Job No.10292

MEMORANDUM

To: Stephen Heath, Wairoa District Council

From: Angela Lane and Phil Lake, Lowe Environmental Impact

Date: 17 October 2018

Subject: Additional Environmental Monitoring Data (LEI, 2018: A3I4)

Background

The Wairoa wastewater treatment system requires a replacement consent upon expiry of the current consent on 31 May 2019. Since continuation of the present discharge to the Wairoa River is to be sought (with improved treatment and reducing discharge volumes in future), then both the quality of the receiving waters and the effects of the discharge on that environment need to be assessed based on the most recent and complete monitoring datasets.

Purpose

This Memo identifies and assesses all Wairoa River water quality monitoring and reporting undertaken or obtained since completing the environmental data report (LEI, 2017:A3I2).

Scope

This Memorandum reports on the outcomes of the following aspects:

- Report results from Linnaeus' water quality monitoring undertaken for WDC;
- Obtain any information available relating to AFFCO discharges into the Wairoa River;
- Obtain additional river water quality and flow data and reports from HBRC; and
- Assess the temporal and spatial trends and general statistics of river water quality.

This Memorandum is not intended to cover cultural perspectives on the Wairoa River, public health issues, or benthic ecological and sediment characteristics, which are addressed and reported separately.

Sources of Information

The sources of information from which this memorandum has been prepared are as follows:

- Linnaeus Sampling Report for LEI on behalf of WDC, 10 May 2017. A single set of samples was collected on 27 April 2017.
- Wairoa River Nutrient Survey 2017: Argo Environmental, (2017). Wairoa River Nutrient Survey. Unpublished report by Argo Environmental to AFFCO Wairoa, July 2017 54 pp. Sets of samples were collected during November 2016 to May 2017.
- Wairoa River water quality monitoring data provided by HBRC on 7 August 2018.
- Land and Water Aotearoa (LAWA) national environmental monitoring database.
- Daily Wairoa River flow data provided by HBRC on 10 August 2018.
- Daily Wairoa meteorological data from NIWA's publicly accessible database.

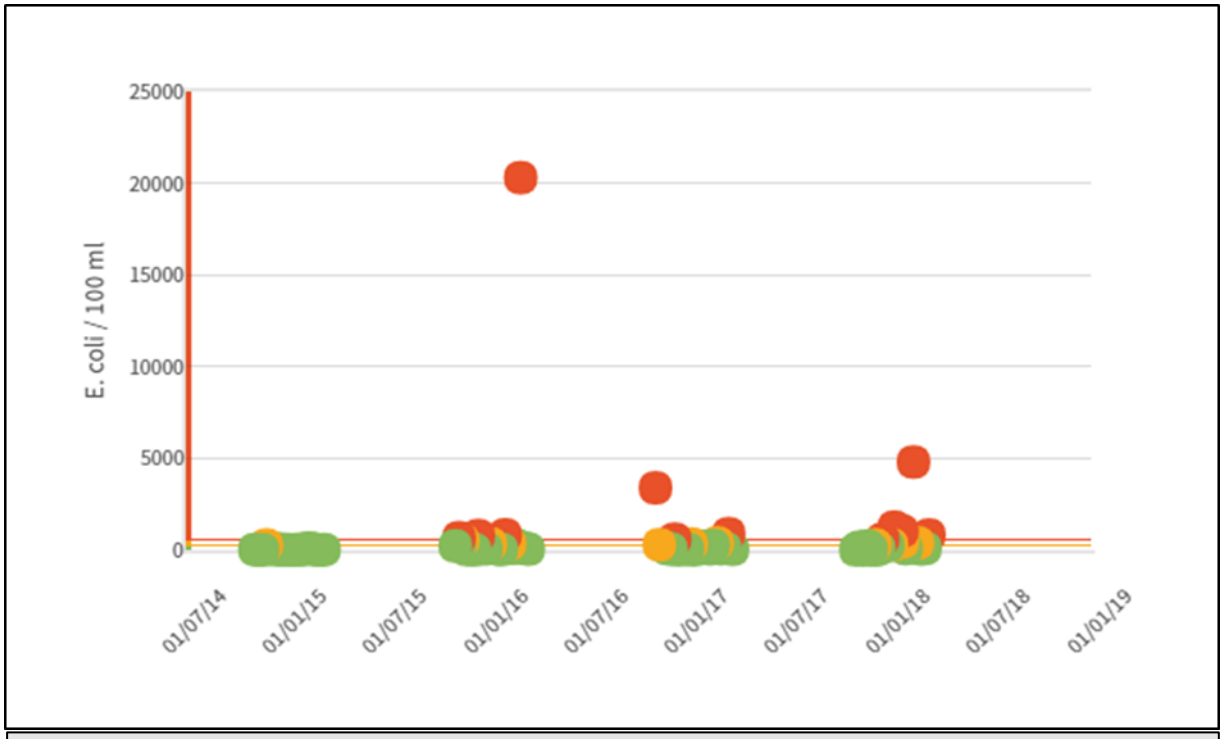
Table 1 below summarises the Argo Environmental and Linnaeus river water quality monitoring data for 2016-17.

Table 1: Wairoa River Water Quality Results for 2016-2017

Parameter	Ski Club	100 m Upstream of AFFCO[1]	AFFCO Outfall	1 km Downstream of AFFCO[1]	Yacht Club	Estuary	Whakamahi Lagoon	Guideline or Limit	Source of Limit
Ammoniacal-N (g/m^3)	<0.010		<0.010		0.012	0.014	<0.010	0.1 mg/L	HBRC RRMP (2006)
Nitrite-N (g/m^3)	<0.002		<0.002		<0.002	<0.002	<0.002		
Nitrate-N (g/m^3)	0.150		0.155		0.153	0.135	0.149	$\leq$1.0 annual median and $\leq$1.5 annual 95th percentile	NPS-FM 2017, Attribute State A
Nitrate + Nitrite (g/m^3)	0.152	0.002 – 0.26 Mean: 0.068	0.157	0.004 – 0.26 Mean: 0.070	0.155	0.136	0.150		
Total Kjeldahl Nitrogen (g/m^3)	<0.10		0.13		0.15	0.11	0.13		
Total Nitrogen (g/m^3)	0.15	0.15 – 0.45 Mean: 0.27	0.28	<0.11 – 0.52 Mean: 0.27	0.30	0.25	0.28		
Dissolved Reactive Phosphorus (g/m^3)	0.016	<0.004 – 0.021 Mean: 0.010	0.016	<0.004 – 0.018 Mean: 0.010	0.016	0.016	0.016	0.015 mg/L	HBRC RRMP (2006)
Total Phosphorus (g/m^3)	0.020	0.008 – 0.046 Mean: 0.021	0.022	0.007 – 0.048 Mean: 0.020	0.025	0.025	0.023	0.033 mg/L	ANZECC (2000)
E. coli (MPN/100ml)	82		110		160	110	150	Median $\leq$130 cfu/100 ml and <20% exceed 260 cfu/100 ml	NPS-FM 2017, Attribute State A

Note: [1] Data taken from Argo Environmental, 2017 for AFFCO Wairoa. All other data in Table 1 is from Linnaeus, 2017 collected specifically for WDC.

In addition to these specific studies, HBRC undertake recreational water quality monitoring of *E. coli* in the Wairoa River at the Ski Club boat ramp (just upstream of the SH2 bridge) on a weekly basis during November to March (the bathing season) each year. The graph below is sourced from LAWA and shows the last four years of data and an overall risk assessment.



Overall bacterial risk information

Long-term risk guide based on three years of data			
Minimum data points required	30	Highest *E. coli* per 100ml value	20,300
Number of data points available	58	Lowest *E. coli* per 100ml value	6
Hazen percentile result	815	Overall bacterial risk result	High Risk

Figure 1: LAWA Presentation of Ski Club Recreational Water Quality for 2014-18

HBRC monitoring data for the Railway Bridge site and a sampling site downstream of the WWTP discharge during 2000-2008 had not been obtained from HBRC prior to finalising the LEI, A3I2 report, and was recently provided to LEI by HBRC staff. HBRC also provided monthly monitoring data for the Railway Bridge site during January – December 2017 and weekly recreational monitoring data for the Ski Club site during October 2017 to March 2018. Statistics for these additional and expanded datasets are summarised in Table 2 below.

Table 2: HBRC Data for Wairoa River Water Quality Results for 2000-18

Monitoring Site and Sample Date Ranges	Ammoniacal-Nitrogen (g/m^3)		Dissolved Reactive Phosphorus (g/m^3)		Total Suspended Solids (g/m^3)		*E. coli* (cfu/100ml)		
	Range	Median	Range	Median	Range	Median	Range	Median	95th %ile
Railway Bridge									
May 2000 or Aug 2004 – Nov 2008[1]	<0.010 – 0.061	0.020	<0.001 – 0.043	0.008	<3 – 261	13	<1 – 150	28	86
Feb 2009 – Dec 2016	<0.005 – 0.12	<0.010	<0.001 – 0.032	0.010	0.7 – 2,900	11	<1 – 14,000	80	3,600
Jan 2017 – Dec 2017	<0.005 – 0.014	<0.005	<0.001 – 0.019	0.008	2.9 – 250	11	23 – 1,100	58	935
All data	<0.005 – 0.12	0.020	<0.001 – 0.043	0.010	0.7 – 2,900	12	<1 – 14,000	56	2,550
Wairoa Ski Club									
Nov 2010 – Dec 2016							<1 – >100,000	70	2,320
Jan 2017 – Mar 2018							3 – 4,800	223	1,114
All data							<1 – >100,000	80	1,250
Downstream of WWTP Discharge									
May 2000 or Aug 2004 – Nov 2008[1]	<0.010 – 0.25	0.061	<0.001 – 0.030	0.013	3 – 1,280	47	<1 – 280	25	175
Feb 2009 – Jun 2012	<0.010 – 0.11	0.044	<0.004 – 0.078	0.010	7.1 – 1,210	53	<1 – 19,000	160	8,380
All data	<0.010 – 0.25	0.054	<0.001 – 0.078	0.013	3 – 1,280	50	<1 – 19,000	48	1,112
Guideline or Limit[2] and Source of Limit	Maximum 0.1 mg/l at or below median river flows HBRC RRMP (2006)		Maximum 0.015 mg/l at or below median river flows HBRC RRMP (2006)		Maximum 25 mg/l at all river flows HBRC RRMP (2006)		Median ≤130 cfu/100 ml and 95th percentile ≤1,200 cfu/100 ml NPS-FM 2017, Attribute State C		

Notes:

[1] Data for the Railway Bridge and Downstream of WWTP Discharge sites commenced in August 2004 for *E. coli* and commenced in May 2000 for all other parameters.

[2] 1 g/m^3 = 1 mg/l.

The Wairoa River water quality was identical or very similar at all sites when sampled by Linnaeus on 27 April 2017. Based on the additional monitoring data for AFFCO Wairoa and the Linnaeus data, AFFCO's discharge does not appear to cause measurable effects on water quality downstream, and the urban Wairoa environment (stormwater discharges etc) also does not appear to affect water quality, even in the Whakamahi Lagoon downstream of the town's treated wastewater discharge.

Every parameter except DRP was within its relevant guideline or limit, and all DRP and TP results were essentially identical at all sites on each day of sampling, which indicates that the sources of phosphorus are upstream of Wairoa's urban area and the phosphorus is neither accumulating nor decreasing as the river flows past Wairoa.

HBRC's monitoring of the Railway Bridge and historic monitoring of a site downstream of the WWTP discharge indicate that ammoniacal-nitrogen, DRP, and suspended solids all increase as the river flows towards Hawke Bay. However, these increases probably reflect the more saline, tidal, and turbulent estuarine environment with abundant birdlife rather than being attributable to the WWTP's treated wastewater discharges. All of these natural estuarine influences stir up sediment and elevate the nutrient concentrations in the river water.

HBRC's monitoring of *E. coli* at three sites demonstrates that, in most years, the river is high risk for contact recreation due to its frequency of results exceeding 540 cfu/100 ml and 95th percentiles exceeding 1,200 cfu/100 ml. The *E. coli* populations appear to reduce as the river flows towards Hawke Bay, and this may reflect the intolerance of *E. coli* to saline and brackish water that is encountered closer to the sea due to tidal influxes of seawater. Despite this, even at the site downstream of the WWTP discharge, the river remains in NPS-FM Attribute State C or D when assessed using the 2017 amendments to the criteria for recreational water quality in the NPS-FM 2014.

It is interesting to note that the **median** *E. coli* results for all sites are low and meet the Attribute State A requirements, but the river's categorisation is driven down the scale by the exceedances of the 1,200 cfu/100 ml limit for the 95th percentile value. Several statistical criteria must all be met when determining which Attribute State should be allocated to a water body.

River Flows

LEI, 2017:A3I2 provided river flow statistics for Wairoa River at Marumaru as representative of river flows through urban Wairoa. The Marumaru site does not include flows from the Waikaretaheke and Waiau Rivers, so the statistics only represented about half of the actual flows through urban Wairoa and out to sea. HBRC monitor river flows on these other major tributaries at Terapatiki and Ardkeen respectively, and daily data for January - September 2018 is shown below on Figures 2 and 3 for each site. The red line on each of these graphs shows 3 x annual median flow at each monitoring site as an approximate indicator of when the river is considered to be in flood conditions.

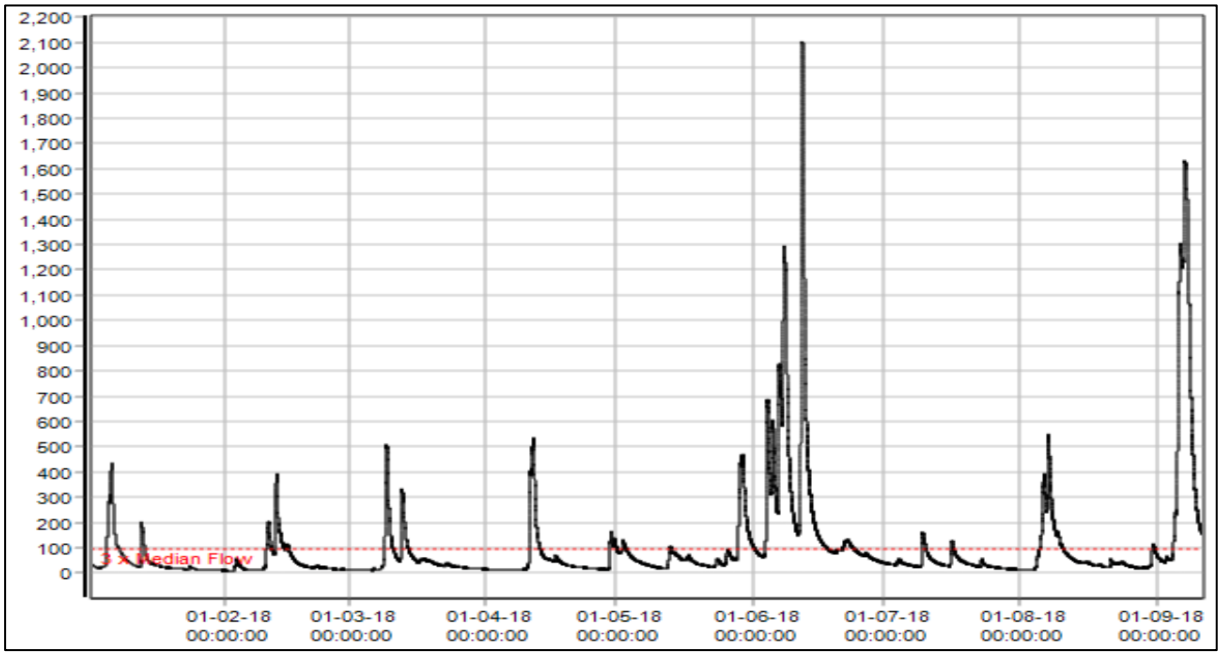


Figure 2: Daily Wairoa River Flow Rates at Marumaru (Source: HBRC website)

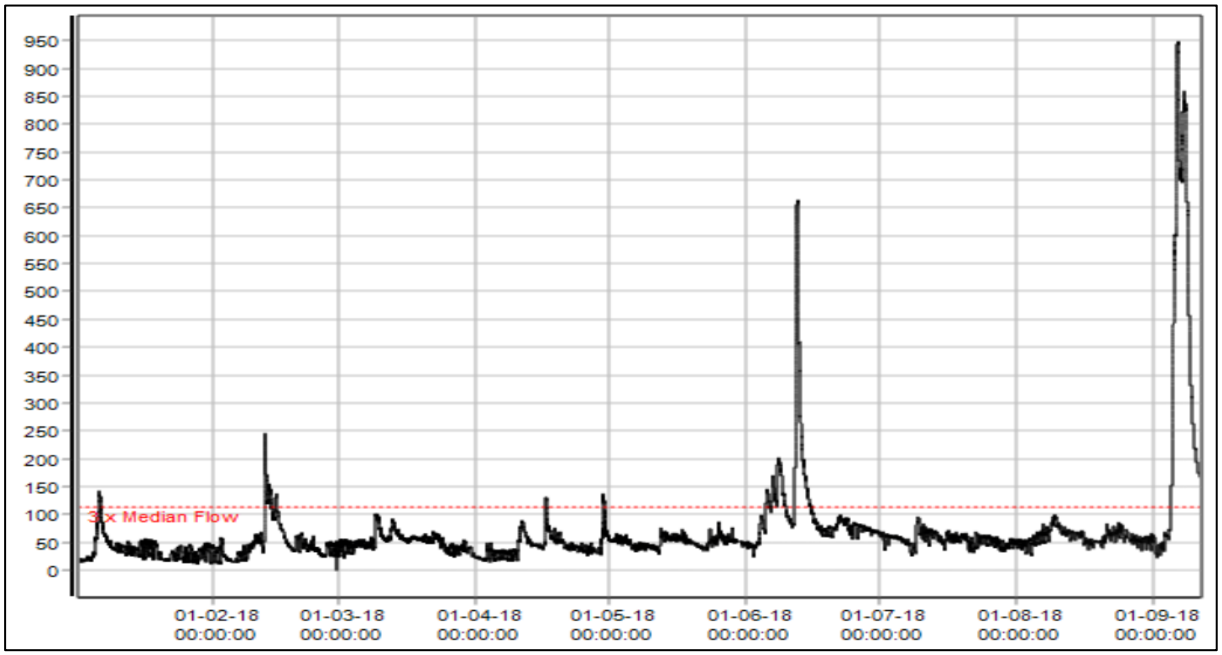


Figure 3: Daily Waiau River Flow Rates at Ardkeen (Source: HBRC website)

These graphs show large flood events occurred on 12-13 June and 5-6 September 2018. The September 2018 flood was an unusually large event. An extreme flood event also occurred about 3 years earlier on 21-22 September 2015. The graphs also show that the river flows in each catchment are different and reflect the localised nature of rainfall patterns and, in the case of the Waiau River at Ardkeen, the daily flow contributions from the Waiau hydroelectric power station are apparent as they maintain higher base flows, pulse frequently, and mask seasonal and small rainfall effects on river flows.

Because the river is tidal for at least 11 km inland and upstream of these tributaries entering the Wairoa River, flows for the Wairoa River cannot be measured accurately downstream of the last tributary. Some water is also believed to be lost to groundwater aquifers in this area as the river meanders across the valley floodplains. HBRC therefore calculate daily river flows for the Lower Wairoa River based on the Marumaru and Waiau measurements.

Table 3 below summarises the river flow statistics for the three key monitoring sites (as shown on the LAWA website) and for HBRC's calculated flows for the Lower Wairoa River.

Table 3: Wairoa River Flow Statistics (m^3/s) – (Source LAWA website)

Statistic	Marumaru	Waikaretaheke	Waiau	Lower Wairoa
Lowest Record	2.2	0.11	3.4	7.6
7-day MALF	5.8	-	14	19
Median	31	17	38	60
Mean	65	21	49	119
Mean Annual Flood	1,600	86	560	2,200
Highest Record	2,600	130	1,300	4,015

Weather Data

Additional weather data has been obtained to update previous datasets. Graphs of monthly averages for the entire dataset are shown in Figures 4 to 6 below.

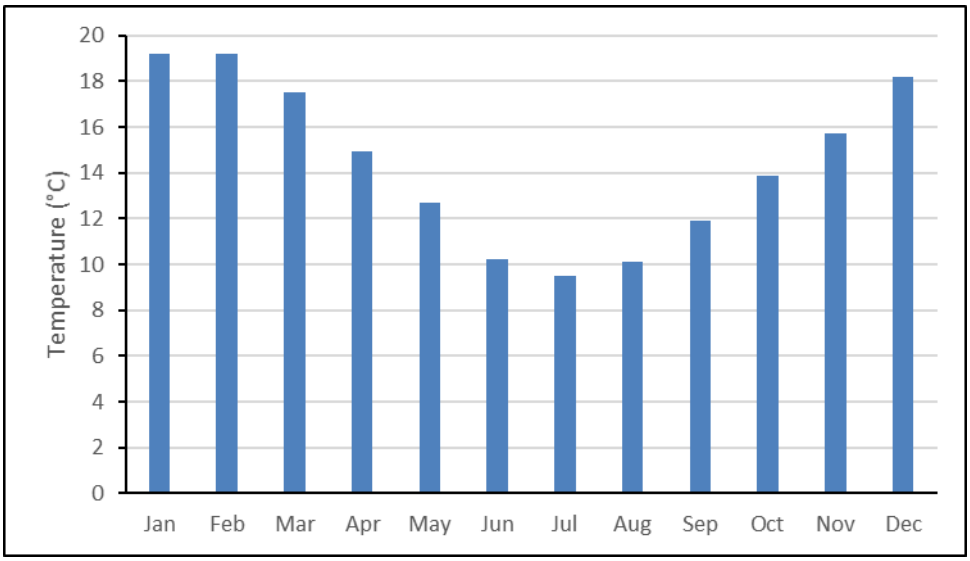


Figure 4: Average Monthly Air Temperature for 1997-2018

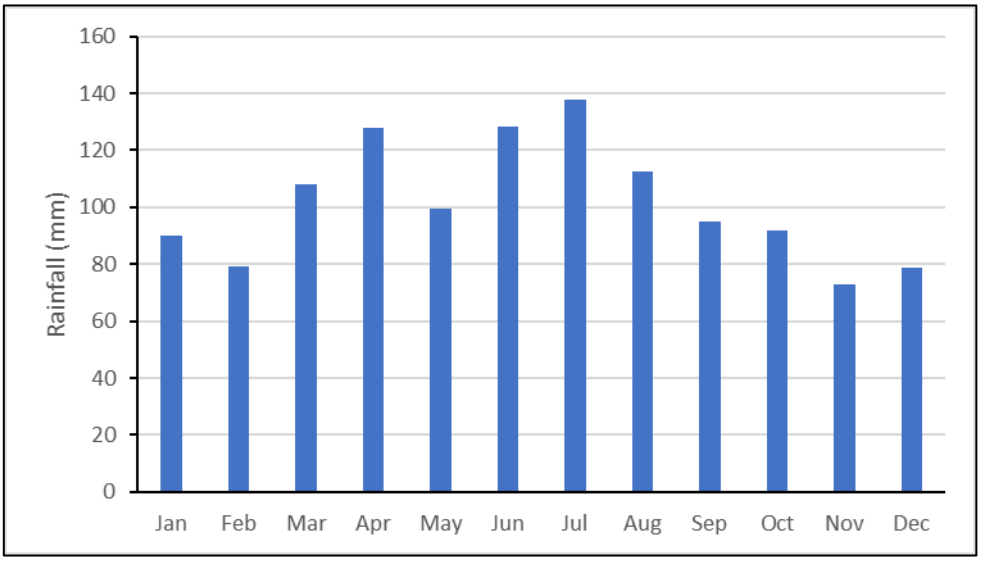


Figure 5: Average Monthly Total Rainfall for 1997-2018

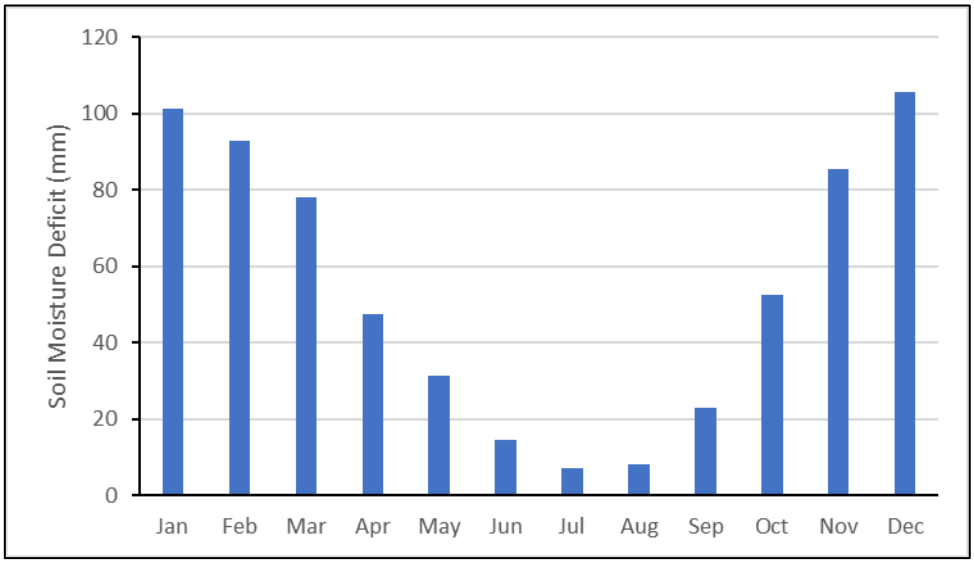


Figure 6: Average Monthly Soil Moisture Deficit for 1997-2018

These graphs show the consistent seasonal cycles of monthly average temperature and soil moisture deficit. These are typical patterns for much of New Zealand.

The average monthly rainfall does not form such a smooth pattern, as the May rainfall is lower than April and March which are higher than might be expected for the transition from dry summer months into wetter autumn months. January is also slightly wetter than December and February, which reflects summer storm events. November is the driest month.

Figure 7 below presents a windrose for 2012-18, sourced from eCoast's hydrodynamic modelling report (eCoast, 2018:C1.1).

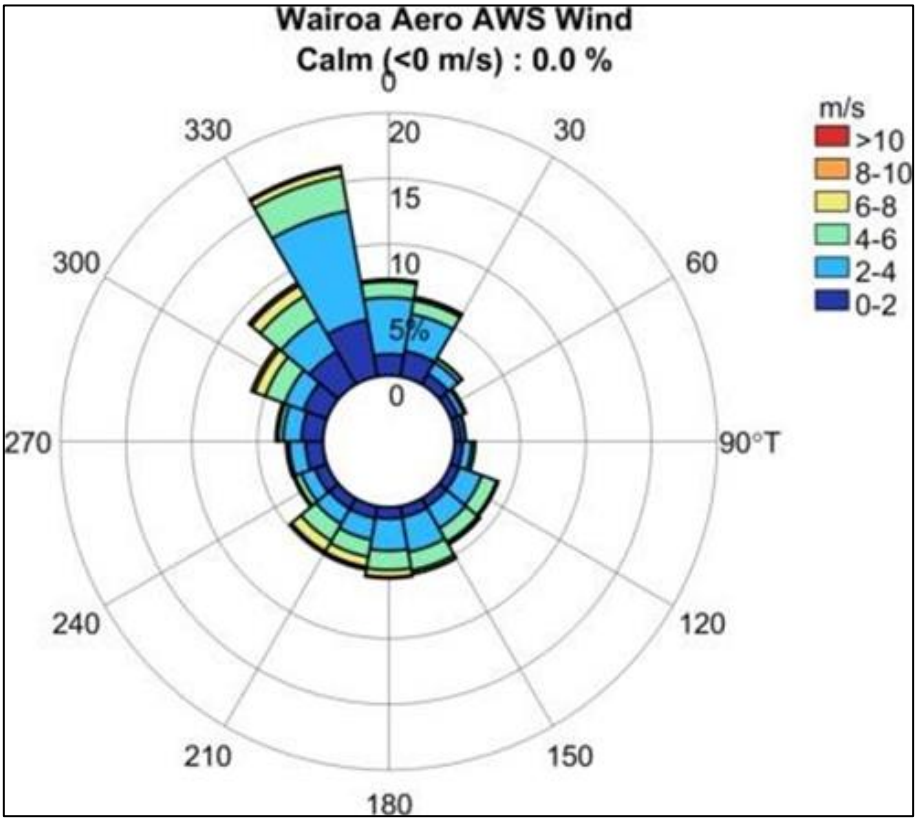


Figure 7: Windrose for Wairoa Airport During 2012-18 (Source: eCoast, 2018:C1.1)

The windrose highlights that Wairoa enjoys a large percentage of calm or light wind conditions, and that the most common wind direction is NNW. The strongest winds also come from NNW. The next most common direction and strongest winds are from the NW. The least common and weakest winds are from the east and ENE.