16	2.5	96
Betela Beach	RAM17	0.3	124
Avatiu	RAM18	1.0	134
Muri Koka	RAM19	2.4	107
Ngatipa	RAM20	2.0	130
Matavera Outfall	RAM21	1.3	148
Muri Aroko	RAM22	NO WATER SAMPLED	
Tikioki	RAM23	0.3	113
Papaaroa	RAM24	0.3	120



GRADING SCALE	
Excellent	Poor
Very Good	Very Poor
Good	Extremely Poor

Lagoon:

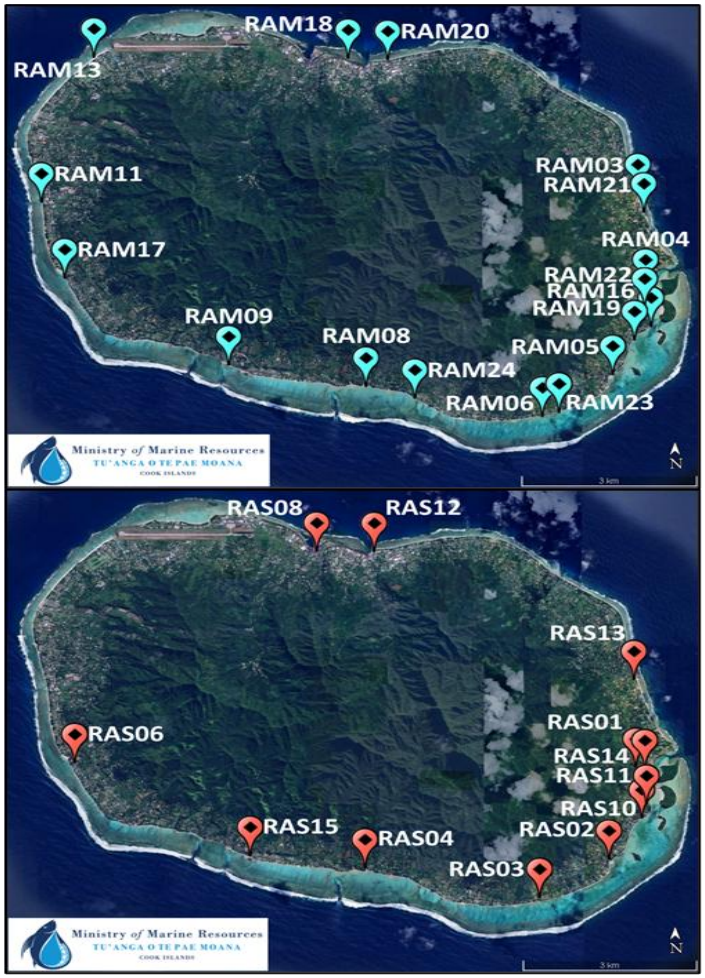
- Total suspended solids results were below 5.0 mg/L, ranging from 0.3 mg/L to 4.8 mg/L with good to excellent levels at all sites indicating clearer waters and minimal threat to coral reefs.
- Dissolved oxygen levels were above the recommended threshold of 80% showing excellent levels at all sites.
- Temperature ranged from 26 degrees at Betela Beach to 31.3 degrees at Matavera Outfall with a mean of 27.7 degrees.
- Salinity was stable ranging from 34.5 ppt at Avana Mudflats and Papaaroa to 37.2 ppt at Papua with a mean of 35.8 ppt.
- pH ranged from 7.81 at Muri Koka to 8.51 at Matavera Outfall with a mean of 8.04.

The monthly summary and lab study reports can be found at the end of this report. November rainfall data will be available in the next monthly report.

1. ENTEROCOCCI BACTERIAL COUNTS - RAROTONGA - Most Probable Number of Enterococci per 100 mL (MPN/100mL)

Lagoon Site	Site ID	Jul	Aug	Sep	Oct	Nov	Dec
Pouara Raui	RAM03	<1	<1	<1	10	<1	ND
Avana Mudflats	RAM04	20	20	74	10	10	ND
Paringaru	RAM05	75	<1	10	<1	86	ND
Tikioki Packing Shed	RAM06	134	<1	31	<1	41	ND
Totokoitu Station	RAM08	63	41	20	20	<1	ND
Papua	RAM09	185	<1	52	10	<1	ND
Arorangi School	RAM11	109	10	31	10	31	ND
Social Centre	RAM13	<1	<1	110	<1	<1	ND
Muri Buoy	RAM16	<1	<1	<1	63	<1	ND
Betela Beach	RAM17	<1	10	20	<1	20	ND
Avatiu	RAM18	<1	10	<1	<1	<1	ND
Muri Koka	RAM19	20	10	<1	75	20	ND
Ngatipa	RAM20	NO DATA	<1	NO DATA	<1	NO DATA	ND
Matavera Outfall	RAM21		<1		<1		ND
Muri Aroko	RAM22		20		97		ND
Tikioki	RAM23		<1		<1		ND
Papaaroa	RAM24		<1		<1		ND

Stream Site	Site ID	Jul	Aug	Sep	Oct	Nov	Dec
Avana	RAS01	649	NW	435	NW	NW	NW
Paringaru	RAS02	1203	NW	NW	NW	NW	NW
Akapuao	RAS03	>2420	NW	NW	NW	NW	NW
Totokoitu	RAS04	488	2420	816	NW	NW	NW
Betela	RAS06	1553	1986	NW	1046	NW	NW
Avatiu	RAS08	299	NW	NW	NW	NW	NW
Vaiterenga	RAS10	>2420	NW	NW	NW	NW	NW
Areiti	RAS11	>2420	488	328	58	112	NW
Takuvaine	RAS12	NO DATA	NW	NO DATA	NW	NO DATA	NW
Pouara	RAS13		NW		NW		NW
Avana Mouth	RAS14		NW		NW		NW
Papua	RAS15		NW		NW		NW

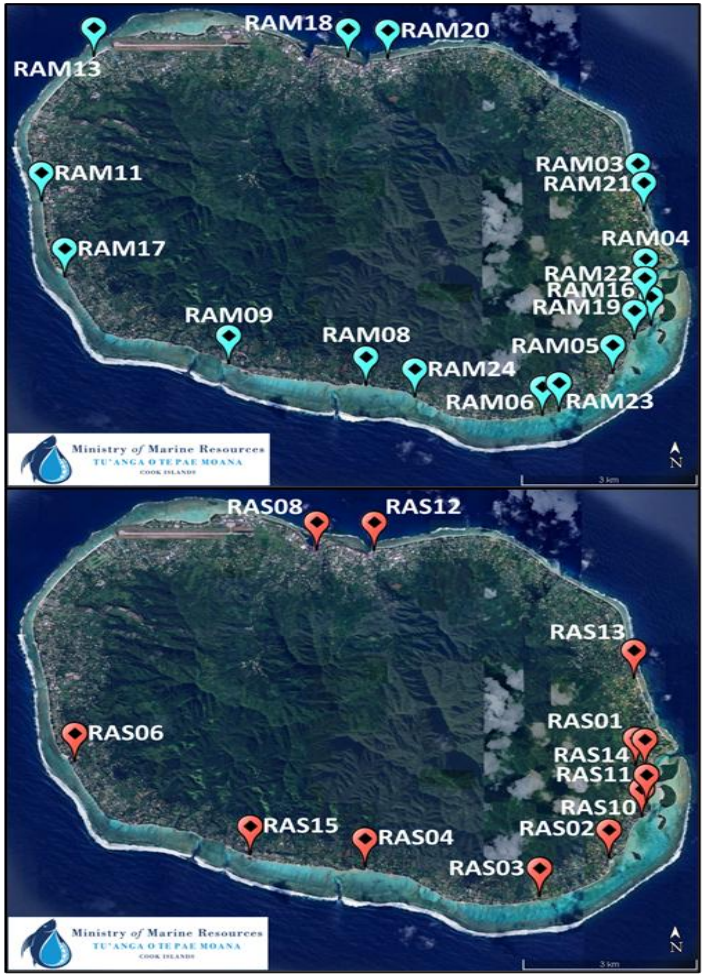


GRADING SCALE			REFERENCE
Excellent	A	< 41	WHO 2021
Very Good	B	41 ≥ 100	Guidelines on
Good	C	101 ≥ 200	Recreational
Poor	D	201 ≥ 350	Water Quality for
Very Poor	E	351 ≥ 500	Coastal and Fresh
Extremely Poor	F	> 500	Waters.

2. TOTAL SUSPENDED SOLIDS - RAROTONGA - Milligrams per Litre (mg/L)

Lagoon Sampling Site	Site ID	Jul	Aug	Sep	Oct	Nov	Dec
Pouara Raui	RAM03	1.3	2.0	2.6	0.4	0.3	0.3
Avana Mudflats	RAM04	0.6	3.0	2.0	0.4	1.3	1.4
Paringaru	RAM05	2.9	2.0	1.9	1.9	3.3	3.0
Tikioki Packing Shed	RAM06	1.3	2.0	2.2	0.3	2.3	2.5
Totokoitu Station	RAM08	33.3	4.3	16.7	1.3	2.3	1.3
Papua	RAM09	7.8	2.0	10.1	0.3	0.3	0.3
Arorangi School	RAM11	6.8	4.1	7.4	1.3	0.3	1.0
Social Centre	RAM13	1.9	2.0	3.9	0.3	0.3	4.8
Muri Buoy	RAM16	0.5	2.0	0.3	0.3	0.3	2.5
Betela Beach	RAM17	25.2	5.0	5.6	0.3	1.3	0.3
Avatiu	RAM18	17.9	3.0	0.3	2.3	3.3	1.0
Muri Koka	RAM19	0.5	4.0	1.3	2.3	2.3	2.4
Ngatipa	RAM20	NO DATA	0.3	NO DATA	1.3	NO DATA	2.0
Matavera Outfall	RAM21		2.0		2.3		1.3
Muri Aroko	RAM22		1.0		0.3		ND
Tikioki	RAM23		2.0		0.3		0.3
Papaaroa	RAM24		3.0		1.3		0.3

Stream Sampling Site	Site ID	Jul	Aug	Sep	Oct	Nov	Dec
Avana	RAS01	1.0	NW	0.7	NW	NW	NW
Paringaru	RAS02	2.7	NW	NW	NW	NW	NW
Akapuao	RAS03	5.0	NW	NW	NW	NW	NW
Totokoitu	RAS04	0.3	0.3	4.4	NW	NW	NW
Betela	RAS06	2.5	4.5	NW	4.0	NW	NW
Avatiu	RAS08	2.0	NW	NW	NW	NW	NW
Vaiterenga	RAS10	4.0	NW	NW	NW	NW	NW
Areiti	RAS11	68.8	3.8	36.7	25.0	12.1	NW
Takuvaine	RAS12	NO DATA	NW	NO DATA	NW	NO DATA	NW
Pouara	RAS13		NW		NW		NW
Avana Mouth	RAS14		NW		NW		NW
Papua	RAS15		NW		NW		NW

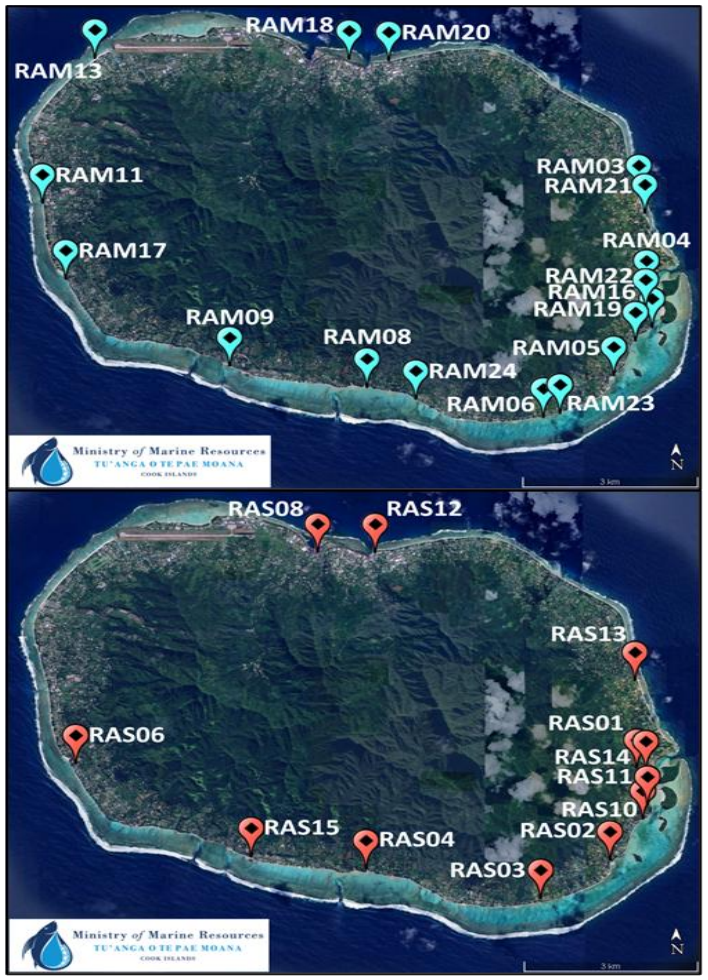


GRADING SCALE			REFERENCE
Excellent	A	< 1.0	Bell 1992, total suspended solids recommended limit is ≤5mg/L for healthy coral reef.
Very Good	B	1.0 ≥ 2.5	
Good	C	2.5 ≥ 5.0	
Poor	D	5 ≥ 10	
Very Poor	E	10 ≥ 20	
Extremely Poor	F	> 20	

3. DISSOLVED OXYGEN - RAROTONGA - Percent (%)

Lagoon Sampling Site	Site ID	Jul	Aug	Sep	Oct	Nov	Dec
Pouara Raui	RAM03	137	118	181	127	137	159
Avana Mudflats	RAM04	101	115	109	120	110	103
Paringaru	RAM05	102	119	120	136	114	131
Tikioki Packing Shed	RAM06	119	130	125	128	125	110
Totokoitu Station	RAM08	119	125	122	128	128	117
Papua	RAM09	125	126	131	126	130	125
Arorangi School	RAM11	131	129	125	140	154	145
Social Centre	RAM13	124	127	127	133	125	120
Muri Buoy	RAM16	104	118	96	118	114	96
Betela Beach	RAM17	121	128	126	135	138	124
Avatiu	RAM18	134	136	165	142	135	134
Muri Koka	RAM19	101	122	113	123	121	107
Ngatipa	RAM20	NO DATA	140	NO DATA	137	NO DATA	130
Matavera Outfall	RAM21		123		127		148
Muri Aroko	RAM22		116		119		ND
Tikioki	RAM23		128		127		113
Papaaroa	RAM24		128		129		120

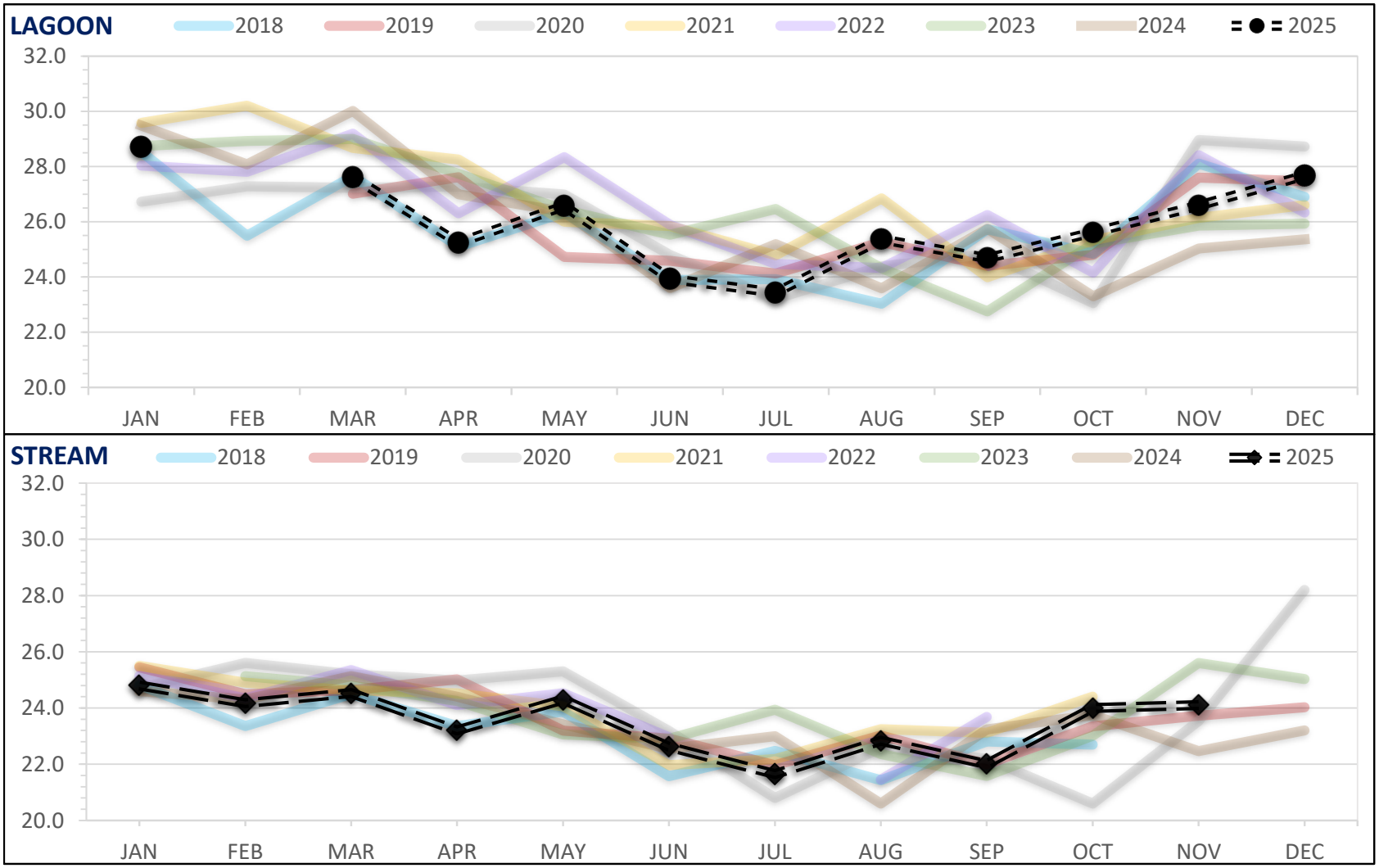
Stream Sampling Site	Site ID	Jul	Aug	Sep	Oct	Nov	Dec
Avana	RAS01	95	NW	76	NW	NW	NW
Paringaru	RAS02	79	NW	NW	NW	NW	NW
Akapuao	RAS03	61	NW	NW	NW	NW	NW
Totokoitu	RAS04	95	81	ND	NW	NW	NW
Betela	RAS06	91	53	NW	79	NW	NW
Avatiu	RAS08	91	NW	NW	NW	NW	NW
Vaiterenga	RAS10	62	NW	NW	NW	NW	NW
Areiti	RAS11	64	49	62	55	47	NW
Takuvaine	RAS12	NO DATA	NW	NO DATA	NW	NO DATA	NW
Pouara	RAS13		NW		NW		NW
Avana Mouth	RAS14		NW		NW		NW
Papua	RAS15		NW		NW		NW



GRADING SCALE			REFERENCE
Excellent	A	>95	Department of Health, Clean Water Branch Hawaii 1994: Dissolved oxygen recommended limit is ≥75% saturation for oceanic waters, embayments, open coastal waters & estuaries; ≥80% saturation for streams.
Very Good	B	90 ≥ 95	
Good	C	80 ≥ 90	
Poor	D	60 ≥ 80	
Very Poor	E	40 ≥ 60	
Extremely Poor	F	< 40	

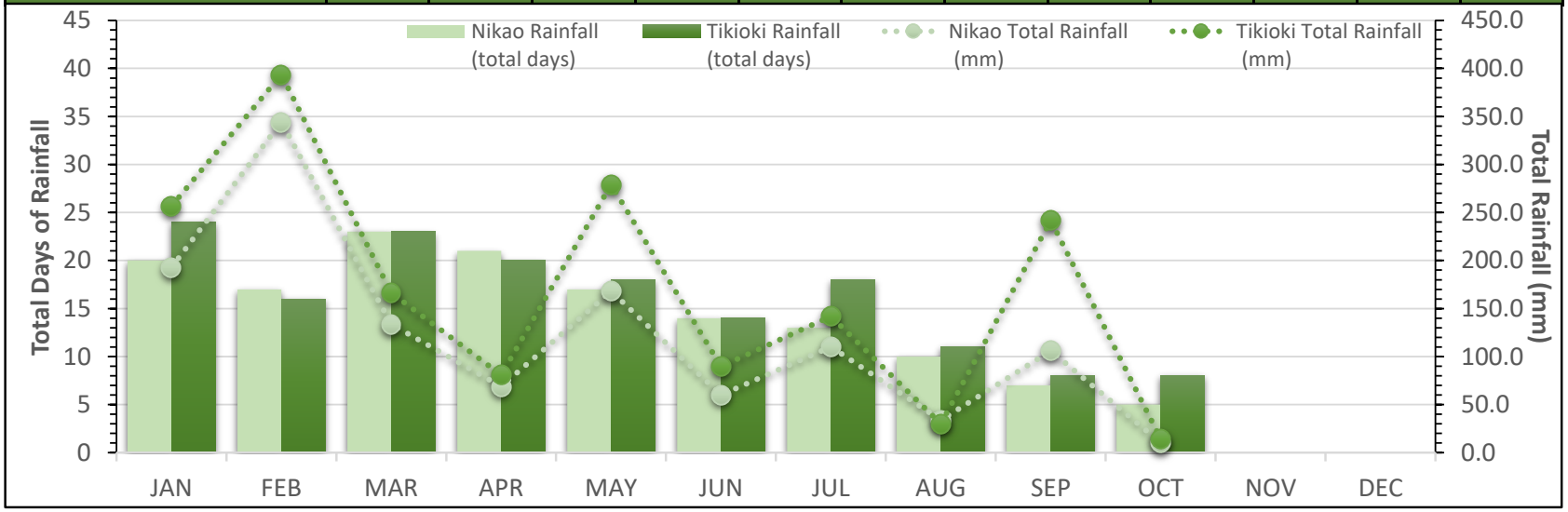
4. AVERAGE TEMPERATURE - RAROTONGA - Degrees Celcius (˚C)

2025	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Lagoon	28.7	ND	27.6	25.2	26.6	23.9	23.4	25.4	24.7	25.6	26.6	27.7
Stream	24.8	24.2	24.5	23.2	24.3	22.6	21.7	22.8	22.0	24.0	24.1	ND



5. RAROTONGA RAINFALL - NIKAO & TIKIOKI - Total Rainfall (mm) & Total Days of Rainfall

Month	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Nikao Total Rainfall (mm)	192.6	344.3	133.6	68.8	168.3	60.0	110.2	33.7	106.1	10.4	NA	
Nikao Rainfall (total days)	*20*	*17*	*23*	*21*	*17*	*14*	*13*	*10*	*7*	*5*	*NA*	
Nikao Highest 1-Day (mm)	37.4	72.5	43.0	10.6	28.5	19.1	80.6	15.2	50.6	3.1	NA	
Nikao Highest 1-Day (date)	*9th*	*13th*	*3rd*	*2nd*	*24th*	*16th*	*6th*	*7th*	*18th*	*15th & 16th*	*NA*	
Tikioki Total Rainfall (mm)	256.6	393.6	166.4	80.8	279.2	89.8	141.8	30.2	241.8	14.4	NA	
Tikioki Rainfall (total days)	*24*	*16*	*23*	*20*	*18*	*14*	*18*	*11*	*8*	*8*	*NA*	
Tikioki Highest 1-Day (mm)	83.8	94.4	53.6	13.0	67.8	48.0	79.6	15.4	145.0	8.0	NA	
Tikioki Highest 1-Day (date)	*9th*	*20th*	*30th*	*6th*	*15th*	*16th*	*6th*	*6th*	*15th*	*15th*	*NA*	



Report Date: 03.12.2025		RAROTONGA LAB STUDY REPORT – DECEMBER				Lab Report No.: 12L5389 – 12L5404	
SAMPLE DESCRIPTION							
Date Samples Collected:	Name of Sample:	Collected By:	Submitted By:	Time of Receipt:	Physical Description:		Quantity Per Site Received:
Tuesday 2nd December	Marine	NES		12:40PM	Clear		2L
Study No.		1	2	3	4	5	6	7
SITE ID	LAB ID	Enterococci (MPN/100ml)	Temperature (°C)	Salinity (ppt)	Dissolved Oxygen (%)	Dissolved Oxygen (mg/L)	pH	Total Suspended Solids (mg/L)
MARINE								
RAM03	12L5389	ND	27.0	36.6	159.4	10.34	8.11	0.3
RAM04	12L5390	ND	27.6	34.5	103.3	6.72	7.94	1.4
RAM05	12L5391	ND	28.5	34.8	131.2	8.39	8.03	3.0
RAM06	12L5392	ND	27.8	35.5	110.3	7.11	7.96	2.5
RAM08	12L5393	ND	27.3	34.7	117.3	7.66	7.93	1.3
RAM09	12L5394	ND	26.5	37.2	125.1	8.16	8.04	0.3
RAM11	12L5395	ND	28.5	35.9	145.2	9.22	8.11	1.0
RAM13	12L5396	ND	27.0	36.4	120.1	7.80	8.02	4.8
RAM16	12L5397	ND	27.3	36.0	95.9	6.21	7.88	2.5
RAM17	12L5398	ND	26.0	36.2	124.1	8.21	7.99	0.3
RAM18	12L5399	ND	28.5	37.0	133.6	8.44	8.17	1.0
RAM19	12L5400	ND	27.1	35.1	106.9	6.99	7.81	2.4
RAM20	12L5401	ND	27.1	36.3	130.2	8.44	8.05	2.0
RAM21	12L5402	ND	31.3	36.5	148.1	8.98	8.51	1.3
RAM22	-	ND	ND	ND	ND	ND	ND	ND
RAM23	12L5403	ND	27.6	35.8	113.3	7.32	7.96	0.3
RAM24	12L5404	ND	27.7	34.5	119.5	7.76	8.05	0.3
Study Method		IDEXX Enterolert*	YSI Manual	YSI Manual	YSI Manual	YSI Manual	YSI Manual	MMR Lab Manual Water Quality Monitoring V5
Recommended Limit		Ref. Comments	Ref. Comments	Ref. Comments	Ref. Comments	Ref. Comments	Ref. Comments	Ref. Comments

Abbreviation

NL: Not Listed, MPN: Most Probable Number, cfu: Colony Forming Unit, mL: milli Litre, FAU: Formazin Attenuation Unit, NTU: Nephelometric Turbidity Unit, ppt: Parts Per Thousand, DB: Designated Bathing Beach, MB: Moderate Use of Bathing, LB: Light Use of Bathing, IB: Infrequent Use of Bathing

NA: Not Available, however data will be available at a later date; ND: No Data due to equipment failure or logistics problems or time delay or methodology problem or combination of all; NW: No Water, stream dry or water stagnant or water level too low for sample collection or water dirty/murky.

Comments

1. Temperature[#]
   Subtropical regions (south of Cape Canaveral and Tampa Bay, Florida, and Hawaii).
   Short-term Max. 32.2^{o}C, Max. True daily mean 29.4^{o}C (average of 24-hourly temperature reading).
   Temperature is the measure of warmth and coldness, reported as an average and measured in degrees celcius (°C).
2. pH
   Changes to pH can be caused by a range of potential water quality problems (e.g., low values due to acid sulphate runoff). pH values are also related to soil geology and may be naturally low or high (in limestone areas). High pH values can also be caused temporarily when high rates of photosynthesis by aquatic plants (including algae) lead to a decrease in carbon dioxide, and therefore a decrease in carbonic acid in the water.
3. Salinity
   A measure of the amount of dissolved salts in the water, and therefore an indicator of salinity. Excess salinity in freshwater streams occurs as a result of excess soil salinity, which may be caused by excess land clearing and changes to the groundwater table. Salinity is reported as parts per thousand (ppt).
4. Dissolved Oxygen^
   DO levels indicate how much oxygen is in the water. Low DO levels indicate an abnormal disturbance in the ecosystem such as an algal bloom. DO is measured in percentage (%).
   Low DO: 3.5 mg/L at 26C leads to 100% mortality of *Acipenser oxyrhincus*
   2.7 mg/L at 19C leads to 22% mortality of *Acipenser oxyrhincus*
   <3.7 mg/L Demersal finfish biomass diminishes
   <3.5 mg/L Species richness diminishes
   Below 2 mg/L infaunal species migrate to sediment surface and epifaunal species move to better aerated water.
   Oxygen is essential for life processes of most aquatic organisms. Many aquatic organisms will suffocate if there is insufficient oxygen in the water.
5. Suspended Solids[@]
   Settleable and suspended solids should not reduce the depth of the compensation point for photosynthetic activity by more than 10% from the seasonably established norm for aquatic life. Total suspended solids (TSS) are non-living (inorganic) such as silt and mud; and organic matter such as animal and plant material found in the water. The presence of large amounts of particles are responsible for creating the murky appearance of dirty water and can quickly kill coral reefs. TSS is measured in milligrams per litre (mg/L).
6. Turbidity
   Water clarity (the degree of light penetration) is important as aquatic plants depend on light to photosynthesize and produce oxygen. Large amounts of sediment in a water body can also smother benthic organisms. Suspended solid results are interactive and interdependent with turbidity. Expert interpretation needed. Turbidity is measured as FAU.
7. Enterococci[β]
   The presence of bacteria Enterococci *sp* is monitored as an indicator of human and animal waste pollution. The higher the numbers of Enterococci bacteria present in a sample, the greater the amount of faecal pollution in the water. Bacteria count is measured in Most Probable Number of Enterococci cells per 100mL of sample (MPN/100mL).
8. Nutrients (Nitrate, Nitrite, Ammonia, Phosphate)
   High nutrient concentrations in a water body (eutrophication) may lead to excessive weed and algal growth. Excess nutrients enter a water body through several means, including discharge of treated sewage, storm water, and in run-off from land, for example as fertiliser, animal waste, or decaying plant matter.
9. Chlorophyll-a
   Chlorophyll-a is a pigment found in green plants, including aquatic plant. Measuring the amount of chlorophyll-a in the water therefore indicates the amount of green algae present in the water. High concentrations of algae (algal blooms) may harm other aquatic organisms, either through the production of toxins, reduction of available light through covering the water surface, or by using all available oxygen during respiration at night. Chlorophyll-a is measured in micrograms per litre (µg/L).
10. Rainfall
    Rarotonga: daily rainfall data is provided by the Cook Islands Meteorological Service.
    Aitutaki: daily rainfall data is recorded by MMR Staff (Aitutaki Marine Research Centre – AMRC) at Amuri and by Rowan Strickland at Vaipae.
    Rainfall is measured in millimetres (mm) and reported as an average per month, total number of days that had no rainfall and the highest amount of rainfall in 1-day.

[#]EPA Quality Criteria for Water Gold Book 1986
^EPA Ambient Aquatic Life Water Quality Criteria for DO (Saltwater): Cape Cod to Cape Hatteras Nov 2000
[@]EPA Quality Criteria for Water Red Book 1976
[β]WHO Guidelines on Recreational Water Quality for Coastal and Fresh Waters 2021