South Taranaki District Council
Hawera Municipal Oxidation Ponds System
Monitoring Programme
Biennial Report
2012-2014

Technical Report 2014–26

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Executive summary

The South Taranaki District Council (STDC) operates seven municipal oxidation pond systems within the district of South Taranaki. This report, for the period July 2012 to June 2014, focusses on the oxidation ponds system located at Hawera, which has recently been refurbished and comprises an anaerobic pond, two primary/facultative ponds in parallel, and a maturation pond. This report for the period July 2012-June 2014 describes the monitoring programme implemented by the Taranaki Regional Council (the Council) to assess STDC's environmental performance during the period under review, and the results and environmental effects of STDC's activities in relation to the Hawera Wastewater Treatment Plant (HWWTP).

STDC holds two resource consents which include a total of 26 conditions setting out the requirements that STDC must satisfy. STDC holds consent **5079** for operation of the Hawera oxidation ponds system, and consent **7520** to discharge to an unnamed stream in the event of high rainfall. Monitoring was performed to ensure continued maintenance and efficient operation of the treatment system, plus compliance with discharge consent conditions.

During the monitoring period, STDC demonstrated an overall high level of environmental performance and compliance with the resource consents.

Since February 2001, the treated wastewater from the HWWTP has been discharged into the Tasman Sea via the marine outfall that also discharges water from the Fonterra Co-operative Group Limited dairy factory at Whareroa. The discharge from the Fonterra Co-operative Group Limited dairy factory is reported on separately (Technical Reports 2013-24 and 2014-73).

The Council's monitoring programme over the 2012-2014 period included 12 site inspections, 12 pond samples collected for physicochemical analysis, 60 shoreline water samples collected for microbiological analyses, 48 shellfish samples collected for microbiological analyses, four shellfish samples collected for trace metals analysis and four marine ecological surveys.

During the 2012-2014 period, STDC demonstrated a high level of environmental performance in relation to the HWWTP, however, an improvement in administrative compliance with resource consents is required. Dissolved oxygen (DO) levels did not often comply with consent conditions due to on-going maintenance issues with the aerators. DO is monitored to ensure the ponds are functioning appropriately and ensure odours are reduced. While DO levels did not often comply, there were no odours from the two ponds noted during the monitoring period.

During the period under review there were no unauthorised incidents reported at the site.

For reference, in the 2012-2013 year, 35% of consent holders in Taranaki monitored through tailored compliance monitoring programmes achieved a high level of environmental performance and compliance with their consents, while another 59% demonstrated a good level of environmental performance and compliance with their consents. In the 2013-2014 year, 60% of consent holders achieved a high level of environmental performance and compliance with their consents, while another 29% demonstrated a good level of environmental performance and compliance.

This report includes recommendations for the 2014-2015 monitoring period

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1. Introduction

1.1 Compliance monitoring programme reports and the Resource Management Act 1991

1.1.1 Introduction

This is the report for the period July 2012-June 2014 by the Taranaki Regional Council (the Council) on the monitoring programme associated with the resource consents held by South Taranaki District Council (STDC) for the Hawera wastewater treatment plant (HWWTP).

This report covers the results and findings of the monitoring programme implemented by the Council in respect of the consents held by STDC that relate to the discharge of wastewater from HWWTP into the Tasman Sea via the Whareroa outfall (the Outfall). This is the 21st report to be prepared by the Council to cover the discharge of municipal wastewater from Hawera.

1.1.2 Structure of this report

Section 1 of this report is a background section. It sets out general information about compliance monitoring under the Resource Management Act (the RMA) and the Council's obligations and general approach to monitoring sites through annual programmes, the resource consents held by STDC, the nature of the monitoring programme in place for the period under review, and a description of the activities and operations conducted at the HWWTP.

Section 2 presents the results of monitoring during the period under review, including scientific and technical data.

Section 3 discusses the results, their interpretation, and their significance for the environment.

Section 4 presents recommendations to be implemented in the 2014-2015 monitoring year.

A glossary of common abbreviations and scientific terms, and a bibliography, are presented at the end of the report.

1.1.3 The Resource Management Act (1991) and monitoring

The RMA primarily addresses environmental `effects' which are defined as positive or adverse, temporary or permanent, past, present or future, or cumulative. Effects may arise in relation to:

(a) the neighbourhood or the wider community around a discharger, and may include cultural and socio-economic effects;
(b) physical effects on the locality, including landscape, amenity and visual effects;
(c) ecosystems, including effects on plants, animals, or habitats, whether aquatic or terrestrial;
(d) natural and physical resources having special significance (eg, recreational, cultural, or aesthetic);

(e) risks to the neighbourhood or environment.

In drafting and reviewing conditions on discharge permits, and in implementing monitoring programmes, the Council is recognising the comprehensive meaning of `effects' inasmuch as is appropriate for each discharge source. Monitoring programmes are not only based on existing permit conditions, but also on the obligations of the RMA to assess the effects of the exercise of consents. In accordance with section 35 of the RMA, the Council undertakes compliance monitoring for consents and rules in regional plans; and maintains an overview of performance of resource users against regional plans and consents. Compliance monitoring, (covering both activity and impact) monitoring, also enables the Council to continuously assess its own performance in resource management as well as that of resource users particularly consent holders. It further enables the Council to continually re-evaluate its approach and that of consent holders to resource management, and, ultimately, through the refinement of methods, and considered responsible resource utilisation to move closer to achieving sustainable development of the region's resources.

1.1.4 Evaluation of environmental performance

Besides discussing the various details of the performance and extent of compliance by the consent holder/s during the period under review, this report also assigns a rating as to each Company's environmental and administrative performance.

Environmental performance is concerned with actual or likely effects on the receiving environment from the activities during the monitoring year. **Administrative performance** is concerned with the Company's approach to demonstrating consent compliance in site operations and management including the timely provision of information to Council (such as contingency plans and water take data) in accordance with consent conditions.

Events that were beyond the control of the consent holder and unforeseeable (i.e. a defence under the provisions of the *RMA* can be established) may be excluded with regard to the performance rating applied. For example loss of data due to a flood destroying deployed field equipment.

The categories used by the Council for this monitoring period, and their interpretation, are as follows:

Environmental Performance

- **High** No or inconsequential (short-term duration, less than minor in severity) breaches of consent or regional plan parameters resulting from the activity; no adverse effects of significance noted or likely in the receiving environment .The Council did not record any verified unauthorised incidents involving significant environmental impacts and was not obliged to issue any abatement notices or infringement notices in relation to such impacts.

- **Good** Likely or actual adverse effects of activities on the receiving environment were negligible or minor at most. There were some such issues noted during monitoring, from self reports, or in response to unauthorised incident reports, but these items were not critical, and follow-up inspections showed they have been dealt with. These minor issues were resolved positively, co-operatively, and quickly. The Council was not obliged to issue any abatement notices or infringement notices in relation to the minor non-compliant effects; however abatement notices may have been issued to mitigate an identified potential for an environmental effect to occur.

For example:

- High suspended solid values recorded in discharge samples, however the discharge was to land or to receiving waters that were in high flow at the time;
- Strong odour beyond boundary but no residential properties or other recipient nearby.

- **Improvement required** Likely or actual adverse effects of activities on the receiving environment were more than minor, but not substantial. There were some issues noted during monitoring, from self reports, or in response to unauthorised incident reports. Cumulative adverse effects of a persistent minor non-compliant activity could elevate a minor issue to this level. Abatement notices and infringement notices may have been issued in respect of effects.

- **Poor** Likely or actual adverse effects of activities on the receiving environment were significant. There were some items noted during monitoring, from self reports, or in response to unauthorised incident reports. Cumulative adverse effects of a persistent moderate non-compliant activity could elevate an 'improvement required' issue to this level. Typically there were grounds for either a prosecution or an infringement notice in respect of effects.

Administrative compliance

- **High** The administrative requirements of the resource consents were met, or any failure to do this had trivial consequences and were addressed promptly and co-operatively.

- **Good** Perhaps some administrative requirements of the resource consents were not met at a particular time, however this was addressed without repeated interventions from the Council staff. Alternatively adequate reason was provided for matters such as the no or late provision of information, interpretation of 'best practical option' for avoiding potential effects, etc.

- **Improvement required** Repeated interventions to meet the administrative requirements of the resource consents were made by Council staff. These matters took some time to resolve, or remained unresolved at the end of the period under review. The Council may have issued an abatement notice to attain compliance.

- **Poor** Material failings to meet the administrative requirements of the resource consents. Significant intervention by the Council was required. Typically there were grounds for an infringement notice.

For reference, in the 2012-2013 year, 35% of consent holders in Taranaki monitored through tailored compliance monitoring programmes achieved a high level of environmental performance and compliance with their consents, while another 59% demonstrated a good level of environmental performance and compliance with their consents. In the 2013-2014 year, 60% of consent holders achieved a high level of environmental performance and compliance with their consents, while another 29% demonstrated a good level of environmental performance and compliance.

1.2 Treatment plant description

Up until February 2001, effluent from Hawera municipal wastewater treatment system was discharged into a small unnamed coastal stream and across the foreshore before entering the Tasman Sea. Consent 1335 authorised the discharge of up to 10,000 m^3/day of treated wastewater from the municipal ponds system. That consent lapsed during the 2000-2001 monitoring period. Consent 5079 was granted in February 2001, for the discharge of the same volume of wastewater from the refurbished ponds system into the Tasman Sea via the Outfall, located approximately 3 km to the southeast of the plant.

Currently, the oxidation pond system at HWWTP treats both industrial and domestic wastes from Hawera and Eltham. Partially treated (screened) wastewater from meat processors Silver Fern Farms and Graeme Lowe Protein Limited are treated in an anaerobic lagoon before discharging into the oxidation pond system (Figure 1).

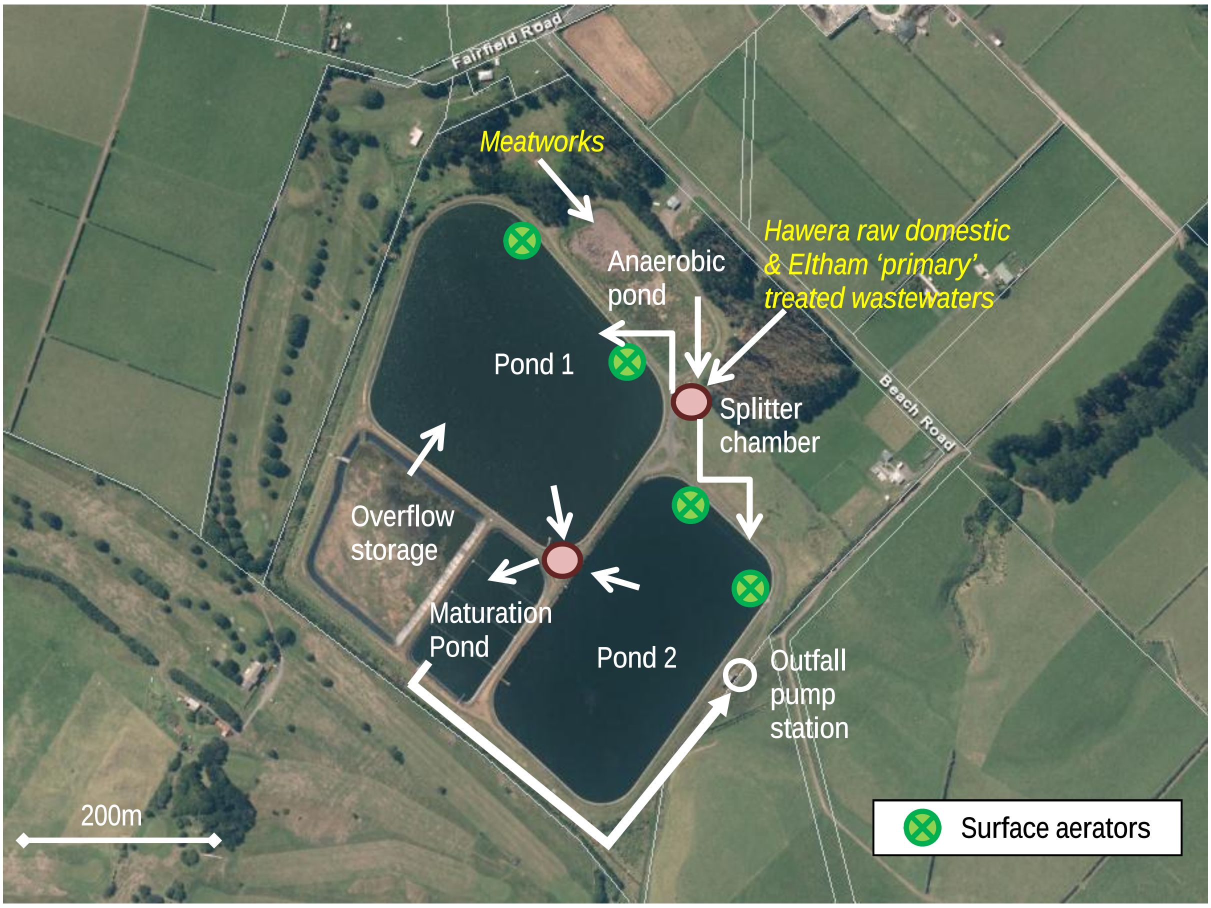

Figure 1 Configuration of oxidation ponds at Hawera wastewater treatment system (adapted from NIWA 2012)

Since 2000, the ponds have been reconfigured several times. Prior to November 2000, the two primary ponds (Pond 1 and Pond 2) operated in parallel. After November 2000, the two ponds were operated in series to increase treatment efficiency, with the treated wastewater from Pond 2 discharging to a pipeline that transferred the final effluent to the Outfall. However, since 2010, the ponds changed back to operate in parallel, with effluent from these two ponds now passing into a tertiary/maturation pond (divided into 4 cells) which is the final pond system (Figure 1).

Since June 2010, primary treated wastewater from the single oxidation pond at Eltham is discharged intermittently to HWWTP, at approximately 90 m^3/hour. Raw domestic wastewater from Hawera and primary wastewater from Eltham combine on site at the HWWTP with the anaerobic lagoon effluent and are then split 60:40 to enter the two primary ponds (Figure 1). Both Pond 1 and Pond 2 have surface aerators. The hydraulic residence time (HRT) for Pond 1 is approximately 20 days (NIWA 2012).

The effluent from both Ponds 1 and 2 combines at the outlet points from each pond and flows through to the new maturation pond, constructed in 2009 (Photo 1). The maturation pond has three baffles dividing the pond into four cells to increase the residence time within the pond. The total HRT for the ponds is estimated to be approximately 60 days (NIWA 2012). Final treated effluent from the maturation pond is gravity-fed to the pump station from where it is pumped (preferentially at night) via a 2.8 km pipeline, to the mixing chamber on the cliff top and combines with wastewater from the Whareroa dairy factory for discharge via the 1,845 m long Outfall.

During high rainfall events, the maturation pond can overflow into the neighbouring emergency overflow/storage detention pond (capacity approximately 65,000 m^3, NIWA 2012) with wastewater then being passed back into Pond 1. Consent 7520-1 has been granted to allow overflow from the detention area into the local stream that borders the HWWTP. Since being granted in 2009, this consent has not yet needed to be exercised.

Photo 1 Construction of maturation ponds, July 2009

1.3 Resource consents

1.3.1 Water discharge permit

Section 15(1)(a) of the RMA stipulates that no person may discharge any contaminant into water, unless the activity is expressly allowed for by a resource consent or a rule in a regional plan, or by national regulations.

STDC holds consent **5079-1** to allow the discharge of up to 12,000 m^3/day [seven day average discharge] of treated municipal wastes generated in the Hawera and Eltham townships, including treated meat processing and dairy industry wastes, through a combined outfall into the Tasman Sea near Hawera (Appendix 1).

The consent was originally granted on 22 March 1998, with the purpose and conditions being changed on 20 December 2007 to increase the volume of the discharge from 10,000 to 12,000 m^3/day, and to include wastes generated in Eltham. Conditions on the consent increased from 14 to 17 to reflect these changes. On 29 June 2010 amendments were made to Conditions 1 and 2 (relating to sampling timing) in order to comply with pond best practice guidelines and bring in line with other wastewater treatment facilities in South Taranaki.

There are 17 special conditions on coastal permit **5079-1**.

Conditions 1 and 2 deal with maintaining aerobic conditions in the ponds.

Conditions 3, 4, 5 and 7 deal with the discharge including effects on the Tasman Sea beyond the mixing zone, effects on shellfish on the shoreline, volume of the wastewater and management of the discharge.

Condition 6 requires the consent holder to advise and consult with the Council should trade wastes be accepted in to the wastewater system, as it may be necessary to place limits on toxic or hazardous components in the discharge.

Conditions 8, 9 and 10 deal with reporting including a contingency plan (to be reviewed annually), an annual report outlining the performance of the system and compliance with the consent, and a report on the best practicable option for treatment and disposal of wastewater generated at Hawera and Eltham (to be provided by December 2009).

Condition 11 requires the reduction of stormwater infiltration into the system, and upgrade of the Eltham and Hawera wastewater treatment plants and the construction for a pipeline to the transfer of sewage from Eltham to Hawera.

Condition 12 requires reports on the implementation of condition 11, and condition 13 requires the consent holder and staff of the Council to meet at least once per year, with representatives from iwi, submitters and other interested parties, to discuss any matters relating to the consent.

Conditions 14 and 15 deal with the establishment of a monitoring programme to analyse effects of the exercise of the consent on the intertidal reefs and coastal water quality adjacent to the discharge.

Condition 16 requires the consent holder to install a screen to prevent the discharge of undisintegrated solids into and from the oxidation pond.

Condition 17 deals with review of the consent.

The consent is due to expire on 1 June 2015.

In June 2003 STDC applied to change consent 5079-1 to increase the discharge volume from 10,000 m^3/day to 12,000 m^3/day to allow for the additional treatment and discharge of partially treated industrial and domestic wastewater from Eltham. This wastewater would be treated in the HWWTP, pumped to the Outfall and then discharged to the Tasman Sea. This consent required pre-hearing meetings, held during 2004-2005 and 2005-2006, due to submissions against the consent. The consent variation was the subject of a formal hearing with the decision to grant the variation subsequently appealed by one submitter early in the 2006-2007 period.

A meeting was held on 16 July 2007 between the Council, STDC and authorised representatives of Inuawai - Okahu and Kanihi - Umutahi hapu. Positive progress was made with agreement that a scheduled mediation meeting on 20 August 2007 would not be required. An agreed deadline for reaching a conclusion on the state of the hapu appeal was 30 August 2007. If an agreement was not reached by this date then it was agreed that a hearing would be requested, otherwise the Hapu's counsel would submit a memorandum to the Court requesting that the Hearing Committee's decision stands.

On 1 August 2007, STDC wrote to iwi and the Council committing to: work on decreasing storm water ingress to the Hawera sewerage system; testing the permeability of the detention storage pond; not exceed the 12,000 m^3/day volume of the consent; and undertaking the necessary work under the consent (condition 10) to review in 2009 the best practicable option for treatment and disposal of wastewater, including the option of disposal to land.

Iwi agreed to withdraw the appeal, and this was lodged with the registrar of the Environment Court on 19 September 2007. The appellants wished to inform the Court that the discharge of treated human waste and industrial pollutants to the sea is, and always will be, culturally abhorrent to both hapu.

On 23 October 2007 the Environment Court recommended to the Minister of Conservation that the decision to grant the changes to consent 5079 stand. Approval was sought from the Department of Conservation (Wanganui branch) and the variation to consent 5079 was granted on 19 December 2007.

On 29 June 2010, Conditions 1 and 2 of the consent were changed. Condition 1 was altered slightly to include the words 'during daylight hours' so that the condition reads:

> *"the consent holder shall properly and efficiently maintain and operate the oxidation ponds system, with aerobic ponds maintained in an aerobic condition during daylight hours".*

Condition 2 was changed to include a time period where the dissolved oxygen (DO) is to be maintained above 2 g/m^3, so that the condition reads:

> *"for 90%of the time between 1100 and 1400 hours the dissolved oxygen level in the aerobic ponds, and in the waste water immediately prior to discharge, shall be maintained at or above 2g/m^3 and that the consent holder shall monitor the dissolved oxygen levels in the aerobic ponds, on a continuous basis, and supply the results to the Chief Executive, Taranaki Regional Council, upon request".*

STDC holds consent **7520-1** to discharge, as a consequence of high rainfall, partially treated wastewater from the HWWTP into Unnamed Stream 22. The consent was originally granted on 4 November 2009.

There are nine special conditions on coastal permit **7520-1**.

Condition 1 states that the discharge shall only occur as a consequence of high rainfall events.

Conditions 2 and 3 deals with the holding capacity of the pond, and modifications to the plant.

Conditions 4, 5 and 6 deals with record keeping, operating under best practicable option and notification of the Council during and after overflow events.

Conditions 7 and 8 deals with supply of a contingency plan and monitoring any discharge and condition 9 deals with review of the consent.

The consent is due to expire on 1 June 2027.

1.4 Monitoring programme

1.4.1 Introduction

Section 35 of the RMA sets out obligations upon the Council to gather information, monitor, and conduct research on the exercise of resource consents, and the effects arising, within the Taranaki region and report upon these.

The Council may therefore make and record measurements of physical and chemical parameters, take samples for analysis, carry out surveys and inspections, conduct investigations, and seek information from consent holders.

The monitoring programme for the Hawera oxidation ponds over the 2012-2014 reporting period was designed to assess the performance of the treatment system and to determine any effects of the discharge from the Outfall to the Tasman Sea. The monitoring was carried out by both the Council and South Taranaki District Council as outlined below.

The monitoring programme consisted of six main components: site inspections, physicochemical analysis of the ponds, ecological survey of the intertidal zone, bacteriological survey of shoreline waters, shellfish tissue analysis, and review of data provided by STDC.

1.4.2 Programme liaison and management

There is generally a significant investment of time and resources by the Council in:

- ongoing liaison with resource consent holders over consent conditions and their interpretation and application;
- discussion over monitoring requirements;
- preparation for any reviews;
- renewals;
- new consents;
- advice on the Council's environmental management strategies and content of regional plans; and
- consultation on associated matters.

1.4.3 Site inspections

Twelve inspections of the ponds were undertaken during the monitoring period. The inspections were conducted during mid-morning (i.e. 0810-1110 hours) at approximately two-monthly intervals and focused on the operating condition of the oxidation ponds system and the immediate environment.

1.4.4 Analysis of the ponds system

The Council performed sampling on 12 occasions during the 2012-2014 monitoring period, at approximately two-monthly intervals. Samples from Ponds 1 and 2 were analysed for temperature, chlorophyll *a* and DO.

In addition, samples of the ponds' combined effluent (from the maturation cells) was analysed for pH, conductivity, uninhibited biochemical oxygen demand (BOD; total, carbonaceous and filtered), total grease, suspended solids, ammonia, nitrogen, phosphorus, turbidity, *E. coli* faecal coliform and enterococci and, on two occasions, for trace metals (total arsenic, cadmium, chromium, copper, lead, mercury, nickel, and zinc).

Some additional bacteriological monitoring of the second pond's effluent was performed in relation to the shoreline water quality surveys during the period.

1.4.5 Impacts on receiving waters

The Council conducted four surveys during the monitoring period at four intertidal sites to assess the effect on ecological richness and diversity of discharges from the Outfall. The surveys were undertaken at the peak of the dairy season in November 2012 and 2013, and in the post-peak period in March 2013 and 2014.

The Council carried out 12 microbiological surveys of water quality at five shoreline sites and one river site in relation to discharges of municipal wastewater (also sampled) through the Outfall. Faecal coliforms were measured using the most probable number (MPN) method, as is recommended for shellfish gathering waters (Ministry for the Environment and Ministry of Health, 2003). The frequency of sampling ranged from monthly to three-monthly (depending on tidal conditions), with one to two months the usual period between surveys.

Microbiological surveys of shellfish (mussel) tissue quality were carried out on 12 occasions at four shoreline sites in relation to discharges of municipal wastewater through the Outfall, while shellfish tissue analysis for trace metals was carried out on one occasion at four sites.

1.4.6 Monitoring by South Taranaki District Council

South Taranaki District Council wastewater treatment staff undertake frequent, regular maintenance and operational surveillance surveys of the HWWTP system. Monitoring undertaken by STDC includes two matters that relate directly to consent compliance, these being effluent flow rate and pond DO concentrations.

1.4.6.1 Flow rate

The volume of wastewater discharged from Hawera wastewater treatment system was measured continuously throughout the monitoring period.

1.4.6.2 Dissolved oxygen

The consent holder supplied Council with continuous DO readings from both ponds during the monitoring period.

1.4.7 Additional reporting by South Taranaki District Council

Consent conditions require STDC to provide various reports during the monitoring period. These reports are reviewed by Council staff.

2. Results

2.1 Inspections

Inspections of Hawera wastewater treatment system were carried out on 12 occasions at approximately two-monthly intervals. During these inspections physical features of the components of the system were recorded, and both oxidation ponds were sampled near the surface adjacent to their discharge outlets and analysed for DO concentration.

Ponds 1 and 2 varied in colour from light to dark green/brown during the monitoring year. All four aerators were operating on most occasions during inspections.

The level of effluent in the maturation cells fluctuated during the period from low to normal, never overtopping the dividing wall during inspections. The final effluent colour was generally dark green/brown.

There was noticeable odour, occasionally described as 'strong/pungent', emanating downwind from the anaerobic lagoon during all inspections. On four occasions odours were noted around the entrance to the property, and on one occasion a strong pungent odour emanating from the anaerobic lagoon was detected around the boundary with the Hawera Golf Club.

The site and surrounds were found to be tidy on all occasions.

2.2 Waste water treatment plant monitoring

2.2.1 Dissolved oxygen

Conditions 1 and 2 of consent **5079-1** require that the ponds are maintained in an aerobic condition, with the DO maintained at a level at, or exceeding, 2 g/m^3 for 90% of the time during the hours of 11:00 to 14:00.

The DO monitoring results for both ponds during the 2012-2014 period are presented in Table 1.

The photosynthetic activity of the microalgae within the ponds is a major factor affecting variation in pond DO concentrations. However, fluctuating industrial loadings, operation of the mechanical aeration system and weather conditions can also influence DO concentrations in ponds systems.

A wide range of DO concentrations were recorded in the ponds, from 10 to 192% of saturation in Pond 1 and 4 to 44% in Pond 2. Samples taken on 15 August 2012 and 11 June 2013 were collected between 11:00 and 14:00, providing direct assessment against Condition 2 (Table 1). The remaining samples were collected before 11:00. Although these samples were not collected within the time period specified within the consent (11:00-14:00), lower DO concentrations would be expected earlier in the morning due to shorter hours of daylight and less time for oxygen accumulation due to photosynthesis.

Table 1 Council DO measurements from the surface of Hawera oxidation ponds (Ponds 1 and 2) for the 2012-2014 monitoring year

Date	Pond 1				Pond 2			
			Dissolved oxygen				Dissolved oxygen	
	Time (NZST)	Temp (C)	Concentration (g/m³)	Saturation (%)	Time (NZST)	Temp (C)	Concentration (g/m³)	Saturation (%)
15-Aug-12	1100	12.2	9.6	90	1110	12.1	2.5	24
16-Oct-12	0940	13.5	12	110	0945	13.5	6.4	4.3
13-Dec-12	0845	20.9	3.2	42	0850	22.0	1.2	42
12-Feb-13	0900	20.9	4.6	52	0910	21.1	1.2	13
15-Apr-13	0945	16.1	8.0	81	0955	16.3	2.3	24
11-Jun-13	1135	11.7	3.8	35	1145	11.7	4.0	37
12-Aug-13	0900	11.6	4.8	45	0915	12.1	4.7	44
17-Oct-13	0955	14.7	3.7	36	1005	14.1	6.6	15
6-Dec-13	0900	20.6	17	192	0915	20.2	0.95	10
11-Feb-14	0900	17.8	6.0	62	0915	19.3	0.36	3.8
10-Apr-14	0945	16.3	0.98	10	0930	16.1	1.8	18
10-Jun-14	0940	12.8	1.6	15	0950	12.6	0.70	7

Table 2 Percentage time DO was greater than 2.0 g/m^3 (between the hours of 11:00 and 14:00)

Month	Pond 1 (DO g/m³)			Pond 2 (DO g/m³)		
	Average	Max	% > 2.0	Average	Max	% > 2.0
Jul-12	2.6	2.6	100	16.5	16.5	100
Aug-12	2.6	2.6	100	16.5	16.5	100
Sep-12	2.6	2.6	100	16.5	16.5	100
Oct-12	11.6	12.5	100	6.2	17.8	81
Nov-12	12.3	12.5	100	10.8	18.5	100
Dec-12	10.9	12.5	100	7.1	18.5	94
Jan-13	11.9	12.5	100	8.0	18.5	95
Feb-13	11.1	12.5	100	6.8	18.5	79
Mar-13	9.4	12.5	100	6.2	18.4	87
Apr-13	12.0	12.5	100	3.3	18.5	65
May-13	11.4	12.5	98	2.8	10.3	55
Jun-13	10.4	12.5	100	1.8	7.8	41
Jul-13	8.2	8.5	100	5.7	20.1	78
Aug-13	5.5	8.5	99	5.1	20.1	89
Sep-13	4.7	8.4	90	3.6	19.1	57
Oct-13	4.7	7.3	98	3.5	20.1	68
Nov-13	4.6	8.5	90	1.4	6.2	24
Dec-13	0.8	1.0	*	5.8	17.3	78
Jan-14	0.8	2.3	*	2.5	9.3	49
Feb-14	8.6	18.6	91	6.2	20.1	75
Mar-14	7.6	20.0	99	7.1	20.1	76
Apr-14	11.9	20.0	87	4.8	20.0	71
May-14	10.8	20.0	98	3.9	15.1	72
Jun-14	10.3	17.9	99	5.7	13.0	67

Values in **bold** indicate months where consent condition 2 was not complied with
* DO meter away for repair in December 2013 and January 2014

Condition 2 also requires that STDC monitor the DO concentrations on a continuous basis and supply the results to the Council (Table 2, Figures 2 and 3). In Pond 1 the DO levels satisfied the '2 g/m^3 compliance condition for 90% of the time' for all but one month (April 2014). During December 2013 and January 2014 the DO meter was away for repair. In Pond 2 this condition was only met in six out of seven months over the start of the monitoring period – the remainder of the results were below the required 90% (Table 2).

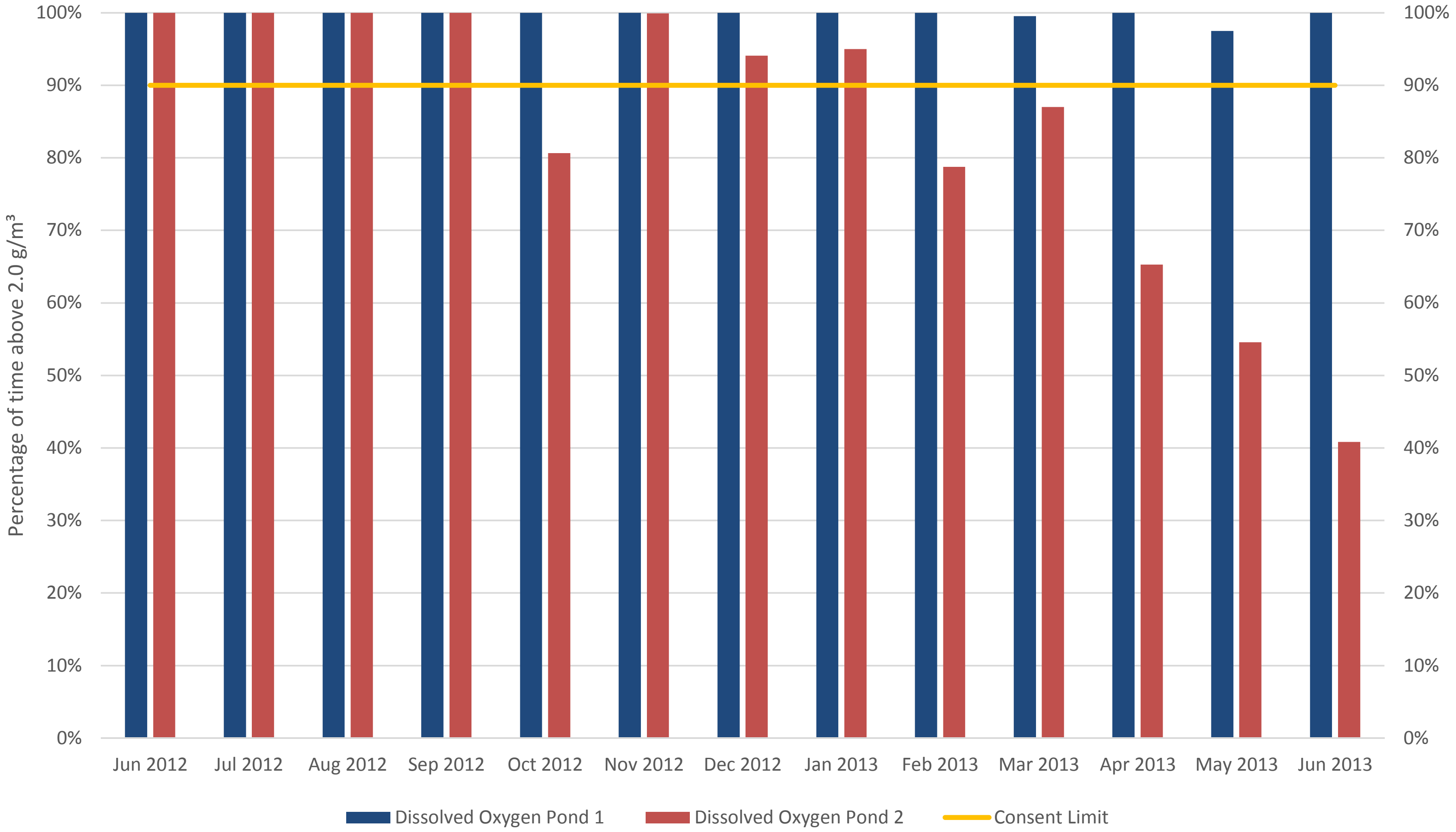

Figure 2 Compliance of DO concentration (g/m^3) with consent conditions in the primary and secondary oxidation ponds 2012-2013 (between hours of 1100 – 1400). Data from pond outlet.

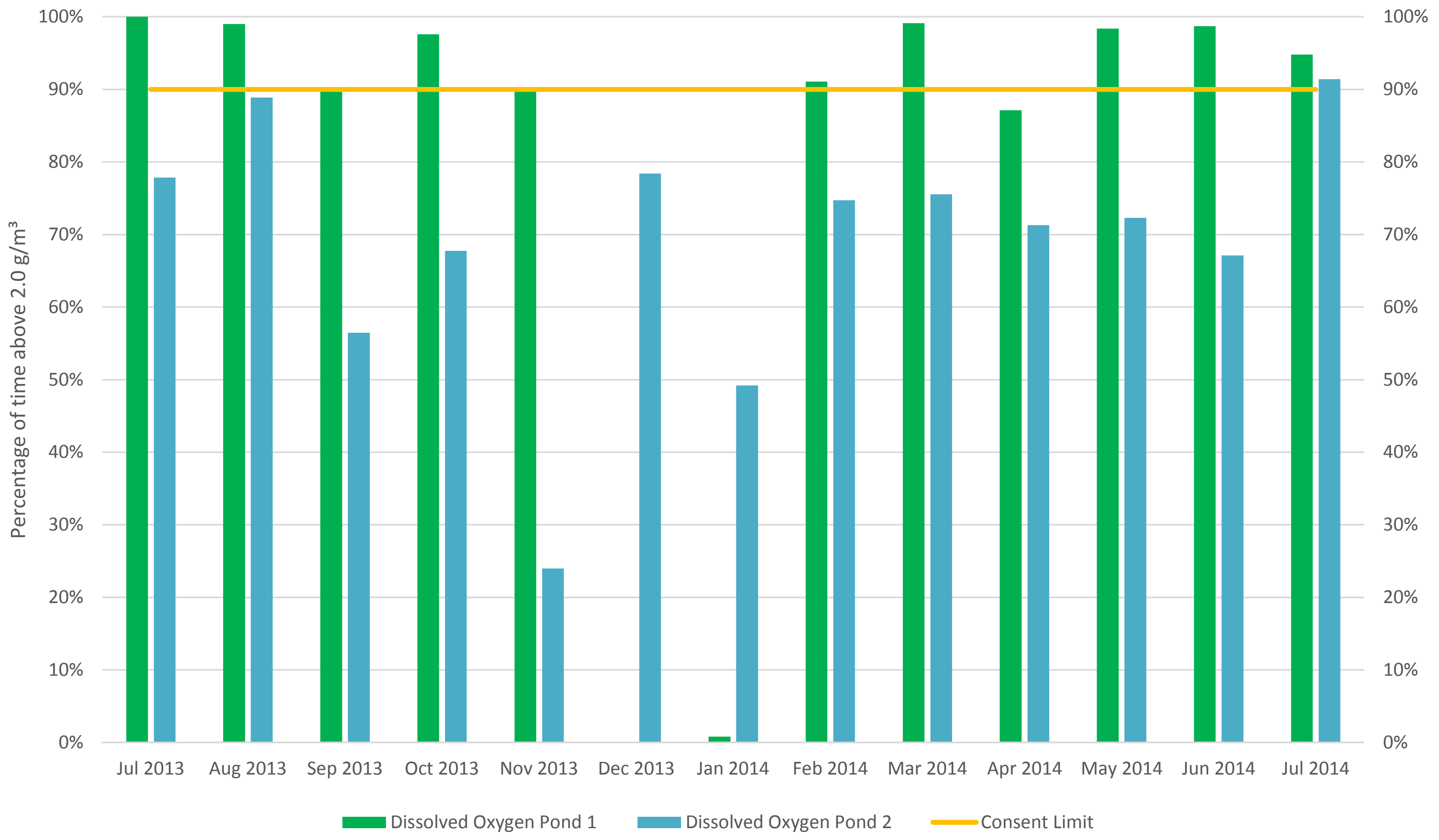

Figure 3 Compliance of DO concentration (g/m^3) with consent conditions in the primary and secondary oxidation ponds 2013-2014 (between hours of 1100 – 1400). Data from pond outlet.

2.2.2 Effluent monitoring

During the 2012-2014 period, samples of the combined effluent of the ponds' parallel configuration were collected from the maturation cells. Effluent quality varied through the period, with lower BOD_5 concentrations found during late winter and spring (Table 3).

Previous investigations into the nature of the high total BOD_5 concentrations has indicated that at times there is a significant non-carbonaceous component (83 to 88% of total BOD_5: March to June 2007) indicative of nitrification contributions, likely to be associated with the high industrial waste loadings.

Table 3 Results of effluent analytical surveys from the (combined) final effluent from the maturation cells during the period 2012-2014

Parameter		BOD_5								Bacteria		Nutrients		
Date	Time (NZST)	Total (g/m^3)	Total carbonaceous (g/m^3)	Filtered (g/m^3)	pH	Condy @20 C (mS/m)	Suspended solids (g/m^3)	Turbidity (NTU)	Total grease (g/m^3)	Faecal coliforms (nos/100ml)	Enterococci (nos/100ml)	Ammonia-N (g/m^3)	Total N (g/m^3)	Total P (g/m^3)
4-Jul-12	14:25					77.5				3.0 x10^{4}				
15-Aug-12	11:30	55	26	>17	7.7	63.6	28	26	<5	1.2 x10^{4}	2.3 x10^{3}	30	37	7
17-Sep-12	15:30					64.2				8.0 x 10^{2}				
16-Oct-12	09:55	18	16	5.1	7.9	65.3	34	32	<5	1.2 x 10^{3}	1.3 x 10^{2}	29	38	7
15-Nov-12	16:20					74.4				7.0 x 10^{3}				
13-Dec-12	09:10	19	16	6.2	7.8	90.2	47	41	12	1.2 x10^{4}	1.6 x 10^{2}	47	56	13
11- Feb-13	14:20					101				5.0 x10^{3}				
12-Feb-13	08:45	-	32	-	7.7	101	63	41	27	16 x10^{4}	7.4 x10^{2}	52	61	15
12- Mar -13	14:10					115				1.7 x10^{3}				
15-Apr -13	10:15	250	33	43	7.7	104	70	41	<5	6.6 x10^{3}	9.6 x10^{2}	40	51	18
26-Apr-13	15:20					99.3				2.8 x10^{4}				
11-Jun-13	11:55	94	31	17	7.7	85.7	48	30	-	7.0 x10^{3}	3.1 x10^{3}	45	54	11
23-Jul -13	13:30					68.4				3.5 x 10^{4}				
12-Aug-13	10:00	39	20	14	7.6	71.3	16	17	6	5.7 x 10^{3}	7.0 x 10^{2}	35	42	7
18-Sep-13	12:45					64.0				1.1 x 10^{3}				
17-Oct-13	10:30	11	9.2	8.8	7.7	69.9	9	16	<5	9.3 x10^{3}	3.2 x 10^{2}	39	49	7
5-Nov-13	13:45					69.5				2.0 x10^{1}				
6-Dec-13	09:30	21	20	17	7.8	75.6	22	12	5	4.3 x10^{2}	6.0 x10^{1}	43	51	9
30-Jan-14	13:05					109				1.7 x10^{4}				
11-Feb-14	09:25	200	31	43	8.1	109	64	42	<5	1.0 x10^{4}	7.6 x10^{2}	61	92	6
1-Apr-14	14:35					121				3.5 x10^{3}				
10- Apr-14	10:15	330	60	>83	7.9	127	99	67	<5	7.8 x10^{3}	2.0 x10^{4}	64	85	21
10- Jun-14	10:10	44	19	14	7.6	110	31	35	<5	3.7 x10^{4}	9.0 x10^{3}	75	80	14
13-Jun-14	16:20					108				1.7 x10^{4}				
Range		11-330	9.2-60	5.1->83	7.6-8.1	63.6 - 127	9 - 99	12 - 67	<0.5 - 27	2.0 x 10^{1} – 3.7 x10^{4}	6.0 x 10^{1} – 2.0 x10^{4}	28 – 75	37-92	6-21
Median		44	23	17	7.7	88.0	41	34	<5	7.0 x10^{4}	7.5 x10^{2}	44	53	10

* = final effluent from new parallel pond system

Trends in final wastewater bacteriological quality (Figure 4) indicated an improvement in the bacteriological quality of the treated wastewater discharged to the Tasman Sea since the reconfiguration of the treatment ponds system in 2001. After the reconfiguration, bacteriological quality initially decreased; this was to be expected as the increased flow reduced the overall retention time and hence bacteriological die-off within the treatment system. During the current monitoring period, faecal coliform numbers have remained slightly elevated, although within the range of previous results post-2001.

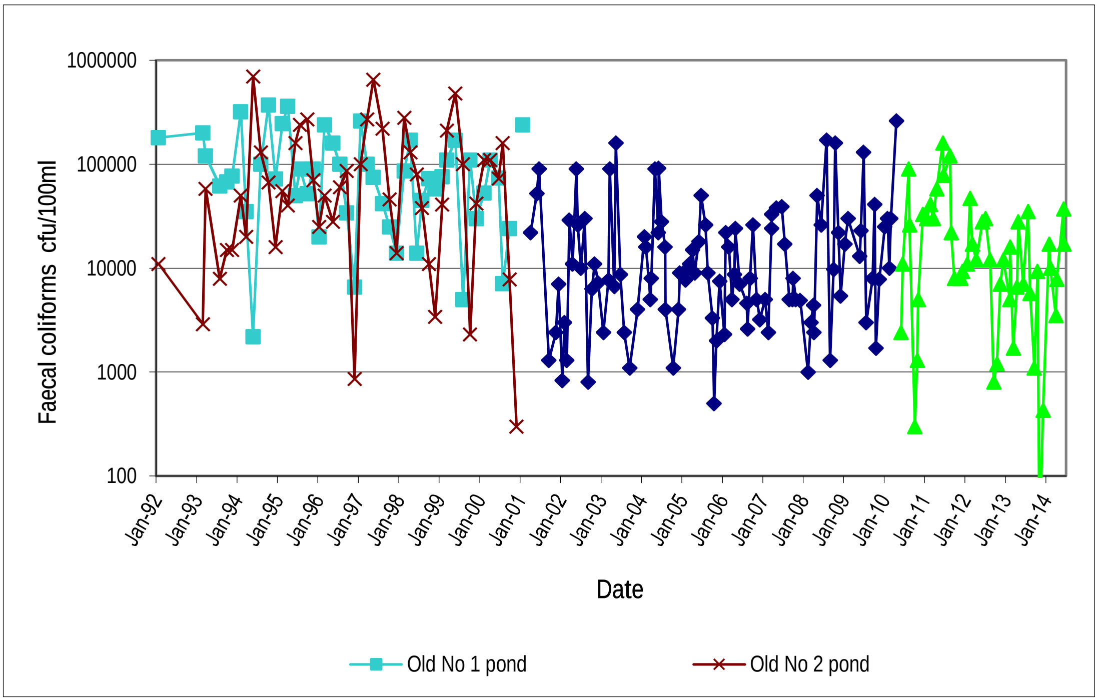

Figure 4 Faecal coliform numbers in the HWWTP effluent(s), 1992 to 2014

Table 4 Trace metal (g/m³) analyses from the combined final effluent from the maturation cells during the 2012-2014 monitoring period

Parameter	Hawera secondary oxidation pond						Fonterra	NP WWTP
	16-10-12	15-4-13	17-10-13	6-12-13	10-4-14	2001-2012	2002-2013	1995-2013
Arsenic	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001 - <0.005	<0.001	-
Cadmium	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005 – 0.006	<0.005 - 0.007	<0.008
Chromium	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03 - 0.04	<0.03	<0.05
Copper	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01 – 0.01	<0.01 - 0.02	<0.01 - 0.05
Lead	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05 – 0.07	<0.02 – 0.04
Mercury	<0.0002	<0.0002	0.0012	0.0006	<0.0002	<0.0002	<0.0002	<0.001
Nickel	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02 - 0.05	<0.02 - 0.04	<0.02 – 0.07
Zinc	0.014	0.034	0.028	0.029	0.026	<0.005 - 0.035	0.06 - 0.181	<0.02 - 0.15

Concentrations of trace metals in Hawera wastewater (Table 4) have been low, near or below levels of detection for routine analyses of municipal wastewaters for most metals. Only traces of chromium, copper, and nickel and low levels of zinc have been found on any occasion since reconfiguration of the system in early 2001. Trace metals' concentrations were similar to those measured elsewhere in the region.

2.2.3 Chlorophyll *a*

To maintain facultative conditions in a pond system there must be an algal community present in the surface layer. The principal function of algae in an oxidation pond is the production of oxygen which maintains aerobic conditions while the main nutrients are reduced by biomass consumption. Elevated pH (due to algal photosynthetic activity) and solar radiation combine to reduce faecal bacteria numbers significantly.

Samples of Pond 1 and 2 effluent were collected during inspection of the Hawera oxidation ponds system for semi-quantitative microalgal assessment prior to curtailment of this component of the programme in July 2013. The microalgal taxa present in both ponds has been summarised and discussed in previous annual reports.

During the 2013-2014 inspections, samples were collected from Pond 1 and Pond 2 for chlorophyll *a* analysis. Chlorophyll *a* concentration can be used as a measure of algal biomass in the system. Pearson (1996) recommends that a minimum in-pond chlorophyll *a* concentration of 300 mg/m^3 is necessary to maintain stable facultative conditions. However, seasonal changes in algal populations and dilution by stormwater infiltration is expected to occur in wastewater treatment systems which together with fluctuations in waste loadings results in chlorophyll *a* variability.

The results of Pond 1 and 2 effluent chlorophyll *a* analyses are provided in Table 5.

Table 5 Chlorophyll *a* concentrations in Ponds 1 and 2 during the 2013-2014 period

Date	Pond 1		Pond 2	
	Time (NZST)	Chl-a (mg/m^3)	Time (NZST)	Chl-a (mg/m^3)
12-Aug-13	09:00	57	09:15	240
17-Oct-13	09:55	9	10:05	132
11-Feb-14	09:00	499	09:15	426
10-Apr-14	09:45	1,160	09:30	1,840
10-Jun-14	09:40	216	09:50	111

Higher chlorophyll *a* concentrations (>300 mg/m^3) were recorded from late summer through to autumn. Lower concentrations (<300 mg/m^3) were recorded in winter/spring – a time of elevated rainfall resulting in the greatest stormwater dilution through the HWWTP system.

2.2.4 Discharge volume monitoring by STDC

Condition 5 of consent **5079-1** requires STDC to provide records of the discharge volumes to the Outfall. The consent holder supplied records for the period from 1 July 2012 to 30 June 2014 (Figure 5).

There were no exceedances of the allowable discharge rate of 12,000 m^3 (average over seven days) during the 2012-2014 period.

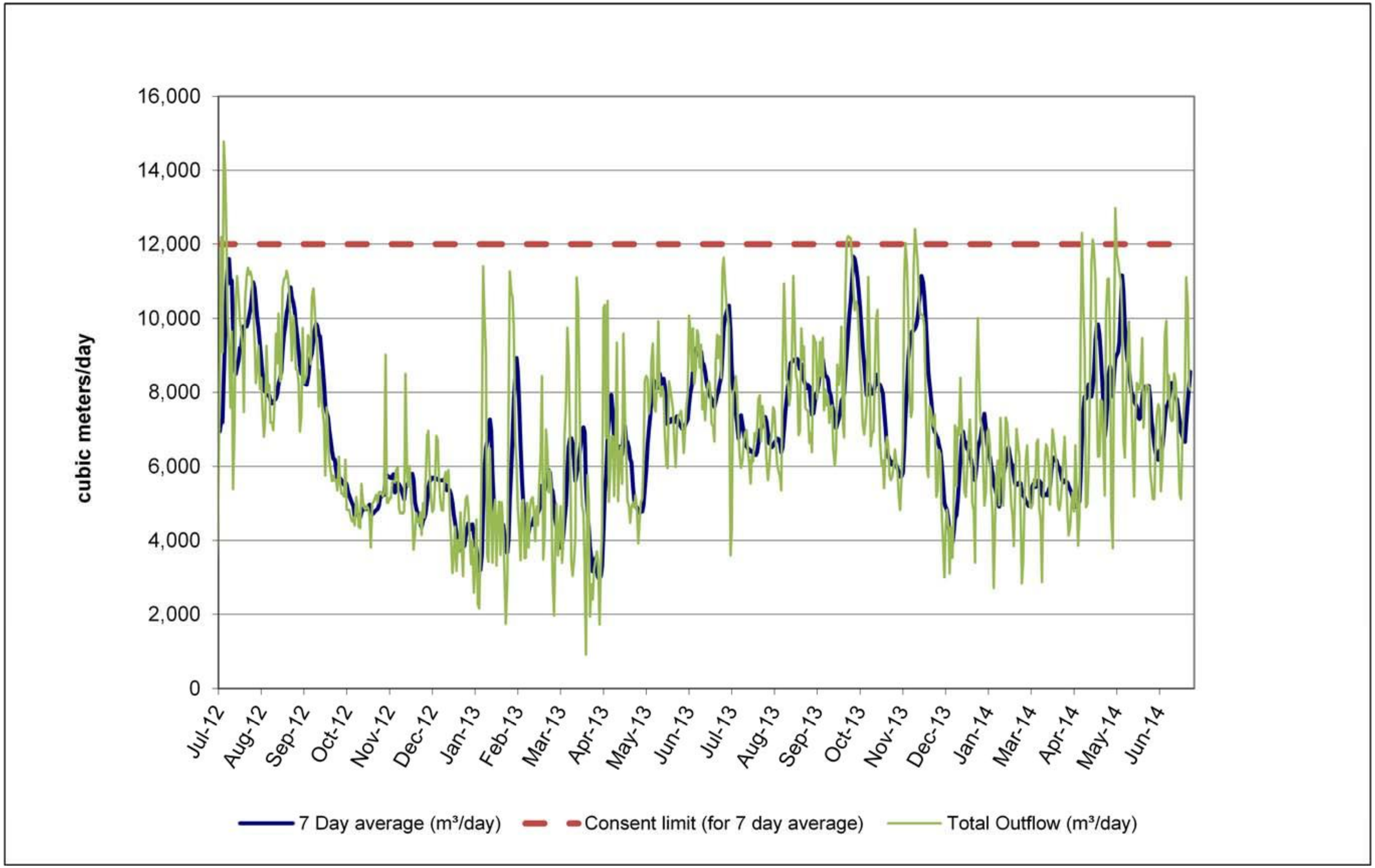

Figure 5 Daily discharge volumes (m^3/day) from the Hawera oxidation ponds system, July 2012 to June 2014

2.3 Impacts on receiving waters

Condition 3 of the consent requires that the discharge does not give rise to various effects on the Tasman Sea beyond a mixing zone of 200 m from the centre line of the outfall diffuser. Sub-condition d) requires that there are no significant adverse effects on aquatic life. Condition 14 requires that the consent holder ensure that a monitoring programme is established to record and analyse effects on the intertidal reefs and coastal water quality adjacent to the discharge. Monitoring is by way of marine ecological surveys, shellfish tissue analysis and shoreline water quality.

2.3.1 Marine ecological surveys

In order to assess the effects of the Whareroa dairy factory and HWWTP outfall discharge on the nearby intertidal communities, ecological surveys were conducted in November 2012, March 2013, November 2013 and March 2014 at four sites (Figure 6, Photo 2). The four survey reports, including statistical analysis of results and further discussion of the findings, are included in Appendix II. Section 2.3.1 summarises the main findings of these survey reports.

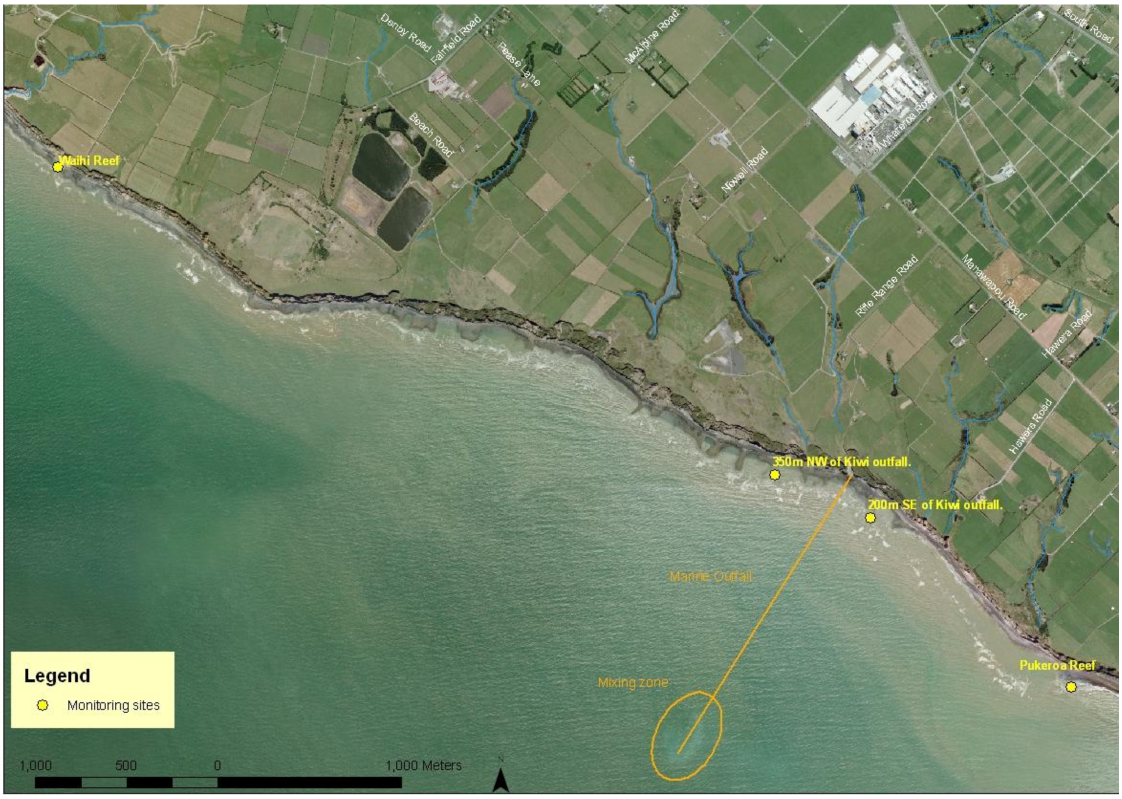

Figure 6 Location of marine ecological monitoring sites

It is expected that adverse effects of the outfall discharge on the intertidal communities would have been evident as a significant decline in species richness and diversity at the potential impact sites relative to the control sites. No such adverse effects were evident during the 2012-2014 monitoring period.

As both species richness (number of species per quadrat) and diversity (Shannon-Weiner Index per quadrat) were higher at the two potential impact sites closest to the outfall relative to the control site at Waihi Road during all four surveys, and results from sites closest to the Outfall had not declined notably in recent years, the results indicate that the outfall discharge was not having detectable adverse effects on the intertidal reef communities of South Taranaki. Natural environmental factors, including coastal erosion, exposure and substrate mobility, appeared to be dominant drivers of species richness and diversity at the sites surveyed.

From the historical record it can be seen that prior to the installation of the long marine Outfall in August 1997, generally there was lower species richness and diversity (number of species and Shannon-Weiner Index per quadrat) at the impact site 200 m SE relative to the control site at Waihi Reef (Figures 7, 8, 9 and 10). Other adverse effects observed at the time included the coating of rocks and tidal pools with fats and significant coverage by filamentous algal and bacterial species. A sharp increase in species diversity occurred at the site 200 m SE following installation of the Outfall (Figures 8 and 10). Since then (August 1997), sites have shown interannual variability in both number of species and Shannon-Weiner Index, but there has been no noticeable difference in trends between the impact site and the control sites over this period.

Photo 2 Survey site 200m southeast of the Outfall (2013)

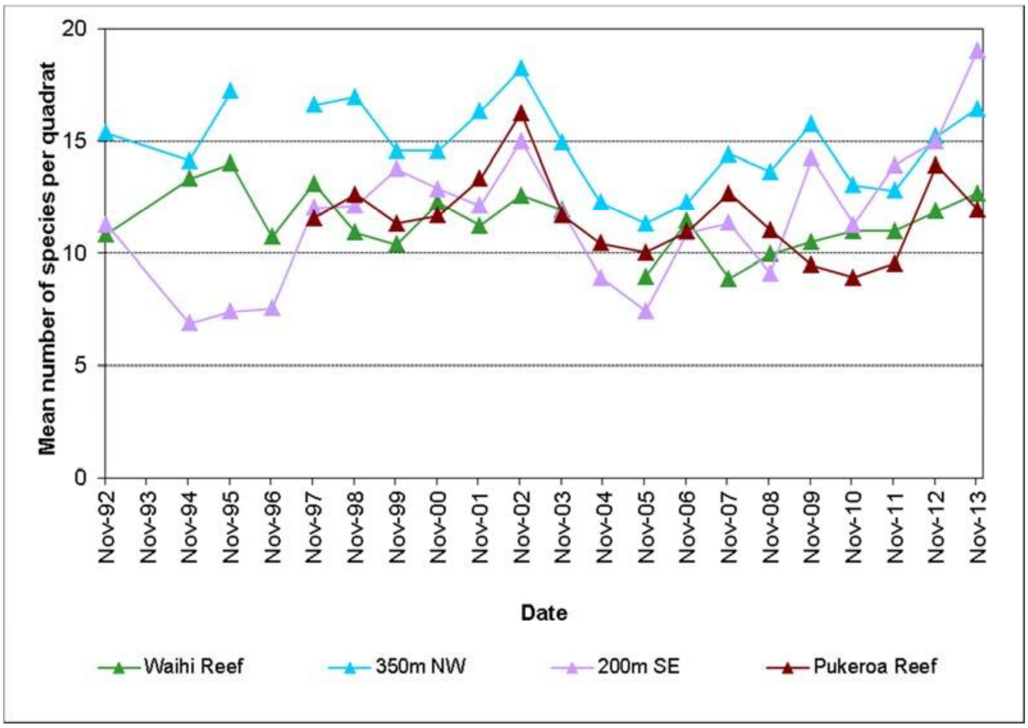

Figure 7 Mean number of species per quadrat: spring surveys 1992-2013

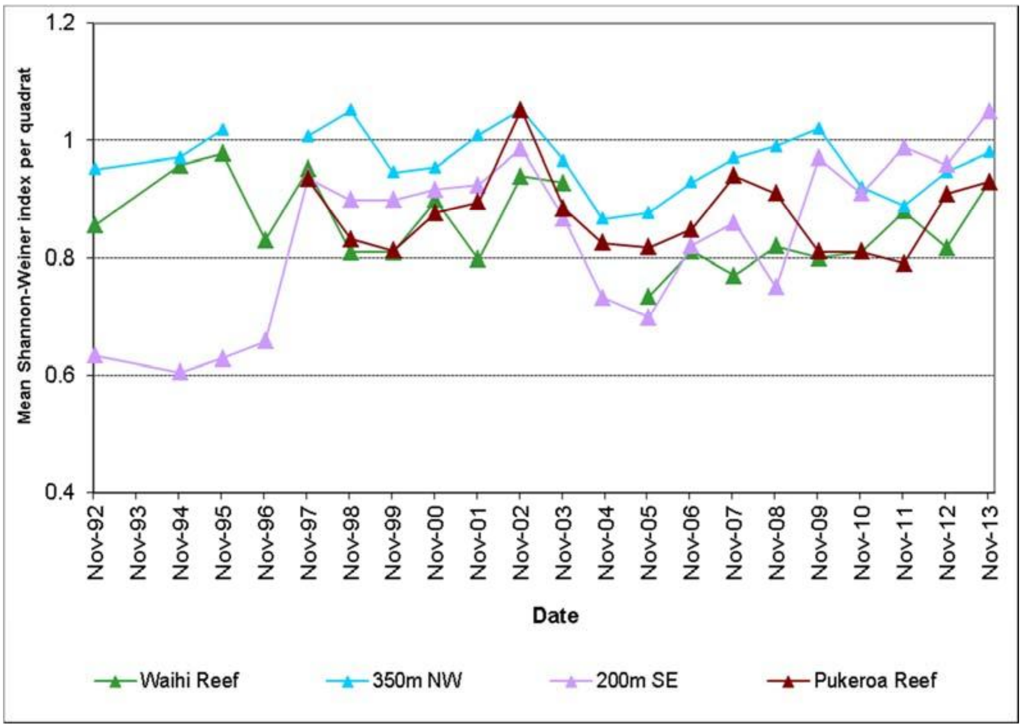

Figure 8 Mean Shannon-Weiner index per quadrat: spring surveys 1992-2013

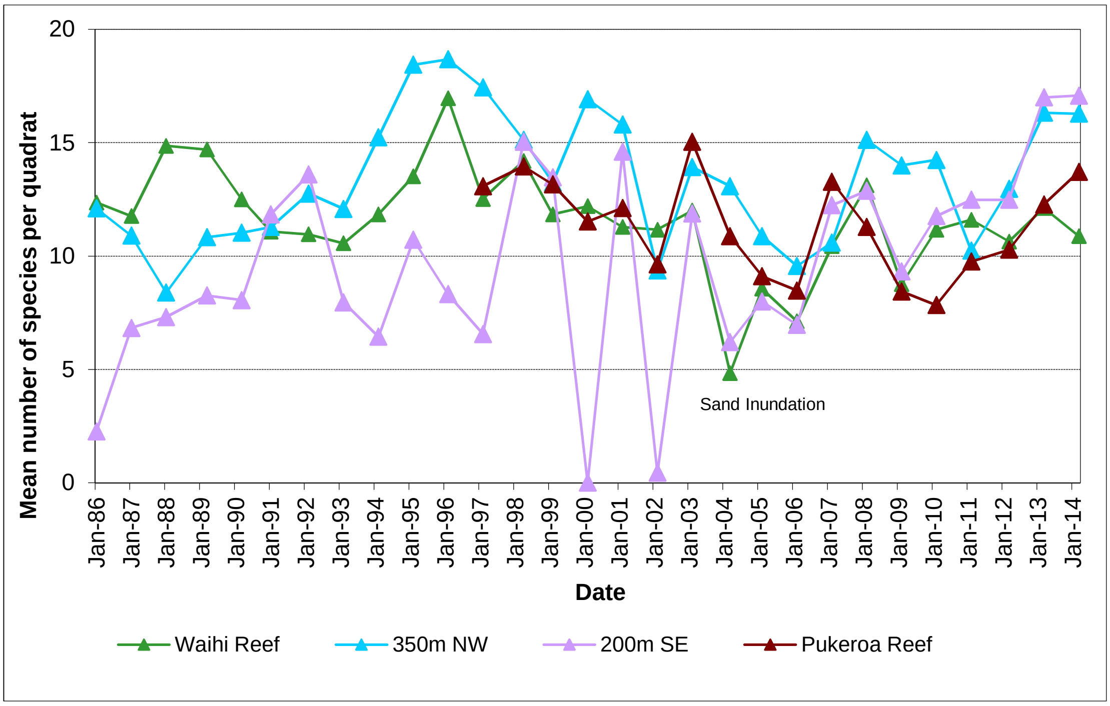

Figure 9 Mean number of species per quadrat: summer surveys 1986-2014

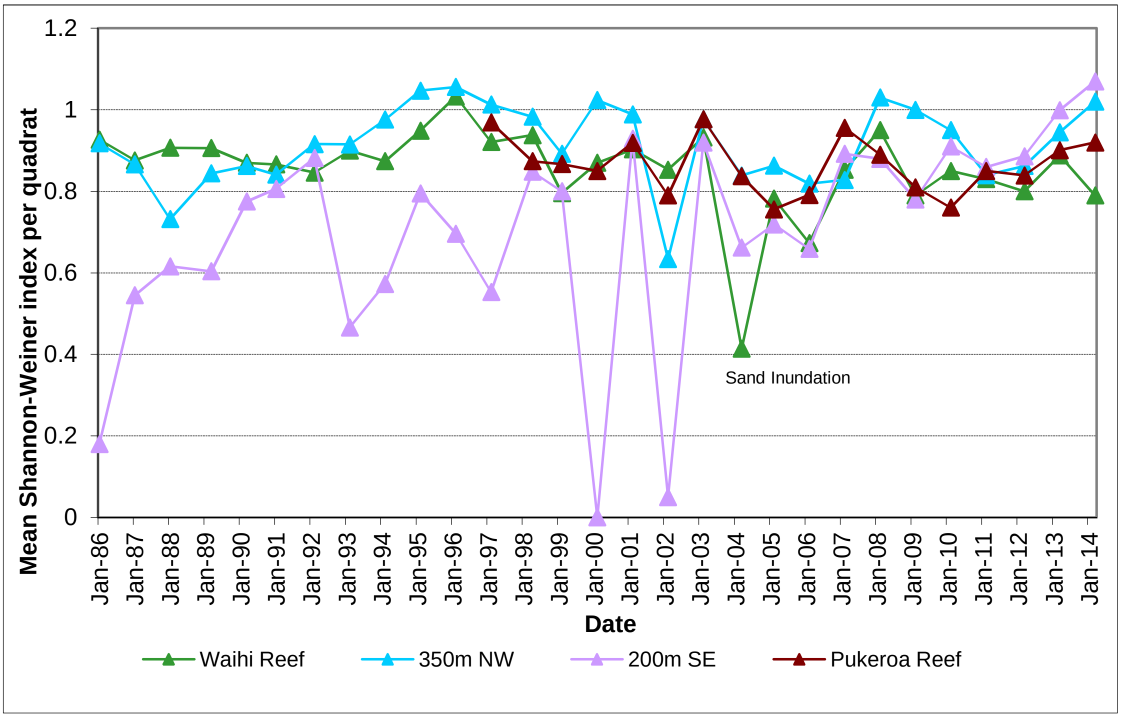

Figure 10 Mean Shannon-Weiner index per quadrat: summer surveys 1986-2014

2.3.2 Shellfish tissue surveys

Condition 4 of the consent states that the discharge shall not result in the guidelines for shellfish-gathering waters, as specified in the '*Provisional Microbiological Water Quality Guidelines for Recreational and Shellfish-Gathering Waters in New Zealand*' being exceeded at the shoreline. Shellfish tissue trace metal and faecal coliform concentrations can provide evidence of longer term bio-accumulation of metals and pathogens which may originate from non-point source run-off and/or point source discharges (e.g. sewage treatment systems).

Samples of the green lipped mussel, *Perna canaliculus*, were gathered from scattered natural populations at four sites (Table 6, Figure 11, Photos 3 and 4).

Table 6 Location of shellfish (mussel) monitoring sites

Site Code	Location	Grid reference
SEA906049	350 m NW of outfall	1710960 - 5612942
SEA906062	1,000 m SE of outfall	1712138 - 5612117
SEA906067	1,650 m SE of outfall	1712574 - 5611784
SEA906072	3,200 m SE of outfall	1713874 - 5610803

2.3.2.1 Faecal coliforms in shellfish tissue

Faecal coliform counts in shellfish tissue provide information relating to the bioaccumulation of faecal indicator bacteria which may originate from non-point source runoff (particularly into nearby rivers and streams) and/or point source discharges.

Photo 3 Green lipped mussel, *Perna canaliculus*

Photo 4 Green lipped mussels at Pukeroa Reef

Figure 11 Water and shellfish collection sites

Mussel samples collected at shoreline sites in the vicinity of the outfall discharge were analysed for faecal coliform concentration by the most probable number (MPN) method.

There are microbiological standards for a lot/consignment of bivalve molluscs under the Australia New Zealand Food Standards Code (2002): The acceptable concentration of *Escherichia coli* (230 MPN/100g), should not be exceeded in more than one in five samples of food, and no sample of food shall exceed a concentration of 700 MPN/100g. *Escherichia coli* belong to the faecal coliform group and in some environmental samples, *E. coli* can account for the majority of faecal coliforms present.

Monitoring of shellfish for microbiological quality in the vicinity of the Outfall commenced in April 1997, two months before the Outfall was commissioned. The frequency of sampling was monthly for three months, then six-monthly in spring and autumn, until spring 2002 when sampling frequency increased to six per year (at about two-monthly intervals). Results for the 2012-2014 period are presented in Table 7 and a summary of pre- and post- HWWTP reconfiguration data is presented in Table 8. All data for the period since early 1997 are presented in Figure 12.

These shellfish tissue bacteriological results were typical of past results, with some samples containing relatively high numbers of faecal coliforms, potentially exceeding guideline levels[1]. Samples collected on 11 February 2013 contained particularly high counts of faecal coliforms as a result of heavy rain on 4 February 2013 following a long dry period.

If the mussels sampled at an individual site were considered to be from the same "lot of food" during the monitoring period, then three of the four sites exceeded the microbiological limits for food. Samples collected from three of the sites in February 2013 exceeded the maximum limit of 700 MPN/100g *E. coli*. None of the sites exceeded the acceptable concentration of *E. coli* (230 MPN/100g) in more than one in five samples.

Table 7 Mussel tissue faecal coliform counts (MPN/100g) from coastal sites adjacent to the Outfall, 2012-2014

Date	Sites			
	SEA906049	SEA906062	SEA906067	SEA906072
4-Jul-12	<20	40	40	130
17-Sep-12	70	80	20	80
15-Nov-12	40	20	40	20
11-Feb-13	9000	3000	500	2400
12-Mar-13	40	500	40	170
26-Apr-13	140	40	170	40
23-Jul-13	45	20	20	130
18-Sep-13	<18	78	20	130
5-Nov-13	68	20	<18	78
30-Jan-14	230	78	45	20
1-Apr-14	20	<18	<18	45
13-Jun-14	78	230	110	220
Range	<18 - 9000	<18 - 3000	<18 - 500	20 - 2400
Median	57	59	40	105

Values in red indicate potential exceedance of the guidelines

[1] Although the faecal coliform results cannot be compared directly with *E. coli*-based guidelines, *E. coli* does belong to the faecal coliform group and in some environmental samples, *E. coli* can account for the majority of faecal coliforms present.

In comparison with pre 1997 data, there has been no apparent change in faecal coliform bacteria numbers in shellfish tissue at sites adjacent to the Outfall since the long Outfall was commissioned. Median counts (Table 8) indicate no increases in numbers at any of the four sites since the incorporation of the HWWTP discharge through the Outfall.

All four sites' median counts have been within the guideline limit (230 MPN/100g) since 2001, however since 2001, six samples exceeded the maximum 700 MPN/100g *E. coli* limit at SEA906049 (8%), three at SEA906062 (4%), seven at SEA906067 (10%), and ten at SEA906072 (14%).

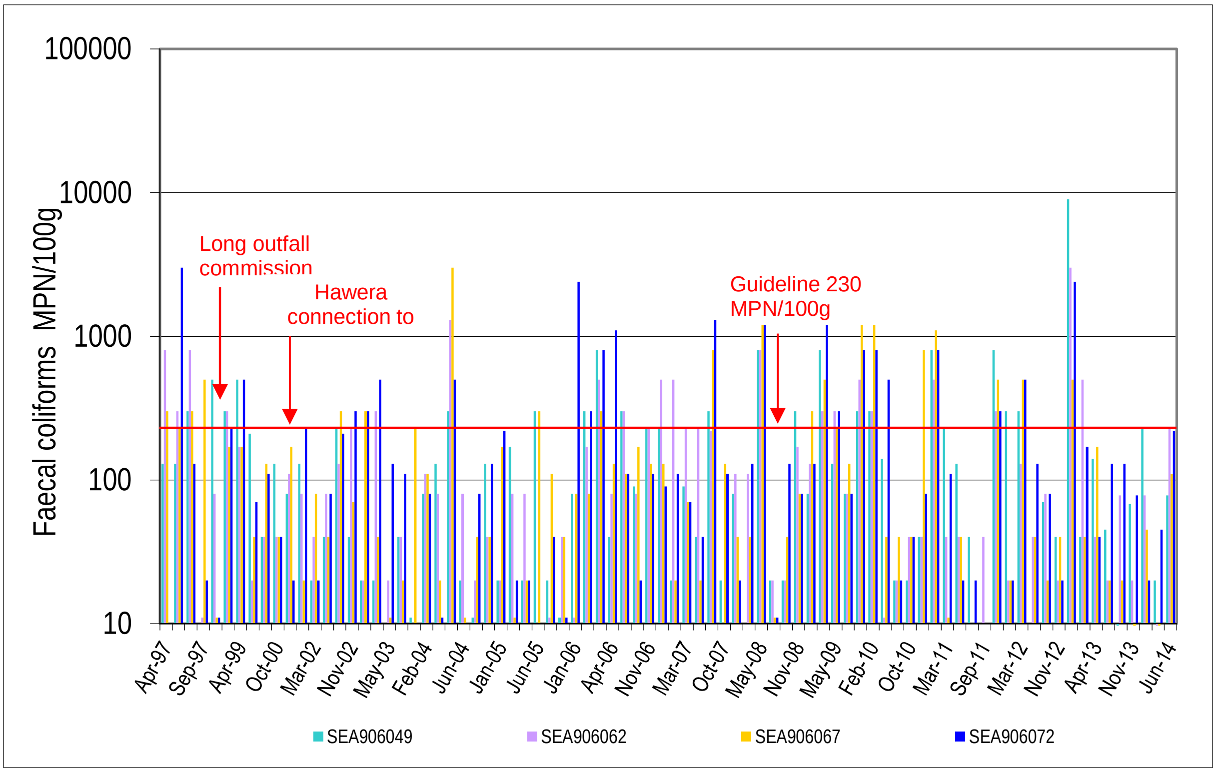

Figure 12 Shellfish (mussel) tissue faecal coliform bacteria numbers (MPN/100g) from surveys of coastal sites (since 1997) adjacent to the Outfall

Usually these exceedances have followed wet weather when faecal coliform numbers in the coastal seawater have increased due to the run-off from many small coastal streams and the nearby Tangahoe River catchment (see TRC, 2004).

Table 8 Summary of mussel tissue faecal coliform counts (MPN/100g) at coastal sites adjacent to the Outfall for the periods prior to (April 1997 to January 2001) and post (February 2001 to June 2014) HWWTP reconfiguration

Period		Sites			
		SEA906049	SEA906062	SEA906067	SEA906072
Pre	Range Median N	40 – 500 210 9	20 – 800 125 10	20 – 500 170 10	20 – 3,000 110 9
Post	Range Median N	<18 – 9,000 80 72	<18 – 3,000 80 70	<18 – 3,000 70 73	<20 – 2,400 110 70

2.3.2.2 Trace metals in shellfish tissue

Trace metal concentrations in shellfish tissue are monitored in relation to discharges from the Hawera oxidation pond system and Fonterra Co-operative Group Limited dairy factory at Whareroa biennially. Each sample is depurated (mussels are placed in seawater for a period of time to allow the elimination of waste products from the gut) prior to analysis of a number of trace metals. The results of the current monitoring period are presented in Table 9, while previous analyses are summarised in Table 10. Trace metal analysis is next scheduled to be undertaken during the 2014-2015 monitoring period.

Table 9 Results of shellfish (mussel) trace metals (mg/kg wet weight) survey 15 November 2012

Parameter (mg/kg)	Site in relation to outfall				Australia NZ Food Standards Code 2002
	350 m NW SEA906049	1000 m SE SEA906062	Pukeroa Reef SEA906067	3200 m SE SEA906072	
Arsenic	0.96	0.84	0.82	0.85	1.0*
Cadmium	0.046	0.040	0.048	0.048	2.0
Chromium	0.09	0.10	0.10	0.07	--
Copper	0.56	0.79	0.63	0.79	-
Lead	0.043	0.10	0.040	0.064	2.0
Mercury	0.011	0.011	0.009	0.015	-
Nickel	0.28	0.33	0.36	0.53	-
Zinc	5.8	5.1	5.8	8.1	-

**Australia New Zealand Food Standards Code guideline is for inorganic arsenic which is estimated to be 10% of total arsenic. The Council results are for total arsenic.*

Table 10 Results (ranges) of previous mussel trace metal concentrations (mg/kg wet weight), up to November 2011

Parameter		Site			
		350 m NW SEA906049	1000 m SE SEA906062	Pukeroa Reef SEA906067	3200 m SE SEA906072
Arsenic	Post	1.12	1.02	0.98	0.97
Cadmium	Pre Post	0.015 0.039 – 0.048	<0.005 0.024 - 0.046	0.008 - 0.032 0.032 - 0.05	0.014 0.026 - 0.042
Chromium	Pre Post	0.26 0.06 – 0.14	0.21 0.03 - 0.10	0.2 - 0.22 0.03 - 0.13	0.19 0.03 - 0.10
Copper	Pre Post	1.18 1.02 – 1.39	0.84 0.73 – 1.35	0.87 - 0.98 0.66 - 1.82	0.97 0.64 – 1.96
Lead	Pre Post	<0.05 <0.05 – 0.12	<0.05 <0.05 - 0.1	<0.05 <0.05 - <0.1	<0.05 <0.05 – 0.26
Mercury	Pre Post	0.010 0.001 - 0.012	0.009 0.008 - 0.014	0.010-0.012 0.001 - 0.01	0.014 0.001 - 0.016
Nickel	Pre Post	0.67 0.33 – 1.6	0.46 0.34 - 0.77	0.51 - 0.55 0.34 - 1.1	0.58 0.31 - 1.6
Zinc	Pre Post	5.7 5.6 – 8.1	4.2 6.8 - 7.5	4.2 - 5.9 5.8 - 6.7	4.3 5.6 - 7.2

Results from the current monitoring period (Table 9) show levels of cadmium and lead are well below the Australia New Zealand Food Standards Code 2002 guidelines.

Levels of arsenic were well below the guideline value taking into consideration that the Council results are for total arsenic and that the Australia New Zealand Food Standards Code guideline is for inorganic arsenic which is estimated to be 10% of total arsenic.

Although no guidelines exist for the remaining metals, these trace metal levels are consistent with ranges of concentrations found in shellfish elsewhere on the Taranaki coastline.

2.3.3 Receiving water quality in relation to shellfish

Special Condition 4 of consent **5079-1**, which provides for the discharge of Hawera municipal effluent from the Outfall, states:

> *'That the discharge shall not result in the guideline for shellfish-gathering waters, as specified in the document 'Provisional Microbiological Water Quality Guidelines for Recreational and Shellfish-Gathering Waters in New Zealand[2]' (Department of Health 1992), being exceeded at the shoreline.'*

That is, the median faecal coliform content of samples taken over a shellfish gathering season shall not exceed 14 MPN/100 ml, and not more than ten percent of the samples should exceed 43 MPN/100 ml (five-tube decimal dilution test).

To determine compliance with this condition, the Council has monitored bacteriological water quality at five sites along the coastline and one site at the Tangahoe River mouth (Table 11, Figure 11).

Background monitoring started in April 1997, with three surveys conducted prior to the commissioning of the long Outfall. Seventeen surveys were undertaken during the period when only the dairy factory wastewater was discharged. A further 79 surveys have been undertaken since the introduction of the HWWTP discharge to the Outfall in February 2001 until the end of the reporting period in June 2014.

Table 11 Location of bacteriological receiving water quality monitoring sites

Site code	Location	Grid reference
SEA906020 (control site)	Tasman Sea; NW Waihi S, 5.7 km NW of outfall	E1706404 – N5615244
SEA906047	Tasman Sea; 1.05 km NW of outfall	E1710960 – N5612942
SEA906062	Tasman Sea; Pukeroa reef (north end), 1 km SE of outfall	E1712138 – N5612117
SEA906067	Tasman Sea; Pukeroa reef (south end), 1.65 km SE of outfall	E1712574 – N5611784
SEA906072	Tasman Sea; 3.2 km SE of outfall	E1713874 – N5610803
TNH000998	Tangahoe River; at mouth, 5 km SE of outfall	E1715337 – N5609999

[2] These have been replaced by Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas, 2003.

The samples were analysed for faecal coliforms by the MPN method. Conductivity was analysed to provide an indication of the influence of freshwater inflows from coastal streams and/or the Tangahoe River. Results for the 2012-2014 monitoring period are presented in Table 12.

Although the guideline requiring that the faecal coliform numbers not exceed 43 MPN/100ml by more than 10% of samples in a shellfish-gathering season cannot be assessed comprehensively on an annual basis, as less than ten samples are collected each season, it is noted that one sample at SEA906020 (the control site) exceeded 43 MPN/100 ml during the monitoring period.

In terms of median counts, bacteriological water quality was acceptable at all five sites, with no exceedances of the guideline of 14 MPN/100 ml. A typical, much higher, median level was recorded for the Tangahoe River (Table 12). This is likely due to runoff from the extensively farmed land in the catchment.

Table 12 Receiving water faecal coliform counts MPN/100ml and (conductivity values, mS/m @ 20 C) at sites adjacent to the Outfall during the 2012-2014 period

Date	Site					
	SEA906020	SEA906047	SEA906062	SEA906067	SEA906072	TNH000998
4-Jul-12	4 (4,600)	2 (4,650)	<2 (4,650)	<2 (4,650)	2 (4,650)	3,000 (19)
17-Sep-12	14 (4,410)	4 (4,570)	2 (4,680)	2 (4,690)	4 (4,680)	800 (41)
15-Nov-12	<2 (4,690)	<2 (4,680)	<2 (4660)	<2 (4,670)	2 (4,670)	170 (154)
11-Feb-13	80 (4,690)	30 (4,730)	30 (4,720)	13 (4,700)	4 (4,700)	1,300 (879)
12-Mar-13	4 (4,750)	4 (4,750)	13 (4,710)	21 (4,720)	17 (4,640)	500 (121)
26-Apr-13	13 (4,550)	30 (4,630)	22 (4,620)	13 (4,620)	13 (4,630)	700 (195)
23-Jul-13	<2 (4,640)	2 (4,630)	9 (4,620)	8 (4,620)	8 (4,620)	230 (26)
18-Sep-13	8 (4,620)	<2 (4,710)	<2 (4,690)	<2 (4,690)	<2 (4,680)	280 (29)
5-Nov-13	<2 (4,620)	2 (4,550)	2 (4,620)	13 (4,620)	2 (4,610)	460 (347)
30-Jan-14	23 (4630)	17 (4,660)	2 (4,710)	2 (4,700)	5 (4,730)	1,300 (850)
1-Apr-14	2 (4,710)	2 (4,720)	<2 (4,720)	<2 (4,710)	2 (4,720)	210 (1,020)
13-Jun-14	7 (4,640)	<2 (4,640)	13 (4,620)	17 (4,630)	11 (4,600)	790 (23)
Range	<2 - 80	<2 - 30	<2 - 30	<2 - 21	<2 - 17	170 – 3,000
Median	6	2	2	5	4	600

Values in red exceed the 43 MPN per 100 ml or the median of 14 MPN

There has been a tendency for the higher faecal coliform results at the shoreline to coincide with elevated counts in the nearby Tangahoe River, particularly following floods. Conductivity data support this, as lower conductivities (indicative of increased freshwater influence) have often coincided with increased bacterial counts.

A comparison of monitoring data for pre and post-HWWTP discharge connection to the Outfall is provided in Table 13 and Figure 13 (see Appendix III for an explanation of the 'box and 'whisker' plots).

In terms of median faecal coliform concentrations at the shoreline sites adjacent to the Outfall and 'control' site north of Waihi Stream (SEA906020), counts were not significantly different between sites or between the periods before and after connection of the HWWTP discharge.

Table 13 Summary of receiving water faecal coliform counts (MPN/100ml) at six sites adjacent to the Outfall for the periods prior to (July 1997 to June 2000), and post (March 2001 to June 2014) HWWTP reconfiguration

Period		Site					
		SEA906020	SEA906047	SEA906062	SEA906067	SEA906072	TNH000998
Pre	Range Median N	<2 – 240 4 17	<2 – 300 6 17	<2 – 240 4 17	<2 – 130 7 17	<2 – 130 13 17	22 – 16,000 900 15
Post	Range Median N	<2 – 900 8 79	<2 – 300 4 79	<2 – 500 4 77	<2 – 300 4 79	<2 – 300 7 79	80 – 9,000 500 79

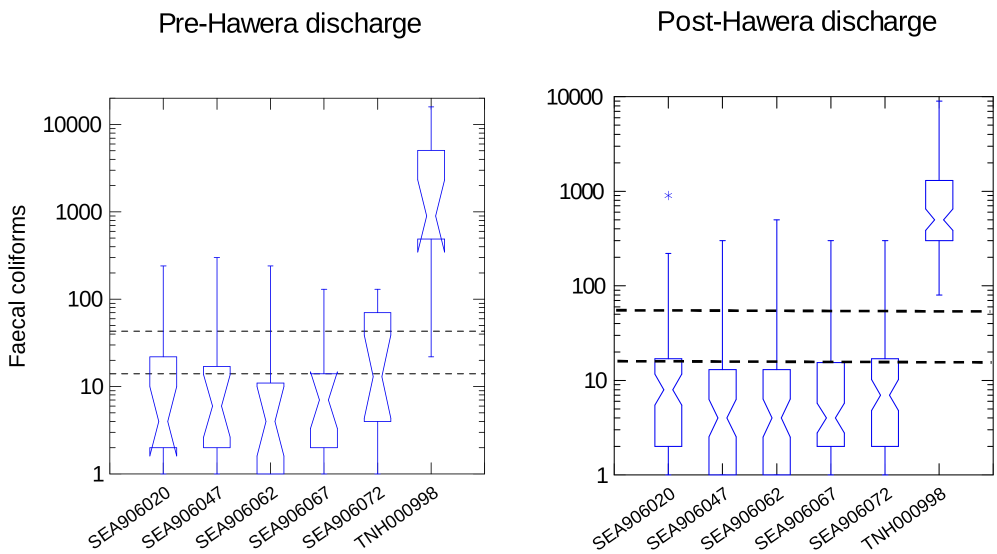

Figure 13 Faecal coliform counts (MPN/100ml) at shoreline sites and in the Tangahoe River before and after connection of the HWWTP discharge to the Outfall

Note: top limit line equals the 90% guideline bottom limit line equals median guidelines for shellfish-gathering waters

2.4 Additional reporting requirements

Consent **5079-1** contains six special conditions relating to reporting and approval requirements.

Condition 6 required that STDC advises and consults with the Council if trade wastes are accepted into the wastewater system for which it may be appropriate or necessary to place limits on concentrations of any toxic or hazardous contaminants. Around 2,000 – 3,000 m^3 of excess buttermilk from Fonterra Co-operative Group Limited dairy factory at Whareroa was pre-treated in the Eltham Eader before being piped to the HWWTP. No discernible effects were detected at the HWWTP.

Condition 8 required STDC to provide, within three months of granting of the consent (ie. by 20 March 2008), a contingency plan outlining measures and procedures to be undertaken to prevent spillage or accidental discharge of contaminants in the event of a breakdown, including measures to avoid, remedy or mitigate the environmental effects of such a discharge. The consent condition requires that this plan is updated annually. A management and contingency plan for the site was produced in May 2008, and this was up-to-date as of July 2014.

Condition 9 required STDC to supply an annual report on its waste treatment system, including the performance of the Outfall and compliance with the consent, by 31 August each year. The contents of this report are discussed further in Section 3.1.

Condition 10 required that STDC supply a report reviewing the best practicable option for treatment and disposal of wastewater generated at Hawera and Eltham, due by 31 December 2009. This was carried out by consultants, and after initial discussions with iwi and Council in October 2008, was presented to iwi in December 2008. A further presentation was made in March 2009, and no feed-back from iwi was received. The report was submitted to the Council in December 2009.

Condition 11 outlined the four main actions required to complete the project. Condition 12 required that reports on the implementation of condition 11 are provided to the Council by 31 March, 30 June, 30 September and 15 December of each year until implementation is complete. Implementation was complete by 30 June 2011; therefore reports are no longer required to be submitted.

Condition 13 requires that the consent holder and staff of the Council meet with representatives various iwi, other submitters to the consent and any other interested party to discuss any matters relating to the consent and facilitate ongoing consultation. In addition, condition 15 requires that the scope and detail of the monitoring programme (as required by condition 14) is developed in consultation with submitters. Meetings to fulfil Condition 13 of the consent were held in July 2012 and September 2013.

2.5 Investigations, interventions, and incidents

The monitoring programme for the year was based on what was considered to be an appropriate level of monitoring, review of data, and liaison with the consent holder.

During the year matters may arise which require additional activity by the Council e.g. provision of advice and information, or investigation of potential or actual causes of non-compliance or failure to maintain good practices. A pro-active approach that in the first instance avoids issues occurring is favoured.

The Council operates and maintains a register of all complaints or reported and discovered excursions from acceptable limits and practices, including non-compliance with consents, which may damage the environment. The Incident Register (IR) includes events where the company concerned has itself notified the Council. The register contains details of any investigation and corrective action taken.

Complaints may be alleged to be associated with a particular site. If there is potentially an issue of legal liability, the Council must be able to prove by investigation that the identified company is indeed the source of the incident (or that the allegation cannot be proven).

In the 2012-2014 period, it was not necessary for the Council to undertake significant additional investigations and interventions, or record incidents, in association with STDC's conditions in resource consents or provisions in Regional Plans in relation to the activities at the HWWTP during the monitoring period.

3. Discussion

3.1 Plant performance

During this 2012-2014 reporting period, the HWWTP was in its third and fourth monitoring years since the upgrade and reconfiguration of the treatment system. The upgrade involved the reconfiguration of wastewater flows, so that the two existing oxidation ponds operate in parallel rather than in series, and included the addition of waste from Eltham township.

Regular inspections of the HWWTP found the site and surrounds were generally tidy. Pungent/strong odours were often detected downwind from the anaerobic lagoon and were noticeable around the entrance of the property on occasion. STDC are working with Silver Fern Farms to review issues with the anaerobic lagoon. A joint contingency plan for the anaerobic lagoon is being progressed.

STDC continued to have maintenance issues with DO meters and aerators. As a result the percentage compliance for the year for exceeding 2 g/m^3 of oxygen in the pond for 90% of the time between 11:00 and 14:00 was not achieved. The process of replacing the brush aerators that were installed during the recent plant upgrade with diffuser aerators commenced during the monitoring period in an attempt to resolve this issue. The first diffuser aerator was installed in August 2013 into Pond 2 as an extra, as this pond currently receives a larger portion of the incoming flow, and has struggled to meet the required consent DO levels. The electronic controls for a further two aerators have also been installed. Despite not meeting the consent requirements for DO in the ponds, no significant odours were detected from either pond.

The de-sludging trial on Pond 1 which begun in March 2012 has progressed well and has been extended to Pond 2. Both ponds are expected to have finished their de-sludging programme in March 2015.

The consent limit (12,000 m^3) on the volume of discharge from the HWWTP was not exceeded over the two year period from 1 July 2012 to 1 July 2014.

No significant overflows from the oxidation pond to the retention area occurred during the monitoring period. Therefore consent **7520** to discharge to the stream in the event of high rainfall was not used in the 2012-2014 monitoring period.

3.2 Environmental effects of exercise of water permits

During the 2012-2014 period, STDC discharged effluent from HWWTP to coastal water via the Outfall.

The Council monitored the environmental effects of discharges by assessment of hard substrate communities in the intertidal zone, along with shoreline water and shellfish monitoring for microbiological quality.

Impacts of the outfall discharge on local intertidal communities were not evident in the four surveys undertaken during the monitoring period (Appendix II).

Microbiological surveys of shoreline waters and shellfish (mussels) showed no significant differences in faecal coliform counts before and after the HWWTP wastewater was introduced to the Outfall.

The microbiological quality of seawater met the Ministry of Health guideline for recreational shellfish-gathering at the five sites sampled. In regards to shellfish tissue testing, three of the 48 samples exceeded the single sample level of 700 *E. coli* MPN/100g. However, none of the four sites exceeded the level of not more than one in five samples containing more than 230 *E. coli* MPN/100g.

The influence of runoff to rivers and streams along the coast is the principal reason that this guideline was not met, as would be the case along most of the Taranaki coastline, and elsewhere in New Zealand where pastoral agriculture affects the microbiological quality of water.

3.3 Evaluation of performance

A summary of the consent holder's compliance record for the year under review is presented in Tables 14 and 15.

Table 14 Summary of performance for Consent 5079 to discharge treated municipal wastes

Condition requirement	Means of monitoring during period under review	Compliance achieved?
1. Maintenance and operation of system	Inspections and sampling	Yes
2. Maintenance of DO level in ponds ≥ 2 gm^{-3} for 90% time between hours of 11:00 and 14:00	Consent holder continuous recording; supply of data; and sampling	No
3. Limits on receiving water effects in Tasman Sea	Inspections and ecological surveys	Yes
4. Compliance with shellfish-gathering microbiological guidelines	Bacteriological sampling	Yes
5. Provision of discharge volume records	Records supplied by consent holder	Yes
6. Consultation with Council re trade wastes	LIasion with consent holder	Yes
7. Management of system	Inspections and self monitoring data from STDC	Yes
8. Provision of contingency plan (annual review)	Up-to-date as of July 2014	Yes
9. Supply of annual report by 31 August	Supplied by consent holder	Yes
10. Supply of report reviewing options for treatment of wastewater	Previously supplied by consent holder	Yes
11. Schedule of works and upgrades to be completed	Works complete	N/A
12. Supply of reports on implementation of condition 11	Works complete	N/A
13. Annual meeting with interested parties	Held July 2012 and September 2013	Yes
14. Establishment of coastal and ecological monitoring programmes	Implementation of tailored monitoring programmes	Yes

Condition requirement	Means of monitoring during period under review	Compliance achieved?
15. Monitoring programme to be developed in consultation with submitters	Liaison with consent holder and parties	Yes
16. Installation of screening	Inspections	Yes
17. Optional review provision re environmental effects		N/A
Overall assessment of environmental performance and compliance in respect of this consent Overall assessment of administrative performance in respect of this consent		High Improvement required

Table 15 Summary of performance for Consent 7520 to discharge partially treated wastewater

Condition requirement	Means of monitoring during period under review	Compliance achieved?
1. Discharge shall only occur as a consequence of high rainfall events	Notification and inspections	N/A no overflows
2. Temporary holding pond capacity shall be no less than 55,000 cubic metres	Inspections	Yes
3. No modifications to the treatment plant that may result in an increase in the frequency of the discharge.	Inspections	Yes
4. Provision of discharge timing and volume records	Records supplied by consent holder	N/A no overflows
5. Adopt the best practicable option	Inspections	Yes
6. Notification of Council immediately after a discharge.	Records supplied by consent holder	N/A no overflows
7. Provision of contingency plan	Up-to-date as of July 2014	Yes
8. Monitoring programme including physicochemical, bacteriological and ecological monitoring of the wastewater treatment system and receiving waters	Inspection and sampling	N/A no overflows
9. Optional review provision re environmental effects	Next due June 2015, recommendation in section 3.6	N/A
Overall assessment of environmental performance and compliance in respect of this consent Overall assessment of administrative performance in respect of this consent		High High

Monitoring during the year indicated that STDC achieved a high level of environmental performance, however improvement is desirable in regard to administrative compliance with resource consents at the HWWTP. DO levels did not comply with consent conditions. DO is monitored to ensure the ponds are functioning appropriately and ensure odours are reduced (although no significant odours were detected).

During the period under review there were no unauthorised incidents reported at the HWWTP site.

3.4 Recommendations from the 2011-2012 Annual Report

In the 2011-2012 Annual Report, it was recommended:

1. THAT monitoring of the HWWTP, comprising inspection, microalgae survey and effluent analysis in relation to the treatment system, and water quality and shellfish tissue analysis in relation to the receiving waters, be continued for the 2012-2013 monitoring period.

2. THAT the 2012-2013 monitoring programme continues to be integrated with and complementary to that for Fonterra's discharge through the same ocean outfall.

3. THAT regular maintenance of the waste treatment system is performed by the consent holder who shall maintain adequate records of the operation of the system.

4. THAT the consent holder liaises with the Council with respect to any proposed additional industrial waste discharge to the system in order that potential impacts may be addressed and if necessary, additional monitoring requirements formulated.

5. THAT the consent holder liaises with the Council with respect to any modifications to the ponds system, and its performance.

6. THAT the consent holder continues a bi-monthly schedule for reporting volumes discharged and continuous ponds' DO levels to the Council.

7. THAT the consent holder supply Council with an annual report on its waste treatment system, including the performance of the outfall and compliance with the consent by 31 August 2013, as required by condition 9 of consent 5079.

8. THAT a liaison meeting is held with iwi, submitters and other interested parties as per condition 13 of consent 5079.

   These recommendations were carried out in full.

3.5 Alterations to monitoring programmes for 2014-2015

In designing and implementing the monitoring programmes for air/water discharges in the region, the Council has taken into account the extent of information made available by previous authorities, its relevance under the RMA, the obligations of the RMA in terms of monitoring emissions/discharges and effects, and subsequently reporting to the regional community, the scope of assessments required at the time of renewal of permits, and the need to maintain a sound understanding of industrial processes within Taranaki emitting to the atmosphere/discharging to the environment.

It is proposed that for 2014-2015, the programme remains unchanged from that of the 2013-2014 monitoring programme. A recommendation to this effect is attached to this report.

3.6 Exercise of optional review of consent

Resource consent **7520-1** provides for an optional review of the consent in June 2015. Condition 9 allows the Council to review the consent, for the purpose of ensuring that the conditions are adequate to deal with any significant adverse effects on the environment arising from the exercise of this consent.

Based on the results of monitoring in the period under review, and in previous years as set out in earlier annual compliance monitoring reports, it is considered that there are no grounds that require a review to be pursued, or grounds to exercise the review option.

A recommendation to this effect is presented in Section 4 of this report.

4. Recommendations

1. THAT monitoring of the HWWTP, comprising inspection and effluent analysis in relation to the treatment system, and water quality and shellfish tissue analysis in relation to the receiving waters, be continued for the 2014-2015 monitoring period.

2. THAT the 2014-2015 monitoring programme continues to be integrated with and complementary to that for Fonterra's discharge through the same ocean outfall.

3. THAT regular maintenance of the waste treatment system is performed by the consent holder who shall maintain adequate records of the operation of the system.

4. THAT the consent holder liaises with the Council with respect to any proposed additional industrial waste discharge to the system in order that potential impacts may be addressed and if necessary, additional monitoring requirements formulated.

5. THAT the consent holder liaises with the Council with respect to any modifications to the ponds system, and its performance.

6. THAT the consent holder continues a bi-monthly schedule for reporting volumes discharged and continuous ponds' DO levels to the Council.

7. THAT the consent holder supply Council with an annual report on its waste treatment system, including the performance of the outfall and compliance with the consent by 31 August 2015, as required by condition 9 of consent 5079.

8. THAT a liaison meeting is held with iwi, submitters and other interested parties as per condition 13 of consent 5079.

9. THAT the option for a review of resource consent 7520-1 in June 2015, as set out in condition 9 of the consent, not be exercised, on the grounds that the current conditions are adequate to deal with any potential environmental effects.

Glossary of common terms and abbreviations

The following abbreviations and terms are used within this report:

As*	arsenic
Biomonitoring	assessing the health of the environment using aquatic organisms
BOD	biochemical oxygen demand. A measure of the presence of degradable organic matter, taking into account the biological conversion of ammonia to nitrate
BODF	biochemical oxygen demand of a filtered sample
bund	a wall around a tank to contain its contents in the case of a leak
CBOD	carbonaceous biochemical oxygen demand. A measure of the presence of degradable organic matter, excluding the biological conversion of ammonia to nitrate
Cd*	cadmium
cfu	colony forming units. A measure of the concentration of bacteria usually expressed as per 100 millilitre sample
Condy	Conductivity, an indication of the level of dissolved salts in a sample, usually measured at 20°C and expressed in mS/m
Cr*	chromium
Cu*	copper
DO	dissolved oxygen
DRP	dissolved reactive phosphorus
E.coli	*Escherichia coli,* an indicator of the possible presence of faecal material and pathological micro-organisms. Usually expressed as colony forming units per 100 millilitre sample
Ent	Enterococci, an indicator of the possible presence of faecal material and pathological micro-organisms. Usually expressed as colony forming units per 100 millilitre of sample
FC	Faecal coliforms, an indicator of the possible presence of faecal material and pathological micro-organisms. Usually expressed as colony forming units per 100 millilitre sample
fresh	elevated flow in a stream, such as after heavy rainfall
g/m^3	grammes per cubic metre, and equivalent to milligrammes per litre (mg/L). In water, this is also equivalent to parts per million (ppm), but the same does not apply to gaseous mixtures
Hg*	mercury
Incident	an event that is alleged or is found to have occurred that may have actual or potential environmental consequences or may involve non-compliance with a consent or rule in a regional plan. Registration of an incident by the Council does not automatically mean such an outcome had actually occurred
Intervention	action/s taken by Council to instruct or direct actions be taken to avoid or reduce the likelihood of an incident occurring
Investigation	action taken by Council to establish what were the circumstances/events surrounding an incident including any allegations of an incident
l/s	litres per second
mS/m	millisiemens per metre

mixing zone	the zone below a discharge point where the discharge is not fully mixed with the receiving environment. For a stream, conventionally taken as a length equivalent to 7 times the width of the stream at the discharge point.
NH_4	ammonium, normally expressed in terms of the mass of nitrogen (N)
NH_3	unionised ammonia, normally expressed in terms of the mass of nitrogen (N)
Ni*	nickel
NO_3	nitrate, normally expressed in terms of the mass of nitrogen (N)
NTU	Nephelometric Turbidity Unit, a measure of the turbidity of water
O&G	oil and grease, defined as anything that will dissolve into a particular organic solvent (e.g. hexane). May include both animal material (fats) and mineral matter (hydrocarbons)
Pb*	lead
pH	a numerical system for measuring acidity in solutions, with 7 as neutral. Numbers lower than 7 are increasingly acidic and higher than 7 are increasingly alkaline. The scale is logarithmic i.e. a change of 1 represents a ten-fold change in strength. For example, a pH of 4 is ten times more acidic than a pH of 5.
physicochemical	measurement of both physical properties (e.g. temperature, clarity, density) and chemical determinants (e.g. metals and nutrients) to characterise the state of an environment
resource consent	refer Section 87 of the RMA. Resource consents include land use consents (refer Sections 9 and 13 of the RMA), coastal permits (Sections 12, 14 and 15), water permits (Section 14) and discharge permits (Section 15)
RMA	Resource Management Act 1991 and subsequent amendments
SS	suspended solids,
Temp	temperature, measured in °C (degrees Celsius)
Turb	turbidity, expressed in NTU
UI	Unauthorised Incident - an event recorded by the Council on the basis that it had potential or actual environmental consequences that may represent a breach of a consent or provision in a Regional Plan
UIR	Unauthorised Incident Register
Zn*	zinc

*an abbreviation for a metal or other analyse may be followed by the letters 'As', to denote the amount of metal recoverable in acidic conditions. This is taken as indicating the total amount of metal that might be solubilised under extreme environmental conditions. The abbreviation may alternatively be followed by the letter 'D', denoting the amount of the metal present in dissolved form rather than in particulate or solid form. For further information on analytical methods, contact the Council’s laboratory

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Appendix I

Resource consents held by South Taranaki District Council

Consent 5079-1

TARANAKI
REGIONAL
COUNCIL

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on all correspondence

Coastal Permit

Pursuant to the Resource Management Act 1991
a resource consent is hereby granted by the
Taranaki Regional Council

Name of Consent Holder:	South Taranaki District Council Private Bag 902 HAWERA 4640
Change To Conditions Date:	29 June 2010 [Granted: 22 March 1998]

Conditions of Consent

Consent Granted:	To discharge up to 12,000 cubic metres/day [seven day average discharge] of treated municipal wastes generated in the Hawera and Eltham townships, including treated meat processing and dairy industry wastes, through a combined marine outfall into the Tasman Sea near Hawera at or about (NZTM) 1710652E-5611568N
Expiry Date:	1 June 2015
Review Date(s):	June 2010
Site Location:	Rifle Range Road, Hawera
Legal Description:	Pt Lot 13 DP 2625 and Foreshore Blks IX & X Hawera SD
Catchment:	Tasman Sea

For General, Standard and Special conditions pertaining to this consent please see reverse side of this document

General conditions

a) On receipt of a requirement from the Chief Executive, Taranaki Regional Council the consent holder shall, within the time specified in the requirement, supply the information required relating to the exercise of this consent.

b) Unless it is otherwise specified in the conditions of this consent, compliance with any monitoring requirement imposed by this consent must be at the consent holder's own expense.

c) The consent holder shall pay to the Council all required administrative charges fixed by the Council pursuant to section 36 in relation to:

   i) the administration, monitoring and supervision of this consent; and
   ii) charges authorised by regulations.

Special conditions

1. The consent holder shall properly and efficiently maintain and operate the oxidation ponds system, with aerobic ponds maintained in an aerobic condition during daylight hours.

2. For 90% of the time between the hours of 1100-1400 the dissolved oxygen level in the aerobic ponds, and in the wastewater immediately prior to discharge, shall be maintained at a level at or exceeding 2 gm^{-3} and that the consent holder shall monitor the dissolved oxygen levels in the aerobic ponds, on a continuous basis, and supply the results to the Chief Executive, Taranaki Regional Council, upon request.

3. The discharge authorised by this consent shall not give rise to any of the following effects in the Tasman Sea beyond a mixing zone of 200 metres from the centre line of the outfall diffuser:

   a) the production of conspicuous oil or grease films, scums or foams or floatable or suspended materials;
   b) any conspicuous change in the colour or visual clarity;
   c) any emission of objectionable odour;
   d) any significant effects on aquatic life.

4. The discharge shall not result in the guideline for shellfish-gathering waters, as specified in the document 'Provisional Microbiological Water Quality Guidelines for Recreational and Shellfish-Gathering Waters in New Zealand' [Department of Health 1992], being exceeded at the shoreline.

5. The consent holder shall monitor the volume of wastewater discharged on a continuous basis and shall supply this information to the Chief Executive, Taranaki Regional Council, upon request.

6. The consent holder shall undertake to advise and consult with the Taranaki Regional Council if trade wastes are accepted into the consent holder's wastewater system, for which it may be appropriate or necessary to place limits on the concentrations in the final discharge of any toxic or hazardous contaminants which may be contained in that trade waste. If such limits are considered necessary, the Chief Executive, Taranaki Regional Council, shall require a review of the consent conditions in accordance with s128 of the Resource Management Act 1991.

7. The consent holder shall manage the discharge so as to ensure compliance with special condition 3.

8. Within three months of the granting of this consent, the consent holder shall provide to the Chief Executive, Taranaki Regional Council, a contingency plan outlining measures and procedures undertaken to prevent spillage or accidental discharge of contaminants in the event of plant, including the wastewater pipeline and pumping system, breakdown or maintenance and measures to avoid, remedy or mitigate the environmental effects of such a spillage or discharge. The consent holder shall annually review and maintain the plan.

9. The consent holder shall supply to the Chief Executive, Taranaki Regional Council, an annual report on its waste treatment system, including the performance of the outfall and compliance with the consent; such report to be provided by 31 August each year.

10. The consent holder shall supply to the Chief Executive, Taranaki Regional Council, a report reviewing the best practicable option for treatment and disposal of wastewater generated at Hawera and Eltham, including the option of disposal to land, such report to be provided by 31 December 2009.

11. The consent holder shall, substantially in accordance with information submitted in support of application 2541, including the Eltham Sewage Disposal Project Schedule:

    a) Reduce stormwater infiltration to the Hawera wastewater system;
    b) Upgrade the Eltham wastewater treatment plant;
    c) Upgrade the Hawera wastewater treatment plant; and
    d) Construct a pipeline for the transfer of municipal sewage waste from Eltham to Hawera.

    Once the above works are complete, the consent holder shall discharge all Eltham wastewater, via the pipeline, to the Hawera wastewater treatment plant. The works shall be completed, and the discharge shall commence, by 31 July 2009.

12. The consent holder shall provide reports on implementation of condition 11 [including progress on the Eltham Sewage Disposal Project Schedule, and detailing changes to the schedule] to the Chief Executive, Taranaki Regional Council, by 31 March, 30 June, 30 September, and 15 December of each year until implementation is complete.

13. The consent holder and staff of the Taranaki Regional Council shall meet as appropriate and at least once per year, with representatives of Ngati Ruanui Iwi Authority, Inuawai/Okahu hapu and Kanihi/Umutahi hapu, other submitters to the consent, and any other interested party, at the discretion of the Chief Executive, Taranaki Regional Council, to discuss any matter relating to the exercise of this resource consent, in order to facilitate ongoing consultation.

14. The consent holder shall ensure that a monitoring programme is established to record and analyse effects of the exercise of this consent on the intertidal reefs and coastal water quality adjacent to the discharge to the satisfaction of the Chief Executive, Taranaki Regional Council.

15. The scope and detail of the monitoring programme established in special condition 14 shall be developed in consultation with submitters to applications 96/302 and 2541 in relation to this consent.

16. The consent holder shall install a screen prior to the influent reaching the southern aerobic oxidation pond for the purpose of preventing the discharge of undisintegrated solids into and from the oxidation pond.

17. In accordance with section 128 and section 129 of the Resource Management Act 1991, the Taranaki Regional Council may serve notice of its intention to review, amend, delete or add to the conditions of this resource consent within six months of receiving a report prepared by the consent holder pursuant to condition 10 of this consent, or by giving notice of review during the month of June 2010, for the purposes of:

    a) dealing with any significant adverse effect on the environment arising from the exercise of the consent which was not foreseen at the time the application was considered or which it was not appropriate to deal with at the time; and/or
    b) requiring the consent holder to adopt the best practicable option for treatment and disposal of wastewater generated in Hawera and Eltham.

    In determining, whether such a review is undertaken, the Regional Council will take into account the views expressed by Ngati Ruanui Tahua Iwi Authority Inc., Inuawai/Okahu Hapu and Kanihi/Umutahi Hapu, and the consent holder.

Signed at Stratford on 29 June 2010

For and on behalf of
Taranaki Regional Council

Director-Resource Management

TARANAKI REGIONAL COUNCIL
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Please quote our file number on all correspondence

Discharge Permit

Pursuant to the Resource Management Act 1991
a resource consent is hereby granted by the
Taranaki Regional Council

Name of Consent Holder:	South Taranaki District Council Private Bag 902 HAWERA 4640
Consent Granted Date:	4 November 2009

Conditions of Consent

Consent Granted:	To discharge, as a consequence of high rainfall, partially treated wastewater from the Hawera Wastewater Treatment Plant into Unnamed Stream 22 at or about (NZTM) 1708616E-5614555N
Expiry Date:	1 June 2027
Review Date(s):	June 2015, June 2017, June 2021
Site Location:	Beach Road, Hawera
Legal Description:	Lot 1 DP 382332 Lot 1 DP 16178 Blk IX Hawera SD
Catchment:	Unnamed Stream 22

For General, Standard and Special conditions pertaining to this consent please see reverse side of this document

General conditions

a) On receipt of a requirement from the Chief Executive, Taranaki Regional Council the consent holder shall, within the time specified in the requirement, supply the information required relating to the exercise of this consent.

b) Unless it is otherwise specified in the conditions of this consent, compliance with any monitoring requirement imposed by this consent must be at the consent holder's own expense.

c) The consent holder shall pay to the Council all required administrative charges fixed by the Council pursuant to section 36 in relation to:

   i) the administration, monitoring and supervision of this consent; and
   ii) charges authorised by regulations.

Special conditions

1. The discharge shall only occur as a consequence of high rainfall events when the inflows to the wastewater treatment plant are such that the holding capacity of the treatment plant is exceeded.

2. The temporary holding pond capacity shall be no less than 55,000 cubic metres.

3. The consent holder shall not undertake any modifications to the treatment plant that may result in an increase in the frequency of the discharge.

4. The consent holder shall record the timing and duration of the overflow to the Unnamed Stream, and report these records to the Chief Executive, Taranaki Regional Council, on request.

5. The consent holder shall at all times adopt the best practicable option, as defined in section 2 of the Resource Management Act 1991, to prevent or minimise any adverse effects on the environment from the exercise of this consent.

6. The consent holder shall phone the Taranaki Regional Council immediately after becoming aware of each discharge authorised by this permit, in order to enable the undertaking monitoring of the discharge in accordance with special condition 8.

7. Within three months of the granting of this consent, the consent holder shall prepare and maintain a contingency plan. The contingency plan shall be adhered to in the event of a discharge and shall, to the satisfaction of the Chief Executive, Taranaki Regional Council, detail measures and procedures to be undertaken to avoid, remedy or mitigate the environmental effects of the discharge.

8. Subject to Section 36 of the Resource Management Act [1991], monitoring, including physicochemical, bacteriological and ecological monitoring of the wastewater treatment system and receiving waters shall be undertaken, as deemed reasonably necessary by the Chief Executive, Taranaki Regional Council, to understand the effects of the discharge.

9. In accordance with section 128 and section 129 of the Resource Management Act 1991, the Taranaki Regional Council may serve notice of its intention to review, amend, delete or add to the conditions of this resource consent by giving notice of review during the month of June 2015 and/or June 2017 and/or June 2021, for the purpose of ensuring that the conditions are adequate to deal with any adverse effects on the environment arising from the exercise of this resource consent, which were either not foreseen at the time the application was considered or which it was not appropriate to deal with at the time.

Signed at Stratford on 4 November 2009

For and on behalf of
Taranaki Regional Council

Director-Resource Management

Appendix II

Reports on marine ecological surveys related to combined outfall November 2012, March 2013, November 2013 and March 2014

Internal Memorandum

To: Science Manager – Hydrology/Biology, Regan Phipps
From: Scientific Officer, Emily Roberts and Technical Officer Abbie Bates
File: #1381872
Date: 1 August 2014

Fonterra Whareroa/Hawera Municipal Combined Outfall – Marine Ecological Survey November/December 2013

Introduction

Consent 1450 allows the discharge of dairy factory wastewater from the Fonterra Whareroa factory via a marine outfall. The consent allowing this discharge was renewed in September 1995, requiring the Company to install a long outfall by 31 August 1997. Prior to the renewal of this consent, the wastewater was discharged via a short marine outfall at approximately mean low water spring (MLWS) level which caused significant adverse effects on marine intertidal ecology to at least 1000m southeast of the outfall.

In February 2001, wastewater from the Hawera Oxidation Ponds was connected to the long outfall by consent 5079, allowing a municipal wastewater discharge of 10,000 m^3/day. By comparison, the Fonterra Whareroa wastewater discharge limit was 26,000 m^3/day. As of 19 September 2006, the permitted volume of wastewater discharge increased to 40,000 m^3/day. The oxidation pond discharge was also increased to 12,000 m^3/day in December 2007.

Special condition 6 of consent 1450 and special condition 3 of consent 5079 requires there to be no significant visual, chemical or ecological impacts outside of a 200m mixing zone or within the intertidal zone. Specifically, consent 5079 requires the consent holder to ensure that a monitoring programme is established to record and analyse the effects on the intertidal reefs and water quality adjacent to the discharge. Accordingly, two intertidal surveys of the intertidal zone were carried out as part of the 2013-2014 monitoring programme for the combined marine outfall. The first survey for the 2013-2014 monitoring period was conducted at four sites between 4 November and 3 December 2013.

Methods

Field Work

Of the four sites surveyed, three have been identified by NIWA as having shoreline contact with the wastewater discharged from the outfall (Palliser *et al.*, 2013): 350m northwest of the outfall (SEA906049), 200m southeast of the outfall (SEA906057) and 1550m southeast of the outfall on Pukeroa Reef (SEA906067) (Photographs 1-3, Figure 1). The control site at Waihi Reef (Photograph 4, Figure 1), approximately 4500m northwest of the outfall (SEA906025), has been identified by NIWA as unlikely to be impacted by the discharged wastewater (Palliser *et al.*, 2013).

Photograph 1 Surveying 350m northwest of the outfall (2013)

Photograph 2 Survey site 200m southeast of the outfall (2013)

Photograph 3 Surveying Pukeroa Reef (2013)

Photograph 4 Survey control site Waihi Reef (2013)

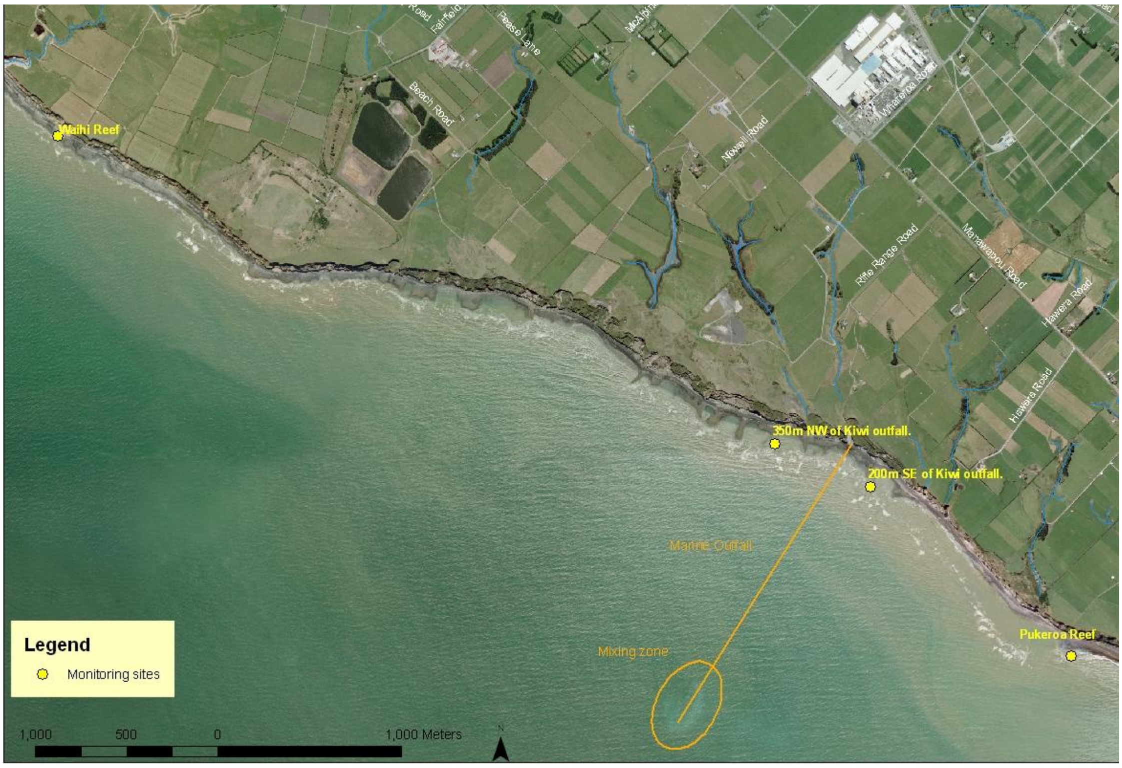


Figure 1 Survey sites in relation to the outfall

At each site, a 50m transect was used to establish five 5m x 3m blocks. Within each block, five random 0.25m² quadrats were laid giving a total of 25 random quadrats (Photograph 5). For each quadrat the percentage cover of algae and encrusting animal species was estimated using a grid. For all other animal species, individuals larger than 3mm were counted. Under boulder biota was counted where rocks and cobbles were easily overturned.

Photograph 5 Survey at 200m southeast of the outfall showing the quadrat and transect used

Results

Summary statistics, including the mean number of species per quadrat and the mean Shannon-Weiner indices, are shown in Table 1. The site 200m SE had the highest number of species, followed by 350m NW, Waihi Reef and Pukeroa Reef respectively. Diversity (Shannon-Weiner index) was highest at the site 200m SE followed by 350m NW, Pukeroa reef and Waihi reef.

Table 1 Mean results for the November/December 2013 survey

Site	No. of quadrats	Mean number of species per quadrat			Mean Shannon-Weiner indices per quadrat		
		Algae	Animals	Total Species	Algae	Animals	Total Species
Waihi Reef	25	3.52	9.16	12.68	0.36	0.86	0.93
350m NW	25	5.52	10.92	16.44	0.54	0.84	0.98
200m SE	25	10.28	8.76	19.04	0.77	0.81	1.05
Pukeroa Reef	25	3.20	8.76	11.96	0.42	0.79	0.93

Number of Species per Quadrat

Figure 2 shows the total number of species per quadrat as a box and whisker plot. The notched area of the box represents the median plus and minus a 95% confidence interval for the median. This form of graphical representation allows a quick comparison to be made between sites. Generally, if the notched areas of the boxes for the different sites do not overlap, one would expect to obtain a significantly different result with ANOVA.

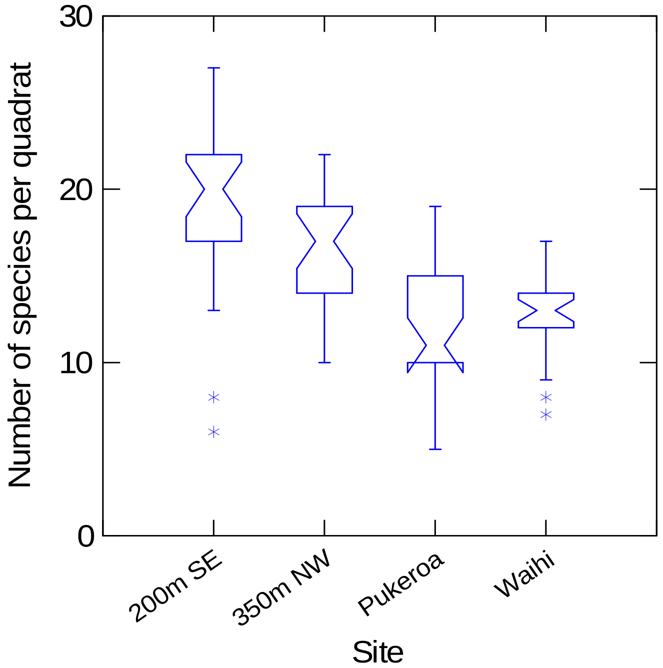


Figure 2 Box and whisker plots of mean number of species per quadrat

Only one site (200m SE) showed a significant deviation from normal distribution at the 95% confidence level (Lilliefors test, n = 25, P <0.001). There was a significant difference in mean number of species per quadrat between the sites (ANOVA, n = 25, F = 18.6, P = <0.001).

Table 2 Tukey's multiple comparison test of number of species per quadrat

Site	Waihi Reef	350m NW	200m SE
350m NW	SIG		
200m SE	SIG	NS	
Pukeroa Reef	NS	SIG	SIG

SIG = Significant difference
NS = No significant difference

Significant differences between sites were determined using Tukey's multiple comparison test (Table 2). At Waihi Reef and Pukeroa Reef the mean number of species per quadrat was significantly lower than that at 350m NW and 200m SE (Tukey's, N = 25, P = <0.05)

Shannon-Weiner Diversity Index

Figure 3 shows the mean Shannon-Weiner index data at each site as a box and whisker plot.

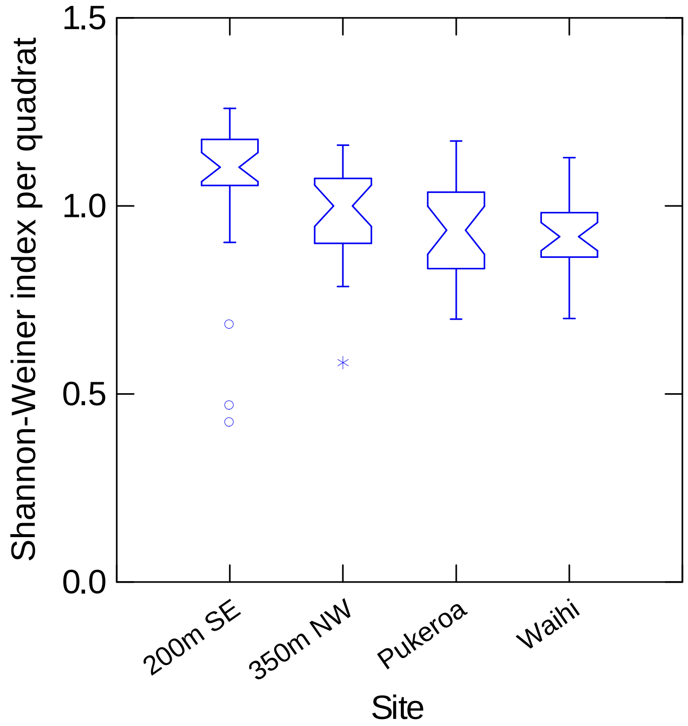


Figure 3 Box and whisker plots of mean Shannon-Weiner indices per quadrat

Only one site (200m SE) showed a significant deviation from normal distribution at the 95% confidence level (Lilliefors test, n = 25, P = < 0.001). There was a significant difference in the mean Shannon-Weiner index per quadrat between sites (ANOVA, n = 25, F = 3.1, P 0.032).

Table 3 Tukey multiple comparison test of Shannon-Weiner index per quadrat

Site	Waihi Reef	350m NW	200m SE
350m NW	NS		
200m SE	SIG	NS	
Pukeroa Reef	NS	NS	NS

SIG = Significant difference
NS = No significant difference

Significant differences between sites were determined using Tukey's multiple comparison test (Table 3). At Waihi Reef the mean Shannon-Weiner index per quadrat was significantly lower than that at 200 m SE (Tukey's, N = 25, P = 0.049)

Sand Coverage

The level of sand cover was low (<6.5%) at all sites (Table 4). Abundance and diversity of intertidal species/communities can be significantly impacted by sand cover of 30% and higher.

Table 4 Mean percentage sand cover per quadrat

Site	Mean coverage per quadrat (%)
Waihi Reef	1.4
350m NW	5.0
200m SE	6.3
Pukeroa Reef	0.9

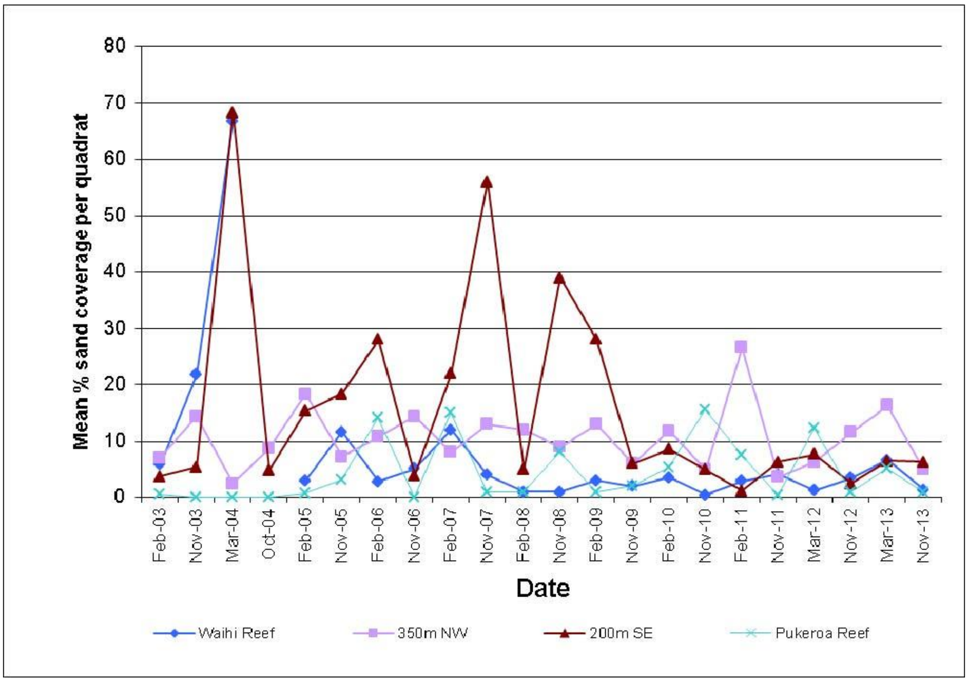


Figure 4 Mean percentage sand cover (summer & spring) by site since February 2003

Trends over time

Species number and diversity

Comparisons of the mean number of species per quadrat (Figure 5) and mean Shannon-Weiner diversity index per quadrat (Figure 6) for all spring surveys undertaken since November 1992 are shown below.

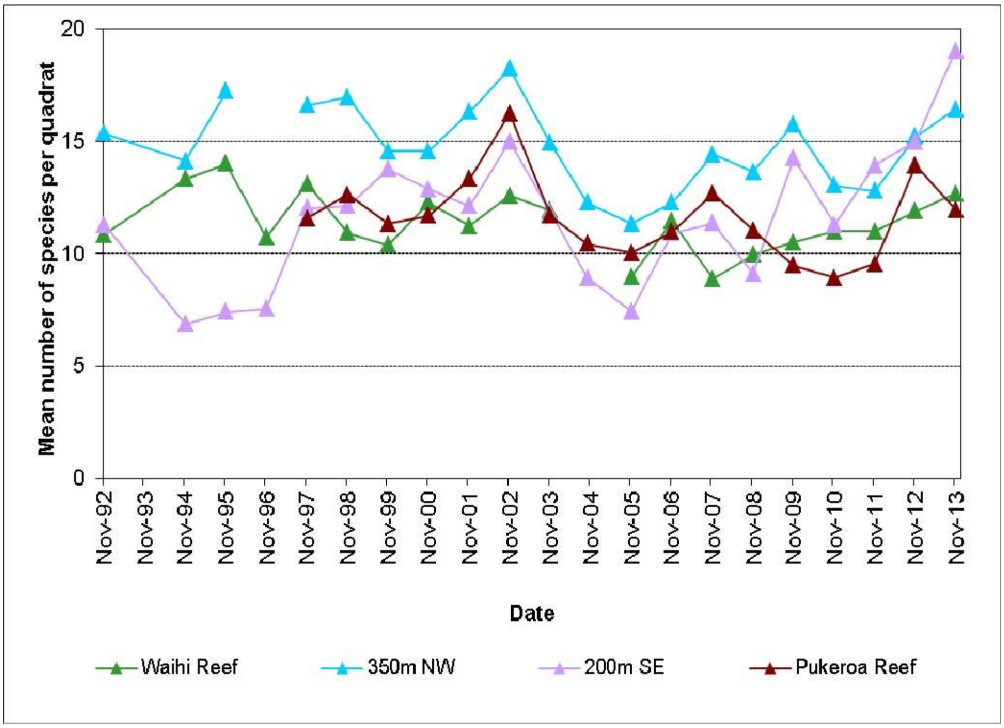


Figure 5 Mean number of species per quadrat for spring surveys 1992-2013

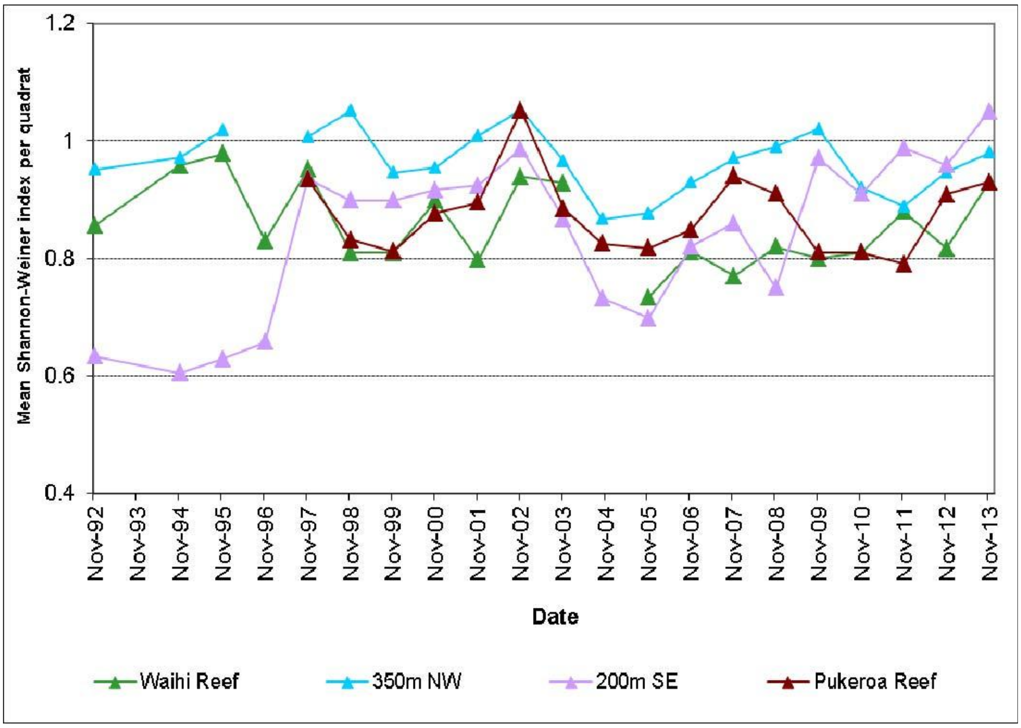


Figure 6 Mean Shannon-Weiner indices per quadrat for spring surveys 1992-2013

Prior to the installation of the long marine outfall in August 1997, there was notably lower species richness and diversity (number of species and Shannon-Weiner Index per quadrat) at the impact site 200m SE relative to the control site at Waihi Reef (Figures 5 and 6). A sharp increase in species diversity occurred at the site 200m SE following installation of the outfall (Figures 5 and 6). Since then (1997), sites have shown interannual variability in both number of species and Shannon-Weiner Index, but there has been no noticeable difference in trends between the impact site and the control sites over this period.

The results of the November 2013 survey show a slight decrease in the number of species at Pukeroa Reef since November 2012, however, at all other sites the survey show the number of species and Shannon-Weiner Index per quadrat increasing (Figures 5 and 6). The results at 200m SE were the highest number of species and Shannon-Weiner to date at this site, partly due to high algae diversity (Table 1).

Discussion

Previous surveys have shown that the dairy factory wastewater discharged through the near-shore outfall prior to 1997 (Photograph 1) was having significant adverse effects on the local intertidal community. The adverse effects recorded included the coating of rocks and tidal pools with fats, significant coverage by filamentous bacterial growths and a significant decrease in ecological diversity. The nature and magnitude of adverse effects varied with distance from the outfall, and were most apparent at the sites 30m and 200m southeast of the outfall (note that the former site is no longer surveyed as of 2007). In 1997 the dairy company installed a long outfall to discharge the wastewater nearly 2km offshore in order to mitigate the adverse effects occurring along the coastline. Numerous spring and summer intertidal surveys have now been undertaken along the Hawera coastline subsequent to installation of the long outfall. Results show a general improvement in the health of intertidal communities following installation of the outfall. In February 2001 the Hawera Oxidation Ponds municipal wastewater was also connected to the long outfall.

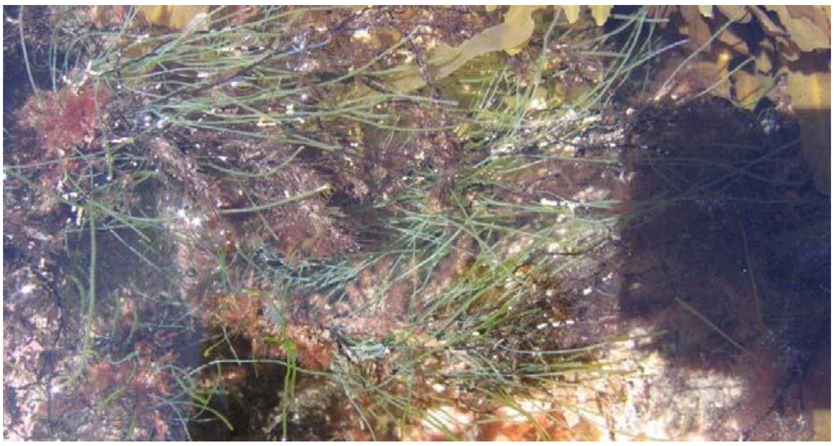
Photograph 6 Discharge from the dairy factory near-shore outfall prior to 1997

Impacts of the marine outfall discharge on the local intertidal communities were not evident from the November 2013 survey results (Figures 2 and 3). The impact sites 350m NW and 200m SE had a significantly higher number of species per quadrat than the control site at Waihi Reef.

Sand cover was low (<6.5%) at all sites during the November 2013 survey. Long term monitoring of intertidal rocky reefs around the Taranaki coastline have shown the abundance and diversity of these communities can be adversely affected when sand levels exceed 30% cover. Although it is not expected that sand cover would have impacted the reef communities monitored during the November 2013 survey, high percentage sand cover (>30%) has previously been recorded at the site 200m SE (Figure 4).

The historical record of survey results (Figures 5 and 6) showed no obvious impact of the marine outfall discharge on the local intertidal communities since installation of the long outfall in 1997. Both control and potential impact sites showed interannual variability and there were no obvious declining trends at the impact sites closest to the outfall relative to the control site. It must be noted that the high energy receiving environment combined with the effects of suspended sediments from nearby rivers/streams and eroding cliffs prevent the development of stable biological communities along the South Taranaki coastline (Clark *et al*., 2012). Such communities could potentially mask any subtle ecological effects from the outfall wastewater discharge. However, in spite of these limitations, the long term record indicates that the intertidal surveys are useful for detecting more noticeable effects from the wastewater, as the impact on intertidal communities prior to installation of the outfall is clearly evident (Figures 5 and 6, Clark *et al*., 2012).

The most notable change in species composition since the commissioning of the long outfall is the decline of *Chaetomorpha* sp. (Photograph 2) and the absence of filamentous bacterial growths at 200m SE (Figures 7 and 8). The adverse effects recorded prior to the long outfall also included the coating of rocks and tidal pools with fats and a significant decrease in ecological diversity. Sand/silt inundation resulting from cliff erosion (Photograph 8) can be an important factor effecting species composition and diversity along the South Taranaki coastline. The coast is in a constant state of erosion with layers of sand and silt often smothering marine life at some sites. Resulting high seawater turbidity can also affect light availability impacting on macroalgae. Observations indicate that freshly fallen boulders from the cliffs provide a poor habitat for intertidal organisms.



Photograph 7 Green filaments of *Chaetamorpha*, an algal genus often associated with high nutrient concentrations (North Taranaki)

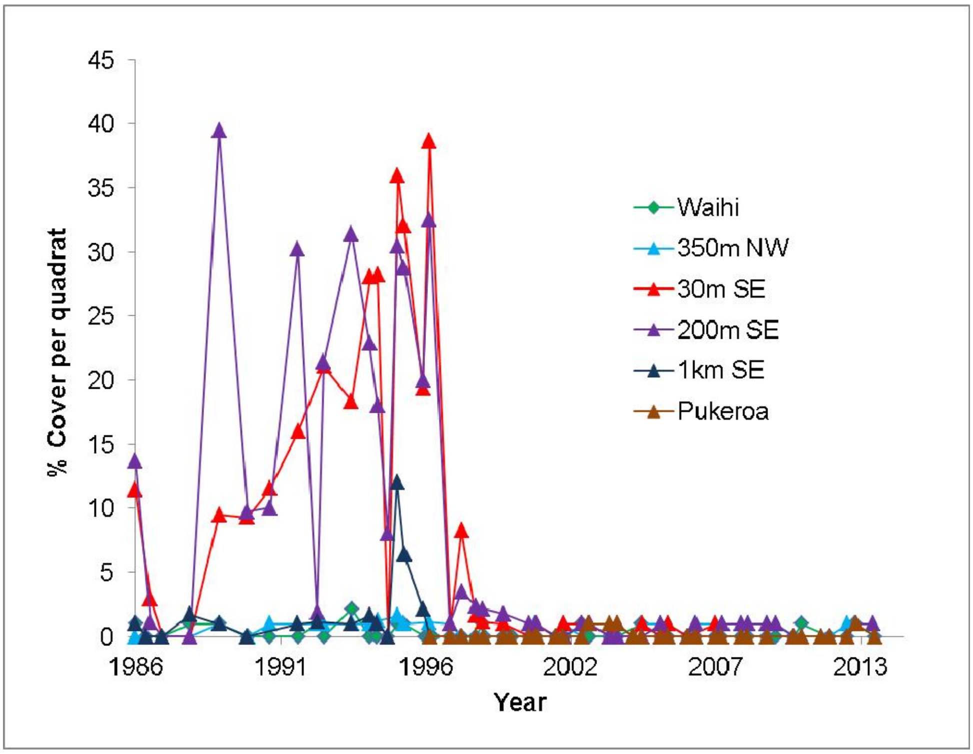


Figure 7 Percentage cover per quadrat of *Chaetamorpha* since 1986

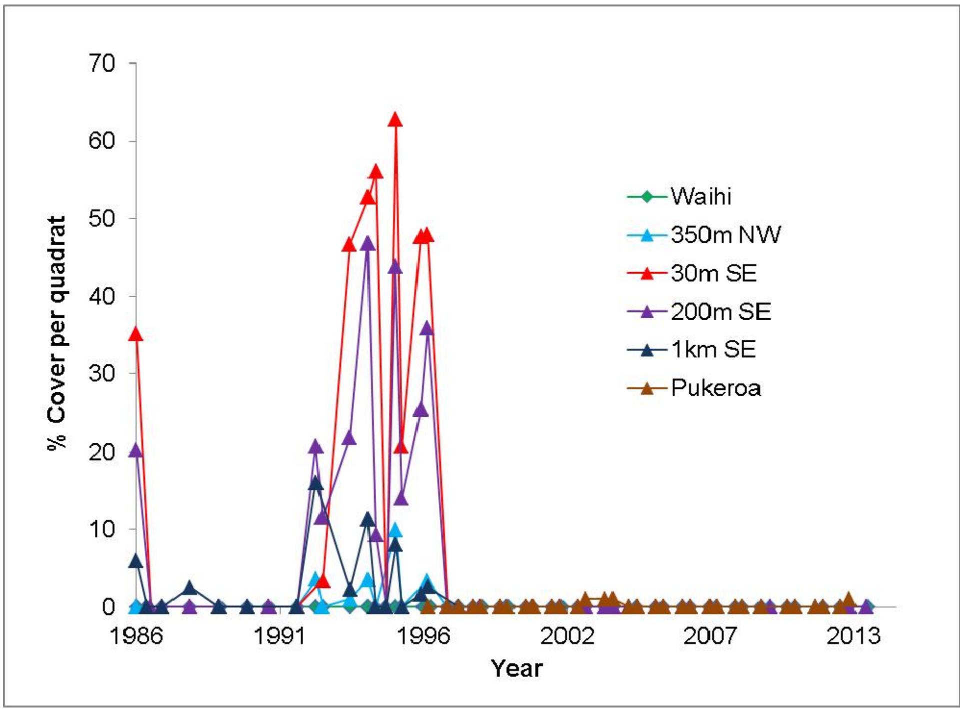


Figure 8 Percentage cover per quadrat of filamentous bacteria since 1986

N.B. Since 2007, the sites 30m SE and 1km SE are no longer monitored as part of the Fonterra Whareroa intertidal survey.

Photograph 8 Erosion of the cliffs close to 350m NW site (2013)

Conclusions

In order to assess the effects of the Fonterra Whareroa and Hawera Waste Water Treatment Plant outfall discharge on the nearby intertidal communities, surveys were conducted between 4 November and 3 December 2013 at four sites. These surveys included three potential impact sites either side of the outfall (two southeast and one west) and one control sites to the northwest. It is expected that adverse effects of the marine outfall discharge on the intertidal communities would have been evident as a significant decline in species richness and diversity at the potential impact sites relative to the control site.

As both species richness and diversity were higher at the two potential impact sites closest to the outfall relative to the control site, and results from sites closest to the outfall had not declined notably in recent years, the results indicate that the marine outfall discharge was not having detectable adverse effects on the intertidal reef communities of South Taranaki. Natural environmental factors, including coastal erosion, exposure and substrate mobility, appeared to be dominant drivers of species richness and diversity at the sites surveyed.

Emily Roberts
Marine Ecologist

Abbie Bates
Technical Officer

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Clark, D., Barter, P., Clement, D., Tremblay, L., Forrest, R. (2013) Whareroa Marine Outfall ecological investigation 2012. Cawthron Report No. 2348

Internal Memorandum

To: Science Manager – Hydrology/Biology, Regan Phipps
From: Scientific Officer, Emily Roberts and Technical Officer Abbie Bates
File: #1383183
Date: 1 August 2014

Fonterra Whareroa/Hawera Municipal Combined Outfall – Marine Ecological Survey March/April 2014

Introduction

Consent 1450 allows the discharge of dairy factory wastewater from the Fonterra Whareroa factory via a marine outfall. The consent allowing this discharge was renewed in September 1995, requiring the Company to install a long outfall by 31 August 1997. Prior to the renewal of this consent, the wastewater was discharged via a short marine outfall at approximately mean low water spring (MLWS) level which caused significant adverse effects on marine intertidal ecology to at least 1000m southeast of the outfall.

In February 2001, wastewater from the Hawera Oxidation Ponds was connected to the long outfall by consent 5079, allowing a municipal wastewater discharge of 10,000 m^3/day. By comparison, the Fonterra Whareroa wastewater discharge limit was 26,000 m^3/day. As of 19 September 2006, the permitted volume of wastewater discharge increased to 40,000 m^3/day. The oxidation pond discharge was also increased to 12,000 m^3/day in December 2007.

Special condition 6 of consent 1450 and special condition 3 of consent 5079 requires there to be no significant visual, chemical or ecological impacts outside of a 200m mixing zone or within the intertidal zone. Specifically, consent 5079 requires the consent holder to ensure that a monitoring programme is established to record and analyse the effects on the intertidal reefs and water quality adjacent to the discharge. Accordingly, two intertidal surveys of the intertidal zone were carried out as part of the 2013-2014 monitoring programme for the combined marine outfall. The second survey for the 2013-2014 monitoring period was conducted at four sites between 30 March and 15 April 2014.

Methods

Field Work

Of the four sites surveyed, three have been identified by NIWA as having shoreline contact with the wastewater discharged from the outfall (Palliser *et al*., 2013): 350m northwest of the outfall (SEA906049), 200m southeast of the outfall (SEA906057) and 1550m southeast of the outfall on Pukeroa Reef (SEA906067) (Photographs 1-3, Figure 1). The control site at Waihi Reef (Photograph 4, Figure 1), approximately 4500m northwest of the outfall (SEA906025), has been identified by NIWA as unlikely to be impacted by the discharged wastewater (Palliser *et al*., 2013).

Photograph 1 Surveying 350m northwest of the outfall (2013)

Photograph 2 Survey site 200m southeast of the outfall (2013)

Photograph 3 Surveying Pukeroa Reef (2013)

Photograph 4 Survey control site Waihi Reef (2013)

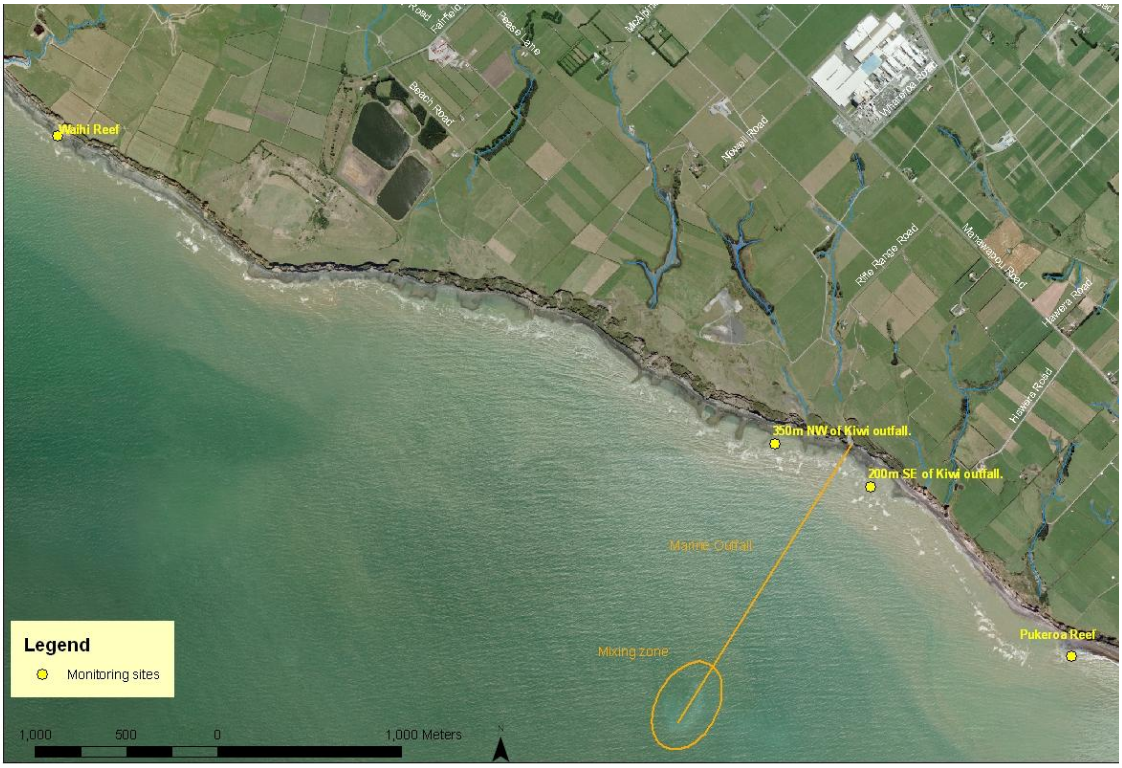


Figure 1 Survey sites in relation to the outfall

At each site, a 50m transect was used to establish five 5m x 3m blocks. Within each block, five random 0.25m² quadrats were laid giving a total of 25 random quadrats (Photograph 5). For each quadrat the percentage cover of algae and encrusting animal species was estimated using a grid. For all other animal species, individuals larger than 3mm were counted. Under boulder biota was counted where rocks and cobbles were easily overturned.

Photograph 5 Survey at 200m southeast of the outfall showing the transect used

Results

Summary statistics, including the mean number of species per quadrat and the mean Shannon-Weiner indices, are shown in Table 1. The site 200m SE had the highest number of species and diversity (Shannon-Weiner index), followed by 350m NW, Pukeroa Reef and Waihi Reef respectively.

Table 1 Mean results for the March/April 2013 survey

Site	No. of quadrats	Mean number of species per quadrat			Mean Shannon-Weiner indices per quadrat		
		Algae	Animals	Total Species	Algae	Animals	Total Species
Waihi Reef	25	3.04	7.84	10.88	0.35	0.68	0.79
350m NW	25	4.92	11.36	16.28	0.62	0.86	1.02
200m SE	25	7.88	9.20	17.08	0.73	0.81	1.07
Pukeroa Reef	25	3.80	9.92	13.72	0.49	0.78	0.92

Number of Species per Quadrat

Figure 2 shows the total number of species per quadrat as a box and whisker plot. The notched area of the box represents the median plus and minus a 95% confidence interval for the median. This form of graphical representation allows a quick comparison to be made between sites. Generally, if the notched areas of the boxes for the different sites do not overlap, one would expect to obtain a significantly different result with ANOVA.

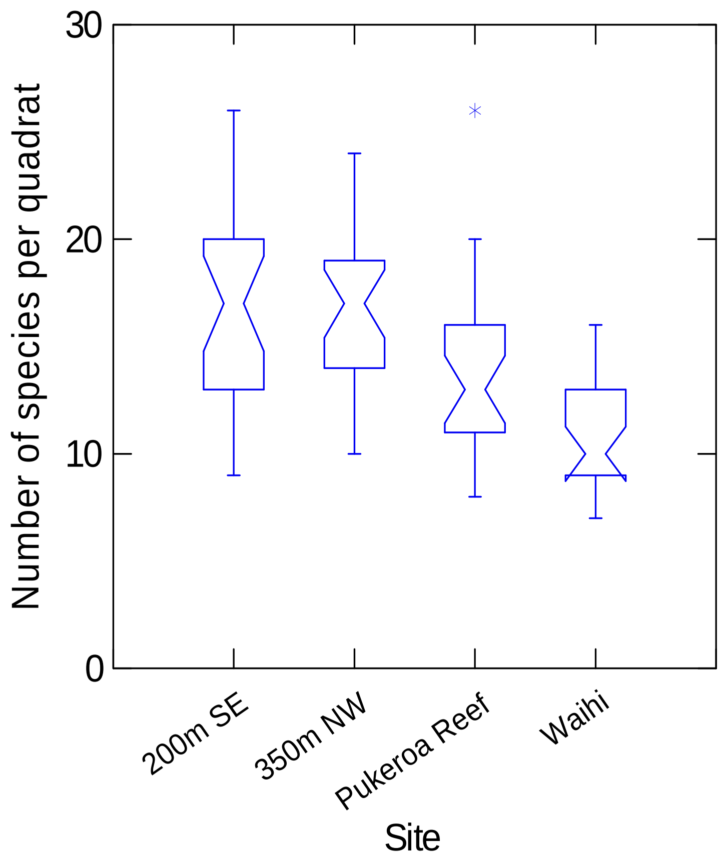


Figure 2 Box and whisker plots of mean number of species per quadrat

At all four sites, there was no significant deviation from normal distribution at the 95% confidence level (Lilliefors test, n = 25, P >0.05). There was a significant difference in mean number of species per quadrat between the sites (ANOVA, n = 25, F = 13.6, P <0.001).

Table 2 Tukey's multiple comparison test of number of species per quadrat

Site	Waihi Reef	350m NW	200m SE
350m NW	SIG		
200m SE	SIG	NS	
Pukeroa Reef	SIG	NS	SIG

SIG = Significant difference
NS = No significant difference

Significant differences between sites were determined using Tukey's multiple comparison test (Table 2). At 200m SE, 350m NW and Pukeroa Reef the mean number of species per quadrat was significantly higher than that at and Waihi Reef. The mean number of species per quadrat was significantly higher at 200m SE than at Pukeroa Reef.

Shannon-Weiner Diversity Index

Figure 3 shows the mean Shannon-Weiner index data at each site as a box and whisker plot.

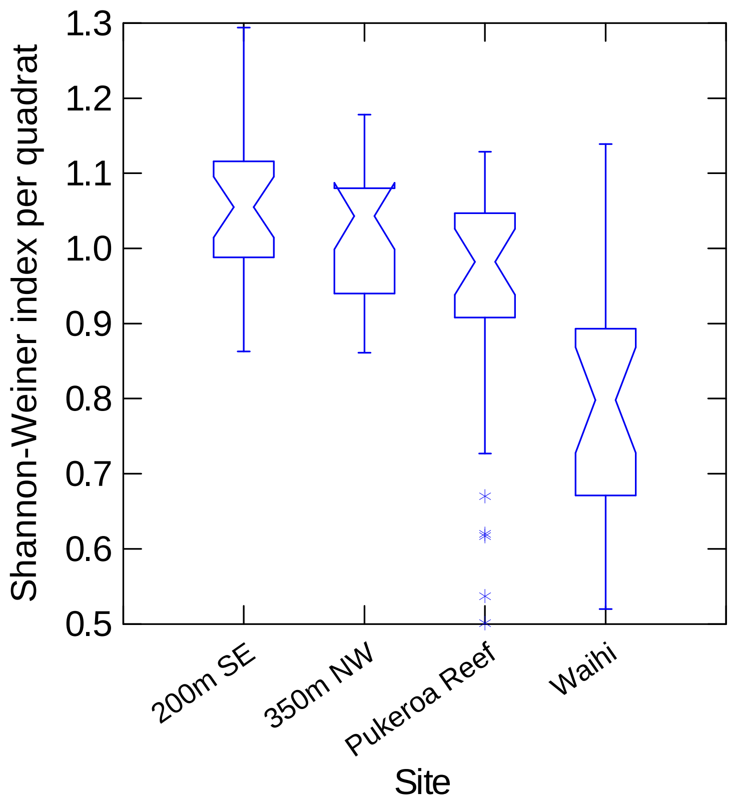


Figure 3 Box and whisker plots of mean Shannon-Weiner indices per quadrat

Only one site (Pukeroa Reef) showed a significant deviation from normal distribution at the 95% confidence level (Lilliefors test, n = 25, P <0.001). There was a significant difference in the mean Shannon-Weiner index per quadrat between sites (ANOVA, n = 25, F = 19.8, P <0.001).

Table 3 Tukey multiple comparison test of Shannon-Weiner index per quadrat

Site	Waihi Reef	350m NW	200m SE
350m NW	SIG		
200m SE	SIG	NS	
Pukeroa Reef	SIG	SIG	SIG

SIG = Significant difference
NS = No significant difference

Significant differences between sites were determined using Tukey's multiple comparison test (Table 3). At 200m SE, 350m NW and Pukeroa Reef the mean Shannon-Weiner index per quadrat was significantly higher than that at and Waihi Reef. The mean Shannon-Weiner index per quadrat was significantly higher at 200m SE and 350m NW than at Pukeroa Reef.

Sand Coverage

The level of sand cover was relatively low (<8.5%) at all sites (Table 4). Abundance and diversity of intertidal species/communities can be significantly impacted by sand cover of 30% and higher.

Table 4 Mean percentage sand cover per quadrat

Site	Mean coverage per quadrat (%)
Waihi Reef	0.9
350m NW	6.4
200m SE	8.3
Pukeroa Reef	1.2

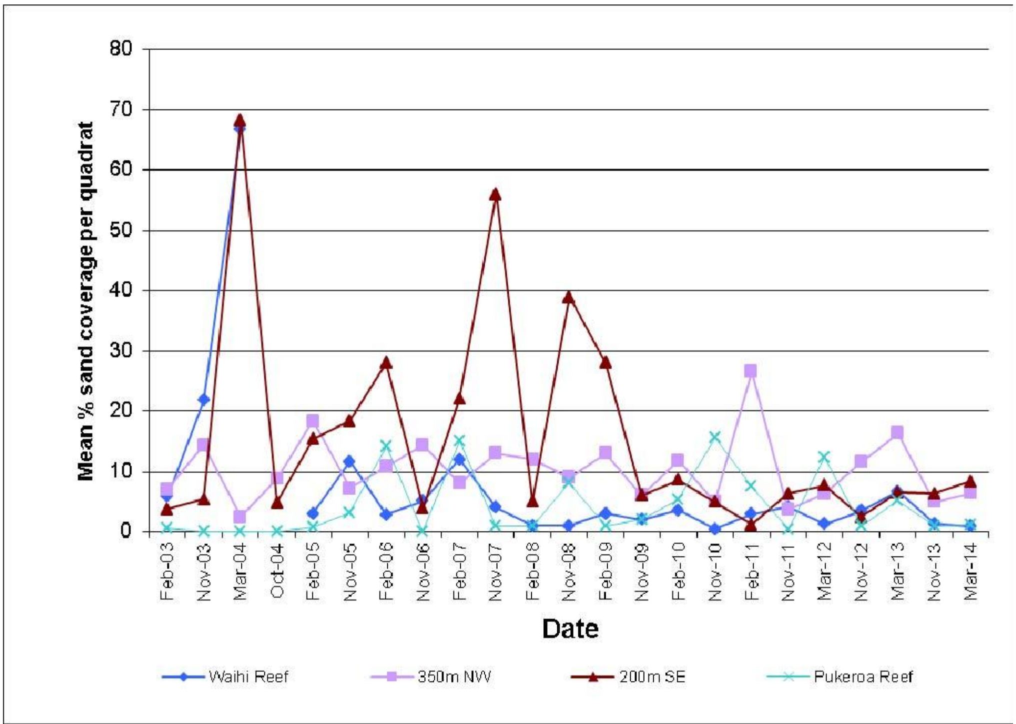


Figure 4 Mean percentage sand cover (summer & spring) by site since February 2003

Trends over time

Species number and diversity

Comparisons of the mean number of species per quadrat (Figure 5) and mean Shannon-Weiner diversity index per quadrat (Figure 6) for all summer surveys undertaken since January 1986 are shown below.

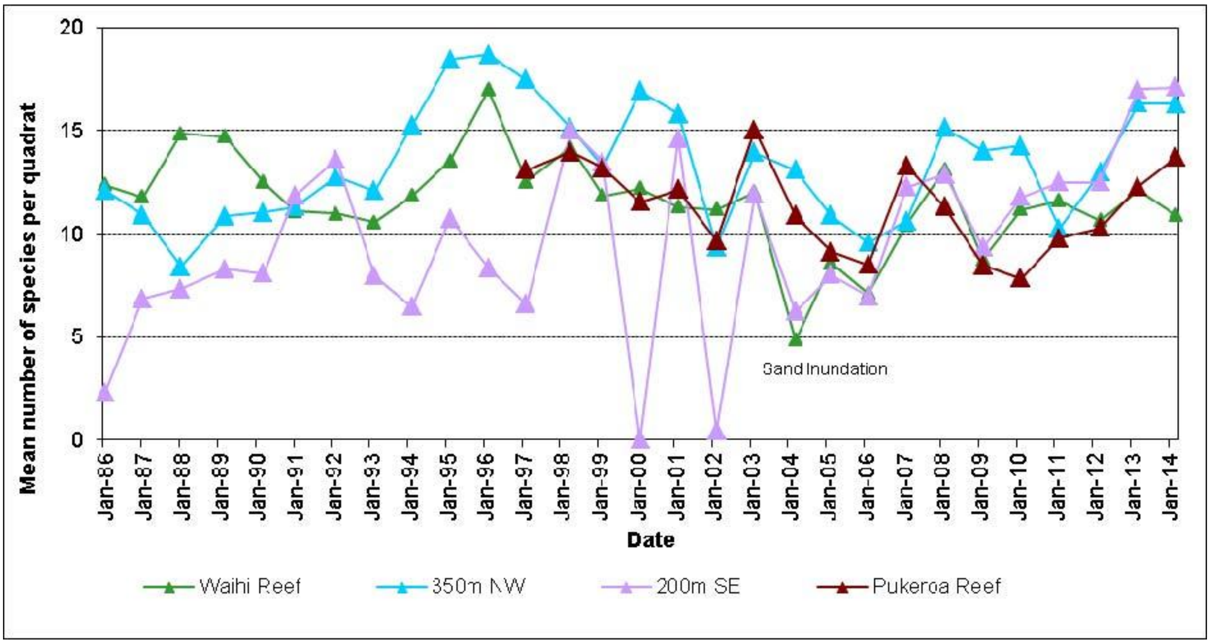


Figure 5 Mean number of species per quadrat for summer surveys 1986-2014

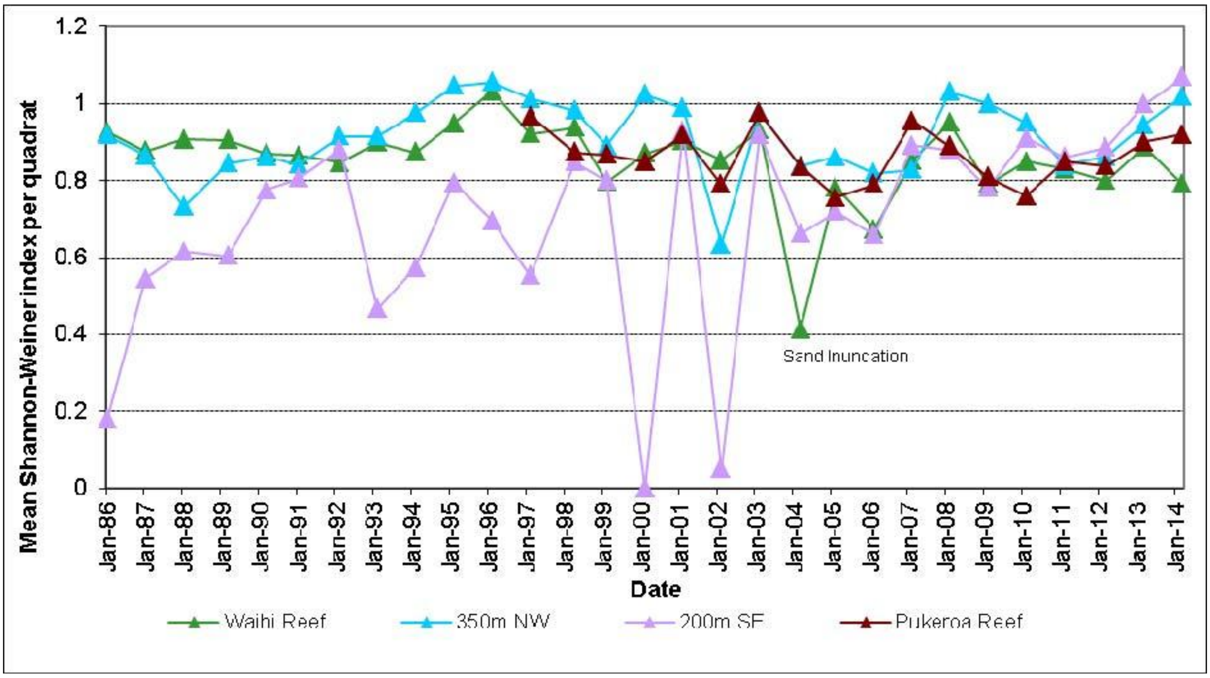


Figure 6 Mean Shannon-Weiner indices per quadrat for summer surveys 1986-2014

Prior to the installation of the long marine outfall in August 1997, both number of species and Shannon-Weiner Index per quadrat at the impact site 200m SE were generally lower than at the control site at Waihi Reef (Figures 5 and 6). Since then (1997), sites have shown interannual variability in both number of species and Shannon-Weiner Index, but there has been no noticeable difference in trends between the impact site and the control sites over this period, with the exception of years with heavy sand inundation (e.g. 2000 and 2002 at 200m SE, Figures 5 and 6).

The results of the March 2014 survey show a slight decrease in the mean number of species per quadrat at Waihi Reef since March 2013, however, at all other sites the survey show the number of species and Shannon-Weiner Index per quadrat increasing (Figures 5 and 6).

Discussion

Previous surveys have shown that the dairy factory wastewater discharged through the near-shore outfall prior to 1997 (Photograph 1) was having significant adverse effects on the local intertidal community. The adverse effects recorded included the coating of rocks and tidal pools with fats, significant coverage by filamentous bacterial growths and a significant decrease in ecological diversity. The nature and magnitude of adverse effects varied with distance from the outfall, and were most apparent at the sites 30m and 200m southeast of the outfall (note that the former site is no longer surveyed as of 2007). In 1997 the dairy company installed a long outfall to discharge the wastewater nearly 2km offshore in order to mitigate the adverse effects occurring along the coastline. Numerous spring and summer intertidal surveys have now been undertaken along the Hawera coastline subsequent to installation of the long outfall. Results show a general improvement in the health of intertidal communities following installation of the outfall. In February 2001 the Hawera Oxidation Ponds municipal wastewater was also connected to the long outfall.

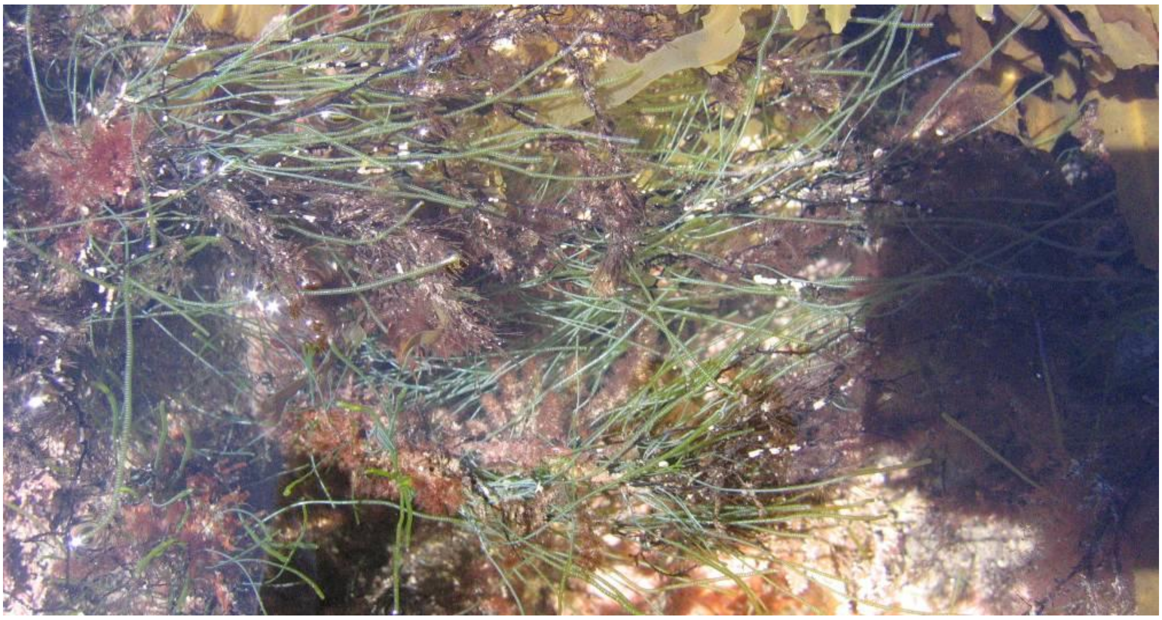
Photograph 6 Discharge from the dairy factory near-shore outfall prior to 1997

Impacts of the marine outfall discharge on the local intertidal communities were not evident from the March 2014 survey results (Figures 2 and 3). The impact sites 350m NW and 200m SE had a significantly higher number of species per quadrat than the control site at Waihi Reef.

Sand cover was low (<8.5%) at all sites during the March 2014 survey. Long term monitoring of intertidal rocky reefs around the Taranaki coastline have shown the abundance and diversity of these communities can be adversely affected when sand levels exceed 30% cover. Although it is not expected that sand cover would have impacted the reef communities monitored during the March 2014 survey, high percentage sand cover (>30%) has previously been recorded at the site 200m SE (Figure 4).

The historical record of survey results (Figures 5 and 6) showed no obvious impact of the marine outfall discharge on the local intertidal communities since installation of the long outfall in 1997. Both control and potential impact sites showed interannual variability and there were no obvious declining trends at the impact sites closest to the outfall relative to the control site. It must be noted that the high energy receiving environment combined with the effects of suspended sediments from nearby rivers/streams and eroding cliffs prevent the development of stable biological communities along the South Taranaki coastline (Clark *et al*., 2012). Such communities could potentially mask any subtle ecological effects from the outfall wastewater discharge. However, in spite of these limitations, the long term record indicates that the intertidal surveys are useful for detecting more noticeable effects from the wastewater, as the impact on intertidal communities prior to installation of the outfall is clearly evident (Figures 5 and 6, Clark *et al*., 2012).

The most notable change in species composition since the commissioning of the long outfall is the decline of *Chaetomorpha* sp. (Photograph 2) and the absence of filamentous bacterial growths at 200m SE (Figures 7 and 8). The adverse effects recorded prior to the long outfall also included the coating of rocks and tidal pools with fats and a significant decrease in ecological diversity. Sand/silt inundation resulting from cliff erosion (Photograph 8) can be an important factor effecting species composition and diversity along the South Taranaki coastline. The coast is in a constant state of erosion with layers of sand and silt often smothering marine life at some sites. Resulting high seawater turbidity can also affect light availability impacting on macroalgae. Observations indicate that freshly fallen boulders from the cliffs provide a poor habitat for intertidal organisms.



Photograph 7 Green filaments of *Chaetamorpha*, an algal genus often associated with high nutrient concentrations (North Taranaki)

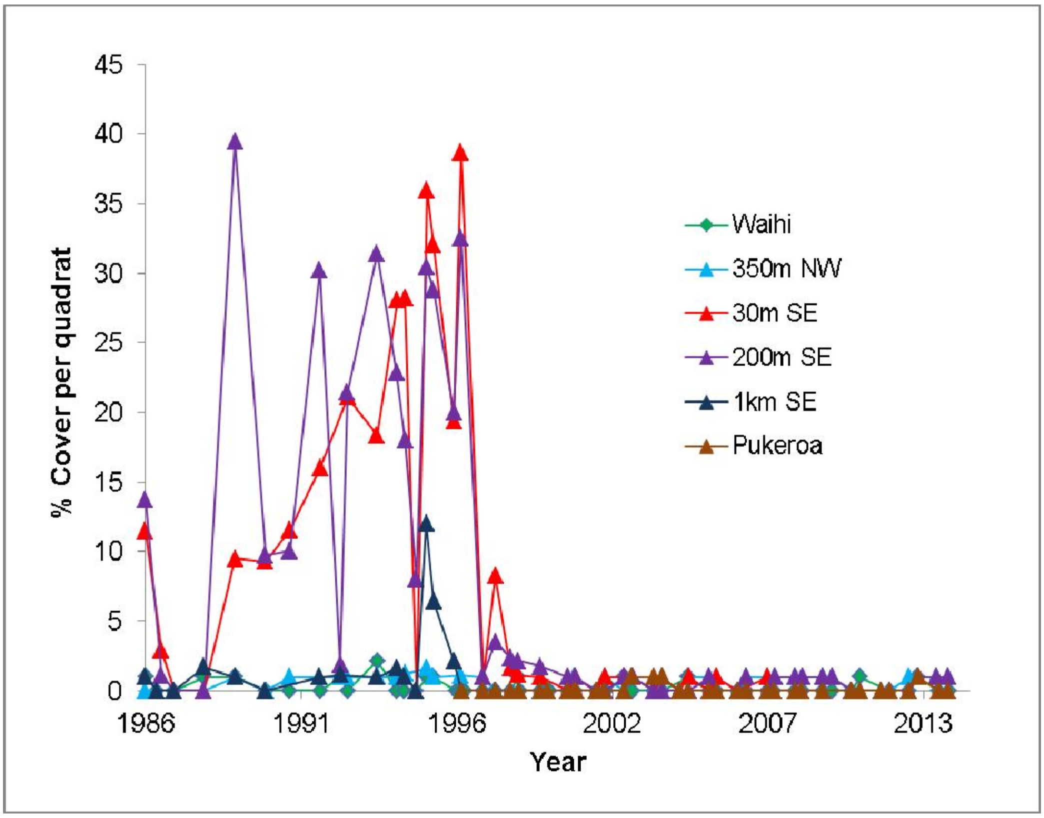


Figure 7 Percentage cover per quadrat of *Chaetamorpha* since 1986

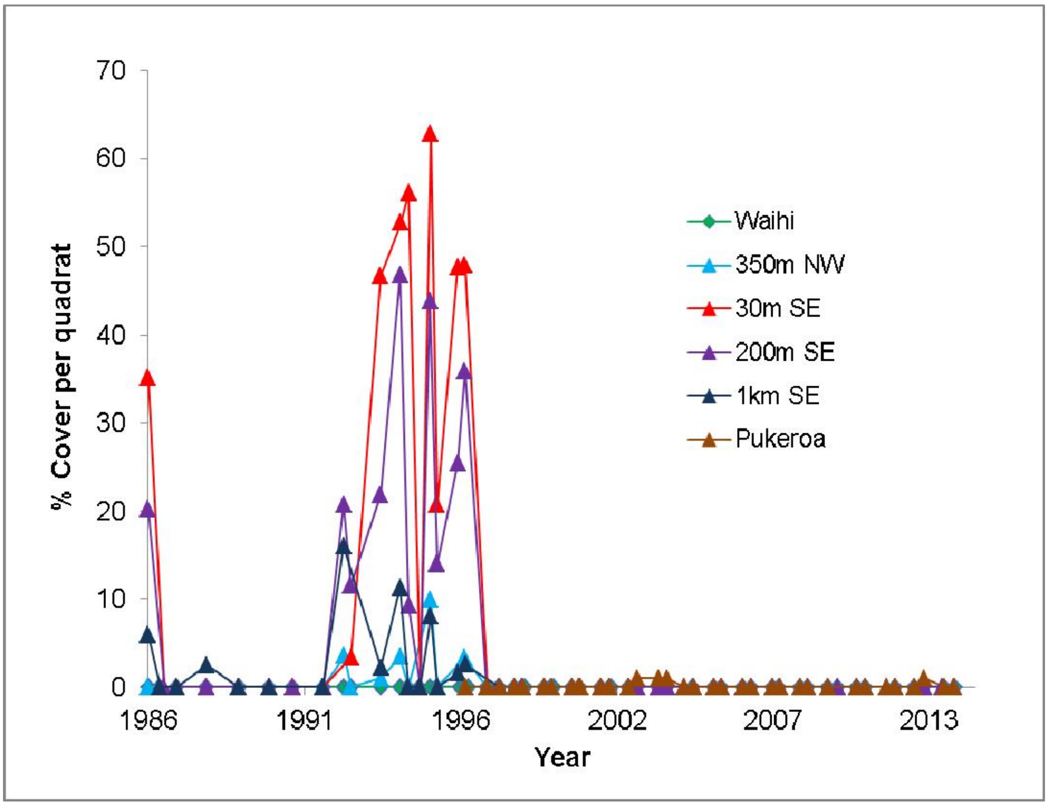


Figure 8 Percentage cover per quadrat of filamentous bacteria since 1986

N.B. Since 2007, the sites 30m SE and 1km SE are no longer monitored as part of the Fonterra Whareroa intertidal survey.

Photograph 8 Erosion of the cliffs close to 350m NW site (2013)

Conclusions

In order to assess the effects of the Fonterra Whareroa and Hawera Waste Water Treatment Plant outfall discharge on the nearby intertidal communities, surveys were conducted between 30 March and 15 April 2014 at four sites. These surveys included three potential impact sites either side of the outfall (two southeast and one west) and one control sites to the northwest. It is expected that adverse effects of the marine outfall discharge on the intertidal communities would have been evident as a significant decline in species richness and diversity at the potential impact sites relative to the control site.

As both species richness and diversity were higher at the two potential impact sites closest to the outfall relative to the control site, and results from sites closest to the outfall had not declined notably in recent years, the results indicate that the marine outfall discharge was not having detectable adverse effects on the intertidal reef communities of South Taranaki. Natural environmental factors, including coastal erosion, exposure and substrate mobility, appeared to be dominant drivers of species richness and diversity at the sites surveyed.

Emily Roberts
Scientific Officer - Marine Ecologist

References

Palliser, C., McBride, G., Goodhune, N., Bell, R., Stott, R. (2013) Fonterra Whareroa Dairy Factory and Hawera WWTP, Stage 2 QMRA based on the combines discharge. NIWA Client Report No. HAM2013-050

Clark, D., Barter, P., Clement, D., Tremblay, L., Forrest, R. (2013) Whareroa Marine Outfall ecological investigation 2012. Cawthron Report No. 2348

Internal Memorandum

To: Scientific Officer, James Kitto
Environmental Monitoring Manager, Keith Brodie
From: Scientific Officer, Emily Roberts
File: #124022
Date: 4 September 2013

Fonterra Whareroa/Hawera Municipal Combined Outfall – Marine Ecological Survey November 2012

Introduction

Consent 1450 allows the discharge of dairy factory wastewater from the Fonterra Whareroa factory via a marine outfall. The consent allowing this discharge was renewed in September 1995, requiring the Company to install a long outfall by 31 August 1997. Prior to the renewal of this consent, the wastewater was discharged via a short marine outfall at approximately mean low water spring (MLWS) level which caused significant adverse effects on marine intertidal ecology to at least 1000m southeast of the outfall.

In February 2001, wastewater from the Hawera Oxidation Ponds was connected to the long outfall by consent 5079, allowing a municipal wastewater discharge of 10,000 m^3/day. By comparison, the Fonterra Whareroa wastewater discharge limit was 26,000 m^3/day. As of 19 September 2006, the permitted volume of wastewater discharge increased to 40,000 m^3/day. The oxidation pond discharge was also increased to 12,000 m^3/day in December 2007.

Special condition 6 of consent 1450 and special condition 3 of consent 5079 requires there to be no significant visual, chemical or ecological impacts outside of a 200m mixing zone or within the intertidal zone. Specifically, consent 5079 requires the consent holder to ensure that a monitoring programme is established to record and analyse the effects on the intertidal reefs and water quality adjacent to the discharge. Accordingly, two intertidal surveys of the intertidal zone were carried out as part of the 2012-2013 monitoring programme for the combined marine outfall. The first survey for the 2012-2013 monitoring period was conducted at four sites between 12 and 15 November 2012.

Methods

Field Work

Of the four sites surveyed, three have been identified by NIWA as having shoreline contact with the wastewater discharged from the outfall (Palliser *et al.*, 2013): 350m northwest of the outfall (SEA906049), 200m southeast of the outfall (SEA906057) and 1550m southeast of the outfall on Pukeroa Reef (SEA906067) (Photographs 1-3, Figure 1). The control site at Waihi Reef (Photograph 4, Figure 1), approximately 4500m northwest of the outfall (SEA906025), has been identified by NIWA as unlikely to be impacted by the discharged wastewater (Palliser *et al.*, 2013).

Photograph 1 Surveying 350m northwest of the outfall with Mere Brooks and Phoebe Paraha

Photograph 2 Survey site 200m southeast of the outfall

Photograph 3 Surveying Pukeroa Reef with Will and Maakere Edwards

Photograph 4 Survey control site Waihi Reef

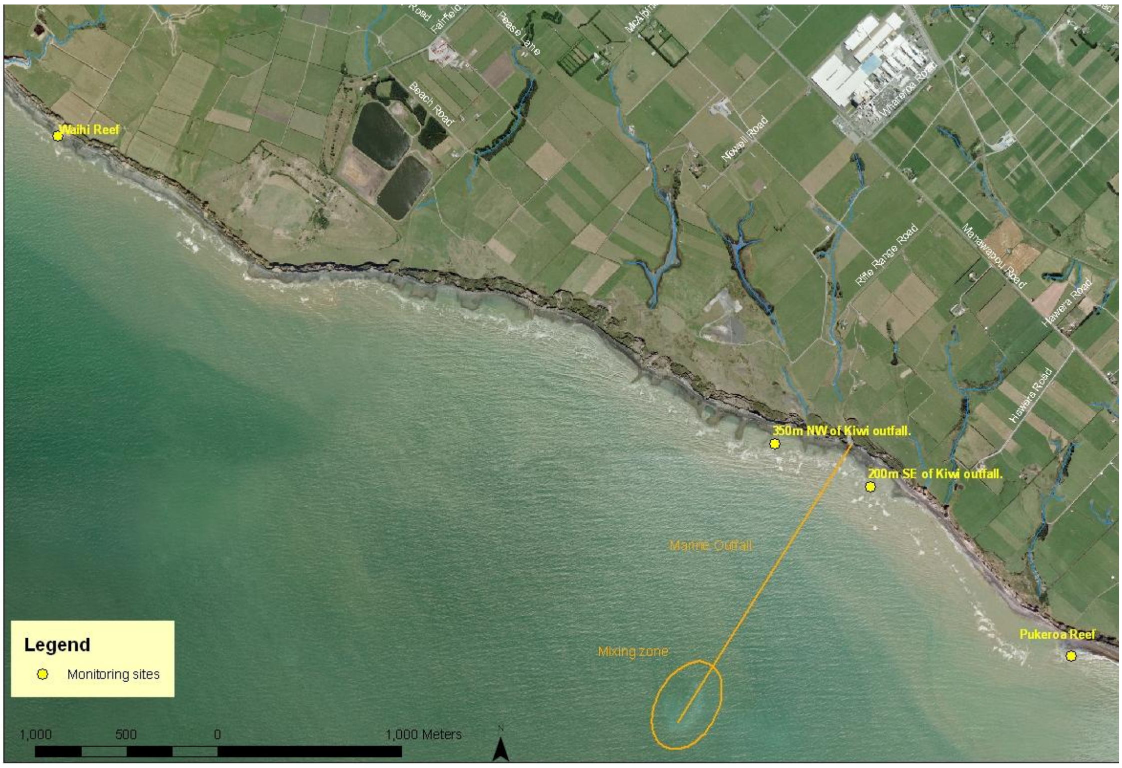


Figure 1 Survey sites in relation to the outfall

At each site, a 50m transect was used to establish five 5m x 3m blocks. Within each block, five random 0.25m² quadrats were laid giving a total of 25 random quadrats (Photograph 5). For each quadrat the percentage cover of algae and encrusting animal species was estimated using a grid. For all other animal species, individuals larger than 3mm were counted. Under boulder biota was counted where rocks and cobbles were easily overturned.

Photograph 5 Survey at 200m southeast of the outfall showing the quadrat and transect used

Results

Summary statistics, including the mean number of species per quadrat and the mean Shannon-Weiner indices, are shown in Table 1. The site 350m NW had the highest number of species, followed by 200m SE, Pukeroa Reef and Waihi Reef respectively. Diversity (Shannon-Weiner index) was highest at the site 200m SE followed by 350m NW, Pukeroa reef and Waihi reef respectively.

Table 1 Mean results for the November 2012 survey

Site	No. of quadrats	Mean number of species per quadrat			Mean Shannon-Weiner indices per quadrat		
		Algae	Animals	Total Species	Algae	Animals	Total Species
Waihi Reef	25	2.92	8.96	11.88	0.32	0.72	0.82
350m NW	25	4.64	10.56	15.20	0.50	0.84	0.95
200m SE	25	7.44	7.56	15.00	0.67	0.73	0.96
Pukeroa Reef	25	4.04	9.88	13.9	0.52	0.77	0.91

Number of Species per Quadrat

Figure 2 shows the total number of species per quadrat as a box and whisker plot. The notched area of the box represents the median plus and minus a 95% confidence interval for the median. This form of graphical representation allows a quick comparison to be made between sites. Generally, if the notched areas of the boxes for the different sites do not overlap, one would expect to obtain a significantly different result with ANOVA.

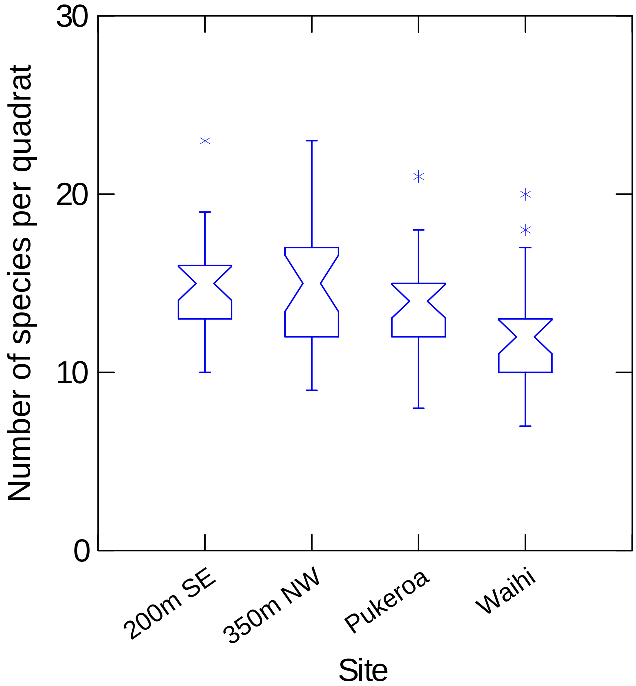


Figure 2 Box and whisker plots of mean number of species per quadrat

Only one site (200m SE) showed a significant deviation from normal distribution at the 95% confidence level (Lilliefors test, n = 25, P = 0.036). There was a significant difference in mean number of species per quadrat between the sites (ANOVA, n = 25, F = 5.93, P = 0.001).

Table 2 Tukey's multiple comparison test of number of species per quadrat

Site	Waihi Reef	350m NW	200m SE
350m NW	SIG		
200m SE	SIG	NS	
Pukeroa Reef	NS	NS	NS

SIG = Significant difference
NS = No significant difference

Significant differences between sites were determined using Tukey's multiple comparison test (Table 2). At Waihi Reef the mean number of species per quadrat was significantly lower than that at 350m NW and 200m SE.

Shannon-Weiner Diversity Index

Figure 3 shows the mean Shannon-Weiner index data at each site as a box and whisker plot.

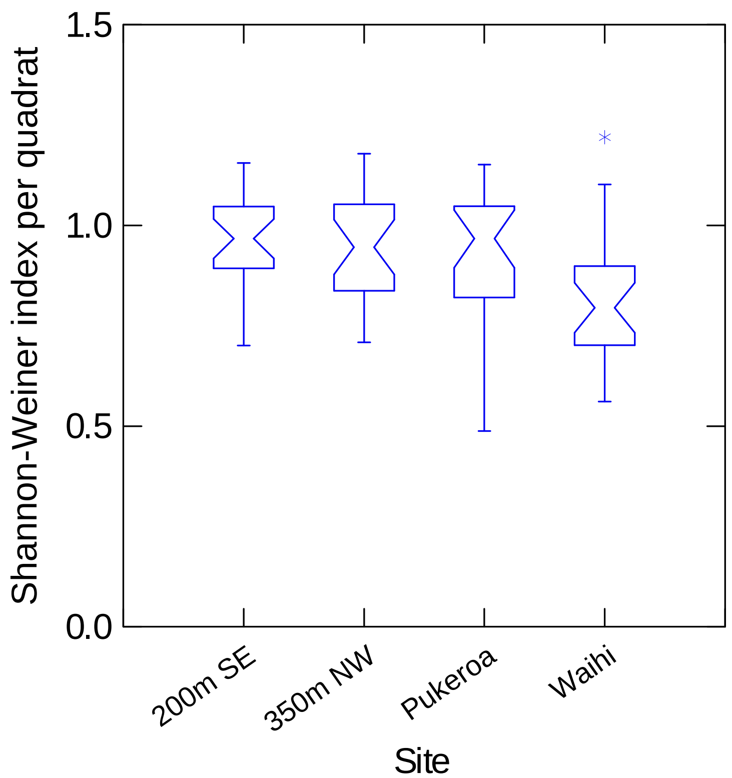


Figure 3 Box and whisker plots of mean Shannon-Weiner indices per quadrat

Only one of the sites (Pukeroa) showed a significant deviation from normal distribution at the 95% confidence level (Lilliefors test, n = 25, P = 0.009). There was a significant difference in the mean Shannon-Weiner index per quadrat between sites (ANOVA, n = 25, F = 4.501, P 0.005).

Table 3 Tukey multiple comparison test of Shannon-Weiner index per quadrat

Site	Waihi Reef	350m NW	200m SE
350m NW	SIG		
200m SE	SIG	NS	
Pukeroa Reef	NS	NS	NS

SIG = Significant difference
NS = No significant difference

Significant differences between sites were determined using Tukey's multiple comparison test (Table 3). At Waihi Reef the mean Shannon-Weiner index per quadrat was significantly lower than that at 200 m SE and 350m NW.

Sand Coverage

The level of sand cover was low (<12%) at all sites (Table 4). Abundance and diversity of intertidal species/communities can be significantly impacted by sand cover of 30% and higher.

Table 4 Mean percentage sand cover per quadrat

Site	Mean coverage per quadrat (%)
Waihi Reef	3.4
350m NW	11.5
200m SE	2.4
Pukeroa Reef	1.0

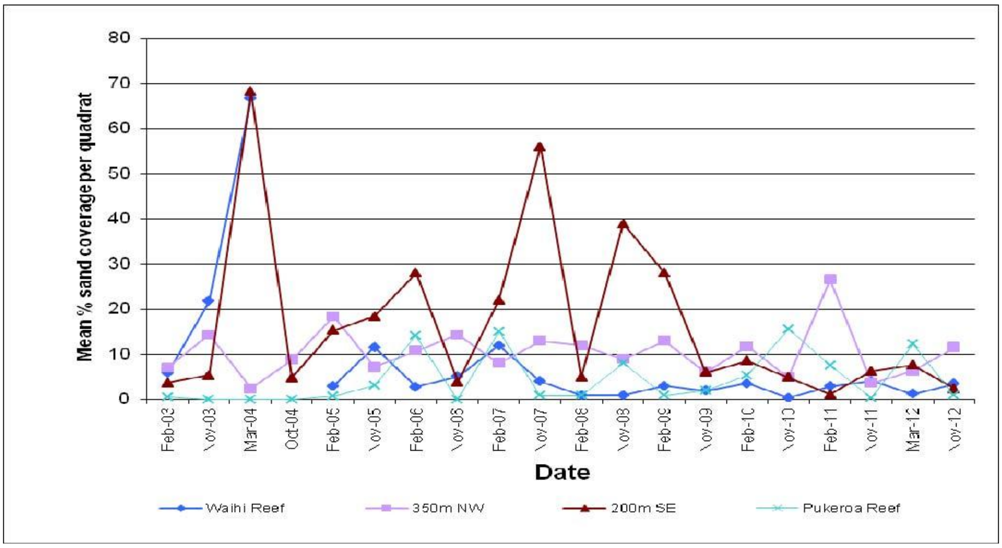


Figure 4 Mean percentage sand cover (summer & spring) by site since February 2003

Trends over time

Species number and diversity

Comparisons of the mean number of species per quadrat (Figure 5) and mean Shannon-Weiner diversity index per quadrat (Figure 6) for all spring surveys undertaken since November 1992 are shown below.

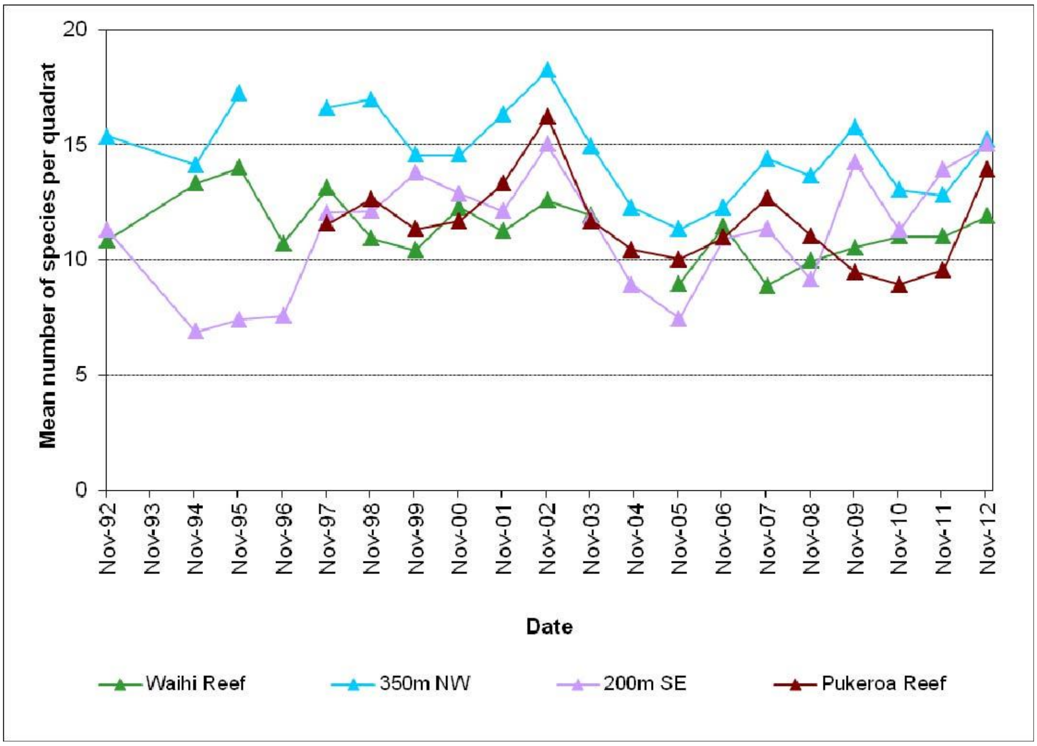


Figure 5 Mean number of species per quadrat for spring surveys 1992-2012

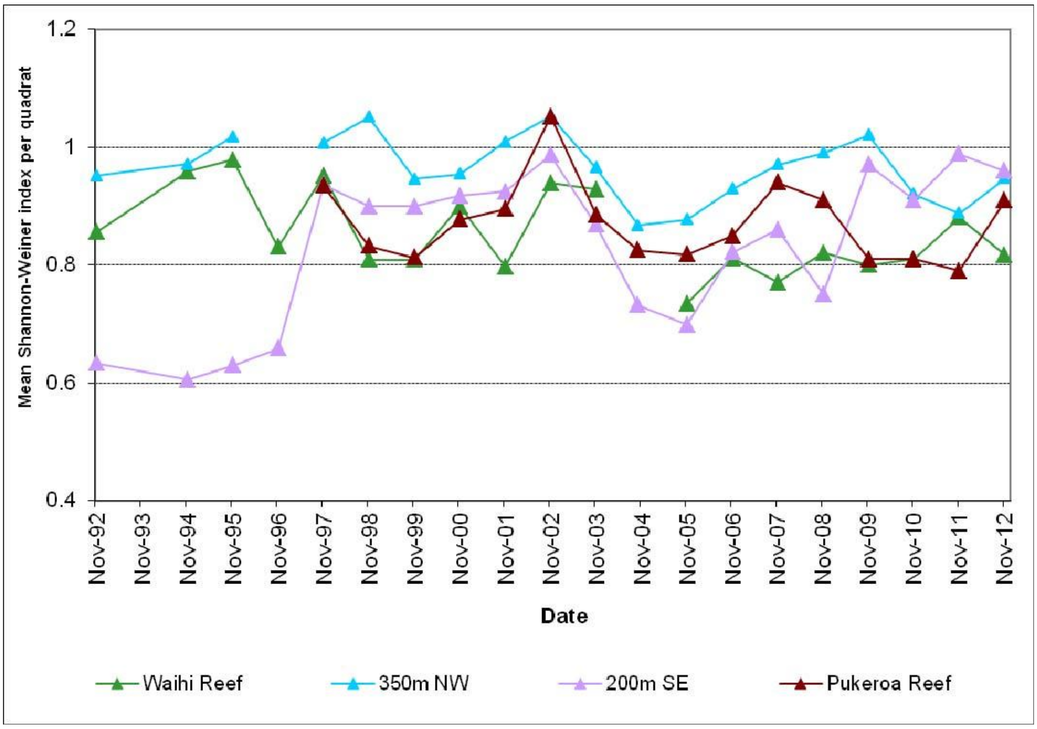


Figure 6 Mean Shannon-Weiner indices per quadrat for spring surveys 1992-2012

Prior to the installation of the long marine outfall in August 1997, there was notably lower species richness and diversity (number of species and Shannon-Weiner Index per quadrat) at the impact site 200m SE relative to the control site at Waihi Reef (Figures 5 and 6). A sharp increase in species diversity occurred at the site 200m SE following installation of the outfall (Figures 5 and 6). Since then (1997), sites have shown interannual variability in both number of species and Shannon-Weiner Index, but there has been no noticeable difference in trends between the impact site and the control sites over this period.

In previous survey reports, concern had been expressed regarding the general decline in both number of species and Shannon-Weiner Index per quadrat for the site at Pukeroa Reef since 2007 (Figures 5 and 6). The results of the November 2012 survey show a change in this trend, with number of species and Shannon-Weiner Index per quadrat increasing at all three impact sites, including Pukeroa Reef (Figures 5 and 6).

Discussion

Previous surveys have shown that the dairy factory wastewater discharged through the near-shore outfall prior to 1997 (Photograph 1) was having significant adverse effects on the local intertidal community. The adverse effects recorded included the coating of rocks and tidal pools with fats, significant coverage by filamentous bacterial growths and a significant decrease in ecological diversity. The nature and magnitude of adverse effects varied with distance from the outfall, and were most apparent at the sites 30m and 200m southeast of the outfall (note that the former site is no longer surveyed as of 2007). In 1997 the dairy company installed a long outfall to discharge the wastewater nearly 2km offshore in order to mitigate the adverse effects occurring along the coastline. Numerous spring and summer intertidal surveys have now been undertaken along the Hawera coastline subsequent to installation of the long outfall. Results show a general improvement in the health of intertidal communities following installation of the outfall. In February 2001 the Hawera Oxidation Ponds municipal wastewater was also connected to the long outfall.

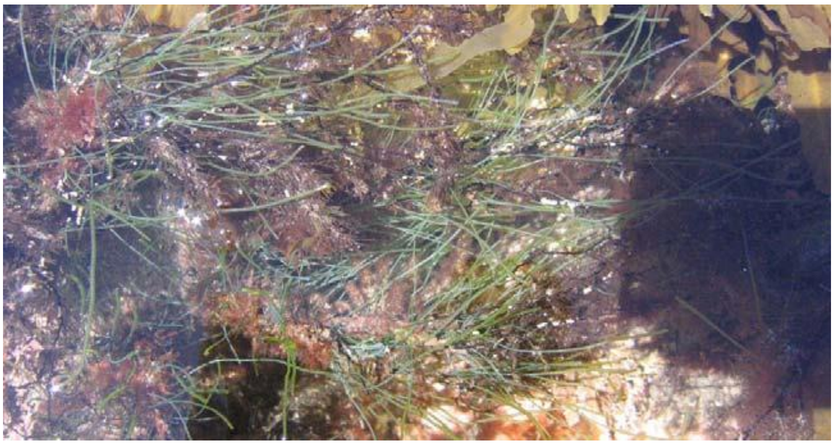
Photograph 6 Discharge from the dairy factory near-shore outfall prior to 1997

Impacts of the marine outfall discharge on the local intertidal communities were not evident from the November 2012 survey results (Figures 2 and 3). The impact sites 350m NW and 200m SE had a significantly higher number of species per quadrat than the control site at Waihi Reef.

Sand cover was low (<12%) at all sites during the November 2012 survey. Long term monitoring of intertidal rocky reefs around the Taranaki coastline have shown the abundance and diversity of these communities can be adversely affected when sand levels exceed 30% cover. Although it is not expected that sand cover would have impacted the reef communities monitored during the November 2012 survey, high percentage sand cover (>30%) has previously been recorded at the site 200m SE (Figure 4).

The historical record of survey results (Figures 5 and 6) showed no obvious impact of the marine outfall discharge on the local intertidal communities since installation of the long outfall in 1997. Both control and potential impact sites showed interannual variability and there were no obvious declining trends at the impact sites closest to the outfall relative to the control site. It must be noted that the high energy receiving environment combined with the effects of suspended sediments from nearby rivers/streams and eroding cliffs prevent the development of stable biological communities along the South Taranaki coastline (Clark *et al*., 2012). Such communities could potentially mask any subtle ecological effects from the outfall wastewater discharge. However, in spite of these limitations, the long term record indicates that the intertidal surveys are useful for detecting more noticeable effects from the wastewater, as the impact on intertidal communities prior to installation of the outfall is clearly evident (Figures 5 and 6, Clark *et al*., 2012).

The most notable change in species composition since the commissioning of the long outfall is the decline of *Chaetomorpha* sp. (Photograph 2) and the absence of filamentous bacterial growths at 200m SE (Figures 7 and 8). The adverse effects recorded prior to the long outfall also included the coating of rocks and tidal pools with fats and a significant decrease in ecological diversity. Sand/silt inundation resulting from cliff erosion (Photograph 8) can be an important factor effecting species composition and diversity along the South Taranaki coastline. The coast is in a constant state of erosion with layers of sand and silt often smothering marine life at some sites. Resulting high seawater turbidity can also affect light availability impacting on macroalgae. Observations indicate that freshly fallen boulders from the cliffs provide a poor habitat for intertidal organisms.



Photograph 7 Green filaments of *Chaetamorpha*, an algal genus often associated with high nutrient concentrations (North Taranaki)

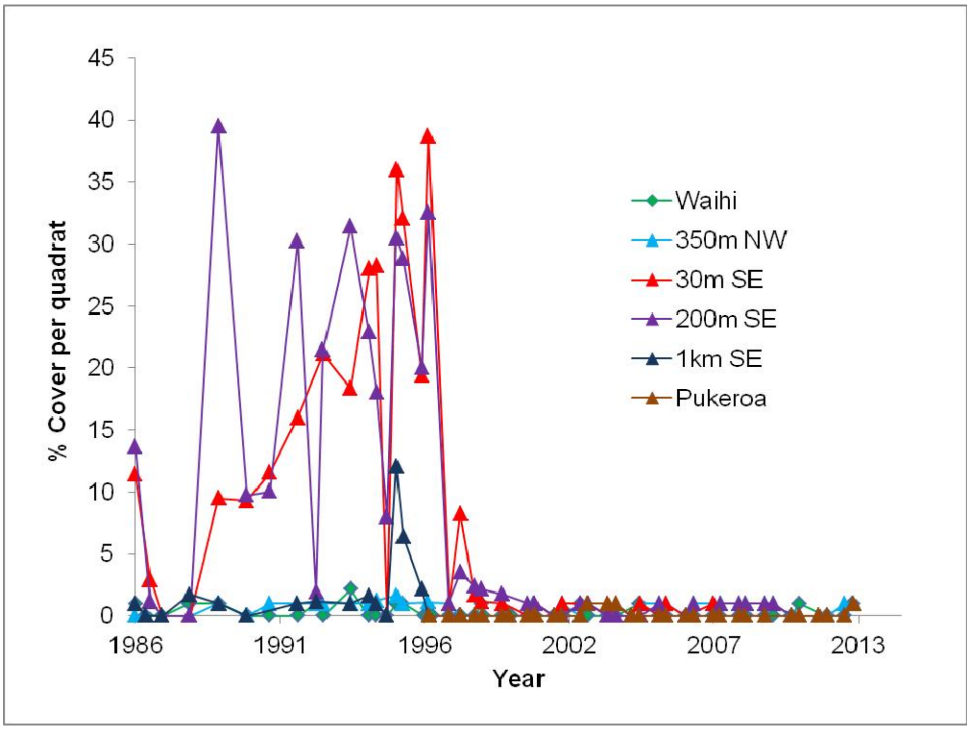


Figure 7 Percentage cover per quadrat of *Chaetamorpha* since 1986

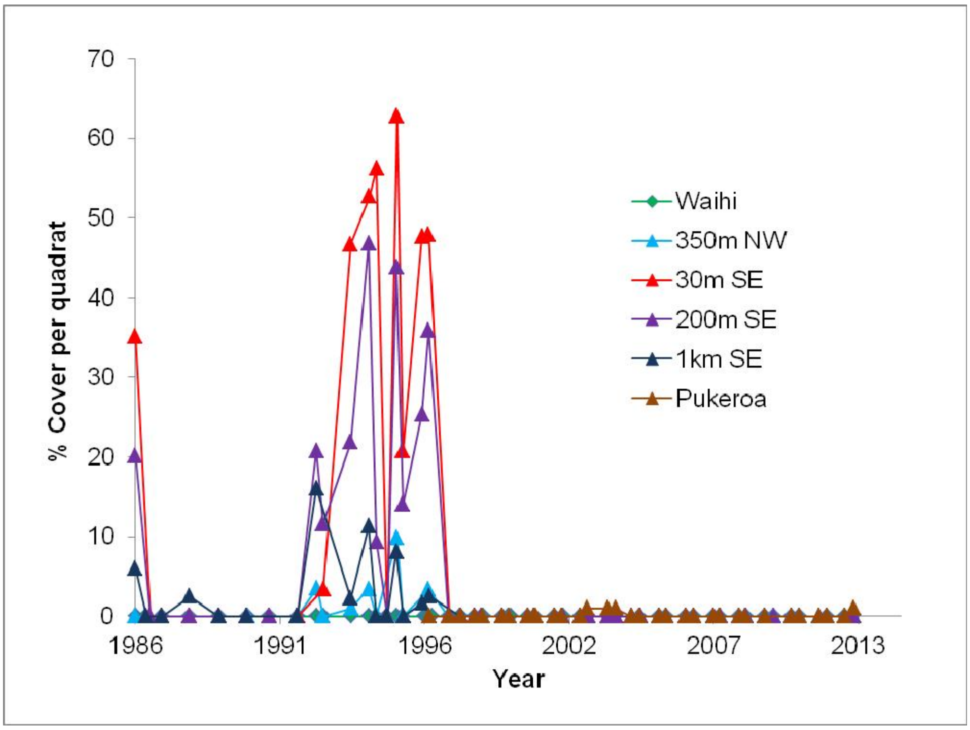


Figure 8 Percentage cover per quadrat of filamentous bacteria since 1986

N.B. Since 2007, the sites 30m SE and 1km SE are no longer monitored as part of the Fonterra Whareroa intertidal survey.

Photograph 8 Erosion of the cliffs close to Pukeroa Reef (2006)

Conclusions

In order to assess the effects of the Fonterra Whareroa and Hawera Waste Water Treatment Plant outfall discharge on the nearby intertidal communities, surveys were conducted between 12 and 15 November 2012 at four sites. These surveys included three potential impact sites either side of the outfall (two southeast and one west) and one control sites to the northwest. It is expected that adverse effects of the marine outfall discharge on the intertidal communities would have been evident as a significant decline in species richness and diversity at the potential impact sites relative to the control site.

As both species richness and diversity were higher at the two potential impact sites closest to the outfall relative to the control site, and results from sites closest to the outfall had not declined notably in recent years, the results indicate that the marine outfall discharge was not having detectable adverse effects on the intertidal reef communities of South Taranaki. Natural environmental factors, including coastal erosion, exposure and substrate mobility, appeared to be dominant drivers of species richness and diversity at the sites surveyed.

Emily Roberts
Marine Ecologist

References

Palliser, C., McBride, G., Goodhune, N., Bell, R., Stott, R. (2013) Fonterra Whareroa Dairy Factory and Hawera WWTP, Stage 2 QMRA based on the combines discharge. NIWA Client Report No. HAM2013-050

Clark, D., Barter, P., Clement, D., Tremblay, L., Forrest, R. (2013) Whareroa Marine Outfall ecological investigation 2012. Cawthron Report No. 2348

Internal Memorandum

To: Scientific Officer, James Kitto
Environmental Monitoring Manager, Keith Brodie
From: Scientific Officer, Emily Roberts
File: #1246957
Date: 6 September 2013

Fonterra Whareroa/Hawera Municipal Combined Outfall – Marine Ecological Survey March 2013

Introduction

Consent 1450 allows the discharge of dairy factory wastewater from the Fonterra Whareroa factory via a marine outfall. The consent allowing this discharge was renewed in September 1995, requiring the Company to install a long outfall by 31 August 1997. Prior to the renewal of this consent, the wastewater was discharged via a short marine outfall at approximately mean low water spring (MLWS) level which caused significant adverse effects on marine intertidal ecology to at least 1000m southeast of the outfall.

In February 2001, wastewater from the Hawera Oxidation Ponds was connected to the long outfall by consent 5079, allowing a municipal wastewater discharge of 10,000 m^3/day. By comparison, the Fonterra Whareroa wastewater discharge limit was 26,000 m^3/day. As of 19 September 2006, the permitted volume of wastewater discharge increased to 40,000 m^3/day. The oxidation pond discharge was also increased to 12,000 m^3/day in December 2007.

Special condition 6 of consent 1450 and special condition 3 of consent 5079 requires there to be no significant visual, chemical or ecological impacts outside of a 200m mixing zone or within the intertidal zone. Specifically, consent 5079 requires the consent holder to ensure that a monitoring programme is established to record and analyse the effects on the intertidal reefs and water quality adjacent to the discharge. Accordingly, two intertidal surveys of the intertidal zone were carried out as part of the 2012-2013 monitoring programme for the combined marine outfall. The second survey for the 2012-2013 monitoring period was conducted at four sites between 27 February and 14 March 2013.

Methods

Field Work

Of the four sites surveyed, three have been identified by NIWA as having shoreline contact with the wastewater discharged from the outfall (Palliser *et al.*, 2013): 350m northwest of the outfall (SEA906049), 200m southeast of the outfall (SEA906057) and 1550m southeast of the outfall on Pukeroa Reef (SEA906067) (Photographs 1-3, Figure 1). The control site at Waihi Reef (Photograph 4, Figure 1), approximately 4500m northwest of the outfall (SEA906025), has been identified by NIWA as unlikely to be impacted by the discharged wastewater (Palliser *et al.*, 2013).

Photograph 1 Surveying 350m northwest of the outfall with Mere Brooks and Phoebe Paraha

Photograph 2 Survey site 200m southeast of the outfall

Photograph 3 Surveying Pukeroa Reef with Will and Maakere Edwards

Photograph 4 Survey control site Waihi Reef

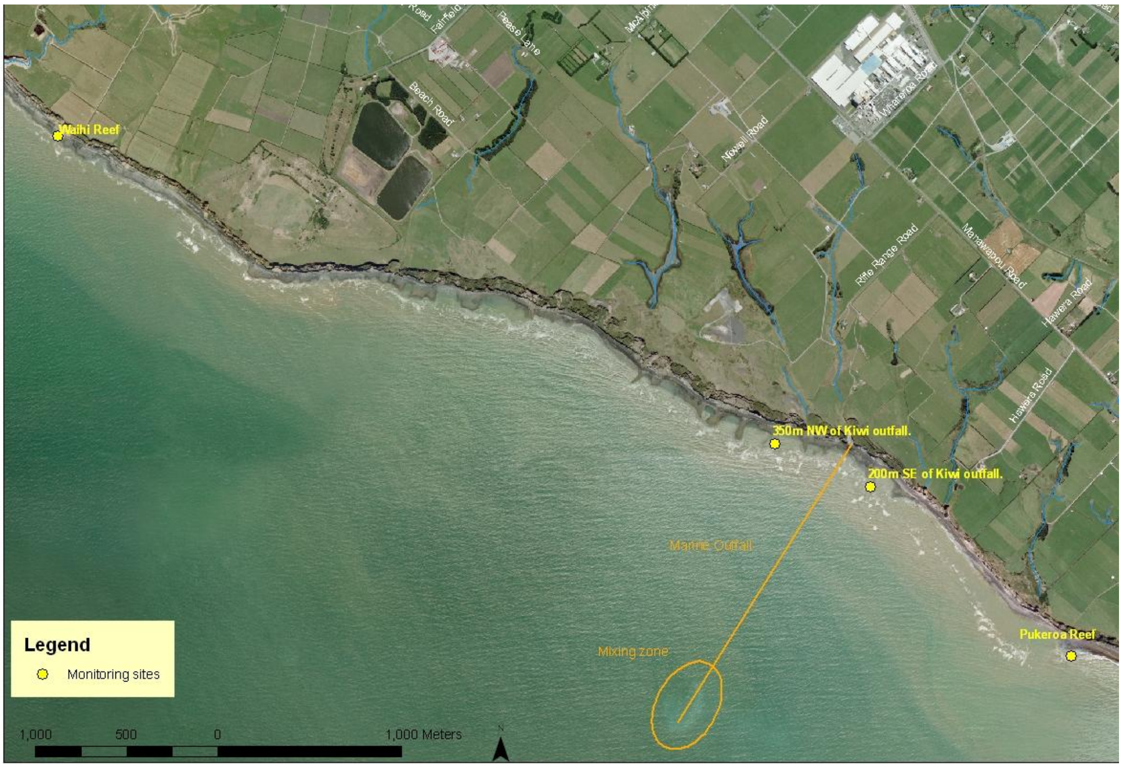


Figure 1 Survey sites in relation to the outfall

At each site, a 50m transect was used to establish five 5m x 3m blocks. Within each block, five random 0.25m² quadrats were laid giving a total of 25 random quadrats (Photograph 5). For each quadrat the percentage cover of algae and encrusting animal species was estimated using a grid. For all other animal species, individuals larger than 3mm were counted. Under boulder biota was counted where rocks and cobbles were easily overturned.

Photograph 5 Survey at 200m southeast of the outfall showing the transect used

Results

Summary statistics, including the mean number of species per quadrat and the mean Shannon-Weiner indices, are shown in Table 1. The site 200m SE had the highest number of species and diversity (Shannon-Weiner index), followed by 350m NW, Pukeroa Reef and Waihi Reef respectively.

Table 1 Mean results for the March 2013 survey

Site	No. of quadrats	Mean number of species per quadrat			Mean Shannon-Weiner indices per quadrat		
		Algae	Animals	Total Species	Algae	Animals	Total Species
Waihi Reef	25	3.24	8.88	12.12	0.36	0.76	0.89
350m NW	25	5.24	11.08	16.32	0.51	0.80	0.95
200m SE	25	7.80	9.20	17.00	0.65	0.78	1.00
Pukeroa Reef	25	3.56	8.72	12.28	0.47	0.74	0.90

Number of Species per Quadrat

Figure 2 shows the total number of species per quadrat as a box and whisker plot. The notched area of the box represents the median plus and minus a 95% confidence interval for the median. This form of graphical representation allows a quick comparison to be made between sites. Generally, if the notched areas of the boxes for the different sites do not overlap, one would expect to obtain a significantly different result with ANOVA.

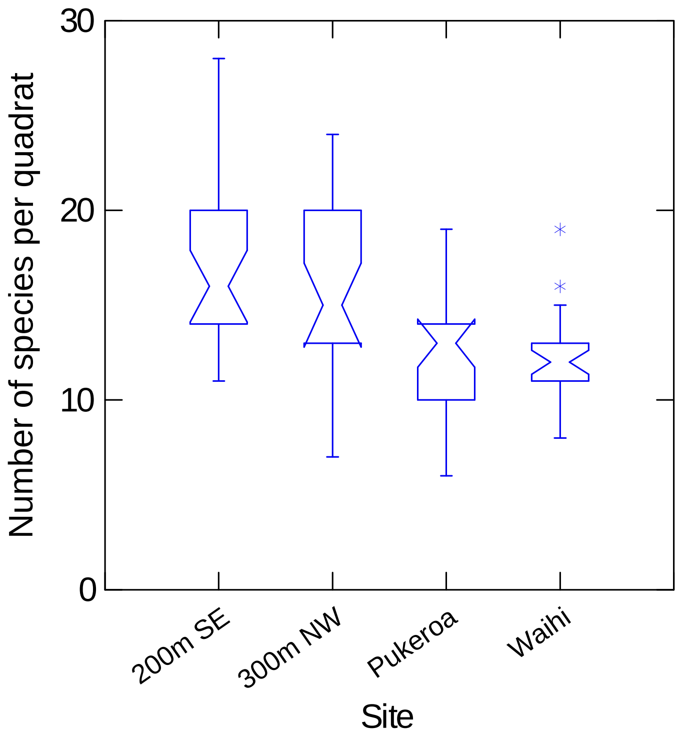


Figure 2 Box and whisker plots of mean number of species per quadrat

Only one site (Waihi) showed a significant deviation from normal distribution at the 95% confidence level (Lilliefors test, n = 25, P = 0.007). There was a significant difference in mean number of species per quadrat between the sites (ANOVA, n = 25, F = 12.193, P <0.001).

Table 2 Tukey's multiple comparison test of number of species per quadrat

Site	Waihi Reef	350m NW	200m SE
350m NW	SIG		
200m SE	SIG	NS	
Pukeroa Reef	NS	SIG	SIG

SIG = Significant difference
NS = No significant difference

Significant differences between sites were determined using Tukey's multiple comparison test (Table 2). At 200m SE and 350m NW the mean number of species per quadrat was significantly higher than that at Pukeroa Reef and Waihi Reef.

Shannon-Weiner Diversity Index

Figure 3 shows the mean Shannon-Weiner index data at each site as a box and whisker plot.

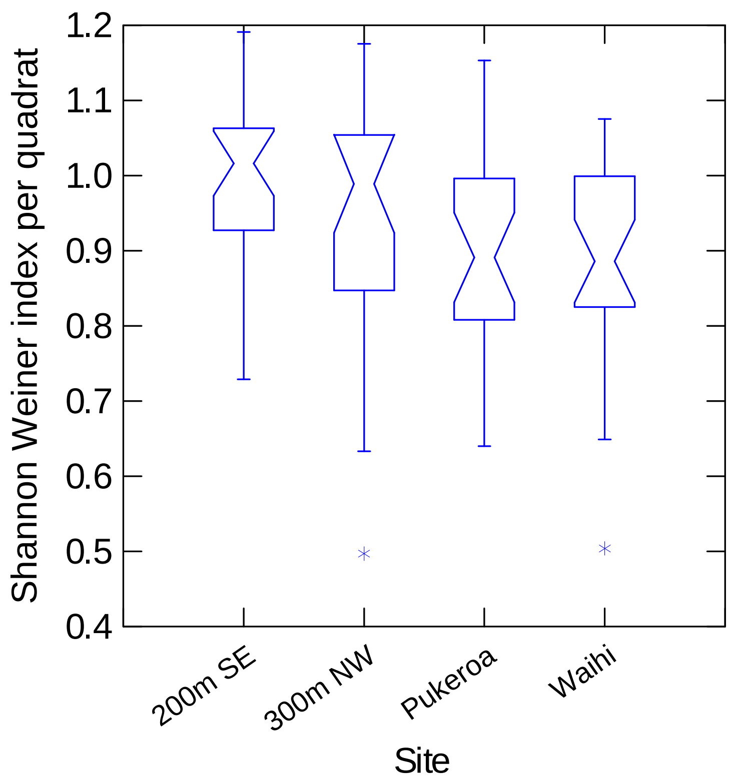


Figure 3 Box and whisker plots of mean Shannon-Weiner indices per quadrat

At all four sites, there was no significant deviation from normal distribution at the 95% confidence level (Lilliefors test, n = 25, P >0.05). There was a significant difference in the mean Shannon-Weiner index per quadrat between sites (ANOVA, n = 25, F = 3.095, P = 0.031).

Table 3 Tukey multiple comparison test of Shannon-Weiner index per quadrat

Site	Waihi Reef	350m NW	200m SE
350m NW	NS		
200m SE	SIG	NS	
Pukeroa Reef	NS	NS	NS

SIG = Significant difference
NS = No significant difference

Significant differences between sites were determined using Tukey's multiple comparison test (Table 3). At Waihi Reef the mean Shannon-Weiner index per quadrat was significantly lower than that at 200 m SE.

Sand Coverage

The level of sand cover was relatively low (<17%) at all sites (Table 4). Abundance and diversity of intertidal species/communities can be significantly impacted by sand cover of 30% and higher.

Table 4 Mean percentage sand cover per quadrat

Site	Mean coverage per quadrat (%)
Waihi Reef	6.7
350m NW	16.3
200m SE	6.5
Pukeroa Reef	5.2

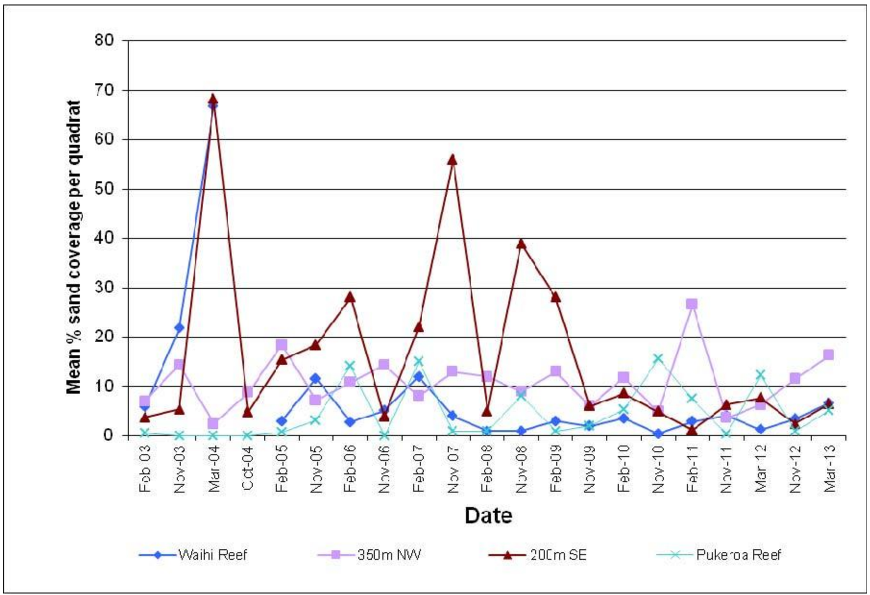


Figure 4 Mean percentage sand cover (summer & spring) by site since February 2003

Trends over time

Species number and diversity

Comparisons of the mean number of species per quadrat (Figure 5) and mean Shannon-Weiner diversity index per quadrat (Figure 6) for all summer surveys undertaken since January 1986 are shown below.

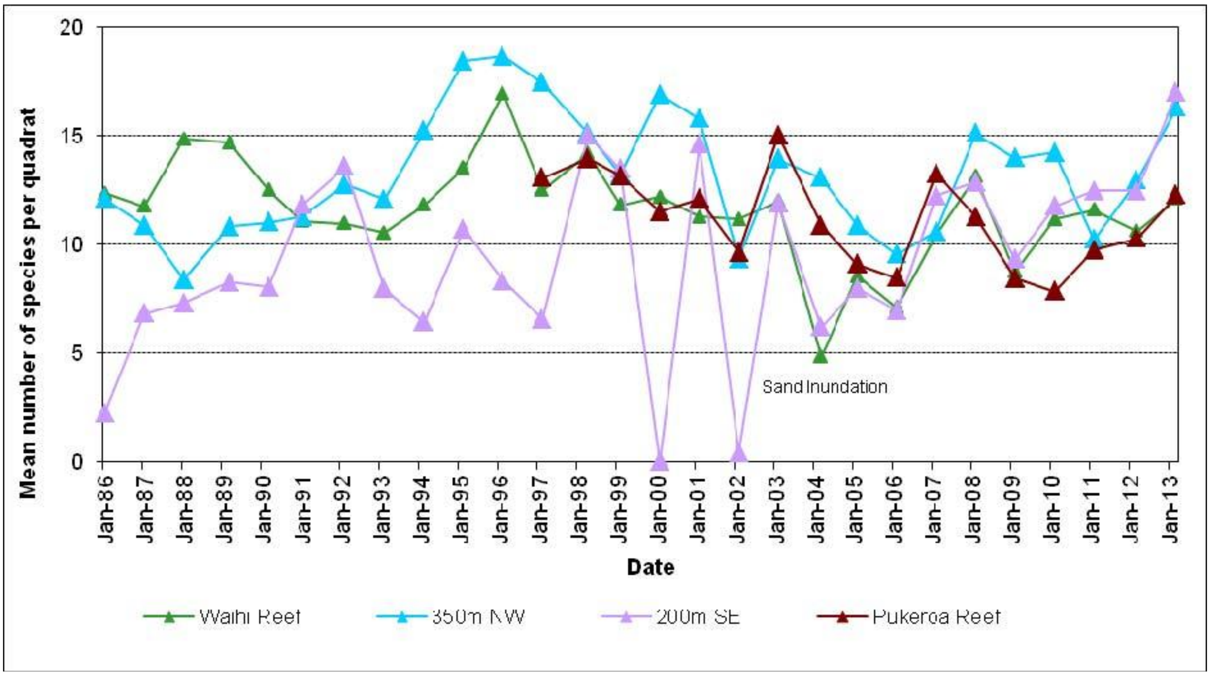


Figure 5 Mean number of species per quadrat for summer surveys 1986-2013

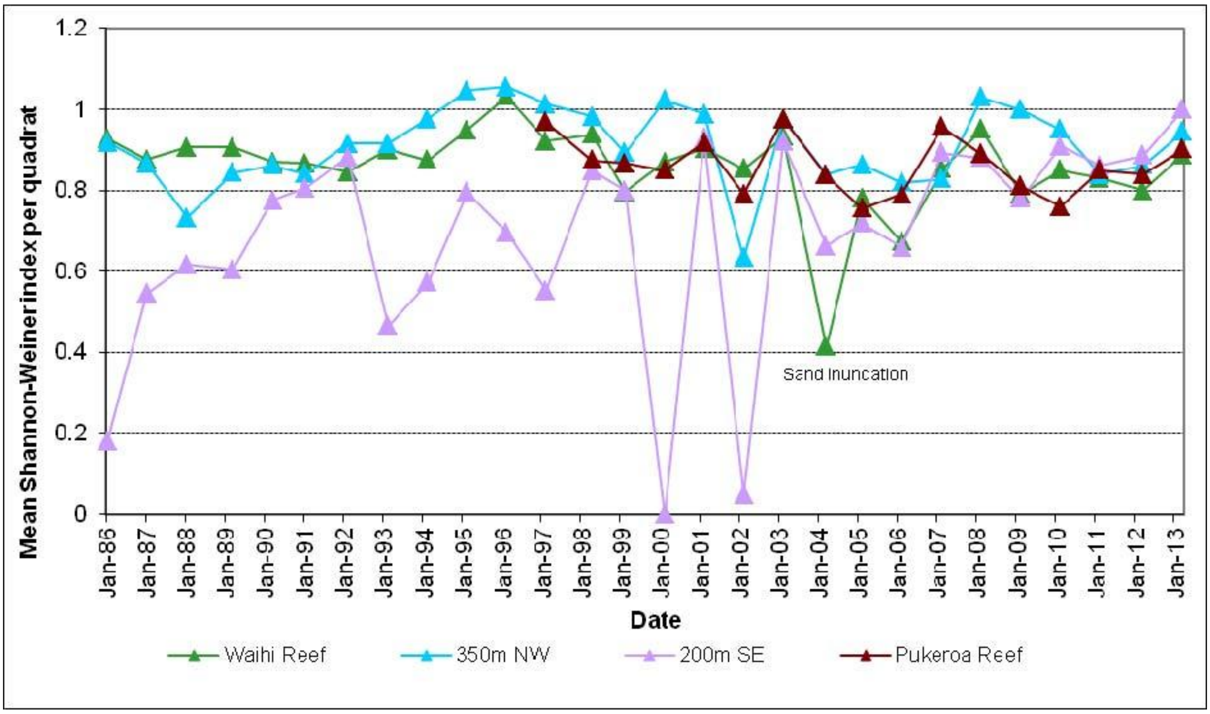


Figure 6 Mean Shannon-Weiner indices per quadrat for summer surveys 1986-2013

Prior to the installation of the long marine outfall in August 1997, both number of species and Shannon-Weiner Index per quadrat at the impact site 200m SE were generally lower than at the control site at Waihi Reef (Figures 5 and 6). Since then (1997), sites have shown interannual variability in both number of species and Shannon-Weiner Index, but there has been no noticeable difference in trends between the impact site and the control sites over this period, with the exception of years with heavy sand inundation (e.g. 2000 and 2002 at 200m SE, Figures 5 and 6).

Discussion

Previous surveys have shown that the dairy factory wastewater discharged through the near-shore outfall prior to 1997 (Photograph 1) was having significant adverse effects on the local intertidal community. The adverse effects recorded included the coating of rocks and tidal pools with fats, significant coverage by filamentous bacterial growths and a significant decrease in ecological diversity. The nature and magnitude of adverse effects varied with distance from the outfall, and were most apparent at the sites 30m and 200m southeast of the outfall (note that the former site is no longer surveyed as of 2007). In 1997 the dairy company installed a long outfall to discharge the wastewater nearly 2km offshore in order to mitigate the adverse effects occurring along the coastline. Numerous spring and summer intertidal surveys have now been undertaken along the Hawera coastline subsequent to installation of the long outfall. Results show a general improvement in the health of intertidal communities following installation of the outfall. In February 2001 the Hawera Oxidation Ponds municipal wastewater was also connected to the long outfall.

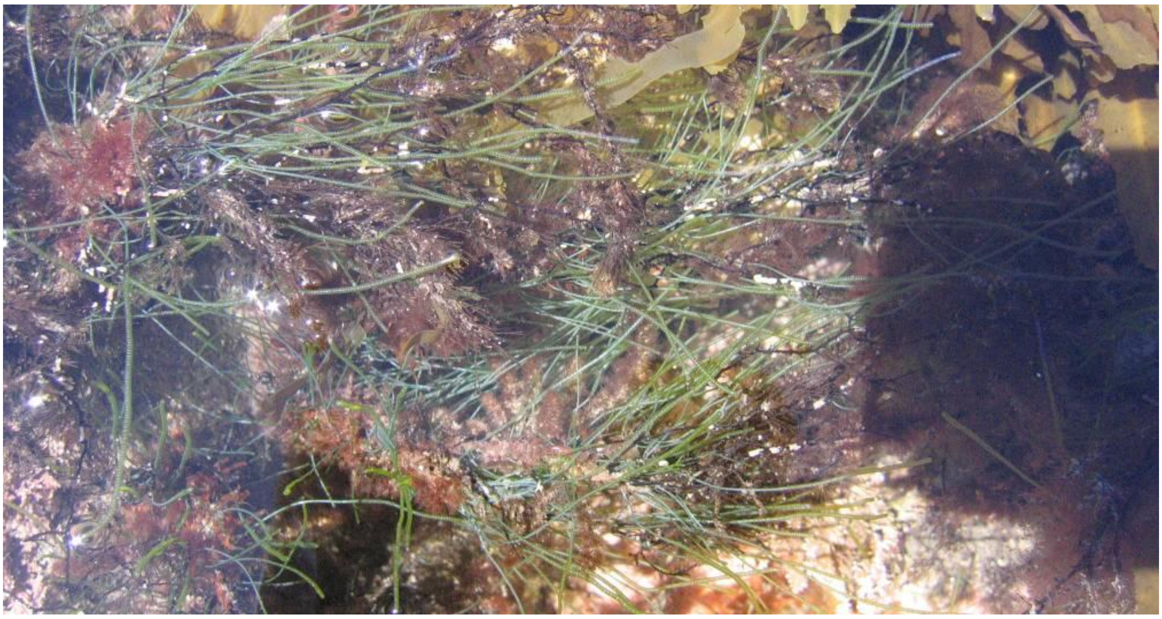
Photograph 6 Discharge from the dairy factory near-shore outfall prior to 1997

Impacts of the marine outfall discharge on the local intertidal communities were not evident from the March 2013 survey results (Figures 2 and 3). The impact sites 350m NW and 200m SE had a significantly higher number of species per quadrat than the control site at Waihi Reef.

Sand cover was low (<17%) at all sites during the March 2013 survey. Long term monitoring of intertidal rocky reefs around the Taranaki coastline have shown the abundance and diversity of these communities can be adversely affected when sand levels exceed 30% cover. Although it is not expected that sand cover would have impacted the reef communities monitored during the March 2013 survey, high percentage sand cover (>30%) has previously been recorded at the site 200m SE (Figure 4).

The historical record of survey results (Figures 5 and 6) showed no obvious impact of the marine outfall discharge on the local intertidal communities since installation of the long outfall in 1997. Both control and potential impact sites showed interannual variability and there were no obvious declining trends at the impact sites closest to the outfall relative to the control site. It must be noted that the high energy receiving environment combined with the effects of suspended sediments from nearby rivers/streams and eroding cliffs prevent the development of stable biological communities along the South Taranaki coastline (Clark *et al*., 2012). Such communities could potentially mask any subtle ecological effects from the outfall wastewater discharge. However, in spite of these limitations, the long term record indicates that the intertidal surveys are useful for detecting more noticeable effects from the wastewater, as the impact on intertidal communities prior to installation of the outfall is clearly evident (Figures 5 and 6, Clark *et al*., 2012).

The most notable change in species composition since the commissioning of the long outfall is the decline of *Chaetomorpha* sp. (Photograph 2) and the absence of filamentous bacterial growths at 200m SE (Figures 7 and 8). The adverse effects recorded prior to the long outfall also included the coating of rocks and tidal pools with fats and a significant decrease in ecological diversity. Sand/silt inundation resulting from cliff erosion (Photograph 8) can be an important factor effecting species composition and diversity along the South Taranaki coastline. The coast is in a constant state of erosion with layers of sand and silt often smothering marine life at some sites. Resulting high seawater turbidity can also affect light availability impacting on macroalgae. Observations indicate that freshly fallen boulders from the cliffs provide a poor habitat for intertidal organisms.



Photograph 7 Green filaments of *Chaetamorpha*, an algal genus often associated with high nutrient concentrations (North Taranaki)

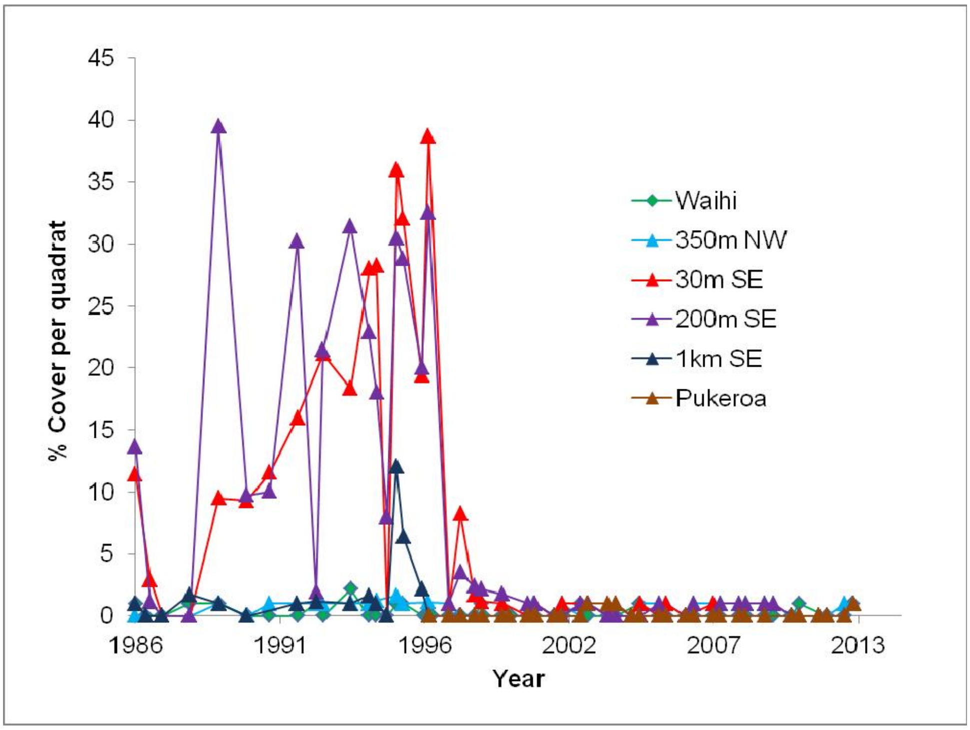


Figure 7 Percentage cover per quadrat of *Chaetamorpha* since 1986

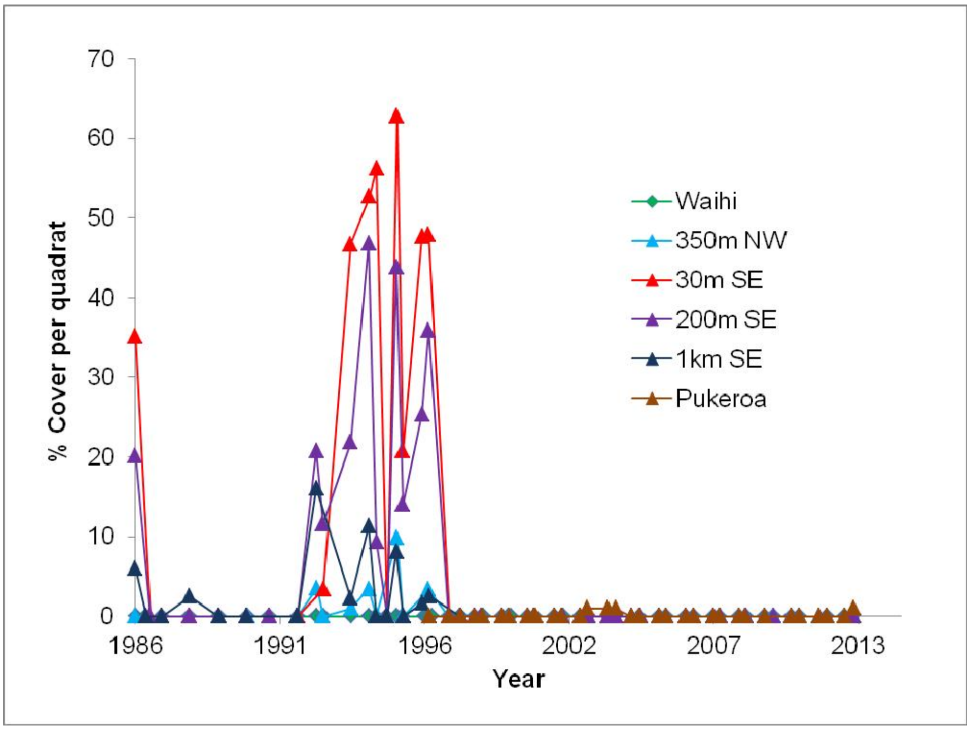


Figure 8 Percentage cover per quadrat of filamentous bacteria since 1986

N.B. Since 2007, the sites 30m SE and 1km SE are no longer monitored as part of the Fonterra Whareroa intertidal survey.

Photograph 8 Erosion of the cliffs close to Pukeroa Reef (2006)

Conclusions

In order to assess the effects of the Fonterra Whareroa and Hawera Waste Water Treatment Plant outfall discharge on the nearby intertidal communities, surveys were conducted between 27 February and 14 March 2013 at four sites. These surveys included three potential impact sites either side of the outfall (two southeast and one west) and one control sites to the northwest. It is expected that adverse effects of the marine outfall discharge on the intertidal communities would have been evident as a significant decline in species richness and diversity at the potential impact sites relative to the control site.

As both species richness and diversity were higher at the two potential impact sites closest to the outfall relative to the control site, and results from sites closest to the outfall had not declined notably in recent years, the results indicate that the marine outfall discharge was not having detectable adverse effects on the intertidal reef communities of South Taranaki. Natural environmental factors, including coastal erosion, exposure and substrate mobility, appeared to be dominant drivers of species richness and diversity at the sites surveyed.

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References

Palliser, C., McBride, G., Goodhune, N., Bell, R., Stott, R. (2013) Fonterra Whareroa Dairy Factory and Hawera WWTP, Stage 2 QMRA based on the combines discharge. NIWA Client Report No. HAM2013-050

Clark, D., Barter, P., Clement, D., Tremblay, L., Forrest, R. (2013) Whareroa Marine Outfall ecological investigation 2012. Cawthron Report No. 2348

Appendix III

Explanation of box and whisker plots

Explanation of box and whisker plots

Box and whisker plots are a useful method of summarising data in a graphical form that allows rapid comparisons of data groups. The data is represented as a box with a whisker from each end.

The median (middle value of the sorted data; half of the data is either side of the median is represented by a single horizontal line. The notch, symmetrically spread around the median represents the 95% confidence interval of the median). It is a feature that allows rapid comparison between groups. If notches overlap, there is no significant difference between groups (at the 95 % confidence interval). If notches do not overlap, a statistical difference is expected.

The top and bottom of the box represent the upper and lower hinges respectively. The median splits the ordered group of data in half and the hinges split the remaining halves in half again. This means that 50% of the data lies within the box.

Hspread, comparable to the interquartile (25% and 75%) range is the difference between the values of the two hinges, ie, Upper hinge – Lower hinge = Hspread. The inner fences are defined as follows:

Lower fence = lower hinge – (1.5 x Hspread)
Upper fence = upper hinge + (1.5 x Hspread)

The outer fences are defined as follows:

Lower fence = lower hinge – (3 x Hspread)
Upper fence = upper hinge + (3 x Hspread)

The whiskers show the range of values that lie within the inner fences. Values outside the inner fence are plotted as asterisks (*). values outside the outer fence are plotted as open circles (o).