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# AITUTAKI WATER QUALITY DATA REPORT

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January – December 2009



June 2010

Tuaine Turua  
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Ngere George  
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Annual Report 2009

## INSHORE AND AQUACULTURE DIVISION



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**Additional Pages:** Water Quality Report Card Aitutaki 2010  
and Aitutaki Stream Summary – 2009 data analysed

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## 1. Introduction

Aitutaki is one of the islands in the Cook Islands that is developing rapidly and because of its pristine lagoon it attracts a considerable number of tourists. Tourism is one of the main sources of income for the people on the island, therefore, it is vital that the health of the lagoon is monitored and action taken to protect the health of the lagoon, coral reef and the people that use it.

In 2004, the Ministry of Marine Resources started to monitor Aitutaki lagoon with 11 lagoon sampling sites. In 2005 Paradise Cove and Waste Management were added and in 2006 4 stream and 4 lagoon sites were introduced to the programme. Measurements made include temperature, dissolved oxygen, pH, salinity, nutrients, chlorophyll *a*, suspended solids and bacterial contamination to measure long term changes in water quality of the lagoons and streams.

Temperature varies seasonally and influences the occurrence and growth of aquatic plants, and animals. The solubility of dissolved oxygen (DO) is regulated by temperature however other factors also affect DO including water flow. In the water, DO is either absorbed directly from the atmosphere or is produced by algae via photosynthesis and is removed by respiration and decomposition of organic matter. The recommended minimum for DO saturation is not less than 75% saturation for oceanic waters, embayments, open coastal waters and estuaries and not less than 80% for streams (Department of Health, Clean Water Branch Hawaii 1994). Salinity varies little in most marine environments and saltwater is normally between 34ppt and 36ppt in areas away from freshwater influences (Smith 2004). Mosely *et al* (2004) in water quality guidelines developed for Pacific Countries suggest that pH should be between 8.0 and 8.4 in lagoon type environments. The Department of Health, Clean Water Branch Hawaii (1994) pH standard for open coastal waters is between 7.6 and 8.6 and can be as low as 7.0 in areas influenced by freshwater input.

Nutrients such as nitrate and phosphate which are naturally present in seawater are essential for the growth of phytoplankton and other algae which form the base of the food web. Elevated nutrients concentration can lead to an increase in algae and aquatic plants biomass which can have detrimental impacts on the coral reef health. The guidelines for nutrient concentrations for the protection of coral reef health are 14 µg/L for dissolved inorganic nitrogen (DIN), which is made up of nitrate and ammonia (NO<sub>3</sub>-N + NH<sub>4</sub>-N), and 2.6 µg/L for dissolved reactive phosphorus (DRP) (Bell 1992).

The ANZECC guideline values for streams or lowland rivers that are a cause for concern in Australia tropical areas based on measured values are 10µg/L for nitrate (NO<sub>3</sub>) and ammonia (NH<sub>4</sub>), and 4µg/L for DRP (ANZECC 2000).

Chlorophyll *a* and total suspended measure phytoplankton biomass, inorganic and organic particulate material in the water respectively. Elevated concentrations of both have been shown to impact negatively on coral reef health above concentration of 4-5 mg/L Bell (1992).

Increased inorganic and organic materials entering lagoons are often associated with increases in bacteria numbers and are disease causing organisms. Enterococci bacteria are used to indicate the potential presence of human pathogens in marine and freshwater environment. Guidelines have been developed by the World Health Organisation (WHO) for contact recreation using Enterococci numbers (Table 1). This guideline is also used for freshwater samples to evaluate the bacterial water quality of the streams as they flow directly into the lagoon and are likely to impact the bacterial water quality of the lagoon.

**Table 1. WHO Standards for Bathing Water Quality.**

Category	Indicator Counts	Microbiological Assessment
A.	≤ 40 Enterococci / 100ml	Suitable for swimming
B.	≥ 41 to ≤ 200 Enterococci / 100ml	Suitable for swimming but requires surveillance
C.	≥ 201 to ≤ 500 Enterococci /100ml	Not suitable for swimming, requires assessment
D.	≥ 501 Enterococci / 100ml	Not suitable for swimming, public warnings

This report is a Data Report summarising the findings of the water quality sampling program in 2009 and supports of the Water Quality Report Card. The Water Quality Report Card for Aitutaki 2010 is attached.

## **2. Methods**

### **2.1 Sampling**

All the water quality parameters were measured monthly for both lagoon and streams. In total, there are 15 marine sites and 4 stream sites for Aitutaki (Figure 1 and Table 2 & 3). Water samples from Aitutaki were stored in the dark on ice and the samples were air freighted to Rarotonga and processed within 9 hours of sample collection.

## 2.2 Aitutaki Marine and Stream Sampling Site Map

- Marine Sites
- Stream Sites

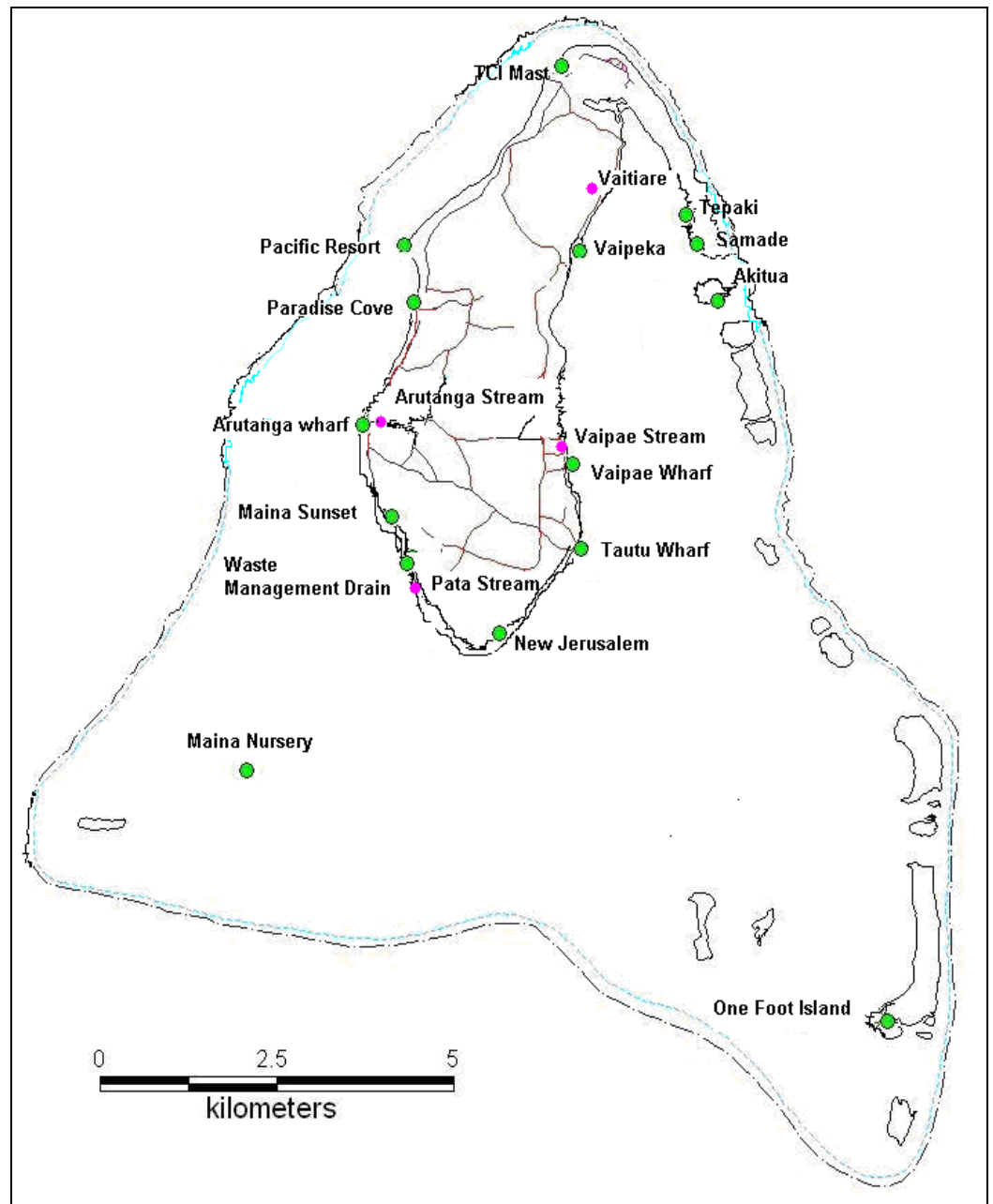


Figure 1. Aitutaki Water Quality Sampling Sites – Marine & Streams



**Table 2. Aitutaki Lagoon sampling site locations.**

Site Numbers	Location	Latitude	Longitude
1	Akitua	S18 51.058	W159 45.494
2	Samade	S18 50.816	W159 45.671
3	Tepaki Site	S18 50.381	W159 45.659
4	Vaipeka	S18 50.866	W159 46.431
5	Vaipae Wharf	S18 52.287	W159 46.441
6	Tautu Wharf	S18 52.925	W159 46.352
7	New Jerusalem	S18 58.607	W159 47.282
8	Waste Management	S18 53.002	W159 47.647
9	Maina Sunset	S18 52.599	W159 47.919
10	Arutanga Wharf	S18 51.825	W159 48.061
11	Pacific Resort	S18 50.806	W159 47.704
12	Paradise Cove	S18 50.174	W159 46.983
13	TCI Mast Airport	S18 49.509	W159 46.525
14	Maina Nursery	S18 54.393	W159 49.140
15	One Foot Island	S18 56.180	W159 44.178

**Table 3. Aitutaki Stream sampling site locations.**

Stream site	Location	Latitude	Longitude
1	Vaitiare	S18 50.866	W159 46.431
2	Vaipae	S18 52.268	W159 46.511
3	Pata	S18 52.908	W159 47.699
4	Arutanga	S18 51.871	W159 47.942

### 2.3 Physical Parameters

At each site temperature (°C), dissolved oxygen (DO), % saturation and concentration, pH, and salinity (‰) were measured using a YSI 556 Probe. The individual probes were calibrated before use in the field and measurements were made at each site at the time of sampling (Hall et al., 2007). Temperature was measured using a Eutech digital thermometer at the two control sites (Maina Nursery and One Foot Island).

### 2.4 Nutrients

All water samples for nutrient analysis were filtered through a Whatman GF/F glass fibre filter into a 250ml acid washed plastic bottle. These samples were stored frozen until they were shipped on ice in chilly bins to NIWA for analysis. All nutrient analysis was conducted using an Astoria Pacific autoanalyser 300 series with methods from the Astoria Pacific International Methods Manual (A 6/00). NO<sub>3</sub>-N was analysed

by the cadmium column reduction method (Astoria 305-A177), DRP by the molybdenum blue method (Astoria 305-A204) and NH<sub>4</sub>-N by the indophenol blue method (Astoria 305-A026).

## **2.5 Chlorophyll *a* and Suspended Solids**

Samples for chlorophyll *a* and total suspended solids analysis of known volumes were filtered on to GF/F filters and frozen immediately. The frozen filters for chlorophyll *a* were then analyzed later by acetone extraction and fluorometry (APHA 1998) in the MMR laboratory (Hall et al., 2007). Total suspended solids analysis followed Hall *et al* (2007).

## **2.6 Bacteria**

Water samples collected for Enterococci were analyzed in duplicate using Membrane Filtration method and placed on Enterococci agar. The volumes filtered differed depending on how clean the water was and on previous results. Enterococci plates were incubated at 37°C for 24 hours (Hall et al., 2007).

## **2.7 Missing Data**

### **Lagoon:**

All salinity readings in the month of January at all sites were deleted because instrument calibration was not within specification. The pH readings in the months of April, June, August, October and November were also deleted because of instrument calibration not being within specification. There was no physical data recorded at Pacific Resort in January and One Foot Island in the month of July, 2009. The nitrate data for Paradise Cove was deleted due to out of range reading.

### **Stream:**

All pH readings in the months of March, April, May, June, August, October and November were deleted because of instrument calibration not being within specification. There was no nutrient data for the month of February at Pata and Arutanga Wharf streams due to sample contamination. In the months of January, October and December at Pata stream, there was no water.

### **3. Acknowledgments**

We thank Drs Julie Hall and Els Maas for both technical advice and editorial comments, Mike Crump and his team at NIWA for their technical support, and the staff of the Ministry of Marine Resources for editorial comments. To the Aitutaki Marine Research Station staff for sample collecting. The Ministry of Marine Resources would also like to thank NZAid for all the funding support.

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Water Quality Database-Ministry of Marine Resources.

YSI 556 MPS Multi Probe System Operations Manual. YSI Incorporate

## 5. Appendix 1.

### 5.1 Water Quality data lagoon sites

Location	Site Number	Date	Temp (°C)	Salinity (ppt)	DOSat (%)	DO (mg/L)	pH	DRP (µg/L)	NH4-N (µg/L)	NO3-N (µg/L)	TSS (mg/L)	VSS (mg/L)	Enterococci (Count/100ml)
Akitua	1	20-Jan-09	29.2		101.3	5.1	8.2	0.5	5	1	3.3	1.2	2250
Akitua	1	17-Feb-09	27	36.6	71.9	4.7	7.9	2	3	2	2.7	0.4	63
Akitua	1	10-Mar-09	27.7	35.7	86.3	5.6	8.1	4	4	0.5	4.7	0.1	10
Akitua	1	17-Apr-09	26.5	34.6	62.9	4.2		0.5	7	13	2.9	2.9	13
Akitua	1	19-May-09	21.3	35.9	95.7	6.9	8.7	2	8	1	12	1.7	25
Akitua	1	9-Jun-09	22.9	35.3	79.9	5.6		8	10	24	6.1	0.8	6
Akitua	1	7-Jul-09	25.2	35.9	86.8	5.8	8.2	9	7	10	9	0.6	4
Akitua	1	18-Aug-09	22.1	35.9	86.9	6.2		5	3	7	11.3	1	50
Akitua	1	8-Sep-09	23.3	35.5	90.7	6.3	8.2	4	12	7	5.6	0.4	8
Akitua	1	20-Oct-09	23.5	36.3	94	6.5		2	5	0.5	2.6	0.3	0
Akitua	1	10-Nov-09	24.5	35.6	100.6	6.9		3	3	17	2.3	0.9	2
Akitua	1	10-Dec-09	25.8	35.5	92.8	6.2	8.1	1	2	7	2.6	0.7	2
Samade	2	20-Jan-09	29.6		86.2	4.3	8.2	0.5	18	5	6.1	1.1	180
Samade	2	17-Feb-09	28.8	36.3	56.2	3.6	8.1	1	5	0.5	3.4	0.6	6
Samade	2	10-Mar-09	27.2	34.7	76.1	5	8	4	6	2	4.8	4.8	16
Samade	2	17-Apr-09	26.5	35	92.8	6.1		0.5	13	12	5.4	0.5	950
Samade	2	19-May-09	25.4	33.7	89.9	6.1	7.9	0.5	9	1	7.3	0.9	60
Samade	2	9-Jun-09	22.8	33	88.6	6.3		0.5	8	2	10	1.4	8
Samade	2	7-Jul-09	24.4	33.8	74.7	5.1	8.2	5	10	8	4.2	0.5	745
Samade	2	18-Aug-09	23.9	35.8	81	5.6		6	6	16	4.8	0.2	16
Samade	2	8-Sep-09	22.8	35.2	85.8	6	8.1	3	12	3	6.5	1.4	3
Samade	2	20-Oct-09	23.9	36.7	64.8	4.4		2	24	0.5	7.1	1.9	30
Samade	2	10-Nov-09	25.5	31.3	74.6	5.1		2	5	12	2.8	0.7	18
Samade	2	10-Dec-09	27.7	36.8	99.4	6.4	8	1	8	3	4.5	1.5	12
Tepaki	3	20-Jan-09	29.8		55.3	2.8	8.1	0.5	27	0.5	16.9	4.2	10

Location	Site Number	Date	Temp (°C)	Salinity (ppt)	DOSat (%)	DO (mg/L)	pH	DRP (µg/L)	NH4-N (µg/L)	NO3-N (µg/L)	TSS (mg/L)	VSS (mg/L)	Enterococci (Count/100ml)
Tepaki	3	17-Feb-09	28.9	36.3	103.8	6.5	8.2	5	69	2	14	1.6	17
Tepaki	3	10-Mar-09	26.4	29.2	69.2	4.7	7.9	0.5	16	0.5	14.7	1.1	182
Tepaki	3	17-Apr-09	26	34.2	86.4	5.8		0.5	34	6	5.8	1.1	66
Tepaki	3	19-May-09	23.7	32.4	93.8	6.6	8.4	0.5	17	1	6.2	1.3	105
Tepaki	3	9-Jun-09	22	30.4	84.3	6.2		0.5	2	1	12.4	1.7	28
Tepaki	3	7-Jul-09	23.6	32.9	48.2	3.4	8.1	5	64	5	12.5	2.2	26
Tepaki	3	18-Aug-09	23	34.6	73.1	5.1		5	7	1	5	1.4	42
Tepaki	3	8-Sep-09	22.2	33.8	82.7	5.9	7.9	8	33	6	9.2	2.3	105
Tepaki	3	20-Oct-09	23.2	36.9	63.7	4.4		2	42	0.5	11.6	2.8	2
Tepaki	3	10-Nov-09	25.3	33.7	93.9	6.4		0.5	8	15	4.9	1	43
Tepaki	3	10-Dec-09	27.3	37.3	54.4	3.5	7.9	1	24	5	14.7	1.6	7
Vaipeka	4	20-Jan-09	28.2		89.9	4.8	8	5	34	0.5	2.8	1.2	72
Vaipeka	4	17-Feb-09	29.1	36.5	97.5	6.1	8.2	3	11	2	1.6	0.6	51
Vaipeka	4	10-Mar-09	25.4	30.7	59.4	4.1	7.7	6	26	1	3.4	0.4	70
Vaipeka	4	17-Apr-09	26.5	34.4	82.9	5.5		33	160	10	3.8	1.7	975
Vaipeka	4	19-May-09	25	31.8	87.8	6.1	8.2	11	14	5	6.9	1.6	1880
Vaipeka	4	9-Jun-09	22.3	34.1	67.3	4.8		2	11	3	4.4	1.2	0
Vaipeka	4	7-Jul-09	22.3	24.3	91.9	6.9	8.3	5	18	9	14.4	1.7	7
Vaipeka	4	18-Aug-09	24	36	99	6.8		5	7	2	2.5	0.8	17
Vaipeka	4	8-Sep-09	22.7	33.5	94	6.7	8.2	4	8	3	5.2	1.4	8
Vaipeka	4	20-Oct-09	21.5	37.8	100.4	7.1		12	47	5	4.9	1.9	15
Vaipeka	4	10-Nov-09	25.1	34.3	97.8	6.6		4	4	17	1.9	0.7	8
Vaipeka	4	10-Dec-09	25.7	36.2	94.1	6.3	7.9	2	7	5	2.8	1.3	5
Vaipae Wharf	5	20-Jan-09	29.1		80.4	4	8.1	2	8	0.5	9.6	0.8	5
Vaipae Wharf	5	17-Feb-09	26.4	35.7	49.7	3.3	7.8	5	16	4	3.6	1.3	14
Vaipae Wharf	5	10-Mar-09	28	35.9	69.1	4.4	8.1	4	13	2	7.4	7.4	22
Vaipae Wharf	5	17-Apr-09	26.4	34.7	93.2	6.2		0.5	10	4	4.3	1.9	117
Vaipae Wharf	5	19-May-09	26.3	34.9	86.5	5.7	7.8	0.5	26	20	34.6	5.9	4950
Vaipae Wharf	5	9-Jun-09	23.6	35	96.3	6.7		0.5	1	2	11.2	1.7	0
Vaipae Wharf	5	7-Jul-09	25.8	36.1	62.3	4.1	8.1	4	39	10	4.5	0.8	4
Vaipae Wharf	5	18-Aug-09	24.1	35.7	96.8	6.6		3	2	1	3.8	0.2	24
Vaipae Wharf	5	8-Sep-09	22.5	35.4	83.2	5.9	8.4	4	15	5	7.3	1	16

Location	Site Number	Date	Temp (°C)	Salinity (ppt)	DOSat (%)	DO (mg/L)	pH	DRP (µg/L)	NH4-N (µg/L)	NO3-N (µg/L)	TSS (mg/L)	VSS (mg/L)	Enterococci (Count/100ml)
Vaipae Wharf	5	20-Oct-09	23.1	35.6	83.1	5.8		5	19	6	6.3	1.7	16
Vaipae Wharf	5	10-Nov-09	27.2	31.9	104.9	7		2	30	13	3.5	1	18
Vaipae Wharf	5	10-Dec-09	27.8	36.8	100.1	6.4	8	2	20	5	6.4	0.9	2
Tautu Wharf	6	20-Jan-09	29.7		81.3	4.1	8.1	3	46	5	15.6	1.6	1
Tautu Wharf	6	17-Feb-09	28.2	34.6	65.4	4.2	8.1	1	34	2	4.4	1.1	4
Tautu Wharf	6	10-Mar-09	28	36.1	54.1	3.5	8	2	30	1	5.7	0.7	68
Tautu Wharf	6	17-Apr-09	25.5	21.4	72.2	5.2		0.5	45	8	5.9	1	40
Tautu Wharf	6	19-May-09	22.3	30.7	98.5	7.2	7.6	0.5	36	12	16.3	3.7	1805
Tautu Wharf	6	9-Jun-09	21.2	31.3	91.9	6.8		0.5	5	2	9	1.4	47
Tautu Wharf	6	7-Jul-09	25.5	35.8	60.8	4.1	8.1	1	47	12	11.7	4.9	27
Tautu Wharf	6	18-Aug-09	22.2	28.9	82.6	6.1		3	14	3	7.4	0.6	14
Tautu Wharf	6	8-Sep-09	22.2	35.2	86.4	6.1	8.2	4	14	8	7.1	1.4	28
Tautu Wharf	6	20-Oct-09	22.9	36.1	89.6	6.3		0.5	18	0.5	7	2.3	5
Tautu Wharf	6	10-Nov-09	25.8	34.2	83	5.6		0.5	21	9	3.8	1.4	100
Tautu Wharf	6	10-Dec-09	25.1	38.3	52.8	3.5	7.9	2	35	4	5.3	1.1	69
New Jerusalem	7	20-Jan-09	29		71.7	3.8	7.9	3	46	19	6.6	1.3	2
New Jerusalem	7	17-Feb-09	28.2	34	48.8	3.2	7.9	4	14	6	10.6	1.8	0
New Jerusalem	7	10-Mar-09	26.2	32.8	77.8	5.2	7.8	6	34	1	13.7	1.7	33
New Jerusalem	7	17-Apr-09	24.7	21.4	93.1	6.9		3	24	1	7.6	1.4	79
New Jerusalem	7	19-May-09	22.5	27.1	98.6	7.3	8.3	0.5	8	27	11.5	2.7	645
New Jerusalem	7	9-Jun-09	22.4	35.5	87.6	6.2		0.5	14	3	41.3	3.6	118
New Jerusalem	7	7-Jul-09	23.8	34	75.4	5.2	8.1	3	7	3	12.7	0.6	16
New Jerusalem	7	18-Aug-09	23.3	32.1	86.3	6.1		9	30	7	3.2	1.9	600
New Jerusalem	7	8-Sep-09	22.2	35.4	95.4	6.8	8.3	3	6	1	11.8	1.7	26
New Jerusalem	7	20-Oct-09	23	35	96.8	6.8		5	18	0.5	7.5	1.5	5
New Jerusalem	7	10-Nov-09	26.2	33.7	58.3	3.9		2	12	8	11	1.9	17
New Jerusalem	7	10-Dec-09	28.2	36.9	81.4	5.2	8.1	2	4	0.5	3.8	0.8	1
Waste Management	8	20-Jan-09	30.7		56.8	2.9	7.9	8	26	1	15.4	3.8	5
Waste Management	8	17-Feb-09	28.3	31.7	70.7	4.6	8	6	58	7	14.1	3	10
Waste Management	8	10-Mar-09	25.6	20.7	70.4	5.1	7.8	8	6	0.5	7.6	0.7	7100
Waste Management	8	17-Apr-09	25.2	24.7	71.5	5.1		5	38	6	15.4	3.5	111
Waste Management	8	19-May-09	22.8	28.2	94.6	6.9	8.2	2	17	7	7.2	3	995

Location	Site Number	Date	Temp (°C)	Salinity (ppt)	DOSat (%)	DO (mg/L)	pH	DRP (µg/L)	NH4-N (µg/L)	NO3-N (µg/L)	TSS (mg/L)	VSS (mg/L)	Enterococci (Count/100ml)
Waste Management	8	9-Jun-09	22.2	34.7	90.5	6.4		5	40	1	17.7	1.8	140
Waste Management	8	7-Jul-09	23.8	32.6	68	4.8	8	5	0.5	0.5	16.3	3.2	10
Waste Management	8	18-Aug-09	23.4	31.9	85.6	6.1		7	14	3	3.9	2	86
Waste Management	8	8-Sep-09	22.7	34.1	79.7	5.7	7.9	5	8	2	22.4	2.5	49
Waste Management	8	20-Oct-09	25.5	32.7	68.7	4.7		7	30	8	18.9	5	172
Waste Management	8	10-Nov-09	26.5	32.8	90.6	6.1		4	21	4	24.6	3.2	36
Waste Management	8	10-Dec-09	28.2	36.9	61.7	3.9	7.9	4	12	4	5.8	1.6	36
Maina Sunset	9	20-Jan-09	29.2		59.2	3	8	3	24	0.5	10.4	1.7	5
Maina Sunset	9	17-Feb-09	29.7	27.4	54.3	3.6	7.8	5	39	6	7	2.1	22
Maina Sunset	9	10-Mar-09	26.2	27.8	73.6	5.1	7.7	6	21	5	42.7	1.2	13950
Maina Sunset	9	17-Apr-09	25.9	23.3	104.3	7.4		3	33	19	8.2	1.5	70
Maina Sunset	9	19-May-09	22.8	29.1	94.9	6.9	8.3	0.5	7	7	11.2	2	35
Maina Sunset	9	9-Jun-09	21.7	34.6	93.4	6.7		0.5	12	2	14.4	2.7	40
Maina Sunset	9	7-Jul-09	24.1	28.3	68.4	4.9	7.9	5	22	6	18.7	3.1	180
Maina Sunset	9	18-Aug-09	22.8	24.1	77.3	5.8		5	12	2	13.5	1.4	115
Maina Sunset	9	8-Sep-09	22.6	34.7	71.7	5.1	7.6	5	4	1	11.9	1.6	165
Maina Sunset	9	20-Oct-09	23.4	36.2	48.7	3.4		4	11	0.5	5.6	0.8	36
Maina Sunset	9	10-Nov-09	29.6	31.3	81	5.2		2	14	1	10.2	2.1	595
Maina Sunset	9	10-Dec-09	27	37.6	64.2	4.1	7.9	3	22	3	9.8	1.5	5
Arutanga Wharf	10	20-Jan-09	29.2		72.9	3.6	8.1	1	8	4	3.7	0.9	12
Arutanga Wharf	10	17-Feb-09	28.9	36.5	36.7	2.3	7.9	0.5	8	5	3.5	0.6	5
Arutanga Wharf	10	10-Mar-09	27.6	35.4	68.1	4.4	7.8	1	11	3	7.7	0.6	430
Arutanga Wharf	10	17-Apr-09	27.3	30.1	68.3	4.6		0.5	15	9	4.4	0.9	33
Arutanga Wharf	10	19-May-09	24.3	30.4	72.4	5.1	8.3	0.5	5	7	4	0.6	151
Arutanga Wharf	10	9-Jun-09	22.1	33.1	75.4	5.4		1	8	16	12.2	12.2	9
Arutanga Wharf	10	7-Jul-09	24.7	35.7	67.2	4.6	8	5	6	4	4.2	0.3	27
Arutanga Wharf	10	18-Aug-09	24.1	33.7	40.1	2.8		2	6	2	2.8	0.9	15
Arutanga Wharf	10	8-Sep-09	23	35.8	79.1	5.5	7.8	2	6	1	6.5	1.8	29
Arutanga Wharf	10	20-Oct-09	24.5	36.1	92.7	6.3		4	13	7	3.3	0.4	96
Waste Management	8	19-May-09	22.8	28.2	94.6	6.9	8.2	2	17	7	7.2	3	995
Arutanga Wharf	10	10-Nov-09	26.6	28.3	80.6	5.5		4	8	10	3	0.3	25
Arutanga Wharf	10	10-Dec-09	27.5	36.9	58.8	3.8	7.8	2	7	4	2.2	0.3	0



Location	Site Number	Date	Temp (°C)	Salinity (ppt)	DOSat (%)	DO (mg/L)	pH	DRP (µg/L)	NH4-N (µg/L)	NO3-N (µg/L)	TSS (mg/L)	VSS (mg/L)	Enterococci (Count/100ml)
Pacific Resort	11	20-Jan-09						4	7	8	1.5	0.6	1
Pacific Resort	11	17-Feb-09	28.6	36.5	50.3	3.2	8	2	11	8	1.3	0.4	2
Pacific Resort	11	10-Mar-09	26.3	34.4	86.1	5.7	8.2	6	9	4	4.5	0.4	20
Pacific Resort	11	17-Apr-09	26.7	34.3	59.4	3.9		4	20	13	2.9	1.6	785
Pacific Resort	11	19-May-09	24.5	34.8	88.9	6.1	8.2	0.5	0.5	10	2.1	0.5	5
Pacific Resort	11	9-Jun-09	23.1	34.8	89.6	6.3		4	7	7	4.3	0.7	4
Pacific Resort	11	7-Jul-09	24.8	35.8	90.2	6.1	8.2	7	12	9	3.2	1	16
Pacific Resort	11	18-Aug-09	23.9	33.7	72.2	5		5	9	50	1.1	0.5	9
Pacific Resort	11	8-Sep-09	23.1	35.2	98.2	6.9	7.9	1	1	3	3.3	1.2	15
Pacific Resort	11	20-Oct-09	24.2	35.4	90.6	6.2		2	11	3	5.4	2.3	0
Pacific Resort	11	10-Nov-09	26	35.4	79.6	5.3		5	4	7	2.5	0.4	15
Pacific Resort	11	10-Dec-09	28.2	36.6	64.7	4.1	7.9	4	9	7	2.5	0.8	0
Paradise Cove	12	20-Jan-09	28.1		64	3.2	8.2	3	9	4	5.4	0.2	110
Paradise Cove	12	17-Feb-09	25.4	36.6	70.6	4.7	8.2	4	15	11	5	1.5	5
Paradise Cove	12	10-Mar-09	26.2	33.7	82.8	5.5	8.1	8	9	9	13.6	1.1	32
Paradise Cove	12	17-Apr-09	26.2	34.2	70.7	4.7		5	19	17	4.8	1.4	29
Paradise Cove	12	19-May-09	24	33.1	94.5	6.6	8.5	4	8	12	0.3	0.3	147
Paradise Cove	12	9-Jun-09	23.6	34.6	93.4	6.5		8	9	15	1.9	0.4	6
Paradise Cove	12	7-Jul-09	25.4	35.4	42.8	2.9	7.9	6	7	10	1.8	0.5	6
Paradise Cove	12	18-Aug-09	23.8	33.9	52.5	3.7		4	8		2.8	0.5	360
Paradise Cove	12	8-Sep-09	23.2	34.9	82.2	5.7	8.2	4	4	4	7.1	1.3	21
Paradise Cove	12	20-Oct-09	24.9	35.7	87.2	5.9		8	15	10	5.1	1.1	0
Paradise Cove	12	10-Nov-09	23.2	36	89.2	6.2		7	9	5	2.9	0.6	4
Paradise Cove	12	10-Dec-09	25.8	35.9	86.1	5.7	8.1	4	6	4	2.9	0.7	0
TCI Mast Airport	13	20-Jan-09	27.5		94.3	4.8	8.2	1	2	0.5	2.9	0.7	5
TCI Mast Airport	13	17-Feb-09	25.9	36.4	77.6	5.1	8.3	6	13	2	1.6	0.5	0
TCI Mast Airport	13	10-Mar-09	26.8	34	91.7	6.1	8.1	5	3	0.5	13.2	1.7	8
TCI Mast Airport	13	17-Apr-09	26.7	34.2	80.4	5.3		2	7	6	1.1	0.3	28
TCI Mast Airport	13	19-May-09	24.1	32.9	85.9	6	8.4	0.5	0.5	7	2.7	0.5	186
TCI Mast Airport	13	9-Jun-09	22.1	33.2	78.4	5.7		7	7	5	2.8	0.5	112
TCI Mast Airport	13	7-Jul-09	24.5	35.7	80	5.4	8	4	5	1	3.5	0.9	35

Location	Site Number	Date	Temp (°C)	Salinity (ppt)	DOSat (%)	DO (mg/L)	pH	DRP (µg/L)	NH4-N (µg/L)	NO3-N (µg/L)	TSS (mg/L)	VSS (mg/L)	Enterococci (Count/100ml)
TCI Mast Airport	13	18-Aug-09	24	34.4	89.9	6.2		2	16	1	3.5	0.2	52
TCI Mast Airport	13	8-Sep-09	22.7	35.3	72.1	5.1	8.1	6	7	5	0.9	0.3	14
TCI Mast Airport	13	20-Oct-09	21.9	34.6	57.4	4.1		17	30	13	0.9	0	0
TCI Mast Airport	13	10-Nov-09	23.1	36.1	72.3	5		2	6	2	0.9	0.1	3
TCI Mast Airport	13	10-Dec-09	26.8	36	46.9	3.1	7.9	4	6	4	1.9	0.5	0
Maina Nursery	14	20-Jan-09	28.2		87.1	4.4	8.2	2	0.5	1	0.7	0.5	0
Maina Nursery	14	17-Feb-09	28	36.5	82.2	5.3	8.1	5	0.5	0.5	0.4	0.3	0
Maina Nursery	14	10-Mar-09	28	35.7	94	6.7	8.3	2	0.5	0.5	0.3	0.3	14
Maina Nursery	14	17-Apr-09	25.4	35.7	81.4	5.5		2	2	3	0.6	0	15
Maina Nursery	14	19-May-09	24.1	33.7	93.9	6.5	8.5	0.5	0.5	4	0.4	0	9
Maina Nursery	14	9-Jun-09	24.1	35.9	76.2	5.2		5	6	4	1.3	0.2	31
Maina Nursery	14	7-Jul-09	20.5	35.6	115.4	8.4	8.3	6	4	5	0.7	0.1	128
Maina Nursery	14	18-Aug-09	23.5	34.9	65.6	4.6		7	2	4	0.8	0.3	0
Maina Nursery	14	8-Sep-09	24.2	36	84.6	6	8.5	6	2	1	0.5	0.3	0
Maina Nursery	14	20-Oct-09	21.9	36.3	78.7	5.6		9	6	11	0.3	0	0
Maina Nursery	14	10-Nov-09	26.2	35.5	91.6	6.1		4	0.5	1	0.5	0.2	3
Maina Nursery	14	10-Dec-09	27.2	36.5	52.9	3.4	7.9	4	5	6	0.8	0.1	0
One Foot Island	15	20-Jan-09	22.9		86.1	4.7	8.4	3	1	0.5	1.6	0.3	0
One Foot Island	15	17-Feb-09	28.3	36.3	56.9	3.6	8.1	2	2	0.5	0.7	0	36
One Foot Island	15	10-Mar-09	28	35.1	85.5	5.9	8.2	5	1	0.5	0.6	0.6	9
One Foot Island	15	17-Apr-09	24.7	35.6	89.1	6		4	6	3	1.1	0.4	58
One Foot Island	15	19-May-09	23.1	35.1	91.7	6.4	8.6	0.5	0.5	3	0.7	0.1	6
One Foot Island	15	9-Jun-09	25.2	35.7	82.6	5.6		7	5	9	0.8	0.3	5
One Foot Island	15	7-Jul-09						7	9	4	0.3	0.2	41
One Foot Island	15	18-Aug-09	21.7	36.1	101.2	7.2		6	1	7	0.7	0.7	0
One Foot Island	15	8-Sep-09	24.2	36.2	81.7	5.8	8.6	5	3	3	0.4	0.1	0
One Foot Island	15	20-Oct-09	20.1	36.3	81.7	6		7	7	14	0.5	0	0
One Foot Island	15	10-Nov-09	26.2	35.6	74.3	4.9		5	0.5	1	0.6	0.2	16
One Foot Island	15	10-Dec-09	25.4	35.9	83.1	5.6	8.1	0.5	1	1	0.8	0.5	0

## 5.2 Water Quality data stream sites

Location	Site Number	Date	Temp (°C)	Salinity (ppt)	DOSat (%)	DO (mg/L)	pH	DRP (µg/L)	NH4-N (µg/L)	NO3-N (µg/L)	TSS (mg/L)	VSS (mg/L)	Enterococci (Count/100ml)
Vaitiare	1	20-Jan-09	26.9	2.0	31.6	2.5	7.3	29	110	18	22.2	13.3	3
Vaitiare	1	17-Feb-09	25.2	0.4	3.6	0.3	7.3	152	31	5	27.9	11.0	670
Vaitiare	1	10-Mar-09	25.2	0.3	3.4	3.4		0.5	96	2	20.0	3.3	18600
Vaitiare	1	17-Apr-09	25.3	0.1	66.6	5.5		115	16	24	13.3	4.0	14000
Vaitiare	1	19-May-09	23.5	0.1	82.4	7.0		364	7	298	53.8	13.8	18950
Vaitiare	1	09-Jun-09	22.9	0.3	3.2	13.6		14	10	17	3.6	0.9	177
Vaitiare	1	07-Jul-09	22.6	0.2	23.8	2.1	7.7	26	0.5	10	14.3	5.3	11950
Vaitiare	1	18-Aug-09	23.3	2.8	18.0	1.5		11	145	13	10.7	3.7	18250
Vaitiare	1	08-Sep-09	22.9	1.4	15.2	1.3	6.8	31	56	2	29.2	7.7	1790
Vaitiare	1	20-Oct-09	22.26		18.1	1.3		288	508	13	7.4	2.2	68
Vaitiare	1	10-Nov-09	24.7	4.09	21.2	1.4		4	170	12	15.5	4.5	9700
Vaitiare	1	10-Dec-09											
Vaipae	2	20-Jan-09	28.8	0.3	62.8	4.8	7.5	0.5	125	8	3.0	1.5	11
Vaipae	2	17-Feb-09	26.4	0.2	59.9	4.8	7.0	0.5	14	26	5.4	2.1	490
Vaipae	2	10-Mar-09	27.0	0.2	5.2	5.2		3	67	93	55.3	12.0	22000
Vaipae	2	17-Apr-09	27.0	0.2	57.8	4.6		0.5	48	92	4.1	0.6	10700
Vaipae	2	19-May-09	25.3	0.2	61.1	5.0		0.5	41	61	9.2	2.5	1260
Vaipae	2	09-Jun-09	25.1	0.2	64.3	5.3		5	41	57	3.6	0.9	163
Vaipae	2	07-Jul-09	25.0	0.2	62.1	5.1	7.3	3	13	57	4.9	1.6	1310
Vaipae	2	18-Aug-09	25.5	0.2	77.5	6.3		0.5	13	60	2.2	0.2	795
Vaipae	2	08-Sep-09	25.0	0.2	80.1	6.6	6.7	0.5	26	76	5.7	0.9	140
Vaipae	2	20-Oct-09	23.88	0.13	90.6	7.6		0.5	6	10	4.4	0.4	130
Vaipae	2	10-Nov-09	27.0	0.18	90.2	7.1		2	10	14	2.9	1.8	395
Vaipae	2	10-Dec-09	25.3	0.3	71.9	5.9	7.6	0.5	11	6	11.6	3.2	6950
Pāta	3	20-Jan-09											
Pāta	3	17-Feb-09	24.8	0.4	5.8	0.5	7.3				7.3	3.0	480
Pāta	3	10-Mar-09	25.4	0.2	1.6	1.6		15	6	7	2.9	1.4	21450
Pāta	3	17-Apr-09	25.2	0.2	14.4	1.2		5	74	1	7.3	2.0	2500

Location	Site Number	Date	Temp (°C)	Salinity (ppt)	DOSat (%)	DO (mg/L)	pH	DRP (µg/L)	NH4-N (µg/L)	NO3-N (µg/L)	TSS (mg/L)	VSS (mg/L)	Enterococci (Count/100ml)
Pāta	3	19-May-09	24.0	0.2	44.0	3.7		23	29	17	14.0	3.3	6650
Pāta	3	09-Jun-09	23.9	0.2	12.5	1.1		3	60	6	6.0	1.6	80
Pāta	3	07-Jul-09	23.2	0.2	14.3	1.2	7.3	3	143	8	4.3	1.9	660
Pāta	3	18-Aug-09	23.4	0.2	15.4	1.3		3	59	2	0.7	0.7	1235
Pāta	3	08-Sep-09	22.8	0.2	12.4	1.1	6.7	1	127	1	6.7	1.3	655
Pāta	3	20-Oct-09											
Pāta	3	10-Nov-09	24.0	0.55	7.1	0.6		3	179	12	4.6		1565
Pāta	3	10-Dec-09											
Arutanga Wharf	4	20-Jan-09	28.3	0.2	97.9	7.6	8.2	8	6	271	0.5	0.7	2650
Arutanga Wharf	4	17-Feb-09	26.3	0.3	75.0	6.1	8.3				1.4	0.7	625
Arutanga Wharf	4	10-Mar-09	26.6	0.3	2.4	2.4		16	3	884	2.2	0.7	19000
Arutanga Wharf	4	17-Apr-09	27.8	0.3	62.1	4.9		8	19	1170	6.7	1.7	7100
Arutanga Wharf	4	19-May-09	26.1	0.2	95.3	7.7		10	29	916	4.0	0.0	1255
Arutanga Wharf	4	09-Jun-09	26.0	0.2	92.6	7.5		3	10	792	0.9	0.1	140
Arutanga Wharf	4	07-Jul-09	25.5	0.2	75.9	6.2	7.7	3	2	756	2.4	0.6	1725
Arutanga Wharf	4	18-Aug-09	26.1	0.2	100.6	8.1		5	12	1060	1.4	0.3	4550
Arutanga Wharf	4	08-Sep-09	26.4	0.3	79.0	6.4	7.0	4	4	902	0.5	0.5	235
Arutanga Wharf	4	20-Oct-09	26.15	0.18	107.2	8.7		4	8	752	1.4	0.4	306
Arutanga Wharf	4	10-Nov-09	26.6	0.18	82.5	6.6		7	6	731	1.2	0.4	7150
Arutanga Wharf	4	10-Dec-09	26.5	0.2	72.5	5.8	7.9	6	8	533	4.4	1.2	1765